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HP Test & Measurement Catalog 1999

HP's Test & Measurement Web site.
The more you visit, the more you'll know.

News and information you need, 24 hours a day. Get the most complete support available for all of HP's Test & Measurement tools. Immediate access to information, 24 hours a day, means always getting the most from your instruments:

- Product Information
- Usage Tips
- Application Note Library
- Service, Support and Training
- Sales and Service Contacts
- Selection Guides
- Newsletters
- Feature Stories Showing Products in Use
- Information on Your Industry
- News Releases
- Country-Specific Sites

These features are only a snapshot of what's available at the Web site. Bookmark it—and visit it regularly—to stay completely up to date on all of HP's test and measurement solutions.

Quickly find the information you need

HP offers a vast range of test and measurement products, services, and support material for a wide span of applications. To help you efficiently find the solutions you're seeking, we provide various information search aids and tools, including the following:

- **Alphabetical Index**
  Beginning on this page, this index lists major product types and services, as well as key words relating to many T&M application issues.
- **Numerical Index**
  The HP products and services in this catalog are listed by model number in the index that starts on page 18.
- **Application Notes Index**
  A wealth of helpful HP T&M support literature is arranged by subject matter in the index that begins on page 604.
- **Online Reference Tools**
  Electronic reference and support capabilities, including a powerful search engine, are available at HP's site on the World Wide Web. They let you obtain updated technical data, application information, and much more, 24 hours a day. For additional details, see facing page.
- **HP Touch Tone Fax Service for US and Canada**
  Technical information for test and measurement products and services is available 24 hours a day, seven days a week, by dialing 1-800-800-5281.

Printed on recycled paper containing 20% post consumer fiber.

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Trademark Information

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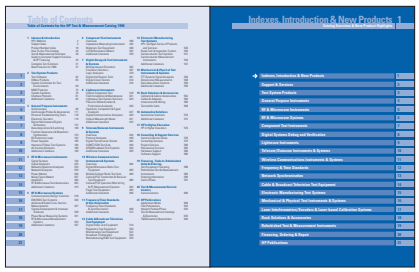
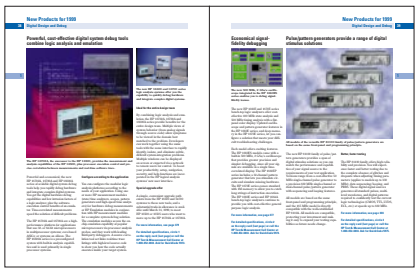


1

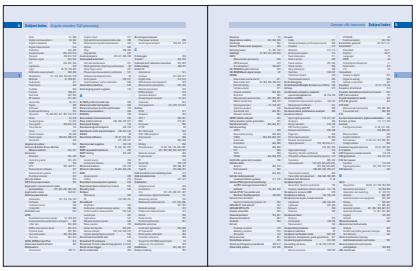
Easily find the major section of products or systems that you need. Refer to major sections by the number on the thumb tabs. Major sections and subsections are listed throughout the contents by page number. The contents of each major section and additional references are repeated for you on the first page of each section.
See page 1.

New Products for 1999



Hewlett-Packard introduces hundreds of new products each year. This full-color section features 55 new products for 1999 from HP's Test & Measurement Organization. These exciting and innovative new products reflect HP's commitment to research and development investments. They also illustrate major technology and market trends.
See page 37.

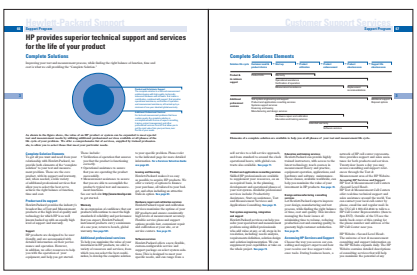
Indexes



There are two indexes in this catalog. The Subject Index references product categories, key terms, applications, and other useful information. **See page 3.**

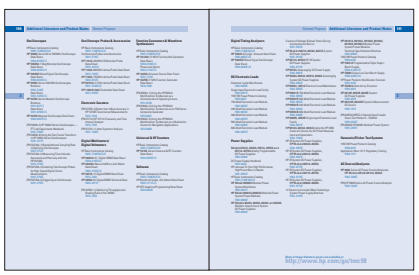
The Product Number Index allows you to find HP products if you already know their product numbers. All new products for 1999 are identified. Page numbers in bold type indicate the main references for that product.
See page 25.

Support & Services



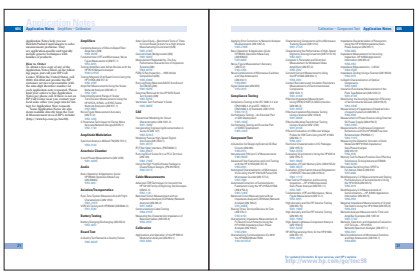
This section provides you with an overview of the wide range of consulting and support services available through HP's Test & Measurement Organization. HP offers services and consulting for all phases of your test & measurement solution life cycle.
See page 66

Additional Literature & Product Notes



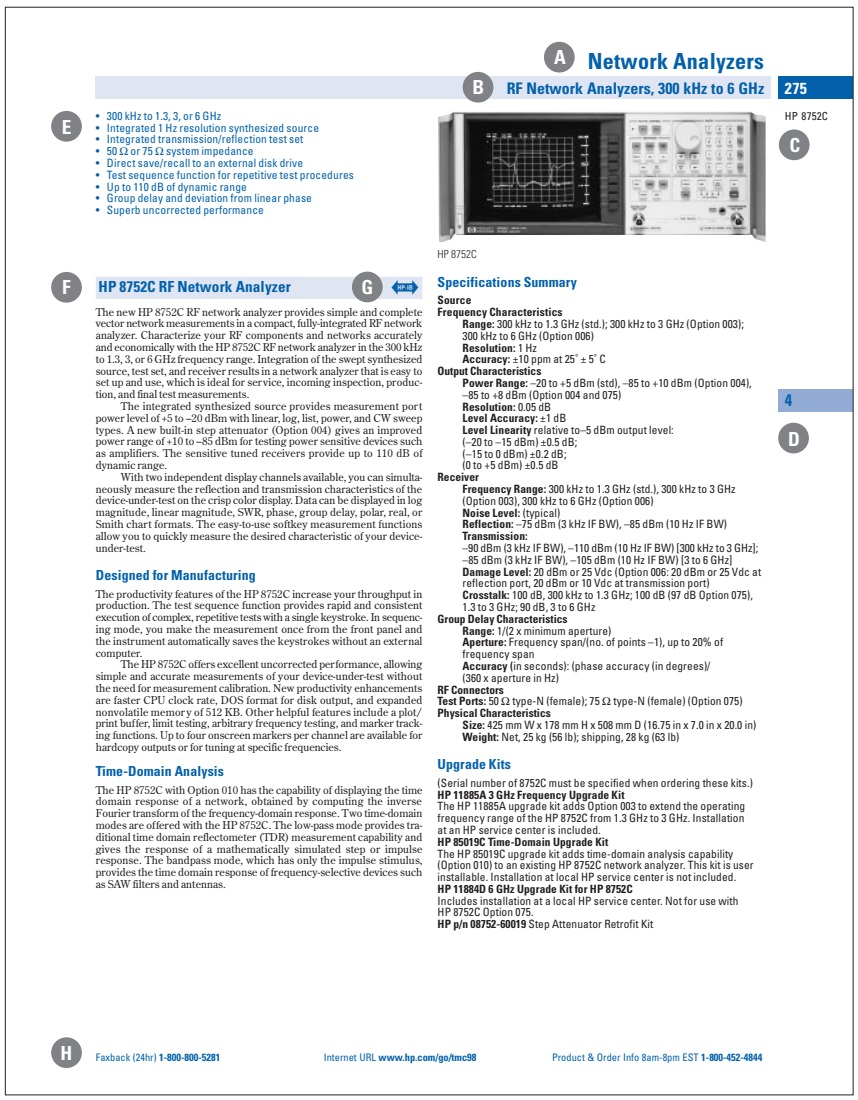
HP has published considerable additional information on the instruments noted at the end of most sections of the Catalog. This includes focused data sheets, brochures and catalogs. In addition, Product Notes, written for specific instruments, are available on request. You may obtain this literature from our web site: **http://www.hp.com/go/tmc99,** or use our convenient reply card in the back.

Application Notes



The 1999 Catalog contains a comprehensive listing of Application Notes, all of which are available to you free of charge. **See pages 594–618.** This literature covers topics such as impedance, modulation, and semiconductors, and provides information to help you solve many test and measurement problems. A completely updated list of Application Notes is available from our web site: **http://www.hp.com/go/tmc99**

Product Descriptions



A Network Analyzers

B RF Network Analyzers, 300 kHz to 6 GHz

275

HP 8752C

C

E
- 300 kHz to 1.3, 3, or 6 GHz
- Integrated 1 Hz resolution synthesized source
- Integrated transmission/reflection test set
- 50 Ω or 75 Ω system impedance
- Direct save/recall to an external disk drive
- Test sequence function for repetitive test procedures
- Up to 110 dB of dynamic range
- Group delay and deviation from linear phase
- Superb uncorrected performance

HP 8752C

F HP 8752C RF Network Analyzer G

The new HP 8752C RF network analyzer provides simple and complete vector network measurements in a compact, fully-integrated RF network analyzer. Characterize your RF components and networks accurately and economically with the HP 8752C RF network analyzer in the 300 kHz to 1.3, 3, or 6 GHz frequency range. Integration of the swept synthesized source, test set, and receiver results in a network analyzer that is easy to set up and use, which is ideal for service, incoming inspection, production, and final test measurements.

The integrated synthesized source provides measurement port power level of +5 to –20 dBm with linear, log, list, power, and CW sweep types. A new built-in step attenuator (Option 004) gives an improved power range of +10 to –85 dBm for testing power sensitive devices such as amplifiers. The sensitive tuned receivers provide up to 110 dB of dynamic range.

With two independent display channels available, you can simultaneously measure the reflection and transmission characteristics of the device-under-test on the crisp color display. Data can be displayed in log magnitude, linear magnitude, SWR, phase, group delay, polar, real, or Smith chart formats. The easy-to-use softkey measurement functions allow you to quickly measure the desired characteristic of your device-under-test.

Designed for Manufacturing

The productivity features of the HP 8752C increase your throughput in production. The test sequence function provides rapid and consistent execution of complex, repetitive tests with a single keystroke. In sequencing mode, you make the measurement once from the front panel and the instrument automatically saves the keystrokes without an external computer.

The HP 8752C offers excellent uncorrected performance, allowing simple and accurate measurements of your device-under-test without the need for measurement calibration. New productivity enhancements are faster CPU clock rate, DOS format for disk output, and expanded nonvolatile memory of 512 KB. Other helpful features include a plot/print buffer, limit testing, arbitrary frequency testing, and marker tracking functions. Up to four onscreen markers per channel are available for hardcopy outputs or for tuning at specific frequencies.

Time-Domain Analysis

The HP 8752C with Option 010 has the capability of displaying the time domain response of a network, obtained by computing the inverse Fourier transform of the frequency-domain response. Two time-domain modes are offered with the HP 8752C. The low-pass mode provides traditional time domain reflectometer (TDR) measurement capability and gives the response of a mathematically simulated step or impulse response. The bandpass mode, which has only the impulse stimulus, provides the time domain response of frequency-selective devices such as SAW filters and antennas.

Specifications Summary

Source
Frequency Characteristics
Range: 300 kHz to 1.3 GHz (std.); 300 kHz to 3 GHz (Option 003); 300 kHz to 6 GHz (Option 006)
Resolution: 1 Hz
Accuracy: ±10 ppm at 25° ± 5° C
Output Characteristics
Power Range: –20 to +5 dBm (std), –85 to +10 dBm (Option 004), –85 to +8 dBm (Option 004 and 075)
Resolution: 0.05 dB
Level Accuracy: ±1 dB
Level Linearity relative to–5 dBm output level:
(–20 to –15 dBm) ±0.5 dB;
(–15 to 0 dBm) ±0.2 dB;
(0 to +5 dBm) ±0.5 dB
Receiver
Frequency Range: 300 kHz to 1.3 GHz (std.), 300 kHz to 3 GHz (Option 003), 300 kHz to 6 GHz (Option 006)
Noise Level: (typical)
Reflection: –75 dBm (3 kHz IF BW), –85 dBm (10 Hz IF BW)
Transmission:
–90 dBm (3 kHz IF BW), –110 dBm (10 Hz IF BW) [300 kHz to 3 GHz];
–85 dBm (3 kHz IF BW), –105 dBm (10 Hz IF BW) [3 to 6 GHz]
Damage Level: 20 dBm or 25 Vdc (Option 006: 20 dBm or 25 Vdc at reflection port, 20 dBm or 10 Vdc at transmission port)
Crosstalk: 100 dB, 300 kHz to 1.3 GHz; 100 dB (97 dB Option 075), 1.3 to 3 GHz; 90 dB, 3 to 6 GHz
Group Delay Characteristics
Range: 1/(2 x minimum aperture)
Aperture: Frequency span/(no. of points –1), up to 20% of frequency span
Accuracy (in seconds): (phase accuracy (in degrees)/(360 x aperture in Hz)
RF Connectors
Test Ports: 50 Ω type-N (female); 75 Ω type-N (female) (Option 075)
Physical Characteristics
Size: 425 mm W x 178 mm H x 508 mm D (16.75 in x 7.0 in x 20.0 in)
Weight: Net, 25 kg (56 lb); shipping, 28 kg (63 lb)

Upgrade Kits

(Serial number of 8752C must be specified when ordering these kits.)
HP 11885A 3 GHz Frequency Upgrade Kit
The HP 11885A upgrade kit adds Option 003 to extend the operating frequency range of the HP 8752C from 1.3 GHz to 3 GHz. Installation at an HP service center is included.
HP 85019C Time-Domain Upgrade Kit
The HP 85019C upgrade kit adds time-domain analysis capability (Option 010) to an existing HP 8752C network analyzer. This kit is user installable. Installation at local HP service center is not included.
HP 11884D 6 GHz Upgrade Kit for HP 8752C
Includes installation at a local HP service center. Not for use with HP 8752C Option 075.
HP p/n 08752-60019 Step Attenuator Retrofit Kit

4

D

H Faxback (24hr) **1-800-800-5281** Internet URL **www.hp.com/go/tmc98** Product & Order Info 8am-8pm EST **1-800-452-4844**

The body of this catalog contains over 10,000 new and existing test and measurement products and accessories from HP. Although not every HP product is included, you will find all relevant references to other sources.

A General product headline
Identifies the broad product category of the instrument, system or service described in the section.

B Product description
Defines the specific purpose and function for the product described.

C Product number
Defines the specific HP model numbers and versions that are described on the page.

D Section tab number
Relates to the Section numbers identified in the Table of Contents, and defines a product family.

E Product features
Give an "at-a-glance" view of the key features of the products on the page.

F Specific product identification
Defines the features and specifications of one model in the family of products on the page.

G Product attribute marks
Define, by symbols described below, which special features or services apply to this product.

H HP action and help locations

1

Symbols

NEW

This symbol identifies all new products for 1999 throughout the general products and systems pages.

HP-IB

This symbol is used throughout the catalog and identifies products that have HP-IB (IEEE-488) capability.

The QuickShip symbol, used in the ordering information, indicates specific products available for quick delivery.

UID

This symbol identifies programmable instruments that support the Hewlett-Packard family of Instrument Drivers, which allow test code development using standard links in multiple vendor hardware, and are based on the VISA I/O libraries. Additional information is available: **http://www.hp.com/go/inst_drivers**

X11

This symbol identifies products that include an HP interface for simplified FTP and NFS LAN/WAN remote access and control via an X11 window display. This HP networked user interface adds instrumentation resources to client-server computing systems and increases the capability of existing network connections.

Bill Hewlett (right) and the late Dave Packard (left) are the founders of the Hewlett-Packard Company.

The Hewlett-Packard Test & Measurement Organization

The company that Bill Hewlett and Dave Packard started in 1939 in a garage in Palo Alto, CA offered size, price and performance advantages in its initial product, the HP 200A audio oscillator. Today, the HP Test & Measurement Organization (TMO) that produces this catalog is the world's leading supplier of standard and customized test and measurement solutions, including test systems, equipment, instruments, accessories, components, and services. Customers such as you are the focus of the nearly 20,000 people in HP TMO who produce the unmatched variety of TMO hardware and software products, as well as low-risk, broad technology-based, tailored test and measurement solutions and professional services. Our aims are unchanged: to provide the quality, value, features, and performance you need.

As we enter our 60th year, Hewlett-Packard Company is a leading global manufacturer of computing, communications, and measurement products and services recognized for excellence in quality and support. HP has 125,300 employees and had a revenue of $42.9 billion in its 1997 fiscal year. We strive to make a fundamental, positive difference to your firm's business and to your job performance. We are accomplishing this by continuing to grow our measurement, computation, and communications capabilities. HP endeavors to be increasingly flexible and innovative in fashioning the timely, effective, and affordable solutions you need now and will need in the future.

Your Single Source for Consulting & Support Services

The exceptional depth and breadth of HP TMO products and services allows you to use Hewlett-Packard as a single source, whether you need complete, integrated, expandable, and upgradeable standard products, or customized solutions. In addition to standard products and new details on custom test solutions, this catalog includes products for such important growing and emerging fields as telecommunications and data communications networks, and multimedia. See chapter two for details about HP's fully customizable consulting and support programs.

To best serve some applications, we have established strategic alliances with a select group of industry-leading companies that share our dedication to excellence in products and service. Together, HP and its Channel Partners are able to provide you with superior turnkey solutions.

Open Industry Standards

Because open systems (systems in which different manufacturers' products can work in unison) reduce test costs, time, and risk, HP takes a leadership role in developing industry standards and in implementing many of them. Among the many standards supported by HP TMO are VXI, Modular Measurement Systems (MMS), HP-IB, and SCPI.

A Total Commitment to Quality

HP employees uphold high standards for performance, reliability, and service, earning the company a well-deserved reputation for excellence. Continual refinements in employee empowerment and processes have produced our comprehensive Quality Maturity System (QMS), which is dedicated to providing you with the highest levels of satisfaction, even as your needs change. The standards within HP's QMS exceed the intent of ISO 9000, the set of international standards for quality management and quality assurance.

Nearly all HP Test & Measurement divisions and HP calibration laboratories worldwide are ISO 9000 registered. Selected laboratories are accredited to ISO Guide 25. The integrity of the periodic audits by independent experts required for continued ISO 9000 registration enables many customers to augment their internal quality systems without costly audit teams. To make it easier to put HP equipment immediately into service, we include an ISO 9000 compliant calibration certificate with almost every new instrument.

In keeping with the scope and impact of HP's QMS, we are constantly working to improve your overall HP experience. This includes providing better, faster service. For example, to answer questions, offer objective advice, and render quick assistance, we continue to expand our technical call centers. To make updated information—and much more—available to you 24 hours a day, we are increasing the online services available at HP's site on the World Wide Web: **www.hp.com/go/tmc99**. To help you get significantly faster delivery of the products you order, we are streamlining our production processes, scheduling methods, and handling procedures—on a worldwide scale.

Innovative products that make a difference

The exciting new products in this section of the catalog offer you important new capabilities and enhanced benefits. They reflect the wide scope of HP's research investments and underscore an unwavering commitment to meeting your changing test and measurement needs with continually improved instruments, systems, software, and services.

Among the characteristics and trends illustrated by the new products in this section are the following:

Increased value—and affordability, with nothing left out, has been achieved through improved designs, patented measurement techniques, higher integration, and efficient manufacturing.

Ease of use—one-button test capabilities boost efficiency and make sophisticated HP instruments simple to operate, and improved graphical interfaces help you achieve results faster.

Breakthroughs—unique solutions to long-standing problems have been developed by HP engineers, continuing a legacy of product innovations.

Higher performance—new, extended performance limits permit insights into problems that were previously impossible to analyze.

More powerful methodologies—new, advanced troubleshooting techniques let you analyze problems with unprecedented speed.

Modularity—modular test solutions give you greater measurement flexibility with considerable economy—a combination that offers value now and in the future.

Faster test speeds—higher measurement throughputs increase productivity in both engineering and production environments.

Improved data-analysis capabilities—new HP instruments make it easier than ever to complete the entire test and measurement task, including data analysis and report preparation.

Upgradeability—the flexible architectures used in many HP instruments enable timely software performance and feature upgrades, extending the equipment's useful life, and safeguarding capital investments.

Portability—many new HP analysis instruments are exceptionally small and lightweight, so they are easily carried to the problem site for efficient troubleshooting.

Application-specific solutions—HP now has an expanded capability to support the complete test engineering solution process, from consulting services to fully configured test systems, and offers more standard products optimized for applications such as data communications and video.

User familiarity—leveraging familiar user elements of computers to allow you to spend more time on your project and less time learning the instrument.

Web enabled—more instruments that interface directly to the internet to make HP and other resources more readily available.

More products, more solutions

HP, the worldwide test and measurement leader, offers you the industry's most extensive, most trusted line of standard and custom solutions. The new products for 1999 build on a vast base of existing products. To obtain a more complete picture of how HP products and services can help you, please refer to the main product sections, which begin on page 89. If you need additional information on a specific application, contact the HP Call Center in your region.

Powerful, cost-effective digital system debug tools combine logic analysis and emulation

The HP 16702A, the successor to the HP 16500, provides the measurement and analysis capabilities of the HP 16500, plus processor execution control and precise correlation between measurements and real-time software trace.

Powerful and economical, the new HP 16702A, 16700A and HP 16600A series of scalable digital system debug tools help you rapidly debug hardware and integrate complex digital systems. You get the digital hardware debug capabilities and low intrusion factors of a logic analyzer, plus the software-execution control benefits of an emulator. Time-correlated measurements speed the solution of difficult problems.

The HP 16702A and 16700A are a high-performance platform for applications that use 32- or 64-bit microprocessors in multiprocessor systems; core-based ASICs; or systems on silicon. The HP 16600A series is a preconfigured system with built-in analysis capabilities and is used primarily in single processor systems.

Configure according to the application

You can configure the modular logic analysis platforms according to the needs of your application. Using one or more HP measurement modules (state/time analyzers, scopes, pattern generators and high-speed time analyzers) for hardware debug measurements or HP Emulation modules in conjunction with HP measurement modules for a complete system debug solution. The emulation modules access the on-chip emulation capability of popular microprocessors via processor analysis probes, and they work with leading third-party debuggers. A source correlation tool set links real-time trace listings with high-level source code to show you how the code actually executes inside your target system.

The new HP 16600 and 16700 series logic analysis systems offer you the capability to quickly debug hardware and integrate complex digital systems.

Ideal for the entire design team

By combining logic analysis and emulation, the HP 16702A, 16700A and 16600A series provide benefits for the entire design team. Multiple views of system behavior (from analog signals through source code) allow symptoms to be viewed in the domain best matched to the problem. Developers can work together using the same tools with the same interface to rapidly identify, isolate, and eliminate subtle, difficult system-integration problems. Multiple windows can be displayed on screen or exported via a network to remote users for control. To boost your productivity, setup, navigation, security, and help functions are incorporated in the HP logical analysis systems' new user interface.

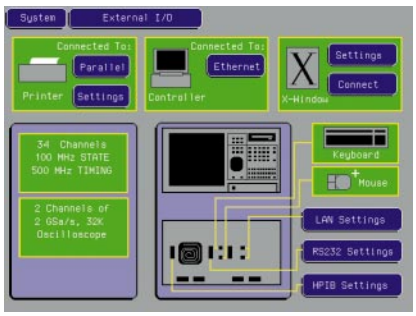
Special upgrade offer

A simple, convenient upgrade path exists from the HP 16500 and 64700 systems to these new tools, and a substantial trade-in allowance is available until March 31, 1999, to most HP 16500 or 16505 users who want to move up to the HP 16702A or 16700A.

For more information, see page 380–382

For detailed specifications, circle 1 on the reply card (last page) or contact the HP Call Center in your region.

Economical signal-fidelity debugging



The new 500 MHz, 2 GSa/s oscilloscope integrated in the HP 1660ES series enables you to debug signal-fidelity issues.

The new HP 1660E and 1670E series bench-top logic analyzers offer cost-effective 100 MHz state analysis and 500 MHz timing analysis with a flat-panel color display. Updated oscilloscope and pattern generator features in the HP 1660E series, and deep memory in the HP 1670E series, let you configure a solution that meets your difficult troubleshooting challenges.

Each model offers exciting features. The HP 1660ES models come with a built-in 500 MHz, 2 GSa/s oscilloscope that provides greater precision and simpler debugging, since all your signals are available in a single time-correlated display. The HP 1660EP series includes a 32-channel pattern generator that lets you stimulate circuits and simulate missing hardware. The HP 1670E series comes standard with 1M memory to allow you to catch long strings of instruction execution. The HP 1660E series and HP 1664A bench-top logic analyzers continue to provide you with cost-effective general purpose logic analysis.

For more information, see page 378

For detailed specifications, circle 2 on the reply card (last page) or contact the HP Call Center in your region.

Pulse/pattern generators provide a range of digital stimulus solutions

All models of the versatile HP 81100 family of pulse/pattern generators are based on the same front-panel and programming principle.

The new HP 81100 family of pulse/pattern generators provides a span of digital stimulus solutions so you can match the performance and capabilities of your signal source to the requirements of your test application. Versions range from a cost-effective 50 MHz single-channel pulse generator to a precision 660 MHz single-channel or dual-channel pulse/pattern generator with sequencing and looping features.

All models are based on the same front-panel and programming principle, and the 165 MHz model is directly compatible with the well-established HP 8110A. All models are compatible, protecting your investment and making it easy to expand your testing capabilities as future needs change.

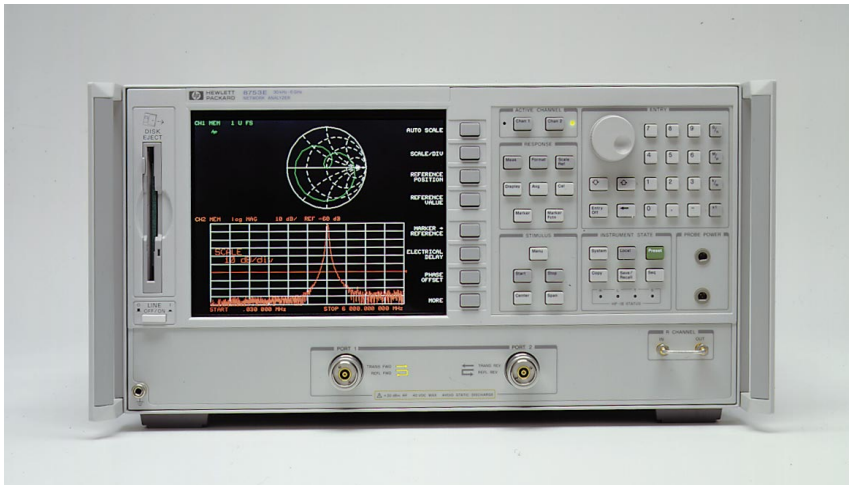
Better, faster testing

The HP 81100 family offers high reliability and precision. You will experience faster and better testing due to the complete absence of glitches and dropouts when adjusting timing parameters (applies to models up to 330 MHz), data sequencing/looping, and PRBS. These digital signal sources generates all standard pulses, multi-level waveforms, and digital patterns required to confidently test the current logic technologies (CMOS, TTL, LVDS, ECL, etc.) at speeds up to 660 MHz.

For more information, see page 404

For detailed specifications, circle 3 on the reply card (last page) or contact the HP Call Center in your region.

Vector network analyzer: Exceptional measurement speed and performance



Optimize development and measurement throughput of RF components with the incomparable HP 8753E vector network analyzer.

The high-performance HP 8753E RF network analyzer brings an unbeatable combination of speed, performance, and ease-of-use to solve your measurement needs. The built-in 30-kHz to 3- or 6-GHz source and S-parameter test set allow complete forward and reverse characterization of the device under test, with a single connection.

Up to seven times faster

The HP 8753E raises the performance of the industry-standard HP 8753 family to a new level, providing an up to seven times improvement in measurement speed and data transfer rate. Superb measurement accuracy, as well as numerous calibration techniques for coaxial, on-wafer and in-fixture measurements, enhance product yields. In addition, the world's most popular RF network analyzer now offers a four-parameter display, VGA output, multiple productivity enhancements, and a smaller size.

Ideal RF component test solution

The HP 8753E vector network analyzer is the ideal test solution for designers and manufacturers of RF components for wireless communications, cable TV, and consumer-electronic products. Its extensive set of performance and productivity features is optimized for reducing development and test times.

For more information, see page 291

For detailed specifications, circle 4 on the reply card (last page) or contact the HP Call Center in your region.

High-performance, wide bandwidth signal analyzers

The HP E3830 series is a new R&D tool for complex signal analysis in LMDS, W-CDMA, broadband satellite, and wideband microwave systems.

The HP E3830 series wide-bandwidth signal analyzer systems are high-performance, full-featured, custom test systems for research and development of wideband digital communications and modern microwave systems. They are based on the industry standard HP 89410A vector signal analyzer and the HP 71910 wideband receiver.

Applications for these test systems in microwave wireless include LMDS, W-CDMA, and broadband satellite systems. Applications in aerospace and defense include radar development, EW, and surveillance systems.

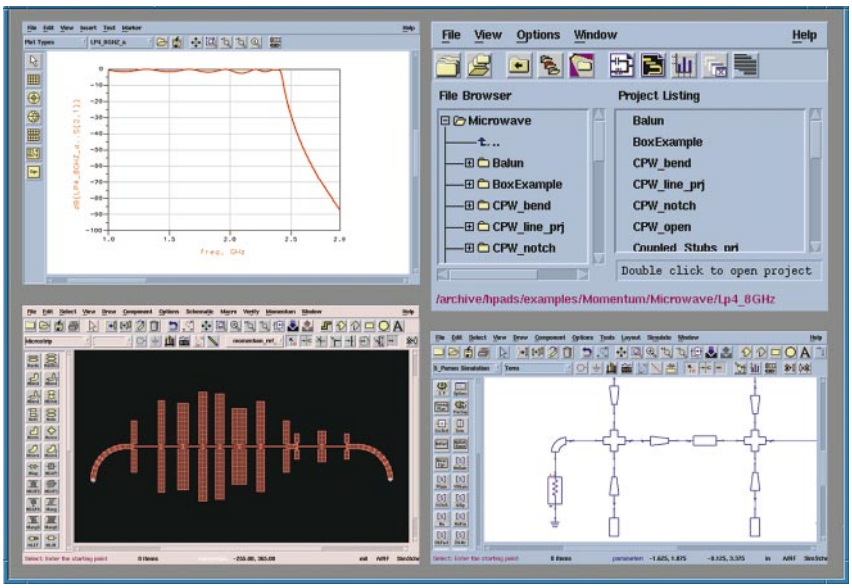
Analyze complex signals

In the HP E3830 series test systems, the HP 89410A vector signal analyzer is the measurement engine for the advanced analysis of complex signals. It provides extensive digital modulation analysis with 20 MHz or 100 MHz of bandwidth. The full 100 MHz bandwidth will be necessary for the accurate measurement and analysis of the wideband signals that will characterize the next-generation of high data rate communication applications.

For more information, see page 263

For detailed specifications, circle 5 on the reply card (last page) or contact the HP Call Center in your region.

Planar EM simulator expands the range and accuracy of circuits and circuit models



The HP Momentum planar electromagnetic (EM) simulator helps you analyze multilayer arbitrary geometrics. It greatly increases the range and accuracy of passive circuits and circuit models, and can help you bring new products to market faster and at a lower cost. It also increases yields and helps you produce physically smaller and denser products of higher quality

HP Momentum accounts for coupling and parasitic effects, and helps analyze multilayer arbitrary geometries. It works in conjunction with HP EEsof's high-frequency circuit simulators to compute the S-, Y-, and Z-parameters of general planar circuits. The EM simulator analyzes microstrip, stripline, slotline, coplanar waveguide, and other circuit topologies.

Specialized ports are available for coplanar waveguide, ground ports, and ports on any strip surface or edge. This allows design results to be used efficiently with circuit simulators when subcircuits or components are connected to the HP Momentum geometry.

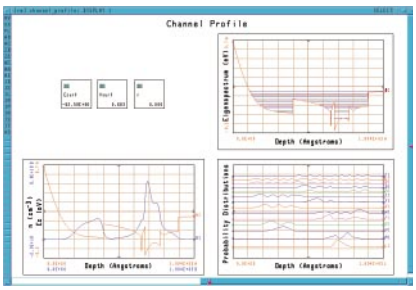
HP Momentum is part of the HP Advanced Design System.

HP Momentum runs on most PC and UNIX platforms.

For more information, see page 332

For detailed specifications, circle 6 on the reply card (last page) or contact the HP Call Center in your region.

Design environment for high-frequency ICs



HP APDS provides quick physical device simulation, DC and HF simulation, takes minutes, not hours.

HP Active Physical Device Simulator (APDS) 1.0 is a fast, complete design environment that offers MESFET and HEMT simulation. Based on the Leeds Physical Model, the HP APDS puts physical device simulation in the circuit simulation environment, and provides a link between the physical structure of a device (geometry, doping profile, etc.) and its electrical characteristics. Linear or nonlinear models are generated for use in circuit design. Simulations of DC and HF device performance take minutes rather than hours, device performance can be predicted.

HP APDS has an easy-to-use interface and includes built-in design of experiments (DOE). It takes into account quantum effects and device self-heating, hot electron/velocity overshoot effect, and avalanche and gate breakdowns. In combination with other HP EEsof tools, the HP APDS 1.0 provides a complete solution for MMIC and other high-frequency IC designs.

For more information, see page 333

For detailed specifications, circle 7 on the reply card (last page) or contact the HP Call Center in your region.

Single-box instruments combine microwave counter, power meter, and DMM capabilities

The HP 53140 series provides the functions most commonly needed during microwave link installation and maintenance tasks.

The HP 53140 series microwave counter/power meters, when equipped with the optional digital multimeter, provide all the fundamental measurements required to install and maintain today's digital microwave radio links. Rugged field portability, a battery option, and an analog peaking meter complete the ensemble.

These instruments are also at home in ATE applications with HP-IB and RS-232 fully programmable I/O ports as standard features. The HP 53140 series' multi-faceted functionality saves expensive and hard-to-come-by rack space as well.

Lab-level performance
For those challenging R&D applications, the HP 53140 series offers the laboratory-level performance and accuracy you've come to expect from HP. Instrument features include:

- an ultrawide frequency input (50 MHz up to 46 GHz)
- a large choice of power sensors from the HP 8480 series
- frequency and power offset and relative measurements
- an optional oven timebase
- measurement averaging.

HP 53140 series available Spring 1999.

For more information, see page 145

For detailed specifications, circle 8 on the reply card (last page) or contact the HP Call Center in your region.

RF power limiters prevent overload

Get economical input protection for RF and microwave test instruments.

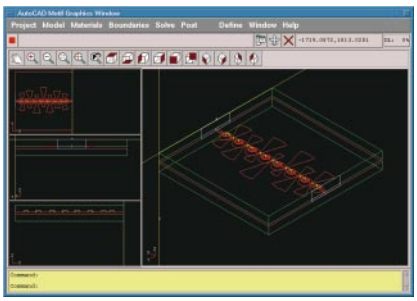
The HP 11930A/B power limiters provide reliable, effective input protection for a variety of RF and microwave test instrumentation. Available with APC-7 connectors, the HP 11930A (DC to 6 GHz) limiters will protect the input circuits of network and spectrum analyzers for input power levels as high as 6 watts peak and 3 watts average power. The HP 11930B (5 MHz to 6.5 GHz) limiter provides the same level of protection with type-N connectors. Should these limiters encounter higher input power levels, they will still prevent instrument damage because their failure mode is either an open or short circuit.

To minimize measurement degradation, the HP 11930A/B power limiters have low insertion loss and linear operation providing exceptional accuracy.

For more information, see page 293

For detailed specifications, circle 9 on the reply card (last page) or contact the HP Call Center in your region.

Powerful software for electromagnetic design



HP Empipe3D Optimizer includes a sophisticated set of proven optimization techniques.

HP HFSS Designer now offers fully-automated electromagnetic optimization of arbitrary-shaped passive 3D structures through HP Empipe3D.

HP Empipe3D is a powerful software tool for automated electromagnetic (EM) design optimization. It allows users of HP HFSS to designate geometric and material parameters as candidate variables for optimization.

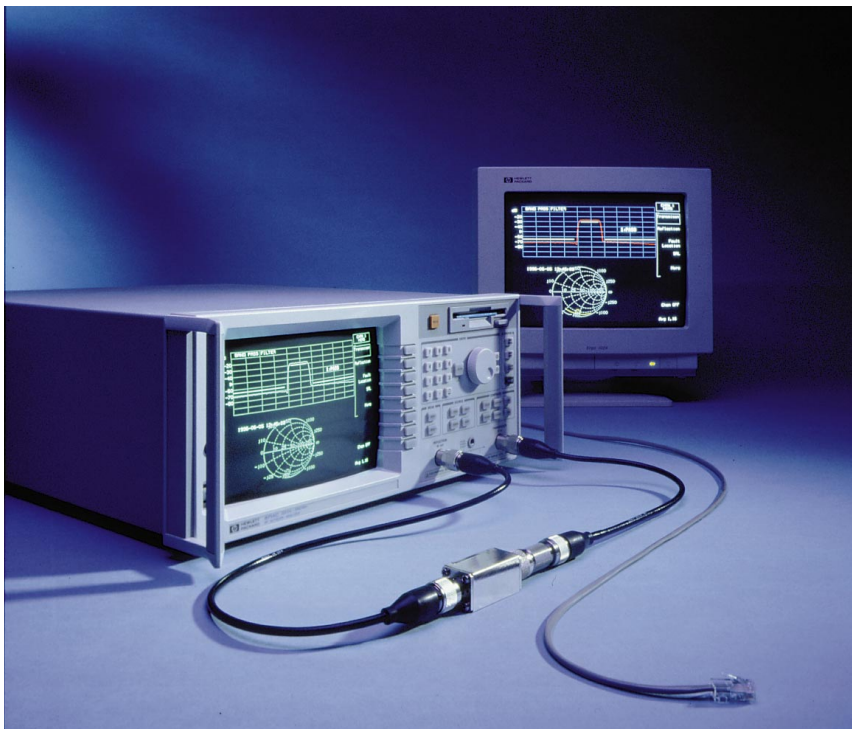
The HP Empipe3D's sophisticated set of optimization techniques includes l1, l2, minimax, Huber, quasi-Newton, conjugate gradient, simplex, simulated annealing, and random algorithms. All of these techniques have proven track records in engineering applications.

Any structure that can be simulated using HP HFSS can now be optimized using this new tool.

For more information, see page 332

For detailed specifications, circle 10 on the reply card (last page) or contact the HP Call Center in your region.

RF economy network analyzers: Fast, accurate, and affordable



These HP RF network analyzers fit tight budgets and have the testing capabilities needed for use in high-volume manufacturing.

Offering the best combination of speed, accuracy, automation features, and low cost, HP RF economy network analyzers are optimized for high-volume manufacturing. These analyzers help you reduce your tune and test times, increase your throughput, and lower your overall cost per component.

The new HP 8712ES and 8714ES models have evolved to meet today's test demands of higher-performance components with the addition of S-parameter measurement capability. This capability brings new levels of accuracy, convenience, and affordability for testing both forward and reverse characteristics of components and assemblies.

All models in the RF economy network analyzer family offer frequency and power sweeps so you can quickly and accurately characterize both linear and nonlinear performance. These analyzers include many productivity features that help speed and simplify your measurements. Also, LAN capability and IBASIC are now included as standard features.

For more information, see page 285

For detailed specifications, circle 11 on the reply card (last page) or contact the HP Call Center in your region.

Convenient waveguide-to-coax adapters

HP V/W281C/D waveguide-to-coax adapters provide simple, low-SWR transition connections.

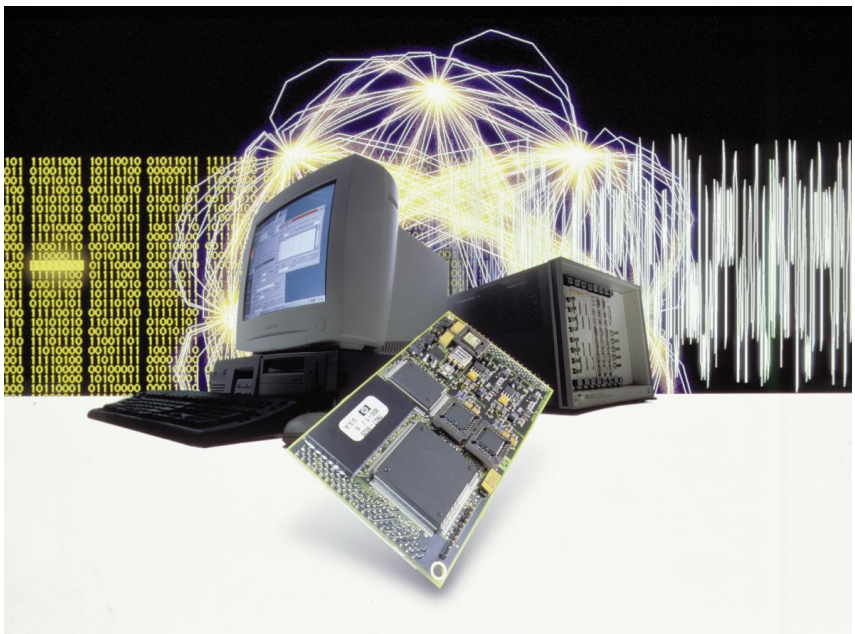
Now you can keep the convenience of coax even when testing waveguide components or take advantage of stable, low-loss and low-SWR waveguide when measuring coaxial devices at higher frequencies. The HP V281C/D and W281C/D waveguide-to-coax adapters provide a simple, low-SWR transition between V-band or W-band waveguide and the precision 1.0 mm coax connector. Their low SWR reduces mismatch uncertainty. Their excellent repeatability ensures consistent measurements.

The HP V281C/D adapters have a frequency range of 50 to 75 GHz, while the HP W281C/D adapters operate from 75 to 110 GHz. They enhance the versatility of your mm-wave test system, and are especially useful for HP 8510XF single-connection, single-sweep VNA system setups.

For more information, see page 301

For detailed specifications, circle 12 on the reply card (last page) or contact the HP Call Center in your region.

Vector waveform generator helps speed wireless communication products to market



The HP E2747/48A vector waveform generator provides wide-ranging, flexible, and easy multichannel signal sourcing.

Now, manufacturers of new and emerging wireless communications products can create a wide range of digitally modulated signals with the new HP E2747A and E2748A. These vector waveform generators use a generalized digital transmitter architecture and provide flexible and easy multichannel signal sourcing, from dc to 6 MHz.

Open platforms

Designed as versatile, open platforms, the vect or waveform generators provide complete control over the various parameters of their block diagram stages. In addition, you can generate real-world messages, including protocol bits, such as header, midamble, framing, and more–even for your own proprietary systems.The HP E2747/48A eliminate the need to precompute output samples. You provide actual data, which is then coded, filtered, resampled, and output in real time.

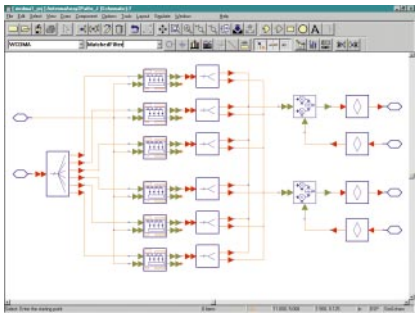
Realistic spectral simulations

For multichannel applications, independent controls for each channel's symbol rate, modulation format, and message structure allow realistic spectral environment simulation. Upconversion options are also available for the vector waveform generators.

For more information, see page 237

For detailed specifications, circle 13 on the reply card (last page) or contact the HP Call Center in your region.

Jump start W-CDMA design efforts



Use the W-CDMA design library to develop wireless products quickly and efficiently.

The HP Wideband Code Division Multiple Access (W-CDMA) Design Library, an HP Advanced Design System option, provides optimized circuit simulation that lets you quickly begin design studies and hardware implementations of 3G (third generation) mobile communications products. With this library, specification-compliant algorithms are refined at the system level where design choices have the greatest impact. Using seamless links to other HP Advanced Design System options, W-CDMA signal processing algorithms and analog circuits help move designs quickly to manufacturing.

The library's development environment includes links to circuit simulators and to test instrumentation. This allows comprehensive system-level refinements as behavioral models are replaced with actual circuit designs or measured data.

Incorporating the library into a design flow will speed W-CMDA design activities, optimize designs before prototyping, and increase chances of first-time hardware success.

For more information, see page 332

For detailed specifications, circle 14 on the reply card (last page) or contact the HP Call Center in your region.

Cellular phone functional test platform readily configures for different test requirements

The modular HP TS-5500 cellular phone test platform can be configured for testing multiple cellular phones simultaneously.

The HP TS-5500 cellular phone functional test platform is designed for manufacturing functional test of GSM and/or CDMA cellular phones. Test engineers gain productivity by using this common core of both hardware and software, which can easily be tailored for turn-on, calibration, or final test.

HP's test platform configures as a multiple-up tester that lowers phone testing cost with lower capital costs and faster test times. To facilitate a quick ramp up of new production facilities, test system development begins with a prebuilt system, for a shorter time-to-market or time-to-volume while using fewer test engineering resources.

The HP TS-5500 test platform includes:

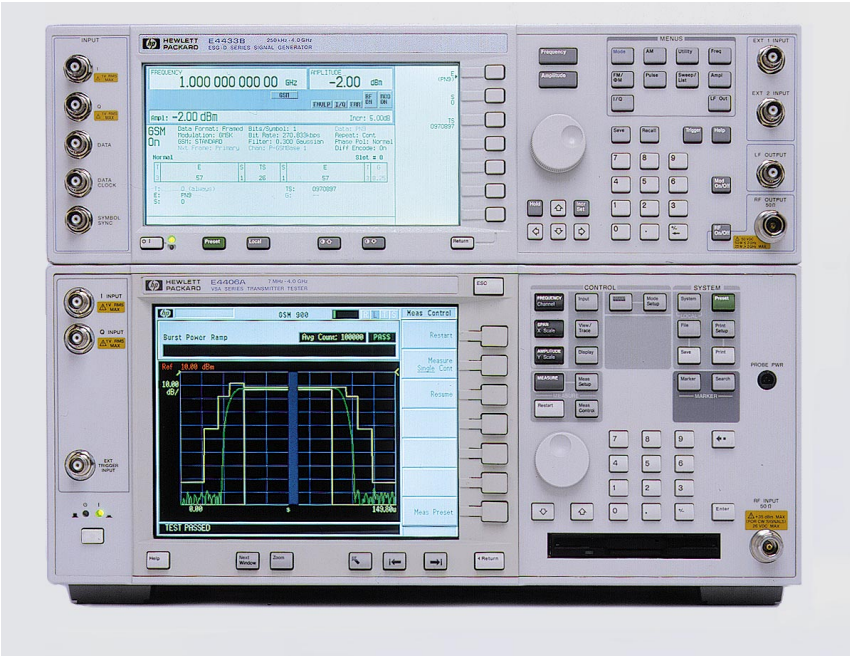
- RF instruments, audio measurements, VXI switching, digital I/O, serial communications, and power supplies for GSM/CDMA cellular phone testing
- standard racking, cabling, and system resource panel
- test, measurement, and utility software for GSM or CDMA, audio, battery, and general purpose measurements
- time-saving templates for GSM or CDMA final tests and operator interfaces
- configurations for testing up to four phones simultaneously and asynchronously
- system verification and diagnostic software

HP Test Engineering completes each TS-5500 cellular phone functional test platform with customer-specific tasks, such as test plans, operator interface, fixturing, automation, and data reporting.

For more information, see page 478

For detailed specifications, circle 15 on the reply card (last page) or contact the HP Call Center in your region.

GSM and cdmaOne™ measurements at the touch of a button



HP's new transmitter tester provides unmatched speed and accuracy for transmitter measurements

Due to the fast-paced wireless communications market, equipment manufacturers need flexible production lines that are capable of testing different formats with little or no change in setup. The new HP E4406A VSA series transmitter tester meets this challenge, offering one-button measurements and the best combination of speed and accuracy for making both GSM and cdmaOne measurements. When combined with one of the HP ESG series digital signal generators, this solution will be an excellent choice for wireless equipment manufacturers.

Powerful DSP technology provides the fastest transmitter measurements available today. Excellent accuracy lets engineers reduce guard bands, allowing tighter specifications for the final product. Additionally, the flexible card cage design and downloadable firmware allows quick and easy expansion for future needs. The HP E4406A VSA series transmitter tester meets the challenges of wireless equipment manufacturers today, and in the future.

For more information, see page 479

For detailed specifications, circle 17 on the reply card (last page) or contact the HP Call Center in your region.

Create your own modulation with flexible RF signal generators

The HP ESG series of digital signal generators continue to keep pace with changing digital communications applications.

Significant enhancements to the HP ESG-D series include multichannel W-CDMA and CDMA signal generation, custom modulation and bit-error-rate analysis. The fully upgradeable, flexible modular design of the HP ESG series simplifies retrofitting these enhancements and protects your investment. And performing multichannel CDMA testing with a spectrally correct signal provides actual component performance rather than the loose correlation obtained with additive white Gaussian noise.

Create custom digitally modulated signals
You can create custom digitally modulated signals, modify existing digital protocols, or simulate standard communications transmissions with the HP ESG-D series. Any of the included TDMA standards can be modified to simulate impairments for component characterization. Alternatively, you can build a digitally modulated signal by mapping an I/Q constellation, building a filter, selecting a symbol rate, and inputting real-time data or downloading a mathematically modeled waveform.

The HP ESG-D series has an internal bit-error-rate analysis capability that simplifies test design by providing the BER for PN9 and PN15 bit sequences.

For more information, see page 214

For detailed specifications, circle 16 on the reply card (last page) or contact the HP Call Center in your region.

Exceptional mobile dc power sourcing

Specially designed for testing digital wireless communications products, the compact HP 66311A provides 5 A peak and 15 V sourcing.

The HP 66311A mobile communications dc source expands HP's line of high-throughput, high-precision measurement system dc power supplies. Excellent voltage transient response characteristics ensure maximum test system throughput by minimizing device shut-downs due to transient voltage amplitude and recovery time. Standard programming languages reduce software development time and preserve software investment. High-speed output programming increases test throughput, and 2.8-A current sinking can be used to test built-in battery chargers.

The HP 66311A's dynamic current pulse measurement capability provides the information needed to evaluate the battery loading characteristics of cellular phones. High-accuracy, low-current measurements allow you to gauge the low "off" current or "sleep mode" current drain of cellular phones. Precision voltage measurement makes possible the accurate tracking of charger voltage levels. This "one-box" solution lowers test system costs by reducing the number of instruments and rack or bench space needed for the system.

For more information, see page 182

For detailed specifications, circle 18 on the reply card (last page) or contact the HP Call Center in your region.

Lower the cost of servicing mobile phones

To better correlate service measurements with production tests, the HP 8924E has the accuracy and repeatability of the HP 8924C manufacturing test set.

By combining measurement accuracy, automation, and optimized features, the HP 8924E CDMA mobile station service test set helps reduce the cost of mobile-phone testing without sacrificing quality or thoroughness. This test set is ideal for service providers doing incoming inspection, failure verification, repair verification, and customer-return (churn) testing of CDMA cellular and PCS phones. It can also be used for troubleshooting and verification at repair stations on manufacturing lines.

The test set includes analog cellular, CDMA cellular, and PCS test capabilities, enabling quick call handoffs from one format to another. A single front-panel key initiates the complex, over-the-air call processing required to make CDMA and analog phone calls. Automation software runs test suites in minutes that would take hours to perform manually.

Accurate measurements

The HP 8924E provides accurate CDMA average power measurements (±5%) and low-level power measurements (±1.0 dB absolute, ±0.5 dB relative). It also offers Frame Error Rate (FER) confidence-limit testing, an Additive White Gaussian Noise (AWGN) source, highly accurate digital signal processing, and a high-stability time base. The HP 8924E's 30-MHz to 1000-MHz frequency range covers analog and CDMA cellular testing; option 102 adds PCS frequency coverage.

For more information, see page 472

For detailed specifications, circle 19 on the reply card (last page) or contact the HP Call Center in your region.

Use integrated air-interface measurement systems to optimize wireless networks

The new HP E74xx series provides measurements that optimize CDMA and GSM networks.

The HP E74xx series of integrated air-interface measurement systems offers comprehensive RF and call-based measurements for CDMA and GSM networks. A phone supplies critical, call-based performance indicators, while a digital receiver provides complete characterization of the RF coverage. By providing call-based and RF parameters as a function of location, these systems allow wireless service providers to characterize the performance of their networks and understand the underlying causes of performance problems.

Versatile measurement capabilities

The HP E74xx series makes technology-specific and generic measurements. The HP E7470A and E7472A CDMA systems can perform characterization of multipath effects by measuring aggregate Ec/Io and delay spread. The HP E7471A GSM system can assist with interference management using specialized measurements. All systems can make CW and channel-power measurements for site evaluation and selection testing, and can provide a spectrum display that aids the diagnosis of RF problems.

All of the HP E74xx series air-interface measurement systems use Microsoft Windows 95 (Windows NT-compatible) software and the same graphical user interface. Software automates the data-collection process, providing fast, repeatable measurements and helping to minimize the time spent collecting data.

For more information, see page 494

For detailed specifications, circle 20 on the reply card (last page) or contact the HP Call Center in your region.

One-box testing for PCS environment

The HP E6381A TDMA base station test set is a comprehensive, one-box test set for today's cellular and PCS environments.

The HP E6381A, a member of the HP 8935 series of next-generation base station test equipment, meets the needs of installation teams, service providers, and network equipment manufacturers. This full-featured, single-box tester is ideal for testing both cellular and PCS systems.

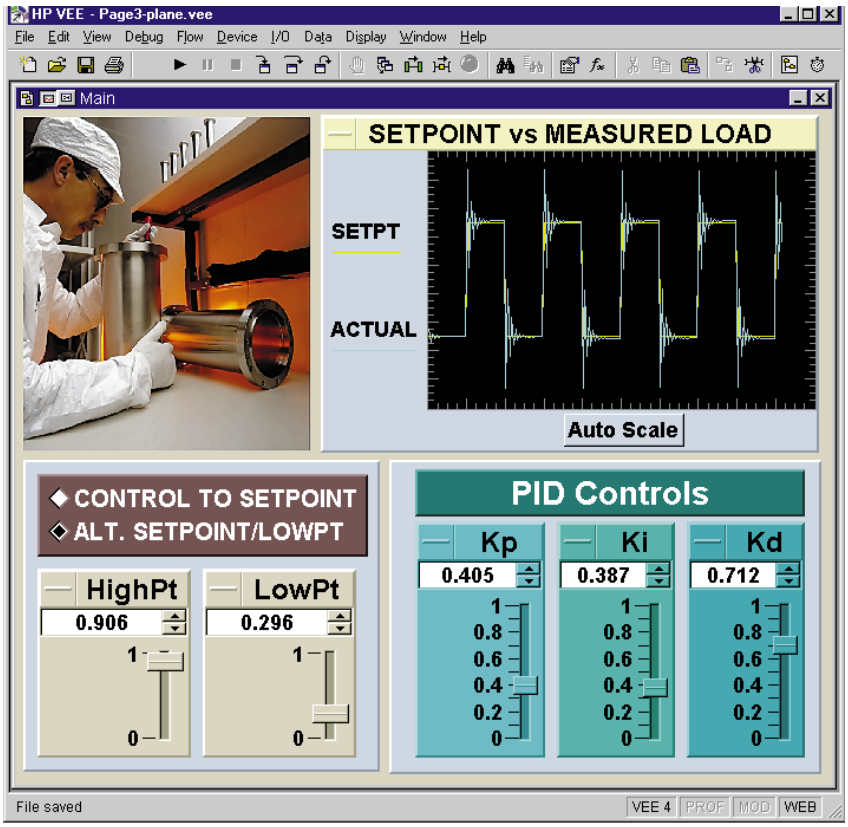
The HP E6381A has an operator interface with Windows-type pull-down menus that is easier to use. This improved interface, coupled with the instrument's measurement speed and automated software for Lucent, Ericsson, and Nortel base stations, decreases base station off-line time and improves system performance. Errors due to test variability are reduced and measurement data can be output to a printer or to a PCMCIA memory card.

Firmware for the HP E6381A is user upgradeable (with a PCMCIA card) to Flash PROM, so new features and capabilities can be added without returning the instrument to a service center. Helpful options include TDMA technician training programs that provide installation teams and service providers with a complete TDMA base station solution.

For more information, see page 468

For detailed specifications, circle 21 on the reply card (last page) or contact the HP Call Center in your region.

HP VEE 5.0 supports ActiveX Controls/Automation, Internet applications, and IEEE-1394



The HP VEE 5.0 visual programming language now connects you with the world of ActiveX software.

To allow you to create test and measurement programs for test systems in less time with less effort, the new Version 5.0 of HP VEE, the popular visual programming language, supports Microsoft's ActiveX. ActiveX technology is changing the software development process, and HP VEE 5.0 now brings that technology to the test and measurement world.

You can load and use ActiveX Controls within HP VEE 5.0. It's easy to customize the HP VEE environment for your specific application by adding bar-code readers, video clips, databases, and a wide variety of user interface features.

Through ActiveX Automation, HP VEE 5.0 can interact with any application that provides access to ActiveX objects. You can send and receive data from spreadsheets, databases, and word processors.

HP VEE 5.0 runs on PCs with Windows 95/NT, and on HP Series 700 workstations. Automation kits bundle HP VEE 5.0 with HP's popular HP-IB cards. Site licenses include 10- and 50-seat configurations.

Request your free evaluation kit by visiting us on the Web: **www.hp.com/go/hpvee**

For more information, see page 90

For detailed specifications, circle 22 on the reply card (last page) or contact the HP Call Center in your region.

Low-cost, clean dc power

The programmable HP E3633A provides 200 watts of clean power (ripple and noise are <3 mV p-p) at an affordable price.

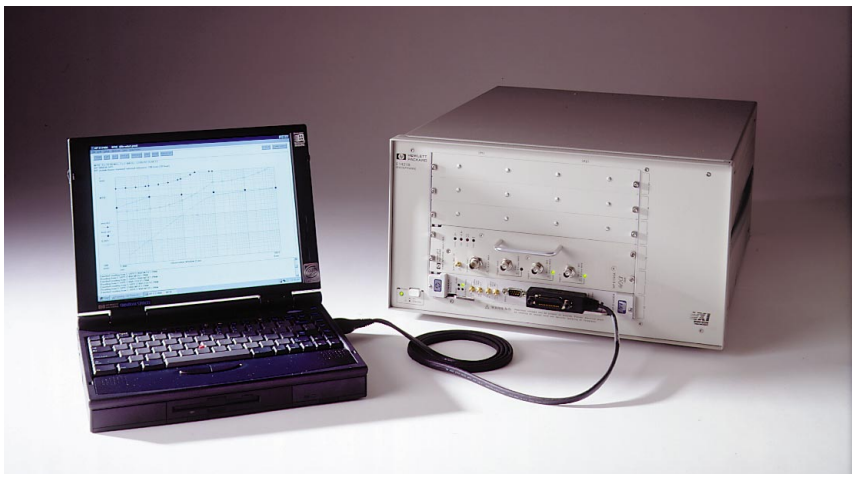
The HP E3633A single-output dc power supply provides easy-to-use front panel controls for bench operation, a brightly lit dual display for easy viewing at any angle, and the resolution you need for fine adjustments and readback. It has two ranges to provide both 20 amps at up to 8 volts, or 10 amps at up to 20 volts. To maintain a constant output at the circuit under test, remote sensing is provided with a quick disconnect shorting bar.

The HP E3633A's 1 mV/1 mA resolution, 0.5 mV/1 mA readback and 0.05% accuracy allow you to perform automated testing with confidence at low cost. The dc power supply has GPIB and RS-232 ports and can be connected to any PC via the RS232 port. To simplify programming, it uses SCPI for its command definition and provides examples in the manual. For permanent output connections, screw terminal outputs are provided in the rear.

For more information, see page 193

For detailed specifications, circle 23 on the reply card (last page) or contact the HP Call Center in your region.

Powerful jitter analysis made easy



Jitter analysis is now simpler with the new HP E1725C time interval analyzer.

The HP E1725C time interval analyzer (TIA) and its companion HP E174XA software packages help you reduce jitter when you evaluate network synchronization, integrate new SONET/SDH technologies with existing telecommunications equipment, test the performance of high-speed clock distribution circuits, or characterize high-speed data storage devices.

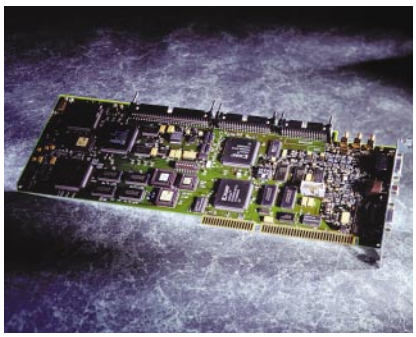
Portable and expandable
A VXI-based instrument, the HP E1725C TIA offers expandability and portability. It combines the HP E1740A TIA module in a VXI cardcage with an external laptop computer. The on-card functionality of the HP E1740A TIA module includes basic arming and measurement control and a large 512K memory for storing results. Multiple HP E1740A TIA modules can be added into the VXI cardcage to allow measurements of up to 32 channels simultaneously.

The computer's Microsoft Windows interface and optional HP software packages simplify measurements and offer powerful display and analysis capabilities for viewing and interpreting complex measurement results. Causes of jitter can be easily determined via histograms, window margin analysis, and advanced statistical displays.

For more information, see page 149

For detailed specifications, circle 24 on the reply card (last page) or contact the HP Call Center in your region.

Fast, 2-channel DSP servo electronics



This DSP Servo-Axis Board can be customized to meet your specific needs.

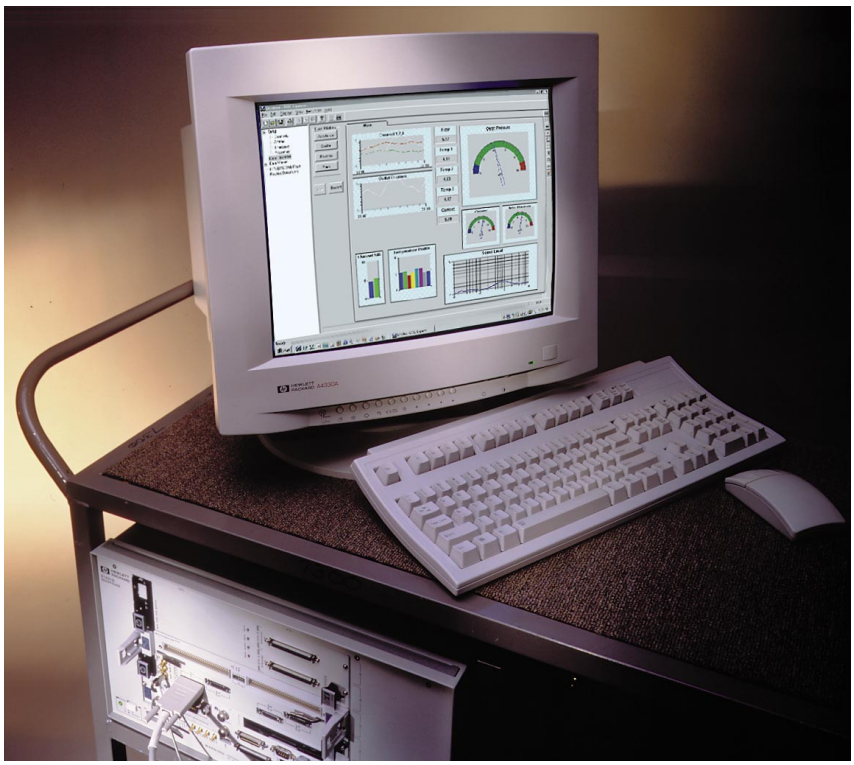
The HP E1723A DSP Servo-Axis Board is a user-programmable, two-axis servo card with custom input circuitry for each axis. Both servos can run a 8th order IIR equation at 50 kHz. You can write your own low-level programming code or use the supplied software.

In a typical application, the board's axis #1 could control the HP E1710A/20A encoder system, while its axis #2 controls the HP E1721A non-contact push pin (NCPP). Axis #1 accepts input from the HP E1711A encoder sensor head, which monitors the position of a linear or angular scale, and produces an analog voltage used to control stage position; axis #2 accepts input from the NCPP sensor head. The NCPP sensor head monitors a target feature located on the stage to be controlled, detecting optically whether the target is right, left or centered. The signal from the sensor is processed through the servo equation to produce a voltage used to control the stage carrying the target feature, keeping it in a fixed position relative to the sensor head ("nulling servo").

For more information, see page 562

For detailed specifications, circle 25 on the reply card (last page) or contact the HP Call Center in your region.

Easy data acquisition and recording



HP DAC EXPRESS saves you time by enabling you to set up multichannel analog measurements easily.

With HP's DAC *Express* (HP E9801A), it's easy to set up a multichannel analog measurement, saving time data to disk for future processing. Once you acquire the data, you can check its validity, monitoring it in real-time with a full-featured data browser. And you can send the data to anyone with a copy of HP DAC *Express* (E9800A) Data Viewer software-via a LAN or the Internet for additional analysis on a PC. All the related measurement setup information is stored in HP SDF (Standard Data Format) when you send data.

The HP E9801A combines the functionality of signal conditioning, digitization, instrumentation tape recorders, and strip chart recorders in a single, standalone product. It outperforms DAT-based tape recorders in channel count, per-channel bandwidth, and depth of storage. Up to 4 billion samples can be stored at aggregate rates up to 7.5 million samples/s. Any of the various displays can be copied to attached printers, so there is no need for separate strip chart recorders. A drag-and-drop feature allows data to be inserted into word processors for report generation.

The architecture of the HP E9801A lets you implement a data system with mixed sampling rates for example, low sampling rates for measurements like temperatures, and high sampling rates for acoustic or vibration signals. This mixed sampling rate capability is always time correlated, so you can determine the timing of a position signal relative to the transient response of a microphone or accelerometer signal.

For more information, see page 550

For detailed specifications, circle 26 on the reply card (last page) or contact the HP Call Center in your region.

PC-to-VXI interface uses IEEE-1394 bus

With the HP E8491A you can make a direct connection from your PC to a VXI mainframe.

The HP E8491A IEEE-1394 PC Link to VXI is a C-size, 1-slot, message-based VXI module that provides a direct connection from your PC to a VXI mainframe via the industry-standard IEEE-1394 bus (FireWire). For high-speed data acquisition applications moving large blocks of data, the HP E8491A is faster than other MXI-bus solutions. The module implements an affordable VXI solution for test applications when used with the new HP E8400 VXI mainframe series.

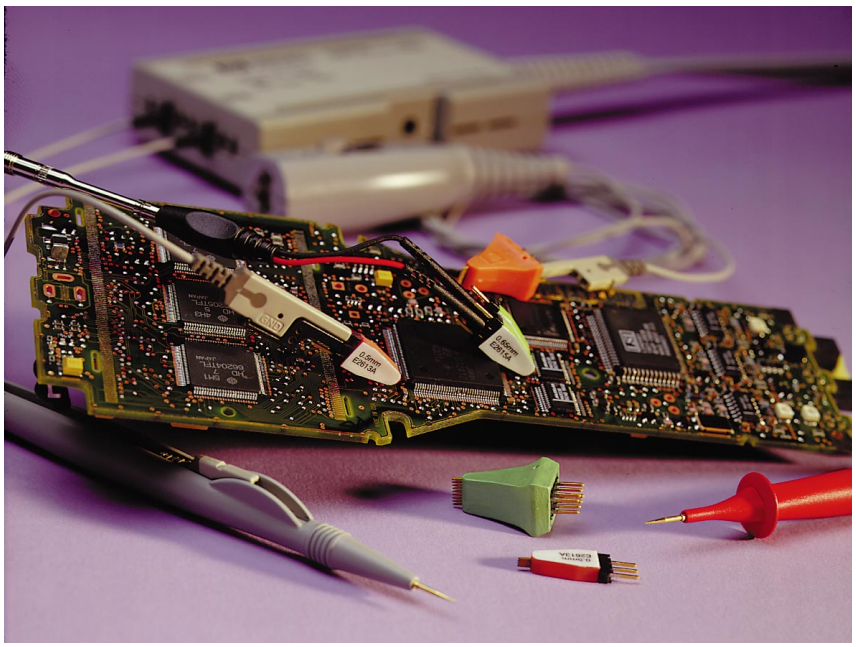
The HP E8491A ordered with Option 001 comprises an IEEE-1394/PCI card that is installed into your PC, a C-size VXI Slot 0 module, and a 4.5-meter cable. It supports up to 16 mainframes with one PC. A "hot plug-in capability" eases configuration changes-new IEEE-1394 devices are automatically recognized without powering down the PC.

The HP E8491A has clock and triggering capabilities, and includes a complete SICL/VISA I/O library software for the Windows 95 and Windows NT 32-bit environments. The interface also supports 32-bit Interpreted SCPI (I-SCPI).

For more information, see page 101

For detailed specifications, circle 27 on the reply card (last page) or contact the HP Call Center in your region.

Probe and accessories to ease fine pitch frustrations



With the HP Wedge probe adapter and low mass probes, it's easy to make reliable hands-free connections to fine-pitch ICs.

As ICs and components continue to shrink, probing is becoming increasingly difficult. A new range of ultra-low-mass active and passive probes and the HP Wedge probe adapter will help you precisely probe fine-pitch ICs and dense circuit boards, regardless of whether you need to browse or make a hands-free connection.

Hands-free connections

The HP Wedge technology provides an easy, hands-free method to connect your scope or logic analyzer to 0.5-mm and 0.65-mm thin quad flat pack (TQFP) and plastic quad flat pack (PQFP) IC packages. The innovative design is mechanically non-invasive and doesn't damage the device under test. It works by inserting compressible dual conductors between adjacent legs of the IC package. The flexible conductors conform to the size and shape of each leg and provide a reliable contact and good electrical performance with little chance of shorting adjacent pins.

Low-mass passive probes

The HP 1170 series of low-mass (<1 gram), high-performance passive probes for the HP Infinium oscilloscopes are exceptionally small and light, yet provide the same high-performance you've come to expect from HP's passive probes. When used in conjunction with the HP Wedge, they provide a hands-free solution for probing 0.5-mm and 0.65-mm IC packages. The probe tip connects directly to board headers.

High-bandwidth active probe

The HP 1155A low-mass active probe for Infinium oscilloscopes has a probe tip that weighs less than 1 gram, making it ideal for attaching to fine-pitch ICs and probing surface mount components. The probe combines high bandwidth (750 MHz), low input capacitance (2 pF), and high input resistance (1 MΩ).

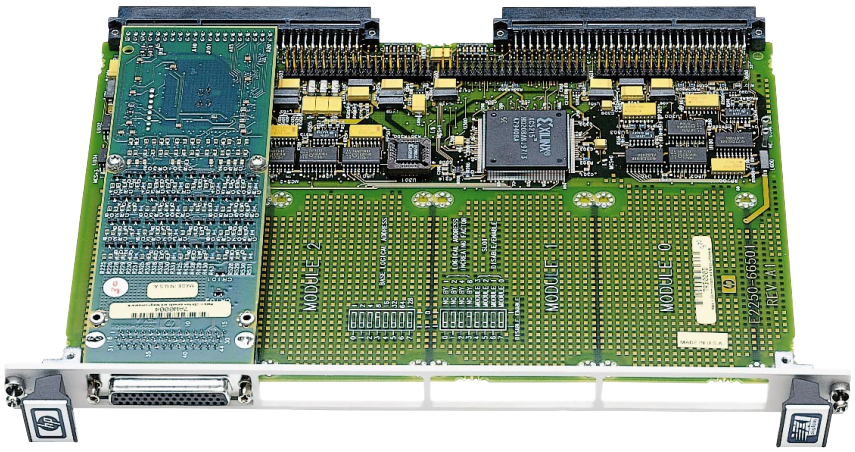
New Passive Probes

The HP 10400B series of probes comes complete with a new range of accessories, including a browser for probing fine-pitch parts. The B series offers the performance, reliability, and small size of the HP 10400A series they replace.

For more information, see pages 130–134

For detailed specifications, circle 28 on the reply card (last page) or contact the HP Call Center in your region.

Add small, functional M-modules affordably



The HP E2250A B-size M-module carrier enables a VXI user the flexibility to use M-Modules in many combinations.

The HP E2250A B-size, 1-slot M-module carrier allows you to cost-effectively add small blocks of functionality to a VXI test system. It provides backplane access to as many as four different M-modules, each with independent addresses, plus the function and point count that exactly matches the your system requirements. You can use up to 31 M-modules with the HP E1306A command module, or up to 255 M-modules with embedded controllers. For additional data and addressing, the HP E2250A also supports MA-modules for D32 and A32 capability.

Because each M-module has its own address, you can use them in many combinations. This flexibility allows you to get the amount of functionality you need in smaller blocks, lowering your overall system costs.

The HP E2250A M-module carrier is fully compliant with VXI Specifications Rev. 1.4 and provides the electrical and mechanical interface between the VXIbus system backplane and the M-modules. It also provides VXI register configuration, access to M-module I/O and memory spaces, interrupt handling, triggering, and burst access capability.

For more information, see page 101

For detailed specifications, circle 29 on the reply card (last page) or contact the HP Call Center in your region.

Fast, reconfigurable channel relay multiplexer

The HP E8462A high-density relay multiplexer is a C-size, 1- slot, register-based VXI module.

The HP E8462A C-size, single-slot, 256-channel multiplexer expands the signal switching choices available for the efficient implementation of VXI test systems. The high-density, register-based multiplexer module uses nonlatching armature relays and offers a quick, reconfigurable, high point-count switching topology.

The HP E8462A can be programmed into individual topologies; many other combinations can also be supported. With this VXI multiplexer module, you can configure 2-wire, 3-wire, and 4-wire measurements.

For more information, see page 102

For detailed specifications, circle 30 on the reply card (last page) or contact the HP Call Center in your region.

Low-cost PCI to HP-IB interface

The HP 82350A PCI to HP-IB interface for Windows 95/NT is a high-speed PCI card that offers superior performance.

The HP 82350A, a low-cost, high-performance IEEE-488 interface and software for PCI-based PCs, makes it easy to access and control instruments and exchange data. The high-speed PCI card has built-in buffering, which decouples HP-IB transfers from the PCI bus transfers. The resulting I/O and system performance is superior to direct memory access (DMA)-up to 750 kB/s.

The HP 82350A comes with SICL and VISA software for Windows NT and Windows 95 that is compatible with all previous versions of SICL/VISA. The hardware is software configurable and compatible with the VXIplug&play standard for easy hardware installation.

The HP-IB interface card plugs into a PCI slot in the backplane of your PC. This card connects to HP-IB instruments via an HP-IB cable. For VXI applications, an HP-IB cable connects the card to the command module in Slot 0 of the VXI mainframe.

For more information, see page 106

For detailed specifications, circle 31 on the reply card (last page) or contact the HP Call Center in your region.

Low-cost VXI mainframes have monitor functions and quiet, efficient cooling

HP VXI mainframes are economical, reliable choices for your test system applications.

The HP E8400 series of VXI mainframes features superior cooling technology, mainframe monitoring, improved backplane design, and versatile accessories. Four versions comprise the series:

- The HP E8401A and E8402A are HP's lowest cost C-size, 13-slot mainframes. They are ideal for test systems requiring medium power (up to 550 W) and low cost.
- The HP E8403A and E8404A C-size, 13-slot mainframes handle high-power applications (up to 1000 W), also at a low cost.

Monitor functions are built in

Enhanced monitoring of the HP E8402A and HP E8404A are designed to give you confidence in the operation of your test system. They have new monitor functions that provide instant assurance that the power supply and cooling are operating within specifications. System status and user messages can be viewed on the color front panel display. A diagnostic connector is conveniently located on the front of all four new mainframes, allowings remote monitoring of power supply voltages, power supply and backplane temperatures, and fan functions. This connector also allows remote on/standby, provides access to +5V STDBY, ACFAIL, and SYSRESET signals, and facilitates diagnostic tests.

The fan in the HP E8400A series VXI mainframes has an innovative impeller design for extremely quiet and efficient cooling.

For more information, see page 101

For detailed specifications, circle 32 on the reply card (last page) or contact the HP Call Center in your region.

VXI mainframes for M-Modules and B-size modules

These B-size, 9-slot, VXI mainframes can handle low-cost M-Modules and powerful B-size modules.

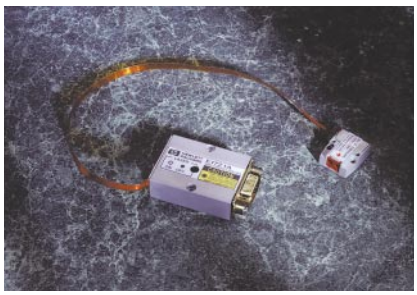
The HP E1300B and E1301B B-size VXI mainframes feature improved dual-fan cooling to support even the most demanding M-Modules and high-performance B-size modules. Two of the mainframes' nine slots are located internally, dedicated to housing the 2-slot HP E1326B multimeter. Three A-size slots are also available for installing modules such as the HP E1324A RS-232C/422 terminal interface.

The HP E1300B/E1301B mainframes have a built-in, high-performance command module (functionally identical to the HP E1306A command module) with a built-in HP-IB interface. The HP E1301B features a front panel and keyboard for manual control and troubleshooting without the use of HP-IB, making it a great choice for remote applications.

For more information, see page 101

For detailed specifications, circle 33 on the reply card (last page) or contact the HP Call Center in your region.

Non-contact sensor improves positioning systems



Replace traditional mechanical push pins with the HP E1721A non-contact push pin sensors.

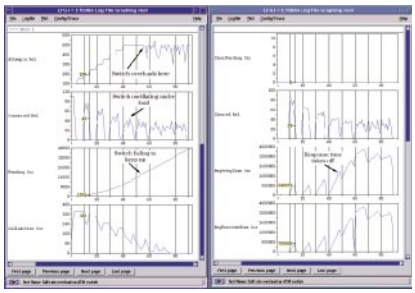
The HP E1721A non-contact push pin (NCPP) sensor is an optical replacement for the mechanical push pin. Because no physical contact is being made with the head stack assembly (HSA), the NCPP sensor has important advantages: It does not introduce any new resonances to-nor changing existing resonances in-the servotrack writing process. It also eliminates stiction errors.

The sensor head of the NCPP is attached to the master arm of the servotrack writer (STW) and contains a laser diode, optics, and a detector. The laser diode's focused beam reflects off a target feature on the HSA. The image formed by the target feature is itself imaged onto the detector. The detector signals are then electronically processed to provide an error signal proportional to the relative displacement between the master arm and the HSA. Applied to either the HP E1723A DSP Servo-Axis Board or to customer-supplied electronics, this error signal is used to servo-control the position of the HSA to the position of the master arm.

For more information, see page 562

For detailed specifications, circle 34 on the reply card (last page) or contact the HP Call Center in your region.

Real-world, multiport performance testing



Maximize switch and network performance to get a better return on your ATM investment.

The HP E1600A Multiport UNI Signaling Performance test solution provides up to 20 ports which can be used to generate and analyze the behavior of UNI signalling traffic at very high rates. Your HP Broadband Series Test System (BSTS) equipped with this solution becomes a powerful tool for determining the signaling capabilities of an ATM switch or network-quickly, easily, and reliably.

Through the specification of the call attempt rate and profile call duration, source and destination address, and SETUP parameters, you can simulate real-world signaling conditions in a controlled and deterministic way.

The test system's extensive set of measurements and events allow you to thoroughly characterize the signalling performance of the system under test. Measurements are made in a continuous and real-time fashion to ensure a reliable, accurate assessment of the switch's ATM signaling performance.

For more information, see page 452

For detailed specifications, circle 35 on the reply card (last page) or contact the HP Call Center in your region.

Powerful, portable tester solves signaling problems fast

The HP 37907A Signaling Advisor's graphical user interface, context-sensitive help, and its optional language localization ensure user-friendly operation.

The HP 37907A Signaling Advisor is designed for signaling engineers and technicians who maintain, install, and develop multilink, multiprotocol wireline or wireless signaling networks. This practical, intuitive-to-use test tool enables technicians to deal with routine signaling problems easily, and frees engineers to focus on major or complex signaling issues.

Analyze interactions, verify services

The HP Signaling Advisor can be used to check out signaling interactions in fixed, access, PCS, and GSM networks, and to verify services such as AIN, CLASS, and LNP. You can work with up to 40 SS7, ISDN, X.25, and V5 protocols. Plus, you can perform measurements on up to 40 timeslots across up to 8 duplex signaling links (16 using the optional undercradle)–working at sub and fractional rates, or full rate T1/E1.

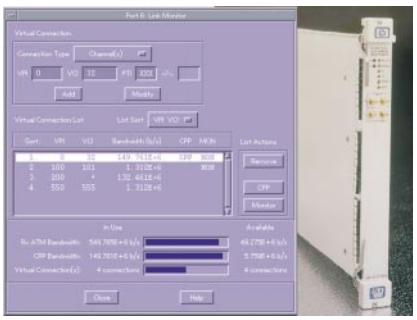
The HP Signaling Advisor lets you pass data directly to standard spreadsheet and word-processing packages, making trend analysis and report writing straightforward.

An optional emulation application enhances the versatility of the HP 37907A. The emulation application's built-in programming capabilities are useful for installation, verification, development, and acceptance tests.

For more information, see page 438

For detailed specifications, circle 36 on the reply card (last page) or contact the HP Call Center in your region.

Comprehensive ATM test solutions



The new HP 622 Mb/s ATM test solution provides the industry's most comprehensive suite of higher layer OC-12 testing capabilities.

To stay at the leading edge, designers, manufacturers, and providers of ATM/B-ISDN products, services, and networks need higher layer OC-12 testing capabilities. A comprehensive suite of such capabilities is provided by a new 622 Mb/s ATM test solution for the HP Broadband Series Test System (BSTS). The solution consists of the HP E1618A 622 Mb/s optical line interface and the HP E1609A 0-622 Mb/s ATM Stream Processor, combined with the HP E4209B Cell Protocol Processor for higher protocol testing.

The HP E1618A provides OC-12c/STM-4c access to the system under test. It has extensive SONET/SDH generation and analysis capabilities.

The HP E1609A raises the testing of broadband devices and services to new levels of thoroughness, accuracy, and insight. This ATM Stream Processor is a powerful tool for real-time Quality of Service, ATM, and AAL-5 traffic generation and performance measurements.

For more information, see page 452

For detailed specifications, circle 37 on the reply card (last page) or contact the HP Call Center in your region.

2.4 Gb/s ATM analyzer supports SVC testing

Analyze SONET/SDH ATM and higher layers at up to 2.4 Gb/s.

The new HP E4210B option 005 is a 2.4 Gb/s ATM analyzer bundle that provides access to the HP E4209A/B Cell Protocol Processor on the industry-standard Broadband Series Test System. You can perform tests at higher layers, including ATM, AAL (1,2,3/4,5), signalling and IP/ATM over an OC-48c/STM-16c interface.

This is a 7-slot VXI solution when fully configured and supports a 1310 nm 2.4 Gb/s optical line interface (with optional 1550 nm optics).

Key features:

- Generate and analyze OC-48c/STM-16c frames for testing alarms, errors, and SONET/SDH pointer movements
- Generate and analyze ATM cell streams at full rate 2.4 Gb/s
- Perform OAM fault management tests
- Make ATM Quality of Service (QoS) measurements

For more information, see page 452

For detailed specifications, circle 38 on the reply card (last page) or contact the HP Call Center in your region.

Portable SDH and SONET multi-rate testing to STM-16/OC-48

The HP 37718A and 37719A communications performance analyzers offer a multi-rate test solution for both network operators and network equipment manufacturers.

The HP 37718A communications performance analyzer meets the varied requirements of network operators and network equipment manufacturers, without compromising on test capability. It offers functional and parametric testing of WDM, SDH/SONET, and PDH equipment, including jitter generation and measurement, to ITU-T and ANSI standards.

To rigorously test new services carried in synchronous networks, the analyzer is equipped with STM-16c/OC-48c and STM-4c/OC-12c concatenated payloads for complete clear-channel testing, as well as mixed payloads for evaluating networks carrying mixed rates of traffic. In addition, automatic protection switch times on SDH/SONET rings and linear networks can be verified against ITU-T and Bellcore standards. The analyzer provides a range of SDH/SONET interfaces from STM-0/STS-1 to STM-16/OC-48 and includes ITU-T PDH tributary interfaces (2, 8, 34, and 140 Mb/s), plus DS1/DS3.

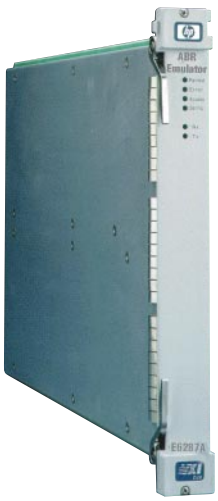
SONET-only version

The HP 37719A is a SONET-only version of the HP 37718A analyzer. It can help network operators install, commission, and maintain their SONET/T-carrier networks, and resolve quality-of-service issues. The HP 37719A shares all the measurement attributes of its sister product, providing multi-rate test capability, including jitter, up to OC-48. The analyzer supports full GR-253 mappings for ANSI payloads.

For more information, see page 448

For detailed specifications, circle 39 on the reply card (last page) or contact the HP Call Center in your region.

ABR functional testing on the industry-standard BSTS



The new HP E6287A ABR Emulator

The Available Bit Rate (ABR) service category is the most complex ATM traffic type yet defined by the ATM Forum because of the variety of feedback mechanisms, parameters, rules, and real-time response expectations.

The new HP E6287A ABR Emulator for the BSTS is a solution that allows you to develop and deliver ABR services to your customers in the shortest possible time.

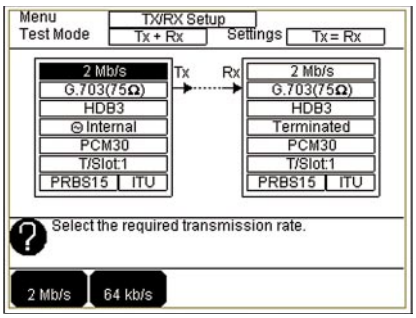
You can now use the BSTS to monitor switch marking behavior, measure switch reaction times, check the interaction with signalling, and measure the overall QoS.

The BSTS ABR solution can generate ABR traffic at rates up to 155 Mb/s, decode resource management (RM) cells, and analyze ABR flows. A range of measurements are available to determine the functional performance of an ABR connection. The ABR Emulator can work with existing BSTS ATM Line Interfaces from 1.5 Mb/s to 622 Mb/s.

For more information, see page 452

For detailed specifications, circle 40 on the reply card (last page) or contact the HP Call Center in your region.

Powerful handheld circuit testing



ProBER has 2 Mb/s BER and signal quality measuring capabilities.

The HP E7580A ProBER is a powerful handheld solution for testing 2 Mb/s and 64 kb/s digital circuits. It offers extensive BER test functions plus a unique range of signal quality measurements (pulse mask, jitter, level, and frequency). This test capability, combined with ProBER's intuitive operation, simplifies installation and maintenance testing for faster problem resolution.

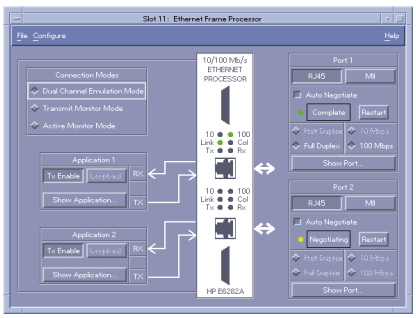
The battery-powered ProBER provides simultaneous transmit and receive capability with framed and unframed 2 Mb/s and n x 64 kb/s signals. It also provides full error and alarm generation/analysis, talk/listen capability, and VF tone generation and measurement.

ProBER's simplified operation includes AutoSetup mode, which automatically configures to the line rate, signal structure, and test pattern when you connect to an unknown signal structure.

For more information, see page 439

For detailed specifications, circle 41 on the reply card (last page) or contact the HP Call Center in your region.

Full-featured LAN/WAN/ATM analyzer



The HP E6282A 10/100 Mb/s Ethernet Frame Processor supports dual port transmit and active monitor mode configurations.

The HP E6282A 10/100 Mb/s Ethernet Frame Processor brings LAN interworking and native Ethernet testing to the HP Broadband Series Test System (BSTS). The HP E6282A has a rich set of test features that are tailored for functional and stimulus/response testing of IP services over Ethernet.

The HP E6282A is a single-slot VXI 10/100 Mb/s Ethernet module. By adding this Ethernet module to a BSTS system, you can perform LAN-LAN, LAN-WAN and LAN-ATM interworking testing by using your existing ATM and Frame Relay line interfaces. Multiple Ethernet Frame Processor modules can be installed in a BSTS system for multiport layer 2/3 IP traffic generation and analysis.

You can use the HP E6282A Ethernet Frame Processor to create up to 8 independent traffic streams containing LAN protocol data units (PDUs) such as IP packets. On the receive side, you can configure filters on up to 8 data streams of LAN traffic for layer 2 and layer 3 performance measurements, real-time statistics and capture. The capture playback viewer supports decoding of over 100 LAN protocols with a resolution of 100 ns.

For more information, see page 452

For detailed specifications, circle 42 on the reply card (last page) or contact the HP Call Center in your region.

Small, low-cost, GPS-based time and frequency reference source

The HP 58533A GPS time and frequency reference receiver is ideal for both integration and bench-top applications.

The compact HP 58533A is a low-cost source of precise time and frequency signals for system integration applications and general bench-top use in research and development laboratories. It is based on the signals from the 24 global positioning system (GPS) satellites, so it doesn't need periodic recalibration.

The new reference receiver provides a 10 MHz output with a frequency accuracy of better than 1 x 10^{-11} for a one-day average, and a 1 pps output with time accuracy within 110 ns of UTC (USNO MC) when locked to GPS. When unlocked, holdover aging is less than 2 x 10^{-8} per day, maximum. The sine wave frequency output is 1 V p-p into a 50 Ω load, and the 1 pps output is a 2.4 V pulse into a 50 Ω load.

The HP 58533A features an alarm output, RS-232 interface for monitoring operation remotely, and T-RAIM satellite error detection. It also has an 8-channel, parallel-tracking GPS engine for C/A code, and the L1 carrier.

For more information, see page 505

For detailed specifications, circle 43 on the reply card (last page) or contact the HP Call Center in your region.

Time/frequency receiver with multiple outputs

The HP 58540A generates precise 10 MHz, 1 pps, and 1pp 2s outputs and has optional output configurations.

Designed for system and bench-top applications, the HP 58540A is a small, cost-effective source of GPS time and frequency. In its standard configuration, this GPS-based reference receiver produces precise 10 MHz and 1 pps outputs. Phase coherency is maintained between the outputs, and a frequency accuracy of better than 1x10^{-11} (one-day average) is achieved when the crystal oscillator is locked to the GPS signal. Optional configurations/OCXO's are available to cover a range of timing/frequency applications that include Paging, GSM, CDMA, and E-911.

The HP 58540A's alarm output and RS-232 interface allow remote monitoring. The receiver incorporates T-RAIM satellite error detection, and has 8-channel, parallel tracking for C/A code, and the L1 carrier.

For more information, see page 505

For detailed specifications, circle 44 on the reply card (last page) or contact the HP Call Center in your region.

High-performance optical spectrum analyzers

The HP 86140 series provides bench-top and portable solutions for the factory and the field.

The HP 86140 optical spectrum analyzer (OSA) series is designed to meet the spectral analysis needs of manufacturers, developers, and system installers working in fiber-optic communications. The family includes bench-top and portable versions, both of which have an integral printer and floppy disk drive for easy access to results. The analyzers make accurate spectral measurements over the 600 to 1700 nm wavelength range and offer high sensitivity and a wide dynamic range.

Characterize DWDM components

Behind the uncluttered front panel and intuitive graphic user interface of the bench-top analyzer lies a high performance monochromator designed for characterizing DWDM components and multiple channel systems. The functions and capabilities of this OSA are well suited for manufacturing, incoming inspection, and verification. Its bright 10.4-inch color LCD display and custom application software simplify measurements and enable fast volume ramp up with minimal training.

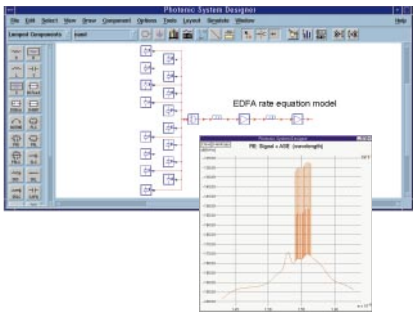
Ideal for factory or field

The portable analyzer offers the full capability of a bench-top unit in a rugged, small-footprint package, so it is an excellent choice for use in the factory and the field. This unit is optimal for situations where space is limited, or where the instrument has to be transported between locations.

For more information, see page 426

For detailed specifications, circle 45 on the reply card (last page) or contact the HP Call Center in your region.

Photonic tools get products to market fast



HP Photonic System Designer includes co-simulation technology and a wide array of behavioral models.

The result of many years of development and validation, the HP Photonic System Designer is a design automation tool that helps engineers tackle even the most challenging photonic system design problems. Its co-simulation technology and wide array of behavioral models targeted at optical and electro-optical systems enables photonic component, equipment manufacturers and service providers to get competitive products to market in less time. In addition, the HP Photonic System Designer provides a medium for demonstrating product value to customers, a powerful competitive advantage.

The first in a series of photonic design automation tools, HP Photonic System Designer is the result of joint efforts between HP and BNeD. The co-simulation technology is based on HP Ptolemy, the technology of choice for over 400 leading communication companies worldwide. HP Ptolemy includes analog and RF behavioral models, optimization, yield analysis, instrument links, and a model development kit. It also includes optical and photonic behavioral models .

HP Photonics Systems Designer is part of the HP Advanced Design System.

For more information, see page 332

For detailed specifications, circle 46 on the reply card (last page) or contact the HP Call Center in your region.

Testing optical dense WDM components to the limits

Modular system allows the configuration of stimulus/response tests in a single frame.

Available in spring 1999.

The technological evolution of optical telecommunication networks continuously challenges measurement limits.

Wherever upgradeability and reliability is key for the characterization of optical components, the new Lightwave Measurement System will be a solid foundation for the future. It supports a whole range of tunable and fixed source and sensor modules, including the existing HP 8153A Lightwave Multimeter series.

Superior wavelength accuracy and linearity are essential test conditions to ensure the transmission quality of passive optical components for the most recent dense WDM systems. A new tunable laser module has been designed to address this requirement with a built-in wavelength control loop. Its ultra-low source spontaneous emission enables accurate crosstalk measurement of dense WDM system components with many channels at narrow spacing.

Setting up a realistic test bed for dense WDM transmission systems is possible by combining the high-power module with an arbitrary number of the compact, yet fully remote controlled tunable laser modules.

For more information on the presently available tunable laser products, see page 414

For more information, see page 414

For detailed specifications, circle 47 on the reply card (last page) or contact the HP Call Center in your region.

Measure both wavelengths and powers

Use this multi-wavelength meter for optical transmission system design, installation, operation, and maintenance.

The HP 86120C multi-wavelength meter gives developers and installers of wavelength division multiplexing (WDM) systems the capability to accurately measure the wavelength and powers of multiple optical carriers. In addition, this high-performance instrument addresses traditional wavelength measurements with outstanding performance. The meter's rugged design makes it ideal for both laboratory and field applications.

With the HP 86120C, you can:

- verify the total system power or the levels of the individual optical carriers
- use the signal-to-noise ratio function to verify transmission system performance, and also determine the signal-to-noise ratios of individual signals
- use its automatic drift routine to monitor changes in signal wavelength and amplitude while data is logged simultaneously
- characterize Fabry-Perot lasers using the built-in automated measurement routine
- send measurement data to an external printer or computer

For more information, see page 430

For detailed specifications, circle 48 on the reply card (last page) or contact the HP Call Center in your region.

Optimize your fiber optic network

AccessFiber simplifies construction, configuration and maintainence of fiber optic networks.

HP's AccessFiber is an invaluable aid for planning and constructing new fiber optic networks as well as expansions to existing networks. AccessFiber puts information developed during the various phases of the network documentation lifecycle into its database.
It provides tools that support the construction workflow and work-order generation. In the commissioning and configuring operations, AccessFiber uses the information in its database to verify the integrity of the construction operations. In the maintenance operation, archived data facilitates proactive fiber monitoring as well as fast, accurate fault location. Finally, data collected in all process steps is available for planning new changes, closing the cycle of information flow.

AccessFiber is a scalable solution that can be tailored to fully fit all customer environments. Its wide range of configuration options ensures that AccessFiber meets the needs of fiber-optic network management today and in the future. The software can run on a single Windows NT workstation as well as on a HP-UNIX server based configuration—your business needs will determine the right solution.

For more information, see page 422

For detailed specifications, circle 49 on the reply card (last page) or contact the HP Call Center in your region.

Test multi-layer ceramic capacitors at high speeds

The HP 4268A provides a powerful solution to high-value MLC test needs.

Designed for testing high-value multi-layer ceramic capacitors (MLCs) in production lines, the HP 4268A capacitance meter performs high-speed capacitance measurements at a constant large test signal level. An auto level control feature maintains a constant test signal level, in compliance with IEC 384 or other standards; there is no voltage drop for high-value capacitors. The HP 4268A can test devices at 120 Hz or 1 kHz within 25 ms, including ALC time. This high throughput helps reduce production test cost.

The HP 4268A has an opto-isolated handler interface, so you can easily integrate it with chip component handlers and maximize test efficiency. The meter's built-in comparator can sort the measured capacitance to up to 9 bins. A contact check function detects contact failures between the four-terminal contact probes and the device under test within 5 ms.

For more information, see page 368

For detailed specifications, circle 50 on the reply card (last page) or contact the HP Call Center in your region.

Simplify structural testing

The HP E1529A remote strain conditioning unit supports up to 5000 channels of strain measurement from a single system.

The HP E1529A remote strain conditioning unit simplifies structural testing of large mechanical designs, such as airframes and rockets, which require many channels of strain measurement. Strain gage cables connect to the unit with standard RJ45 telecom plugs, making it exceptionally easy to reconfigure or replace strain gages. Bridge completion and shunt calibration resistors are provided for each channel, with provision for special values.

For greater flexibility in providing the appropriate excitation voltages to banks of eight gages, the HP E1529A has connectors for four external sources. Each channel is protected with an automatic resetting fuse so that a shorted gage does not disturb other channels.

The HP E1529A provides gain, filtering, and muliplexing functions for connection to an C-size VXI HP E1422A Remote Channel DAC Unit, which digitizes and stores the readings in buffer memory. Each HP E1422A can support up to sixteen HP E1529A remote strain gage units.

For more information, see page 552

For detailed specifications, circle 51 on the reply card (last page) or contact the HP Call Center in your region.

Reduce test costs for RF power amplifiers

New RF power amplifier tester offers high throughput and a small footprint.

The HP 84000 Model A20pa RFIC Test System provides the lowest production test costs for the RF power amplifiers used in cellular and PCS phones. A high-speed digital receiver, fast dc subsystem, and rapid servo loops for setting device output power help to maximize test throughput, and the system's single-rack footprint minimizes tester floor space.

The measurement capability of the HP 84000 model A20pa includes error-corrected S-parameters from 750 MHz to 3 GHz, gain compression, power-added efficiency, adjacent channel power, and harmonics (to 8 GHz), as well as (optionally) intermodulation, noise figure, and pulse rise and fall times.

The RFIC test system has two RF measurement ports, built-in measurement libraries for quick test-plan development, and support for CDMA, NADC, PDC, PHS, GSM, DECT and TETRA standards.

For more information, see page 537

For detailed specifications, circle 52 on the reply card (last page) or contact the HP Call Center in your region.

High-throughput in-circuit testing

The HP 3070 Series 3 comprehensively tests boards with as little as 50% access at up to two times the speed of the previous system.

If more and more of your new boards have less and less electrical access, you may wonder if in-circuit testing is a viable test strategy. It is, with the new HP 3070 Series 3 board test system.

Built on the same platform that has become the most popular board test solution in the market, the Series 3 systems perform complete in-circuit tests on boards with as little as 50% access, thanks to HP MagicTest technology. The systems also include new software that makes on-board programming of Flash devices easier than ever.

Throughput on the Series 3 machines is up to two times faster than previous systems, so tests can keep pace with the rest of the manufacturing line. The Series 3 provides the precise and transportable measurements that characterize the HP 3070 series, and uses the extensive library of tools that enable rapid test development, such as automatic program generators.

For more information, see page 535

For detailed specifications, circle 53 on the reply card (last page) or contact the HP Call Center in your region.

Unbeatable automated inspection systems

Get high-fault coverage for boards that have too many small parts to be adequately inspected by an operator.

If you are plagued by component placement problems caught too late in the manufacturing process or missed altogether, you'll want to learn more about the optical inspection capabilities of the HP BV3000 family. These new in-line process test systems automate visual inspection and deliver high-fault coverage with 95% repeatability.

The BV3000 family has an unbeatable combination for early, reliable visual inspection: intense fiber-optic lighting that enables the capture of a clear image; charge-coupled device cameras for repeatable, well-defined image capture; and robust algorithms that quickly analyze and return data. The systems identify a variety of faults, including tombstone, billboard, misaligned, missing, or extra parts; reversed polarity; incorrect component size; gross solder errors; and lifted or bent leads.

HP BV3000 automated optical inspection systems are an excellent match for manufacturing lines with high-volume, low-to-medium complexity circuit boards, such as those found in personal computers and their peripherals.

For more information, see page 535

For detailed specifications, circle 54 on the reply card (last page) or contact the HP Call Center in your region.

Fast, flexible communications testing

The HP 79000 FCT provides quick test-development time, and has the flexibility to grow as your needs grow.

If you have traditionally built your own rack-and-stack functional test systems for production testing your communications products and are considering purchasing a system instead, the HP 79000 FCT is your answer. Building and maintaining your own custom systems becomes more and more difficult and costly as you transition to an outsourcing or global manufacturing strategy. The HP 79000 FCT brings easy replication of systems, standard interfaces, standard fixturing, and worldwide support to functional test. It moves the highly successful functional test power of the HP 3079CT system into a more open functional test environment.

The HP 79000 FCT system incorporates VXI, the HP Serial Test Card (for serial bit stream emulation), the HP AccessPlus card (for easily integrating external instrumentation), and HP Performance Port (for RF and pneumatic control) into a small, ergonomic package. It uses the HP Visual Test Advisor software, which helps any user, novice or experienced, quickly get to a functional test fixture that is electrically correct the first time. The test system also supports the award-winning HP Fault Detective software, which brings the capability of in-circuit quality fault isolation to functional test.

For more information, see page 535

For detailed specifications, circle 55 on the reply card (last page) or contact the HP Call Center in your region.

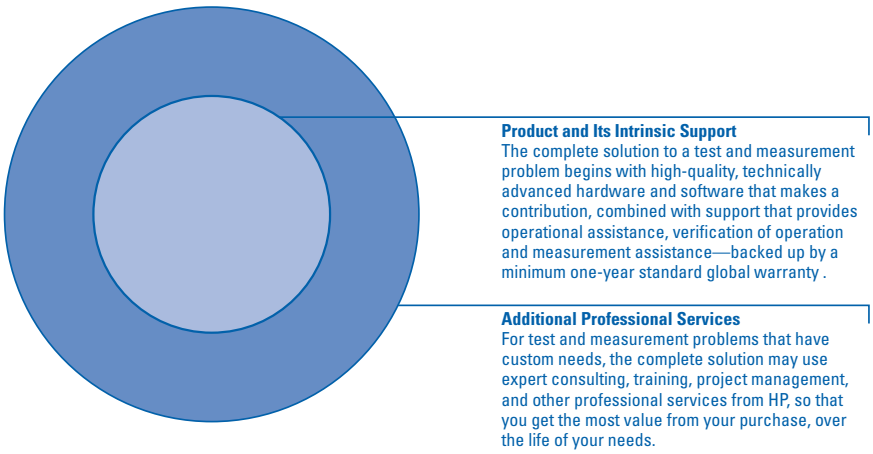
Support & Services 2

Hardware, Software, Consulting and Project Services 65

HP provides superior technical support and services for the life of your product

Complete Solutions

Improving your test and measurement process, while finding the right balance of function, time and cost, is what we call providing the "Complete Solution."



As shown in the figure above, the value of an HP product or system can be expanded to meet special test and measurement needs by utilizing additional professional services that are available at all phases of the life cycle of your problem. We offer a comprehensive list of services, supplied by trained professionals, to allow you to select those that meet your particular needs.

Complete Solution elements

To get all you want and need from your relationship with Hewlett-Packard, we provide both elements of the "complete solution" to your test and measurement problem. These are the core product, with its support and warranty, and, when needed, a wide variety of additional professional services that allow you to select the best set of services to achieve the right balance of function, time and cost.

Product and its support

Hewlett-Packard provides the industry's broadest line of test and measurement products—at the high level of quality and technology for which HP is so well known, backed up with an equally high level of support and warranty.

Support

HP products are designed to be user friendly, and are accompanied with detailed information on their performance and operation. However, in addition, we offer resources to help you with the operation of your equipment, and help you get started. These resources include:

- Verification of operation that assures you that the product is functioning correctly.
- Operational assistance to assure that you are operating the product successfully.
- Measurement assistance to assure that you are able to accomplish the product's typical test and measurement functions.

See our website **http://www.tmo.hp.com** to get started.

Warranty

As an expression of confidence that our products will continue to meet the high standards of reliability and performance that you expect, Hewlett–Packard instrument products carry a minimum of a one-year, return-to-bench, global warranty. **See page 581.**

Additional professional services

To help you maximize the value of your investment in HP products, we offer a variety of resources and services, from which you can select the best combination, to develop the complete solution to your specific problem. **For a Services Selection Guide see page 69.**

Leasing and financing

Hewlett-Packard makes it as easy as possible to acquire HP products. We offer a variety of options to finance your purchase, all tailored to your budget, and often including an attractive trade-in option. **See page 84 and 580.**

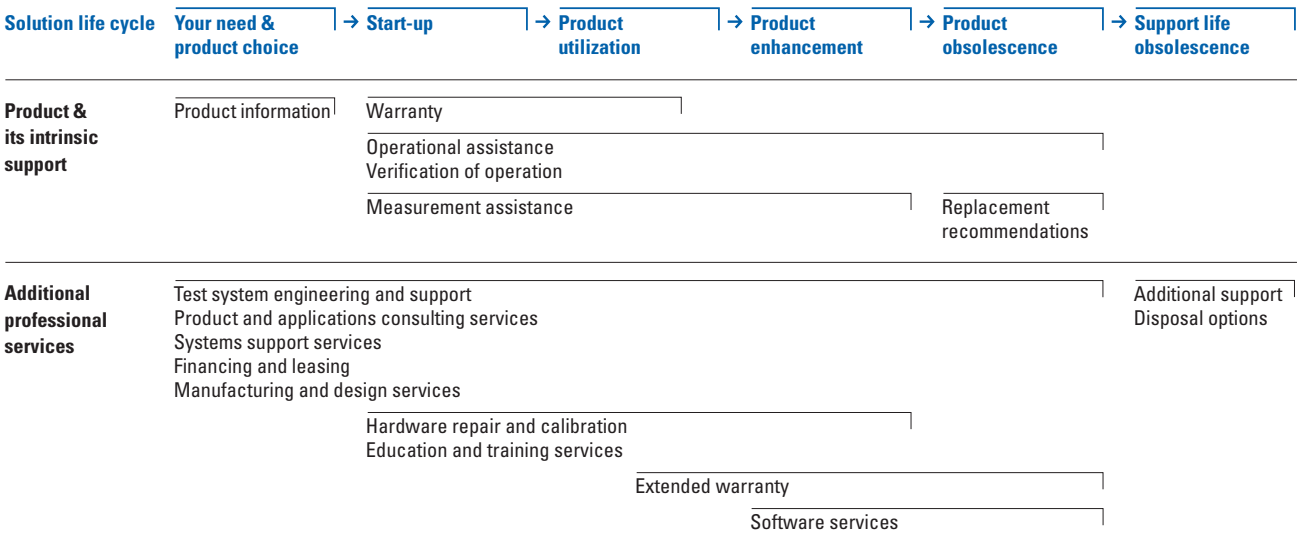
Hardware repair and calibration services

Hewlett-Packard repair and calibration services maximize the uptime of your HP products and ensure consistently high levels of measurement accuracy. Flexible service plans and support options provide fast, convenient repair and calibration at your site, or at service centers. **See page 70.**

Software services

Hewlett-Packard offers a new, flexible, custom-configurable service-and-support package on select system solutions. This is designed to meet your

Complete Solutions Elements



Elements of a complete solution are available to help you at all phases of your test and measurement life cycle.

specific needs, and can range from a self-service to a full-service approach, and from standard to around the clock operational hours. Global contracts are also available. **See page 71.**

Product and applications consulting services
Skilled HP professionals are available to supplement your resources, on an as-required basis, in the planning, development and operational phases of your test system. Available professional services include: Productivity Assistance, Start-up Assistance, Test and Measurement Services and Applications Consulting. **See page 72.**

Test system engineering, integration and support
Hewlett-Packard services can help you solve your special test and measurement problem using skilled professionals who add value at any, or all, steps in its resolution, including: needs analysis, requirements definition, solution design, and solution implementation. We can supplement your capabilities or take on the whole project. **See page 73.**

Education and training services
Hewlett-Packard can provide highly trained instructors, with access to the latest technology, to teach courses in measurement theory and practice, equipment operation, applications, and hardware and software maintenance. These classes, available worldwide, can help you maximize the value of your investment in HP products. **See page 77.**

Design and manufacturing consulting services
Let Hewlett-Packard experts improve your design, manufacturing and test process, while finding the right balance of time, cost and quality. This involves managing the basic issues of minimizing time to volume, reducing production cost and ensuring quality to guaranty high customer satisfaction. **See page 75.**

Accessing HP services and support

Choose the way you access our consulting and support experts and how you receive our free support reference tools.

HP Test & Measurement Call Centers
HP Test & Measurement Call Centers offer real-time technical support and sales assistance around the world. You can contact your local call center by phone, email, fax, and regular mail. In the US call 1 800-452-4844 to talk to a HP Call Center representative (8am to 8pm EST). Outside of the US, see the inside back cover of this catalog for the phone number and address of the HP Call Center near you.

HP Website
The HP Website contains detailed descriptions of consulting services that will help you maximize the potential of any Test and Measurement solution you now own or plan to develop. The HP Website also offers access to free support information such as product, application, and service notes. To learn more about the test & measurement consulting and support services listed on the HP Website, see page 2 or visit our Website: **http://www.hp.com/go/tmc99**

Year 2000 Compliance—HP Test and Measurement Products

For information on "Year 2000 compliant" HP test and measurement products, an updated list of exception products, background data the Year 2000 issue, descriptions of HP support services, and more, visit the "T&M Year 2000" Website, accessible from the test and measurement home page: http://www.hp.com/go/tmc99.

The year 2000 ("Y2K") issue is a very real deadline that has potentially serious implications for a wide space of electronic applications, ranging from large computer networks to products that are controlled by embedded processors. HP can help you prepare for the new millennium, and we urge you to visit our "T&M Year 2000" Website, which you can access from the HP test and measurement home page:**http://www.hp.com/go/tmc99**

The T&M Year 2000 Website also links you to the "HP Year 2000 Program" Website, which offers background information, a project planning overview, HP computer product compliance status, and links to other product groups. It also describes upgrades and support services relating to Year 2000 compliance.

Reviews and tests

HP has conducted, and is continuing to conduct, reviews and tests (when appropriate) of our test and measurement products for compliance with HP's Year 2000 standards. As a result, HP can state that all test and measurement hardware, software, and firmware products on HP's Corporate Price List[1] (dated 1 July 1998 or later)—with the exception of the models listed at the T&M Y2K Website—are either "Year 2000 Compliant"[2] or contain no date function.

Validate in your own environment

Although HP has made every effort to ensure the accuracy of our product testing, each customer's environment differs from HP's laboratory test environment. Therefore, you have a responsibility to validate the Year 2000 compliance of your HP test and measurement products within your own application environment.

Upgrades for Year 2000 compliance

Any HP test and measurement product purchased prior to July 1, 1998 may or may not be Year 2000 compliant, and may require upgrades to become certifiably compliant. HP will modify some test and measurement products that do not comply with our Year 2000 standards to make them compliant, and will generally offer those modifications for sale to customers who want to upgrade their units. Please visit the T&M Year 2000 Website for the latest details.

Upgrades may not be available for obsolete products or for "system" products not listed on the HP Corporate Price List, regardless of their support life commitments. When phoning your HP call center to determine if upgrade(s) are required and can be made, please supply the product type, model number, and serial number so that we can better serve you.

[1] The HP test and measurement products that are listed on the Corporate Price List include models from the following product lines: automatic test systems, automotive test solutions, broadband communications test, component test, communications measurements, communications synchronization, component test, digital IC test systems, distributed measurements, DSP measurement systems, element management systems, fiber-optic instruments, frequency and time analysis, general purpose instruments, integrated systems, lightwave instruments, linear/mixed signal ATE, logic analyzers, logical signal sources, logic systems, microwave CAE, microwave sources, microwave test accessories, network monitoring solutions, precision motion control, protocol test center, power products, RF communications test, RF/microwave device test, RF signal generators, semiconductor parametric test, signal analyzers, system solutions, test system components, Versatest products, and video products.

[2] The term "Year 2000 Compliant" means that if the HP product processes date data (including-but not limited to-calculating, comparing, and sequencing), it does so accurately from, into, and between the twentieth and twenty-first centuries (including leap-year calculations), when used in accordance with the product documentation provided by HP. Accurate data processing is ensured, provided that all other hardware, software, and firmware products used in combination with the HP product do establish and maintain a proper exchange of date data. Where compliance testing is required, HP certifies products to be "Year 2000 Compliant" after the verification of all test suites.

Supporting your success

You chose Hewlett-Packard equipment because it best meets your test, measurement, and computing needs. HP wants you to be successful, and we're committed to helping you achieve the best results from your system for years to come. We don't stop serving you after the sale is completed. Our flexible support solutions—in hardware, software, customer education, and in application and engineering consulting services—bring you many benefits. Our support services will:

- Shorten the period between purchase and effective use of an HP product
- Make available unique worldwide resources for maintenance and troubleshooting
- Ensure continued measurement accuracy

You can measure the results in greater overall productivity and lower cost of ownership.

Maximizing the return from your equipment investment can be seen as a three-phase process of planning and design, implementation, and operation. Hewlett-Packard offers support services to ensure that you obtain maximum performance from your measurement system during each of these phases.

Test & Measurement System Support Life Cycle

Planning and Design	Implementation	Operation
Engineering services Consulting	Application consulting Installation services Engineering services Education services Integration	Hardware support Software support Education services

Smooth implementation through knowledge

A thorough understanding of your equipment's capabilities is essential to achieving maximum performance from your investment. That's why back our products with education courses and materials to ensure that you learn the best way to apply our equipment to your environment.

We also offer site planning, site environmental surveys, and installation services to ensure that your system is installed correctly and quickly.

Peak operation through maintenance

To help maximize your equipment uptime and measurement accuracy, HP has a worldwide customer service organization, staffed with trained engineers who are backed by factory designers. We focus the necessary resources to keep your equipment operating at peak performance.

Because computers are playing a key role in today's measurement systems, software support can be essential to optimizing your system's performance. HP keeps you up to date on the latest software improvements to ensure that your system continues performing to its maximum potential.

Support life

To help you maximize your product's life, Hewlett-Packard will continue to offer support services for as long as feasible. To continue offering these services, we manage our trained staff and repair parts inventories to match your needs.

In any event, HP offers support services on all of our products for at least five years beyond the end of production.

In addition, we will make our best effort to repair or calibrate any Hewlett-Packard product, whatever its age, even if the product has passed through its support life.

Support for your needs

The following pages provide more details on Hewlett-Packard's wide range of support services. Contact the HP Call Center in your region for help in selecting the services that best meet your needs in maximizing your measurement systems' performance.

Service Selection Guide

	Services	Major benefits	Best fit
Hardware support (page 70)	HP instrument repair and calibration HP and major brands on-site instrument calibration System repairs and calibrations	Fast turnaround time Cost savings Dependable measurement accuracy Flexible scheduling	Standalone transportable instruments A variety of instruments in accuracy-critical applications Complex systems, production systems, or other mission critical application
Software support (page 71)	HP Response Center services Software and documentation update services Notification services	Software usage and problem resolution assistance New software releases Up-to-date software information Fast, accurate support	Test systems Instruments with software Instrument controllers
Consulting and Engineering services (pages 73-76)	Installation services Engineering and integration services Productivity assistance	Expert implementation assistance Quick startup of instrument systems Increased productivity	Test systems for manufacturing or semiconductor test Custom test systems Test system design and implementation Project services
Educational services (page 77)	Wide variety of courses covering latest HP products and technology Variety of audiences and skill levels Flexible delivery options	Fast learning Time and cost savings compared to learning independently	Whenever new products or technology are introduced in your environment New people
Design and manufacturing consulting services (page 75)	Consulting services to optimize product and manufacturing process design for best quality, time, and cost	Fast time to production Experts used for specific problem Resource conservation	New product development and introduction Changes in product demand Increased productivity required

Optional Hardware Services

HP quality support services

Whether your company has one oscilloscope, or an entire factory floor full of production test systems, you can trust Hewlett-Packard to meet your test and measurement repair and calibration needs.

- HP's 42 Customer Service Centers worldwide deliver repair and calibration services when and where it is most convenient for you.
- The purchase plans for HP's hardware support are flexible, with the choice of purchasing repair and calibration services either on a contractual or per-incident basis.
- HP's services are the highest quality available and comply with national defense and international standards; HP's major Customer Service Centers are ISO 9000-registered.

Whatever your test and measurement hardware support needs, HP can provide a dependable, cost-effective support selection that you can trust to reduce downtime and get you back to business quickly.

Time-of-purchase support services

At the time of equipment purchase, you can also purchase extended repair and calibration service plans—called the *HP Support Options*. These plans extend the HP support beyond the original product warranty for a total term of three to five years. You lock in maintenance cost savings and HP's high-quality repair or calibration services. Ask your HP sales representative for more information.

HP also offers a variety of services for instrument and systems that you can purchase anytime after product purchase.

After-purchase support services

No matter what your repair or calibration needs, HP offers a variety of flexible choices to maximize instrument uptime, with just the coverage you need.

HP reliable repairs

Standalone, non-mission-critical instruments can be repaired most cost-effectively at an HP Customer Service Center. Repair services include all the necessary parts, labor and materials. Whenever an instrument is sent to an HP Customer Service Center for repair, HP covers the return freight. Repairs sent to HP can be purchased either on a contractual or per-incident basis.

- *HP Standard Repair (STREP)* is a single-event, fixed-price repair service. This alternative is a good choice for low-usage applications.
- *HP Mini-STREP* charges a lower price for a simple repair if it requires less than one hour of labor and falls below a set price for parts.
- The most cost-effective alternative, especially for frequently-used products used in critical applications, is a one-year *HP Repair Agreement*. Repair agreements typically offer significant savings over equivalent per-incident service.

In cases where maximum uptime, greater flexibility or faster turnaround time are critical factors, HP offers On-Site Repair for selected standalone instruments. Ask your HP sales representative for more information.

HP thorough calibrations

All measurements made in HP's calibration processes are traceable to national and international standards. In the United States, measurements are traceable to the National Institute of Standards and Technology (NIST). Each product's performance is compared to standards of known accuracy to ensure conformance with published specifications.

HP's calibration services may be purchased on a contractual or per-incident basis. *HP Standard Calibration*, a per-incident calibration service, is best suited for low-usage applications where there has been a change in instrument use or operating conditions. Standard Calibration includes calibration at HP's recommended intervals, complete data reports for all measured product performance, a calibration certificate and a label that notifies you when your next calibration is due

For accuracy-critical applications where regular calibrations and traceability are required, covering instruments under an *HP Calibration Agreement* is a beneficial, cost-effective alternative. Calibration agreements typically offer significant cost savings over equivalent per-incident service. Agreements also provide the additional benefits of free recalibration after any repair performed by HP, free HP ExpressCal service, and calibration-due notification.

For cases when instrument uptime and accuracy are critical, HP offers the *HP ExpressCal* service. HP ExpressCal offers the convenience of scheduling calibrations in advance, simply by calling the nearest HP Customer Service Center. HP ExpressCal service is included with all calibration contracts and calibration-related HP Support Options. There is a service fee for HP ExpressCal service for calibrations done on a per-incident basis.

HP also offers calibration services specifically designed to meet national defense and international standards, including AQAP-6 and MIL-STD-45662A. In addition to the features of HP's standard calibration service, an enhanced data report is provided that includes appropriate "before" and "after" data and a certificate stating compliance with the appropriate standard. HP will also notify you if one of HP's measurement standards is found to be out of tolerance such that your calibration may be compromised. HP will then recalibrate your instrument free of charge.

On-site calibration for large instrument pools

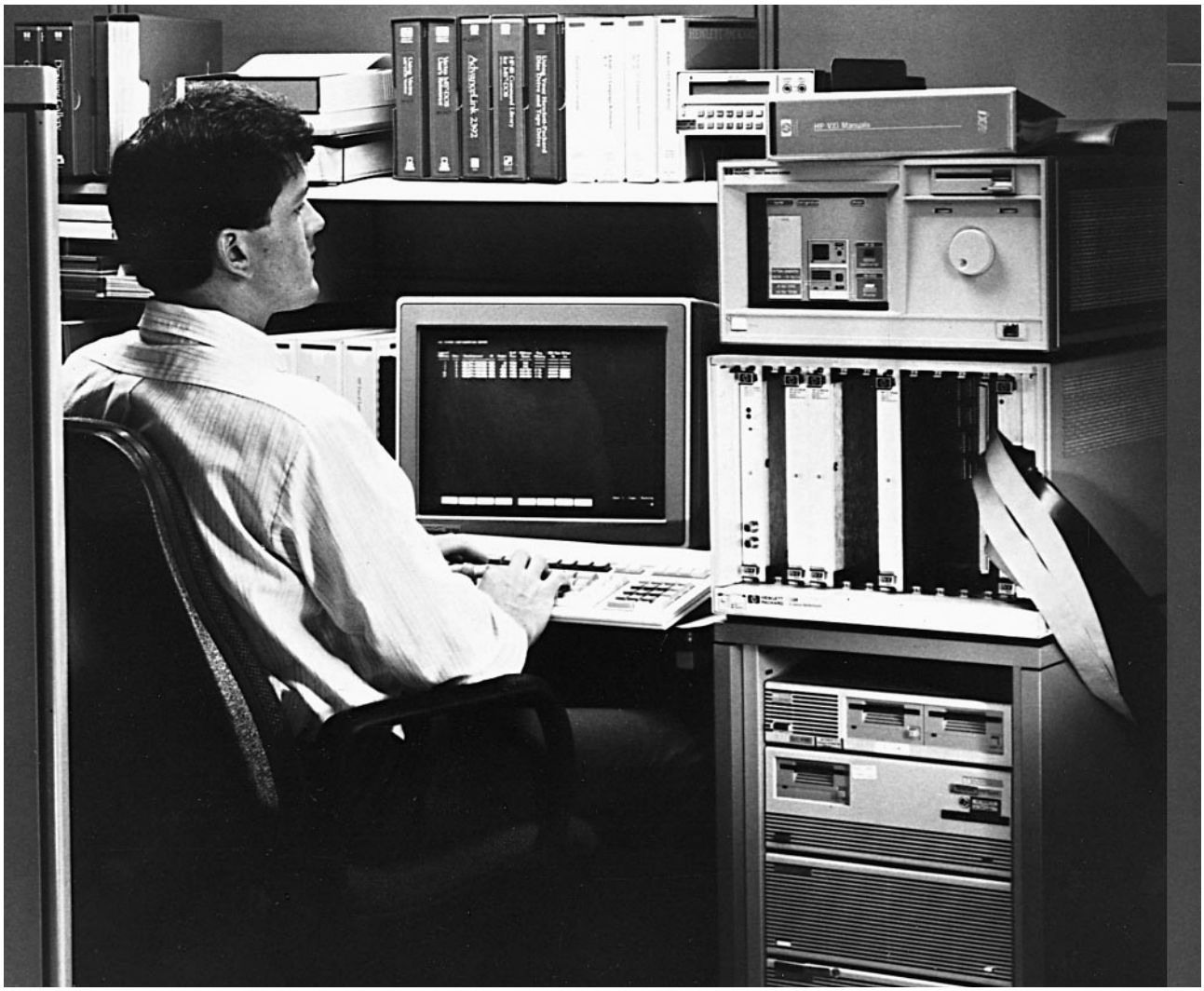
If your company has numerous instruments from a variety of vendors that require maximum instrument uptime, and if you need the most flexible scheduling available, *HP Volume On-Site Calibration* is the best calibration service for you. HP engineers will come to your site when and where it is most convenient to calibrate a broad range of sophisticated products, including more than 6,000 various test and measurement products from other vendors. In addition to the normal test and measurement equipment, HP will calibrate physical, dimensional, and mechanical devices such as particle counters, gauge blocks, humidity and temperature controls, ring gauges, and many others. This service can be tailored to meet your needs, including calibration of all functions to specification, military-compliant calibration, custom calibration, and operation verification. Turnaround time is reduced from days to hours with HP's Volume On-Site Calibration, providing maximum uptime for production or accuracy-critical applications.

How to order

Your HP sales representative can help you select the best support services to meet your needs. Ask your local HP sales representative for more information.

For all instrument calibration and repair services in the U.S., just call 1-800-403-0801.

Outside the U.S. see inside back cover for Call Center phone number for your region.



HP software support services

Ongoing success with your instrumentation and systems requires a partner who understands the need for up-to-date information and software. Hewlett-Packard understands this need and excels at offering three software support services for instrumentation products: Response Center support, software updates, and notification services.

HP response center support

With test systems becoming larger and more complex, even the most experienced system users have questions. And the faster they receive answers, the more productive they become. With HP Test and Measurement Response Center support service, you place one telephone call: HP handles the rest. Specialists at the HP Response Center have access to sophisticated knowledge databases of known solutions to problems, product data, and system history. As a result, they can isolate the problem quickly and minimize downtime. Some of our systems even have remote diagnostic capabilities that enable our specialists to gain valuable information for identifying and resolving problems quickly. Additional authorized caller services may be purchased separately. This will allow more callers beyond the designated caller or specified alternate. HP Response Centers offer telephone assistance for normal software usage, clarification of documentation, and resolution of software

Software update subscriptions

HP continually updates test system software to incorporate improvements that enhance the productivity of your staff and repair known defects. A specialized HP Test and Measurement Application Software Update Subscription service for each of your applications ensures that you receive the latest software and documentation as it becomes available. That way, you'll maximize productivity and the return on your investment. Materials and right-to-use licenses may be purchased separately, so you minimize costs by purchasing only the services you need.

Notification service

For mature products and hardware products with minimal software, HP offers a notification service. The HP T&M notification will provide some of the following services: notification of available product revisions (updates, upgrades, enhancements) to software, firmware, and hardware, notification of important product service issues, notification of product obsolescence, and new product information and availability.

Specific support services

HP provides software support services for our full range of systems and products.

- Board test systems
- Semiconductor test systems
- Telecommunications test products
- Data communications test products
- High-frequency design systems
- Logic development systems
- HP VXI test systems
- Dynamic signal analyzers
- General-purpose test and measurement software
- Radio frequency and microwave products
- Electromagnetic compatibility products

Maximize test system up time with HP on-site support, repair and calibration

Hewlett-Packard offers a new, flexible, custom-configurable service and support package on select systems solutions. This is designed to meet your specific needs, and can range from a self-service to a full-service approach, and from standard to around the clock operational hours, with global contracts also available.

2

On-site system repair

To maximize test system uptime, HP offers high-quality on-site support with flexible response times and coverage periods that enable you to tailor the support programs to your needs. When you order one of HP's onsite service selections, a customer engineer (CE) is assigned to your company. The CE becomes familiar with your measurement system maintenance program. Your CE will also perform preventative maintenance on a regular basis.

On-site system support

Hewlett-Packard offers consulting, project engineering, systems integration, support, and project management services to help you implement a complete test and measurement solution, customized for your specific needs.

Priority-Plus Support

For mission-critical applications where you need HP to work around your schedule and provide very rapid service, the best alternative is Priority-Plus Support. This service level provides on-site repair service 24 hours a day, seven days a week, including HP holidays. Customers within 100 miles of an HP support facility receive an on-site visit within four hours.

Priority Support

This next level of support is the best choice for critical operations where alternative equipment or process cannot be substituted. This service provides coverage for on-site repairs from 8:00a.m. to 9:00 p.m. Monday through Friday except HP holidays. This coverage allows all scheduled maintenance to be performed after normal working hours. Customers within 100 miles of an HP support facility receive an on-site visit within four hours.

Next-Day Support

This is the best choice for less-critical applications where equipment or process can be substituted. This repair service level provides next-day, on-site service coverage from 8:00 a.m. to 5:00 p.m. Monday through Friday, excluding HP holidays for customers within 100 miles of an HP support facility.

Cooperative Support

Cooperative Support service is for customers who maintain their own systems, and rely on HP for training, replacement parts, diagnostic support tools, repair documentation, and remote backup support. This service is available for customers with specific systems, spares, and personnel. Ask your HP representative for information on these prerequisites.

There are volume discounts for all of these support alternatives. In addition, if you have purchased Priority Support or Next-Day Support and have a critical support need, you can order a faster response time for an additional fixed charge when you have an open purchase order on file with HP.

On-site system calibration

For rapid, traceable, mission-critical test and measurement systems calibrations, on-site systems calibration is your best choice. With an on-site calibration agreement, your HP CE calibrates measurement systems at your site, when and where it is most convenient. HP also offers on-site calibration on a per-incident basis. HP performs the same high-quality level of calibration service on-site as it does for instruments returned to HP.

How to order

For more information on these services in the U.S., contact the HP Call Center at 1-800-452-4844 (for Call Center numbers outside the U.S., see the inside back cover of this Catalog). You can also visit our Web site: **www.hp.com/go/tmc99**

If you can't access the World Wide Web, and there is no Call Center in your area, please contact your local HP Sales Office (see page 582 for a complete listing).

The test system shown is typical of the type of system supported by HP's on-site service package.

Realize the full potential of your new instruments or measurement system with HP Productivity Services

Productivity assistance

Hewlett-Packard stands ready to help you maximize the return on your measurement investment. A wide range of productivity-enhancing services helps you realize the full potential of your planned or newly acquired instrument or measurement system. HP has the trained personnel to help you get started and produce measurable results quickly. Whether you need a few hours of advice from an experienced systems or applications engineer, help with your overall test and measurement processes, or a complex custom system solution involving a major project, HP is ready to help—your success is our business.

Startup assistance

Are you considering the purchase or lease of a complex piece of test equipment? You probably are concerned about getting results from your new equipment immediately. Or, you may have questions regarding the best way to apply a new instrument to your specific situation. HP's startup assistance is the answer. A few hours with an HP expert can often help you overcome measurement system roadblocks, or help you fine-tune your system for optimum speed and accuracy. Our engineers are experienced in the latest technology, measurement applications, and instrument operation. They can show you tips and techniques for maximizing your HP measurement system's performance, as well as assist you in customizing and integrating measurement systems into your environment.

For example, HP's startup assistance service can be used to help you in the following areas:

- System setup, installation, and initialization
- Operator or user training
- Controller, instrument, and system interfacing
- Calibration and measurement techniques
- Help with data management and presentation

HP's startup assistance provides you with quick answers to your questions, letting you harness the full power of your measurement system right away. HP's experienced system engineers can come to your site at your convenience, to consult with you on your specific questions or problems.

Startup assistance is available on a half-day and daily basis, to give you the flexibility you need. For more specific information on productivity and startup assistance services offered in your area, please consult your local HP field engineer.

Test services

Do you require a special measurement performed on a one-time basis, but cannot justify the purchase or lease of a complete system? Or, do you have a special measurement need that you cannot perform due to lack of equipment or expertise? HP can provide test and measurement services on specific instruments and in many applications.

Here are just some of the many examples of HP test and measurement services:

- Phase noise measurements
- High-frequency network measurements
- Local Area Network (LAN) audit/health check service
- HP 64000 system installation and application assistance
- Process data monitoring (data acquisition systems)
- RF/microwave component design consulting
- Transceiver test application services
- Three-dimensional X-ray board testing services
- Cable test applications consulting
- High-frequency materials testing services

Applications consulting

Would you like some help with improving your overall component or device test strategy to optimize throughput, accuracy, or quality? This consulting service leverages HP's knowledge and experience with current industry practices and HP instrument capabilities. Measurement performance consulting is an extension of basic applications assistance and instrument startup support. This service involves a more in-depth understanding and analysis of your measurement process or measurement protocol and provides you with possible suggestions for improvement.

How to order

For more information on these services in the U.S., contact the HP Call Center at 1-800-452-4844 (for Call Center numbers outside the U.S., see the inside back cover of this Catalog). You can also visit our Web site: **www.hp.com/go/tmc99.** If you can't access the World Wide Web, and there is no Call Center in your area, please contact your local HP Sales Office (see page 582 for a complete listing).

HP designed this VXI-based manufacturing test system with a high-density, quick-disconnect DUT fixture interface.

Combine HP T&M skill and experience with HP products for complete solutions

Hewlett-Packard services can help you solve your special test and measurement problem using skilled professionals who add value at any, or all, steps in its resolution. We can supplement your capabilities or take on the whole project. This gives you flexibility in resource deployment, schedule development, and minimizes the need to attract, train and support specialized test personnel.

A comprehensive range of professional services from Hewlett-Packard for test system design and implementation allows you to chose how best to meet your special needs. We offer professional consulting, project engineering, system integration, support, and project management services to help you implement a complete test and measurement solution. Our ability to provide test and measurement solutions and support them on a worldwide basis, combined with our systematic and collaborative approach to managing solution implementation, results in your lowest risk alternative.

On request HP experts will apply their extensive knowledge of measurement, computing, communication technologies and products to a broad range of your activities. We can provide:

- Needs analysis
- Requirements specification
- Solution planning
- Solution design engineering
- Solution implementation
- Solution support

As a result, with HP you get the test systems you need, exactly when you need them. You reduce your time to market and increase your capacity with low additional risk. Most importantly, you are free to focus on your core business because we fully support you with ours.

Make or buy

Should you build your own test and measurement system, or contract with an outside supplier?

Consider that by engaging HP you can:

- Concentrate on designing and developing your new products and applications
- Capitalize on the expertise of HP test and measurement professionals
- Meet more aggressive development schedules
- Optimize your process.

Choose the best; choose HP

Whether your test requirements are small or large, simple or complex, when you purchase a custom test system from HP, you:

- Gain access to leading-edge process and system design capabilities.
- Benefit from the latest advancements in measurement and test technologies.
- Reduce your own risk through increased visibility of true cost and schedule control
- Accelerate your overall project schedule and improve your resulting time to market
- Enjoy a long-term support and maintenance strategy backed by a strong reliable company
- Free your engineering resources to focus on your company's core capabilities and strengths

In working with HP's consultants, engineers, and project managers, you are assured of retaining a comfortable level of control. You are our customer and we want to be in position to be able to continue to address more of your measurement and test challenges in the future.

Key Intergration Partners

To compliment our test system design and implementation services, HP has formed alliances with other test system integrators as part of our Key Integration Partner (KIP) Program. Together with our partners, we can offer test systems solutions in a broad spectrum of applications. HP can quickly assess your test system needs and engage the right team to address those needs.

For more information on these services in the U.S., contact the HP Call Center at 1-800-452-4844 (for Call Center numbers outside the U.S., see the inside back cover of this Catalog). You can also visit our Web site: **www.hp.com/go/tmc99**

If you can't access the World Wide Web, and there is no Call Center in your area, please contact your local HP Sales Office (see page 582 for a complete listing).

Let HP experts improve manufacturing and test processes and find the right balance of time, cost and quality

The challenge of constant change

Today's business environment requires the ability to deal with constant change. The time-to-market, or, more realistically, the time-to-profitability requires tremendous flexibility and knowledge of:

- new processes
- new product technologies
- higher customer expectation

Manufacturing and test capabilities must be tailored to meet these changes, and implemented faster, better, and at lower cost.

Meeting the challenges

Managing your product life cycle from design to warranty, and all the associated processes, is a dynamic situation. Special skills are often needed to develop the manufacturing and test capabilities for each phase. Shorter product cycles and new technologies require a tighter integration across your organization, from the design through build processes. Test strategies should couple test methods tightly with those processes so you can give your customers the highest value at the lowest cost. As your existing products evolve and new products are created, your processes must evolve and change as well. Design, manufacture and test methods, processes and costs must be well understood and managed.

HP can provide expertise to help you meet challenges

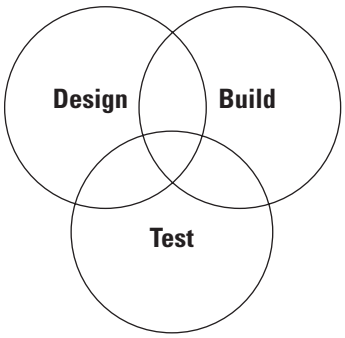
HP's Design, Manufacturing and Test Process Consultants know every aspect of business processes, both inside the electronics field and out of it. Over the years they have been involved in our fundamental business decisions, allowing us to get our products to market faster, at lower cost and with the highest quality. They have been integral to some of our own successful programs, including:

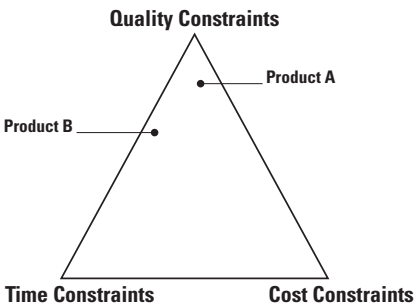
- Design for manufacturing
- Design for testability
- Short cycle times
- Test process design
- Supplier management

The "Test Strategy Triangle" (right) shows the three fundamental elements—time, quality and cost—that must be considered when developing a process strategy. To achieve a process optimized for your customer's needs, the dynamics of your marketplace, and your profitability, an effective time/quality/cost balance must be made.

HP will work with you to apply our knowledge and proven techniques to help you plan and execute the process that meets your overall business objectives.

For more information on these and other programs from HP, visit our web site: **www.hp.com/go/tmc99** or contact your HP representative at 1-800-452-4844





In this "Test Strategy Triangle," an optimized process results from understanding the effects of time, quality, and cost. By analyzing the constraints for a given product, an optimum process strategy can be developed to meet your customer's needs, as well as the needs of your business. For example, the optimum process for product "A" differs from the optimum process for "B", but each is be successful in meeting marketplace objectives.

The Ford Service Bay Diagnostic System that HP helped develop combines computer-driven service tools and diagnostic strategies with on-line service information to save time and reduce repeat repairs.

Hewlett-Packard reduces your time-to-market by providing consulting and full-time support for project engineering, systems integration, and project management. HP can tailor these services to meet your specific needs and timelines through a network of technical resources. These resources include Hewlett-Packard industry-focused solutions and HP Channel Partners. Together, these programs provide you with the knowledge and systems to help your company remain competitive.

For example, HP offers one of the most comprehensive sets of industry-specific solutions for the automotive industry; some of these solutions are briefly described on this page. For more information, visit: **www.hp.com/auto/design/index.html**

HP also offers industry-focused solutions for wireless networks, copper or optical-fiber centric communication networks, educational institutions, aerospace/defense, electronics manufacturing, and semiconductor manufacturing. For more information about these solutions, visit our HP Web site: **http://www.hp.com/go/tmc99**

Automotive design and development solutions

The automotive and transportation industries are undergoing dramatic changes. Business pressures are coming from regulatory agencies, new technologies, and customers. Automotive designers and developers need state-of-the-art, cost-effective solutions. With HP's 50 years of experience in electronics—and with the assistance of our HP Channel Partners—we are helping the automotive industry work faster, less expensively, and with more agility than ever before, to meet the competitive and regulatory challenges of the industry. Here are some of the specific areas in which Hewlett-Packard automotive design and development products and services excel.

Invaluable design and development feedback

HP helps reduce time-to-market and increase engineering productivity with proven, integrated software solutions for design and development teams. For example, the HP Algorithm Prototyping System is an integrated tool suite that facilitates the rapid and efficient design and debug of open- and closed-loop control systems used in powertrain, safety, and comfort systems. The tools allow new control algorithms to be validated with the actual processes, for improved confidence in the system's control capability, and it helps engineers make timely improvements. The developed, verified, and validated control algorithm that the prototyping system generates can be unambiguously communicated to the software developer.

Optimized powertrain systems

Powertrain design teams today need to optimize performance, fuel economy, and emissions. Also, powertrain systems must operate in concert with the other subsystems in a vehicle. To meet these rigorous demands, HP has developed a high-performance measurement, control, and computing platform that is well-suited to powertrain test. The platform's tools perform rapid prototyping, simulation, and calibration of vehicle control modules to streamline development and ensure high quality while improving cost efficiency.

Reduced noise, vibration and harshness

HP offers an unmatched range of test and measuring equipment for reducing levels of noise, vibration and harshness (NVH), and we have partnerships with leading providers of the software used to solve NVH problems. All you need to do is to choose the solution that's right for you. Test and measurement solutions from HP and our partners can help you fine-tune the driving experience and better differentiate your products from the competition.

Improved manufacturing and production

Cost reductions in manufacturing and production can be achieved through higher throughput, lower warranty costs, reduced waste, and increased productivity. HP has a wide array of tools, solutions, and services to help you achieve these goals.

For example, HP VXI products conform to an open modular instrument standard and allow faster, simpler test system design. Specialized configurations are available. The HP TS 5450, for example, is a functional test system specifically for testing automotive electronics such as engine control modules. This complete, measurement-ready platform puts you in production in less time. We also offer smaller, lower-cost test platforms for ABS electronics, airbags, body electronics, and lighting systems. HP's automotive-production-tuned systems help you shorten your development and test times.

Superior service solutions

As electronic technology continues to expand in automotive applications, the gap between the complexity of that technology and the automotive technician's knowledge widens. HP can help to bridge that gap. For example, HP's Automotive Solutions Division (ASD) worked with Ford to develop the Service Bay Diagnostic System (SBDS), a combination of computer-driven service tools and diagnostic strategies with online service information. SBDS provides a direct link to the engine control computer. It allows a technician to download data from the ECU and take control of vehicle systems for test. The SBDS puts technicians ahead of the technology.

HP Channel Partners

There are many specialized test and measurement applications where HP resources and products are only a part of the total solution. Often, these applications require the additional capabilities offered by third party experts that have great skills and experience in specific fields. HP recognizes this and, as a result, has formed relationships with many other world-class companies to provide you with the complete and reliable solutions you need. The Channel Partners program combines each Channel Partners' strengths in application-specific products, systems, and services with HP's high-quality test and measurement products and worldwide sales support. Together, HP and its Channel Partners can provide you with optimized turnkey measurement systems.

HP Channel Partners offer solutions in the following general application areas:

- Antenna RCS testing
- Electrical system components
- Electronic components
- EMC
- Piston engine test
- Turbine engine test
- Structural vibration analysis
- Frequency spectrum monitoring
- Rotating machinery
- Mechanical functional test
- RF and microwave semiconductor test
- Power generation
- Process monitoring and control
- Signal simulation

For more information on these services in the U.S., contact the HP Call Center at 1-800-452-4844 (for Call Center numbers outside the U.S., see the inside back cover of this Catalog). You can also visit our Web site: **www.hp.com/go/tmpartners**

If you can't access the World Wide Web, and there is no Call Center in your area, please contact your local HP Sales Office (see page 582 for a complete listing).

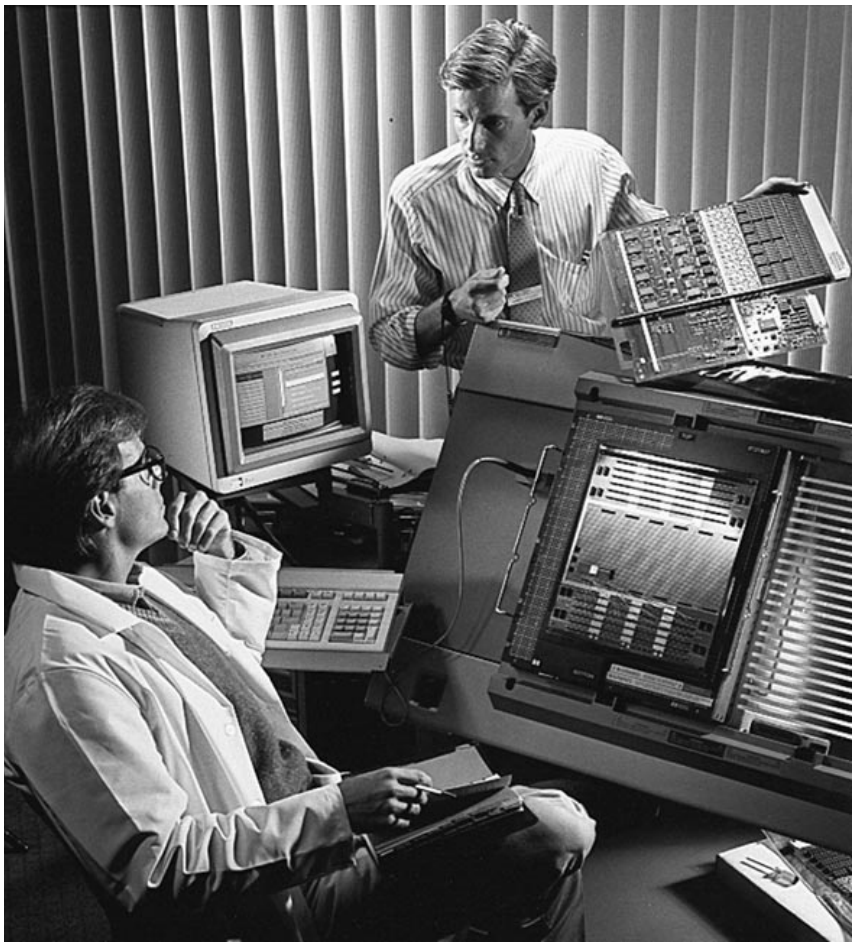
HP educational services

We are committed to offering training that will permit you to get the best possible use of your Hewlett-Packard equipment. HP recognizes that both initial instruction and ongoing education contribute to your success; that is why we offer courses covering applications, software and hardware maintenance, and operations for a wide range of HP instrument and computer solutions.

Our courses can help you build basic technical skills and learn new measurement techniques. Moreover, HP courses can enable you to minimize startup times on complex instruments, improve the quality of your measurements, and increase the accuracy of your data.

Quality training

- Our instructors understand your industry—They speak the language. We make sure our instructors have a deep understanding of the subject and can effectively explain—in clear, concise terms—everything you need to know, from specialized test techniques to the physics behind the measurements. Working as a team, product specialists, industry experts, curriculum engineers, course writers, and instructors develop training materials and design courses with the goal of maximizing your learning experience.
- Limited class sizes—Classes are limited to six to ten students. We believe small classes encourage closer interaction with the teacher and other students, thus permitting students to share learning experiences and applications expertise.
- It's not all books—Hands-on training is important to your success. That is why we provide lab equipment in our classes.
- The payback—Our experience shows that you will learn faster with HP education courses. The benefits are twofold: the equipment can be used sooner and the time you would have spent on independent learning can be used for other opportunities.
- Worldwide training—HP has training centers throughout the world, with classes in continuous progress. Training schedules are published regularly.
- On-site training—Almost all HP courses can be scheduled and taught at your site. This option might prove more attractive to you, bringing the advantages of training in a familiar environment with your own equipment.
- Off-schedule training—In order to accommodate your emerging training needs, additional HP courses can be arranged beyond those published in the local training schedule. Contact your local HP sales representative for more details.
- Customized classes—We can meet special training needs by developing classes and curricula tailored to your needs. These changes may include modification of class materials, development of modular training, development of special labs, integration of new sections in the course, and even the development of entirely new classes.
- Specialized training materials—HP education is typically based on classroom training, led by professional instructors with solid engineering experience. Other HP training formats include computer-based training, videotape sessions, satellite-broadcast, and self-paced training modules.



Test and measurement curriculum

We offer education courses for a wide range of test and measurement applications and industries:

- Computer-Aided Test and GeneralPurpose Instruments
- Electromagnetic Compatibility Products
- Signal Analysis and Monitoring Products
- RF and Microwave Products
- High-Frequency Design Systems
- Datacom, Telecom, and Mobil Communications Test Products
- Board Test Systems
- Digital Design and Characterization/ Embedded Control Systems
- Semiconductor Test Systems
- Open Systems, UNIX, HP-UX, and
- Networking Products
- Component and Material Test Products

Schedules and literature

Your sales office can also provide the following training literature:

- Course data sheets—Every HP class has a data sheet that describes the course in detail. Included are key topics, target audience, course outline, prerequisites, and ordering information.
- Education course schedule—HP training schedules are published throughout the world and list class schedules for each area.
- Education catalog—The catalog presents information on the entire HP course range, including curriculum flow diagrams, course objectives, outlines, and course content. It is your tool for planning the best possible education for yourself and other members of your organization.

Course information on the Worldwide Web

Course date sheets and schedules are also available on the Worldwide Web.

How to order

To register for any HP class in the United States or to order a Test & Measurement Education Catalog, call 1-800-593-6632. In Canada, call 1-800-561-3276. Elsewhere, contact the HP Call Center at 1-800-452-4844 (for Call Center numbers outside the U.S., see the inside back cover of this Catalog). For more information, visit the Test and Measurement education website: **http://www.hp.com/go/tmeducation.** If you can't access the World Wide Web, and there is no Call Center in your area, please contact your local HP Sales Office (see page 582 for a complete listing).

HP helps customers worldwide improve their business results

Let HP's expert consultants assist you with your test and measurement activities whenever needed—for example, when you lack internal engineering resources.

As a technology company, HP understands the ever-increasing sophistication and complexity of the measurements you must make during the entire life cycle of design, manufacturing and support. We recognize that you require instruments and systems that are not just more capable, but that are also easy to learn and easy to use. HP products are designed to help you work efficiently on your project, solving problems and getting to market as quickly as possible, spending the least possible time on tests and measurements.

Typically you purchase an HP product or service for use as an element in the solution of a specific problem. More and more often, you need a broad set of skills, a combination of equipment, a customized piece of software, and specialized technical knowledge to implement the solution and maintain it. Many customers request HP's help in augmenting their internal capabilities to develop a complete, optimized test and measurement solution in the shortest time, using a minimum of their own resources. HP can provide assistance during any or all phases of the problem resolution.

When you choose HP as your test and measurement partner, you get the best product technology and quality, plus access to an unequaled source of problem-solving expertise, whether it is an application of a standard HP product, or a customized system for a major project. We have helped develop solutions for customers ranging from start-up companies to large international firms. Trained HP professionals staff our facilities around the world and know the language and the culture. As a result, they can combine HP's resources with local capabilities to provide the best solution possible.

Lockheed Martin's Lunar Prospector Program achieved aggressive cost and schedule goals with custom HP test system and management help.

Case studies show customer successes with HP Complete Test Solutions

Siemans automotive systems achieves more throughput flexibility at reduced cost with HP TS 5400 systems.

The following pages describe some of the successful "Complete Test Solutions" developed by HP and customers. The stories feature large and small companies from around the world that had a variety of needs. The one thing they have in common is that, in cooperation with HP, they were able to solve a major test and measurement problem. By reading these case studies you may get some new ideas about how HP can help you improve your own business results.

Motorola mobile phone test

The complex architecture of cellular networks, especially digital systems, and the fast turnover of new products makes it impossible to use traditional test instruments. Motorola designers work with HP experts to develop the test systems for all phases of the phone life cycle. (More details on page 80)

Boeing fabrication facility energy management

During normal production, the Boeing Auburn facility uses 30 megawatts. This is a major expense, and the local utility requires the potential to reduce consumption 10 percent in 30 minutes. An HP real-time applications platform helps control costs and manage demand. (More details on page 80)

Newbridge networks inspection and test of dense printed circuits

Newbridge found its assembled printed circuit boards getting more complex and the real estate being fully utilized, obscuring inspection sight lines, and reducing test points. HP provided a solution that improved quality and time-to-market. (More details on page 81)

University Of Illinois study on aerosol effects in atmosphere

University of Illinois scientists, with technical help from an HP engineer, quickly configured an HP VXI test system, with HP VEE, to perform tests on aerosol influence in the atmosphere. Semi-continuous, unattended operation was achieved for extended periods of time. (More details on page 81)

Product debug at Altera

Altera needs to supply its customers with known, and reliable programmable logic devices that can simply be dropped into the proposed design. This is possible using HP PCI series computer verification tools, ensuring conformance to specification and that the product is bug-free. (More details on page 82)

Nortel test strategy

When forecast demand appeared to overwhelm test capacity at Nortel in Northern Ireland, HP test experts were called in to perform a review and make recommendations. The result was higher yields and lower costs, while using the existing equipment. (More details on page 82)

Bell Atlantic's real-time approach to direct-dial fraud

To combat direct-dial fraud throughout its entire service area, Bell Atlantic decided that a real-time system was the only approach that would have any impact. The HP acceSS7 system performs this function plus many more. (More details on page 83)

Network management at SGS Thomson

Many SGS Thomson operations around the world cooperate and communicate on the same project. They rely on the continuous operation of their network for transmission of large amounts of data. HP NetMetrix has solved network congestion and helped establish a procedure that keeps traffic under control. (More details on page 83)

Motorola uses HP mobile phone test system to test products during total life cycle

HP test systems equip this Motorola mobile phone repair facility in Italy.

The cell phone market demands a regular turnover of innovative products. To produce large volumes of a new design at short notice, the manufacturer must be able to test its functions all the way through the production process, from design to completion, with a minimum amount of test design and development for each product. As a result the system used must have comprehensive capabilities, plus the ability to change easily and inexpensively with the development of new products.

The complex architecture of cellular networks, especially digital systems, makes it impossible to use traditional instruments. Motorola designers work side by side with HP experts to develop nearly all the test and measurement instrumentation used worldwide by Motorola in their mobile phone plants. In addition, the entire Motorola aftersales service sector uses HP designed test sets for GSM (Global Standard for Mobile Communications) mobile phones that simulate the real network, as well as the stimuli that the phone will receive in use. While the need for mobile phone repair is not a frequent occurrence, the HP test sets give Motorola technicians the accuracy and repeatability required for their precise work. By using the same test set for final testing after repair as that used during manufacture, results are practically identical to the original product.

Boeing uses HP's real-time applications in energy management

The Boeing Company's Auburn, Washington fabrication facility, located south of Seattle, is the primary location for fabricated parts for all of Boeings commercial airplanes. The facility consists of 25 buildings with over 6 million square feet of manufacturing space on 1.25 square miles of land and consumes more than 30 megawatts during normal production hours. Controlling energy costs is considered a key Boeing business strategy for staying competitive in the worldwide aircraft market place.

The energy provider requires that all major customers be able to reduce their demand, on request, by 10 percent within 30 minutes of notification. The penalties resulting from a failure to comply range from steep financial charges to grid disconnect, which would have drastic effects at the time of the disconnection. Boeing needed timely information from a Centralized Energy Management System (CEMS) to gain and keep control of its energy usage.

POWER Engineers from Hailey, Idaho, the company selected to design and implement the CEMS, chose to use the HP Real-Time Applications Platform (RTAP) software running on UNIX workstations. The result was single-view monitoring and control of equipment, automated electrical curtailment and demand limitation, and acquisition and reporting of energy consumption for Manufacturing Business Units. Dramatic energy cost savings have been realized and meaningful management reports on energy use are produced in a fraction of the time previously required.

Newbridge applies HP systems and complementary test strategies to get to market faster, with higher quality

AXI locates process defects on densely-loaded boards with hidden joints.

Printed circuit assembly at Newbridge Networks Corporation of Ontario, Canada is typically high-mix, low-to-medium volume of densely loaded, double-sided boards with a wide range of components, including ball-grid arrays and ultrafine-pitch devices. Like most telecommunications manufacturers, Newbridge found its assembled boards becoming more complex, with real estate fully utilized. The result was obstruction of visual or optical inspection sight lines, and reduced room for electrical test points. Yet, the need for test remained as strong as ever.

No single test strategy seemed sufficient to capture all the faults that could occur during a typical manufacturing process. After exploring multiple approaches, Newbridge worked with HP and developed a complementary strategy that moves defect detection and rework upstream, increasing design flexibility while lowering costs and moving products to market faster.

HP representatives with manufacturing expertise helped Newbridge engineers combine automated X-ray inspection (using a three dimensional X-ray laminography technique) to detect structural faults such as bad solder joints, with in-circuit test to detect electrical faults such as defective components and electrical circuit problems. Defects found at X-ray, such as opens and shorts, receive pin-level diagnostics for exact location and easy repair. Likewise, defects identified at ICT such as wrong or dead components are easier to repair at that stage.

ICT finds an electrical class of faults, such as defective components and electrical circuit problems.

Newbridge's use of these complementary test strategies has reduced field failures, increased design flexibility and shortened time-to-market.

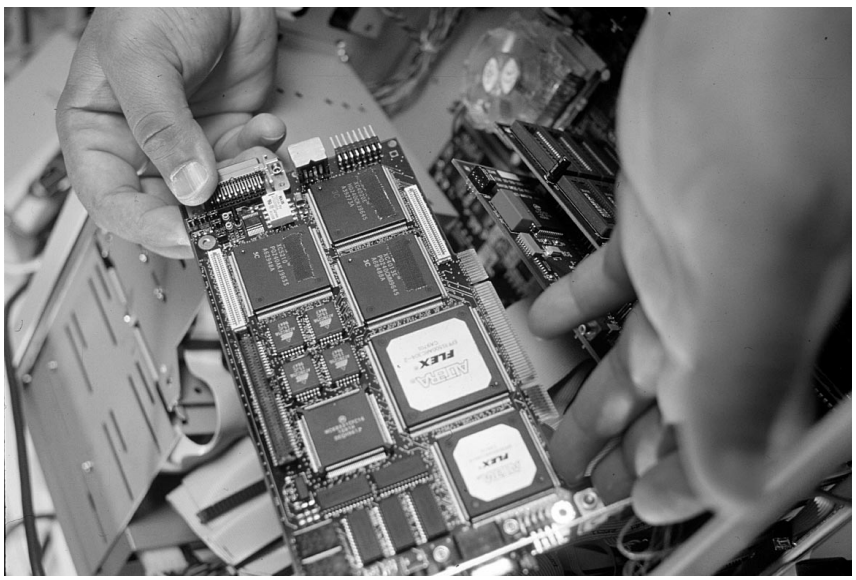
U of I designs HP VXI/HP VEE system for climate study

The effect of human activities on the global climate is a topic of great concern, with economic and political implications. The increase in anthropogenic emissions into the atmosphere has the potential to perturb the radiative energy balance of the earth significantly. There is a great deal of uncertainty as to the effect of the resulting anthropogenic aerosol particles and the interactions between land, ocean and the atmosphere itself. Thus, better measurements, over an extended period of time, are important to understand these processes fully.

Aerosols are the single largest unknown in estimating human influence on global climate. Accurate regional and global measurements of parameters that describe the influence of particles on the climate are needed. They may lead to the development of numerical models that could potentially become a tool for making policy changes. A University of Illinois research team headed by Mark J. Rood and Christian M. Carrico, with technical help from HP, have developed a system to address surface based observations.

A standardized measurement platform was the key for accurate, worldwide, unattended measurements. The entire system designed by the researchers consists of a variety of sensors tied to an HP B-size VXI instrument system. Using a PC with the graphical programming language HP VEE, the system was quickly configured. The final system is capable of semi-continuous unattended operation for extended periods of time. The U of I team also used HP VEE on-site for the data display.

By using HP computer verification tools, Altera acheives fast time-to-market with virtually bug-free product



This is a typical circuit board with the Altera Flex 10K product installed.

Altera Corporation of San Jose, California, is the number-one producer of high-density programmable logic devices worldwide. Its FLEX 10K product line leads the marketplace in density and speed of device design. Altera has seen a dramatic increase in PCI-based systems using FLEX 10K devices. To ensure their customers' success in PCI design, and to shorten their customers' design cycle, Altera chose to develop a PCI core solution that could be sold independently and incorporated by customers into their own designs as needed; the PCIBus Master/Target MegaCore Function (PCI/A).

By using the PCI/A core, customers could slash up to six months off their product development time. Altera's known and reliable core could simply be dropped into the customer's system design. To convince customers to buy rather than build, however, Altera had to ensure them that the core conforms to the PCI specification and is bug-free.

To meet these requirements, Altera chose to use the HP E2920A PCI series of computer verification tools. These tools enable developers to determine that the function under test meets all the specifications required by the PCI. They also exercise the functionality of the design itself, generating real-world traffic conditions, and applying stress beyond what is possible with current off-the-shelf devices during system validation.

"Altera firmly believes that using the HP analyzer gives us a competitive advantage and fortifies our status as the number-one producer of high density programmable logic devices," says Ziad Abu-Lebdeh, Senior MegaCore Development Engineer.

HP analysis helps Nortel improve manufacturing yields and lower costs

Nortel's success in the communications equipment market caused testing challenges at its manufacturing facility in Monkstown, Northern Ireland. Sales were growing more rapidly than expected, and production volumes were projected to exceed the capacity of the functional test systems used on the manufacturing floor. This predicted increase in volume caused a total test strategy review, because it was impractical to add more of the test capability used in the existing approach.

Alan Bowers, Test Technology Manager, asked Hewlett-Packard to perform a Manufacturing Process Analysis, a consulting service that HP offers to all electronics manufacturing companies. "It was our perception of HP's manufacturing expertise that made it attractive to us," says Bowers.

HP consultants visited Nortel to gather data and interview personnel from all levels across the site, then helped develop manufacturing and test process solutions that would contribute directly to the achievement of Nortel's business goals. The recommendations addressed the quantity of test as well as the quality. By budgeting the amount of test per product, the new Nortel test strategy eliminated some overlapping tests, moved tests to more strategic locations in the manufacturing process, and optimized functional test to reduce the amount of testing undertaken.

Bowers reports that post in-circuit test yields jumped from 85% to 95%. Functional test times were reduced by 25%, allowing the existing installed equipment to cope with the increased production volume and avoiding additional capital expenditure.

Bell Atlantic relies on HP's acceSS7 Fraud Management Toolkit to combat direct-dial fraud in its service area

The HP acceSS7 system allows Bell Atlantic to detect direct-dial fraud instantly.

Bell Atlantic Corporation is at the forefront of the new communications, entertainment, and information industry. With approximately 39 million access lines in 13 states, and more than five million cellular customers, Bell Atlantic is a leading provider of local telecommunications and advanced services.

To combat direct-dial fraud, a major problem for service providers, Bell Atlantic previously had to wait through 30-60 day billing cycles before some types of fraud came to its attention. The company determined that only a real-time fraud monitoring system—one that can to pull information off the network as the fraud occurred—would improve its fraud prevention efforts.

HP's leading-edge acceSS7 Fraud Management Toolkit was installed across the entire system to monitor fraudulent activity on direct dial lines. The system has been very easy to use, and its scaleability is key to its being used effectively. During its first day of use, the acceSS7 system provided information that allowed Bell Atlantic to shut down a bogus account and call law enforcement officials, who made an arrest. Since then, the system has helped drive down fraud.

"Fraudsters will not simply be able to move elsewhere, as they have in the past, if they want to escape Bell Atlantic's monitoring," says Paul Glover Manager of Fraud Prevention. With the HP acceSS7 system working all across the network, Bell Atlantic is well positioned to protect its customers from being fraudulently compromised.

SGS Thomson uses HP LAN management to reduce cost and time-to-market

SGS-Thomson (ST) is a global company with research and production centers in Italy, France, the United Kingdom, Germany, the United States and Singapore. ST designs, develops and manufactures standard and custom integrated circuits (ICs) by managing a network of large and complex data. At ST Castelletto, Italy, designers develop and test ICs for several vertical markets, including automotive, computer peripheral and audio.

Designers use several Computer Aided Design (CAD) software tools for designing ICs that are manufactured at Agrate, Italy or in Singapore. The network traffic between design groups at Castelletto and other facilities is very heavy, so network uptime is critical. Compounding the need for maximum uptime is the fact that the traffic is comprised of CAD data, including cell library data, circuit descriptions and layout information. "Often," says Giorgio Sgarbai, ST System Manager, "an integrated circuit is designed by groups from different design centers. When the design is completed, data is sent to appropriate groups for manufacturing, and is lastly stored in a file for future reference. All these factors necessitate heavy data transmission."

To help maximize network uptime, ST uses HP's NetMetrix system, among the most reliable solutions to monitor and analyze network traffic. HP NetMetrix has not only solved the congestion problems of ST's network traffic, but has allowed the sharing of resources over several segments in the best logical way. In addition, using HP NetMetrix helped ST establish a procedure that keeps network traffic and bottlenecks under constant control.

Buying & Leasing Plans for New Equipment

With HP's flexible financing options, you can implement test and measurement solutions when you need them, on terms tailored to your budget. Financing plans even apply to multivendor systems containing non-HP products.

Financing

HP offers financing plans to USA customers that schedule payments to accommodate your cash flow requirements. Similar plans are available worldwide. **See page 580.**

Leasing

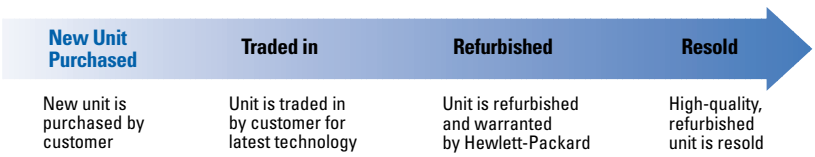
The HP EasyLease is a 12- to 60-month plan for USA customers that provides attractive leasing terms and can include fair market value purchase options. Similar plans are available worldwide. **See page 580.**

Renting

The HP EasyRent financing plan is ideal for customers facing tight budget constraints. It combines the low rate of a longer-term financing plan with exit options, to achieve the ease of a shorter-term plan. Fair market value purchase options are available. Similar plans are offered worldwide. **See page 580.**

Trade-in Options and Purchasing Refurbished Equipment

To help you maximize your equipment budget and keep your technology current, HP offers several trade-in options and high quality refurbished equipment.



Trade-in

Whether you want to trade in a single instrument or a pallet of used equipment, HP helps you take advantage of the value of underutilized test equipment in your inventory. Our trade-in options, designed to make it easy for you to stay competitive and upgrade to the latest available technology, are continuously available throughout the year.

Refurbished equipment

High-quality, used equipment—refurbished by HP to our own rigorous quality standard—is available with full HP warranty and support. Any used instrument you purchase from HP has a guaranteed support life of at least two years—many have a support life up to five years. You don't need to worry about obsolete products or parts—we'll continue to provide support until the product support life ends.

To learn more about HP's trade-in opportunities and growing pool of high quality, refurbished instruments, contact your local Call Center. **See page 576.**

To determine which finance options are available in your region

For more information about which of these services are available in your region contact your local HP Call Center during business hours:

In the U.S., call 1-800-452-4844

Outside the U.S., see the inside back cover

Reference and Education Tools from Hewlett-Packard

Hewlett-Packard is committed to providing you with a range of optional education services to help you keep pace with changes in your industry or technology focus. This includes promoting a range of technical books published by industry leading publishers. The following books help describe and explain emerging technologies, industries, and test and measurement instruments and systems.

Hewlett-Packard Press Offers Technical Book Series

Hewlett-Packard Press is HP's retail book publishing program. PTR Prentice Hall publishes the Hewlett-Packard Professional Books series. Authors are HP and industry experts. Published titles cover a broad range of subjects including T&M technologies, computer architectures, HP-UX system administration and DCE.

To Order Books

New titles, book descriptions, and a list of U.S. technical bookstores can be found on the World Wide Web:

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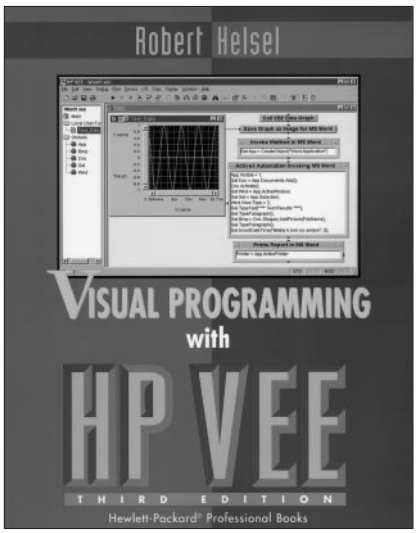
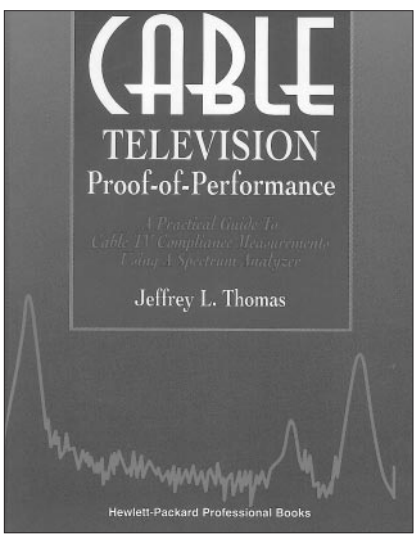
  www.hp.com/go/retailbooks
- Prentice Hall
  www.prptr.com

For pricing and availability, contact the HP Call Center in your region. (See inside back cover)



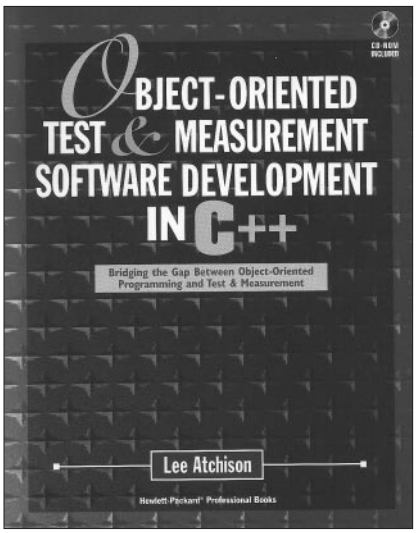
Visual Programming with HP VEE,
by Robert Helsel, 384 pages,
ISBN 0-13-096005-5

The fastest and easiest way to learn HP VEE 5.0. Includes a disk with an evaluation copy of HP VEE.



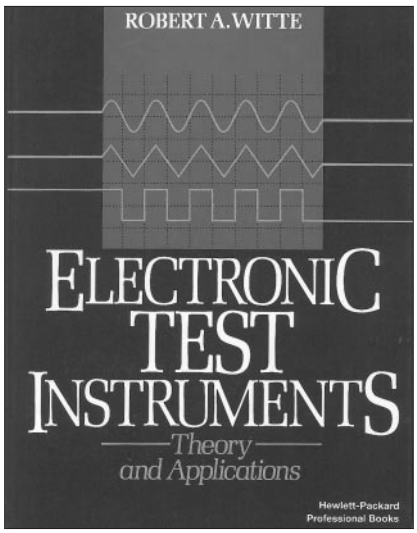
Cable Television Proof-of-Performance,
by Jeffrey L. Thomas, 250 pages,
ISBN 0-13-306382-8 (30638-1)

Helps the cable technician and engineer make fast, accurate measurements using almost any quality spectrum analyzer. Teaches basic cable television measurements with graphics, examples, tips and procedures.



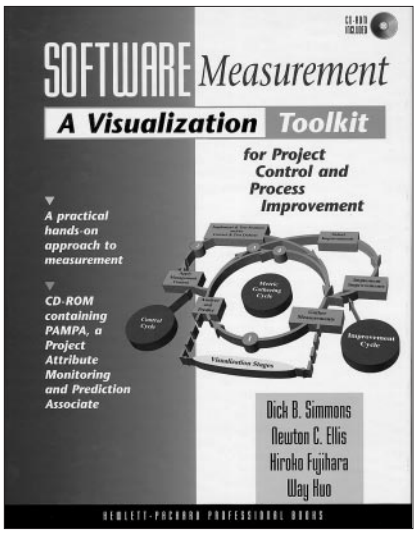
Object-Oriented Test and Measurement Software Development in C++: Bridging the Gap Between Object-Oriented Programming and Test Measurement,
by Lee Atchison, 416 pages
ISBN 0-13-227950-9

Teaches object-oriented design and programming principles and how they can help test and measurement system developers build more efficient and reliable applications. Learn, step-by-step, the design of an object-oriented test and measurement system and fundamental object concepts, such as inheritance. Specific information on how to use object-oriented techniques for error-handling is provided.



Electronic Test Instruments, Theory and Applications,
by Robert Witte, 416 pages,
ISBN 0-13-253147-X (25314-6)

Moves the reader from an understanding of electric theory to practical electronic instruments. Provides the available instruments, their advantages, disadvantages, and how to choose an appropriate instrument for a particular job.



Software Measurement: A Visualization Toolkit for Project Control and Process Improvement
by Dick B. Simmons, 384 pages,
ISBN 0-13-840695-2

Software Measurement begins with an overview of software process visualization. Quality systems criteria and standards are applied to the concepts of life cycle processes and project object classes.

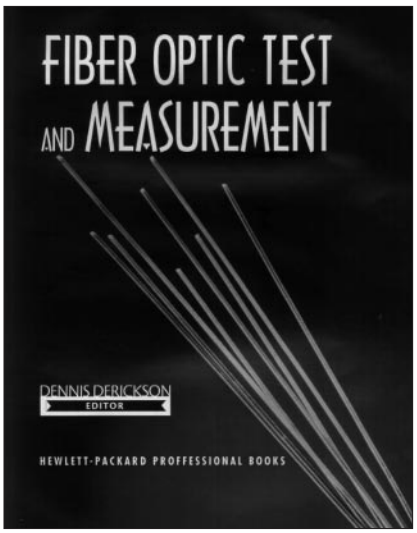
With this foundation, the discussion goes on to specific models and metrics, including:

Scale	Quality
Reliability	Development Time
Productivity	Usability

Verification, validation, and testing techniques complete the picture. Appendices include a complete Users Manual for PAMPA and a guide to its object classes.

Software Measurement will be a valuable asset for software developers, team leaders, and project managers, as well as students of software engineering, and anyone involved in software metrics and process improvement.

The accompanying CD-ROM, for use on Windows NT 3.5 or later and Windows 95, contains everything you need to put PAMPA to work on your next software project.



Fiber Optic Test and Measurement,
by Dennis Derickson, 672 pages,
ISBN 0-13-534330-5

Authoritative, complete, up-to-date test and measurement information for engineers who design and maintain fiber-optic networks. Covers measurement principles, system-level measurements, the principles and limitations of current fiber-optic testing equipment, and much more. Emphasizes practical issues more than theory.

Hewlett-Packard Authors Provide Complete Information in Two Essential Handbooks

International teams of HP experts have produced comprehensive handbooks that answer all the questions you ask about two of the most important elements of the electronics and communications technologies: the tools used in making tests and measurements and how to get the most from them. The capabilities and complexities of today's electronic instruments and instrument systems can be overwhelming. These books demystify the hardware and software and how they work together to perform a function. They start with fundamentals and then progress to include detailed information on all parts of stand-alone instrumentation through instrument systems to software defined instruments, making them important references for the beginner as well as the practicing professional.

To Order Books

Both books are available at all bookstores where McGraw-Hill reference and professional books are sold. In addition, for more information, or to place an order directly go to McGraw-Hill's website:
www.bookstore.mcgrawhill.com

You can also order by mail or fax.

Address:

The McGraw-Hill Bookstore
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Fax:

1-212-512-4105

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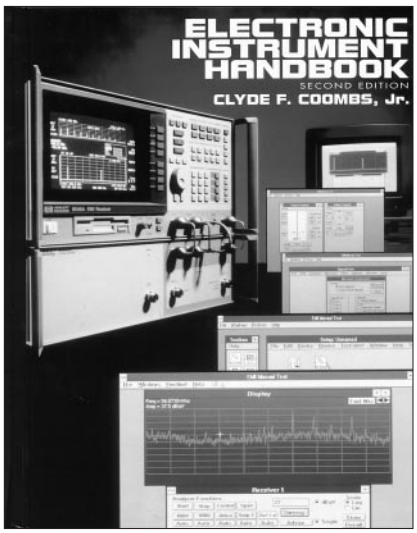
(See inside back cover)

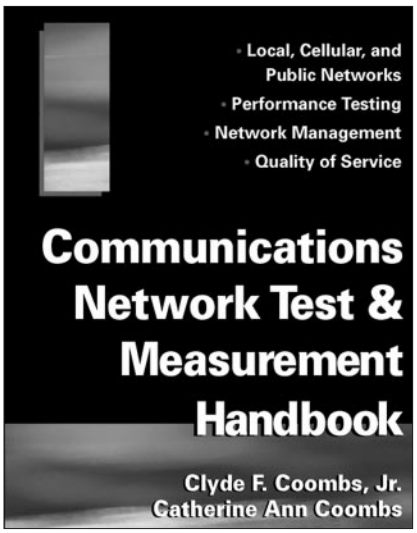


The Electronic Instrument Handbook
by Clyde F. Coombs, Jr.
1100 pages, Hardcover
ISBN 007012616X,

This is a one-volume source of information on all aspects of electronic instruments. It is the only book that provides descriptions of the technology and functions of instruments and instrument systems: what they are, how they work, how to chose the right one and how to get the most from them. It also includes information on the underlying technologies of instruments such as A to D converters, microprocessors, transducers, lightwave, VXI and software. Also included are descriptions of the common issues associated with connecting instruments.

With the development of digital technology in electronic instrumentation, the devices themselves have become more complex and capable. This book provides information on both the fundamentals needed by the newcomer to the field as well as the complexities needed to answer the questions of the practicing professional.

The early chapters provide an introduction to electronic instruments. The sections that follow describe stand-alone instruments, instrument systems, then software defined and virtual instruments.



Communications Network Test & Measurement Handbook
by Clyde F. Coombs, Jr.
826 pages, Hardcover
ISBN 0070126178,

This is a handbook on the measurements and tools required in all phases of the life cycle of a "Communications Network." It provides a comprehensive single volume reference on the technologies of communications networks and the test, measurement, and monitoring instrumentation needed to ensure effective performance and quality of service. Starting with a discussion of the Open Systems Interface (OSI) model, it describes protocols, transmission errors, and physical connection.

It also includes background information on the technologies, applications and purposes of communications networks so that the information on test and measurement instruments and processes is clear, and in context. The chapters on instrumentation describe what they are, how they work and how to get the most from them. In addition, there are descriptions on how to develop the tests that ensure that the network meets local specifications, as well as conforms to international standards.

HP's Test & Measurement Web site.
The more you visit, the more you'll know.

News and information you need, 24 hours a day. Get the most complete support available for all of HP's Test & Measurement tools. Immediate access to information, 24 hours a day, means always getting the most from your instruments:

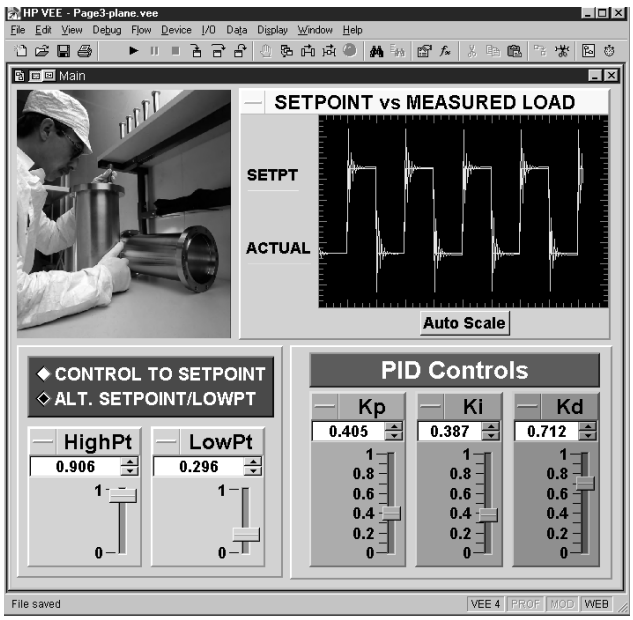
- Product Information
- Usage Tips
- Application Note Library
- Service, Support and Training
- Sales and Service Contacts
- Selection Guides
- Newsletters
- Feature Stories Showing Products in Use
- Information on Your Industry
- News Releases
- Country-Specific Sites

These features are only a snapshot of what's available at the Web site. Bookmark it—and visit it regularly—to stay completely up to date on all of HP's test and measurement solutions.

HP VEE 5.0

NEW

- For Windows 95/NT and HP-UX
- Simplifies communication to and from instrumentation
- Used in manufacturing test, design characterization verification, and data acquisition
- Usability benchmarks show HP VEE improves engineering productivity
- Now in version 5.0



With its wide variety of user interface objects, HP VEE makes it easy to create operator interfaces and soft front panels.

Rapid Program Development

HP VEE is a visual programming language for developing instrument-control and data acquisition programs. With HP VEE you create a visual program by linking together functional objects to form a kind of block diagram. The range of functions within HP VEE makes it a universal tool for measurement and control programs.

Using HP VEE, you can:

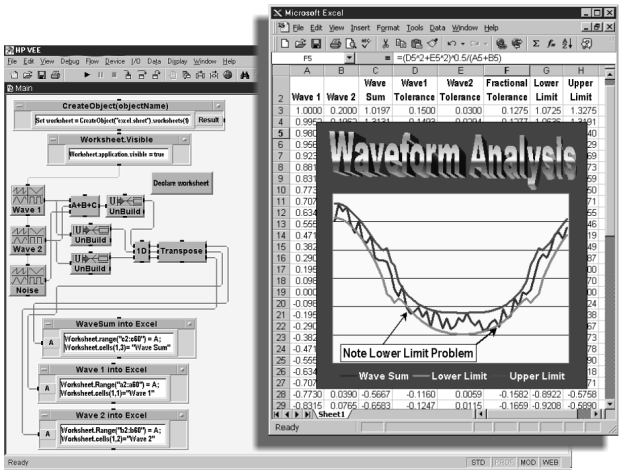
- Gather data from instrumentation and PC-plug-in modules.
- Control interfaces and equipment (serial, HP-IB or GPIB, VXI).
- Display data using many different plots, alphanumeric displays, and display objects.
- Load and use ActiveX Controls to add functionality to HP VEE.
- Communicate with other Windows programs using ActiveX Automation.
- Save programs using many formats such as binary, ASCII, table formats.
- Process data as strings, arrays, bytes, records, etc.
- Compute, analyze and simulate from simple addition to FFTs, fitting, integration, etc.
- Work with loops such as if/then/else, <, =, >, for, while, repeat until, etc.
- Control and regulate to simulate data, measure and compute output variables, etc.
- Create structured programs and user interfaces.
- Access any HP VEE panel over the World Wide Web.

Introducing HP VEE 5.0 NEW

HP VEE can now connect with the vast collection of ActiveX-enabled software tools and applications. ActiveX technology is changing the software development process, and HP VEE 5.0 is on the leading edge of that change.

Here are the major enhancments in version 5.0:

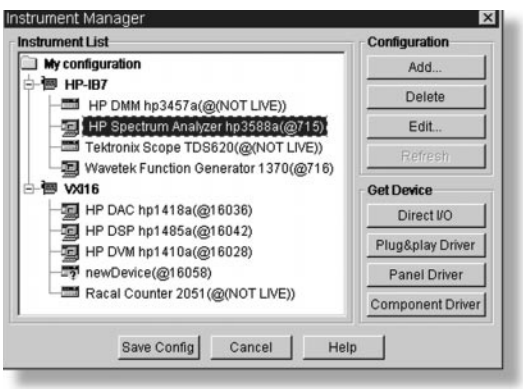
- Enhance HP VEE with ActiveX Controls: With HP VEE 5.0, you can load and use ActiveX Controls within HP VEE. It's easy to customize the HP VEE environment for your specific application by adding bar-code readers, video clips, file encryption and compression, databases, scientific functions, calendars, and a wide variety of user interface features.
- Link to ActiveX Applications: Through ActiveX Automation, HP VEE 5.0 can interact with any application that provides access to ActiveX objects. This means you can send data to a Microsoft Excel spreadsheet or to a Microsoft Access database. In other words, you can use some of the best software in the business to add power and usability to your test systems/automatically.
- Built-in Web Server: HP VEE 5.0 includes a built-in web server so you can monitor a HP VEE program remotely using standard HTTP protocol. Any HP VEE control panel can be accessed over your intranet or the World Wide Web, so you can troubleshoot systems, retrieve information from HP VEE programs, and monitor test systems remotely.



ActiveX Automation allows you to send HP VEE test data automatically to Microsoft Excel, for example, for further analysis.

Easy to Use

HP VEE provides a set of powerful objects that you can connect to create a program—making HP VEE easy to use. It leverages the rapidly developing software technology that characterizes today's world, resulting in a tool that automates inherently complex tasks—controlling instruments, creating operator interfaces, sequencing tests, and distributing programs—and simplifies and streamlines the entire programming effort.



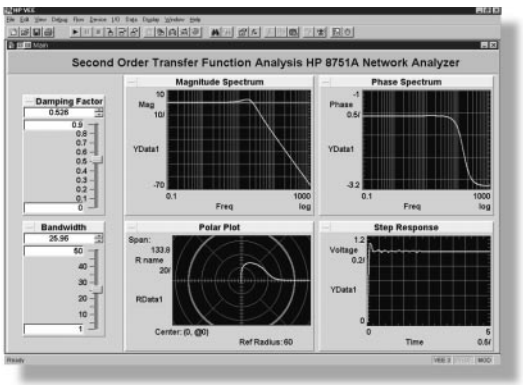
The Instrument Manager automatically configures instrument addressing.

With its streamlined instrument control, HP VEE simplifies communication with instruments and other devices. HP VEE Instrument Manager scans the bus for devices and automatically handles the interfacing details of your system. You no longer need to build address strings, load drivers, and manage I/O session handles. HP VEE provides easy point-and-click driver control for both HP VEE drivers and VXI*plug&play* drivers. And when you don't have or want to use a driver, HP VEE Direct I/O enables you to communicate directly with instruments via instrument command strings.

You can create operator interfaces, including soft front panels for instruments, in a fraction of the time it takes using a textual programming language. HP VEE offers a wide variety of user interface objects to choose from—toggles, sliders, drop-down lists, buttons for control, dialog boxes, pop-up boxes, and indicators to visually represent data.

With HP VEE, you can link tests in a logical sequence—easier and faster—making you even more productive.

Broad Feature Set

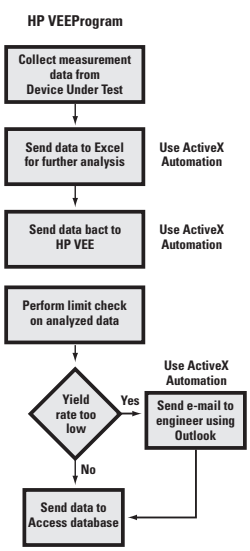


HP VEE provides a broad feature set that handles your everyday test tasks. These include: controlling instruments, taking measurements, acquiring and processing data, displaying results, and generating reports. That's the fundamental power of HP VEE, and no programming language—visual or textual—does it better. You'll work not just faster but smarter, with distinct bottom-line results including shorter development cycles, lower engineering costs and, ultimately faster delivery of quality products.

With HP VEE, you can use any of over 450 HP VEE drivers, or any industry-standard VXI*plug&play* driver, or control instruments directly —even those you build yourself or those from other vendors—with fast, efficient Direct I/O. With over 200 math and analysis functions that range from elementary math to calculus, you can construct a solution from a long mathematical equation with HP VEE's formula box by simply typing it in. And with 14 flexible and powerful data types, HP VEE reduces development time by automatically handling conversion between data types, building and unbuilding text and binary numbers, and swapping bytes.

Productivity in an ActiveX World

With its ActiveX Automation links, HP VEE allows you to create applications that integrate HP VEE's instrument control, test and measurement capabilities with popular ActiveX-compliant applications.
Here's a look at how HP VEE and ActiveX team up to bring step-function improvements in productivity and communication.



HP VEE can load and use ActiveX Controls, so you can quickly customize your HP VEE programs for specific applications. With over 10,000 ActiveX Controls currently available, you can minimize the amount of custom code you develop by incorporating ActiveX Controls into your HP VEE programs.

For application notes on using ActiveX Controls and ActiveX Automation with HP VEE, visit the HP VEE web site: **www.hp.com/go/hpvee**

Worldwide Service and Support

With HP VEE, you have access to HP's worldwide resources for start-up assistance, telephone support, training classes, and update services. Additionally, through contracts with leading PC plug-in card suppliers, HP provides total solutions for test, measurement, and data acquisition. Many companies offer hardware/software solutions based on HP VEE.

Join the HP VEE electronic users group. Sign up through the HP VEE web site and get assistance on using HP VEE from experts around the world: **www.hp.com/go/hpvee**

Evaluation Copy

There's only one way to fully appreciate the power and elegance of HP VEE. You need to get your hands on it. The HP VEE evaluation kit includes a full working copy of HP VEE plus instrument I/O libraries. To download the evaluation copy or to request it on CD-ROM visit the HP VEE website: **www.hp.com/go/hpvee**

Ordering Information

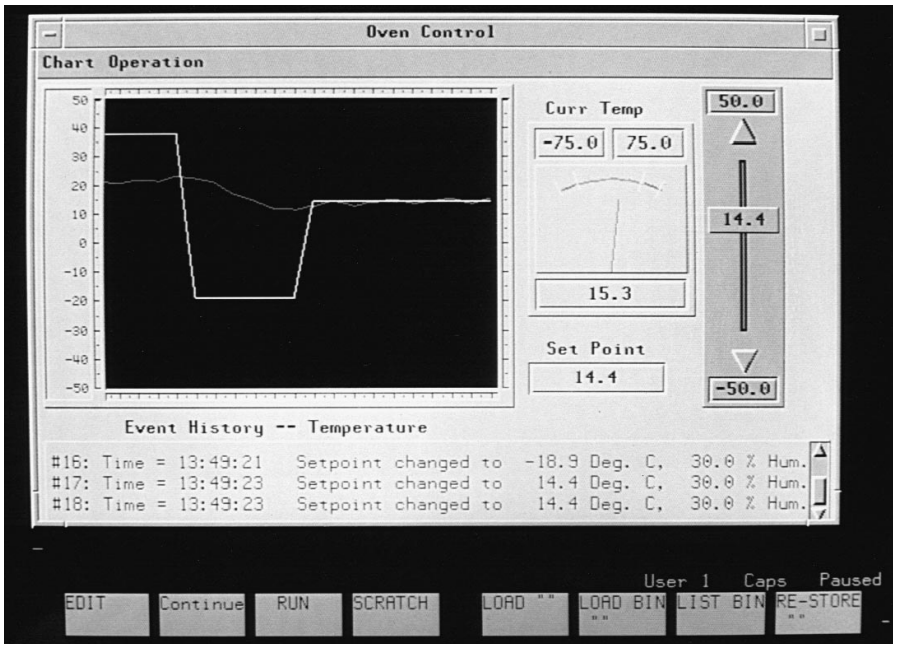
Standard Products
HP E2120F HP VEE 5.0 for Windows 95/NT
Opt AA8 Software shipped on 3.5-inch floppy disks
Opt UP1 Upgrade from HP VEE 4.0 to 5.0[1]
Opt UP2 Upgrade from HP VEE 3.x to 5.0[1]
HP E2111F HP VEE 5.0 for HP-UX
Opt UP1 Upgrade from HP VEE 4.0 to 5.0[1]
Opt UP2 Upgrade from HP VEE 3.x to 5.0[1]
HP 82345F HP VEE 5.0 for Windows 95/NT plus HP 82341C HP-IB Card

Site Licenses
E2117F HP VEE 50-seat site license
Opt CDT Credits for up to 25 previously purchased copies
Opt AGE Upgrades for existing 50-seat site license customers
E2119F HP VEE 10-seat site license
Opt CDT Credits for up to 5 previously purchased copies
Opt AGE Upgrades for existing 10-seat site license customers
Both site licenses include 1 year of phone support and 1 year of software update service.

Training Products
HP E2120E, Opt 24D Introduction to HP VEE
HP E2110E, Opt 24Q Advanced Topics
Both classes may be given at your site and can be specifically tailored to your needs. For more information contact the HP Call Center in your region

HP VEE in Education Products
The following HP VEE products are available to accredited universities, colleges, or vocational/technical schools that qualify for HP's education purchase agreements.
H2327F Opt WNT HP VEE 5.0 for Windows 95/NT 40 development licenses
AE13V/AE16V discount
H2327F Opt PCN HP VEE 5.0 for Windows 95/NT 40 development licenses plus HP-IB card
AE13V/AE16V discount
H2326A Educator's Lab Starter Kit
Includes HP VEE 5.0 for Windows95/NT plus 40 licenses as well as computer-based training software, videos and text books
AE13V/AE16V discount

[1]Upgrade products will only install if an earlier version of HP VEE is already loaded on the computer.



HP BASIC: The Premier Language for Measurement Automation

HP BASIC is a computer language that is optimized for test and measurement. It includes many test-oriented features:

- I/O libraries integrated within HP BASIC, as opposed to add-on I/O libraries used by other languages.
- Unified I/O, permitting a common approach to instrument control —no matter what interface you use.
- Syntax checking—HP BASIC checks the syntax of every line—as you type it in.
- Automatic use of direct memory access (DMA) if DMA hardware is available.
- Support of separate context subprograms. Code modules are easily reused, shared, or updated.
- Full interrupt processing, with 15 levels of software prioritization.
- Advanced commands for analysis, such as complex data types and matrix manipulation.
- Powerful graphics commands that allow quick development of sophisticated graphics displays, enhanced with the addition of HP BASIC Plus.
- Excellent HP support and documentation.
- Ease of use that lets you create results quickly.

HP BASIC: An Integrated Family of Products

HP BASIC is a family of products supported on many different computer platforms and operating systems:

- HP BASIC/UX runs on HP 9000 Series 700 UNIX workstations. This version gives the programmer access to multi-tasking, networking, and the vast software associated with UNIX.
- HP BASIC for Windows, a compatible Rocky Mountain BASIC for the Windows environment, combining the power and flexibility of HP BASIC with the widespread popularity of Microsoft Windows.
- HP BASIC/DOS, a fully-compatible version of HP BASIC that runs on the HP Measurement Co-processor in a PC. This is the lowest-priced HP BASIC platform.
- IBASIC, a subset of HP BASIC that runs in "smart" instruments such as VXI. IBASIC is often used by instruments to control other instruments, or to execute a complete test program in one instrument.

HP BASIC Accessory Products

- HP BASIC Compiler, a product for users of HP BASIC/WS who want the faster execution and security of a compiler.
- DOS File System, a binary system that gives HP BASIC/WS devices the ability to read and write DOS-formatted disks.
- SMR/UX, a network that allows multiple HP BASIC workstations to share resources such as disks and printers.

HP BASIC Plus

HP BASIC Plus adds even more capabilities to the HP BASIC language. With it, you can create any of over 35 graphic objects—stripcharts, XY graphs, sliders, toggle buttons, menus (pull-down or cascade), on-screen warnings, and more. HP BASIC Plus is available on all HP BASIC platforms.

The latest HP BASIC Plus revision adds the following:

- APP, a keyword that gives you access to all HP BASIC Plus features when the main HP BASIC program is stopped.
- Panel Builder, a tool for creating custom interfaces, including the ability to change size, color, display range, and attributes of any object.
- Notepad, an ASCII file editor that lets you edit code without needing line numbers.
- Help File, a tool that lets you create your own Help files—an excellent feature for new programmers.
- New Widgets, innovative tools for performing a variety of tasks, from displaying X.11 Windows files to formatting hex or octal numbers to creating analog and digital clocks. The new "widget scrolling" feature lets you see all information on smaller widgets, while "widget closure" lets you shut down any widget on screen.
- Online Reference Manual, the entire HP BASIC Reference Manual, now at your fingertips. A new Search capability allows you to quickly find the information you need.
- HP BASIC Plus is included with HP BASIC for Windows.

Ordering Information

HP BASIC for Windows
HP E2060B for Windows 3.1/95/NT, media and manuals plus one license-to-use, software includes HP BASIC Plus
Opt 0CC Upgrade from any previous HP BASIC platform or revision
Opt AGE Upgrade from previous HP BASIC for Windows revision
HP E2066B HP BASIC for Windows additional license-to-use $
Opt 0B1 manual set

HP BASIC/UX HP
E2045C HP BASIC for HP-UX 10.2 media and manual; does not include license-to-use; to be use in conjunction with HP E2046A product
HP E2046A HP BASIC for HP-UX 10.2 license-to-use
Opt 0CC Upgrade from any previous HP BASIC platform or revision

A Wide Range of Instrument Controllers

Hewlett-Packard offers a wide range of test and measurement controllers. HP provides VXI embedded and external controllers based on industry-standard operating systems: HP-UX, MS Windows 95/NT, LynxOS.

Embedded Controllers

Hewlett-Packard provides embedded controllers for both PC-based systems and workstation applications. The HP V743 VXI embedded controller—HP E1498A—offers workstation performance in an integrated C-size package. This high-performance message-based controller uses HP's PA-RISC technology to deliver extraordinary performance and direct VXI access at a very competitive price. Developed specifically as an embedded HP-UX (UNIX) controller for VXI, the V743 controller provides the high I/O performance of direct VXI backplane support, the space savings of an embedded controller, and the high power and speed of HP PA-RISC. The V743 controller supports all VXI addressing modes (A16, A24, A32), programmable interrupt handling, single channel DMA for VXI extended memory devices, and a 1 MB dual-ported memory buffer for high-speed data acquisition.

If you need a PC-based system with the high-performance I/O of VXI, HP offers the HP E6232A and HP E6234A, as well as the HP E6237A for LynxOS real-time application needs. All PC controllers combine the high I/O performance of direct VXI backplane support, the space-saving size of embedded controllers, and the high power of the Intel Pentium processor. A variety of applications use these controllers, such as standalone VXI systems, mixed systems, with VXI and HP-IB instruments, and distributed systems networked together.

Ordering Information

HP E6232A VXI Pentium PC Controller - Win95/133MHz
HP E6234A VXI Pentium PC Controller - 166MHz/32MB
HP E6237A VXI Pentium Real-time Controller
HP E1498A V743/100 VXI embedded controller module

External Controllers

From the low-cost HP B-Class to the unparalleled, top-of-the-line performance of the J-Class workstations, HP provides external controllers for practically every test and measurement need. The HP 745/132 controller based on HP's PA-RISC 7300 processor, is rugged and rack-mountable, with built-in HP-IB, four EISA slots, and excellent flexibility. It is completely compatible with all HP 9000 Series 700 controllers and workstations. The B-Class features the networking functionality you need for test system growth, while offering plenty of built-in interfaces and high-performance graphics. It is a good solution for design, development, and analytical work. Also, the B-Class controllers offer the lowest true-color graphics a PCI expansion slot for HP-IB, and extensive built-in interfaces.

The HP VISUALIZE B-,C-, J-Class workstations complete HP's external controller selections. The J-Class workstations are HP's "personal supercomputers". These controllers use HP's industry-leading 2D/3D graphics to deliver the power and performance you need for computational analysis, advanced 3D design work, and memory intensive workloads. The B-Class controllers are midrange, powerful, and economical. The C-Class workstations provide no-compromise, full computing power for a demanding workload.

Investment Protection

Hewlett-Packard is committed to five-year product sales and five-year product support for all HP-UX Workstations. HP continues to develop, upgrade, and add to this product line while still providing compatibility between the various components, when possible. Offering the best support in the industry, Hewlett-Packard will work with you to develop the solutions and systems that are right for you.

Considerations in Designing Instrument Systems

Several aspects of system design must be considered in creating a new instrumentation system application, under the broad categories of hardware, software, integration and support. The controller is only part of the consideration.

Whether to use open industry standard architectures for hardware and/or software top the list when considering the life-cycle of the application. The consideration is whether to build the system yourself or to employ an in-house or external system integrator. Finally, the types of instruments and performance specifications of the overall system operation must be considered. Today your choice of instrument platforms is broader than ever. You may elect to employ proven rack-and-stack instrumentation, controlled by a standalone instrument controller. Even more attractive might be the new VXI industry-standard open platform. If open industry standards for both the hardware and software aspects of the system are important to you, VXI deserves your investigation.

Hewlett-Packard leads the industry in scalable architecture for the VXI platform, offering a variety of VXI mainframes and embedded VXI system controllers to meet your application and budget.

Ordering Information

HP A4323A B180L HP-UX Workstation
HP A4318A C200 HP-UX Workstation
HP A4945A C240 HP-UX Workstation
HP A4487A J282 HP-UX Workstation
HP A4964A 745/132 HP-UX Workstation

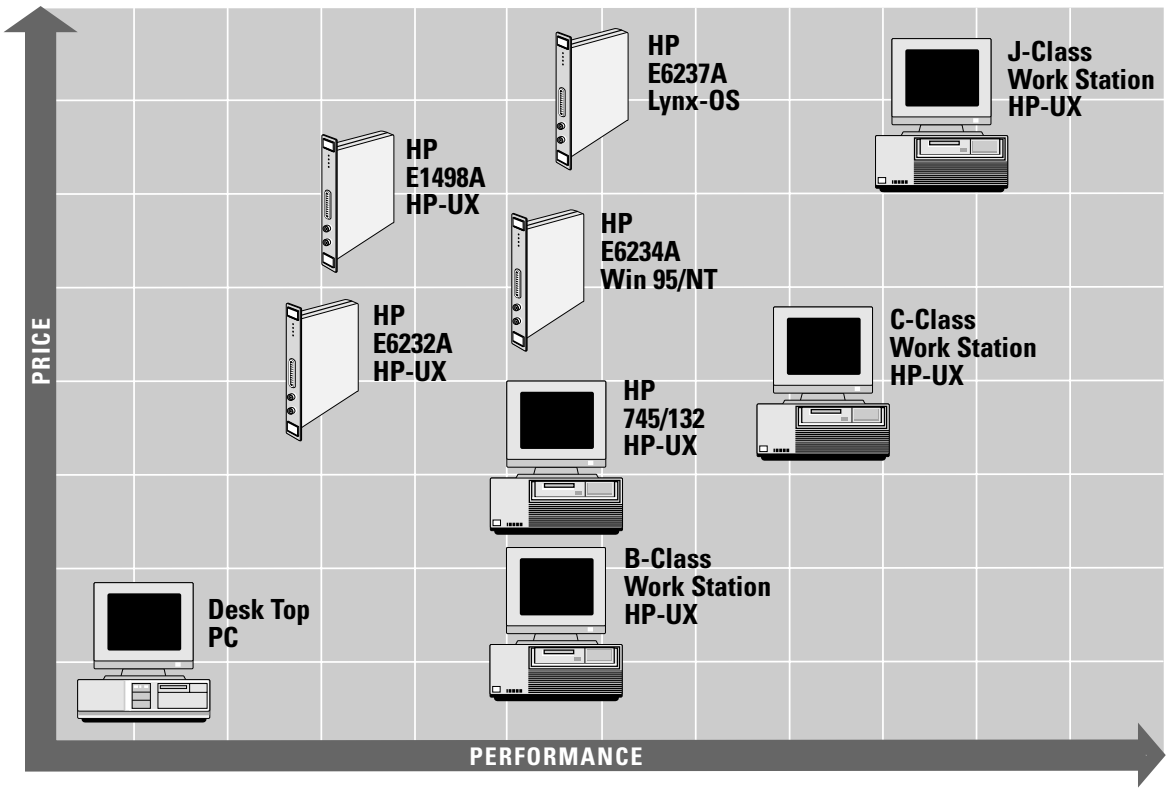
LAN/HP-IB Gateway

The LAN/HP-IB Gateway provides low-cost access to HP-IB instrumentation over your LAN. It lets you use SICL-based or VISA-based applications designed for HP-IB over the LAN without modifying the applications beyond a simple address change. The LAN/HP-IB Gateway allows you to perform a range of measurement tasks on command, store raw or processing data, return information on request, and enjoy access to measurement data locally or remotely.

Ordering Information

HP E2050A LAN/HP-IB Gateway, including gateway hardware, power supply, and power cable
Opt AG1 SICL for Series 700 workstations (HP-UX 9.0 or later)
Note: You must have SICL with LAN for your workstation
HP-IB cables.
Note: You will need LAN cabling (either ThinLAN or Twisted Pair) and HP-IB cables.
HP 10833A 1-meter HP-IB Cable
HP 10833B 2-meter HP-IB Cable
HP 10833C 4-meter HP-IB Cable
HP 10833D 5-meter HP-IB Cable
HP E2051A Rackmount Kit—holds two HP E2050A LAN/HP-IB Gateways

Controller Price/Performance Comparison by Family



Controller Comparison

	PC		HP-UX Workstation						
	E6232A	E6234A	E6237A	745/132	VXI V743/100	B 180L	C 200	C 240	J 282
Operating System									
MS Windows 95	●	●	—	—	—	—	—	—	—
MS Windows NT	—	●	—	—	—	—	—	—	—
LYNX-RT	—	—	●	—	—	—	—	—	—
HP-UX	—	—	—	●	●	●	●	●	●
HP BASIC/UX	—	—	—	●	●	●	●	●	●
Processor									
Main Processor	Pentium	Pentium	Pentium	PA 7100LC	PA 7100LC	PA 7300LC	PA 8000	PA 8000	PA 8000
Clock speed (MHz)	133	166	166	132	100	180	200	236	180
Math coprocessor	Built-in	Built-in	Built-in	Built-in	Built-in	Built-in	Built-in	Built-in	Built-in
Performance									
SPEC int 95	4.20	4.82	4.52	5.9	2.89	9.06	14.3	17.3	11.9
SPEC fp 95	3.08	3.40	3.40	6.2	3.47	9.35	21.4	25.4	19.3
Memory									
256 MB	128 MB Max	128 MB Max	128 MB Max	●	—	768 MB Max	1.5 GB Max	1.5 GB Max	1.5 GB Max
128	—	—	—	●	●	●	●	●	●
64	—	—	—	●	●	●	—	—	●
32	●	●	●	—	●	●	—	—	●
16	●	●	●	—	—	—	—	—	—
8	●	●	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—
2 MB	—	—		—	—	—	—	—	—
Display									
1280 x 1024	●	●	●	●	●	●	●	●	●
1024 x 768	●	●	●	●	●	—	—	—	—
800 x 600	●	●	●	—	—	—	—	—	—
640 x 480 VGA	●	●	●	●	—	—	—	—	—
Slots Max									
EISA cards	1 (EXM)	1 (EXM)	1 (EXM)	4 or	0	—	1 or	1 or	4
PCI	—	—	—	4	—	2	4	4	—

- Optimized for RF and microwave automatic test systems
- Modular for easier system integration
- Wide variety of products and configurations available

HP developed and supplies an integrated rack of RF test equipment for communication satellite payload test. MMS signal generators, spectrum analyzers and power meters were selected for a compact, EMC-rugged, highly-accurate, 1 GHz to 20 GHz broadband system. The HP 70611A Attenuator/Switch Driver (an MMS system module) is included providing a convenient interface to a custom switch matrix.

Modular Measurement System

The Modular Measurement System (MMS) is an open, industry standard controlled by a consortium. The high-performance, modular platform is especially suited for RF, microwave, and lightwave text applications. It offers the lowest life-cycle cost when you integrate, support or upgrade your system. The MMS offers system designers a number of advantages:

- A wide variety of over 50 modules offer low frequency, RF, microwave and lightwave measurement capability.
- Easy system integration is aided by standard- and custom-switching modules, plus an open architecture with design tools that allow you to design and build your own specialized modules.
- Easy-to-use displays allow you to operate a system from local or remote locations, and mainframes and displays can be separated by up to 1 kilometer.
- Electromagnetic compatibility (EMC) design is optimized for microwave environments. Rugged mainframes, shielded enclosures, grounding and a 40 kHz switched power supply reduce emissions and module-to-module interference.
- Automatic system control can be based on DOS, HP BASIC or UNIX® operating systems.
- Compatibility with other open standards allows you to make use of new and existing hardware, software and engineering expertise. MMS and VXI combine easily to solve complex measurement requirements. Both platforms continue to take advantage of their own internal high-speed bus, but can be tied to a common 10 MHz clock reference. Both use common trigger signal levels.

Maximize Your Investment

Several factors reduce MMS life-cycle costs:

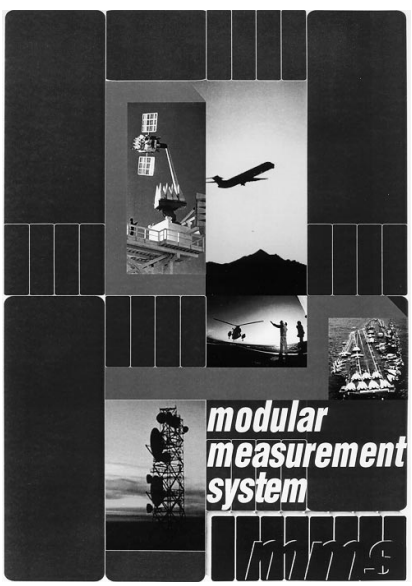
- MMS integrates quickly, using off-the-shelf mainframes, components and software packages.
- MMS allows system configuration to provide just the right amount of measurement capability.
- Downsizing enhances ATE systems by reducing rack space.
- A central, shared display allows operator focus and monitors up to four instruments at once in real time. This further reduces rack space. The system will even work without a display, saving more space and reducing cost.
- Built-in diagnostics and modularity team up to maximize system uptime, allowing you to make the best use of your investment.

3

HP 70000 Modular Measurement System

HP offers a variety of products and services to help you customize your entire system. Multiple support alternatives allow you to customize the logistics of each system to fit installation needs. With MMS, you are assured of the highest performance and best customer support—today, and in the years to come. Your HP sales representative can help you configure the best solution for your specific application.

The following pages highlight selected components and systems in the HP 70000 family. A complete listing of all HP MMS products and most MMS products from other suppliers with full descriptions, specifications and services is also available.



Key Literature

HP 70000 Modular Measurement System Catalog, p/n 5965-2818E

HP 70000 MMS Product Information

HP 70001A

HP 70004A

Mainframes and Displays

Product	Description
HP 70001A System Mainframe	8-slot mainframe for MMS plug-in modules Provides cooling, power, digital communication interface buses (MSIB and HP-IB) Compatible with standard EIA racks Good EMC performance and rugged structural design make it suitable for sensitive measurements in tough industrial environments
HP 70205A Display	Compact, 3-slot module format Provides manual interface and control
HP 70207B PC Display for MMS	PC board, cable and software Provides the MMS display and user interface on a PC Sends graphics directly to any PC peripheral printer or plotter Provides mass storage to any PC peripheral disc or hard drive Options with an HP PC available
HP 70004A Color Display and Mainframe	Integrated mainframe and display with full system interface and control capabilities 4 available module slots

Instruments

Choose from instruments that are single modules or multiple modules configured into a system.

HP 70340A

HP 71708A

Sources

Product	Description
HP 70340A Microwave Synthesizer, 1 to 20 GHz	Synthesized signal generator with add-on frequency extension +13 to –90 dBm amplitude range Harmonic suppression above 55 dBc; no subharmonics
HP 70341A Frequency Extension Module, 10 MHz to 1 GHz	±2 dB output power accuracy and ±0.5 dB flatness 4-slot width + 1-slot extension module
HP 71708A Microwave Source, 2.4 to 25.8 GHz	Excellent LO substitute for radar, phase noise measurement systems; test source for receiver test systems
HP 70428A Microwave Source Module, 2.4 to 25.8 GHz	600 MHz frequency resolution (0.1 Hz option) Up to +16 dBm output power 8-slot system includes mainframe display; 4-slot module

Signal Analyzers

Product	Description
HP 70100A Power Meter, 100 kHz to 50 GHz	Single-channel module with features, capability of HP 437B ±0.5% accuracy in linear mode; ±0.02 dB accuracy in logarithmic mode –70 to +44 dBm power range 1-slot width
HP 70110A Digital Multimeter	1450 readings per second 3 ½ to 6 ½ digits of resolution Measures dc and ac volts, 2-wire and 4-wire Ω , dc and ac current, frequency, power Basic dc accuracy of 5 ppm and common-mode rejection >90 dB 2-slot width
HP 70120A Universal Counter	100 MHz, 200 MHz, 2.4 GHz inputs Minimum sensitivity of 100 mV p-p Built-in TCXO Built-in functions: frequency, period, time interval, rise and fall times, ratios, totalize, pulse width, ac/dc voltage minimum and maximum 1-slot width
HP 70700A Digitizer	20 megasamples per second, 10 bits 256 K memory Waveform recorder and oscilloscope features Up to 8 channels Improves analyzer sweep times 1-slot module
HP 70703A Digitizing Oscilloscope	4-input, 2-channel operation 500 MHz repetitive bandwidth 20 megasamples per second for single-shot measurements to 2 MHz 2-slot width
HP 71500A Microwave Transition Analyzer, DC to 40 GHz	2-channels, sampler-based, internal trigger Time-domain measurements with FFTs Up to 1 ps delta time accuracy
HP 71707A Microwave Downconverter, 2 GHz to 26.5 GHz **HP 70427A Microwave Downconverter Module,** 2 GHz to 26.5 GHz	Translates microwave signals to RF frequencies for phase noise measurements AM noise detection Specified spurious performance System includes mainframe/color display, 4-slot microwave downconverter module

Spectrum Analyzers and Receivers

Product	Description
All HP 70000 series spectrum analyzers offer the following:	10 Hz minimum bandwidth 90 dB calibrated display range 0.1 ppm frequency stability Color display with digital persistence or PC display Wide range of optional performance and features by adding other MMS modules and mainframes
HP 71100C RF Spectrum Analyzer, 100 Hz to 2.9 GHz **HP 71100P RF Spectrum Analyzer,** 100 Hz to 2.9 GHz	Synthesized, high performance RF spectrum analysis –134 dBm sensitivity, –156 dBm with preamplifiers AC or dc coupled RF input 2-mainframe system with 6 slots available or 1 mainframe with PC display
HP 71200C Microwave Spectrum Analyzer, 50 kHz to 22 GHz **HP 71200P Microwave Spectrum Analyzer,** 50 kHz to 22 GHz	Microwave spectrum analysis with optional preselection 2-mainframe system with 5 slots available or 1 mainframe with PC display

HP 71209A

HP 71400C with HP 70810B

HP 71604B

HP 71451B

Spectrum Analyzers and Receivers (cont'd)

Product	Description
HP 71209A Microwave Spectrum Analyzer, 100 Hz to 26.5 GHz **HP 71209A Option Z40 Spectrum Analyzer,** 100 Hz to 40 GHz **HP 71209P Microwave Spectrum Analyzer,** 100 Hz to 26.5 GHz	Continuous sweeps from 100 Hz to 26.5 or 40 GHz –138 to –128 dBm sensitivity across the frequency range (HP 71209A/P); –107 dBm at 40 GHz (Option Z40) Built-in external mixer interface for mm applications Rugged 2.4 mm input connector (Option Z40) 2-mainframe system with 5 slots (HP 71209A) or 3 slots (Option Z40) available or 1 mainframe with PC display
HP 71210C Microwave Spectrum Analyzer, 100 Hz to 22 GHz **HP 71210P Microwave Spectrum Analyzer,** 100 Hz to 22 GHz	Fundamentally mixed, highest microwave performance –139 dBm sensitivity at 1 GHz; –133 dBm at 22 GHz; –155 dBm at 22 GHz with HP 70620B preamplifier Dynamic tracking preselector keeps analyzer peaked under all environmental conditions +10 dBm TOI from 10 MHz to 22 GHz 2-mainframe system with 5 slots available or 1 mainframe with PC display
HP 71910A HP 71910P Wide Bandwidth Receiver	Includes HP 71209A/P Adds 10 MHz to 100 MHz linear bandwidth capability See page 260

Lightwave and Communication

Product	Description
HP 71400C Lightwave Signal Analyzer, 100 Hz to 22 GHz **HP 71401C Lightwave Signal Analyzer,** 100 Hz to 2.9 GHz **HP 70810B Lightwave Signal Analyzer Module**	Calibrated measurement of intensity modulation from 100 kHz to 22 GHz 1200 to 1600 nm operation (750 to 870 nm option 850) RIN measurements to –165 dB/Hz Interferometer for laser linewidth and chirp measurements Systems based on HP 71210C spectrum analyzer 2-mainframe systems with 4 slots available
HP 71450B Optical Spectrum Analyzer **HP 71451B Optical Spectrum Analyzer** **HP 71452B Optical Spectrum Analyzer**	Spectral measurements from 600 to 1700 nm Double-pass monochromator Real-time sweep rates –90 dBm sensitivity, 60 dB dynamic range Wavelength and amplitude calibration across full measurement range Optional current source and white light source 5 modes of operation (HP 71452B) 1 mainframe system with color display
HP 71501C Jitter Analysis System	Expanded measurement range: 50 Mb/s to > 12 Gb/s Jitter transfer, tolerance, output/generation Test systems, networks, modules or components, MUX/DEMUX Eye-diagram and analysis capability

Product	Description
HP 71603B Gigabit Error Performance Analyzer **HP 71604B Pattern Generator**	100 Mb/s to 1 Gb/s pattern generation and error performance analysis Low-phase-noise clock source User-programmable patterns up to 4 Mb with screen-based editor Ability to trigger anywhere in pattern Variable clock/data delay Automatic setting of threshold and decision point True complementary outputs 2-mainframe systems with color display
HP 71612A Series Gigabit Error Performance Analyzers and Pattern Generators	100 Mb/s to 12 Gb/s pattern generation and error performance analysis 8 Mb programmable pattern Fast transition times, low jitter Burst-mode capability for fiberloop testing Four sub-rate outputs Location of specific errored bits 2-mainframe systems with color display

System Building Blocks

Configure an instrument or system for unique applications using off-the-shelf modules.

Product	Description
HP 70300A Tracking Generator, 20 Hz to 2.0 GHz **HP 70301A Tracking Generator,** 2.7 to 18 GHz	Use with spectrum analyzer for scalar and spectrum analysis Use as RF or microwave source for CW and swept signals Stimulus response capability to measure gain, frequency response, return loss 2-slot width (HP 70300A) 3-slot width (HP 70301A)
HP 70310A Precision Frequency Reference	10 MHz to 100 MHz precision reference signals phase-locked to ovenized oscillator 1-slot width
HP 70620B Preamplifier, 1 GHz to 26.5 GHz 100 kHz to 26.5 GHz	Boost sensitivity of analyzers by 15 to 25 dB –156 dBm sensitivity at 2.9 GHz –150 dBm sensitivity at 22 GHz Optional 100 kHz low-end frequency coverage (HP 70620B)
HP 70621A Preamplifier, 100 kHz to 2.9 GHz	Provide drive signal for excess noise source Built-in switches for preamplifier bypass

System Building Blocks (cont'd)

Product	Description
HP 70875A Noise Figure Measurement Personality	Swept noise figure and gain Microwave measurement range: 10 MHz to 26.5 GHz Calibrated measurements Selectable bandwidths Marker functions and limit lines Menu-driven interface
HP 70900B Local Oscillator	Master control module for spectrum analyzers, lightwave signal analyzers, other systems Synthesized local oscillator for excellent phase noise, stability, frequency accuracy 2-slot width
HP 70860A Upgrade Kit	High-speed controller board upgrades HP 70900A with features of HP 70900B
HP 70861A Upgrade Kit	RAM/ROM board upgrades firmware to HP 70900B capabilities
HP 70902A IF Section, 10 Hz to 300 kHz **HP 70903A IF Section,** 100 kHz to 3 MHz	Adds signal processing elements for spectrum analyzers, lightwave signal analyzers, other systems 10% incremental bandwidth steps Calibrated logging amplifiers 1-slot width
HP 70911A IF Section, 10 MHz to 100 MHz bandwidths	Used in HP 71910A wide bandwidth receiver 10% incremental bandwidth steps Up to 70 dB IF step gain Linear detection Standard AM and pulse demodulation Standard 321.4 MHz IF output Optional FM demodulation, analog I/Q, 70 MHz IF, 140 MHz IF, and Chebyshev channel filters 2-slot width
HP 70904A RF Section, 100 Hz to 2.9 GHz	Broadband input conversion for spectrum analyzers, lightwave signal analyzers, other systems Broadband, low noise mixer for high dynamic range 70 dB, 10-dB step attenuator (5-dB step option) 1-slot width
HP 70905A RF Section, 50 kHz to 22 GHz	Broadband input conversion for analyzers Broadband, low noise mixer for high dynamic range 70 dB, 10-dB step attenuator 2-slot width
HP 70908A RF Section, 100 Hz to 22 GHz	Fundamentally mixed broadband input conversion for analyzers Highest sensitivity for greater dynamic range Continuously peaked, dynamically tracking preselector 70 dB, 10-dB step attenuator (5-dB step option) 2-slot width
HP 70909A RF Section, 100 Hz to 26.5 GHz **HP 70910A RF Section,** 100 Hz to 26.5 GHz	Diode-pair mixing, built-in preamplifier for improved sensitivity Switchable bypass filter around YIG tuned filter (HP 70910A) Internal switching for connection to external mixers 2-slot width
HP 70907B External Mixer Interface Module	Interface for external mixers, including HP 11974 preselected mixers and HP 11970 harmonic mixers Provides swept LO and tune/span signals 1-slot width

System Integration

Quickly integrate your test system using these resources and tools.

MMS System with HP 70612A

Product	Description
HP 70611A Attenuator/ Switch Driver	Controls up to 31 electro-mechanical mechanical switches or attenuator switch sections Add HP 84940A driver cards to control up to 248 devices Includes interface for manual measurements 1-slot module
HP 70612A Interface Module, 1 x 6 Matrix, DC to 6.5 GHz **HP 70612C Interface Module, 2 x 5 Matrix,** DC to 26.5 GHz	Off-the-shelf solution to interconnection problems 1 x 6 and 2 x 5 common highway switch matrixes Available in frequency bands covering dc to 26.5 GHz MSIB, HP-IB, and manual control
HP 70613A Interface Module, 1 x 6 Matrix, DC to 6.5 GHz **HP 70613C Interface Module, 2 x 5 Matrix,** DC to 26.5 GHz	Attenuator options for adjusting signal strength Rackmount and other custom interface modules available 2-slot modules Custom configurations available

System Accessories

System accessories for the MMS include standard and optional rack cabinets, testmobiles, probes, transmission/reflection test sets, memory cards, external monitors, HIL keyboard, power line frequency option, external power pack and cabling. See the MMS catalog (described on page 95) for more details.

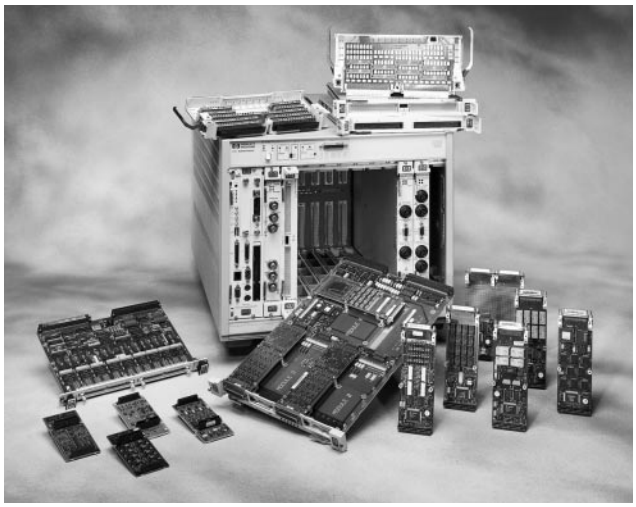
Custom Engineering

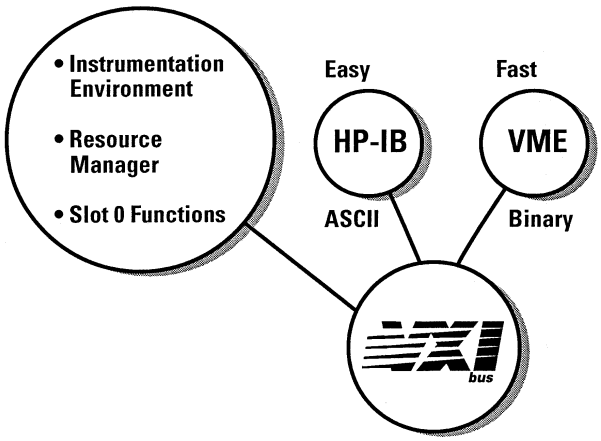
Hewlett-Packard offers engineering and integration services to help you meet your system goals. Our team of experts will ensure that your job is done correctly and cost-effectively. HP can modify existing MMS products, tailoring their functionality to your needs. These enhanced MMS products come with complete operating and service documentation, and are supported at HP service facilities worldwide.

These services are available through your local HP sales representative. See page 582.

Service and Support

The MMS offers many support alternatives. The sytem design allows modules to be exchanged in the field without loss of system calibration. For multiple-module systems, you can add new modules or replace existing ones and run the one-button internal calibration routine. Spares can be stocked based on the MTBF of individual modules — often greater than 15,000 hours. Many MMS instruments have built-in or downloadable diagnostic routines for locating faults. And HP provides for return-to-factory repair and calibration of systems, and offers MIL-STD-45622A certification that is valid for up to three years.





VXIbus Introduction

In 1987, a consortium led by several major test and measurement manufacturers, including Hewlett-Packard, introduced VXIbus, a new standard modular instrument architecture. VXIbus was developed to meet the needs for portable applications, particularly for the military, and to provide an industry-standard instrument architecture with an interface speed significantly higher than that of the HP-IB interface. The design of this new architecture allowed the integration of VXIbus products into traditional HP-IB test systems and for standalone applications. Today, the VXIbus Consortium continues to refine the VXIbus standard and Hewlett-Packard remains an active member.

Since the inception of VXIbus, other standards have been developed, which reduce users' dependence on any one vendor. This lowers the risks and provides maximum investment protection in hardware and software purchases and system development. HP's VXIbus products support the industry-accepted VXI*plug&play* instrument drivers[1]. One set of these standard drivers for the MS Windows environment, for example, is supported by any of several popular software packages: HP VEE, Microsoft C/C++, Visual Basic, Borland C/C++, and NI Lab Windows. Other supported environments are Windows 95/NT, HP-UX, and SUN-OS.

Compact size, high throughput, and flexibility best characterize VXIbus. Today you can use VXIbus products to build a variety of test systems from portable testers for field use and remote data acquisition applications to high-performance data acquisition and functional test systems. While some systems are entirely VXIbus products, many users are integrating VXIbus along with traditional HP-IB instruments. Today VXIbus manufacturers and numerous third-party integrators now are offering dedicated measurement solutions using the VXIbus platform. HP offers several integrated products based on VXIbus. For example, the HP 3587S real-time signal analysis system, the HP HD2000 high-speed data acquisition system, the Model D20 digital functional test system, the HP E1725A time- interval analyzer, and the FTS-40 Functional Test System each consist of a VXIbus mainframe, an embedded controller, and various analog and digital modules. These products are described elsewhere in this catalog.

The pages which follow give a brief overview of the VXIbus Standard and a list of VXIbus products offered. For additional configuration and product ordering information, separate documents are available. For a free HP Test System and VXI Products Catalog and CD, p/n 5966-2815E, in the USA call 1-800-452-4844 . For a more detailed reference in hardcopy form, order the HP Test System and VXI Products Data Book, p/n 5966-2812E

[1] HP joined the VXI*plug&play* Alliance in 1994 and has contributed to the definition of its industry-standard instrument drivers now provided by numerous VXI manufacturers.

The VXIbus Architecture

VXIbus is defined around the highly popular VMEbus architecture known for its excellent computer backplane. High-speed data rates of 40 MB/s along with the necessary communication protocols make it ideal for building instrument systems for high throughputs. VXIbus incorporates the ease-of-use features of intelligent HP-IB instruments (for example, ASCII-level programming) into its message-based devices. It also takes advantage of the high-throughput capability of VMEbus devices which are programmed and communicate directly in binary. The analog to these VMEbus devices is the VXIbus register-based device shown in the above diagram.

Although VMEbus is an excellent computer backplane, it is not adequate for instrumentation without further standardization. The VXIbus Consortium fully defined the operating environment for instrumentation modules. All VXIbus mainframes must state how much power and cooling they provide. And all VXIbus modules must state how much power and cooling they require. Also, there are strict limits on how much conducted and radiated interference is allowed between modules. These parameters allow you to easily configure a workable system.

VXIbus systems provide backplane management and resource management functions. Slot 0, a unique physical location in every VXIbus mainframe, handles the backplane by providing clock signals, data movement arbitration, and more. The Resource Manager program configures the modules for proper operation whenever the system is powered on.

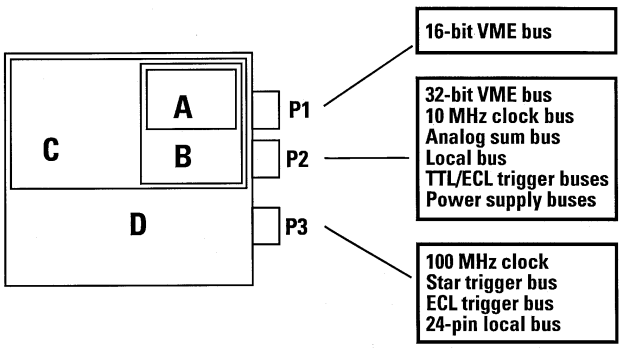
Mechanical and Electrical

The VXIbus specification defines a scalable family of four module sizes as shown in the illustration on page 11.2. The two smaller sizes, A and B, are the defined VMEbus module sizes, and are true VMEbus modules in every sense of the word. The two larger sizes, C and D, are additional sizes to allow higher performance instrumentation. Increased module spacing in the C- and D-size systems makes it possible to fully shield sensitive circuits for high-performance measurements. VXIbus is a scalable architecture, and allows smaller module sizes to fit into larger mainframes.

VXIbus provides other resources for instrumentation. These include additional power supply voltages for powering analog and ECL circuits, and implementation buses for measurement synchronization and triggering. Included are an analog summing bus and a set of local bus lines for private module-to-module communication. Additionally, stringent EMC and noise requirements are specified to maintain an interference-free environment for sensitive instrumentation.

VXIbus specifies three 96-pin DIN connectors: P1, P2, and P3 (page 100). The P1 connector, the only mandatory connector in VMEbus or VXIbus, carries the data transfer bus (up to 24 bits addressing and 16 bits data), the interrupt buses, and some power. The optional P2 connector, available to all card sizes except A-size, expands the data transfer bus and provides the additional resources as shown with particular pin assignments. The local bus indicated is a powerful feature provided by VXIbus. This flexible daisy-chain bus structure allows for adjacent modules to conduct private, high-speed communication.

VXIbus Connectors



Power and Cooling

VXIbus specifies a set of guidelines to ensure adequate cooling. Every vendor's mainframe specifications sheet provides cooling specifications for worse-case module configuration. Available airflow as a function of the maximum allowable pressure differential across any module is specified. This is matched against the specified airflow and pressure parameters specified for each module.

Values of peak dc current and peak-to-peak dynamic current are specified for each module. The system integrator can match the total module current loading to the capacity of the mainframe. The dynamic current specification assures ripple-free noise on the mainframe's power supply lines.

Communications

A more standardized set of communication protocols is defined for VXIbus systems to handle autoconfiguration, resource management, and device communication. The Resource Manager, a message-based commander, takes care of the configuration tasks. It sets up the shared address space, manages the system self-test, creates the commander-servant hierarchies, and then releases the system for operation fully configured.

A message-based device, which communicates directly in SCPI (ASCII), is commonly the most intelligent VXIbus device. Typically it uses a microprocessor and is more costly than a register-based device, but is easier to integrate into a VXIbus system. Most message-based devices provide moderate throughput performance in a VXIbus system.

The most basic level of communication is that handled through register-level (binary-level) reads and writes to the registers of the register-based device (in some instances, direct-register access is provided on a message-based device to improve throughput performance). The register-based device is often controlled by an intelligent message-based device, its commander (command module or embedded controller). The commander interprets SCPI (ASCII) instrument commands converting them into binary for communication to the register-based device. To avoid the speed-reducing effects of the SCPI interpretation, compiled SCPI is used to compile the SCPI instrument commands before runtime. Runtime speeds, then, are commensurate with binary-level speeds as though the user had programmed directly in binary.

An IEEE-488-to-VXIbus interface is also defined in the VXIbus specification allowing for easy integration of VXIbus and HP-IB products into one system. HP's Command Module (HP E1406A), for example, provides the HP-IB connection for interfacing to an external HP-IB controller. For high-throughput systems, an industry-standard interface, MXIbus, is available for direct VXIbus backplane access from an external controller. HP's EISA/ISA-to-MXIbus interface (HP E1489C), for example, provides this capability.

Summary

The benefits of industry-standard VXIbus systems are these:

- Downsizing to save costly rack space
- High-performance, high-throughput measurement capability
- Reduced time and cost for system development
- Reduced dependency on proprietary architectures

If you are interested in custom VXI solutions or project and integration services for VXI systems, refer to page 75.

HP Website Directory

Main HP Website
http://www.hp.com

HP Test and Measurement
http://www.hp.com/go/tmdir

HP VXI Product Information
http://www.hp.com/go/vxi

HP VXI Channel Partners
http:/www.hp.com/go/vxichanpart

HP VEE Application Website
http://www.hp.com/go/hpvee

Data Acquisition and Control Website
http://www.hp.com/go/data_acq

HP Instrument Driver Downloads
http://www.hp.com/go/inst_drivers

HP 75000 VXI Products Information

Model No.	Description	
Mainframes		
HP E8408A	4-Slot, C-Size VXI Mainframe with options to add HP-IB Command Module or IEEE-1394 Slot-0 Interface	NEW
HP E8401A	Low-cost, Medium Power C-Size VXI Mainframe, 13-Slot	NEW
HP E8402A	Medium Power, Enhanced Monitoring, C-Size VXI Mainframe, 13-Slot	NEW
HP E8403A	High Power, C-Size VXI Mainframe, 13-Slot, standard monitoring.	NEW
HP E8404A	High Power, Enhanced Monitoring C-Size VXI Mainframe, 13-Slot	NEW
HP E1401B	High-Power Mainframe, C-size, 13-slot; racking options available	
HP E1421B	Mainframe, C-size, 6-slot; racking options	
HP E1302A	VME/VXI Mainframe, B-size, 20-slot; embedded PC or HP-IB controller and racking options available	
HP E1300B/01B	Mainframes, B-size, 7-slot; built-in 68000 processor and IEEE-488 and RS-232 interfaces; Options: dc power, memory, mass storage, IBASIC	/
Controllers		
HP E1406A	Command Module, C-1, message-based commander, SCPI translator for register-based modules; optional expanded memory available	
HP E1498A	Embedded Controller HP V743 (Series 700), C-1, HP-UX, 100 MHz	
HP E6232A/34 **HP E6237A**	VXI Pentium® PC Controller WIN 95/NT VXI Pentium® PC Controller LynxOS	
Storage		
HP E1488A	Instrument Memory, C-1, RB, 2-16 MB for extending memory of HP E1429/30/45/85	
HP E4208D	SCSI Disk, C-1, 4 GB hard drive, 1.44 MB, 3.5-inch floppy	NEW
HP E3249B	SCSI System Disk, C-2, 4.2 GB hard drive, 4 GB DAT tape	
HP E1562D/E/F	VXI Data Disk, DAT and SCSI-2 Interface Module, C-2, > 5.0 MB/s data rate, > 4 GB disk storage	
Interface		
HP E8491A	IEEE-1394 PC Link to VXI C-Size	NEW
HP E1482B	VXIbus-to-MXIbus Extender, C-size, 1-slot; Connect two or more VXI mainframes together, or interface to external MXIbus controllers	
HP E1489C	EISA/ISA-to-MXI interface; For direct VXI backplane interface to HP 9000 series 700 controllers	
HP E2749A	Fibre Channel Data I/O Module	
Application Software		
HP E2120F, et al.	HP VEE: Graphical Programming Language; Supports MS Windows and HP-UX, VXI*plug&play*, Windows 95/NT/HP-UX Frameworks	
HP E2060B	HP BASIC for Windows: based on the popular HP Rocky Mountain Basic language	

Model No.	Description	
Measurement		
HP E1312A, HP E1412A	6.5 Digit Multimeter, B-2/C-1, RB/MB, Vac/dc, Iac/dc, 2/4-w ohms, frequency, period	
HP E1410A	6.5 Digit Multimeter, C-1, MB, Vdc/ac, 2/4-w Ω, frequency, period, temperature	
HP E1411B, HP E1326B	5 Digit Multimeter, C-1/B1, RB, Vdc/ac, 2/4-w Ω, temperature	
HP E1426A	500 MHz Digitizing Oscilloscope, C-2, MB, 4-Ch., 8 b, 20 MSa/s, 500 MHz	
HP E1428A	1GSa/s Digitizing Oscilloscope, C-1, MB, 2-Ch., 8 b, 250 MHz bw	
HP E1429A/B	20 MSa/s Digitizer, C-1, RB/MB, 12 b, 50 MHz bw	
HP E1430A	10 MSa/s A/D with DSP, C-1, RB 1-Ch., 23 b, 4 MHz bw, 24 digital filters, FIFO	
HP E1432A	16-Ch. 51.2 kHz Digitizer plus DSP C-1, RB, 16-bit, 4-32 MB FIFO, digital anti-alias filters	
HP E1433A	8-Ch. 196 kSa/s Digitizer plus DSP, C-1, RB, 16 b, digital anti-alias filters, 4-32 MB FIFO, 88 kHz bw	
HP E1437A	20 MSa/s Digitizer with DSP, C-1, MB/RB, 1-Ch., 23 b, 8 MHz bw, 24 digital filters, FIFO	
HP SCMVX008	Digital Signal Processor,Dual 60 MHz, Tms 320, C40 DSP with 6 expansion slots	
HP E3242A	Breakout Box accessory interfaces charge and IEPE accelerometers to HP E1432A/33AVXI Digitizers	
HP E3243A	Breakout Box accessory interfaces microphones and IEPE accelerometers to HP E1432A/33A VXI Digitizers	
HP E3245A	12-channel mini-phone plugbreakout box to 26-pin high density connector.	NEW
HP E1313A	32-Ch. or 64-Ch. Scanning A/D, B-size, 3 or 4 slots, RB, 16 b, 100 kSa/s	
HP E1413C	64-Ch. Scanning A/D, C-1, RB, 16 b, 100 kSa/s	
HP E1414A	Pressure Scanning A/D, C-1, RB, up to 512 channels	
HP E1415A	Algorithmic Closed-Loop Controller, C-1, RB, 16 b A/D with signal conditioning	
HP E1419A	Multi-Function Measurement and Control	
HP E1420B	High-Performance Universal Counter, C-1, MB, 2-Ch., 200 MHz/2 GHz	
HP E1332A	4-Ch. Counter/Totalizer, B-1, RB, 4 MHz	
HP E1333A	3-Ch. Universal Counter, B-1, RB, 1 GHz	
HP E1740A	150 MHz Time Interval Analyzer, C-2, MB, 80 M rdgs/s, 100 ps rms	
HP E1416A	Power Meter, C-1, MB, 1-Ch., 110 GHz	
HP E1485C	Digital Signal Processor, C-1, 40 MHz Motorola 96002 DSPwith 4 expansion slots	
HP E1563A, HP E1564A	2-, 4-Ch., 800 kSa/s Digitizers	
M-Modules		
HP E2250A	B-Size M-Module Carrier	NEW
HP E2251A	C-Size M-Module Carrier	
HP E2259A	Double-Wide Breadboard M-Module	
HP E2261A	Quad RS-232 Interface M-Module	
HP E2270A	16-Ch. Form A Switch M-Module	
HP E2271A	4x4 Matrix Switch M-Module	
HP E2272A	Dual 8-to-1 Relay Multiplexer M-Module	
HP E2273A	8-Ch. Form C Switch M-Module	
HP E2274A	4-Ch. Form C Power Relay M-Module	
HP E2290A	16-bit Digital I/O M-Module	
HP E2291A	16-Ch. Isolated Digital Output M-Module	

HP 75000 VXI Products Information

Model No.	Description
Sources and Amplifiers	
HP E1340A	Arbitrary Function Generator, B-1, RB, 12 b, 42 Msa/s, 10.2 V p-p (50 Ω), sweep, waveforms: arbitrary plus sine, square, ramp, triangle, sin(x)x, noise, haversine; Optional waveform software available
HP E1445A	Arbitrary Function Generator, C-1, MB, 13 b, 40 Msa/s, 10.2 V p-p (50 Ω), sweep, waveforms: arb, sine, square, ramp; Optional waveform software available
HP E1328A	4-Ch. D/A Converter, B-1, RB, 16 b, 1.3 kSa/s, 10.92 V dc
HP E1434A	4-Ch. 65 kSa/s Arbitrary Source, C-1, RB, 16-20 bit,10 V, sine, 25.6 kHz, bw, random, swept sine, 4-32 MB RAM FIFO
HP E1418A	8/16-Ch D/A Converter, C-1, RB programmable isolation, ± 16 V, ± 20 mA, 16 bit 1 kHz update rate
HP E1441A	Arbitrary Waveform Generator
HP E1446A	Summing Amplifier, C-1, RB, 15 MHz, 2-Ch., sine + dc, 20 V p-p (50 Ω)
HP E1750A/52A	Broadband Freq./Pulse Amplifiers, C-1, RB, 10 MHz/10 M PPS, 6-Ch., sine/pulse, 1 Vrms (50Ω)
Digital	
HP E1330B	Quad 8-bit Digital I/O, B-1, RB, 32-Ch., I or O, TTL, 325 kb/s
HP E1339A	72-Ch. Open-Collector Dig Out/Relay Driver
HP E1452A	Pattern I/O Module, C-1, RB 32-Ch., Input or Output, TTL/CMOS, 20 M patterns/s
HP E1458A	96-Ch. Digital I/O, C-2, RB, 96-Ch., I or O, TTL
HP E1459A	64-Ch. Isolated Dig Input/Interrupt
Switches—Relay Multiplexer	
HP E1343A	16-Ch., 3-w, B-1, RB, Reed, < 10 μV, 250 V, 10 MHz, 50 mA
HP E1344A	16-Ch., T/C, 3-w, B-1, RB, Reed, < 10 μV, 250 V, 10 MHz, 50 mA
HP E1345A	16-Ch., 3-w, B-1, RB, Reed, < 4 μV, 120 V, 10 MHz, 50 mA
HP E1346A	48-Ch., 1-w, B-1, RB, Reed, < 50 μV, 120 V, 10 MHz, 50 mA
HP E1347A	16-Ch., T/C, 3-w, B-1, RB, Reed, < 4 μV, 120 V, 10 MHz, 50 mA
HP E1351A	16-Ch., 2-w, B-1, RB, FET, < 25 μV, 16 V, 100 kHz, 1 mA
HP E1352A	32-Ch., 2-w, B-1, RB, FET, < 25 μV, 16 V, 100 kHz, 1 mA
HP E1353A	16-Ch., 1-w, B-1, RB, FET, < 25 μV, 16 V, 100 kHz, 1 mA
HP E1355A	8-Ch., 120 Ω Strain, B-1, RB, Reed, < 4μV, 120 V, 10 MHz, 50 mA
HP E1358A	8-Ch., 350 Ω Strain, B-1, RB, FET, < 25 μV, 16 V, 100 kHz, 1 mA
HP E1460A	64/32/128-Ch. 2/3/1-w, C-1, RB, Armature/L, < 7 μV, 60 V, 1 MHz, 1 A
HP E1476A	64-Ch. 3-w, 32-Ch. 4-w, C-1, RB, Reed, voltage, current, temperature (T/C)
HP E8460A	256-Ch. Reed Relay Multiplexer
HP E8462A	256-Ch. Armature Relay Multiplexer NEW
Switches—RF Relay Multiplexer	
HP E1366A	Dual 1x4, 50 Ω, B-1, RB, Armature, < 6 μV, 42 V, 1.3 GHz, 1A
HP E1367A	Dual 1x4, 75 Ω, B-1, RB, Armature, < 6 μV, 42 V, 1.3 GHz, 1A
HP E1470A	60-Ch. Cascade RF Multiplexer, 60:1 to 20 3:1, 50 Ω, C-1, RB, Armature, < 6 μV, 30 V, 500 MHz (3:1), 450 mA (AC)
HP E1472A/73A	Six 1x4, 50 Ω, C-1, RB, Armature, < 6 μV, 42 V, 1.3 GHz, 1A
HP E1474A/75A	Six 1x4, 75 Ω, C-1, RB, Armature, < 6 μV, 42 V, 1.3 GHz, 1A
Switches—Microwave	
HP E1368A	50 Ω, 3-Ch. Form C (SPDT), B-1, RB, Armature, 18 GHz
HP E1369A	Switch Driver, B-1, RB, drives switches up to 26.5 GHz
HP E1370A	Switch/Attenuator Driver, B-2, RB, drives switches up to 26.5 GHz
Switches—Matrix	
HP E1361A	4x4, 2-w, B-1, RB, Armature, < 14 μV, 250 V, 10 MHz, 1 A
HP E1465A	16x16, 2-w, C-1, RB, Armature/L, < 5 μV, 200 V, 10 MHz, 1 A
HP E1466A	4x64, 2-w, C-1, RB, Armature/L, < 5 μV, 200 V, 10 MHz, 1 A
HP E1467A	8x32, 2-w, C-1, RB, Armature/L, < 5 μV, 200 V, 10 MHz, 1A
HP E1468A	8x8, 2-w, C-1, RB, Armature/L, < 7 μV, 220 V, 10 MHz, 1 A
HP E1469A	4x16, 2-w, C-1, RB, Armature/L, < 7 μV, 220 V, 10 MHz, 1A
Switches—General Purpose	
HP E1364A	16-Ch., Form C (SPDT), B-1, RB, Armature, < 7 mV, 250 V, 10 MHz, 1 A
HP E1463A	32-Ch. Form C (SPDT), C-1, RB, Armature, < 7 mV, 125 V, 10 MHz, 5 A
HP E1442A	64-Ch., Form C/A (SPDT), C-1, RB, Armature, < 170 mV, 150 V, 10 MHz, 1 A
Optical Switches	
E4502A/ 03A/04A	2-1x4 / 1-1x16 / 2-1x8 Optical Switches, C-1, RB
Special Purpose Modules	
WJC9119L/R	High-Frequency Tuner (down converter) C-2, RB, 32 MHz
Mass Interconnect	
HP 9420A/21A	Rackmount ICA, High Density, 21 slots, Connector blocks, Cable assemblies
HP E3722A, HP 9421A	Hinged ICA, High Density, 21 slots, Connector blocks, Cable assemblies

C-1 means C-size, 1 slot; B-2 means B-size, 2 slot; RB means Register-based; MB means Message-based, DIO means digital input/output

Whether you are designing a small, medium, or large test system, Hewlett-Packard's switch family provides you with long-lasting quality, reliability, and performance. Hewlett-Packard offers dedicated switches and modular systems that include instrumentation and fixturing. Whatever your application, the ability to make accurate and reliable connections from instruments to test points is critical. Hewlett-Packard's family of switch products allows you to make a quality measurement system in the minimum amount of time.

HP VXIbus Industry Standard Switch Products

The HP 75000 B- and C-size products provide numerous instruments and switches in the VXIbus instrumentation standard. To meet different application requirements and optimize performance, Hewlett-Packard offers switch modules in various topologies with different types of switching components. To meet your switching needs in test systems, HP provides mainframes for B- and C-size VXIbus products.

Selecting the Right HP VXIbus Switch Module

General-Purpose Modules

A general-purpose module provides individual switches for power switching applications and for controlling various devices and routing general-purpose signals.

Matrix Modules

Hewlett-Packard's matrix switch modules provide a convenient method for connecting a group of test instruments to multiple points on a device. Each crosspoint of most matrix modules switches two wires for the high and low of a measurement. Multiple matrix cards can be connected together for applications that require large matrices.

Multiplexer (MUX) or Scanner Modules

The primary use of a multiplexer is to switch multiple analog signals to a voltmeter or other measuring instrument. Different multiplexers can switch one wire (high with a common low), two wires (high and low), or three wires (high, low, and guard or common). The choice of switching topology can be a trade-off between higher point count with single-ended switching or superior measurement accuracy (for example, three-wire guarded measurements) The factors that differentiate HP's multiplexers are: relays vs. FETs, channel count, maximum voltage, thermal offset, and thermocouple or strain gage bridge measurement capability. Most HP multiplexers use tree switching to reduce unwanted capacitive coupling from open channels. Multiplexer modules are offered in both B- and C- size instruments. A single multimeter and one or more multiplexer modules can act as a single instrument.

HP 3488A for a Reliable System

For environments where switching needs are relatively simple or point counts are not very high, the 3488A meets your needs:

- Multiplexers from dc to μ wave
- Simple matrices
- Digital I/O

For more information, refer to the following pages.

HP 34970A for Low-Cost Switching

The HP 34970A Data Acquisition/Switch Unit is ideal for cost-sensitive applications with small- to mid-sized channel count requirements. The three-slot mainframe offers eight switch and control modules which cover a broad spectrum of capabilities:

- Low-frequency multiplexing to 300 V
- 2 GHz RF switching (both 50 and 75 Ohms)
- Matrix switching/General Purpose/Form C switching
- Digital IO/Analog output/Event counting

Refer to page 163 for more information on the 34970A.

The Switch Module Selection Table on this page provides comparative information for each of the VXIbus switches.

Model #	Description	Size, Slots	Switching Type (L-latching)	Thermal Offset (per ch.)	Max. Volts (DC)	Band-width (–3 dB)	Current Rating	Closed Channel Resistance (Ω, initial)
Relay Multiplexers								
HP E1343A	16-Channel, 3-wire	B, 1	Reed relay	<10 μV	250 V	10 MHz	50 mA	100 ±10%
HP E1344A	16-Channel T/C, 3-wire	B, 1	Reed relay	<10 μV	250 V	10 MHz	50 mA	100 ±10%
HP E1345A	16-Channel, 3-wire	B, 1	Reed relay	<4 μV	120 V	10 MHz	50 mA	100 ±10%
HP E1346A	48-Channel, 1-wire	B, 1	Reed relay	<50 μV	120 V	10 MHz	50 mA	100 ±10%
HP E1347A	16-Channel T/C, 3-wire	B, 1	Reed relay	<4 μV	120 V	10 MHz	50 mA	100 ±10%
HP E1351A	16-Channel, 3-wire	B, 1	FET	<25 μV	16 V	100 kHz	1 mA	<3.1 k
HP E1352A	32-Channel, 1-wire	B, 1	FET	<25 μV	16 V	500 kHz	1 mA	<3.1 k
HP E1353A	16-Channel, T/C 3-wire	B, 1	FET	<25 μV	16 V	500 kHz	1 mA	<3.1 k
HP E1460A	64 Ch. Relay Unit	C, 1	Armature, L	<7 μV	220 V	3/10 MHz	0.3, 1 A	<1.5
HP E1476A	64-Channel, 3-wire	C, 1	Reed relay	<2 μV	120 V	100 kHz	35 mA	100 Ohm ±5%
HP E8460A	256-Ch. Relay Multiplexer	C, 1	Reed relay	50 μV	200 V	100 kHz	300 mA	<3
HP E8462A	256-Ch. Armature MUX	C, 1	Armature	3μV	250 V	—	2 A	<0.5 Ohm
HP E2272A	Dual 8-to-1, MUX	M-Mod	DPST, L	<3 μV	60 V/	>10 MHz	2 A	0.2
RF Multiplexers								
HP E1366A	Dual 1 x 4, 50 Ω	B, 1	Armature	<6 μV	42 V	1.3 GHz	1 A	<1
HP E1472A/73A	Six 1 x 4, 50 Ω	C, 1	Armature	<6 μV	42 V	1.3 GHz	1 A	<1
HP E1367A	Dual 1 x 4, 75 Ω	B, 1	Armature	<6 μV	42 V	1.3 GHz	1 A	<1
HP E1474A/75A	Six 1 x 4, 75 Ω	C, 1	Armature	<6 μV	42 V	1.3 GHz	1 A	<1
HP E1470A	60-Channel RF Cascade Multiplexer	C, 1	Armature	—	30 V	500 MHz (1 x 3)	400 MA	<1.5 (typical)
Microwave Switches								
HP E1368A	50 Ω, 3-Ch. Form C (SPDT)	B, 1	Armature	—	—	18 GHz	—	—
HP E1369A	Switch Driver	B, 1	N/A	—	—	Up to 26.5 GHz	—	—
HP E1370A	Switch/Attenuator Driver	B, 2	N/A	—	—	Up to 26.5 GHz	—	—
Matrix Switches								
HP E1361A	4 x 4, 2-wire	B, 1	Armature	<14 μV	250 V	10 MHz	1 A	<1.5
HP E1465A/66A	16 x 16/4 x 64, 2-wire	C, 1	Armature, L	<5 μV	200 V	10 MHz	1 A	<1.8
HP E1467A	8 x 32, 2-wire	C, 1	Armature, L	<5 μV	200 V	10 MHz	1 A	<1.8
HP E1468A	8 x 8, 2-wire	C, 1		<7 μV	220 V	10 MHz	1A	<1.5
HP E1469A	4 x 16, 2-wire	C, 1	Armature, L	<7 μV	220 V	10 MHz	1 A	<1.5
HP E2271A	4 x 4 Matrix	M-Mod	DPST, L	<3 μV	60 V/	>10 MHz	—	0.3
General-Purpose Switches								
HP E1364A	16-Channel Form C (SPDT)	B, 1	Armature	<7 μV	250 V	10 MHz	1 A	<1.5
HP E1463A	32-Channel Form C (SPDT)	C, 1	Armature	<7 μV	125 V	10 MHz	5 A	<0.25
HP E1442A	64-Ch. Form C/A (SPDT)	C, 1	Armature	<70 μV	150 V	10 MHz	1 A	<1.5
HP E2270A	16-Ch. Form A Switch	M-Mod	SPST, L	<3 μV	60 V/	>10 MHz	2 A	<0.2
HP E2273A	8-Ch. Form C Switch	M-Mod	Armature	<20 μV	60 V/	>10 MHz	1 A	N/A
HP E2274A	4-Ch. Form C Power Relay	M-Mod	Armature	<20 μV	60 V/	>10 MHz	5 A	N/A

System Switches

Signal Routing and Measurement

HP 3488A
HP 44470A
HP 44470D
HP 44471A
HP 44471D
HP 44472B
HP 44473A
HP 44474A
HP 44475A
HP 44476A
HP 44477A

- DC to 26.5 signal switching
- Matrix, multiplexer and general-purpose relays
- Digital I/O control actuation
- Up to 100 channels
- 40 configuration storage registers
- 11 switch and control modules

HP 3488A

HP 3488A Switch/Control Unit

HP-IB

The HP 3488A switch/control unit brings versatile, HP-IB programmable switching to tests requiring multi-channel measurements. The HP 3488A provides signal switching with the integrity and isolation needed for high-performance production test systems. It also offers a flexible, low-cost interconnection for automating experiments on the bench and for developing tests in the lab. The HP 3488A is designed to hold up to five of the following switch and control modules:

- 10-channel relay multiplexer
- 10-channel general-purpose relay
- Dual 4-channel VHF switch
- 4 x 4 matrix switch
- 16-bit digital input/output
- Breadboard
- 3-channel 18 GHz switch
- 7-channel form-C relay
- 2-channel microwave switch
- 1.3 GHz 50 and 75 Ω multiplexers

Flexible Switching

The HP 3488A is an economic approach to flexible switching through plug-in modules. You can select the right combination of switching functions to meet both performance and budget needs. Testing is simplified by having one solution of low-level DVM inputs, high level dc and ac power, and microwave signals to 26.5 GHz. Additional devices, such as microwave relays and programmable attenuators, are easily controlled with digital I/O functions. Custom circuitry can also be implemented on breadboard modules.

Versatile Performance

The HP 3488A can store up to 40 complete switch configurations for convenient recall in automated test programs. Switch operation can be done with multiple-relay closures or with selectable channels in a break-before-make mode. Break-before-make and recallable switch configurations can be combined in a programmable scan list. The HP 3488A uses removable screw terminal connectors that provide easily interchangeable wiring for each test. Built-in self-test assures proper operation.

Multiplexer HP 44470A

Option 010 is a 10-channel multiplexer for scanning or multiple-signal connections. Channels switch two wires (Hi and Lo) with 2PST relays for DVM inputs and other signals up to 250V and 2A. This module can also be used to multiplex signals to other switching functions, such as the matrix module.

General-Purpose Relay HP 44471A

This module consists of 10 SPST independent relays for general-signal switching and control of external devices. Quality connections make this module ideal for switching signals when multiplexing is not required, or for supplying switchable power to the device-under-test.

VHF Switch HP 44472B

The VHF module provides broadband switching for high-frequency and pulse signals. The two independent groups of bi-directional 1 x 4 switches can be used for signals from dc to 300 MHz. All channels have 50 Ω characteristic impedance and are break-before-make within a group of four channels. Each group is isolated from the other and from ground to prevent ground loops. Excellent isolation makes this module ideal for high-frequency signal analyzer measurements requiring a large dynamic range.

Matrix Switch 44473A

Option 013 offers highly-flexible switching with a 4 x 4, 2-wire matrix. Any combination of four input channels may be connected to any combination of four output channels. Each cross point or node in the matrix uses a 2PST relay to switch relay to switch two lines (Hi and Lo) at a time. Multiple 4 x 4 modules can be connected to form larger matrices. Multiplexers can be used in conjunction with this module to effectively expand the number of inputs and outputs of the matrix.

Digital I/O HP 44474A

This module offers 16 very flexible bi-directional I/O lines and 4 TTL-compatible handshake lines for sensing and control of external devices. The digital inputs can be used to sense contact closures to ground. Each channel provides current sinks for remote switching of external relays, such as the HP 33311 series coaxial switches.

Breadboard HP 44475A

The breadboard module provides a convenient way to implement custom circuits and special functions that interface directly to the HP 3488A's backplane control signals.

Microwave Switch HP 44476A

This microwave switch furnishes three independent SPST 50 Ω coaxial switches with excellent performance from dc to 18 GHz. The 3-mm SMA connector allows you to easily connect cables for multiple-system configurations.

Form-C Relay HP 44477A

This module provides seven separate SPDT channels for general-purpose switching and control of external devices. Using a power supply, the module can drive programmable attenuators and non-HP coaxial switches.

20-Channel Relay Multiplexer HP 44470D

This module provides 20 two-wire channels to switch analog signals to a common bus. The relays exhibit low thermal offset characteristics for precision low-level measurements.

20-Channel General Purpose Relay HP 44471D

This module provides 20 independent single pole-single throw (SPST, Form A) switches. Its low thermal characteristics make it ideal for independent (non-multiplexed) signal switching.

Microwave Switch HP 44476B

The module brings multi-port 50 Ω coaxial switching to your test system. The module can mount any two HP 3331XX coaxial switches. The HP coaxial relays come in 3-, 4-, and 5-port configurations—different switches for a variety of applications. HP coaxial switches that can be used are:

HP Coaxial Switch	Port	Frequency
HP 33311B/Option 011	3	dc to 18 GHz
HP 33311C/Option 011	3	dc to 26.5 GHz
HP 33312B/Option 011	4	dc to 18 GHz
HP 33312C/Option 011	4	dc to 26.5 GHz
HP 33313B/Option 011	5	dc to 18 GHz
HP 33313C/Option 011	5	dc to 26.5 GHz

1.3 GHz 50 Ω Multiplexer HP 44478A
1.3 GHz 75 Ω Multiplexer HP 44478B

These modules bring bi-directional switching from dc to 1.3 GHz, with high-channel isolation (>55 dB @ 1 GHz). Each module consists of two groups of 1 x 4 multiplexers. All test connections are made to BNCs on the module's edge. Off-channels can be resistively terminated.

Specifications

HP 44470A Multiplexer
HP 44471A General-Purpose Relay
HP 44473A Matrix Switch and
HP 44477A Form-C Relay Switch Modules

Input Characteristics
Maximum Voltage (terminal-terminal or terminal-chassis): 250 V dc, 250 Vac rms, 350 Vac Peak
Maximum Current: 2 A dc, 2 A ac rms
Maximum Power: 60 W dc, 500 VA ac
Thermal Offset: <3 μV
DC Isolation (40°C, 60% RH)
Channel-channel, Open-channel: > 10^{11}Ω

AC Isolation/Performance

50 Ω termination	100 kHz	1 MHz	10 MHz
Insertion Loss (dB)	<0.30	<0.35	<0.90
Crosstalk (dB)	<–73	<–53	<–33

	HP 44470D 20-Ch Relay Multiplexer	HP 44471D 20-Ch GP Relay
Total Channels	20	20
Maximum Voltage	250V dc or ac rms	250V dc or ac rms
Maximum Current (per channel)	2 Adc or ac rms	1A dc or ac rms
Maximum Power (per channel)	60W dc; 125VA ac	60W dc; 125VA ac
Thermal Offset	< 3 _V differential or single-ended	< 3 _V differential or single-ended
Closed Channel Resistance	< 2 _ (end of relay life)	< 2 _ (end of relay life)
Maximum Scan Rate	43 Chans/sec	43 Chans/sec

HP 44472A VHF Switch Module

Input Characteristics
Maximum Voltage
Center-center, Center-low: 250 Vdc, 30 Vac rms, 42 Vac peak
Low-chassis, Low-low: 42 V dc
Maximum Current (per channel): 30 mA dc, 300 mA ac rms
Thermal Offset: <15 μV per channel
Characteristic Impedance: 50 Ω

HP 44474A Digital I/O Module

I/O Lines
Maximum Voltage: + 30 Vdc (line-chassis)
Output Characteristics: V (high) ≥ 2.4V; V (low) ≤0.4V
I (low) Maximum: 125 mA @V (low) ≤1.25 V; fused at 250 mA
Input Characteristics: V (high) ≥ 2 V; V (low) ≤ 0.8 V
External Increment: Advances HP 3488A to next programmed configuration on falling edge of TTL pulse
Channel Closed: Indicates completion of new configuration; TTL pulse

HP 44476A Microwave Switch Module

Frequency Range: DC to 18 GHz
Isolation: > 90 dB
Impedance: 50 Ω
Insertion Loss: <0.05dB
SWR: 1.40

HP 44478A and HP 44478B
1.3 GHz Multiplexers

Input Characteristics
Maximum Voltage: 42 Vdc + ac peak
Maximum Current per Channel: 1 A DC or AC rms
Maximum Power per Channel: 24 W, 24 VA, or 44 dBm
Impedance: 50 Ω (HP 44478A), 75 Ω (HP 44478B)

AC Performance

	≤10 MHz	≤100 MHz	≤500 MHz	≤1.3 GHz
Insertion Loss (db)				
≤(40° C, 95% RH)	<0.3	<0.7	<1.5	<3.0
≤(25°C, 40% RH), (typ.)	<0.2	<0.5	<1.1	<1.9
Crosstalk (dB)				
Channel-Channel				
Channel-Common	<–90	<–80	<–65	<–55
Group-Group, Module-Module	<–90	<–80	<–70	<–60
VSWR	<1.2	<1.25	<1.35	<1.55

General Specifications

Environmental
Temperature: 0° to 55° C (32° to 130°F);
Humidity: 95%, 0° to 40°C (32° to 105°F)
Power: 86 to 132 V/195 to 250 V, switch selectable; 48 to 440 Hz; 18 VA
Interface: HP-IB
Size: 425 mm W x 89 mm H (without feet) x 292 mm D (16.75 in x 3.5 in x 11.5 in). Allow 76 mm (3 in) additional depth for wiring.
Weight: Net, 8.5 kg (18.75 lb); shipping 16 kg (35.25 lb)
Connectors: Removable screw terminal connector. Each terminal accepts 18 to 26 gauge (16 to 40 mils) wire, with strain relief for wiring.
HP 44472A VHF switch: BNC connectors
HP 44476A and HP 44476B: SMA connectors

Ordering Information

HP 3488A Switch/Control Unit
Opt 023/HP 44478A upgrade switch unit for 44470D, 44471D
Rackmounting and Manuals
Opt 401 Side Handle Kit (HP p/n 5061-1171)
Opt 907 Front Handle Kit (HP p/n 5061-1170)
Opt 908 Rack Flange Kit (HP p/n 5061-1168)
Opt 909 Rack Flange with Handles (HP p/n 5061-1169)
Switch Modules—Includes Terminal Connectors
HP 44470A 10-channel Relay MUX Module
HP 44470D 20-channel Relay MUX
HP 44471A 10-channel G.P. Relay Module
HP 4471D 20-channel G.P. Relay MUX
HP 44472A Dual 4-ch. VHF Switch Module
HP 44473A 4 x 4 Matrix Switch Module
HP 44474A 16-bit Digital Input/Output Module
HP 44475A Breadboard Module
HP 44476A Microwave Switch Module
HP 44477A Form-C Relay Module
HP 44476B Microwave Switch Module
HP 44478A 1.3 GHz 50 Ω MUX
HP 44478B 1.3 GHz 75 Ω MUX

Interface Products

HP-IB Cards

Overview

HP offers a full line of interface products to connect your instrumentation and VXI mainframe to your PC or HP workstation. These HP-IB interface cards and software make it easy for you to access and control instruments, exchange data, and create your own automated test applications. HP-IB interfaces are economical and completely compatible with IEEE 488.2. HP offers the following:

- HP-IB interface hardware and software for PCs.
- HP-IB interface hardware and software for HP-UX workstations.
- LAN/HP-IB Gateway for low-cost access to HP-IB instrumentation over LAN.

PC Automation Kits

HP's PC Automation Kits provide the hardware, I/O software, and application software you need to automate your bench or lab at the best possible price. The software includes HP VEE, HP's popular visual programming language that simplifies instrument control, data acquisition, and other aspects of test development.

HP-IB Interface Products for PCs: Add fast, affordable automation to your PC.

Model	HP 82335B	HP 82341C	HP 82341D	HP 82350A NEW
Description	Standard HP-IB interface for PC	High-performance HP-IB interface for PC	Plug and Play high-performance HP-IB interface for PC	High-performance HP-IB interface for PCI bus computers
Operating System	MS-DOS Windows 3.1 Windows 95	Windows 3.1 Windows 95 Windows NT	Windows 95	Windows 95 Windows NT
I/O Library	Command Library, SICL[1]	SICL, VISA	SICL, VISA	SICL, VISA
Backplane	ISA/EISA	ISA/EISA	ISA/EISA	PCI
Max. Speed	335 KB/s	750 KB/s	750 KB/s	750 KB/s
Buffering	None	Built-in	Built-in	Built-in
Languages Supported	C/C++, Pascal, BASIC, Visual Basic HP VEE	C/C++, HP BASIC for Windows,Visual Basic HP VEE	C/C++, HP BASIC for Windows,Visual Basic HP VEE	C/C++, HP BASIC for Windows,Visual Basic HP VEE

[1]Available upon request.

Each of these products includes the interface hardware, I/O software, manuals, and a quick reference card. For complete specifications on these products, please refer to the Hewlett-Packard Test&Measurement website: **http://www.tmo.hp.com/go/tmc99,** in the product datasheet section.

The products listed above all include the Standard Instrument Control Library (SICL). The HP 82341C/D and the HP 82350A also include HP's VISA, the I/O library specified by the VXIplug&play Alliance.

To order, contact the HP Call Center in your region.

HP-UX Workstation and Network Interface Products: Superior, low-cost products that give you fast access to instrument automation.

Model	HP E2070C	HP E2071C	HP E2071D	HP E2050A
Description	HP-IB interface for HP Series 700	High-performance HP-IB interface for HP Series 700	High-performance HP-IB interface for HP Series 700	LAN/HP-IB Gateway
Operating System	HP-UX	HP-UX 9.x, HP-UX 10.01	HP-UX 10.20	HP-UX, Windows 95/NT
I/O Library	SIC L, VISA	SICL, VISA	SICL, VISA	SICL, VISA
Backplane	ISA/EISA	EISA	EISA	LAN
Max. Speed	230 KB/s	750 KB/s	750 KB/s	N/A
Buffering	None	Built-in	Built-in	None
Languages Supported	ANSI C HP BASIC/UX HP VEE	ANSI C HP BASIC/UX HP VEE	ANSI C HP BASIC/UX HP VEE	C/C++ HP BASIC for Windows HP BASIC/UX Visual Basic, HP VEE

[1]For the HP E2050A, you must order option AG1 to get the SICL/VISA software for HP-UX and option AG6 to get the SICL/VISA software for Windows 95/NT. Windows 3.1 not supported.

The HP E2070/71 products include the interface card, I/O software, HP-IB cable, HP-IB connection extender, and documentation. These products provide HP-IB support for the HP Series 700 workstations, including the models 745i, 715, 725, 735, and 755.

Ordering Information

HP 82351F PCI Automation Kit: HP 82350A, HP VEE 5.0 for Windows 95/NT, and an HP-IB cable.
HP 82345F Windows 95/NT Automation Kit: HP 82341C, HP VEE 5.0 for Windows 95/NT, and an HP-IB cable.
HP 82345B Windows 3.1 Automation Kit: HP 82341C, HP VEE 3.2 for Windows 3.1x, and an HP-IB cable.

GPIO Cards
HP E2074B GPIO card for Series 700 workstations.
HP E2075A GPIO card for PCs running Windows 95/NT.

HP E2091D SICL/VISA for Series 700 HP-UX 9.x
HP E2091E SICL/VISA for Series 700 HP-UX 10.20 controllers
HP E2094G SICL/VISA for PCs with Windows 3.1/95/NT.

HP-IB Cables
HP 10833A 1-meter HP-IB cable
HP 10833B 2-meter HP-IB cable
HP 10833C 4-meter HP-IB cable
HP 10833D.5-meter HP-IB cable

To order, contact the HP Call Center in your region.

Test Software

HP BASIC for Windows
5964-0369E
HP BASIC Product Family
5962-7100E
HP VEE 5.0 Evaluation Kit
5966-4450E
HP VEE 5.0 Brochure
5966-3879EN/EUS
HP 35639A DataViewer Product Overview
5962-9499E
HP 37204A Multi-Point HP-IB Extender Technical Data Sheet
5962-6971E

VXIbus Products

Feeling Comfortable with VXI
5965-6497E
Test System and VXI Products Data Book
5966-2812E
Test System and VXI Products Catalog & CD ROM
5966-2815EN/EUS
14 Ways to Work Faster, Smarter, Better
5021-1980
Lowering the Cost of Test with HP VXI
5966-3283E

MMS Products

HP 71000 P-Series Spectrum Analyzers – Modular Spectrum Analyzers with PC Displays, Brochure
5965-5791E
HP 71910A Wide Bandwidth Receiver, Technical Specifications
5964-3895E

(PN 71612A) Extending High-Speed BER Testing to 20 Gb/s with the HP 71612A Error Performance Analyzer
5964-6133E
(PN 71612A) HP 71612A Error Location Analysis
5963-2005E
(PN 71612A) Testing 10-Gb/s SONET/SDH Equipment and Components
5965-0858E

System Switches

(PN 75000) HP IBASIC Product Note
5091-0805E
(PN 75000) Rigorous Stressing of SONET/SDH Alarms Using Programmable 3-Stage Sequences
5965-2742E
(PN 75000) Series 95-1 HP 75000 Series 95 SDH Tributary Test Solutions
5091-8060E
(PN 75000) Series 95-2 HP 75000 Series 95 SONET Tributary Test Solutions
5091-8174E

Interface Products

(PN) Introduction to HP Standard Instrument Control Library (SICL) (82341B)
5963-2228E

Many of these literature pieces are available at:
http://www.hp.com/go/tmc99

Oscilloscopes Hewlett-Packard provides a wide selection of performance from general purpose and troubleshooting, to modular high bandwidth multiple channel instruments, with considerable built-in ease-of-use capabilities.

Mixed Signal
General Purpose
Digitizing
Infiniium

Oscilloscope Probes and Accessories Hewlett-Packard offers a wide selection of probes and accessories to fit your application, and maximize accuracy of signal reproduction.

High Impedance Passive
Surface Mount
Differential
Active
High Voltage, Current

Logic Troubleshooting Tools

HP LogicDart Advanced Logic Probe

Electronic Counters Hewlett-Packard offers the industry's broadest line of electronic counters and counter timers, including Frequency Counters, Universal Counters, and Modulation Domain Counters. The breadth of the HP offering allows the best product to be selected for each application, and delivers the most cost effective solution.

Modulation Domain and Time Interval Analyzers
Universal
High Performance RF and Universal
Universal Time-Interval
CW Microwave Frequency
CW Microwave Counter with Power Measurement
Pulse/CW Microwave

Digital Multimeters/Digital Voltmeters Hewlett-Packard offers a range of products from 3½ all the way to 8½ digits, up to 8 ppm basic dc volts accuracy, down to 100 pV and 100 nΩ, up to 100,000 readings per second and change setups more than 340 times a second.

Low Cost 6½ Digital Multimeter
Nanovolt/Micro-ohm Meter
8½ Digital Multimeter
Handheld
Accessories

Data Acquisition and Switching

Low Cost Data Acquisition/ Switch Unit
Modules

Function Generators and Waveform Synthesizers Hewlett-Packard not only offers standard functions like sine, square and triangle waveforms, but in addition, HP instruments address needs such as multichannel signals, arbitrary waveforms, or even a mix of arbitrary and digital signals.

1 MHz to 21 MHz Synthesizers and Function/Sweep Generators
Multi-functional Synthesizers
Function Arbitrary Waveform Generator

dc Electronic Loads Hewlett-Packard electronic loads deliver precise control and the capabilities needed for analyzing dc power sources and devices.

Single-Input Loads
Modular Mainframes

dc Power Supplies Hewlett-Packard offers a broad line of system and general purpose power supplies. They include: single- and multiple-output, precision, dynamic measurement, autoranging, as well as solar array simulators.

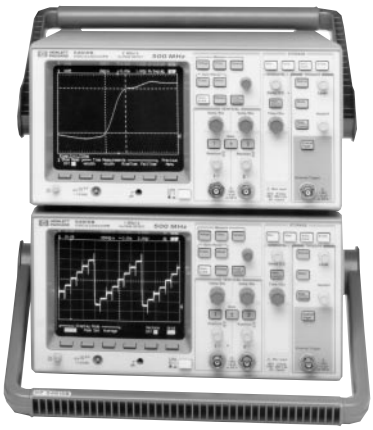
Modular Power System
Dynamic Measurement Single-Output System
Precision Measurement Single-Output System
Multiple-Output System
Single-Output Systems
Solar Array Simulators
Autoranging
Laboratory

Harmonic/Flicker Test Systems Hewlett-Packard's harmonic/flicker test systems are the fastest, least-expensive way to add harmonic/flicker test capability for compliance testing.

Harmonic/Flicker Test Systems

ac Power Source/Analyzers Hewlett-Packard's ac power source/analyzers provide everything needed to generate, measure and analyze ac power.

ac Power Source Analyzers
Graphical User Interface

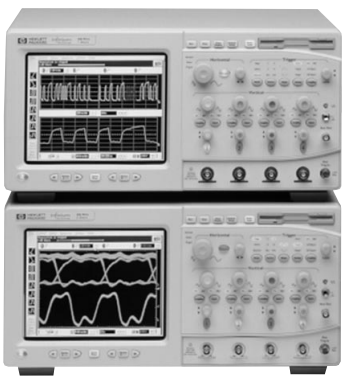


HP 54600-Series Oscilloscopes

- High-Value, General-Purpose Oscilloscopes
- 60 MHz to 500 MHz Bandwidth, up to 2 GSa/s Sample Rate
- Power of Digital with the Feel of Analog
- MegaZoom Deep Memory Technology
- Simultaneous Analog and Digital Capture and Display

	Bandwidth	No. of Chan.	Sample Rate	Memory Depth
HP 54603B	60 MHz	2	20 MSa/s	4k
HP 54600B	100 MHz	2	20 MSa/s	4k
HP 54602B	150 MHz	4(2 + 2)	20 MSa/s	4k
HP 54645A	100 MHz	2	200 MSa/s	1M
HP 54645D	100 MHz	2 + 16	200 MSa/s	1M
HP 54610B	500 MHz	2	20 MSa/s	4k
HP 54615B	500 MHz	2	1 GSa/s	5k
HP 54616B	500 MHz	2	2 GSa/s	5k
HP 54616C	500 MHz	2	2 GSa/s	5k

For more information on HP 54600-series troubleshooting scopes, see page 116.

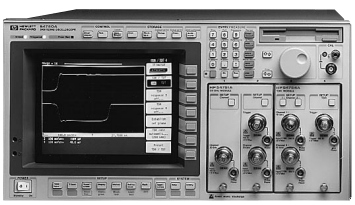


HP Infiniium Oscilloscopes

- High-Performance, Low-Frustration Oscilloscopes
- 500 MHz to 1.5 GHz Bandwidth with up to 8 GSa/s Sample Rate
- Analog-like Front Panel for Simple, Understandable Operation
- Easy Access to Advanced Features Through Windows 95® Based Graphical User Interface
- Built-in Information System and Measurement Expertise

Model	Bandwidth	No. of Chan.	Sample Rate	Memory Depth
HP 54810A	500 MHz	2	1 GSa/s	32K
HP 54815A	500 MHz	4	1 GSa/s	32K
HP 54820A	500 MHz	2	2 GSa/s	32K
HP 54825A	500 MHz	4	2 GSa/s	32K
HP 54845A	1.5 GHz	4	8 GSa/s (2 ch. mode) 4 GSa/s (4 ch. mode)	64K (2 ch. mode) 32K (4 ch. mode)

For more information on the HP Infiniium family of scopes, see page 122.



HP 54700-Series Oscilloscopes

- High-Bandwidth, High-Accuracy Oscilloscopes
- 12 to 50 GHz Bandwidth
- Rich Set of Features and Measurements
- Single Ended and Differential TDR

	Bandwidth	No. of Chan.	Sample Rate	Memory Depth
HP 54750A	12.5 GHz to 50 GHz	2 or 4	N/A	4 K

For more information on HP 54700-series scopes, see page 126.

Making Oscilloscopes Easy To Use—What To Look For?

Today's digitizing oscilloscopes have great power and enhanced capabilities. At the same time, features that look good on the specification sheet are not beneficial if you can't really use them conveniently.

Making scopes easy to learn and use has been a major focus for HP, and the results are products that let you spend more time on your test and less on the instrument doing it. "Ease-of-use," however, is one factor that can only be really evaluated with a hands-on trial at your location. In addition, we think that there are some standard questions and issues which are specific to oscilloscopes which tend to define ease-of-use. We invite you to use our ideas in your comparisons to judge for yourself.

- Adjustment – When you adjust a knob, does the scope respond quickly? How about with the measurement features turned on, or Deep Memory enabled?
- Display quality – As your primary interface, does the display show the signal clearly and accurately?
- Find and Use Features – Is it easy to find and use the features you need, or do you have to relearn the scope's operation for each measurement?
- Help Available – Is help readily available when you can't figure something out?

When the decision is made, the scope will be one of your primary tools for a long time, and we want to help you find the one that's right for you.

10 Steps To Selecting The Right Oscilloscope

Since its introduction, the oscilloscope has been one of the most important and most used test and measurement tools. Its capabilities have grown and changed along with electronics technology, and today there are now a multitude of variations in performance and price. As a result, selecting the right one is an important task that can be time-consuming and confusing.

The steps outlined here are intended to speed your selection process and help you avoid possible pitfalls. Whether it's an HP scope or one from another vendor, following this process will help you make sure you end up with the right scope for your needs. For a more detailed version, look at the HP Infiniium scopes website: **www.hp.com/info/infiniium**, and click on "Selecting a Scope."

1 Analog or Digital?
Analog scopes have familiar front panel controls and are often considered "easy to use." Digitizing oscilloscopes feature a wide range of functionality which cannot be obtained with an analog scope, and recent advances in user interfaces have greatly enhanced usability. As analog-to-digital converters get faster and less expensive with every passing year, the advantage balance continually tilts further toward the digitizing scope, with its increased measurement capabilities and virtually unlimited functionality. Like many T&M manufacturers, HP offers only digitizing scopes.

2 How Much Bandwidth?
Scope bandwidth is typically defined as the frequency above which a sine wave's amplitude is degraded by more than 3 dB. Trying to look at a signal that's too fast for a scope's bandwidth will introduce errors in amplitude and/or time-interval measurements.

There are two types of bandwidth: repetitive (or equivalent time) bandwidth, and real-time (or single-shot) bandwidth. Repetitive bandwidth applies only to repetitive signals, and the display is built up from samples taken during multiple signal acquisitions. Repetitive bandwidth should typically be at least three times greater than the bandwidth of the signals you want to measure. You can estimate non-sinusoidal bandwidth by the equation **BW=0.35/your signal's fastest rise-time.** Real-time bandwidth is the highest frequency a scope can capture in a single acquisition, and is critical when capturing events that occur infrequently. Real-time bandwidth is tied to sample rate, so if real-time bandwidth is important to you, look carefully at "Sample Rate" in Step 3.

Since more bandwidth usually means more money, you'll want to evaluate the frequency content of the signals you usually view against your budget.

3 How Much Sampling Speed ?
There are basically two types of signals you may want to view with a scope: those that occur repetitively and those that happen infrequently. For repetitive waveforms, a scope can either take all the samples in that occurrence (real-time sampling), or take a few samples each time the waveform occurs and combine the samples into a single picture (repetitive sampling). Infrequently occuring events require the scope to capture enough information on a single occurrence of the trigger to accurately represent the waveform. Here's a useful rule of thumb when comparing sample rate and signal bandwidth: if the scope you're looking at has interpolation (filtering to allow reconstruction between sample points), the sample rate to realtime bandwith ratio should be at least 4:1. Without interpolation, use a ratio of 10:1.

4 How Many Channels?
The number of channels you need depends on your application. Two channel scopes are popular for economical general-purpose troubleshooting. However, if you need to view the relationship of several analog signals you'll want a four channel instrument. Many engineers working on systems with both analog and digital signals also consider four channel scopes. Another newer option, called a mixed-signal oscilloscope, combines the channel count and triggering power of a logic analyzer with the greater resolution of an oscilloscope in a single instrument with a time-correlated display.

5 How Much Memory Depth?
Memory depth is a measure of how many samples the scope can store. If you need to capture a pulse train without interruption, you'll need a scope with enough memory to capture the whole thing. You can calculate the memory depth you need by dividing the length of time you want to capture by the sample rate needed to reproduce the signal accurately.

Effective triggering, so you capture your signal at the right place, can often reduce the amount of memory your scope really needs. It is also important to understand that deep memory digitizing oscilloscopes are typically more complex to operate. Hewlett-Packard has introduced a scope (HP 54645 A/D [see page 113]) that combines ease-of-use and deep memory for many 100 MHz applications. For higher bandwidth measurements, you'll want to clearly understand possible trade-off between memory depth and ease-of-use.

Memory depth and sampling rate are intimately related. The memory depth you need depends on the overall time span you need to measure and the time resolution you require. Deep memory instruments are more complex to operate because the user must choose the memory depth that reduces "dead time" needed to fill up the extra memory, or display changing signals inaccurately.

6 What Kind of Triggering Do I Need?
Many general-purpose scope users get by using edge triggering alone. You may find it helpful in some applications, mainly in troubleshooting new designs, to have additional triggering power. Advanced triggering allows you to isolate events of interest to apply the sampling rate and memory depth most efficiently.

In digital applications, it is very helpful to trigger on a specific pattern across channels. In addition, state triggering allows you to sync up you pattern trigger to a clock edge. "Glitch" triggering allows you to trigger on a positive- or negative-going "glitch" or extremely narrow pulse. Other trigger capabilities are often available, and it is important to find out how easy they are to set up and use.

7 Can You Find Those Elusive Anomalies?
Three primary factors affect a scope's ability to display the unknown and complex signals that you encounter in your daily testing and debugging: screen update rate, peak detect, and triggering power (discussed in Step 6).

Update rate gives you an idea of how quickly your scope can respond to signal and control changes, while peak detect helps you capture fast signal peaks in slower signals. Your best bet is to see the scope performing on YOUR signals and view the update rate and peak detect in action, making sure these features aren't compromised by lack of flexibility in other areas.

8 Determine the Analysis Functions You Need
One of the greatest advantages of digitizing oscilloscopes is that they have the abiltiy to make measurements on acquired data and to perform various analysis functions at the touch of a button. The features available vary from vendor to vendor and model to model, but they typically include measurements like frequency, rise time, pulse width and more. Some digitizing oscilloscopes offer Fast Fourier Transform (FFT) capability as well, often at extra cost.

9 What About Probing?
It is easy to forget that the probe becomes part of the circuit as soon as it is attached. As a result it introduces resistive, capacitive, and inductive loading, that can cause to scope to show a different measurement than is actually occuring in the unit under test. The goal, therefore, is to have appropriate probes available for different applications and then choose one that will minimize the loading effects, and allows the most accurate replication of the signal.

10 Will This Scope Be Easy to Use?
It's pretty obvious—if you can't access the features, or spend too much time learning them, your scope becomes less valuable. Because of this, you'll find detailed thoughts on this on the previous page.

General Specifications Chart for HP Digitizing Oscilloscopes

	HP 54603B HP 54600B	HP 54602B	HP 54645A HP 54645D	HP 54610B	HP 54615B HP 54616B/C
Bandwidth Repetitive Real time	60 MHz (54603B) 100 MHz (54600B) 2 MHz	150 MHz 2 MHz	100 MHz 50 MHz	500 MHz 2 MHz	500 MHz 250 MHz (54615B) 500 MHz (54616B/C)
Channels	2	4 (2 + 2)	2 (54645A) 2 + 16 (54645D)	2	2
Horizontal resolution Repetitive (best case)	± 100 ps	± 100 ps	± 40 ps	± 100 ps	± 20 ps
Sample rate	20 MSa/s	20 MSa/s	200 MSa/s	20 MSa/s	1 GSa/s (54615B) 2 GSa/s (54616B/C)
Memory/channel	4K	4K	1M	4K	5K
Vertical resolution	8 bits				
Input voltage ranges	2 mV/div to 5 V/div (1:1 probe; HP 54602B and HP 54645A: 1 mV/div to 5 V/div)				
Input Z, coupling	1 MΩ, ac, dc, ground	50 Ω, 1 MΩ, ac, dc, ground for HP 54610B/615B/616B/616C			
Waveform math	1 + 2, 1–2, XY or versus, invert; optional 1 x 2, FFT, differentiate, integrate, mask comparison				
Other analysis functions	Autostore, peak detect, averaging, roll				
Trigger enhancements	Edge, autolevel, HF/LF reject, noise reject, TV field and line; HP 54610B includes trigger view; HP 54645A includes glitch trigger; HP54645D includes glitch, pattern, and advanced triggers				
Hard copy support	HP printers and plotters, Epson-compatible printers, Centronics printers with optional interface modules				
For more information, order publication number	5964-9339EUS Visit our website: **www.hp.com/go/bi**	5964-9339EUS	5964-9630EUS (54645A) 5964-9634EUS (54645D)	5964-9339EUS	5964-9338EUS and 5964-9339EUS
	HP 54603B: HP 54600B:	HP 54602B:	HP 54645A: HP 54645D:	HP 54610B:	HP 54615B: HP 54616B: HP 54616C:
For more catalog info.	Page 116	Page 116	Page 113	Page 116	Page 116

	HP Infiniium HP 54810A, 54815A, 54820A, 54825A	HP Infiniium HP 54845A	HP 54750A
Bandwidth	500 MHz	50 Ω: 1.5 GHz, 1 MΩ: 500 MHz	50 GHz/20 GHz/12.4 GHz
Channels	HP 54810A/20A: 2 (simultaneous acquisition) HP 54815A/25A: 4 (simultaneous acquisition)	4 (simultaneous acquisition)	2 or 4, depending on plug-ins
Horizontal resolution Equivalent time Real time (best case)	± 60 ps HP 54810A/54815A: ± 200 ps HP 54820A/54825A: ± 100 ps	± 30 ps ± 25 ps	±5 ps N/A
Sample rate	HP 54810A/15A: 1 Gsa/s on each channel HP 54820A/25A: 2 Gsa/s on each channel	2 channel mode: 8 Gsa/s 4 channel mode: 4 Gsa/s	N/A
Memory/channel	32K	2 channel mode: 64K 4 channel mode: 32K	4K
Input voltage ranges	1 mV/div to 5 V / div	1 MΩ: 2 mV/div to 2 V/div 50 Ω: 2 mV/div to 1 V/div	1 to 100 mV/div
Input Z, coupling	50 Ω, 1 MΩ, dc, ac (7 Hz, available in 1 MΩ only), g. ound		50 Ω
Waveform math	4 functions F1–F4. Select from Add, Subtract, Multiply, Divide, Invert, Magnify, Vs., Min., Max., Integrate, Differentiate, FFT Magnitude		+, –, ÷, X, A vs. B, integrate, differentiate, min, max, magnify, invert, FFT, histogram
Other analysis functions	Peak detect, averaging, dual density infinite persistence, variable persistence.		Variable and infinite persistence, averaging, digital BW limit, color-graded display
Waveform storage	4 nonvolatile waveform memories; setups, waveforms, and screen images can be stored to both the floppy drive and the internal 1.4 Gbyte hard drive. Storage toand floppy disk hard drive limited by space only.		1 pixel, 4 waveform,
Trigger enhancements	Edge, glitch, pattern, state, delay by time, delay by events, violation (runt, setup/hold time, pulse width, transition), video, line		2.5 GHz edge trigger, 18 GHz with HP 54118A
Hard copy and disk support	Supports all printers and plotters compatible with Windows 95. Setups, waveforms, and screen images can be stored to both the floppy drive and the internal 1.4 Gbyte hard drive. Storage to hard drive limited by space only. Interface for standard LAN file and printer sharing		HP printers, Epson printers, built-in 3.5-inch flexible disk, and HP-IB and Centronics interfaces
For more information	Order Infiniium brochure (5967-5392 EUS/S) and data sheet (5966-3542 EUS/E) or visit our website: **http://www.hp.com/info/infiniium**		HP 5962-0097E
	HP 54810A: HP 54820A:	HP 54815A: HP 54825A:	HP 54845A:
For more catalog info.	Page 122		Page 126

- Dual-channel 100 MHz scope with 200 MSa/s
- 1 megabyte of memory per channel
- 16 logic timing channels with 400 MSa/s on 8 channels and 200 MSa/s on 16 channels
- Ideal for debugging 8- or 16-bit microcontroller systems
- MegaZoom technology for easy-to-use responsive deep memory
- Simple easy-to-use scope controls
- Powerful triggering

View Analog and Digital Signals Simultaneously

With the introduction of the HP 54645D mixed signal oscilloscope (MSO) to your lab, you will be able to easily view the complex relationships of your circuit's analog and digital operation. Seamless integration of scope and logic channels in the HP 54645D MSO allows you to view both the analog circuit operation on the two 100 MHz scope channels and the logic timing displayed on the 16 logic channels. Analog and digital events are aligned in time so that you can easily relate cause and effect in difficult mixed-signal troubleshooting situations, such as those encountered in debugging 8- or 16-bit micrcontroller systems.

The HP 54645D gives you an oscilloscope-like operation of both the scope and logic channels. For example, simply turn the time base knob to set the time/division for all scope and logic channels. Press Autoscale for the display of all active analog (scope) and digital (logic) channels. There is no scope-logic mode switch, just a seamless integration of logic channels into a scope.

HP MegaZoom Technology

Often when trying to view analog and digital signals, the events of interest take place over a long time span or may be widely separated from the trigger event. With 1 million samples per channel, MegaZoom technology captures long time spans while maintaining the high sample rate, allowing you to see the fine detail needed to solve elusive problems.

Before the introduction of the HP 54645D MSO with MegaZoom technology, deep-memory oscilloscopes were considered specialized tools because of their complex operation, non-responsive control panel, and excessive display dead time. These problems have been eliminated with the development of MegaZoom technology which uses multiple processors optimized for the task of waveform acquisition, storage and display. Now you can have a deep memory scope in your lab that is also a scope you will use every day as it is a deep-memory scope that responds instantly to your control inputs, has a high speed, low dead time display and deep memory with easy-to-use pan-and-zoom.

Powerful Triggering

The HP 54645D MSO provides the triggering power you need to solve your troubleshooting problems with an easy-to-use control system. You will find it ideally suited for everyday use with its familiar scope edge triggering mode. This familiar scope mode is the one that will solve most of your problems as you can trigger on a rising or falling edge on any of the MSO's 18 input channels.

In addition, the powerful, but easy-to-use advanced triggering features will not be regarded as something used in special situations only. Advanced triggering will give you a choice of glitch, pattern, advanced pattern and TV triggering.

In the glitch mode, the MSO will search for a glitch that is less than a specified width on any of the 18 channels. Or you can search for a pulse that is greater than a specified width or within upper and lower limits. Pattern triggering will allow you to set up a pattern of high, low, and don't-care levels across any or all of the MSO's 18 channels. In advanced pattern, the HP 54645D can use two trigger patterns or two edge terms. These terms may be combined in one of several Boolean relationships (AND, OR, and THEN). In addition, you may establish trigger qualifiers such as entered, exited, and duration.

The HP 54600 Product Line

The HP 54645D mixed-signal oscilloscope is a member of the popular HP 54600 series of general purpose scopes that feature the power of digital with the feel of analog. As such, the scope is rugged and built to the same environmental specifications with a 3 year standard warranty. The HP 54645D uses the same interface modules for connecting to printers and computers. Use the BenchLink Scope software package (HP 34810B) for transfer of waveform data, images (.TIF or .PCX), and setups from the scope to a PC.

For more information, visit our web site: **http://www.hp.com/info/mixsig**

HP 54645D

Specifications

Vertical System

Scope Channels: Ch. 1 and Ch. 2
Bandwidth (3dB)**:** dc to100 MHz @ ≥ 10 mv/div (> 75 Mhz @ < 10 mv/div)
ac Coupled: 1.5 Hz to 100 MHz
Rise Time (calculated)**:** ~ 3.5 ns @ > 10 mv/div (< 4.6 ns @ < 10 mv/div)
Dynamic Input Range: ± 32 V or ± 8 div, whichever is less
Math Functions: Ch. 1 ± Ch. 2
Input Resistance: 1 Mohm
Input Capacitance: ~13pF
Maximum Input: 400 V (dc + peak ac)
Range: 1 mV/div to 5 V/div
Vertical Gain Accuracy: ± 1.5% full scale
Vernier: Fully calibrated, accuracy ± 3% full scale
Single-Cursor Accuracy: ± 1.5% full scale; ± 1% full scale; ± 0.5% position value; ± 0.4% full scale;
Dual-Cursor Accuracy: ± 1.5% full scale; ± 0.8% full scale
BW Limit: Approx. 20 MHz
Coupling: ac, dc, GND
Channel Isolation: dc to 20 MHz > 40 dB (with channels at same v/div); 20 MHz to 100 MHz > 30 dB
Inversion: Ch. 1 and Ch. 2

4

Logic Channels

16 channels (0-15) in two pods of 8 channels each
Maximum Input Voltage: ± 40 volts peak
Threshold Range: ± 6.0 volts in 50 mV increments
Threshold Accuracy: ± (100 mV + 3% of threshold setting)
Input Dynamic Range: ± 10 volts about threshold
Minimum Input Voltage Overdrive: To meet the timing specifications, the threshold value must be within 20% of the 50% voltage point of the input signal
Minimum Input Voltage Swing: 500 mV peak-to-peak
Input Resistance: 100 K Ω
Input Capacitance: ~ 8 pF
Channel-to-Channel Skew: 2 ns typical, 3 ns max.
Pre-Defined Thresholds: TTL = 1.4 V, CMOS = 2.5 V, ECL = –1.3 V

Horizontal System, Scope and Logic Channels

Sweep Speeds: 50 s/div to 5 ns/div main and delayed
Accuracy: ± 0.01%
Vernier: Accuracy = ± 0.05%
Horizontal Resolution: 40 ps

Scope Cursor Accuracy

Single Channel: ± 0.01% reading ± 0.2% screen width ± 40 ps
Channel to Channel: ± 0.01% reading ± 0.2% screen width ± 80 ps

Logic Cursor Accuracy

Single Channel: ± 0.01% reading ± 0.2% screen width
± 1 logic sample period
Channel to Channel ± 0.01% reading ± 0.2% screen width
± 1 logic sample period ± channel-to-channel skew
Delay Jitter: < 10 ppm

Delay Range

Pre-Trigger (negative delay)**:** At least 1 screen width or 2.5 msec
Post-Trigger (from trigger point to end of sweep)**:** 500 seconds

Delayed Sweep

Delayed timebase can be as fast as 5 nsec/div. but must be at least 2X the main timebase. Delayed sweep display is the same data acquisition as was the main.
HP MegaZoom Technology (post-acquisition pan and zoom)**:** The time/div and delay controls allow any part of the acquired waveform display to be expanded to the full extent of the memory available.

Trigger System

Modes: Auto, Autolevel, and Normal
Holdoff: ~ 200 ns to ~ 25 seconds
Edge Triggering: Rising or falling on any of the 18 input channels
Pattern Triggering: A pattern of high, low, and don't-care levels and a rising or falling edge can be established across all 18 channels. The analog channel's high level is defined by that channel's trigger level.
Advanced Triggering: Selectable as glitch, pattern, or TV
Glitch: Less than, greater than, or within specified range
Source: Any of the 18 input channels
Polarity: Rising or falling
Minimum Pulse Width Setting: 8 ns
Advanced Pattern: Up to two trigger terms (P1 and P2) and two edge terms (E1 and E2) may be established and these terms can be combined as follows: AND, OR, THEN, Entered, Exited, Duration <, Duration >, and Duration range
TV: Available on scope channels only
TV Line and Field: 0.5 divisions of composite sync required for stable display

Oscilloscope Analog Triggering

Sensitivity	
< 10 mV/div, DC to 25 MHz	≤ 1 div or 2 mV
< 10 mV/div, 25 MHz to 100 MHz	≤ 1.5 div or 3 mV
> 10 mV/div, DC to 25 MHz	≤ 0.35 div or 3.5 mV
> 10 mV/div,25 MHz to 100 MHz	≤ 1 div or 10 mV

Sources: Ch. 1, Ch. 2, and line

Coupling

dc, ac, HF reject, LF reject, noise reject, HF reject and LF reject –3dB @ 50 kHz

XY

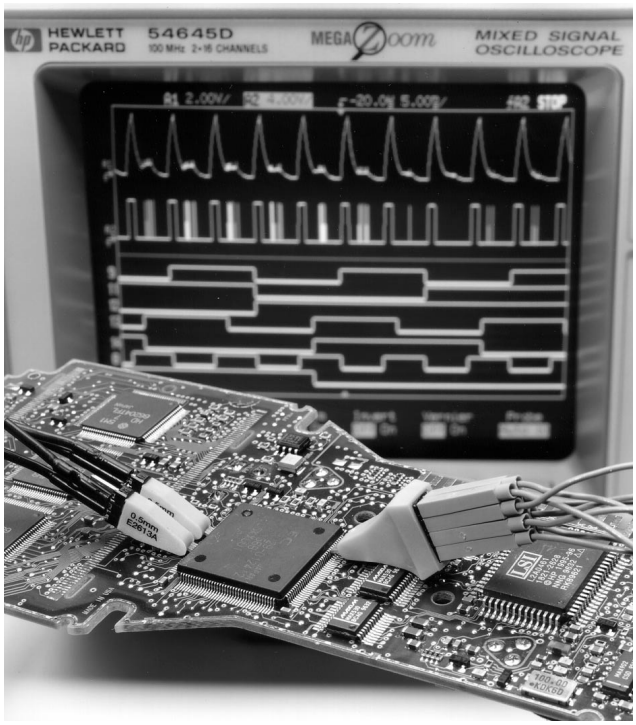
Bandwidth: 100 MHz
Phase Error @ 1 MHz: 1.8 degrees

Acquisition System

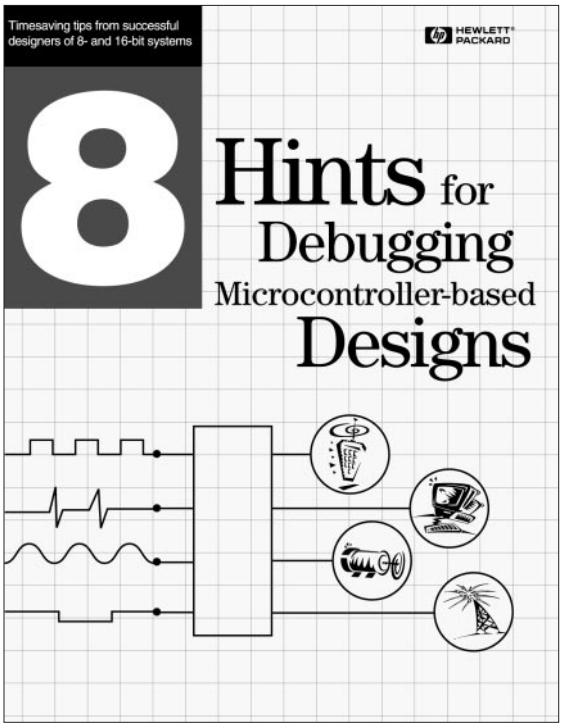
Maximum Display Rate: 3 million samples per second with sufficient trigger rate, and vectors off. 60 full screens per second, vectors on.
Average: Selectable as smoothing, 4, 8, 16, 32, 64, 128, and 256 averages
Roll Mode: At sweep speeds of 200 ms/div and slower, data moves across the display from right to left with no dead time

Oscilloscope Acquisition System

Maximum Sampling Rate: 200 MSa/s on each channel
Single-Shot Bandwidth: 50 MHz
Simultaneous capture on both channels
Vertical Resolution: 8 bits
Peak Detection: Can capture and display a pulse at least 5 nsec wide at any timebase setting
Maximum Memory Depth: 1 megabyte samples per channel



For accessories to help probe fine pitch ICs (0.5mm and 0.65mm) see page 132 for information about the new 3- or 8-signal HP Wedge. See pages 129–135 for other probing solutions.



Ask for your free copy of time-saving tips from successful designers of 8- and 16-bit systems (p/n 5966-3688EUS).

Logic Acquisition System

Vertical Resolution: 1 bit
Maximum Sampling Rate: 400 MSa/s on one pod, 200 MSa/s on two pods
Simultaneous capture on all channels
Peak Detection: Will capture and display a pulse at least 5 nsec wide at any time base setting
Maximum Memory Depth: 2 megabyte samples per channel on one pod, 1 megabytesamples when both pods are used

Display System

Display: 7-inch raster monochrome CRT
Resolution: 255 vertical by 500 horizontal points
Controls: Front-panel intensity
Vectors: Selectable on/off
Graticle: 8 x 10 grid, frame, and none

Advanced Features

Automatic Measurements: Measurements are continuously updated, markers indicate measurement
Voltage: V_{AVG} (dc), V_{RMS}, V_{PP}, V_{MIN}, V_{MAX}, V_{TOP}, V_{BASE}.
Time: Frequency, period, + pulse width, –pulse width, duty cycle, rise time and fall time (rise time and fall time are scope only)
Cursors: Manually or automatically-placed readout of time, 1/time, voltage. Additionally, logic channels can be displayed as binary or hex values.

Setup Functions

Autoscale: Finds and displays all active scope and logic channels, sets edge trigger mode on highest numbered channel, sets vertical sensitivity on scope channels and thresholds on logic channels, time base to display 1.8 periods
Save/Recall (non-volatile)**:** 10 set-ups can be saved and recalled from non-volatile memory
Trace (pixel) **Memory:** 2 volatile

User-Defined Channel Labels: All channels may be assigned a user-defined label of up to 6 characters. Labels displayed in place of first division of waveform.

General

Please refer to HP 54600 Series specifications on page 119.

Ordering Information

HP 54645D Mixed-Signal Oscilloscope
Accessories supplied: Two each HP10074A 10:1 divider probes with readout, HP 10089A16-channel logic input probe assembly, removable front panel ground connector, user's guide and service manual, power cord
- **Opt 001:** RS-03 Magnetic Interference shielding added to the CRT
- **Opt 002:** RE-02 Display Shield added to the CRT to reduce radiated interference
- **Opt 101:** HP 10098A Front-panel Cover and Pouch Kit
- **Opt 103:** HP 54654A Customer Training Kit
- **Opt 104:** HP 1185A Carrying Case
- **Opt 106:** HP 34810B HP BenchLink Scope Software
- **Opt 1CM:** HP 5062-7345 Rackmount Kit
- **Opt W50:** Additional two years of warranty

Accessories
HP 10074A: 10X Probe with Readout
HP 10070A: 1X Probe
HP 10085A: HP 16:16 logic cable and terminator
HP 10089A: HP 16:2 x 8 logic inputprobe assembly
HP 1183A: Testmobile

See the MSO in Action

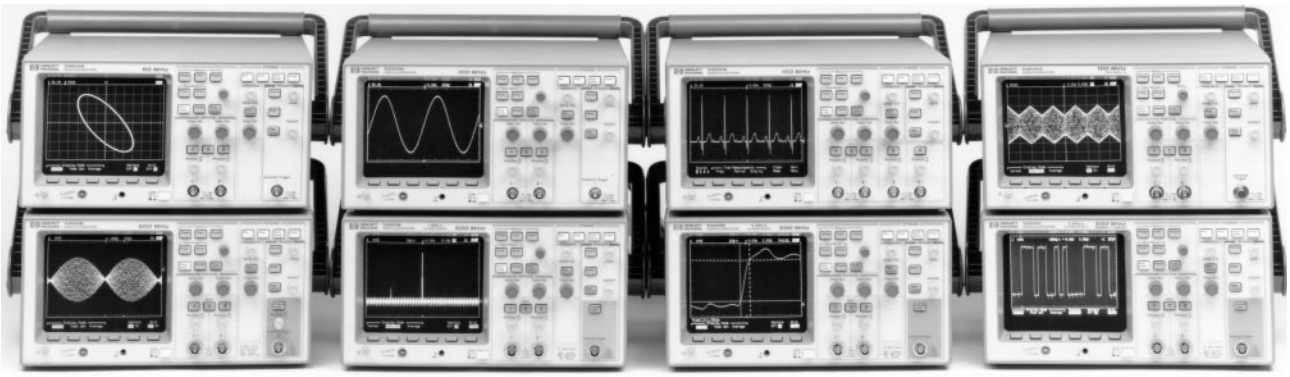
To see the HP 54645D mixed signal oscilloscope in action and for answers to any questions you might have, contact the HP Call Center in your region and request a free copy of 8 Hints for Debugging Microcontroller-based Designs (5966-3688EN/EUS) or of the product presentation CD ROM. The HP 54645D Data Sheet is also available–ask for publication number 5964-6364EN/EUS.

For more information, visit our web site: **http://www.hp.com/info/mixsig**

Indicates QuickShip availability.

HP 54600 Family

- Analog look and feel
- 1 Meg of memory (HP 54645A)
- Automatic and cursor-based measurements of frequency, time, and voltage
- Up to 2 GSa/s sample rates
- Glitch detection
- Add-on interface and enhancement modules for hard copy, remote programming, and FFT
- 60 to 500 MHz bandwidth
- Up to 1 ns peak detect
- Up to 3 million points per second update rate
- Color (54616C)



HP 54600 Family of Oscilloscopes

The HP 54600 family of oscilloscopes offers you the comfortable feel of analog scopes and the measurement power of digital scopes, all at a price you can afford. This family of oscilloscopes gives you the ability to view waveforms you can't see with your analog scope, and they provide the familiar controls and interactive displays you've grown accustomed to. To solve your most difficult test problems, these scopes provide powerful digital features, such as pre-trigger viewing, peak detect, waveform storage, and measurement automation.

This class of oscilloscopes, made possible through HP's advanced integrated circuit technology, presents this power in a small, lightweight package and at a price that fits your budget. The display update rate of up to one and a half million points per second provides a display with unprecedented interactivity.

Eight Models: One Is Right for You

With eight models to choose from, you will be able to pick the oscilloscope that best meets your measurement and troubleshooting needs while meeting the constraints of your budget. The dual-channel 60 MHz HP 54603B is ideally suited for classroom use and other situations where budgets are tight. The HP 54600B offers dual-channel 100 MHz performance for field service and production test applications. With its 150 MHz bandwidth, 1 mV/division sensitivity, and triggering to 250 MHz, the HP 54602B is the "lab quality" general-purpose scope for your bench today, and in the years to come.

The HP 54610B may the lowest priced 500 MHz oscilloscope on the market, but it does not compromise on measurement quality. The HP 54615B boosts the sample rate to 1 GSa/s while preserving the intuitive analog feel and instantaneous response, common in all the members of the HP 54600 family. At the top of the HP 54600 line, the HP 54616B (monochrome) and the HP 54616C (color) provide 500 MHz bandwidth and 2 GSa/s sample rate. The HP 54645A, 100 MHz MegaZoom oscilloscope, brings deep memory to the family. MegaZoom technology makes using the one megabyte of memory effortless.

Model	Bandwidth	Chs	Sensitivity	Maximum Sample Rate
54603B	60 MHz	2	2 mV to 5 V/div	20 MSa/s
54600B	100 MHz	2	2 mV to 5 V/div	20 MSa/s
54645A	100 MHz	2	1 mV to 5 V/div	200 MSa/s
54602B	150 MHz	4 (2 + 2)	1 mV to 5 V/div	20 MSa/s
54610B	500 MHz	2	2 mV to 5 V/div	20 MSa/s
54615B	500 MHz	2	2 mV to 5 V/div	1 GSa/s
54616B/C	500 MHz	2	2 mV to 5 V/div	2 GSa/s

Powerful, Efficient and Compact

When you think about powerful digital scopes, the first thing that might come to mind is large and complicated. The HP 54600 family has four models that are neither, making them ideal troubleshooting and debugging oscilloscopes. These scopes are compact (can fit under a plane seat) and weigh under 15 pounds. They also retain some of the attributes that were valued in analog scopes. Knobs that allow direct access control of vertical and horizontal scaling and positioning are just one of the many features that make these scopes easy to use. High update rate and a real-time vector display respond instantly to changes in your waveform. This powerful combination will help you get answers fast.

Multiple-Processor Architecture

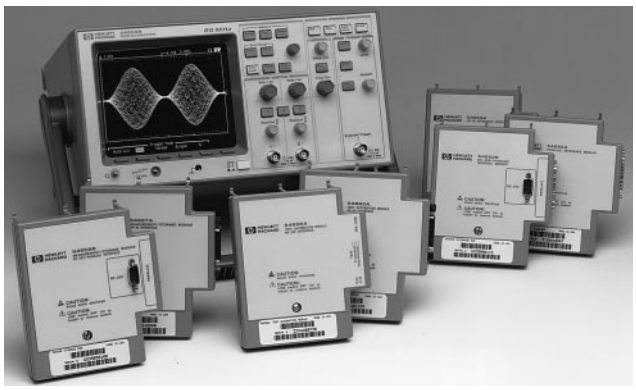
HP uses a multiple-processor architecture in the HP 54600 series of oscilloscopes. This is one of the ways in which HP delivers ease of use, with a responsive high update-rate oscilloscope. The parallel processing utilized in the HP 54600 series allows acquisition and display systems of the oscilloscope to function independent of the human interface and measurement systems. This makes for a general-purpose troubleshooting scope that is responsive to changes in your waveform, as well as responding to changes initiated from the front panel.

HP 54645A MegaZoom Oscilloscope

The HP 54645A oscilloscope makes deep memory highly usable. The HP 54645A is a dual channel 100 MHz oscilloscope with 200 MSa and a full 1 MB of memory behind each of its channels. Through the application of MegaZoom technology, this deep-memory oscilloscope has a high speed/low dead time display and a highly-responsive front panel. Unlike all other deep memory scopes which force the user to choose between fast response and deep memory, MegaZoom technology gives you a scope that is always fast and deep. Pan-and-zoom operation is as simple as turning the time/division knob. No special menus or controls are required to take full advantage of the HP 54645A's deep memory.

A powerful glitch trigger extends the power of MegaZoom technology in solving your toughest troubleshooting problems. Simply set up the desired pulse width that represents a worse case situation and after the scope finds it, pan and zoom through the deep waveform record to find out exactly what was going on in your circuit that caused the problem.

- Hard-copy output to printer or plotter
- Remote instrument control
- Enhanced automatic measurements
- Extended trace storage, math operations, and FFT
- Unattended signal monitoring



A Full Family of Add-On Interface and Enhancement Modules

The HP 54600 series scopes use a complete range of optional interface modules for hard-copy output, remote programmability, and custom test functionality. These modules plug into the back of most HP 54600 series scopes, adding advanced capability to your general-purpose, trouble-shooting scope.

HP 54650A HP-IB Interface Module

This module provides full remote control and hard-copy output to HP-IB printers and plotters. Programming is in accordance with IEEE-488.2.

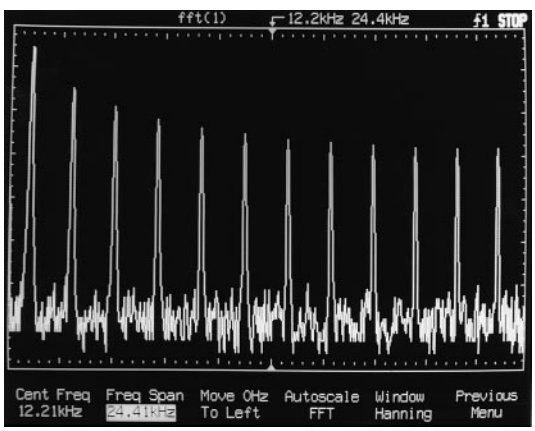
HP 54652B RS-232/Parallel Interface Module

This module provides computer interface via RS-232 and printing via parallel in one module. The RS-232 interface also can be configured for printing when not being used for remote programming.

HP 54657A HP-IB and 54659B RS-232/Parallel Measurement/Storage Modules

The HP 54657A and 54659B measurement/storage modules bring enhanced measurement and storage power to your HP 54600 scope. Added features include:

- FFT
- Up to 100 non-volatile trace memories
- New automatic measurements with user-defined levels
- New channel-to-channel delay and phase measurements
- Real-time clock for time- and date-tagging of hard copy and stored traces
- Unattended pass/fail signal monitoring



HP 54600 Series Software and Accessories

HP 34810B BenchLink Scope Windows Software (Option 106)

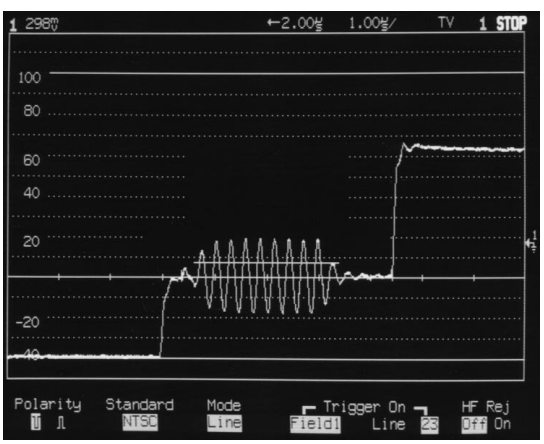
HP BenchLink Scope makes it easy to move important information from scope to PC. You'll be able to transfer:
Screen Images: You can transfer a bitmap picture of the scope screen to your PC for viewing, annotation, storage or printing. HP BenchLink Scope provides convenient annotation tools, and Windows makes it easy to cut and paste your annotated image into other applications. You can also save your image in PCX and TIF formats.
Waveform Data: HP BenchLink Scope transfers the actual waveforms on screen to your PC for further review and analysis. You can simultaneously capture scope and logic waveforms, and, once captured, use waveform markers in HP BenchLink Scope to review your data.
Instrument Setups: The full front-panel setup of your scope can be saved in the PC for later use.

HP 54654A Operator's Training Kit (Option 103)

The operator's training kit consists of a training signal board and lab workbook. The signal board provides 12 signals that show various operating modes and features of an HP 54600 series oscilloscope. Nineteen logic analyzer test points are also provided to demonstrate the features of the HP 54600 series logic analyzers or mixed signal oscilloscope. After completing the labs, the user can operate the instrument and make measurements with no extra training. This kit is ideal for the educational environment and can also be an excellent tool for training new employees.

Enhanced Performance for Video Applications (Option 005)

With the addition of Option 005, enhanced TV/video triggering, to the HP 54602B, HP 54610B, HP 54615B, HP 54616B/C or HP 54645A oscilloscopes, you will be able to trigger on any specified line of video in either NTSC, PAL, PAL-M, SECAM or generic video formats. With this additional triggering, you will be able to easily view signals that are often very dim or invisible on most analog scopes. Once you have the signal of interest displayed, you can measure it with digital precision.



Live NTSC broadcast video

HP 10098A Pouch and Front Panel Cover (Option 101)

The pouch provides probe and accessory storage on top of the scope and is easily removable for rackmounting. The front panel cover provides sturdy protection of the front panel display and knobs when transporting the scope.

HP 1185A Carrying Case (Option 104)

The HP 1185A carrying case makes transporting and shipping your HP 54600 series oscilloscope safe and simple. A scope, optional module, and other accessories fit neatly inside the padded shell of hard plastic, and the case is lockable for shipment.

Product Specific Performance Characteristics

Vertical system	HP 54603B	HP 54600B	HP 54602B	HP 54610B	HP 54615B/ HP 54616B/C	HP 54645A
Bandwidth (BW) Ch. 1 and 2	dc to 60 MHz	dc to 100 MHz	dc to 150 MHz 100 MHz @ 1, 2, & 5 mV/div	dc to 500 MHz[7]	dc to 500 MHz[7]	dc to 100 MHz 75 MHz @ 1, 2 and 5 mV/div
Ch. 3 and 4	N/A	N/A	dc to 250 MHz	N/A	N/A	N/A
Rise time (calculated) Ch. 1 and 2	5.8 ns	3.5 ns	2.3 ns	700 ps	700 ps	3.5 ns
Ch. 3 and 4	N/A	N/A	1.4 ns	N/A	N/A	N/A
Input R & C	1 MΩ, ≈ 13 pf	1 MΩ, ≈ 13 pf	1 MΩ, ≈ 13 pf	1 MΩ, ≈ 9 pf	1 MΩ, ≈ 9 pf	1 MΩ, ≈ 13 pf
Dynamic range (from center screen)	± 8 divisions	± 8 divisions	± 8 divisions	± 12 divisions	± 12 divisions	± 8 divisions
Sensitivity (per division) Ch. 1 and 2	2 mV to 5 V	2 mV to 5 V	1 mV to 5 V	2 mV to 5 V	2 mV to 5 V	1 mV to 5 V
Ch. 3 and 4	N/A	N/A	0.1 V and 0.5 V	N/A	N/A	N/A
Accuracy	± 2%	± 1.5%	± 1.5%	± 2%	± 2%	± 1.5%
Vernier accuracy	± 3.5%	± 3%	± 3%	± 2%	± 2%	± 3%
Maximum input dc + peak ac	400 V	400 V	400 V	250 V or 5 V RMS in 50 Ω mode	250 V or 5 V RMS in 50 Ω mode	400 V
Selectable BW limit Ch. 1 and 2	20 MHz	20 MHz	20 MHz	30 MHz	30 MHz	20 MHz
Horizontal system						
Accuracy	± 0.01%	± 0.01%	± 0.01%	± 0.01%	± 0.005%	± 0.01%
Vernier accuracy	± 0.05%	± 0.05%	± 0.05%	± 0.05%	NA	± 0.05%
Resolution	100 ps	100 ps	100 ps	25 ps	20 ps	40 ps
Delay jitter	10 ppm	10 ppm	10 ppm	10 ppm	1 ppm	10 ppm
Sweep speed	5 s/div to 5 ns/div	5 s/div to 2 ns/div	5 s/div to 2 ns/div	5 s/div to 1 ns/div	5 s/div to 1 ns/div	50 s/div to 2 ns/div
Acquisition system						
Max. sample rate	20 MSa/s	20 MSa/s	20 MSa/s	20 MSa/s	1 GSa/s[10]/2 GSa/s	200 MSa/s[10]
Single shot BW	2 MHz	2 MHz	2 MHz	2 MHz	250 MHz/500 MHz[10]	50 MHz[10]
Peak detect (single chan.)	50 ns	50 ns	50 ns	50 ns	1 ns[10]	5 ns[10]
Record length (pts. vectors off/on)	4k/2k	4k/2k	4k/2k	4k/2k	5k/2k	1 Meg
Max. update rate vectors off	1.5 M pts/s	1.5 M pts/s	1.5 M pts/s	1.5 M pts/s	0.5 M pts/s	3 M pts/s
Trigger system						
Sensitivity Ch. 1 and 2	dc to 25 MHz, 0.35 div or 3.5 mV dc to 60 MHz, 1 div or 10 mV	dc to 25 MHz, 0.35 div or 3.5 mV dc to 100 MHz, 1 div or 10 mV	dc to 25 MHz,[9] 0.35 div or 3.5 mV dc to 150 MHz, 1 div or 10 mV	dc to 25 MHz, 0.35 div or 3.5 mV dc to 500 MHz, 1 div or 10 mV	dc to 100 MHz, 0.5 div or 5.0 mV dc to 500 MHz, 1 div or 10 mV	dc to 25 MHz 0.35 div or 3.5 mV dc to 100 MHz, 1 div or 10 mV
Sensitivity Ch. 3 and 4	N/A	N/A	dc to 250 MHz 1 div or 10 mV	N/A	N/A	N/A
External trigger range	± 18 V	± 18 V	N/A	± 18 V	± 2 V	± 18 V
External trigger sensitivity	dc to 25 MHz, 50 mV dc to 60 MHz, 100 mV	dc to 25 MHz, 50 mV dc to 100 MHz, 100 mV	N/A	dc to 100 MHz, 75 mV dc to 500 MHz, 150 mV	dc to 100 MHz, 75 mV dc to 500 MHz, 150 mV	dc to 25 MHz, 50 mV dc to 100 MHz 100 mV
External trigger input R&C	1 MΩ, ≈ 13pf	1 MΩ, ≈ 13pf	N/A	1 MΩ, ≈ 12pf or 50 Ω	1 MΩ, ≈ 12pf or 50 Ω	1 MΩ, ≈13pf
External trigger input maximum input	400 V (dc + peak ac)	400 V (dc + peak ac)	N/A	250 V (dc + peak ac) or 5 V rms in 50 Ω	250 V (dc + peak ac) or 5 V rms in 50 Ω	400 V (dc + peak ac)

[1] Temperature is ±10° C from calibration.
[2] Use full scale of 80 mV for 2 mV/div and 5 mV/div ranges on HP 54600B, HP 54615B, HP 54616B/C and HP 54603B. Use full scale of 40 mV for 2 mV/div range on HP 54610B. Use full scale of 56 mV for 2 mV/div range on HP 54615B, HP 54616B/C . Use full scale of 16 mV for 1 mV/div or HP 54602B.
[3] Use full scale of 50 ns for 2 ns/div.
[4] Tested to Hewlett-Packard environmental specification section 758 for Class B-1 products.
[5] Characteristic for the HP 54602B only.
[6] Characteristic for HP 54610B and HP 54615B, HP 54616B/C only.
[7] Upper BW reduces by 2 MHz per degree C above +35° C.
[8] Characteristic for HP 54603B only.
[9] 1, 2, 5 mV/div dc to 25 MHz, 1 div or 2 mV.
[10] Simultaneous on both channels.

Product Specific Performance Characteristics

Vertical System–All Models

Math Functions: Channel 1 ± Channel 2
Cursor Accuracy[1,2]/Single Cursor: Vertical accuracy ± 1.2% of full scale ± 0.5% of position value
Dual Cursor: Vertical accuracy ± 0.4% of full scale
Inversion: Channel 1 and Channel 2
CMRR: ≈20 dB at 50 MHz

Vertical System (HP 54610B, 54615B, 54616B/C)

50 Ω Protection: Protects 50 Ω load from excessive voltage
Probe Sense: Automatic readout of 1X, 0X, 20X, and 100X probes

Horizontal System–All Models

Cursory Accuracy (t and 1/t)[3]**:** ± 0.01% reading ± 0.2% screen width ± 200 ps
Pre-Trigger Delay (negative time)**:** 10 div
Post-Trigger Delay (trigger to start of sweep)**:** At least 2560 div or 50 ms. Not to exceed 100 s.
Time Skew (HP 54610B, HP 54615B, 54616B/C)**:** Each channel adjustable over a range of ± 25 ns to remove effects of cabling

Delayed Sweep

Main Sweep 5 s/div to 10 ms/div: Delayed sweep; up to 200 x main
5 ms/div and Faster: Up to 2 ns/div/1 ns/div[6]/5 ns/div[8]

Trigger System

Sources
HP 54602B: Channels 1, 2, 3, 4, or line
HP 54600B, 54603B, 54610B, 54615B, 54616B/C 54645A: Channels 1, 2, line, and external
Coupling: ac, dc, LF reject, HF reject, and noise reject.
LF and HF: –3 db at 50 kHz.
Modes: Auto, Auto-level, Normal, Single, and TV
TV Triggering: TV line and field. Requires 0.5 div of composite sync for stable display (Channels 1 and 2).
Holdoff: Adjustable from 200 ns to 13 s from 300 ns (HP 54615B, 54616B/C)

External Trigger (HP 54600B, HP 54603B, HP 54610B, HP 54615B, HP 54616B/C, HP 54645B)

Coupling: dc, HF reject and noise reject

External Trigger (HP 54610B only)

Coupling: ac and dc
Trigger View: External trigger is viewable
Bandwidth: ≥ 350 MHz

X-Y Operation–All Models

Z-Blanking: TTL high-blanks trace (Not available on HP 54615B, HP 54616B/C)
Bandwidth: X and Y same as vertical system
Phase Difference: ± 3° at 100 kHz, ± 3° at 10 MHz (HP 54615B, HP 54616B/C), ± 1.8° at 1 MHz (HP 54645A)

Display System–All Models Except HP 54616C

Display: 7-inch raster CRT
Resolution: 255 vertical x 500 horizontal points
Controls: Front-panel intensity control
Graticule: 8 x 10 grid or frame
Auto-Store: Saves previous sweeps in half-bright display and the most recent sweep in full-bright display

Acquisition System–All Models

Resolution: 8 bits
Simultaneous Channels: Channels 1 and 2 or Channels 3 and 4 (HP 54602B)
Average: Number of averages selectable from 8, 64, 256

Advanced Functions–All Models

Automatic Measurements: Continuously updated
Voltage: V avg, V rms, V p-p, Vtop, V base, V min, and V max
Time: Frequency, period, + width, – width, duty cycle, rise time, and fall time
Cursors: Manually or automatically placed
Setup Functions Autoscale: Sets the vertical and horizontal deflection and the trigger level
Save/Recall: 15 front-panel setups; 10 front-panel setups (HP 54645A)
Trace Memory: 2 volatile pixel memories
TV Functions/Line Counting: Delay time calibrated in NTSC and PAL line numbers
All-Field Trigger (both fields selected)**:** Oscilloscope triggers on the vertical sync pulse in both fields, allowing use with fields, allowing use with noninterlaced video

General

Power Requirements
Line Voltage Range: 100 Vac to 240 Vac
Line Voltage Selection: Automatic
Line Frequency: 45 Hz to 440 Hz
Max. Power Consumption: 220 VA, 300 VA (HP 54615B, HP 54616B/C)
Environmental Characteristics: Meets the requirements of MIL-T-28800D for Type III, Class 3, Style D equipment as described later in this table
Ambient Temperature
Operating: –10° C to + 55° C
Nonoperating: –51° C to + 71° C
Humidity[4]
Operating: 95% RH at 40° C for 24 hrs.
Nonoperating: 90% RH at 65° C for 24 hrs.
Altitude
Operating: To 4,500 m (15,000 ft)
Nonoperating: To 15,000 m (50,000 ft)
EMI (Commercial) (MIL-T-28800D)**:** Meets FTZ 1046 Class B. Meets requirements in accordance with paragraph 3.8.3 EMI Type III and MIL-STD-461C as modified by Table XII.
CE01: Part 2 narrow band requirements up to 15 kHz
CE03: Part 4
CS01: Part 2
CS02: Part 2
CS06: Part 5 limited to 300 V
RE01: Parts 5 and 6 measured @ 12-inch, 15 dB relaxation to 20 kHz exceptioned from 20 kHz to 50 kHz
RE02: Part 2 (limited to 1 GHz) full limits of Class A1C and A1F with Option 002 installed. Without Option 002 installed, 10 dB relaxation, 14 kHz to 1 GHz.
RS02: Part 2, Part I and Part 2, Part II, exceptioned
RS03: Part 2, limited to 1 V/meter from 14 kHz to 1 GHz (with Option 001 installed); slight trace shift from 80 MHz to 200 MHz.
Vibration: Operating 15 min. along each of the 3 major axes; 0.025-inch peak-to-peak displacement, 10 Hz to 55 Hz in 1-min. cycles. Held for 10 min. at 55 Hz (4 g at 55 Hz).
Shock: Operating 30 g, 1/2 sine, 11-ms duration, 3 shocks/axis along major axis. Total of 18 shocks.
Size (excluding handle)**:** 322 mm W x 172 mm H x 317mm D (12.7 in x (6.8 in x 6.8 in x 12.5 in)
Weight: 6.2 kg (14 lbs)
Safety: CSA certification, IEC-348, UL-1244 listed

Product Specific Performance Characteristics

HP 54650A HP-IB Interface Module

Provides full remote control and hard copy to HP-IB printers and plotters. Programming is in accordance with IEEE-488.2. With the addition of this module, the scope's two pixel memories become non-volatile. An operating and programming manual and a programming examples disk are supplied.
Specifications: The interface capabilities of the HP 54600 series oscilloscope with this module installed are as defined by IEEE-488.1 as SH1, AH1, T5, L4, SR1, RL1, PP1, DC1, DT1, C0 and E2.
HP Printer/Plotter Supported: HP ThinkJet, HP QuietJet, HP PaintJet, HP DeskJet, and HP LaserJet; HP-GL compatible plotters.

HP 54652B RS-232/Parallel Interface Module

Provides full remote control via RS-232 and printing via parallel in one module. The RS-232 can also be configured for printing when not being used for remote control.
Specifications
Connector Type: 9 pin (m) DTE Port, works with HP 34398A RS-232 cable
Protocols: Xon/Xoff, hardwire
Data Bits: 8
Parity: None
Baud Rates: 1200, 2400, 9600, or 19200
HP Printer/Plotter Supported: HP ThinkJet, HP QuietJet, HP PaintJet, HP DeskJet, and HP LaserJet; HP-GL compatible plotters.
Connector Type: 25 pin (F) connector, works with HP C2950A parallel printer cable
Other Supported Printers: Epson FX-80 or HP PCL compatible printers

HP 54657A and 54659B Measurement/Storage Modules

With the the addition of either the HP 54657A module with HP-IB interface or the HP 54659B module with RS-232 and parallel interface, the HP 54600 series oscilloscope will provide all of the following features:

19 Automatic Measurements consisting of:

Voltage: Vamp, Vavg, Vrms, Vpp, Vpre, Vovr, Vtop, Vbase, Vmin, and Vmax
Time: Delay, Duty Cycle, Frequency, Period, Phase Angle, Rise Time, Fall Time, + width, and –width
Thresholds: User selectable among 10%/90%, 20%/80%, or absolute voltage levels
Cursor Readout: Voltage or percentage
Modes: Time or phase angle

Waveform Math Functions

Function 1: Addition, subtraction, and multiplication
Function 2: Differentiation, integration, and FFT
FFT
Windows: Exponential, flat top, Hanning and rectangular
Samples: 1024 points

Storage

Trace Memory: Up to 100 nonvolatile memories
Memories 1–3: High speed storage without compression
Memories 4–100: Storage with compression. Storage time is approximately 7 seconds. Number of traces that can be stored is a function of complexity, with the minimum being 4 highly complex traces and the maximum being 96.
Memory Labeling: An onscreen text editor is provided for creating labels up to 20 characters. Each label contains the date and time it was saved.
Real-Time Clock: 24-hour format with battery back-up. Can be set from front panel.

Unattended Waveform Monitoring

Testing Method: Comparison to waveform mask
Number of Masks: 2
Mask Generation and Operation: Automask, controlled from the front panel, generates mask from displayed wave-form with selectable tolerance. Mask editor function allows pixel-by-pixel editing and line drawing. Smoothing function performs a running average of 3 pixels.
Action on Failure:
Save failed trace to memory with date and time of the failure
Print failed trace with date and time of the failure
Count the failure and maintain pass/fail statistics while continuing the test
Hard Copy and Programmability Interface: HP 54657A: HP-IB (for HP-IB specifications, see HP 54650A)
HP 54659B: RS-232/Parellel (for RS-232/Parallel specifications, see HP 54652B)

HP 54600-Series Scope Interface and Enhancement Modules

Ordering Information Product	Description	HP-IB	RS-232 and Parallel	FFT and Advanced Meas.	Benchlink Software
1. **HP 54650A**	HP-IB Interface Module	•			
HP 54652B	RE-232 and Parallel Interface Module		•		
2. **HP 54657A**	HP-IB Measurement/Storage Module	•		•	
HP 54659B	RS-232 Measurement/Storage Module		•	•	
3. **HP E2657A**	Measurement/Connectivity Kit for HP-IB	•		•	•
HP E2659A	Measurement/Connectivity Kit for RS-232		•	•	•

(Note that the HP 54620A/C logic analyzers can use any of these modules, but they use the modules for I/O only.) HP 34810B BenchLink Scope software for Windows is available separately. See page 97.

1. Basic Connectivity
If all you need is a PC interface, add HP-IB with the HP 54650A or both RS-232 and parallel connections with the HP 54652B.

2. Connectivity and Advanced Measurements
For high-performance tools usually found only in much more expensive scopes–including the FFT to view signals in the frequency domain–add the HP 54657A (HP-IB) or HP 54659B (RS-232 and parallel) measurement/storage module.

This module also provides many other features to make your work easier, including unattended signal monitoring and failure detection, measurements of channel-to-channel delay and phase, user-definable voltage levels for timing measurements, and extended math functions and cursor readouts.

3. Complete Connectivity, Including Software
Get the complete package, including HP BenchLink Scope software for documenting and analyzing measurement results (see page 163 for more information on HP BenchLink).

Ordering Information

HP 54600B Two-Channel 100-MHz Oscilloscope
Includes two 1.5 m 10X probes (HP 10071A), operating and service guide, and line cord
HP 54602B Four-Channel 150-MHz Oscilloscope
Includes two 1.5 m 10X probes (HP 10071A), operating and service guide, and line cord
HP 54603B Two-Channel 60-MHz Oscilloscope
Includes two 1.5 m 10X probes (HP 10071A), operating and service guide, and line cord
HP 54610B Two-Channel 500-MHz Oscilloscope
Includes two 1.5 m 10X probes (HP 10073A), operating and service guide, and line cord
HP 54615B Two-Channel 500 MHz Oscilloscope
Includes two 1.5 m 10X probes (HP 10073A), operating and service guide, and line cord
HP 54616B Two-Channel 500 MHz Oscilloscope
Includes two 1.5m 10X probes (HP 10073A), operating and service guide, and line cord
HP 54616C Two-Channel 500 MHZ Color Oscilloscope
Includes two 1.5m 10X probes (HP 10073A), operating and service guide, and line cord
HP 54645A Two-Channel 100 MHz MegaZoom Oscilloscope
Includes two 1.5m 10X probes (HP 10074A), operating and service guide, and line cord

Accessories
HP 54650A HP-IB Interface Module
HP 54652B RS-232 and Parallel Interface Module
HP 54654A Operator's Training Kit
HP 54657A Measurement/Storage Module with HP-IB Interface
HP 54659B Measurement/Storage Module with RS-232 and Parallel
HP 1146A Oscilloscope AC/DC Current Probe
HP 1137A 1000:1 High Voltage Divider Probe
HP 10070A 1.5 m 1X Probe
HP 10071A 1.5 m 10X 150 MHz Probe
HP 10072A SMT Probe Tip Kit for HP 10070A family of probes
HP 10073A 1.5 m 10X 500 MHz Probe
HP 10074A 1.5 m 10X 150 MHz Probe with Probe Sense
HP 10075A 0.5 mm SMT Probe Accessory Kit for the HP 10070A family of probes
HP 34397A DC to AC Inverter
HP 85901A AC Power Source

Options
Opt 001 Display EMI Shield (HP 54600-68703)
Provides extra shielding for the CRT. For MIL standards or harsh magnetic environments (see page 119 for more details).
Opt 002 Display Filter
Provides additional reduction in radiated emissions. For MIL standards or measurement environments sensitive to radiated emissions (see page 119 for more details).
Opt 005 Enhanced Video Trigger
(not available on HP 54600B or HP 54603B)
Adds the ability to trigger on a specified line of NTSC, PAL, PAL-M,SECAM, or general format video. IRE graticule, IRE cursor readout, video autoscale, and rear-panel outputs for trigger and channel input are added with this option.
Opt 101 Accessory Pouch and Front-Panel Cover (HP 10098A)
Opt 102 Two Additional 10071A Probes (54602B only)
Opt 103 Operator's Training Kit (HP 54654A)
Consists of a training signal board and lab workbook. After completing these labs, an operator will be able to make measurements and operate the oscilloscope without any additional training.
Opt 104 Carrying Case (HP 1185)
Designed to protect the oscilloscope for shipment or for checking as airline baggage
Opt 106 BenchLink Software (HP 34810B)
Windows software that interfaces the scope (with either HP-IB or RS-232 module installed) to a PC for storage, analysis, or easy integration of waveform data into desktop publishing software
Opt 090 Delete Probes for HP 54600B, 54602B, 54603B
Opt 090 Delete Probes for HP 54610B, HP 54615B, HP 54616B/C
Opt 090 Delete Probes for HP 54645A
Opt 1CM Rackmount Kit (HP 5062-7345)
7-inch EIA standard rack
Opt W50 Additional Two-Year Warranty (for a total of five years)
HP 54600B
HP 54602B
HP 54603B
HP 54610B
HP 54615B
HP 54616B
HP 54616C
HP 54645A

For the Educators
These oscilloscopes are ideally suited for classroom use. Contact the HP Call Center in your region for details on specific education discount programs.

HP 54600 Interfacing and Hard Copy Output Information Compatibility Chart

The following table describes the devices supported by the HP 54600 series oscilloscopes:

	HP-IB modules	RS-232 modules	Parallel modules
Hewlett-Packard Printers (LaserJet, DeskJet)	N/A	N/A	Yes
Epson Printers (FX-80 or Compatible)	N/A	Yes	Yes
Computers	Yes	Yes	Yes
HP-PCL Printers	Yes	Yes	Yes
HP-GL Plotters	Yes	Yes	N/A

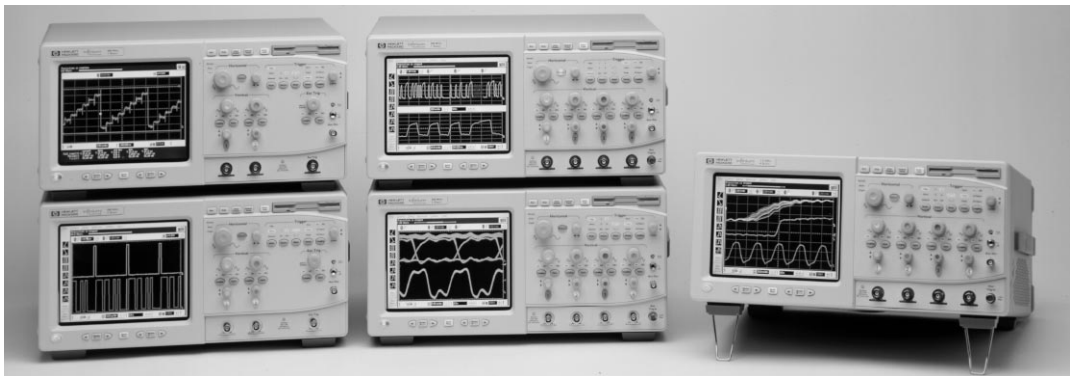
HP-IB Cables for HP 59650A and HP 59657A
HP 10833A 1 m Cable
HP 10833B 2 m Cable
HP 10833C 4 m Cable
HP 10833D 0.5 m Cable
RS-232 Cables for HP 54652B and HP 54659B
For connection to printers and plotters:
HP 34398A 2.5 m, 9 Pin (f) to 9 Pin (f)
HP 34399A Adapter Kit
For connection to PCs:
HP 34398A 2.5 m, 9 Pin (f) to 9 Pin (f) Plus 9 Pin (m) to 25 Pin (f) Adapter
RS-232 Cables for HP 54656A and HP 54658A
For connection to printers and plotters:
HP 13242G 5 m, 25 Pin (m) to 25 Pin (m)
For connection to IBM PC/XT computers:
HP C2913A 1.2 m, 25 Pin (m) to 25 Pin (f)
For connection to PCs:
HP 24542G 3 m, 25 Pin (m) to 9 Pin (f)
Parallel Cable
HP C2950A 2 m, Parallel Printer Cable

Indicates QuickShip availability.

Infiniium Oscilloscopes

HP 54810A
HP 54815A
HP 54820A
HP 54825A
HP 54845A

- 500-Mhz to 1.5-Ghz bandwidth
- 2- or 4-channel models
- Up to 8 Gsa/s sample rates
- Simple, analog-like front panel
- Windows 95-based graphical user interface
- Built-in information system



Infiniium models 54810A and 54820A, Infiniium models 54815A and 54825A, Infiniium model 54845A

Performance You Can Use

HP Infiniium oscilloscopes combine a simple, analog-like front panel, the graphical user interface of a PC, and a built-in information system, to make high-performance features accessible and uncomplicated. We call it usable performance. We think you'll call it a significant improvement.

Simple Analog-like Front Panel

Infiniium high-performance oscilloscopes give you the simple, uncluttered front panel of an analog scope for accessing all basic functions. Dedicated scale and position knobs for each vertical channel provide intuitive scope operation. Trigger LEDs show you trigger status at a glance. To speed up measurements, you can configure the QuickMeas key for instant access to any four measurements. The Default Setup key returns the scope to a known state with one touch – a valuable feature if you share a scope.

Standard Graphical User Interface

Infiniium oscilloscopes employ a graphical user interface based on Windows 95. Because this is a familiar and intuitive user interface, you won't have to spend a lot of time learning and relearning the scope. Pull-down menus give you easy access to advanced features. And many functions can be done without accessing the menus. For instance, drag-and-drop measurements, direct manipulation of waveforms and zooming can all be done using the mouse.

Built-in Information System

Infiniium's built-in information system puts measurement assistance at your fingertips. You'll no longer have to look for the manual when you need help setting up the scope or making complex measurements. A Setup Guide gives you step-by-step instructions for 24 different measurements and procedures. In addition, you'll find a thorough index of help topics and context-sensitive help available from the dialog boxes.

Extra-Large Display

Infiniium's high-resolution color display has a waveform viewing area more than double that of many products in its class. Output the scope display to a VGA monitor for an even larger view of your waveforms.

Display Annotation

You no longer have to manually write notes to annotate print-outs from your oscilloscope. Now you can insert up to 12 labels of 100 characters each to the waveform display area. This display annotation can be saved to and recalled from bitmap image files and instrument setup files.

New Triggering

Infiniium oscilloscopes include HP violation trigger technology, based on a new trigger IC specifically for Infiniium. In addition to standard trigger modes, such as edge, glitch, delay, logic, state and video, HP's violation trigger technology adds trigger capabilities such as rise-time trigger, fall-time trigger, setup and hold-time violation trigger, and runt trigger.

LAN Connectivity

Now you can easily print scope waveforms on any printer connected to your Ethernet LAN. That means you have more flexibility for documenting your results with high-quality print-outs. LAN connectivity also makes it easy to share data with your colleagues and get your scope data to your PC where you can analyze it, archive it or move it to a word processing program.

Internal Hard and Floppy Disk Drives

Use the internal 2.1 GB hard drive or the 3.5-inch MS-DOS-compatible high density floppy disk drive to store instrument setups, waveforms, or screen images. Images can be stored as BMP, EPS, GIF, TIFF, PCX, or PS files for easy import into various programs for documentation or further analysis.

Standard Interfaces

HP-IB, RS-232, Centronics, and LAN interfaces are standard features. Infiniium oscilloscopes are fully HP-IB programmable.

Easy Probing

The AutoProbe interface is an intelligent communication and power link between compatible probes and the Infiniium oscilloscope. AutoProbe completely configures the oscilloscope for the probe. It identifies the type of probe attached and sets up the proper input impedance, attenuation ratio, probe power, and offset range if needed. A whole new line of compatible passive, active, and differential probes is available. See the Infiniium Probes and Accessories Product Overview for more information (5965-7001).

Printer Support

Use any printer that has a Windows 95 driver; that's hundreds of preloaded drivers for printers from over 40 different manufacturers. Also, new drivers can be loaded from a floppy disk.

Clip-on Trackball Option

If you don't have the bench space for a standard mouse, a clip-on trackball option is available. The trackball clips onto the side of the instrument.

Ultimate Performance

Infiniium model 54845A provides the superior bandwidth and sample rate to accurately capture high-speed signals. 1.5 GHz bandwidth and 8 GSa/s sampling rate assure that your signal will be recorded accurately.

Model	Ch.	Bandwidth	Sample Rate	Memory
54810A	2	500 MHz	1 GSa/s	32K
54815A	4	500 MHz	1 GSa/s	32K
54820A	2	500 MHz	2 GSa/s	32K
54825A	4	500 MHz	2 GSa/s	32K
54845A	4	1.5 GHz	8 GSa/s (2 ch.)	64K
			4 GSa/s (4 ch.)	32K

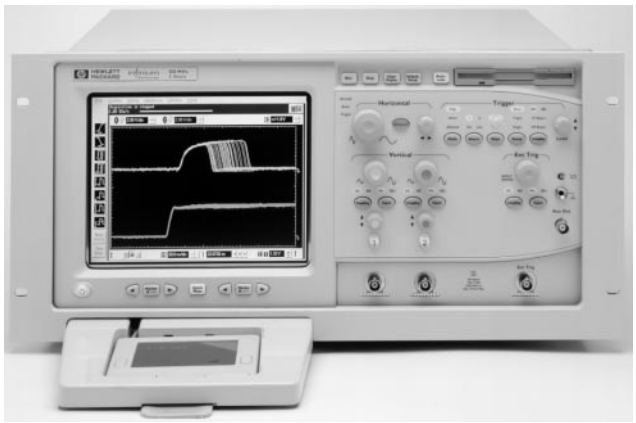
Performance Characteristics	HP 54810A, 54815A, 54820A and 54825A	HP 54845A
Acquisition		
Maximum sample rate, real time	HP 54810A/15A: 1 GSa/s on each channel HP 54820A/25A: 2 GSa/s on each channel	2 channel mode: 8 GSa/s 4 channel mode: 4 GSa/s
Maximum effective sample rate, equivalent time	100 GSa/s	500 GSa/s
Memory depth	32, 768 points/channel	2 channel mode: 65,536 points 4 channel mode: 32,768 points
Averaging	Selectable from 2 to 4096	Selectable from 2 to 4096
Vertical		
Number of channels	HP 54810A/20A: 2 (simultaneous acquisition) HP 54815A/25A: 4 (simultaneous acquisition)	4 (simultaneous acquisition)
Analog bandwidth (–3dB)*	500 MHz	50 Ω: 1.5 GHz; 1 M Ω: 500 MHz (with HP 1161A probe)
System bandwidth with: 1160A 10:1 passive probe 1161A 10:1 passive probe 1162A 1:1 passive probe 1163A 10:1, 500 Ω passive probe 1152A 2.5 GHz, .6pF active probe 1153A 200 MHz differential probe	 500 MHz — 25 MHz 500 MHz 500 MHz 200 MHz	 — 500 MHz 25 MHz 1.5 GHz 1.3 GHz 200 MHz
Real time bandwidth*	HP 54810A/15A: 250 MHz HP 54820A/25A: 500 MHz	50 Ω: 1.5 GHz (2 ch. mode), 1.0 GHz (4 ch. mode) 1 M Ω: 500 MHz
Rise time[1]	HP 54810A/15A: 700 ps (equivalent time); 1.4 ns (real time) HP 54820A/25A: 700 ps	50 Ω : 233 ps 1 M Ω: 700 ps
Sensitivity[2] 1 M Ω 50 Ω	 1 mV/div to 5 V/div 1 mV/div to 5 V/div	 2 mV/div to 2 V/div 2 mV/div to 1 V/div
Input impedance*	1 M Ω ± 1% (≈8 pF), or 50 Ω ± 1%	1 M Ω ± 1% (≈12 pF), or 50 Ω ± 1.5%
Input coupling	dc, ac (7 Hz, available in 1 M Ω only)	dc, ac (7 Hz, available in 1 M Ω only)
Maximum input voltage* 1 M Ω 50 Ω	 ± 250 V (dc + ac) [ac < 10 kHz], CAT I 5 Vrms, CAT I	 ± 100 V (dc + ac) [ac < 10 kHz], CAT I 5 Vrms, CAT I
Hardware bandwidth limit (-3 dB)	On/Off selectable, 30 MHz	N/A
Channel-to-channel isolation (with channels at equal sensitivity)	dc to 50 MHz: 50 dB 50 MHz to 500 MHz: 40 dB	dc to 100 MHz: 40 dB 100 MHz to 1 GHz: 30 dB 1 GHz to 1.5 GHz: 25 dB
Offset range	Vertical Sensitivity / Available Offset 1 mV/div to 50 mV/div: ± 2 V > 50 mV to 250 mV/div: ± 10 V > 250 mV to 1.25 V/div: ± 50 V > 250 mV to 1.24 V/div: ± 250 V	Vertical Sensitivity / Available Offset 1M Ω: 2 mv/div to 100 mV/div: ± 4 V > 100 mV/div to 2 V/div: ± 40 V 50 Ω: all: > ± 12 div
Dynamic range	± 12 div from center screen	± 8 div from center screen
Full resolution channel scales	All volts/division settings > = 7 mV/div	10, 20, 50, 100, 200, 500, 1000 mV/div (plus 2000 mV/div in 1 M Ω)
dc gain accuracy *[2,3]	± 1.25% of full scale at full resolution channel scale	± 1% of full scale at full resolution channel scale
Resolution[2] Real time Equivalent time	 8 bits (0.4% of full scale), 12 bits with averaging 8 bits (0.4% of full scale), 12 bits with averaging	 8 bits (0.4% of full scale), 12 bits with averaging 8 bits (0.4% of full scale), 12 bits with averaging
Horizontal		
Main time base range	500 ps/div to 5 s/div	100 ps/div to 5 s/div
Delayed sweep range	1 ps/div to current main time base setting	1 ps/div to current main time base setting
Delayed sweep delay range	Within main time base acquisition record	Within main time base acquisition record
Resolution	10 ps	2 ps
Timebase accuracy	50 ppm (.005%)	70 ppm (.007%)
Delta-t accuracy* Real time mode[4] Equivalent time mode (≥ 16 avgs.) Peak detect mode Example (equivalent time mode (≥ 16 avgs.), 9 ns signal, 1 ns/div, 1 channel)	 ±[(.005%)(delta-t)+(0.2)(sample period)] ±[(.005%)(delta-t)+(full scale/(2 * memory depth)) + 60ps] ±[(.005%)(delta-t)+(1 sample period)] Accuracy = ±[(.005%)(9 ns)+((10 ns)/(2 * 32,768)) + 60ps] = ±[(450 x 10^{-15})+(152 x 10^{-15}) (60 x 10^{-12})] = 61 ps	 ±[(.007%)(delta-t)+(0.2)(sample period)] ±[(.007%)(delta-t)+(full scale/(2 * memory depth))+ 30ps] N/A Accuracy = ±[(.007%)(9 ns)+((10 ns)/(2 * 65,536)) + 30ps] = ±[(630 x 10^{-15})+(76 x 10^{-15}) +30 x 10^{-12})] = 31 ps

* Denotes warranted specifications, all others are typical. Specifications are valid after a 30-minute warm-up period, and ±10° C (models HP 54810A/15A/20A/25A) or ±5° C (model HP 54845A) from firmware calibration temperature.

	HP 54810A, 54815A, 54820A, and 54825A	HP 54845A
Trigger		
Sensitivity*[2]		
Internal (normal)	dc to 100 MHz: 0.5 div 100 MHz to 500 MHz 1.0 div	dc to 100 MHz: 0.5 div 100 MHz to 500 MHz: 1.0 div 500 MHz to 1 GHz: 1.5 div
Internal (noise reject)	dc to 100 MHz: 1.0 div 100 MHz to 500 MHz: 1.5 div	N/A
External (HP 54810/20A)	dc to 100 MHz: 0.0225 x (signal range) 100 MHz to 500 MHz: 0.045 x (signal range)	N/A
Auxiliary (HP 54815/25/45A)	dc to 500 MHz: 300 mVp-p	dc to 500 MHz: 300 mVp-p
Maximum input voltage*		
External (HP 54810/20A)	1 MΩ ±250 V (dc + ac) [ac<10 kHz], CAT II, 50 Ω: 5 Vrms, CAT I	N/A
Auxiliary (HP 54815/25/45A)	2.5 kΩ: ±15 V, CAT I	2.5 kΩ: ±15 V, CAT I
Min. pulse width (internal, external)	1 ns at > 1.0 div	500 ps at > 1.0 div
Level range		
Internal	± 12 div from center screen	± 8 div from center screen
External (HP 54810/20A)	± 1 V, ± 5 V, ± 25 V	N/A
Auxiliary (HP 54815/25/45A)	± 5 V	± 5 V
Sweep modes	Auto, triggered, single	
Trigger coupling	dc, ac (7Hz), low frequency reject (50 kHz), high frequency reject (50 kHz)	
Trigger holdoff range	60 ns - 320 ms	
Trigger modes	Edge, Glitch, Pattern, State, Delay by Time, Delay by Events, Violation (Runt, Setup/Hold Time, Pulse Width, Transition), Video, Line	
Display		
Display	8.4 inch diagonal color active matrix LCD module incorporating amorphous silicon TFTs	
Active display area	6.73"x 5.04" (33.92 sq. in.), 171 mm x 128 mm (21,888 sq. mm)	
Persistence	Minimum, Variable (up to 6 levels of gray scale, 100 ms to 40 s), Infinite	
Display update rate	Waveforms/sec > 1,750	Waveforms/sec > 1,950
Measurements		
Automatic parametrics	27 automatic measurements	
Statistics	On/Off selectable. Current measurement, mean and standard deviation	
Measurement toolbar	16 drag-and-drop automatic measurement icons	
QuickMeas	Activates 4 preselected automatic measurements	
Markers modes	Manual Markers, Track Waveform Data, Track Measurements	
Waveform math	4 functions f1-f4. Select from Add, Subtract, Multiply, Divide, Invert, Magnify, Vs, Min., Max., Integrate, Differentiate, FFT magnitude	
FFT		
Frequency range[5]	54820A/54825A: dc to 1 GHz (Sample rate/2) 54810A/54815A: dc to 500 MHz (Sample rate/2)	2 channel mode: dc to 4 GHz (Sample rate/2) 4 channel mode: dc to 2 GHz (Sample rate/2)
Frequency resolution	Sample rate/memory depth	
Frequency accuracy	(1/2 frequency resolution) + ($5x10^{-5}$) (signal freq.)	(1/2 frequency resolution) + ($7x10^{-5}$) (signal freq.)
Signal-to-noise ratio	70 dB at 32K memory depth. Noise floor varies with memory depth and with averaging.	
Window modes	Hanning, flattop, rectangular	
Computer System/ Storage		
CPU	AMD-K6 300 MHz microprocessor	
Disk drives	2.1 GByte internal hard drive. Storage capacity is limited only by disk space. 3.5" MS-DOS compatible, high-density, floppy disk drive. Store and recall setups, waveforms, and store screen images to both hard drive and floppy drive.	
File types		
Waveforms	Internal, XY pairs (CSV), Y values,	
Images	BMP, EPS, GIF, PCX, PS (Postscript), TIFF	
Mouse	Standard mouse supplied. Supports any Microsoft mouse-compatible pointing device, serial or PS/2.	
Keyboard	Standard AT style keyboard supplied	
Waveform memories	4 nonvolatile waveform memories	
I/O		
LAN	Enables data/setup file transfers and use of network printers	
HP-IB	Fully programmable, complies with IEEE 488.2	
RS-232	2 ports: COM1, COM2. Printer and pointing device support	
Centronics	Printer support	
Printers and plotters	Supports all printers and plotters compatible with Microsoft Windows 95. Includes but is not limited to HP DeskJet- and LaserJet-series printers. HP-IB devices not supported.	
Video output	15 pin VGA, full color	

[1] Rise time figures are calculated from tr = 0.35/bandwidth.
[2] HP 54810A/15A/20A/25A: Magnification is used below 7 mV/div range. Below 7 mV/div, full scale is defined as 56 mV. HP 54845A: Magnification is used below 10 mV/div range and between major attenuation settings. Full scale is defined as the major attenuator setting above an intermediate setting. (Major settings 50 Ω: 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 1 MΩ: all of the above plus 2 V)
[3] HP 54810A/15A/20A/25A: The dc gain accuracy decreases 0.08% of full scale per degree Celsius from the firmware calibration temperature.
[4] For bandwidth limited signals, tr >=1.4 x sample interval
[5] FFT amplitude readings are affected by input amplifier roll-off; HP 54810A/15A/20A/25A: –3 dB at 500 MHz, with amplitude decreasing as frequency increases above 500 MHz. HP 54845A: –3 dB at 1.5 GHz, with amplitude decreasing as frequency increases above 1.5 GHz.

HP E2609A
HP E2610A
HP E2611A
HP E2612A



HP E2609A Rackmount Kit

The rackmount kit provides a support shelf and hardware for mounting HP Infiniium oscilloscopes into EIA standard 19-in (487 mm) rack cabinets. When installed, the instrument occupies 5 vertical increments [8.75 in (222 mm)]. Each kit includes a support shelf, 2 rackmounts rails, 1 TouchPad (E2612A), 2 brackets, hardware, and a user's reference.

HP E2611A Clip-on Trackball

If you don't have the bench space for a standard mouse, a clip-on track-ball is available for Infiniium oscilloscopes. The trackball clips into holes on the instrument. The driver for the clip-on trackball is pre-installed in the Infiniium oscilloscope.

4

HP E2610A Keyboard

The HP E2610A keyboard is a small keyboard for use with HP Infiniium oscilloscopes. The keyboard makes file naming easier if you are archiving waveforms or instrument setups. You'll appreciate the small size of this keyboard for use on your bench or an oscilloscope cart. The cable has an AT connector. The HP E2610A keyboard is standard on all Infiniium oscilloscopes.

HP E2612A Touchpad

The HP E2612A Touchpad has a touch surface that gives you complete control of your scope with just the tip of your finger. The driver for the Touchpad is pre-installed in the Infiniium oscilloscope.

Ordering Information

HPE2609A Rackmount kit
HPE2610A Keyboard
HPE2611A Clip-on Trackball
HPR2612A Touchpad
HP E2617A Infiinium Transit Case

HP E2617A Infiniium Oscilloscope Transit Case

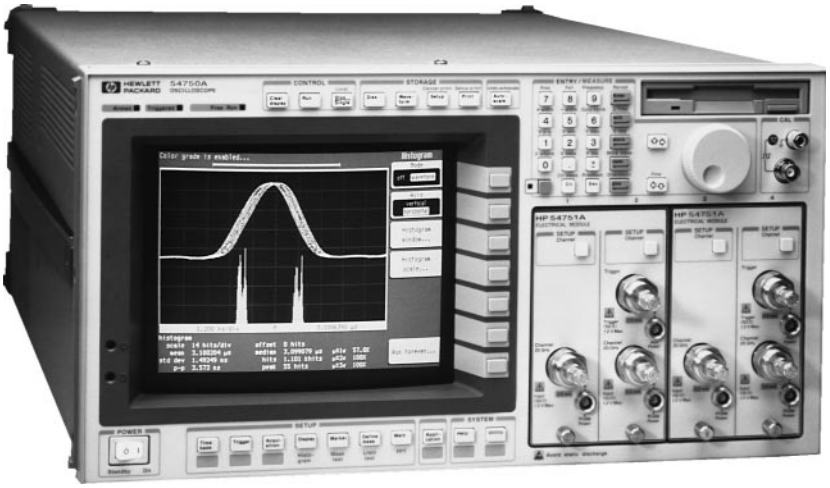
Heavy-duty hard cover carrying case is constructed from rugged A.B.S and has a rubber-grip, steel handles and steels latches. Moving the instrument is easy with the pull out handle and wheels. The case can be padlocked.

Oscilloscopes

Digitizing Oscilloscopes

HP 54750A

- 50 GHz bandwidth
- < 62.5 fs timing resolution
- 8 ps time interval accuracy
- Differential TDR
- Fast data acquisition and throughput
- Modular system design
- 2.5 GHz edge trigger



HP 54750A

HP 54750A Series High-Bandwidth Digitizing Oscilloscope

HP-IB

The HP 54750A provides up to four low-noise high-bandwidth channels coupled with the best measurement feature set in the industry. The exceptionally stable timebase and 2.5 GHz trigger circuits give highly repeatable and accurate results as needed by today's engineers for circuit or device characterization and modeling.

Key Contributions

The 54750A series oscilloscope offers:

- DC to 20 GHz bandwidth (HP 54751A), 17.5 ps rise time
- DC to 50 GHz bandwidth (HP 54752A/B)
- Single-ended TDR (HP 54753A)
- Differential and single-ended TDR (HP 54754A)
- 8 ps time interval accuracy
- 62.5 fs horizontal resolution
- 2.5 GHz or 12 GHz edge triggering
- 500 MHz to 18 GHz triggering with the HP 54118A
- 15 bits vertical resolution with averaging
- < 0.5 mVrms noise (12.4 GHz)
- 1 mV per division to 100 mV per division vertical scaling
- HP-IB programmable
- Support for both HP and Epson (Centronics) printers
- Up to 4 channels
- Modularity for future expansion
- 50 built-in automatic measurements including: FFT, Color-Graded Display, Histograms, Limit Testing, Mask Testing, full parametrics on both single and multi-valued signals
- 4K point memory depth per channel
- Test high-speed circuits remotely with the HP 11898A module extender

Signal Measurements

The HP 54750A offers a very rich feature set giving quick repeatable measurement results so engineering productivity is maximized. A broad range of measurement capability is provided with FFTs, Color-Graded Display, Histograms, Parametric Limit Testing, and Mask Template Testing. These measurements can be used independently or in concert.

An internal database stores acquired data for use with the Color-Graded Display, Histograms, and multi-valued parametric testing. Additional new measurements can be taken without re-acquiring the signal. This database can be stored to the internal MS-DOS compatible disk or internal memory for later analysis.

Data Stream Measurements

Full parametric measurements on multi-valued signals (eye diagrams), found in digital buses and memory circuits, can be taken without the need for an external controller. In addition to the normal parametric measurements such as rise time, fall time, etc., five new measurements have been added specifically to characterize digital data: Eye Height, Crossing Percent, Eye Width, RMS Jitter, and Peak-to-Peak Jitter. Characterizing and evaluating the dynamics of digital data has never been easier.

HP 83480K Digital Communications Option

The HP 83480K is an optional software package that provides the capabilities of the HP 83480A digital communications analyzer/oscilloscope. This option provides the firmware necessary to support the 8348X series of optical to electrical plug-ins. It also adds the communications measurements provided by the HP 83480A digital communications analyzer.

Ordering Information

HP 54750A Digitizing Oscilloscope Mainframe
HP 54751A 2-Channel 20 GHz Plug-in
HP 54752A Dual-Channel 50 GHz
HP 54752B Single-Channel 50 GHz
HP 54753A 2-Channel 20 GHz w/single-ended TDR
HP 54754A 2-Channel 18 GHz w/differential TDR
HP 54755A TDR S/W for the HP 83480A
HP 83480K Communications S/W for HP 54750A
HP 11898A Module Extender

HP 54750A with plug-in modules

HP 54751A Plug-in

The HP 54751A plug-in offers two 20 GHz bandwidth channels. The two-wide configuration allows up to four channels in the HP 54750A mainframe. The bandwidth of each channel may be selected independently from the channel menu as either 20 GHz or 12.4 GHz. The bandwidth of the channel is altered by changing the bias on the sampling bridge.

The low-noise characteristic of the plug-in gives an RMS noise level of < 1.0 mV in the high-bandwidth mode and < 0.5 mV in the low-bandwidth mode. With exceptionally low noise and a minimum sensitivity of 1 mV/div, the HP 54751A is ideally suited for evaluation of low-level signals.

The plug-in provides a single external trigger input of 2.5 GHz or 12 GHz bandwidth. Triggering to 18 GHz is possible by using the HP 54118A.

HP 54752A/B Plug-ins

The HP 54752A has two 50 GHz bandwidth channels and the HP 54752B provides a single cost-effective channel. Both plug-ins use 2.4 mm connectors to provide the highest fidelity from the DUT.

These plug-ins also feature a dual bandwidth scheme which can be selected independently from the mainframe. The low-bandwidth mode bandlimits the signal to 26.5 GHz. The high-bandwidth mode RMS noise performance is < 1.5 mV and the low-bandwidth mode is < 0.75 mV.

HP 54753A TDR/TDT Module

The HP 54753A is a two-channel vertical plug-in with a TDR step generator built into channel one. The bandwidth of the TDR/vertical channel is 18 GHz. The bandwidth of channel two is 20 GHz.

The step generator provides a 200 mV TDR step with a system rise time of < 45 ps. The system has the ability to normalize the TDR by applying a digital filter. Normalization removes errors caused by loss or imperfect launchers or cables.

The rise time of the normalization filter may be varied to allow you to simulate the edge speeds found in your system. You may also push the rise time up to 20 ps. The normalization filter when activated processes every acquisition so you see changes as the DUT is adjusted.

The HP 54753A provides support for external step generators, such as the PicoSecond Pulse Labs 4015B.

HP 54754A Differential TDR/TDT Module

The HP 54754A has two independent vertical channels and two step generators. The bandwidth of both channels is 18 GHz. The step generators may be operated singly, simultaneously but independently, differentially, or as common-mode stimulus. The TDR results may be viewed as common mode or differentially and displayed simultaneously. Once selected, the display mode is computed automatically, freeing the user from setting up mathematical functions.

Each step may be skewed separately in time. Coupled with the ability to skew the vertical channels, it is possible to accurately perform differential TDR when the launch cables are not the same electrical length.

HP 54750A System Specifications

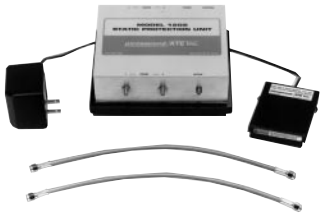
Vertical	**54751A**	**54752A/B**	**54753A**	**54754A**
DC-coupled bandwidth (–3dB)				
High bandwidth				
Channel 1	20 GHz	50 GHz	18 GHz	18 GHz
Channel 2	20 GHz	50 GHz	20 GHz	18 GHz
Low bandwidth				
Channel 1	12.4 GHz	26.5 GHz	12.4 GHz	12.4 GHz
Channel 2	12.4 GHz	26.5 GHz	12.4 GHz	12.4 GHz
Rise time (calculated)				
High bandwidth				
Channel 1	≤ 17.5 ps	≤ 7.0 ps	≤ 19.4 ps	≤ 19.4 ps
Channel 2	≤ 17.5 ps	≤ 7.0 ps	≤ 17.5 ps	≤ 19.4 ps
Low bandwidth				
Channel 1	≤ 28.2 ps	≤ 13.2 ps	≤ 28.2 ps	≤ 28.2 ps
Channel 2	≤ 28.2 ps	≤ 13.2 ps	≤ 28.2 ps	≤ 28.2 ps
Noise (RMS)				
High bw	≤ 1 mV	≤ 1.5 mV	≤ 1 mV	≤ 1 mV
Low bw	≤ 0.5 mV	≤ 0.75 mV	≤ 0.5 mV	≤ 0.5 mV
DC accuracy (single voltage marker)	0.4% of full-scale or marker reading (whichever is greater) ± 2 mV ± 1.2% of (reading-channel offset)			
Dynamic range	± 400 mV relative to channel offset			
Connectors	3.5 mm	2.4 mm	3.5 mm	3.5 mm

TDR System	**Oscilloscope/TDR performance**	**Normalized characteristics**
Rise time	≤ 45 ps	Adjustable from larger of 10 ps or 0.08 x time/div Maximum: 5 x time/div
Flatness	≤ ± 1% after 1 ns from edge; ≤ + 5%, –3% 1 ns from edge	< 0.1%
Low level	0.00 V ± 2 mV	0.00 V ± 2 mV
High level	200 mV ± 2 mV	200 mV ± 2 mV

External Trigger Input (Standard Configuration)	
Sensitivity	40 mVp-p dc to 100 MHz increasingly linearly to 200 mVp-p at 2.5 GHz
Pulse width	200 ps > 200 mV
High frequency reject	Trigger bandwidth reduced to 100 MHz
Jitter (trigger and time base combined)	≤ 2.5 ps + 5E-5 x delay setting

HP 54118A 18 GHz trigger

HP 83440C/D lightwave detector O/E converters



picosecond ATE Static Protection Unit

HP 54008A 20 GHz delay line

HP 54007A RF accessory kit

PicoSecond Pulse Labs Model 4015B

HP 54118A, 500 MHz to 18 GHz Trigger

Simple, Stable Triggering at Microwave Frequencies

For applications requiring more than 2.5 GHz trigger bandwidth, use the HP 54118A 18 GHz trigger. The HP 54118A gives your HP 54750 series oscilloscope true event triggering from 500 MHz to 18 GHz, with less than 1.7 ps of rms jitter at 18 GHz. This powerful and versatile accessory extends the oscilloscope's measurement capabilities to applications in lightwave communications, pulsed RF, gigabit logic, pseudo-random bit-stream eye patterns, and other microwave signals.

HP 83440 Series Unamplified Lightwave Converters and HP 11982A Amplified Lightwave Converter

These products are wide-range optical-to-electrical converters for characterizing SONET/SDH optical waveforms. See page 428 for more information.

S1 Interconnect Analysis System

- Automated measurement, modeling, and simulation in one toolset
- Analyze PC boards, IC packages, connectors and cabling
- Familiar TDR measurement environment

High-speed design requires detailed, accurate interconnect analysis to meet tight timing budgets. The SIS/HP Interconnect Analysis System combines the features of a time-domain reflectometer, network analyzer, and SPICE simulator into an integrated 32-bit Windows 95/NT environment for interconnect evaluation. TDR waveforms are acquired, automatically processed in both time and frequency domains, then translated into SPICE models. A built-in lossy, multiconductor simulator then analyzes the models with I/O receiver/driver information to validate the model and show interconnect performance with respect to overall system specifications. Interconnect applications include PC boards, MCMs, cabling and connectors. In North America contact Amherst Systems Associates at (413) 596-5354.

Launching and Probing Solutions from Inter-Continental Microwave (ICM)

ICM offers both fixed- and variable-spacing 50-Ω TDR/TDT probe assemblies for launching a TDR pulse into transmission systems under test, such as in a PC board trace. These probes can be handheld or placed in a manipulator. ICM also offers a universal test platform (UTP-3000) with accessories for component and package measurements.In North America contact Werner Schuerch at ICM, 1515 Wyatt Dr., Santa Clara, CA 95054-1524; (408)727-1596.

Static Protection Unit from picosecond ATE Inc.

The picosecond ATE Inc. Static Protection Unit model 1202 offers static damage protection for TDR measurements. A foot switch or TTL signal allows connection of the device under test after static charge is removed. Risetime is <40 ps. In North America contact Stu McNaughton at picosecond ATE Inc. (503) 641-3295.

HP 54008A 22 ns Delay Line

Viewing the Trigger Signal

The HP 54008A delay line provides 22 ns of delay with a useable frequency response of 20 GHz. By adding this accessory to your HP 54750 oscilloscope system, you will be able to view the trigger event. The HP 54008A has enough delay to view the trigger event with the HP 54118A trigger installed in the trigger path also.

HP 54007A Accessory Kit

Low-Loss Measurements for HP 54750A Oscilloscope Systems

The HP 54007A accessory kit provides an assortment of parts with 3.5-mm connectors. This kit is highly recommended for low-loss reflection and transmission measurements. It also includes semi-rigid coax, formed for use with the HP 11667B power splitter.

Contents of the HP 54007A Accessory Kit

- 17-in (43.18 cm) cable, APC-3.5 (f-f)
- Coaxial short, APC-3.5
- 50 Ω termination, APC-3.5 (m)
- 7.5-cm "airline", APC-3.5 (m-f)
- 6-cm semi-rigid "L", SMA (m-m)
- 6 dB attenuator, APC-3.5 (m-f)
- Adapter, APC-3.5 mm (m-m)
- 17-in (43.18 cm) cable, APC-3.5 (m-f)
- Coaxial short, APC-3.5 mm (m)
- 50 Ω termination, APC-3.5 (f)
- Power splitter, APC-3.5 mm (f)
- 3-cm semi-rigid "L", SMA (m-m)
- 40 dB attenuator, APC-3.5 (m-f)

PicoSecond Pulse Labs 4015B

15-ps, 9 V External TDR or TDT Source

The PicoSecond Pulse Labs model 4015B pulse generator extends the TDR/TDT performance of the HP 54750 series oscilloscopes. The pulse generator produces a 15-ps fall time with an amplitude of 9 V, which can be triggered by any HP 54750 series TDR step generator. The HP 1167C power splitter is not included. In North America contact Dr. Jim Andrews at PSPL, P.O. Box 44, Boulder, CO 80306; (303)443-1249.

Oscilloscope/Probe Compatibility

	General Purpose Passive Probes								
Oscilloscope	**10:1**	**100:1**	**1:1**	**Low Mass 10:1**	**Low Mass 20:1**	**Low Z**	**50 Ohm**	**Active**	**Differential**
HP Infiniium Oscilloscopes HP 54810/15/20/25A	1160A 1164A	10440B[2]	1162A	1170A	1172A	1163A	10437B	1152A, 1155A	1153A[2]
HP 54845A	1161A	10440B[2]	1162A	1171A	1173A	1163A 10020A	10437B 10020A	1152A[2], 1155A[2]	1153A[2]
HP 54751/52A/B	N/A	N/A	N/A	N/A	N/A	54006A	N/A	54701A[2,4]	1141A[2,3]
HP 54711/12/21/22A	N/A	N/A	N/A	N/A	N/A	54006A	N/A	54701A[4]	1141A[2,3]
HP 54714/15A/13B	10441B	10444B[2]	10439B	1170A[1]	1172A[1]	10442B	10437B	1144A[3], 1145A[3], 54701A[4]	1141A[2,3]
HP 54645A/D	10074A	10440B	10070A	1171A[1]	1173A[1]	N/A	N/A	1144A[3], 1145A[3] w 50 Ohm term	1141A[3] w 50 Ohm term
HP 54615/16B	10073A	10440B	10070A 10439B	1170A[1]	1172A[1]	1163A[1] 10442B	10437B	1144A, 1145A	1141A[3]
HP 54610A/B	10073A	10440B	10070A 10439B	1170A[1]	1172A[1]	1163A[1] 10442B	10437B	1144A[3], 1145A[3]	1141A[2,3]
HP 54600/01/02/03A/B	10071A	10440B	10070A 10439B	1171A[1]	1173A[1]	N/A	N/A	1144A[3], 1145A[3] w 50 Ohm term	1141A[3] w 50 Ohm term
HP 54520/22/40/42A/C	10441B	10440B[2]	10439B	1170A[1]	1172A[1]	10442B	10437B	1144A, 1145A	1141A
HP 54502/03/04/10A/05/06/10/12B	10441B	10440B[2]	10439B	1170A[1]	1172A[1]	10442B	10437B	1144A[3], 1145A[3]	1141A[3]
HP 54501A	10433B	10440B	10439B	N/A	N/A	N/A	N/A	1144A[3], 1145A[3] w 50 Ohm term	1141A[3] w 50 Ohm term
HP 54201A/D	10433B	10440B	10439B	1170A[1]	1172A[1]	10442B	10437B	N/A	1141A[3]
HP 54200A/D	10433B	10440B	10439B	1170A[1]	1172A[1]	N/A	N/A	N/A	1141A[3] w 50 Ohm term
HP 54121/22/23/24T	N/A	N/A	N/A	N/A	N/A	54006A	10020A	54701A[2,4]	1141A[3]
HP 54111/112D	10441B	10440B	10439B	1170A[1]	1172A[1]	10442B	10437B	1144A[3], 1145A[3]	1141A[3]
HP 1980, 1950AA/B	10433B	10440B	10439B	N/A	N/A	10442B	10437B	N/A	N/A
HP 1740/41/42/43/44/45/46A	10436B		10439B	N/A	N/A	10442B	10437B	1144A[3], 1145A[3]	1141A[3]
HP 1715/22/25/26/27	10433B	10440B	10439B	N/A	N/A	10442B	10437B	1144A[3], 1145A[3]	1141A[3]

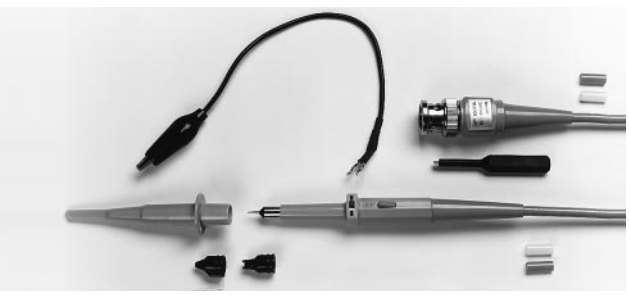
[1]Must remove pogo pin and configure scope for probe manually
[2]Not commensurate with oscilloscope bandwidth
[3]Requires the HP 1142A probe power supply
[4]Requires the HP 1143A probe offset and power module

HP 10070 Passive Divider Probe Family

The HP 10070A family of rugged, general purpose probes are designed to operate with the HP 54600 family of oscilloscopes. This family provides a range of high-quality probing solutions at very reasonable prices.

These reliable probes come with one retractable hook tip, eight color identification tags, one ground bayonet, one IC Tip, one adjustment tool, and one ground lead.

See pages 133 and 132 for compatible SMT probing kit.



HP 10070A Passive Divider Probe Series

Model	**Length**	**Division ratio**	**Circuit loading (1 MΩ scope input)**	**Typical scope bandwidth**	**Compensates oscilloscope input**
10070A	1.5 m	1:1	1 MΩ; 70 pF	20 MHz	High Impedance
10071A	1.5 m	10:1	10 MΩ; 15 pF	150 MHz	1 MΩ; 9 to 17 pF
10073A	1.5 m	10:1	1 MΩ; 12 pF	500 MHz	1 MΩ; 6 to 15 pF
10074A[3]	1.5 m	10:1	10 MΩ; 15 pF	150 MHz	1 MΩ; 9 to 17 pF

[3] Probe ID pin

Other HP 10070 Series Probe Accessories

Accessory	**HP p/n**
Probe tip to BNC (m) adapter	5081-7705
Replacement parts accessory kit	5081-7690
SMT probe accessory kit	10072A

Other Accessories

Accessory	**HP p/n**
BNC 50 Ω feedthrough	10100C
BNC 75 Ω feedthrough	11094B
BNC AC blocking capacitor	10240B

HP 10400B Passive Divider Probe Family

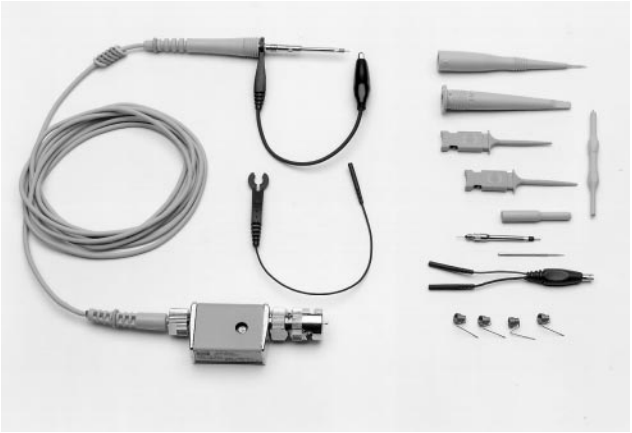
The HP 10400B probe family are reliable general-purpose high performance passive probes that replace the 10400A family of probes. These probes include a no-slip browser. The crown point of the browser digs in to solder and won't slip while the pogo pin allows small hand movements without losing contact.

The 10400B family of probes also comes complete with a range of accessories. For grounding, there's an alligator ground lead for general-purpose probing, 4 spring grounds for high frequency measurements and a socketed ground lead. The accessories also include 2 IC clips for probing 50 mil SMDs and a dual-lead adapter so that both the probe tip and ground can easily be connected to surface mount devices.

The miniature probe has a narrow, sharp tip that is good for probing SMDs. The handle of the probe can be unscrewed and pulled back on the cable to reduce the probe's mass and size. This makes attaching to fine pitch ICs and small devices easier. For connection to fine pitch ICs order the HP Wedge probe adapter or the 0.5 mm IC clips.

The HP 10400 family of probes are built and tested for high reliability. The cable has a Kevlar strengthener for added pull strength and the general purpose retractable hook tip is made from durable music wire. The probe tips are replaceable.

See pages 133 and 132 for compatible SMT probing solutions.



HP 10400B Passive Divider Probe Series

Model	Length	Division ratio	Circuit loading	Typical scope bandwidth	Compensates oscilloscope input	
10437B	2 m	1:1	50 Ohm	1GHz	50 Ohm	
10439B[1]	1.5 m	1:1	65 pF		High Z	
10433B	2 m	10:1	10 MOhm; 10 pF	300 MHz	1MOhm; 10 – 16 pF	
10436B	2 m	10:1	10 MOhm; 11 pF	300 MHz	1MOhm; 18 – 22 pF	
10441B	1.8 m	10:1	10 MOhm; 9 pF	500 MHz	1M; 6 – 9 pF	
10442B	2 m	10:1	500 Ohm; 1.2 pF	1 GHz	50 Ohm	
10440B	2 m	100:1	10M; 2.5 pF	300 MHz	1M; 6 – 14 pF	

[1]This probe can be used with many oscilloscopes, but because of the relatively high capacitance, there will be bandwidth degradation

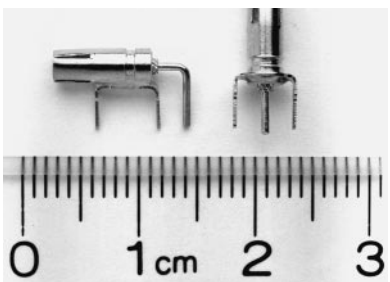
HP 10400B Family Replacement Parts

HP p/n	Description	Qty	
5063-2115	Browser	1	
5063-2120	Socketed ground lead	1	
5063-2135	General-purpose retractable hook tip	2	
5063-2140	Aligator ground lead	2	
5063-2147	Dual lead adapter	1	
5063-2149	SMD INC clips	5	
01160-68701	Accessory Kit: spring grounds browser pogo pins barrel insulators screwdriver	 4 4 4 1	
5063-2167	HP 10433B probe tip	5	
5063-2168	HP 10436B probe tip	5	
5063-2138	HP10437B probe tip	5	
5063-2138	HP 10439B probe tip	5	
5063-2171	HP 10440B probe tip	5	
5063-2172	HP 10441B probe tip	5	
5063-2139	HP 10442B probe tip	5	

Fine Pitch IC Probing Accessories

HP p/n	Description	Qty	
E2613B	HP Wedge probe adapter, 0.5 mm, 3-signal	2	
E2614A	HP Wedge probe adapter, 0.5 mm, 8-signal	1	
E2615B	HP Wedge probe adapter, 0.65 mm, 3-signal	2	
E2616A	HP Wedge probe adapter, 0.65 mm, 8-signal	1	
10467-68701	0.5mm IC clips for surface SMT parts with lead spacings of 0.5 mm (.020 in) to 0.8mm (0.32 in)	4	

HP 1250-2427 and HP 1250-2428 PC Board Mini-Probe Sockets



The HP PC board mini-probe sockets are ideal for reliable, stable, and convenient connection between the 10400 family probe tip and the circuit under test. The HP 1250-2427 horizontal PC board mini-probe replaces HP 1250-1737. The HP 1250-2428 vertical PC board mini-probe socket replaces HP 1250-1918.

Ordering Information

HP 1250-2427 Horizontal Mini-Probe Socket
HP 1250-2428 Vertical Mini-Probe Socket

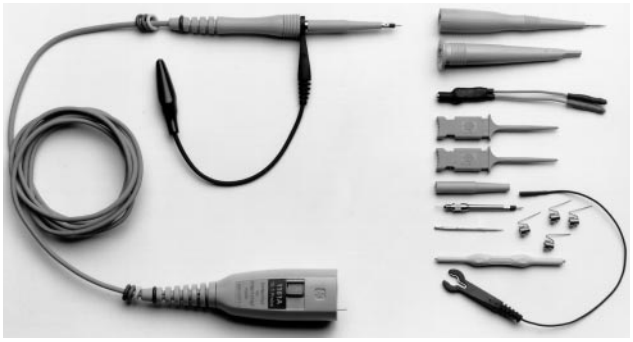
HP 1160A Family Miniature Passive Probes

The HP 1160 family of miniature probes are reliable general-purpose probes for use with Infiniium Oscilloscopes (HP 54800 series). The HP 1160 family probes include a no-slip browser with a crown point that digs in to solder, and won't slip. The pogo pin allows hand movement without losing contact.

A variety of grounding accessories are included. An alligator ground lead for general-purpose probing, 4 spring grounds for high frequency measurements, a socketed ground lead and 2 SMD IC clips for probing 50 mil SMD. Also included is a dual lead adapter so that both the probe tip and ground can be connected to SMD devices. For connection to 0.5 mm–0.8 mm devices, order the 10467-68701 0.5 mm IC clips.

The HP 1160 family probes are built and tested for high reliability. The cable has a kevlar strengthener for added pull strength. The general-purpose retractable hook tip has a durable music wire hook. And probe tips are replaceable.

The miniature probe has a narrow, sharp tip that is good for probing SMD. To fully miniaturize the probe, unscrew the handle and pull it back on the cable.The HP 1160 family probes are compatible with the AutoProbe Interface, which completely configures the Infiniium Oscilloscope for the probe.



4

Model	Type of probe	Length	Division ratio	Circuit loading	System bandwidth (scope and probe)	Oscilloscope input	
HP 1160A	High Impedance, Passive	1.5 m	10:1	10 MOhm, 9pF	500 MHz[1]	1 MOhm, 6-9 pF	
HP 1161A	High Impedance, Passive	1.5 m	10:1	10 MOhm, 10 pF	500 MHz[2]	1 MOhm,12-14 pF	
HP 1162A	High Impedance, Passive	1.5 m	1:1	1 MOhm, 50 pF +scope input	25 MHz[3]	1 MOhm	
HP 1163A	500 Ohm Resistive Divider	1.5 m	10:1	500 Ohm, 1.5 pF	1 GHz[2]	50 Ohm	
HP 1164A	High Impedance, Passive	2.0 m	10:1	10 MOhm, 10pF	500 Mhz	1 MOhm, 6-9 pF	

[1] System bandwidth with 54810A/15A/20A/25A
[2] System bandwidth with 54845A
[3] System bandwidth with all Infiniium scopes

HP 1160 Family Replacement Parts

HP p/n	Description	Qty
5063-2115	Browser	1
5063-2120	Socketed ground lead	1
5063-2135	General-purpose retractable hook tip	2
5063-2140	Alligator ground lead	2
5063-2147	Dual lead adapter	1
5063-2149	SMD IC clips	5
01160-68701	Accessory kit: spring grounds browser pogo pins barrel insulators screwdriver	 4 4 4 1
5063-2136	HP 1160A probe tip	5
5063-2137	HP 1161A probe tip	5
5063-2138	HP 1162A probe tip	5
5063-2139	HP 1163A probe tip	5

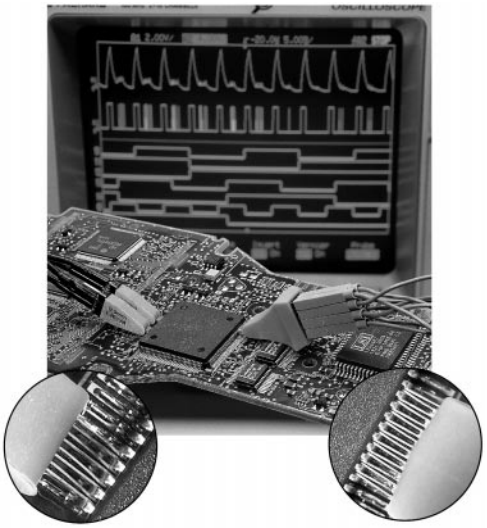
Fine Pitch IC Probing Accessories

HP p/n	Description	Qty
E2613A	HP Wedge probe adapter, 0.5 mm, 3-signal	1
E2613B	HP Wedge probe adapter, 0.5 mm, 3-signal	2
E2614A	HP Wedge probe adapter, 0.5 mm, 8-signal	1
E2615A	HP Wedge probe adapter, 0.65 mm, 3-signal	1
E2615B	HP Wedge probe adapter, 0.65 mm, 3-signal	2
E2616A	HP Wedge probe adapter, 0.65 mm, 8-signal	1
10467-68701	0.5mm IC clips for surface SMT parts with lead spacings of 0.5 mm (.020 in) to 0.8mm (0.32 in)	4

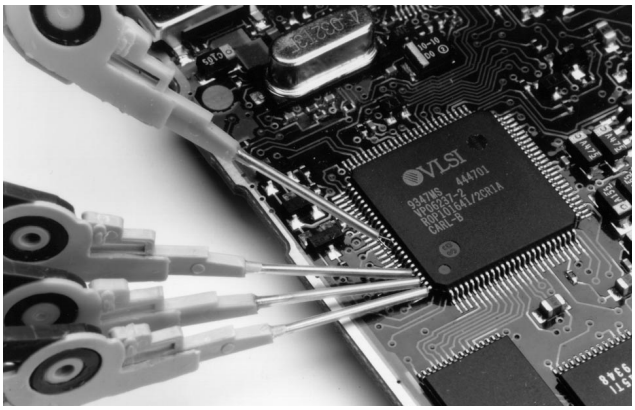
HP 10467–68701
HP 10075A
E2613A
E2613B
E2614A
E2615A
E2615B
E2616A

NEW

- Easy connection to 0.5mm, 0.65 mm TQFP and PQFP packages
- Reliable contact with little chance of shorting to adjacent pins
- Mechanically noninvasive
- Can be inserted while the board is active
- 3- and 8-signal versions



At one end, Wedge conductor segments are inserted into the space between IC pins; at the other end, they easily connect to scopes and logic analyzers.



10467-68701 0.5 mm IC Clips

HP Wedge Probe Adapter NEW

Precise problem-free probing

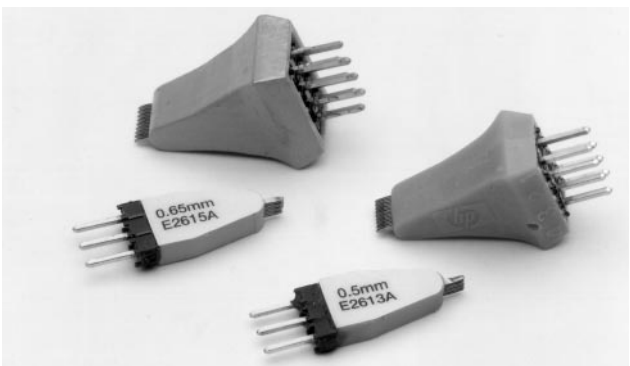
The HP Wedge probe adapter solves the problem of connecting your scope or logic analyzer to fine pitch thin quad flat pack (TQFP) and plastic quad flat pack (PQFP) surface mount ICs. It provides accurate, mechanically noninvasive and reliable electrical contact to 0.5 and 0.65 mm IC packages, with little chance of shorting. It is available in both 3- and 8-signal versions.

Easy to insert, then stays put

It works by inserting compressible dual conductors between adjacent IC pins. The flexible conductors conform to the size and shape of each leg to ensure tight contact. It's then a simple matter to connect your scope or logic analyzer to the HP Wedge.

Electrical reliability

The HP Wedge's unique design delivers secure redundant contact on each pin, with little chance of shorting to adjacent pins. The redundant physical connection created by two contact points on each pin of the IC and its short electrical length dramatically increases the reliability of the electrical connection. Since the HP Wedge doesn't latch directly onto the IC and doesn't require expansion beforehand (as a clip does), it can be inserted while the board is active. Plus, it's mechanically noninvasive so it won't damage your device under test.



3- and 8-signal versions for 0.5 and 0.65 mm IC Packages

0.5 mm IC Clips

These IC clips are the smallest in the industry to date and are suitable for connecting to PQFP and SOIC SMT packages from 0.5 – 0.8 mm pitch. The thin body allows clips to be mounted side by side for probing adjacent IC pins. They are suitable for use with all HP oscilloscope probes and logic analyzers and have a maximum input voltage of ± 40V (dc + peak ac)

HP 10075A 0.5 mm IC Clip Accessory Kit

HP 10467A 0.5 mm IC Clip Accessory Kit

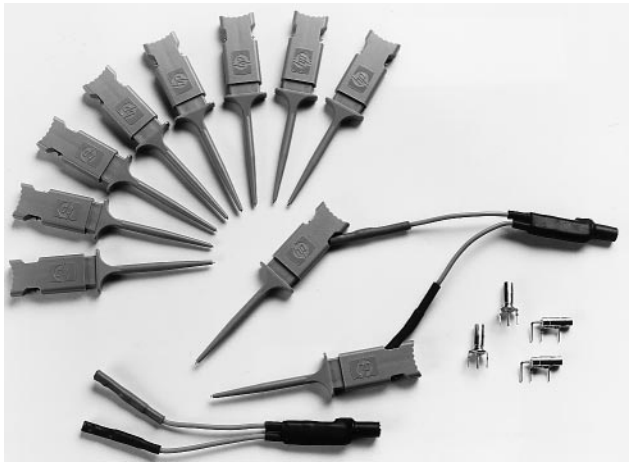
HP 10075A and HP 10467A 0.5 mm IC Clip Accessory Kit

These kits includes four 0.5mm IC clips (10467-69701) and two dual-lead adapters for use with the HP passive probes. Plug the probe tip into one end of the adapter and connect the IC clips to the other end.

The HP 10075A is compatible with the 10070A family of probes. The HP 10467A is compatible with the HP 10400A family of passive probes. The 1160A and 10400B family of probes include a dual-lead adapter as a standard accessory. For these probes the accessory kit is not required. Order the IC clips 10467-68701.

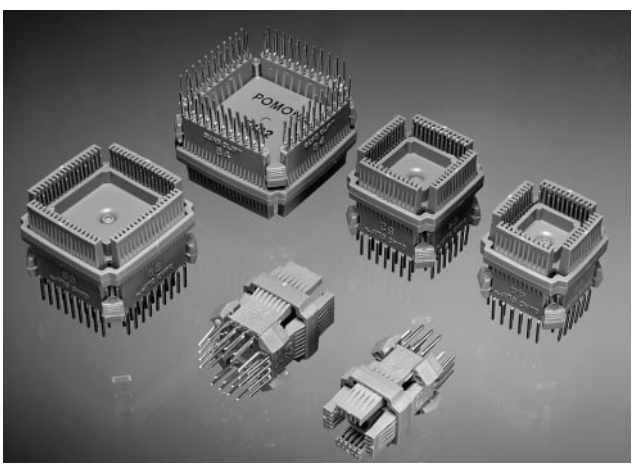
Ordering Information

E2613A 0.5 mm 3-signal, qty 1
E2613B 0.5 mm 3-signal, qty 2
E2614A 0.5 mm 8-signal, qty 1
E2615A 0.65 mm 3-signal, qty1
E2615B 0.65 mm 3-signal, qty 2
E2616A 0.65 mm 8-signal, qty 1
10467-68701 0.5 mm IC Clips, qty 4
HP 10075A 0.5 mm IC Clip Accessory Kit
HP 10467A 0.5 mm IC Clip Accessory Kit



HP 10450A SMT Probe Accessory Kit

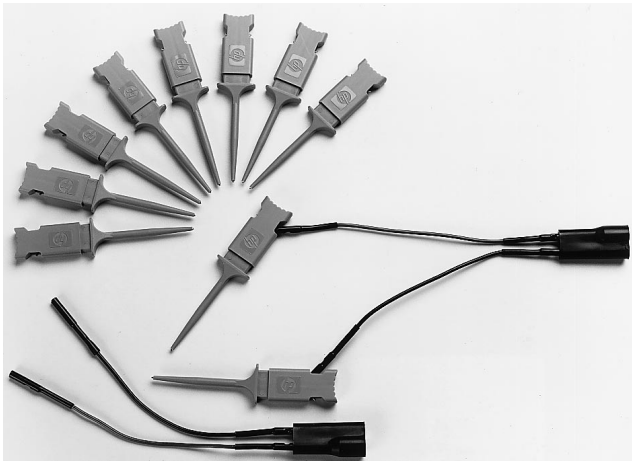
Assorted accessories include 10 SMT lead IC clips that interface the HP 10400A series miniature probes to the fine-pitch circuitry.



HP E2422A

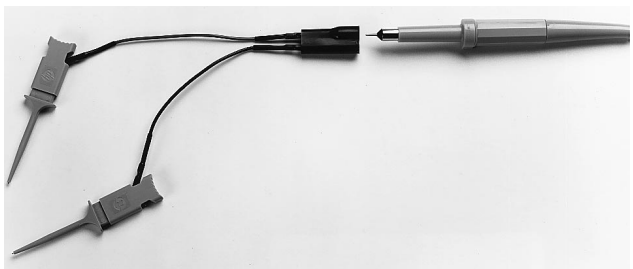
HP E2422A Quad Clip Adapter Kit

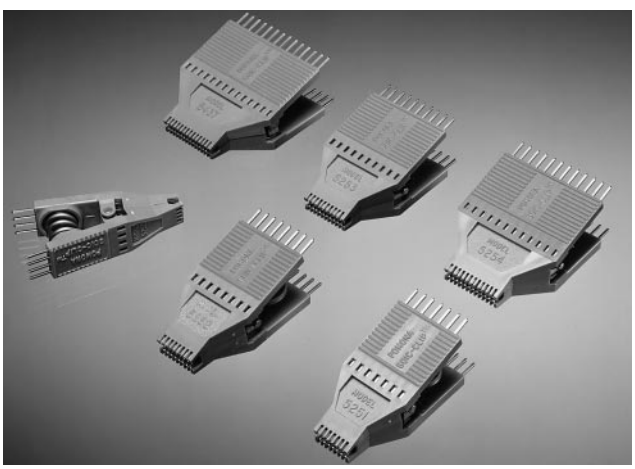
The HP E2422A contains clips for 20, 28, 44, 52, 68, and 84-pin PLCC devices. These clips quickly lock onto J-leaded PLCCs or PCCs providing easy-probing access.



HP 10072A SMT Probe Accessory Kit

The HP 10072A includes 10 SMT lead clips which adapt the 10070A family of low-cost probes to fine-pitch devices.





HP E2421A

HP E2421A SOIC Clip Adapter Kit

The HP E2421A contains clips for 8, 14, 16, 20, 24, and 28-pin SOIC devices.

Ordering Information

HP 10450A SMT Probe Accessory Kit
HP 10072A SMT Probe Accessory Kit
HP E2422A Quad Clip Adapter Kit
HP E2421A SOIC Clip Adapter Kit

HP 1141A
HP 1142A
HP 1145A
HP 1152A
HP 1153A
HP 1155A

HP1141A Differential Probe with HP 1142A Power Supply

The HP 1141A is a 1X FET differential probe with 200 MHz bandwidth and a 3000:1 CMRR (Common Mode Rejection Ratio). The probe has a high-input resistance and low-input capacitance of 7pF to minimize circuit loading. The 1141A must be used with the 1142A probe control and power module which controls input coupling modes dc, dc with variable offset, and dc reject. Two attenuators, 10X and 100X are provided to expand the linear differential input range to ± 30V.

HP1153A 200 MHz Differential Probe

The HP 1153A is a 200 MHz Differential Probe for use with HP Infiniium Oscilloscopes. It is a 1X FET differential probe with 200 MHz bandwidth and 3000:1 CMRR (Common Mode Rejection Ratio). The probe has high-input resistance of 1 MOhm and low-input capacitance of 7 pF to minimize circuit loading. The 1153A is compatible with the AutoProbe Interface which provides power and completely configures the Infiniium Oscilloscope for the probe.

Input coupling modes include dc, dc with variable offset, and lf reject. Two attenuators, 10X and 100X, are provided to expand the linear differential input range to ± 30V.

HP 1155A Low Mass Active Probe for Surface-Mount Devices

The two-channel HP 1155A low mass active probe for Infiniium oscilloscopes has a probe tip that weighs less than 1 gram making it ideal for attaching to fine pitch ICs and probing surface mount components. The probe combines high bandwidth (750 MHz), low input capacitance (2 pF) and high input resistance (1 Mohm). A versatile set of accessories are provided, including an HP browser with a crown point that digs deep in to solder and a spring loaded tip that helps absorb small movements. When used in conjunction with the HP Wedge, the 1155A provides a hands-free solution for probing 0.5mm and 0.65mm IC packages. See page 132 for more information.

HP 1145A Low Mass Active Probe for Surface-Mount Devices

The two-channel HP 1155A low mass active probe has a probe tip that weighs less than 1 gram making it ideal for attaching to fine pitch ICs and probing surface mount components. The probe combines high bandwidth (750 MHz), low input capacitance (2 pF) and high input resistance (1 Mohm). A versatile set of accessories are provided and when used in conjunction with the HP Wedge, the 1145A provides a hands-free solution for probing 0.5mm and 0.65mm IC packages. See page 132 for more information.

This probe can access power directly from the HP 54520/40 series and 54615/16B oscilloscopes. The HP 1142A power supply is required for all other instruments. This configuration requires 50 Ohm inputs.

HP 1152A 2.5 GHz, 0.6 pF Active Probe

The HP 1152A's 0.6pF, 100Kohm input provides ultra low loading of the device-under-test, making it an ideal companion for the HP 54845A 1.5 GHz Infiniium Oscilloscope. Its 40Vac maximum input voltage, ± 15 KV ESD tolerance and replaceable probe tips make the HP 1152A extremely reliable. The 1152A is compatible with the AutoProbe Interface which provides power and completely configures the Infiniium Oscilloscope for the probe.

Ordering Information

HP 1141A 200 MHz Differential Probe
HP 1142A Power Supply
HP 1145A 2 Channel, 750 MHz, Active Probe
HP 1152A 2.5 GHz, 0.6 pF Active Probe
HP 1153A 200 MHz Differential Probe
HP 1155A Low Mass Active Probe

HP 1143A
HP 1144A
HP 1146A
HP 10020A
HP 54006A
HP 54701A

HP 54701A 2.5 GHz, 0.6 pF Active Probe with HP 1143 Power Supply

The HP 54701A 2.5 GHz, 10:1 active probe provides ultra-low loading of the device-under-test because of it's low 0.6 pF capacitive loading and its high 100 KOhm resistive loading.. Its 40Vac maximum input voltage, ± 15 KV ESD tolerance and replaceable probe tips make the probe extremely reliable.

The HP 1143A probe offset and power module provides power for 2 HP 54701A probes with any instrument with 50 Ohm input impedance. The power supply is not required if the probe is used with the HP 54700 series oscilloscopes.

HP 1144A 800 MHz Active Probe

The HP 1144A features 800-MHz bandwidth, 1 MΩ input resistance, 2 pF input capacitance, 10:1 attenuation, and ±40 Vdc + peak ac maximum-input voltage. The HP 1144A can access power directly from the HP 54520 and HP 54540 series and the HP 54615B and HP 54616B oscilloscopes. These oscilloscopes provide power for two channels of active probing. If four channels of probing are needed, a special one-input, two-output adapter is available (p/n 01144-61604). Two adapters are needed for four channels of probing. If the HP 1144A is used with any scope not listed above, then the HP 1142A power supply is required. The HP 01144-61604 adapter can be used with this power supply to provide power for two channels of active probing

HP 10020A Resistive Divider Probe Kit

The HP 10020A Resistive Divider Probe Kit is for measuring fast transition signals in high-impedence systems. It is designed for use with oscilloscopes with 50 Ohm inputs but may be used with other than 50 Ohm systems if a 50 Ohm feedthrough termination is used. The kit includes 6 resistive dividers ranging from 1:1, 50 Ohm to 100:1, 5 KOhm and has an input capacitance of less than 0.7 pF.

HP 54006A 6-GHz Passive Divider Probe

The low 0.25 pF input capacitance and sophisticated ground design of the HP 54006A probe lets you probe multi-GHz systems with minimal loading of the circuit-under-test. The small size of this probe also allows you to access very small components. The HP 54006A is supplied with 10:1, 500 Ω, and 20:1, 1 k Ω resistive dividers.

4

HP 1146A Oscilloscope AC/DC Current Probe

This AC/DC current probe expands oscilloscope applications into industrial, automotive or power environments, and is ideal for analysis and measurement of distorted current waveforms and harmonics. This probe permits accurate display and measurement of currents from 100 mA to 100 A rms, dc to 100 kHz without breaking into the circuit. The 1146A uses Hall-effect technology to measure ac and dc signals. Compatible with any scope or voltage measuring instrument with BNC input, 0.2 to 0.5 V/div, and a minimum input impedance of 1 MOhm. 1 mV/100 mA Range; Output Signal: 10 mV/A ac/dc. 1mV/10mA Range; Output Signal: 100 mV/A ac/dc. Working Voltage: 660 V max., Battery: 9 V alkaline.

Ordering Information

HP 1143A Probe Offset and Power Module
HP 1144A 800 MHz Active Probe
HP 01144-61604 Adapter (1144A)
HP 1146A Oscilloscope AC/DC Current Probe
HP 10020A Resistive Divider Probe Kit
HP 54006A 6-GHz Passive Divider Probe
HP 54701A 2.5 GHz, 0.6 pF Active Probe

Logic Troubleshooting Tools

Low Cost Logic Tools

HP 54620A
HP 54620C
HP E2310A

- Logic monitor (high, low, toggling, tristate)
- 3 ½ digit dc voltage to 35 volts; 33 MHz frequency counter
- 3 channels of 100 MSa/s timing analysis, 2048 samples per channel
- Measure continuity, resistance, check diodes
- 16 channels of 500 MSa/s timing analysis
- Edge, pattern, and advanced triggering
- Simple scope-like controls
- High-speed oscilloscope-like display shows changing and unstable signals
- One button set-up with Autoscale

HP LogicDart Advanced Logic Probe

HP 54620A and 54620C

HP LogicDart Advanced Logic Probe

HP LogicDart is an advanced logic probe that not only performs basic logic monitoring, but also tests continuity, dc voltage, frequency, and does timing analysis. HP LogicDart's precise probe tip allows you to confidently probe fine-pitch surface mount circuitry. Look at up to three channels of logic activity simultaneously. You can trigger on edge, pattern, or edge/pattern combinations.

With 100 MSa/s, you will have up to 10 ns resolution. Movable cursors and pan-and-zoom allow you to easily measure the time between different events. Logic levels are displayed as high, low, or tristate. Logic activity is clearly displayed by two LEDs, plus an audible beeper. Select between several predefined logic families or set up your own thresholds for custom logic. Check out power supplies and clocks quickly. Both dc voltages and frequency are displayed simultaneously. You can measure up to 35 volts with 3 ½ digits of resolution, and frequencies up to 33 MHz.

With HP LogicDart you can also check resistance, continuity, and diodes. Compare a known good waveform to a second waveform, and HP LogicDart will indicate any of the 2048 points that are different. You can store up to ten waveform displays, and later recall them for further analysis or comparison. An optional HP portable printer gives you hard copy of the waveforms you have been monitoring.

Get a measurement demo and complete specifications of LogicDart at our website: **http://www.hp.com/info/LogicDart**

Ordering Information

HP E2310A Advanced Logic Probe
Includes: carrying case, 3 probes, 2 browsers, 6 IC clips, 3 contact pins, user's guide, AC adapter, 3 –1.5 V AA alkaline batteries, and Certificate of Calibration
Opt 001 Security Lock and Cable
HP E2320A Additional Assembled Probe w/Browser
HP E2321A Replacement Probe
HP E2322A Probe Accessory Kit
HP 82240B Portable Thermal Printer

HP 54620A and 54620C 16-Channel Logic Analyzers

Save Valuable Troubleshooting Time

By operating like your familiar oscilloscope, you will be able to put one of these powerful logic analyzers to work in your lab without having to study any manuals. If you are comfortable using a delayed sweep scope, you already know how to operate this logic analyzer. Both the color and monochrome versions offer 16 channels of 500 MSa/s performance which gives you 2-ns resolution.

Triggering performance ranges from the simple scope-like edge mode for most applications to pattern when you need more triggering power than your oscilloscope provides. The advanced triggering feature can be applied for those special situations when you need to capture elusive problems.

Specifications

Timing Channels: 16 channels plus an external trigger
Input RC: 100 KΩ and ~ 8pF
Timebase
Range: 1 s/div to 5ns/div (main and delayed)
Accuracy: 0.01% of reading
Cursor Accuracy
Single Channel: ± (sample period +0.01% of reading + 0.2% of screen width)
Dual Channel: Single channel accuracy ± channel-to-channel skew
Maximum Sample Rate: 500 MSa/sec
Record Length: 2k samples for sample periods of 8 ns or slower (sweep speeds of 1 μs/div to1 s/div) with glitch detect on 8k samples for sample periods of 4 and 2 ns (sweep speeds of 500 ns/div and faster) and all sweep speeds with auto glitch detect off.
Glitch Detection: Minimum detectable pulse width 3.5 ns
Trigger Modes: Edge, pattern and advanced
Advanced Operators: AND, OR Then, Entered, Existed, occurs N times, duration < time, and duration > time

Key Literature

HP 54620A Technical Specifications, p/n 5963-3565 EN/EUS

Ordering Information

HP 54620A 16-Channel Logic Analyzer
HP 54620C 16-Channel Logic Analyzer with Color Display
Please refer to the HP 54600 series oscilloscopes section page 119 for complete environmental specifications and options.

Indicates QuickShip availability.

Electronic Counters

Hewlett-Packard offers the industry's broadest line of electronic counters and counter/timers. Starting with the first frequency-measurement projects in the 1940s, HP has pioneered the major technologies enabling today's electronic counters and modulation-domain analyzers.

Electronic counter/timers are used throughout most technical industries for measuring and analyzing frequency, phase, and time-interval signal characteristics. The breadth of the HP offering allows the best product to be selected for each application. An ideal functional and performance fit delivers the greatest value: the best and most cost-effective solution.

HP counter/timers offer:

- High-measurement accuracy
- Fast system throughput/HP-IB capability
- Low cost of ownership
- Ease of use
- Data reduction on many models
- Triggering simplicity

New Measurement Technology

Modulation domain products feature "continuous count" technology. Unlike traditional counters, these products do not stop between measurements to process data. Rather, they measure continuously and process results on the fly. As a result, new kinds of measurements are made possible.

Modulation domain products include:

HP 53310A: Combines affordability and ease of use

HP E1725C: Highest performance time-interval analyzer

HP E1740A: 150 MHz time-interval analyzer; high-performance analysis for VXI systems

For more information on modulation domain products, see the section starting on page 148.

Counter Products

RF Frequency Counter

The HP 53181A RF counter offers outstanding measurement performance in a low-cost, easy-to-use package.

The HP 53181A leads off Hewlett-Packard's newest line of frequency counters. The HP 53181A RF counter employs continuous measurement technology to provide superior performance at a very low price. Frequency and period measurements are provided over the range of 0.1 Hz to 225 MHz with exceptional resolution of 10 digits in one second. An optional second channel increases the frequency range to 1.5 GHz, 3 GHz, 5 GHz, or 12.4 GHz, making it easy to cover your exact RF measurement needs. Other features of the HP 53181A include HP-IB, automatic limit testing, analog display mode, single-button recall, extensive in-box statistical and math analysis, and more.

The HP 53181A RF counter is designed for systems and bench applications where high-precision frequency measurements are required in an easy-to-use, small and rugged package.

HP 53181A: The low-cost RF counter for systems and bench use

Basic and High-Performance Universal Counters

The HP 53131A universal counter offers high performance for system or bench.

The HP universal counter/timers incorporate frequency measurements, just like the HP 53181A, and additional capabilities for time-interval measurements. Specifically, these HP counters measure precise timing between two trigger events. The high-performance universal products also provide complete, automatic characterization of rise time, pulse width, and other signal parameters. Options are available (frequency extensions, high-performance time bases) to customize the products.

The current HP universal counter offering includes the low-cost portable HP 5314A, and two high-performance universal counters: the HP 53131A and HP 53132A.

The HP 53131A is designed for manufacturing test, troubleshooting, and service. This counter allows you to easily make highly reliable frequency and timing measurements. Featured are extensive in-box analysis, automatic limit testing, analog display mode, single button recall, and more. The HP 53131A's half-rack size and light weight make it well suited for both benchtop and rackmounting.

The HP 53132A is designed for high-performance ATE systems. It combines the functionality of the HP 53131A with improved frequency and time interval resolution.

HP 53131A: High-performance system and bench counter (10 digits/sec. and 500 ps LSD)

HP 53132A: Highest resolution universal counter for system applications (12 digits/sec. and 150 ps LSD)

HP 5314A: An affordable portable

Precision Time-Interval Counter

The HP 5370B universal time-interval counter is optimized for precision time-interval measurements and offers time-interval resolution of 20 ps LSD. It measures frequency and period (with increased accuracy per unit time compared to other counters) from dc to 100 MHz.

HP 5370B: High-precision time-interval mesurements

Microwave and Millimeter-Wave Frequency Counters

These products provide fundamental high-performance frequency measurements, dc to 46 GHz. Many enhancements—power measurement, battery operation, systems interface (HP-IB), and high-accuracy time bases—are available standard or as options.

Pulse counters add the capability to automatically measure and profile burst or pulsed microwave or millimeter-wave signals.

HP 53150A/53151A/53152A: Portable CW microwave counters with power measurement for telecommunications service

HP 5347A/5348A: Portable CW microwave counter plus true power meter for improved power accuracy

HP 5361B: Profiles pulsed/CW microwave frequencies

High-Precision Oscillators

The accuracy of frequency and time-interval measurements is vitally dependent on the time base or reference element selected. HP has pioneered the field of high-precision crystal oscillators. The current counter product line benefits from HP's leadership in quality and precision oscillator technology. Three oscillator varieties are standard or optional with HP counters and counter/timers:

RTXO: Room-temperature crystal oscillators are designed for minimum frequency change over a change in temperature

TCXO: Temperature-compensated oscillators use external components to offset temperature effects. TCXO time bases have temperature characteristics which are typically five times better than an RTXO, or $<5 \times 10^{-7}$ for a 0° to 50° C change.

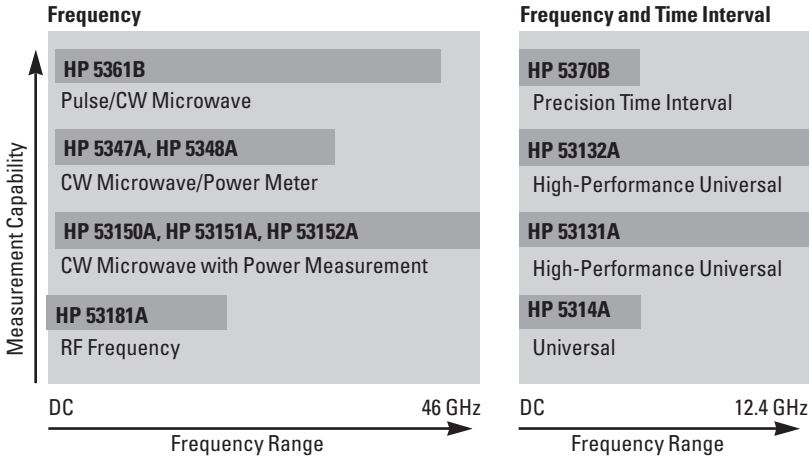
Oven Time Base: This alternative places the crystal and temperature-sensitive elements within a temperature-controlled environment. A heating element maintains a consistent temperature. The best stability is achieved when the operating point is 15° to 20° C above the highest temperature to which the unit will be exposed. After warm-up, the frequency remains very stable, typically $<7 \times 10^{-9}$ over a 0° to 50° C variation.

For more information, please request Application Note 200-2, "Fundamentals of Quartz Oscillators" from the HP Call Center in your region.

Electronic Counters

Counter Product Families

Overview



Counter Selection Guide

Model	Frequency range (extension)	Freq. resolution (1 s gate time)	Best sensitivity	Time-interval res. (single-shot LSD)	Additional features	Page	
Universal Counter							
HP 5314A	100 MHz	1 Hz	25 mV	100 ns	Battery optional	139	
High-Performance Universal Counters							
HP 53131A	225 MHz (3, 5, 12.4 GHz)	10 digits	20 mV	500 ps	HP-IB standard, full math, statistics, limit testing, auto pulse characterization	140	🚚
HP 53132A	225 MHz (3, 5, 12.4 GHz)	12 digits	20 mV	150 ps	HP-IB standard, full math, statistics, limit testing, auto pulse characterization	140	🚚
Precision Time-Interval Counter							
HP 5370B	100 MHz	11 digits	35 mV	20 ps	HP-IB standard, statistics	142	
RF Frequency Counter							
HP 53181A	225 MHz (1.5, 3, 5, 12.4 GHz)	10 digits	20 mV	—	HP-IB standard, full math, statistics, limit testing	140	🚚
CW Microwave Counters with Power Measurement							
HP 53150A	20 GHz	1 Hz	–30 dBm	—	HP-IB standard, battery optional, simultaneous power measurement	144	
HP 53151A	26.5 GHz	1 Hz	–30 dBm	—	HP-IB standard, battery optional, simultaneous power measurement	144	
HP 53152A	46 GHz	1 Hz	–30 dBm	—	HP-IB standard, battery optional, simultaneous power measurement	144	
CW Microwave Counter/Power Meters							
HP 5347A	20 GHz	1 Hz	–32 dBm	—	HP-IB optional, battery optional, –70 dBm to +20 dBm true power meter	146	
HP 5348A	26.5 GHz	1 Hz	–32 dBm	—	HP-IB optional, battery optional, –70 dBm to +20 dBm true power meter	146	
Pulse/CW Microwave Counter							
HP 5361B	20 GHz (26.5 GHz) (40 GHz)	1 Hz	–28 dBm	—	HP-IB standard, full microwave pulse measurements, automatic pulse profiling	143	

🚚 Indicates QuickShip availability.

Additionally, Hewlett-Packard offers electronic counters and counter/timers in an industry standard platform: VXIbus. With VXIbus counters from Hewlett-Packard, you can rely on the same exceptional performance that you have always had from Hewlett-Packard's high-performance rack-and-stack universal counters. All B-size instruments can be adapted to fit into the C-size VXIbus mainframes. Please request the 1998 *HP Test System and VXI Data Book*, p/n 5966-2812E, for additional configuration and product ordering information. Also, see the *VXIbus Products, HP 75000 VXIbus Family* section in this catalog.

HP 5314A

- 100 MHz
- 100 ns time interval
- Portable

HP 5314A

HP 5314A Universal Counter

The HP 5314A universal counter combines excellent performance and traditional HP quality at a very attractive price. This counter is designed to deliver reliable, high-quality operation in such areas as production test, frequency monitoring, education, training, service, and calibration. A battery (Option 002) makes the HP 5314A especially attractive for field and portable applications.

Specifications

Input Channel Characteristics (A and B)

Range
Channel A: 10 Hz to 10 MHz direct, 1 MHz to 100 MHz prescaled
Channel B: 10 Hz to 2.5 MHz
Sensitivity
Channel A: 25 mV rms to 100 MHz, 75 mV peak-to-peak at minimum pulse width of 5 ns (100 MHz range)
Channel B: 25m V rms to 2.5 MHz, 75 mV peak-to-peak at minimum pulse width of 200 ns
Coupling: AC
Impedance: 1M Ω nominal shunted by less than 30 pF
Attenuator: x1 or x20 nominal (channel A only)
Trigger Level: Continuously variable ± 350 mV times attenuator setting around average value of signal
Slope: Independent selection of + or – slope
Channel Input: Selectable SEPARATE or COMMON A
Dynamic Range: 75 mV peak-to-peak to 4 V peak-to peak

Frequency

Range: 10 Hz to 10 MHz direct count; 1 to 100 MHz prescaled by 10
Least Significant Digit (LSD) Displayed: Direct count 0.1 Hz, 1 Hz, 10 Hz switch-selectable. Prescaled 10 Hz, 100 Hz, 1k Hz, switch-selectable
Resolution: ± LSD
Accuracy: ± LSD ± (time base error) x frequency

Period

Range: 10 Hz to 2.5 MHz
LSD Displayed: $\frac{100\text{ ns}}{N}$ for N=1 to 1000 in decade steps of N
Resolution: ± LSD ± $\frac{(1.4 \times \text{trigger error})}{N}$
Accuracy: ± LSD ± $\frac{(1.4 \times \text{trigger error})}{N}$
± (time base error) x period

Time Interval

Range: 250 ns to 1 s
LSD Displayed: 100 ns
Resolution: ± LSD ± START trigger error ± STOP trigger error
Accuracy: ± LSD ± START trigger error;
± STOP trigger error ± (time base error) x TI;
External arming required for START/STOP channels

Ratio (A to B)

Range:10 Hz to 10 MHz Channel A; 10 Hz to 2.5 MHz Channel B
LSD Displayed: 1/N in decade steps of N for N = 1 to 1000
Resolution: ± LSD ± (B trigger error x frequency A)/N
Accuracy: ± LSD ± (B trigger error x frequency A)/N

Totalize

Range: 10 Hz to 10 MHz
Resolution: ± 1 count of input
Totalize controlled by front panel switch

General

Check: Counts internal 10 MHz oscillator
Display: 7-digit amber LED display with gate and overflow indication
Max. Sample Rate: 5 readings per second
Operating Temperature: 0° to 50° C
Power Requirement: 115 V, +10%,–25%; 230 V, +9%,–17%; 48 to 66 Hz; 10 VA max
Weight: 2.0 kg (4.4 lb)
Size: 238 mm W x 98 mm H x 276 mm D (9.38 in x 3.88 in x 10.88 in)
Timebase
Frequency: 10 MHz
Aging Rate: < 3 parts in 10^7 per month
Temperature: < ± 1 part in 10^6, 0° to 50° C
Line Voltage: < ± 1 part in 10^8 for ± 10% variation

Options

Option 001: High-stability timebase (TCX0)
Frequency: 10 MHz
Aging Rate: < 1 part in 10^7 per month
Temperature: < ± 1 part in 10^6, 0° to 40° C
Line Voltage: < ± 1 part in 10^8 for ± 10% variation
Option 002: Battery
Type: Rechargeable lead-acid (sealed)
Capacity: Typically 8 hours of continuous operation at 25° C
Recharging Time: Typically 8 hours to 98% of full charge; instrument non-operating. Charging circuitry included with option. Batteries not charged during instrument operation.
Battery Voltage Sensor: Automatically shuts instrument off when low-battery condition exists
Line-Failure Protection: Instrument automatically switches to batteries in case of line failure
Weight: Option 002 typically adds 1.5 kg (3.3 lb) to weight of instrument

Definition

Trigger error: $\frac{\sqrt{(80\mu V)^2 + e_n^2}}{\text{input slew rate at trigger point } (\mu V/s)}$ (rms)

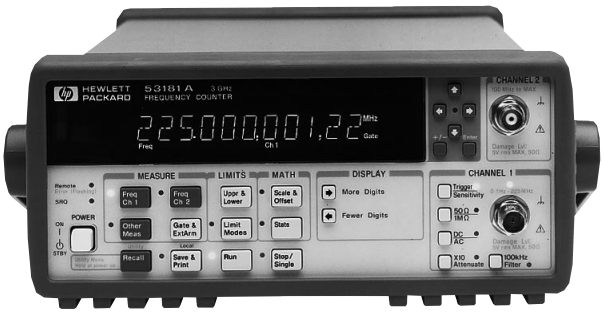
where e_n is the rms noise of the input for a 100 MHz bandwidth in Channel A and 10 MHz bandwidth in Channel B.

Ordering Information

HP 5314A 100 MHz/100 ns Universal Counter
Opt 001 High-Stability Timebase
Opt 002 Battery
Opt W30 Extended Repair Service (see page 70)
Opt W32 Calibration Service (see page 70)
All orders must include one of these line power options:
Opt 115 86 to 127 V
Opt 230 190 to 250 V

HP 53131A
HP 53132A
HP 53181A

- High-accuracy frequency measurements to 225 MHz (optional to 1.5, 3, 5 or 12.4 GHz)
- High-accuracy time-interval measurements with HP 53131A and HP53132A
- Intuitive user interface with shallow menu structure
- HP-IB standard with data transfer rate of up to 200 fully-formatted measurements/second; talk-only RS-232
- Limit test capability
- HP 53181A: 10-digits/s
- HP 53131A: 10-digit/s and 500 psec resolution
- HP 53132A: 12-digit/s and 150 psec resolution



HP 53181A RF Counter

HP 53131A and 53132A Universal Counters

A Full Family of High-Performance RF and Universal Counters

Within Budget, Without Compromise

The HP 53131A/132A/181A high-performance counters offer exceptional price and performance in a rugged, lightweight package with a unique combination of ease of use, complete measurement set, extensive analysis capability, reliability, and high measurement and data transfer speed.

These instruments use real-time digital signal processing technology to analyze data while simultaneously taking new readings, speeding measurement throughput. The technology, developed for HP's high-end line of modulation-domain analyzers, allows the counters to gather more data for each measurement so you get the higher-resolution measurements in a fraction of the time it takes a conventional reciprocal counter.

Powerful Analysis Capability

The HP 53131A/132A/181A counters offer built-in statistics and math functions so you can scale measurements and simultaneously measure and track average, min./max. and standard deviation. Automated limit testing lets you set upper and lower limits for any measurement. When a measurement falls outside those limits, the counters log the out-of-limit conditions, notify the operator and generate an output signal to trigger external devices or stop the test. An analog display mode carries limit testing one step further, letting you see at a glance whether a measurement falls within pass/fail limits.

Analog display mode uses an asterisk to represent the current measurement relative to user-defined upper and lower limits. The colon on the left represents the lower limit and the colon on the right represents the upper limit.

High-Speed Automated Test Capability

For computer-controlled systems applications, each counter includes a standard HP-IB interface with a data transfer rate of up to 200 fully-formatted measurements per second. The counters use the Standard Commands for Programmable Instruments (SCPI) protocol, letting you leverage your programming investment across your measurement system. The standard RS-232 talk-only interface provides printer support or data transfer to a computer through a terminal-emulation program.

HP 53181A RF Counter

HP-IB

Optimized for RF applications, the single-channel HP 53181A gives you frequency, period, and peak-voltage measurements with up to 10 digits/sec frequency resolution. The lowest-cost HP 53181A counter is ideal for benchtop, system RF and analog applications.

A digit-blanking function lets you easily eliminate unnecessary digits when you want to read measurements quickly. For higher-frequency measurements, an optional second channel provides 1.5, 3, 5 or 12.4 GHz bandwidth.

HP 53131A and 53132A Universal Counters

HP-IB

The two-channel HP 53131A counter offers 10 digits per second of frequency resolution at up to 225 MHz. Single-shot time-interval resolution is specified at 500 ps and averaging can reduce this even further. Measurements include frequency, time interval, ratio, period, phase angle, totalize, peak voltage, pulse parameters and more. For quick access to frequently used tests, a single keystroke recalls up to 20 different stored front-panel set-ups. Choose the HP 53131A for general bench or system test where you need excellent performance at an unbeatable price.

For applications requiring higher resolution, the HP 53132A offers the same features and functions as the HP 53131A with up to 12 digits/s frequency resolution. Single-shot time-interval resolution is specified at 150 ps. Choose the HP 53132A when you need the very best in accuracy and resolution, or when speed in an automated system is critical. With the HP 53132A, expanded external arming features can be used to control the start of measurements using an external signal.

Whichever counter you choose, you'll have an accurate, reliable counter that will serve you for years to come. We back that claim with a standard three-year warranty that can be extended an additional two years.

Options Increase Versatility

The HP 53131A/132A/181A counters can be ordered with an optional RF-input channel to provide frequency measurements up to 3 GHz (Option 030) 5 GHz (Option 050) or 12.4 GHz (Option 124). (See table on page 141)

A choice of optional timebases is available for the HP 53131A/132A/181A counters to increase your measurement accuracy. Option 010 provides a high-stability oven timebase with aging of less than 5×10^{-10} per day. Option 012 provides an ultra-high-stability oven timebase with aging of less than 1×10^{-10} per day. (See table on page 141)

BenchLink Meter, HP 34812A optional software turns your PC and counter into a powerful, easy-to-use measurement system. HP BenchLink Meter lets you easily configure and run tests from your Windows-based PC, making data gathering more convenient. HP BenchLink software helps you get more information from your data by providing a variety of basic display formats and analysis tools that let you manipulate and understand your data quickly and easily.

Abridged Measurement Specification & Characteristics

	HP 53131A	HP 53132A	HP 53181A
Measurements	Frequency, frequency ratio, time interval, period, rise/fall time, positive/negative pulse width,duty cycle,phase (CH 1 to CH 2), totalize, peak voltage, time interval average, time interval delay		Frequency, frequency ratio (with optional CH 2), period, peak voltage
Analysis	Automatic limit testing, math (scale and offset, statistics (minimum, maximum,Mean, standard deviation). Statistics available on all measurements or only measurements that fall within limits.		
Measurement characteristic			
Frequency range	CH 1 & 2: dc–225 MHz	CH 1 & 2: dc–225 MHz	CH 1: dc–225 MHz
Frequency resolution:	10 digits/s	12 digits/s	10 digits/s
Measurement speed:	Up to 200 meas/s	Up to 200 meas/s	Up to 200 meas/s
Time interval resolution (LSD)	500 ps	150 ps	NA
Voltage range & Sensitivity (Sinusoid)	DC to 100 MHz: 100 MHz to 200 MHz: 200 to 225 MHz: (75 mVrms with optional rear connectors)	20 mVrms to ±5 Vac + dc 30 mVrms to ±5 Vac + dc 40 mVrms to ±5 Vac + dc	
Input conditioning	(Independently selectable on CH 1 & 2)	(Independently selectable) on CH 1 & 2)	(Selectable on CH 1)
Impedance, coupling	1 MΩ or 50 Ω, ac or dc	1 MΩ or 50 Ω, ac or dc	1 MΩ or 50 Ω, ac or dc
Low pass filter	100 kHz, switchable	100 kHz, switchable	100 kHz, switchable
Attenuation	x1 or x10	x1 or x10	x1 or x10
External timebase reference input	1, 5, 10 MHz	10 MHz	1, 5, 10 MHz
Trigger	CH 1 & 2	CH 1 & 2	CH 1
	Trigger on rising/falling edge; set level by percent of signal level or absolute voltage; set sensitivity to LOW, MED, or HIGH		
Gating and arming	Auto, manual (set gate time or number of digits of resolution); external, delay		
Interfaces	Standard HP-IB (IEEE 488.1 and 488.2) with SCPI-compatable language; talk only RS-232		
Power	100 to 120 VAC ± 10% –50, 60 or 400 Hz ± 10% 220 to 240 VAC ± 10% –50 or 60 Hz ± 10%		
Net weight/size	3 kg (6.5 lbs), 212.6mm W x 88.5mm H x 348.3mm D		

For full specifications, request data sheet, pn 5967-6039EUS/EN, or visit our website: **www.hp.com/go/bi**

Standard and Optional High-Stability Timebases

	Standard (0° to 50° C)	Medium Stability Oven (Option 001)	High Stability Oven (Option 010)	Ultra High Stability Oven (Option 012, 53132A only)
Temperature Stability: (referenced to 25° C)	$< 5 \times 10^{-6}$	$< 2 \times 10^{-7}$	$< 2.5 \times 10^{-9}$	$< 2.5 \times 10^{-9}$
Aging Rate (after 30 days) Per Day:	$< 3 \times 10^{-7}$	$< 4 \times 10^{-8}$	$< 5 \times 10^{-10}$	$< 1 \times 10^{-10}$
Per Month:		$< 2 \times 10^{-7}$	$< 1.5 \times 10^{-8}$	$< 3 \times 10^{-9}$
Per Year:				$< 2 \times 10^{-8}$
Turn-on stability vs. time: (in 30 minutes)		$< 2 \times 10^{-7}$ (referenced to 2 hours)	$< 5 \times 10^{-9}$ (referenced to 24 hours)	$< 5 \times 10^{-9}$ (referenced to 24 hours)
Calibration:	Manual Adjust	Electronic	Electronic	Electronic

Note that power to the time base is maintained when the counter is placed in standby via the front panel switch. The internal fan will continue to operate under this condition to maintain long-term instrument reliability.

Optional High-Frequency Channels

	Frequency range	Coupling	Power range and sensitivity	Damage level
Option 015[1] 1.5 GHz channel	100 MHz to 1.5 GHz	ac	–27 dBm to +19 dBm	5 Vrms
Option 030 3.0 GHz channel	100 MHz to 3.0 GHz	ac	–27 dBm to +19 dBm (100 MHz to 2.7 GHz) –21 dBm to +13 dBm (2.7 GHz to 3 GHz)	5 Vrms
Option 050 5.0 GHz channel	200 MHz to 5.0 GHz	ac	–23 dBm to +13 dBm	25 dBm
Option 124 12.4 GHz channel	200 MHz to 12.4 GHz	ac	–23 dBm to +13 dBm	25 dBm

[1] Option 015 is available only for HP 53181A counters.

Ordering Information

HP 53131A Universal Counter
HP 53132A Universal Counter
HP 53181A RF Counter
Options
Opt 001 Medium-Stability Timebase
Opt 002 DC Power Input
Opt 010 High-Stability Timebase
Opt 012 High-Stability Oven Timebase (HP53132A Only)
Opt 015 1.5 GHz Ch. w/BNC Connector (HP 53181A only)
Opt 030 3 GHz Channel with BNC Connector
Opt 050 5 GHz Channel with Type-N Connector
Opt 124 12.4 GHz Channel with Type-N Connector
Opt 060 Rear-Panel Connectors
Opt 1BP MIL-STD-45662 Calibration w/ Data
Opt 1CM Rackmount Kit
HP 34812A HP BenchLink Meter Software
HP 34161A Accessory Pouch
HP 34131A Hard Transit Case
HP 34397A DC to AC Inverter

Indicates QuickShip availability.

Universal Time-Interval Counter

HP 5370B

- 20 ps single-shot LSD
- 11 digits/s frequency resolution
- Up to 8000 measurements/sec.
- Built-in statistics functions
- Frequency and period to 100 MHz

HP 5370B

The HP 5370B's Precision and Measurement Speed

HP-IB

- IC tester performance verification
- Fast IC characterization
- Disk drive manufacturing
- Digital communications—jitter analysis
- Radar/laser ranging calibration
- Nuclear systems
- Calibration labs

Full Range of Measurement and Analysis Functions

Time Interval: Achieve 20 ps single-shot LSD on time intervals from 0 to 10 s, including negative time (in which the STOP channel event occurs before the START channel event).
Frequency: Measure up to 100 MHz with 11 digits of resolution in 1 s. Choose gate times down to 1 period: use 1 period with average mode and access the powerful Statistics capabilities.
Period: Measure period average from 1 to 100k samples and use statistics.
Statistics: Reduce external computations, reduce random errors, and improve measurement throughput.
Sample Size: Select 1, 10, 1k, 10k or 100k samples from the front panel, or 1 to 65,536 samples over HP-IB. For the selected sample size, you can compute:

Mean
Standard Deviation
Minimum
Maximum

Flexible Arming and Gating: + TI or ±TI with internal or external arming, with or without external hold-off.
Full HP-IB Programming and Fast Data Output:
Up to 8000 readings/s in fast binary mode—125 μs dead time
10 to 20 readings/s fully formatted—330 μs dead time

Time-Interval Measurement Characteristics

Range
±TI: –10 to +10s, including zero
+TI: 10 ns to 10s
Resolution
Measurement resolution depends on input signal noise and slew rate.
Accuracy
Time-interval measurement accuracy is influenced by internal systematic uncertainties, trigger-level timing error for each trigger edge, and timebase aging in addition to resolution or random uncertainties. Uncertainties may be reduced to less than 10 ps by calibration with the HP J06-59992A time-interval calibrator. Careful calibration and averaging will result in accuracies to ± 100 ps.

Frequency and Period Measurement Characteristics

Range
Frequency: 0.1 Hz to 100 MHz
Period: 10 ns to 10 s
Resolution
Measurement resolution depends on input signal noise as well as measurement gate time.
Accuracy
Accuracy is influenced by internal uncertainties, timebase aging, and noise on the input signal. Periodic timebase calibration minimizes uncertainty due to timebase aging. Internal uncertainties and noise effects may be reduced by selecting longer gate times, or by averaging results.

Key Literature

HP 5370B Technical Data Sheet, p/n 5952-7915
HP J06-59992A Technical Data Sheet, p/n 5952-7837
Product Note 5370B -2: *Better than 100 ps Accuracy in HP 5370B Time Interval Measurements Through Bias Error Reduction*, p/n 5952-7834
Application Note 191-7: *High-Speed Timing Acquisition and Statistical Jitter Analysis*, p/n 5952-7908

Ordering Information

HP 5370B Time-Interval Counter
Opt 913 Rack Flange Kit for Use With Supplied Front Handles
Opt 908 Rack Flange Kit, No Front Handles
Opt W30 Extended Repair Service (see page 70)
HP J06-59992A Time-Interval Calibrator

- Frequency extensions to 26.5 GHz, 40 GHz
- Measure frequency (pulsed or CW), PRI, PRF, pulse width, off-time, and frequency profiles directly

HP 5361B

HP 5361B Pulse/CW Microwave Counter

The HP 5361B offers both high-precision pulse and CW performance. With built-in frequency modulation profiling, the HP 5361B characterizes radar, EW, and communications systems or components. This counter lowers your equipment costs by eliminating the need for a separate CW counter, pulse generator, and computer.

Key features include:

Pulse measurements: Frequency, PRF, PRI, pulse width, and off-time.
Frequency profiling: Characterize frequency transients, modulation (such as chirp), and linearity using the PROFILE function. No external gate is required.
Fast track: Measure a signal that is sweeping at up to 800 MHz/s.
Low FM rate: Measure signals that vary slowly in frequency.
Simplified operation: To offload the operator, built-in automatic functions include calibration, signal assessment (pulsed or CW), signal acquisition, gate width calculation and setting, gate positioning, PRF mode, tracking of sweeping signals, pulse averaging for desired resolution and measurement display.
Scope-View: Set up externally gated measurements by viewing the down-converted pulse with a dc offset.

The HP 5361B is a cost-effective choice for manufacturing and service. High-speed throughput saves operator time and lowers cost. Periodic maintenance is limited to time-base calibration.

For radars, VCOs, and DTOs, the HP 5631B makes frequency, timing, and profiling measurements at the touch of a button. The counter makes more complex measurements for the carrier frequency of agile signals, staggered PRIs, or the frequency transients in a pulsed or CW signal. With one instrument you can characterize radar pulses or test a Stable Local Oscillator (STALO). Functions for measuring step response, post-tuning drift, and settling time facilitate accurate and easy testing of VCOs and DTOs.

Summary Specifications

Input Characteristics

	Input 1 (50 Ω)	Input 2 (1M Ω)	Input 2 (50 Ω)
Frequency range	500 MHz to 20, 26.5, 40 GHz	10 Hz to 80 MHz	10 MHz to 525 MHz
Sensitivity		25 mV rms	25 mV rms
0.5 to 12.4 GHz	–28 dBm		
12.4 to 20 GHz	–23 dBm		
0.5 to 26.5 GHz (Option 026, 040)	–20 dBm		
26.5 to 40 GHz (Option 040)	0.37 x f (in GHz) –29.8 dBm		

Frequency (Input 1)

Automatic and Manual Acquisition: 500 MHz to 20 GHz; 500 MHz to 26.5 GHz (Option 026); 500 MHz to 40 GHz (Option 040)
Least Significant Digit: 1 MHz to 1 Hz for frequency, 0.001 Hz for PRF
Pulse Frequency Measurements
- **Pulse Width** (minimum)**:** Manual mode, 60 ns; auto mode, 100 Ns
- **Pulse Rep. Freq.:** Minimum 1 Hz; maximum 2 MHz
- **Measurement Time, Resolution, Accuracy:** See data sheet

CW Frequency Measurements
- **FM Tolerance:** 55 MHz peak-to-peak
- **Tracking Speed** (fast acquisition)**:** 800 MHz/s
- **Acquisition Time:** Manual mode, <40 ms; automatic mode, fast acq., <100 ms
- **Gate Times** (1 Hz resolution)**:** 200 to 1000 ms
- **Measurement Time:** ≥ 8.5 ms (in Dump Mode)

Accuracy: See data sheet

Pulse Parameters (Input 1)

	Pulse width	PRI	Offtime	PRF
Min./Max.	60 ns/10 ms	500 ns/1 s	400 ns/1 s	1 Hz/2 MHz to 0.001 Hz
LSD	(PW < 1 ms) 1 ns; (PW≥ 1 ms) 100 ns			
Accuracy (100 Avg.)	± (20 ns + timebase uncertainty x measurement ± LSD			± (20 ns) x $(PRF)^2$ ± LSD ± timebase uncertainty

Profile (Input 1)

Frequency Range (min./max. for Y axis)**:** 500 MHz/40 GHz
FM Chirp Tolerance (max. span for Y axis)**:** 50 MHz peak-to-peak
Time Range (min./max. for span x axis)**:** 100 ns/10 ms
Time Resolution: 1 ns
Internal Gate Width: Minimum: 11 to 23 ns; typical minimum: 14 ns
External Gate Width: Minimum: manual acquisition 20 ns; auto-acquisition 60 ns
Number of Data Points: Up to 100
Profile Frequency Measurements
- **Printers Supported:** HP 2225A, HP 2227B, HP 3630A Option 002
- **Profile Phase Measurements:** See Application Note 377-4 for details. Computer required.

Frequency (Input 2)

Range: 10 Hz to 525 MHz
Accuracy: 0.001 to 1 Hz
Resolution / LSD: 0.001 to 1 Hz

Options

Option 001 Oven Timebase: Aging rate < 5 x 10^{-10} / day
Option 006, Increased Damage Level: Pulsed, + 50 dBm (100 W) peak; CW, +39 dBm (8 W)
Option 010 High-Stability Oven Timebase: Aging rate < 7 x 10^{-10} /week (Standard timebase: Aging rate < 1 x 10^{-7} /month)
Option 026: Frequency extensions for input 1 to 26.5 GHz
Option 040: Frequency extensions for input 1 to 40 GHz

Ordering Information

HP 5361B Pulsed/CW Microwave Counter
- **Opt 001** Oven Timebase
- **Opt 006** Microwave Limiter
- **Opt 010** High-Stability Timebase
- **Opt 026** 26.5 GHz Frequency Extension
- **Opt 040** 40 GHz Frequency Extension
- **Opt 908** Rackmount Kit for Use with Front Handles Removed
- **Opt 910** Additional Operating and Programming Manual
- **Opt 913** Rackmount Kit for Use With Supplied Front Handles
- **Opt 915** Service Manual
- **Opt W30** Extended Repair Service (see page 70)
- **Opt W32** Calibration Service (see page 70)

CW Microwave Counters with Power Measurement

HP 53150A
HP 53151A
HP 53152A

- Ultra wide range, single input (from 50 MHz up to 46 GHz)
- Simultaneous frequency and power measurement with analog peaking indicator
- Fully programmable via HP-IB and RS-232 standard
- Lightweight with optional battery

HP 53152A

HP 53150A, 53151A, 53152A Microwave Counters

The HP 53150 series represent a total re-thinking of microwave counters: innovative designs that offer no-compromise performance and quality while attaining true portability. The HP 53150A, 53151A, and 53152A measure both frequency and power over the frequency ranges of 20 GHz, 26.5 GHz, and 46 GHz, respectively, and feature a single, extremely wideband microwave input (50 MHz up to 46 GHz).

No Compromise Performance

Utilizing a unique single board design with low phase noise PLL circuitry, the HP 53150 series offers exceptional sensitivity, excellent power measurement accuracy and repeatability as well as fast acquisition times and full programmability. Performance equals or surpasses the industry standard HP 5350 series in virtually every aspect in a package that is less than half the weight and size.

Frequency and Power Measurements with a Single Connection

The heart of the HP 53150 series is an advanced sampler design that integrates a separate zero bias Schottky diode for the accurate measurement of input power. This allows the convenient measurement of both frequency and power with a single connection. The unique cable-loss-compensation feature yields accuracies and repeatabilities that rival power meters with diode sensors. Best of all, since the frequency of the test signal is measured simultaneously, the diode's frequency response is automatically adjusted for. And like the latest in diode sensors, deviation from square law is also compensated for.

Functionality Without Clutter

The HP 53150 series offers a clean, uncluttered front panel with with a minimum of push buttons. Despite their simple appearance, these counters retain all the powerful functions one expects in precision instrumentation, with such useful functions as: measurement averaging, arbitrary as well as nulling offsets for both frequency and power, display of power in either dBm or Watts and full control of resolution, sampling rate, and HP-IB address plus extensive self-diagnostics.

Field Tough but Ready for Benchtop or ATE Applications

The HP 53150 series is as comfortable in the field as in the laboratory. The rugged case with an integrated tilting handle can tolerate the vibration and shock expected in field use. For easy transportation, a soft carrying case is also available. The "see anywhere" backlit LCD display ensures visibility in all environments, from dark to full sunlight. And in situations where AC is unavailable, the internal, replaceable camcorder batteries provide over 2.5 hours of continuous operation. Alternatively, the unit can be powered from an external 11-18 VDC source.

For benchtop and ATE applications, the HP 53150 series delivers full functionality and high measurement speed along with fully programmable RS-232 interface and high speed HP-IB (SCPI compliant) as standard. In addition, these counters are compatible with standard HP rackmount hardware.

HP 53150 Series Abridged Measurement Specifications and Characteristics

All measurement specifications are over the full signal ranges of channels 1 and 2. For full specifications, please call your HP representative and request a Product Overview for the HP 53150 series microwave counters.

Input Characteristics

	Input 1 (1 MΩ)	Input 2 (50 Ω)	
Frequency Range			
53150A	10 Hz to125 MHz	.05–20 GHz	
53151A	10 Hz to125 MHz	.05–26.5 GHz	
53152A	10 Hz to125 MHz	.05–46 GHz	
Sensitivity		**53150/51**	**53152**
<30 Hz	40 mV	—	—
to 125 MHz	25 mV	—	—
<250 MHz	—	–20 dBm	–20 dBm
to 12.4 GHz	—	–33 dBm	–33 dBm
to 18 GHz	—	–33 dBm	–30 dBm
to 20 GHz	—	–29 dBm	–27 dBm
to 26.5 GHz	—	–25 dBm (151)	–27 dBm
to 40 GHz	—	—	–23 dBm
to 46 GHz	—	—	–17 dBm
Maximum Input	2 V_{rms}	+5 dBm, < 2 GHz +13 dBm, > 2 GHz	
Damage Level	5 V_{rms} to120 Vp	+27 dBm	
Coupling	AC	AC	

Channel 1

Resolution: Selectable 1 Hz to 1 MHz
Connector: BNC female
Low Pass Filter: 50 kHz, selectable

Channel 2

Resolution: Selectable 1 Hz to 1 MHz
Acquisition Time: 100 ms to 140 ms
Gate Time: 1/Resolution
FM Tolerance: 20 MHz p-p max. @ 10 MHz rate to 26.5 GHz; 12 MHz p-p max. @ 10 MHz rate to 46 GHz
AM Tolerance: Any depth/rate within dynamic range of input
Amplitude Discrimination (above 250 MHz)**:** 20 dB typ. for greater than 75 MHz separation; 10 dB typ. for less than 75 MHz separation
Connector: 3.5 mm SMA compatible (HP 53150A/53151A); 2.92 mm Planar Crown (HP 53152A)

Power Measurement
Range: Counter sensitivity to +7 dBm
Units: dBm or milliwatts/microwatts
Resolution: 0.01 dB

Accuracy* (0 to –20 dBm)**:**

	53150/51	53152
< 12.4 GHz	±1.5 dB	±1.0 dB
to 20 GHz	±1.5 dB	±1.5 dB
to 26.5 GHz	±2.0 dB (151)	±1.5 dB
to 46 GHz	—	±2.0 dB

*At chanel two input connector

General

Display: Backlit LCD
Sample Rate: User-selectable Fast, Medium, Slow or Hold
Programming: HP-IB and RS-232C, SCPI compatible
Math Functions
Offset: Last reading and/or entered offset to reading for either power or frequency
Averaging: 1 to 99 measurement running average
Cable Loss Compensation: Offsets power reading via linear interpolation of up to 10 user-entered frequency attenuations
Save and Recall: Up to 9 complete instrument setups may be saved and later recalled
Sleep Mode (battery option only)**:** Automatically activated if no input is present for 5 minutes
Power Requirements
75 VA max. (25 W typ.)
90– 132 VAC; 50, 60, 400 Hz
216– 264 VAC; 50, 60 Hz
11–18 VDC: 2A max.: battery option only
Battery (option)**:**
Type: VHS camcorder, sealed lead acid (2 each)
Charge Time: 8 hours in unit
Capacity: 2.5 hours minimum at 25° C
Timebase:

	TCXO (std)	Option 001
Aging Rate	1×10^{-7}/mo	5×10^{-10}/day
Short Term (1 sec. avg.)	1×10^{-9}	2×10^{-10}
Temperature (0—55°C)	$<1 \times 10^{-6}$	$<3 \times 10^{-9}$

Accessories Furnished: Power cord and operating, programming, and service manuals
Size: 213 mm W x 88.5 mm H x 300 mm D
Weight: 4 kg without battery option; 6.4 kg with battery option

Ordering Information

HP 53150A 20 GHz Counter
HP 53151A 26.5 GHz Counter
HP 53152A 46 GHz Counter
Options
Opt 001 Oven Timebase
Opt 002 Battery/DC Input
Opt 007 Soft Carrying Case
Opt 1CM Rack Mounting Kit
Opt W30 3-Yr. Return Repair Service
Opt W50 5-Yr. Return Repair Service

Microwave Counter/Power Meter

HP 5347A
HP 5348A

- Quick, easy power and frequency measurements
- Portable; battery operation
- Built-in sensor calibration tables
- Supports four HP power sensors

HP 5347A portable microwave counter/power meter (shown with Option 803, HP 8485A power sensor, and Option 070 soft carrying case)

HP 5347A and HP 5348A Microwave Counter/Power Meters

HP-IB

The HP 5347A and HP 5348A microwave counter/power meters offer the convenience of a single instrument that meets both your frequency and power measurement needs. The HP 5347A counter/power meter makes these measurements to 20GHz; the HP 5348A, to 26.5 GHz. Both counter/power meters offer the accuracy and resolution that previously required a standalone counter and separate power meter.

Counter Specifications

Input 1

Frequency Range
HP 5347A: 500 MHz to 20.0 GHz
HP 5348A: 500 MHz to 26.5 GHz
Sensitivity
HP 5347A/48A: 500 MHz to 12.4 GHz :–32 dBm; (–35dBm typical); 12.4 GHz to 20.0 GHz: –27dBm; (–32 dBm typical)
HP 5348A: 20.0 GHz to 26.5 GHz: –20 dBm (–27 dBm typical)
Maximum Input: +7dBm
Damage Level: +25 dBm, peak
Connector: HP 5347A: N (f); HP5348A: APC 3.5 (m)
Resolution: 1 Hz or 10 kHz, selectable
Acquisition Time
Resolution = 1 Hz, time = < 125 ms
Resolution = 10 kHz, time < 60 ms
Maximum Deviation: 20 MHz peak-to-peak, automatic mode
Maximum FM Rate: 10 MHz

Input 2

Frequency Range: 10 Hz to 525 MHz
Sensitivity: 25 mV rms (15 mV rms typical)
Resolution: 1 Hz or 10 kHz, selectable

Options

Battery (Option 002)**:** 1 to 2 hours of operation (typical); 12 hours to charge (typical)
Microwave Level Limiter (Option 006)
Damage Level: 500 MHz to 6 GHz: 39 dBm;
6 GHz to 18 GHz: 36 dBm;
18 GHz to 26 GHz: 34.8 dBm
Sensitivity reduced by: 500 MHz to 12.4 GHz: 3 dBm;
12.4 GHz to 20 GHz: 4 dBm;
20 GHz to 26 GHz: 5 dBm

Power Meter Specifications

Frequency Range: 10 MHz to 26.5 GHz, sensor-dependent
Power Range: –70 dBm to + 20 dBm, sensor-dependent
Power Sensors: Orderable as options with the instrument
Option 801: HP 8481A Power Sensor, 0.01 to 18 GHz, –30 to + 20 dBm
Option 802: HP 8481D Diode Power Sensor, 0.01 to 18 GHz, –70 to –20 dBm
Option 803: HP 8485A Power Sensor, 0.05 dB to 26.5 GHz, –30 to + 20 dBm
Display Units: Watts, dBm
Resolution: 0.01 dB in log mode, 0.1% of full scale in linear mode
Accuracy
Instrumentation: ±0.02 dB or ±0.5%
Power Reference
Power Output:1.00 mW. Factory set to ±0.7%, traceable to U.S. National Institute of Standards and Technology.
Accuracy: ±1.2% worst case (±0.9% RSS) for one year

General

Operating Temperature: 0° to 55°C
Power Requirements: 50 VA maximum
External dc: 14 to 26 Vdc, 40 W, binding post
Accessories Supplied: Power cord, operating/programming manual, 1.5 m power sensor cable (HP 11730A)
Size: 325 mm W x 144 mm H x 456 mm D
Weight: 9.1 kg; with battery, 10.4 kg

Ordering Information

HP 5347A 20 GHz Counter/Power Meter
HP 5348A 26.5 GHz Counter/Power Meter
Opt 002 Battery Pack
Opt 006 Microwave Level Limiter
Opt 011 HP-IB Interface
Opt 070 Soft Carrying Case
Opt 801 HP 8481A Power Sensor
Opt 802 HP 8481D Diode Power Sensor
Opt 803 HP 8485A Power Sensor
Opt 913 Rackmount Kit
Opt W30 Extended Repair Service
(see page 70)

HP 53147A
HP 53148A
HP 53149A

- Three frequency ranges up to 46 GHz
- True power meter with HP 8480 series sensors
- DMM and battery optional
- Fully programmable HP-IB and RS-232 standard

HP 53149A with DMM option

HP 53147A, 53148A, 53149A Microwave Counter/ Power Meter/DMMs

The HP 53140 series microwave counter/power meters with optional digital multimeter have all the fundamental measurements required to install and maintain today's digital microwave radio links. Rugged field portability and a battery option complete the ensemble. These instruments are also at home in ATE applications with HP-IB and RS-232 fully programmable I/O ports as standard features. For those demanding R&D application, the HP 53140 series offer the laboratory-level performance and accuracy you've come to expect from HP.

HP 53140 Series Abridged Measurement

Specifications and Characteristics

For full specifications, please call your HP representative and request a Product Overview for the HP 53140 series microwave counters.

Counter Specifications

Input Characteristics

	Input 1 (1 M Ω)	Input 2 (50 Ω)	
Frequency Range			
53147A	10 Hz to 125 MHz	.05-20 GHz	
53148A	10 Hz to 125 MHz	.05-26.5 GHz	
53149A	10 Hz to 125 MHz	.05-46 GHz	
Sensitivity		**53147A/48A**	**53149A**
< 30 GHz	40 mV	—	—
to 125 MHz	25 mV	—	—
< 250GHz	—	–20 dBm	–20 dBm
to 12.4 GHz	—	–33 dBm	–33 dBm
to 18 GHz	—	–33 dBm	–30 dBm
to 20 GHz	—	–29 dBm	–27 dBm
to 26.5 GHz	—	–25 dBm (148)	–27 dBm
to 40 GHz	—	—	–23 dBm
to 46 GHz	—	—	–17 dBm
Damage Level	5 Vrms to 120 Vp	+27 dBm	

Channel 1

Resolution: Selectable 1 Hz to 1 MHz
Low Pass Filter: 50 kHz, selectable

Channel 2

Resolution: Selectable 1 Hz to 1 MHz
Acquisition Time: 100 ms to 140 ms
Gate Time: 1/Resolution
FM Tolerance: 20 MHz p-p max. @ 10 MHz rate to 26.5 GHz;
12 MHz p-p max. @ 10 MHz rate to 46 GHz
Amplitude Discrimination (above 250 MHz): 20 dB typ. for greater than 75 MHz separation; 10 dB typ. For less than 75 MHz separation
Connector: 3.5 mm SMA compatible (HP 53147A/53148A)
2.92 mm Planar Crown (HP 53149A)

Power Meter Specifications

Frequency Range: 10 MHz to 50 GHz, sensor-dependent
Power Range: –70 dBm to +20 dBm, sensor-dependent
Power Sensors: HP 8480 series
Display Units: Watts, dBm
Resolution: 0.01 dB in log mode, 0.1% of full scale in linear mode
Accuracy
Instrumentation: +/- 0.02 dB or +/- 0.5%
Power Reference
Power Output: 1.00 mW. Factory set to +/- 0.7%, traceable to U.S. National Institute of Standards and Technology.
DMM Specifications (option)
Function: AC and DC volts, Ohms

General

Display: Backlit LCD
Programming: HP-IB and RS-232C, SCPI compatible
Math Functions
Offset: Last reading and/or entered offset to reading for either power of frequency
Averaging: 1 to 99 measurement running average
Save and Recall: Up to 9 complete instrument setups may be saved and later recalled
Power Requirements:
90 – 132 VAC; 50, 60, 400 Hz
216 – 264 VAC; 50, 60 Hz
11 – 18 VDC: battery option only
Battery (option):
Type: VHS camcorder, sealed lead acid (2 each)
Charge Time: 8 hours in unit
Capacity: 2 hours typical

Timebase:

	TXCO (std)	Oven (opt)
Aging Rate	1×10^{-7}/mo	5×10^{-10}/day
Short Term (1 sec. avg.)	1×10^{-9}	2×10^{-10}
Temperature (0–55° C)	$<1 \times 10^{-6}$	$<3 \times 10^{-9}$

Accessories Furnished: Power cord, 1.5 m power sensor cable (HP 11730A), operating, programming and service manuals

Ordering Information

HP 53147A 20 GHz Counter/Power Meter	Available Spring 1999
HP 53148A 26.5 GHz Counter/Power Meter	Available Spring 1999
HP 53149A 46 GHz Counter/Power Meter	Available Spring 1999
Options	
DMM	Available Summer 1999
Oven Timebase	Available Spring 1999
Battery/DC Input	Available Spring 1999

Modulation Domain Analysis: A New View of Complex Signals

As a pioneer of counter/timer technology, Hewlett-Packard recognized a need to expand traditional frequency and time measurement techniques. With modulation domain analyzers, HP offers a unique method for viewing complex signals that is both intuitive and insightful.

Oscilloscopes display amplitude (voltage) versus time: the time domain. Spectrum analyzers show amplitude versus frequency: the frequency domain. The HP 53310A, E1725C and E1740A bring a new dimension to frequency and time interval analysis with views of the modulation domain:

- Frequency versus time
- Phase versus time
- Time interval versus time

Improved Measurement Analysis

A wide range of applications benefit from modulation domain analysis. Jitter measurements in digital communication systems, disk and tape drives, and mechanical systems are dramatically improved. Identify the sources of jitter—the first step in improving system performance.

Modulation domain analyzers simplify the study of step response for voltage-controlled oscillators. They easily characterize the frequency-hopping performance of an agile transmitter. Chirp linearity and phase switching in radar systems are easily understood from displays of frequency or phase versus time.

Modulation Domain Analyzer Products

HP modulation domain analyzers provide a range of features and performance. Analysis features include views of frequency and phase versus time, with built-in statistics and histograms. HP-IB programmability lets you control these analyzers remotely, or use the front panel measurement and display options for quick on-the-spot measurements.

The HP 53310A combines modulation domain analysis in a low-cost offering. Single-button functions and automated setup and measurement capabilities make the HP 53310A the easiest to operate of the modulation domain analyzers. The HP 53310A Option 031 includes features that further simplify the analysis steps for RF mobile communications designers, and Option 305 provides software for complete phase analysis.

HP 53310A: Affordable, easy-to-use modulation domain analyzer

Time Interval Analyzer Products

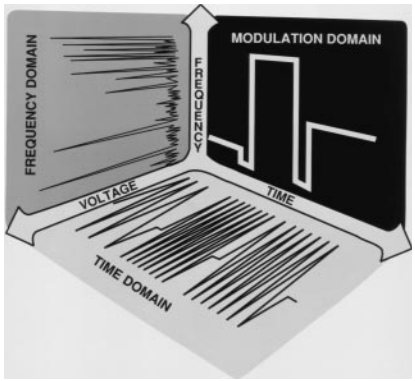
HP's expertise with modulation domain analyzer technology has resulted in a family of time interval analyzer (TIA) products tuned for specific applications. Choose from preconfigured instruments, or design your own solution using the basic TIA module and selecting from a range of software offerings.

The HP E1725C TIA is based on the HP E1740A TIA module, a VXI card that can be plugged into a VXI cardcage. The on-card functionality includes basic arming and measurement control and a large 512K memory for storing results. Histograms are also executed in hardware on the HP E1740A for accelerated analysis operations.

The HP E1725C instruments combine the HP E1740A in a VXI cardcage with a portable computer. The computer's Microsoft Windows interface and optional HP software packages simplify measurements and offer powerful display and analysis capabilities for viewing and interpreting measurement results.

HP E1740A: Two-slot VXI module

HP E1725C: Highest performance time interval analyzer with configurable personalities



The Modulation Domain adds a third dimension of frequency vs. time

Application Solutions

With a range of add-on software packages, the HP E1725C TIAs can be tailored as complete solutions for specific applications. The current family of HP E174XA software products provide full-function and easy-to-use platforms for these complex measurement situations:

Data storage: Evaluate designs and troubleshoot problems for today's high-speed digital storage solutions.

Clock jitter: Study and solve jitter problems in clock distribution networks.

SONET/SDH networks: Evaluate existing equipment for use with new high-speed technologies.

Network Synchronization Determine compliance with today's industry standards.

HP E1741A/E1747A: Data storage test analysis

HP E1742A: SONET/SDH tributary jitter analysis

HP E1743A: Clock jitter analysis

HP E1746A: Network synchronization measurement

HP E1748A: Multiple-channel network sychronization measurement

Modulation Domain Analyzer Selection Guide

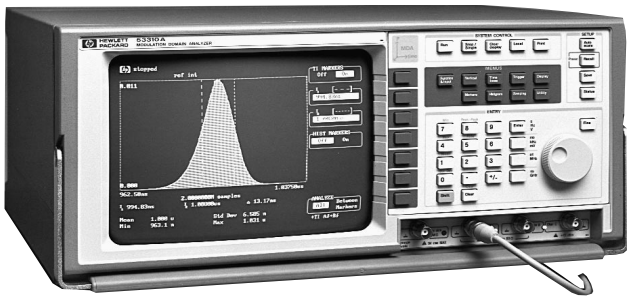
Model	Key selection criteria	Feature highlights
HP 53310A	Low-cost, easy to use	Auto set-up RF transmitter characterization features Fast histograms
HP E1725C	Highest performance analyzer	80 MHz sample rate Microsoft® Windows user interface with custom analysis software
HP E1740A	2-slot VXI module	High performance histograms, window margin analysis, statistics 512K on-card memory

HP 53310A
HP E1725C
HP E1740A
HP E1741A
HP E1742A
HP E1743A
HP E1746A
HP E1747A
HP E1748A

NEW

4

- 200 ps rms single-shot resolution, 1 ps with averaging
- DECT, CT2, CT3 mobile communications measurements
- Easy to use



HP 53310A

HP 53310A Modulation Domain Analyzer

Affordability and Ease of Use

The most affordable modulation domain analyzer, the HP 53310A, includes many innovations for ease of use. Characterization of modulation and jitter is easy with built-in analysis. Parameters such as peak-to-peak deviation, carrier frequency, and modulation rate are all quickly and automatically displayed. Jitter analysis is simplified with automated mean, standard deviation, and probability functions. Key features of this frequency and time interval analysis product include:
Automated setup: A single button can set up the HP 53310A for measurement. Signals are automatically evaluated.
Single-touch measurements: Peak-to-peak deviation, carrier frequency, and modulation rate are easily and quickly measured for quantifying modulation. The Save/Recall function stores up to 10 measurement steps for fast repeat operations.
Built-in statistics: Mean, standard deviation, and probability function buttons simplify jitter analysis.
Softkey-driven menus: Measurement parameters and analysis functions are easily selected while viewing measurement data.
Large display: The expanded screen displays measurement results clearly and aids analysis.
Low cost: The HP 53310A is priced to fit budget-constrained projects and departments.

Product Features

The HP 53310A offers powerful analyzer features:
Dual timebases: Main timebase and window timebase allow data capture while viewing measurement details in the window.
Auto or triggered operation: Select auto triggering, edge triggering (rising or falling), or a unique feature: measurement value triggering (frequency or time interval). Value triggering can eliminate the need for and expense of external sync signal generation, shortening project time and lowering costs.
Display vs. time or histogram: Select appropriate views.
Fast histograms: Up to 16 million measurements per acquisition.
Automated measurements: Autoscale selects appropriate setup parameters; built-in analysis functions eliminate calculations.

Specifications and Ordering Information

See page 152 for key specifications and ordering details.

- Highest performance HP TIA
- Fast histograms, statistics, and window margin analysis
- Analyze data storage devices
- Study and identify clock jitter
- Analyze jitter in SONET/SDH networks

HP E1725C

HP E1725C Time Interval Analyzer

The HP E1725C time interval analyzer (TIA) combines a fast measurement sampling rate with a large memory and advanced analysis capabilities. Optional software packages, purchased separately or as options with the HP E1725C system, tailor the instrument to meet a variety of demanding application areas.

Configured with the HP E1741A time interval analyzer software, the HP E1725C is tailored for the characterization of high-speed data storage devices. HP offers several options to address other applications involving jitter analysis.

Versatile Design and Operation

Tailored for benchtop use, the HP E1725C system integrates a high performance time interval analyzer with an external portable computer based on the Intel Pentium processor. The MS® -Windows interface streamlines setup and offers complete control of measurement and analysis parameters. Measurements are carried out and stored in the instrument's 512K of memory. Built-in histograms, window margin analysis, and statistics functions speed access to many results.

For customers who desire a VXI solution, HP offers the HP E1740A time interval analyzer card. The HP E1725C benchtop instrument and HP E1740A VXI TIA card offer equivalent measurement capabilities, and the software packages that run on the HP E1725C can be purchased as add-on products for the HP E1740A.

Advanced Analysis Software

The current HP E174XA software solutions address five application areas described in the two previous pages of this catalog. These applications and corresponding software include:
- Data storage and test: HP E1741A and HP E1747A
- SONET/SDH tributary jitter analysis: HP E1742A
- Clock jitter analysis: HP E1743A
- Network synchronization measurement: HP E1746A
- Multiple-channel network synchronization measurement: HP E1748A

Specifications and Ordering Information

See page 152 for key specifications and ordering details.

Modulation Domain Analyzer Applications

The application examples on this page and the next illustrate some of the many situations that benefit from HP modulation domain analyzers. For complete product specifications or to arrange a product demonstration, contact the HP Call Center in your region.

Modulation Analysis for Mobile Communications

The HP 53310A's Option 031 "Digital RF Communications Analysis/High Resolution 2.5 GHz Input" provides automatic measurements of synthesizer settling time, Frequency Shift Keyed (FSK) center frequency, and FSK peak deviation on DECT, CT2, and CT3 radios. Features for optimizing RF designs include:

- High resolution measurements—built-in downconversion provides superior frequency resolution for RF signals.
- RF envelope trigger—simplifies measurement setup by automatically triggering on a detected TDMA burst.
- Automatic measurements—synthesizer settling time, Frequency Shift Keyed (FSK) center frequency, and FSK deviation.

Option 305 phase analysis software adds the power of phase analysis to your HP 53310A. Direct phase analysis lets you measure digital communication systems and extract data, including phase settling time, phase noise (phase spectrum), phase deviation, and phase trajectory. When used in combination, Options 031 and 305 allow direct profiles of both wide- and narrowband modulations up to a 500 KHz modulation rate and eliminate the need for external downconversion.

Data Storage Analysis

The HP E1725C Option 141 instrument is tailored for the specific requirements of data storage analysis. High-speed measurements and the large 512K on-board memory allow you to measure a full track on today's high data rate drives. Complete acquisition control allows measuring of data edges in the presence of servo or header fields. The Option 141 TIA software can be combined with the Option 147 timing pattern analysis software to provide powerful display and analysis capabilities:

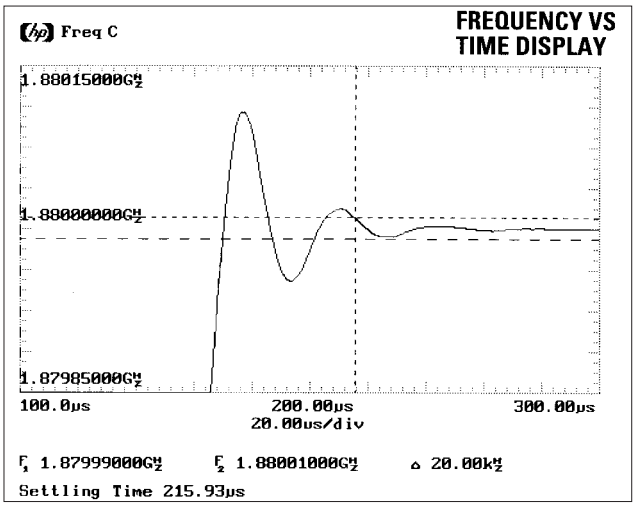
- Window margin analysis and histograms for understanding drive timing (view peak shift, jitter, worst-case data patterns).
- Flexible measurement setup for measuring the edges of your choice, specifying trigger delays and measurement duration, and pacing measurements.
- Sequential displays for characterizing PLL dynamics, viewing spindle speed variations, or verifying correctly written data patterns.
- Computed clock for measuring to an ideal reference.
- Timing pattern analysis for studying worst-case data patterns or viewing problematic data patterns and the surrounding code spacings.
- Online Help for quick answers to operation questions.
- Data export capability for transferring results to another analysis package or to spreadsheet or wordprocessor packages.

Characterization and Reduction of Clock Jitter

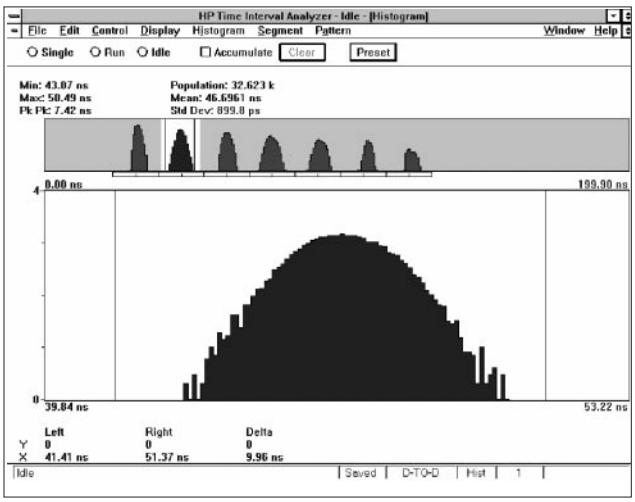
The HP E1725C Option 243 TIA and clock jitter analyzer software provides digital designers with a powerful tool for understanding and reducing clock jitter. High-speed clock distribution networks are critical for high performance digital systems. The clock buffers found in these networks—PLLs, frequency dividers, fanout and translation ICs—are also affected by jitter.

The HP E1725C Option 243 includes powerful jitter measurement and display capabilities:

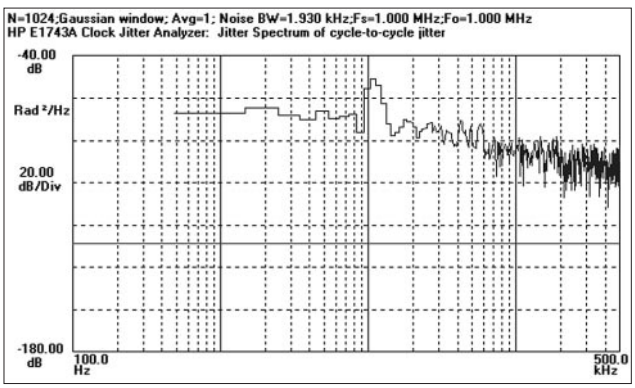
- Capture every clock cycle up to 80 MHz, continuously for a trillion cycles using fast histogram or 256K cycles using a vs. time display.
- Understand true peak-to-peak and cycle-to-cycle jitter using a complete range of statistics.
- Display jitter spectrum (using a built-in FFT) to determine the root causes of jitter.
- View the phase power spectral density display to see phase noise as noise power offset from the carrier.
- Use the Allan variance display to understand the type and level of noise (white phase, flicker phase, random walk phase, flicker FM, random walk FM, and white FM).
- Export data to another analysis package or to spreadsheet or wordprocessor packages.



Settling time is displayed automatically on this direct measurement of the synthesizer step.



The HP E1741A features extensive statistical, histogram, and window margin analysis features to simplify jitter characterization in data storage products.



The HP E1743A phase power spectrum feature allows you to examine jitter spectrum, in this case of cycle-to-cycle jitter on a clock signal. A jitter component near 10 kHz can be easily identified.

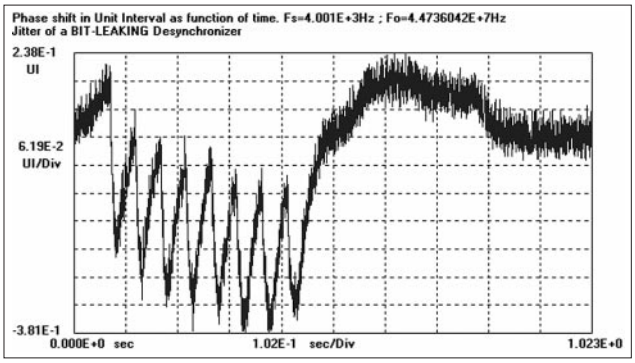
SONET/SDH Tributary Jitter Analysis

When integrating new SONET/SDH technologies with existing telecommunications equipment, network equipment designers use the HP E1725C TIA Option 242 tributary jitter analyzer software to make sure that new designs conform to evolving standards. HP's unique software clock extraction scheme and software filters provide consistent, repeatable results when measuring jitter. The display screens make it easy to examine mapping jitter, pointer-induced jitter, and waiting time jitter.

After a measurement is performed, the HP E1742A software (included in Option 242) extracts the clock signal and performs a variety of analysis functions:

- Phase deviation display shows the cumulative phase difference of a signal relative to the extracted clock.
- Jitter display uses a built-in 10 Hz high pass filter to simultaneously display peak-to-peak jitter, positive peak, negative peak, mapping jitter, and other jitter components.
- Power spectrum display shows the frequency components which contribute to the jitter and gives a better understanding of the jitter sources.
- Frequency deviation display explains the effect of a pointer hit on the desynchronizer phase lock loop inside a network element.
- Allan variance, TVAR, and FFT functions enhance further study and analysis of the tributary jitter. Each measurement can be stored for future analysis. Graphic and numeric results can be transferred to other Windows applications for inclusion in documents or spreadsheets.

A scrolling text window below the data display automatically records every action the instrument takes and records every result. This includes marker clicks and other actions performed in order to read, examine, or interpret results. Custom notes can be intermixed in this file to record important information such as type/length of cable, number of PHYs, pass/fail, and so forth. The file can be saved and used in reports or other documents to provide a complete record of the test.



This HP E1742A display shows the peak-to-peak jitter during an 8 UI phase transient. The phase transient is being leaked out to the tributary over 0.5 seconds one bit at a time.

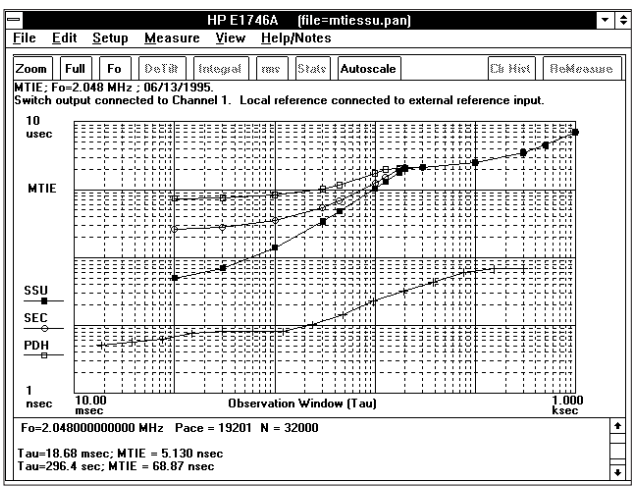
Ensure Compliance with Network Synchronization Standards

Network synchronization problems can lead to slips and degrading voice, fax and video services. The HP E1746A/E1748A network synchronization measurement software packages, available as Options 246 and 248 respectively with the HP E1725C TIA, give network managers powerful tools for evaluating network synchronization and ensuring compliance with industry standards.

All measurements adhere to ITU (CCITT) 0.171, Bellcore and ANSI requirements. On an operational network, MTIE and TDEV are measured and plotted against proposed ITU, ANSI, and ETSI masks for fast reviewing of results. With these measurements, network managers can characterize SSUs and SDH switches. MTIE can be measured over long times, sampling at the ITU-specified rate of 80 samples per second. A unique software clock extraction scheme and software filters result in consistent, repeatable results. Measurement times can be extended even further utilizing concatenation available with the HP E1748A software. As industry standards evolve, the masks, sample rates, and filters used by the HP E1746A and E1748A software packages can be updated.

Jitter levels are accurately measured with the HP E1746A/E1748A and the HP E1725C TIA. Its unsurpassed timing resolution of 100 ps rms, combined with the power of its Phase Power Spectral Density plot, deliver enough detail to determine which network components are improving or degrading incoming signals.

The HP E1748A multiple-channel network synchronization measurement software further enhances the features of the HP E1746A software with simultaneous recording of multiple channels. Overlay displays offer quick visual comparison of data obtained from multiple MTIE or TDEV measurements.



Typical MTIE measurements made with HP E1748A multiple channel network synchronization measurement software show sufficient margin compared to ETSI draft DE/TM 3017 masks. The four simultaneous measurements show, however, degradation from cascading timing signals.

Modulation Domain Analyzer Specification Highlights

Model	Frequency range (extension)	Single-shot freq. res. (1s gate)	Time interval resolution (single-shot/ averaging)	Maximum continuous meas. rate (meas/s)	Memory size	Output meas/s	Analysis and display
HP 53310A	200 MHz (2.5 GHz) (18 GHz)[1]	10 digits	200 ps/1ps	2.5 M	8000 (32,000 w/Option 001)	HP-IB: to 7,500	Frequency and time vs. time; auto-scale (setup); large display; jitter analysis; simple triggering; digital RF communications (Option 031)
HP E1740A **HP E 1725C**	150 MHz (18 GHz)[1]	10 digits	100 ps/1ps	80 M	512K	6,500; VXI shared memory available	Frequency, time interval, time stamps, histogram, statistics, and window margin analysis. Additional analysis and display capability available using the HP E174xA software.

[1] Requires HP 5364A

Ordering Information

HP 53310A Modulation Domain Analyzer
- **Opt 001** Extended Measurement Memory (4 x)
- **Opt 010** High Stability Oven Timebase
- **Opt 030** 2.5 GHz Channel C
- **Opt 031** Digital RF Communications
- **Opt 305** Phase Analysis Software
- **Opt W30** 3-Year Extended Repair Service (see page 70)
- **Opt W32** 3-Year Calibration Service (see page 70)
- **Opt W34** 3-Year Standards Compliant Cal Service
- **Opt W50** 5-Year Return Repair Service
- **Opt W52** 5-Year Return Calibration Service
- **Opt W54** 5-Year Standards Compliant Cal Service

Available Separately
HP 53305A Phase Analysis Software

HP E1725C Time Interval Analyzer
Includes HP E1740A TIA module, HP E1406A Command Module, HP OmniBook portable computer, MS-Windows 95 MS-DOS 6.22, National Instruments PCMCIA-GP-IB kit, and 4 oscilloscope probes.
- **Opt 002** Replace 6-slot card cage with HP E1401A 13-slot mainframe
- **Opt 141** Time Interval Analyzer Software
- **Opt 147** Timing Pattern Analysis Software
- **Opt 242** SONET/SDH Tributary Jitter Analyzer Software
- **Opt 243** Clock Jitter Analyzer Software
- **Opt 246** Network Synchronization Measurement Software
- **Opt 248** Multiple-channel Network Synchronization Software
- **Opt W32** 3-Year Service
- **Opt W50** 5-Year Return Repair Service
- **Opt W52** 5-Year Return Calibration Service

Available Separately
HP E1740A Time Interval Analyzer Module
- **Opt W32** 3-Year Return Calibration Service (see page 70)
- **Opt W50** 5-Year Return Repair Service
- **Opt W52** 5-Year Return Calibration Service

HP E1741A Time Interval Analyzer Software
HP E1742A SONET/SDH Tributary Jitter Analyzer Software
HP E1743A Clock Jitter Analyzer Software
HP E1746A Network Synchronization Measurement Software
HP E1747A Timing Pattern Analysis Software
HP E1748A Multiple-channel Network Synchronization Software

Accessories and Other Products
HP 5364A Microwave Mixer/Detector

HP offers a full line of digital multimeters.

Find Your Fit in the HP Family

From a toolbox to a test rack to a VXIbus system, there's a HP digital multimeter (DMM) that's right for the job:

HP 3458A Multimeter

Up to 8 ½ digits and up to 100,000 readings per second. Test engineers, R&D engineers, and metrologists worldwide rely on its accuracy and speed.

HP 34420A Nanovolt/Micro-ohmeter

With 7 ½ digits of resolution, 8 nVpp noise, and built-in resistance and SPRT functions, the HP 34420A can handle your most demanding low-level measurements.

HP 34401A Multimeter

The world's best-selling benchtop/system DMM delivers 6 ½-digit performance at a 5 ½-digit DMM price.

HP 970 Series Handheld DMMs

Carry benchtop capabilities wherever your job takes you. Choose from resolution as high as 4 ½ digits and a variety of useful features, from temperature to ac+dc to dB/dBm.

HP VXIbus DMMs

Five B- and C-size multimeters to choose from. Perfect for data acquisition and computer-aided test applications. Refer to the VXIbus section of this catalog for more information.

4

HP Digital Multimeters/Digital Voltmeters

	HP 34401A	HP 34420A	HP 3458A	HP 970 series	HP E1312A HP E1412A HP VXIbus DMMs
Digits	6 ½	7 ½	8 ½	3 ½ to 4 ½	6 ½
DC voltage					
Basic 1 yr. accuracy	35 ppm	30 ppm	8 ppm (4 ppm opt.)	0.3% to 0.05%	35 ppm
Sensitivity	100 nV	0.1 nV	10 nV	100 μV to 10 μV	100 nV
Maximum reading rate	1,000 rdg/s	250 rdg/s	100,000 rdg/s	2 rdg/s	1,000 rdg/s
Maximum range	1,000 V	100 V	1,000 V	1,000 V	300 V
Resistance					
Basic 1 yr. accuracy	0.01%	0.006%	0.001%	0.5% to 0.06%	0.01%
Sensitivity	100 $\mu\Omega$	0.1 $\mu\Omega$	10 $\mu\Omega$	0.1 Ω to 0.01 Ω	100 $\mu\Omega$
AC voltage					
Basic 1 yr. accuracy	0.06%	NA	0.014%	1% to 0.5%	0.06%
Bandwidth	3 Hz to 300 kHz	NA	1 Hz to 10 MHz	up to 100 kHz	3 Hz to 300 kHz
Functions	dc and ac V dc and ac I 2- and 4-wire Ω Diode test Frequency Period Continuity Reading hold dB, dBm Null, min/max, pass/fail, ratio 512 rdg Storage HP-IB, RS-232	dc V 2-channel voltage input 2- and 4-wire Ω Offset-compensated Ω Low power Ω Voltage clamped Ω Temperature (including SPRT) Analog and digital filter Chart recorder analog output 1,024 reading storage HP-IB, RS-232	dc and ac V dc and ac I 2- and 4-wire Ω Offset-compensated Ω Frequency Period Math Ratio Internal Basic 20 KB reading memory Digitizing HP-IB	dc and ac V dc and ac I 2-wire Ω Diode test Frequency Capacitance Data hold Continuity Temperature Min/max/avg Bargraph Dual digital display Relative/percent Current shutter	dc and ac V dc and ac I 2- and 4-wire Ω Frequency Period Temperature dB, dBm Null, limit, min/max 1000 rdgs Storage
More information in this catalog	page 154	page 156	page 158	page 160	page 99 VXIbus products

Low-Cost 6½ Digit Multimeter

HP 34401A

- 12 measurement functions
- 1000 V maximum input
- 15 ppm basic dV accuracy (24-hour)
- 1000 readings per second direct to HP-IB
- HP-IB and RS-232 standard
- 512-reading memory
- SCPI commands standard

HP 34401A with optional accessory pouch

HP 34401A Digital Multimeter

The HP 34401A digital multimeter establishes a new price/performance standard by offering such features as 6½ digits of resolution, 1000 readings per second, and 15 ppm basic dc accuracy at a surprisingly affordable price. The HP 34401A has been designed for superior performance while providing the flexibility to meet both your present and future needs.

Great Bench Performance

The clear, logical front panel of the HP 34401A allows you to easily select all primary measurement functions. Traditional "bench" functions, such as continuity and diode test, are included. Math functions, such as NULL, dB, dBm, limit test, and min/max/avg are easily selected. A simple menu scheme gives you access to powerful advanced features, such as the ability to store up to 512 readings in internal memory. Measurement results are displayed on a bright, high-visibility readout. A rugged case ensures survival even under the toughest conditions, and the optional accessory pouch makes it easy to pack up and go with the HP 34401A.

Superior Performance in Your System

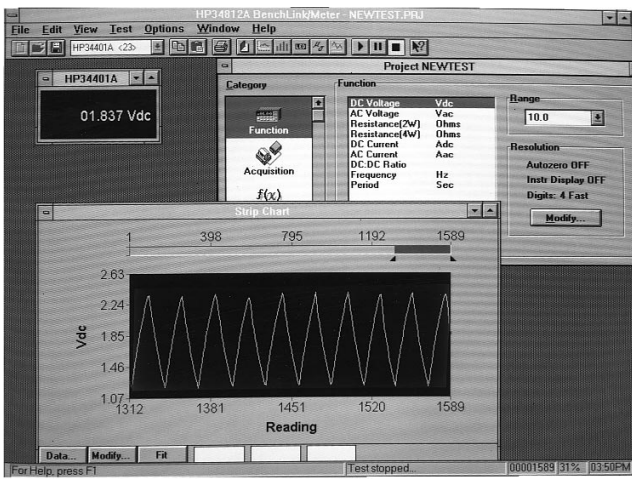
The HP 34401A can take up to 1000 readings per second, including HP-IB bus transfer in ASCII format. Both HP-IB and RS-232 are standard, letting you select the interface that best meets your needs. The HP 34401A responds to three different command languages. It accepts SCPI commands (Standard Commands for Programmable Instruments), which ensures present and future compatibility. It also responds to commands for the HP 3478A and the Fluke 8840A, thereby protecting your software investment with backward compatibility. Drivers are also available for both National Instruments Labview and Hewlett-Packard's VEE software.

Turn Your HP 34401A into a Measurement System with HP 34812A BenchLink Meter Software

The HP 34401A is an exceptional digital multimeter, and you can make it even more valuable with the HP 34812A BenchLink Meter software solution. HP BenchLink Meter turns your PC and DMM into a powerful, easy-to-use single-channel data acquisition system.

One of the HP BenchLink family of PC/basic instrument connectivity solutions, HP BenchLink Meter lets you combine your Windows-based PC and the HP 34401A DMM to easily configure, capture, and display measurement data. HP BenchLink lets you structure your entire test—measurement, acquisition parameters, time of test start, test limits, and more—from the PC, so you create the test environment you need. You'll have a variety of display and analysis formats available, including a strip chart mode, statistics, histograms, and an analysis window to let you zoom in on specific data points for a closer look. In addition, it's easy to transfer captured data to other Windows programs for more detailed analysis.

HP BenchLink Meter supports both HP-IB and RS-232 transfers, and runs on Windows 3.1, Windows 95, and Windows NT 4.0.



Abbreviated Technical Specifications

DC Voltage

Input Characteristics

Range	Maximum reading (6½ digits)	Resolution in digits 6½	5½	4½	Input resistance
100 mV	120.0000	100 nV	1 μV	10 μV	10 MΩ or > 10 GΩ
1 V	1.200000	1 μV	10 μV	100 μV	10 MΩ or > 10 GΩ
10 V	12.00000	10 μV	100 μV	1 mV	10 MΩ or >10 GΩ
100 V	120.0000	100 μV	1 mV	10 mV	10 MΩ
1000 V	1050.000	1 mV	10 mV	100 mV	10 MΩ

Input Protection: >1000 V on all ranges
Measurement Accuracy: ±(% of reading + % of range)

Range	24-Hour 23° C ±1° C	90-Day 23° C ±5° C	1-Year 23° C ±5° C
100 mV	0.0030 + 0.0030	0.0040 + 0.0035	0.0050 + 0.0035
1 V	0.0020 + 0.0006	0.0030 + 0.0007	0.0040 + 0.0007
10 V	0.0015 + 0.0004	0.0020 + 0.0005	0.0035 + 0.0005
100 V	0.0020 + 0.0006	0.0035 + 0.0006	0.0045 + 0.0006
1000 V	0.0020 + 0.0006	0.0035 + 0.0010	0.0045 + 0.0010

Noise Rejection: (50 or 60 Hz, 1 kΩ unbalance in LO lead)
DC CMRR: 140 dB
AC CMRR: 70 dB
Normal mode rejection (60 Hz/50 Hz)± 0.1%:
100 PLC (1.67 s/2.00 s): 60 dB
10 PLC (167 ms/200 ms): 60 dB
1 PLC (16.7 ms/20.0 ms): 60 dB
<1 PLC (3 ms or 800 ms): 0 dB
Maximum Reading Rate: (readings/s)

Power line frequency	Resolution in digits 6½	5½	4½
60 Hz	6	300	1000
50 Hz	5	300	1000

AC Voltage (true rms)

Measurement Accuracy: ± (% of reading + % of range); 1 year, 23° C ± 5° C

Frequency	Ranges 100 mV	Ranges 1, 10, 100, 750 V
3 to 5 Hz	1.00 + 0.04	1.00 + 0.03
5 to 10 Hz	0.35 + 0.04	0.35 + 0.03
10 Hz to 20 kHz	0.06 + 0.04	0.06 + 0.03
20 to 50 kHz	0.12 + 0.04	0.12 + 0.05
50 to 100 kHz	0.60 + 0.08	0.60 + 0.08
100 to 300 kHz	4.00 + 0.50	4.00 + 0.50

Note: –3 dB frequency typically >1 MHz

Input Resistance: 1 MΩ ±2%, in parallel with 100 pF
Input Protection: >750 V rms on all ranges
Maximum Volt–Hz Product: 8 x 10^7
Crest Factor: Maximum of 5:1 at full scale
Maximum Reading Rate: 10 readings/s (50 readings/s with default delays defeated)

Frequency and Period
Range: 3 Hz to 300 kHz (333 ms to 3.33 μs)
1-Year Accuracy: 0.01% (40 Hz to 300 kHz); 0.05% (3 to 40 Hz)
Resolution: 10 μHz to 1 Hz
Other Measurement Functions: Continuity, Diode Test, Ratio dc:dc, Limit Test
Math Functions: NULL, Min/Max/Avg, dB, dBm, Limit Test
Memory: 512-reading internal storage
Standard Programming Languages: SCPI, HP 3478A and Fluke 8840A/42A
Computer Interface: HP-IB and RS-232C standard
Accessories Included: Test lead kit, operators manual, service manual, test report, and power cord
Warranty: 3 years standard

Resistance: (2-wire Ω, 4-wire Ω)

Input Characteristics

Range	Maximum reading (6½ digits)	Resolution in digits 6½	5½	4½
100 Ω	120.0000	100 μΩ	1 mΩ	10 mΩ
1 kΩ	1.200000	1 mΩ	10 mΩ	100 mΩ
10 kΩ	12.00000	10 mΩ	100 mΩ	1 Ω
100 kΩ	120.0000	100 mΩ	1 Ω	10 Ω
1 MΩ	1.200000	1 Ω	10 Ω	100 Ω
10 MΩ	12.00000	10 Ω	100 Ω	1 kΩ
100 MΩ	120.0000	100 Ω	1 kΩ	10 kΩ

Input Protection: >1000 V on all ranges
Measurement Accuracy: ±(% of reading + % of range)
Specs are for 4-wire Ω or 2-wire Ω using Math Null

Range	24-Hour 23° C ±1° C	90-Day 23° C ±5° C	1-Year 23° C ±5° C	Current source
100 Ω	0.0030 + 0.0030	0.008 + 0.004	0.010 + 0.004	1 mA
1 kΩ	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	1 mA
10 kΩ	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	100 μA
100 kΩ	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	10 μA
1 MΩ	0.002 + 0.001	0.008 + 0.001	0.010 + 0.001	5.0 μA
10 MΩ	0.015 + 0.001	0.020 + 0.001	0.040 + 0.001	500 nA
100 MΩ	0.300 + 0.010	0.800 + 0.010	0.800 + 0.010	500 nA*

* Measurement is computed from 10 M Ω in parallel with input.

Maximum Reading Rate: Same as dcV

DC Current

Measurement Accuracy: ±(% of reading + % of range)

Range	24-Hour 23° C ±1° C	90-Day 23° C ±5° C	1-Year 23° C ±5° C	Shunt resistance
10 mA	0.005 + 0.010	0.030 + 0.020	0.050 + 0.020	5.0 Ω
100 mA	0.010 + 0.004	0.030 + 0.005	0.050 + 0.005	5.0 Ω
1 A	0.050 + 0.006	0.080 + 0.010	0.100 + 0.010	0.1 Ω
3 A	0.100 + 0.020	0.120 + 0.020	0.120 + 0.020	0.1 Ω

Burden Voltage: <2 V for 3 A input; <0.1 V for 10 mA input
Input Protection: Externally accessible 3 A 250 V fuse; internal 7 A 500 V fuse
Maximum Reading Rate: Same as dcV

AC Current (true rms)

Measurement Accuracy: ±(% of reading + % of range); 1 year, 23° C ± 5° C

Frequency	Ranges 1 A	Ranges 3 A
3 to 5 Hz	1.00 + 0.04	1.10 + 0.06
5 to 10 Hz	0.30 + 0.04	0.35 + 0.06
10 Hz to 5 kHz	0.10 + 0.04	0.15 + 0.06

Burden Voltage: <1.5 V rms for 3 A input
Input Protection: Externally accessible 3 A 250 V fuse; internal 7 A 500 V fuse
Maximum Reading Rate: Same as acV

General Specifications

Power: 100/120/220/240V, ±10%
Power Line Frequency: 45 to 66 Hz, 360 to 440 Hz
Power Consumption: 25 VA peak (10 W average)
Operating Environment: 0° to 55° C, full accuracy to 80% RH, 40° C
Storage Environment: –40° C to 75° C
Size: 212.6 mm W x 88.5 mm H x 348.3 mm D (8.5 in x 4 in x 14 in)
Weight: Net, 3.6 kg (8.0 lb); shipping, 5.9 kg (13 lb)
Safety: Designed to UL-1244, IEC-348, CSA

Ordering Information

HP 34401A Multimeter
Opt 908 Rackmount Kit
Opt 1BP MIL-STD-45662A Certificate of Calibration with Data
HP 34397A DC to AC Power Inverter
HP 34812A BenchLink/Meter Software
HP 34161A Accessory Pouch

Indicates QuickShip availability.

HP 34420A

- 1.3 nV rms noise/8 nVp-p
- 100 pV, 100 nΩ sensitivity
- Two-channel programmable voltage input; difference and ratio functions
- 7½ digit resolution
- 1 mV to 100 V ranges
- SCPI and Keithley 181 languages
- Direct SPRT, RTD, Thermistor, and thermocouple temperature measurements

HP 34420A

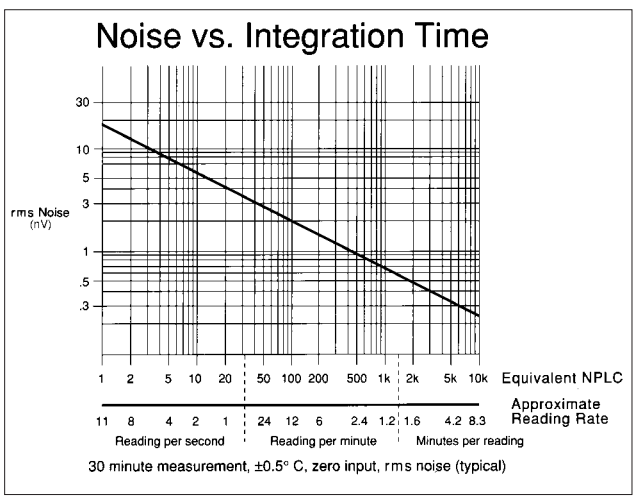
HP 34420A Nanovolt/Micro-ohm Meter

HP-IB

The HP 34420A sets a price/performance standard in low-level measurement capability. The noise performance of the HP 34420A nanovolt/micro-ohm meter is more than an order of magnitude better than that previously available from Hewlett-Packard.

Accurate, Repeatable Low-Level Measurements

A shielded copper pin screw-down connector, a 7½-digit A/D converter, 2 ppm basic dc accuracy, and a new measurement algorithm that gives 100 dB normal mode rejection without front-end filtering result in measurement capability you can depend on to make accurate and repeatable low-level measurements. Low noise input amplifiers and a highly-tuned input protection scheme bring reading noise down to 8 nVp-p. Longer integration times improve noise performance even further.



Unprecedented Functionality

Two input channels allow voltage measurements to be made independently, or they can be mathematically combined to make difference and ratio measurements. Ohms measurements combine the low-noise input circuits with a highly-stable current source to provide outstanding low-resistance measurements. Offset compensation is employed to eliminate the effects of stray thermal EMFs that would otherwise result in measurement error. Low power ohms and a low-voltage resistance measurement capability allow repeatable measurements to be made where a low voltage (20 mV) is required to avoid oxidation punch-through. A wide range of temperature measurement capabilities are also built in, providing support for SPRT, thermocouple, RTD, and thermistor temperature sensors.

Math Functions Enhance Capabilities

Math functions such as NULL, STATS, and SCALE ease the capture of minimum and maximum readings, provide averages and standard deviation, scale your measurement results, and ultimately makes it easier for you to characterize your input signal. The HP 34420A can also store up to 1024 readings in internal memory.

Built-in Versatility

You will find that the HP 34420A will fit equally well into your bench or your system applications. Designed with the bench user in mind, operation of the HP 34420A from the front panel is straightforward and intuitive. For system applications, the HP 34420A includes both HP-IB and RS-232 interfaces standard, and uses Standard Commands for Programmable Instrumentation (SCPI). This ensures both present and future compatibility. The HP 34420A also responds to commands for the Keithley 181 nanovoltmeter.

Abbreviated Technical Specifications

Accuracy Specifications: ± (% of reading ± % of range)

DC Voltage[1] – 7½ digits resolution all ranges

Range	24-Hour 23°C ±1°C	90-Day 23°C ±5°C	1-Year 23°C ±5°C
1 mV	0.0025 + .0020	0.0040 + .0020	0.0050 + .0020
10 mV	0.0025 + .0002	0.0040 + .0002	0.0050 + .0003
100 mV	0.0015 + .0003	0.0030 + .0004	0.0040 + .0004
1 V	0.0010 + .0003	0.0025 + .0004	0.0035 + .0004
10 V	0.0002 + .0001	0.0020 + .0004	0.0030 + .0004
100 V	0.0010 + .0004	0.0025 + .0005	0.0035 + .0005

DCV1/DCV2 (ratio)**:** Ratio error in % = channel 1 accuracy in % + channel 2 accuracy in %
DCV1-2 (difference)**:** Difference error = channel 1 (% reading + % range) + channel 2 (% reading + % range)

DC Voltage Noise Specifications[2]

Range	2-Minute rms noise	2-Minute p-p noise	24-Hour p-p noise
1 mV	1.3 nV RMS	8 nV p-p	12 nV p-p
10 mV	1.5 nV RMS	10 nV p-p	14 nV p-p
100 mV	10 nV RMS	65 nV p-p	80 nV p-p
1 V	100 nV RMS	650 nV p-p	800 nV p-p
10 V	450 nV RMS	3 μV p-p	3.7μV p-p
100 V	11 μV RMS	75 μV p-p	90 μV p-p

DC Voltage
Input Resistance:
10 MΩ ±1% (100 V range)
>10 GΩ (1 mV through 10 V range)
Input Protection:
150 V peak to Channel 1 LO

Resistance[3] – 7½ digits resolution all ranges

Range	Test current	24-Hour 23°C ±1°C	90-Day 23°C ±5°C	1-Year 23°C ±5°C
1Ω	10 mA	0.0015 + .0002	0.0050 + .0002	0.0070 + .0002
10 Ω	10 mA	0.0015 + .0002	0.0040 + .0002	0.0060 + .0002
100 Ω	10 mA	0.0015 + .0002	0.0040 + .0002	0.0060 + .0002
1 kΩ	1 mA	0.0015 + .0002	0.0040 + .0002	0.0060 + .0002
10 kΩ	100 μA	0.0015 + .0002	0.0040 + .0002	0.0060 + .0002
100 kΩ	10 μA	0.0015 + .0003	0.0040 + .0004	0.0060 + .0004
1 MΩ	5 μA	0.0020 + .0003	0.0050 + .0004	0.0070 + .0004

Low Power Resistance[3]

Range	Test current	24-Hour 23°C ±1°C	90-Day 23°C ±5°C	1-Year 23°C ±5°C
1 Ω	10 mA	0.0015 + .0002	0.0050 + .0002	0.0070 + .0002
10 Ω	10 mA	0.0015 + .0002	0.0040 + .0002	0.0060 + .0002
100 Ω	1 mA	0.0015 + .0002	0.0040 + .0002	0.0060 + .0002
1 kΩ	100 μA	0.0015 + .0002	0.0040 + .0002	0.0060 + .0002
10 kΩ	10 μA	0.0015 + .0004	0.0040 + .0004	0.0060 + .0004
100 kΩ	5 μA	0.0015 + .0012	0.0040 + .0015	0.0060 + .0015
1 MΩ	5 μA	0.0020 + .0003	0.0050 + .0004	0.0070 + .0004

Voltage Limited Resistance[3]
Voltage limit selectable: 20 mV, 100 mV, or 500 mV

Range	Test current	24-Hour 23°C ±1°C	90-Day 23°C ±5°C	1-Year 23°C ±5°C
10 Ω	1 mA	0.0020 + .0002	0.0050 + .0002	0.0070 + .0002
100 Ω	100 μA	0.0025 + .0002	0.0050 + .0002	0.0070 + .0002

Temperature – 0.001°C Resolution

Probe type	Accuracy
SPRT[4]	SPRT probe accuracy + 0.003°C
RTD	RTD probe accuracy + 0.05°C
Thermistor	Thermistor probe accuracy + 0.1°C
Thermocouple[5]	Thermocouple probe accuracy + 0.2°C

Temperature
SPRT: ITS-90 calibrated temperature within the range of –190°C to +660°C
RTD: Type α =.00385 and α =.00392. R_0 from 4.9 Ω to 2.1 KΩ. ITS-90 (IEC 751) Callendar - Van Dusen conversion.
Thermistor: 5 KΩ
Thermocouple: ITS-90 conversions of type B, E, J, K, N, R, S, T

Chart Out (Analog Out)
Resolution: 16 bits
Maximum Output: ±3 V
Span and Offset: Adjustable

Filter (Analog or Digital or Both)
Analog: Low pass 2 pole @ 13 Hz, available for dcV on 1 mV, 10 mV, 100 mV ranges
Digital: Moving average filter. 10 (fast), 50 (medium) or 100 (slow) reading averages.

Math Functions
NULL (Channel 1 dcV, Channel 2 dcV, Difference, Resistance, Temperature)
STATS (Min/max/avg, peak-peak, standard deviation, number of readings)
SCALE (Allows linear scaling as Y=MX + B)
CHART NULL (Establishes zero for rear-panel output)

General Specifications

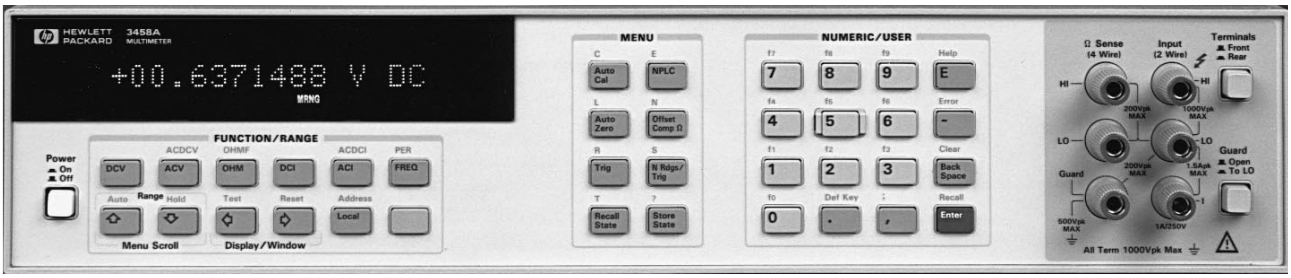
Front-Panel Connection: Shielded, low-thermal, copper contacts
Interface: HP-IB and RS-232 standard
Languages: SCPI-1994 (IEEE-488.2), Keithley 181
Warranty: 3 years standard

Ordering Information

HP 34420A Nanovolt/Micro-Ohm Meter
Includes low-thermal input cable (HP 34102A), low-thermal shorting plug (HP 34103A), operating and service manuals, quick reference guide, test report with calibration sticker, 2.3 ml bottle of contact cleaner, and power cord.
Opt 1CM Rackmount Kit

Accessories
HP 34102A Low-Thermal Input Cable (four-conductor with copper spade lugs)
HP 34103A Low-Thermal Shorting Plug
HP 34104A Low-Thermal Input Connector
HP 34161A Accessory Pouch

[1] Specifications are for channel 1 or channel 2 (100 V range on channel 1 only), after 2-hour warm-up, resolution at 7.5 digits (100 NPLC), with filters off.
[2] After a 2-hour warm-up ± 1° C, 6.5 digits (10 NPLC) with analog filter off digital filter medium (50 readings). 2 minute rms and 24-hour noise typical.
[3] All resistance specifications are for channel 1 only, after 2-hour warm-up, resolution at 7.5 digits (100 NPLC) with filters off, for 4-wire Ω or 2-wire Ω using Null.
[4] For 25 Ω SPRT with triple-point of water check within last 4 hours. With no triple-point of water check, add 0.013° C for 24-hour, 0.035° C for 90-day, and 0.055° C for 1-year specifications.
[5] For fixed reference junction. Add 0.3° C for external reference junction, add 2.0° C for internal reference junction.



HP 3458A

HP 3458A Multimeter

The HP 3458A multimeter shatters long-standing performance barriers of speed and accuracy on the production test floor, in research and development, and in the calibration lab. The HP 3458A is the fastest, most flexible, and most accurate multimeter offered by Hewlett-Packard. In your system or on the bench, the HP 3458A saves you time and money with unprecedented test-system throughput and accuracy, seven-function measurement flexibility, and low cost of ownership.

Select a rate of 100,000 reading per second for maximal test throughput. Or achieve highest levels of precision with up to 8½ digits of measurement resolution and 0.1 part per million transfer accuracy. Add to this the HP 3458A's simplicity of operation, and you have the ideal multimeter for your most demanding applications.

High-Test System Throughput

Faster Testing
- Up to 100,000 reading/s
- Internal test setups > 340/s
- Programmable integration times from 500 ns to 1 s

Greater Test Yield
- More accuracy for tighter test margins
- Up to 8½ digits resolution

Longer Uptime
- Two-source (10 V, 10 kΩ) calibration, including ac
- Self-adjusting, self-verifying auto-calibration for all functions and ranges, including ac

High-Resolution Digitizing

Greater Waveform Resolution and Accuracy
- 16 to 24-bits resolution
- 100,000 to 0.2 sample/s
- 12 MHz bandwidth
- Timing resolution to 10 ns
- Less than 100 ps time jitter
- Over 75,000 reading internal memory

Calibration Lab Precision

Superb Transfer Measurements
- 8½ digits resolution
- 0.1 ppm dc volts linearity
- 0.1 ppm dc volts transfer capability
- 0.01 ppm rms internal noise

Extraordinary Accuracy
- 0.6 ppm for 24 hours in dc volts
- 2.2 ppm for 24 hours in Ω
- 100 ppm mid-band ac volts
- 8 ppm (4 ppm optional) per year voltage reference stability

HP 3458A Multimeter Performance Features

DC Volts
- 5 ranges: 0.1 V to 1000 V
- 8½ to 4½ digits resolution
- Up to 100,000 readings/s (4½ digits)
- Maximum sensitivity: 10 nV
- 0.6 ppm 24-hour accuracy
- 8 ppm (4 ppm optional)/year voltage reference stability

Resistance
- 9 ranges: 10 Ω to 1 GΩ
- 2-wire and 4-wire Ω with offset compensation
- Up to 50,000 readings/second (5½ digits)
- Maximum sensitivity: 10 μ Ω
- 2.2 ppm 24-hour accuracy

AC Volts
- 6 ranges: 10 mV to 1000 V
- 1 Hz to 10 MHz bandwidth
- Up to 50 readings/s with all readings to specified accuracy
- Choice of sampling or analog true rms techniques
- 100 ppm best accuracy

DC Current
- 8 ranges: 100 nA to 1 A
- Up to 1,350 readings/s (5½ digits)
- Maximum sensitivity: 1 pA
- 14 ppm 24-hour accuracy

AC Current
- 5 ranges: 100 μA to 1 A
- 10 Hz to 100 kHz bandwidth
- Up to 50 readings/second
- 500 ppm 24-hour accuracy

Frequency and Period
- Voltage or current ranges
- Frequency: 1 Hz to 10 MHz
- Period: 100 ns to 1 second
- 0.01% accuracy
- AC or dc coupled

Throughput

Maximum Reading Rates
- 100,000 readings/s at 4½ digits (16 bits)
- 50,000 readings/s at 5½ digits
- 6,000 readings/s at 6½ digits
- 60 readings/s at 7½ digits
- 6 readings/s at 8½ digits

Measurement System Speed
- 100,000 readings/s over HP-IB or with internal memory
- 110 autoranges/s
- 340 function or range changes/s
- Postprocessed math from internal memory

Abbreviated Technical Specifications

DC Voltage

Range	Full scale	Maximum resolution	1-Year* accuracy	Transfer accuracy 10 min., tref ±0.5° C	Input impedance
			ppm of reading + ppm of range		
100 mV	120.00000	10 nV	9(5) + 3	0.5 + 0.5	>10 GΩ
1 V	1.20000000	10 nV	8(4) + 0.3	0.3 + 0.1	>10 GΩ
10 V	12.0000000	100 nV	8(4) + 0.05	0.05 + 0.05	>10 GΩ
100 V	120.000000	1 μV	10(6) + 0.3	0.5 + 0.1	10 MΩ ±1%
1000 V	1050.00000	10 μV	10(6) + 0.1	1.5 + 0.05	10 MΩ ±1%

One-year specifications for NPLC 100 within 24 hours and ±1° C of last ACAL, Tcal ±5° C, MATH NULL, fixed range. Add 2 ppm of reading additional error for HP factory traceability of 10 V dc to US NIST. Traceability error is the absolute error relative to National Standards associated with the source of last external calibration. Transfer specifications for NPLC 100, following 4-hour warm-up. Full scale to 10% of full scale. Measurements on the 1000 V range are within 5% of the initial measurement value and following measurement settling. Tref is the starting ambient temperature. Measurements are made on a fixed range using accepted metrology practices.
*High stability (Option 002) ppm of reading in parentheses.

Noise Rejection (dB)[1]

	AC NMR[2]	AC ECMR	DC ECMR
NPLC < 1	0	90	140
NPLC ≥ 1	60	150	140
NPLC ≥ 10	60	150	140
NPLC ≥ 100	60	160	140
NPLC = 1000	75	170	140

[1] Applies for 1 kΩ unbalance in the LO lead and ±0.1% of the line frequency currently set for LFREQ.
[2] For line frequency ±1%, ACNMR is 40 dB for NPLC ≥ 1, or 55 dB for NPLC ≥ 100. For line frequency ±5%, ACNMR is 30 dB for NPLC ≥ 100.

Maximum Input

	Rated input	Nondestructive
HI to LO	±1000 V pk	±1200 V pk
LO to guard	±200 V pk	±350 V pk
Guard to earth	±500 V pk	±1000 V pk

True rms AC Voltage
(Synchronous Subsampled Mode)

Range	Full scale	Maximum resolution	Accuracy* 24 hour–2 year 40 Hz to 1 kHz % of reading + % of range	Input impedance
10 mV	12.00000	10 nV	0.02 + 0.011	1 MΩ ±15% with <140 pf
100 mV	120.00000	10 nV	0.007 + 0.002	1 MΩ ±15% with <140 pf
1 V	1.2000000	100 nV	0.007 + 0.002	1 MΩ ±15% with <140 pf
10 V	12.000000	1 μV	0.007 + 0.002	1 MΩ ±2% with <140 pf
100 V	120.00000	10 μV	0.02 + 0.002	1 MΩ ±2% with <140 pf
1000 V	700.0000	100 μV	0.04 + 0.002	1 MΩ ±2% with <140 pf

*Specifications apply for full scale to 10% of full scale, dc <10% of ac, sine-wave input, crest factor of 1.4. Within 24 hours and ± 1° C of last ACAL. Peak (ac+dc) input limited to 5 x full scale for all ranges. Add 2 ppm of reading additional error for HP factory traceability of 10 Vdc to US NIST.

Maximum Input

	Rated input	Nondestructive
HI to LO	±1000 V pk	±1200 V pk
LO to guard	±200 V pk	±350 V pk
Guard to earth	±500 V pk	±1000 V pk
Volt-Hz product	1 x 10[8]	—

Resistance

Range	Full scale	Maximum resolution	Current through unknown	1-Year Accuracy* (4-wire Ω) ppm of rdg+ppm of range
10 Ω	12.00000	10 μΩ	10 mA	15 + 5
100 Ω	120.00000	10 μΩ	1 mA	12 + 5
1 kΩ	1.2000000	100 μΩ	1 mA	10 + 0.5
10 kΩ	12.000000	1 mΩ	100 μA	10 + 0.5
100 kΩ	120.00000	10 m Ω	50 μA	10 + 0.5
1 MΩ	1.2000000	100 m Ω	5 μA	15 + 2
10 MΩ	12.000000	1 Ω	500 nA	50 + 10
100 MΩ	120.00000	10 Ω	500 nA	500 + 10
1 GΩ	1.2000000	100 Ω	500 nA	0.5% + 10

*Specifications for 100 NPLC, offset compensation on, within 24 hours and ± 1° C of last ACAL, Tcal ±5° C. Add 3 ppm of reading additional error for HP factory traceability of 10 kΩ to US NIST.

Memory

	Standard Readings	Bytes	Option 001 Readings	Bytes
Reading storage (16 bit)	10,240	20 k	+65,536	+128 k
Non-volatile, for subprograms and/or state storage	—	14 k	—	—

Math Functions
The HP 3458A performs the following math functions on measurements: NULL, SCALE, OFFSET, RMS FILTER, SINGLE POLE FILTER, THERMISTOR LINEARIZATION, DB, DBM, % ERROR, PASS/FAIL LIMIT TESTING, and STATISTICS. Two math functions may be used at one time.

General Specifications

Operating Temperature: 0° to 55° C
Warmup Time: Four hours to all specifications except where noted
Humidity Range: 95% RH, 0° to 40° C
Storage Temperature: –40° to +75° C
Power: 100/120 V, 220/240 V ± 10%, 48 to 66 Hz, 360 to 420 Hz automatically sensed. Fused at 1.5 A @ 115 V or 0.5 A @ 230 V. <30 W, < 80 VA (peak).
Size: 425.5 mm W x 88.9 mm H x 502.9 mm D (16.75 in x 3.5 in x 19.8 in)
Weight: Net, 12 kg (26.5 lb); shipping, 14.8 kg (32.5 lb)

Ordering Information

HP 3458A Multimeter (with HP-IB, 20 KB reading memory, and 8 ppm stability)
Opt 001 Extended Reading Memory (expands total to 148 KB)
Opt 002 High-Stability (4 ppm/year) Reference
Opt 1BP MIL-STD-45662A Certificate of Calibration with Data
Opt W30 Two Additional Years Return-to-HP Hardware Support
Opt W32 Three-year Customer Return Calibration Coverage
Opt 907 Front-handle Kit
Opt 908 Rack Flange Kit
Opt 909 Rack Flange Kit (with handles)

Digital Multimeters

Handheld Multimeters

HP E2373A
HP 970 Series

- Sophisticated math functions
- 3½, 4½ digits
- Temperature
- Safety shutter
- Dual display

Handheld Multimeters

These handheld multimeters are ideal for portable measurements requiring basic accuracy from 0.7% to 0.05%, 3½ digits, or 4½ digits.

HP E2373A

This basic multimeter measures dc and ac voltage/current, resistance, diode test and audible continuity. It provides a large 0.85 inch (22 mm) high display as well as an analog bar graph in a compact size.

HP 970 Series Features

These meters come with sophisticated math functions that allow relative (difference) or percent readings for checking tolerances, min./max. with time stamp to monitor all types of measurements including temperature, and Hold and Auto Hold for saving a reading manually or automatically and average to quiet noisy measurements. Auto-diode reverses the leads for you to check semiconductor junctions, a secondary digital display shows the range of the function or elapsed time in min./max. and autopower off turns off the meter after 30 minutes of inactivity, or defeat it for extended measurements. The innovative terminal shutter prevents inadvertent use of the current terminals by requiring two operations by the user to connect the terminals.

Description

All meters come with ac/dc volts, ac/dc current, ohms, continuity, diode test, auto-diode test, frequency volts, and °F and °C high-resolution temperature (using optional temperature probe).

HP 971A
The sophisticated math functions and the extra rugged and bright yellow design make this an ideal meter for general-purpose measurements.

HP 972A
40 mV ac/dc range, 20 kHz bandwidth, capacitance and a dual display distinguishes this meter. The dual display allows the simultaneous reading of voltage and frequency.

HP 973A
For demanding applications this meter has basic dc accuracy of 0.1%, 20 kHz true rms, ac+dc, and dB/dBm for ac. This meter has features and functions for maximum flexibility. You get a dual digital display, frequency, current, capacitance, and thermocouple temperature as added features.

HP 974A
When extra precision is required, so is the HP 974A. 4½ digits, dc accuracy of 0.05%, 100 kHz BW true rms, ac+dc, and dB/dBm with 0.01 dB resolution make this the best value for high precision.

	E2373A	971A	972A	973A	974A
Display count	3200	4000	4000	4000	49999
Basic accuracy					
dc volts	0.7%	0.3%	0.2%	0.1%	0.05%
ac volts	1.2%	1%	0.5%	0.7%	0.5%
ohms	0.7%	0.5%	0.2%	0.2%	0.06%
capacitance	—	—	1.2%	1.2%	—
Frequency response					
ac volts	500 Hz	1 kHz	20 kHz	20 kHz	100 kHz
Resolution/ maximum reading					
dcV	100 µV 1000 V	100 µV 1000 V	10 µV 1000 V	10 µV 1000 V	10 µV 1000 V
acV	1 mV 750 V	100 µV 1000 V	10 µV 1000 V	10µV 1000 V	10µV 750 V
ohms	0.1 Ω 30 MΩ	0.1 Ω 40 MΩ	0.1 Ω 40 MΩ	0.1 Ω 40 MΩ	0.01 Ω 50 MΩ
current	10 µA 10 A	100 nA 10 A	100 nA 10 A	100 nA 10 A	10 nA 10 A
elapsed time	—	1 min. 1999 min.	1 min. 1999 min.	1 min. 1999 min.	1 sec 9999 min.
frequency	—	1 Hz 100 kHz	0.01 Hz 200 kHz	0.01 Hz 200 kHz	0.01 Hz 200 kHz
Battery life (typical hours)	2,500	1000	600	600	120
Current shutter		•	•	•	•
Bargraph	•	•	•	•	
Thermistor temperature		•	•	•	•
Thermocouple temperature				•	
Dual digital display			•	•	
True rms ac response				•	•
dBm/dB				•	•
Warranty (years)	3	3	3	3	3

HP E2373A
Standard accessories include pair of test leads, installed batteries, spare fuse and manual.
Size: 76 mm W x 164 mm H x 33 mm D (3 in x 6.5 in x 1.3 in)
Weight: 240 g (.53 lb)

970 Series
Standard accessories include a pair of test leads, manual, certificate of calibration, spare fuse, rubber boot, and two installed AA batteries.
Size: 87 mm W x 190 mm H x 39 mm D (3.4 in x 7.5 in x 1.5 in)
Weight: 440 mg (1 lb) approx.

Digital Multimeter Accessory Compatibility Chart and Products

Accessory	HP 34401A	HP 3457A	HP 3458A	HP E2373/ HP 970 series	HP34420A[1]
11059A Kelvin Probe Set	Yes	Yes	Yes	No	No
11062A Kelvin Clip Set	Yes	Yes	Yes	No	Yes
11060A Surface-Mount Device Probe	Yes	Yes	Yes	Yes	No
11053A Lug-Lug Jumper Set	No	Yes	Yes	No	No
11174A Lug-Banana Jumper Set	Yes	Yes	Yes	Yes	No
11058A Banana-Banana Jumper Set	Yes	Yes	Yes	Yes	No
E2305A Spare Test Leads	No	No	No	Yes	No
E2301A Surface Type-K Thermocouple Probe **E2303A** SMP-Dual Banana Adapter	Yes[2]	No[3]	No[3]	973A	No
E2307A Type-K Thermocouple Bead Temperature Probe	Yes[2]	No[3]	No[3]	973A	No
E2308A Thermistor Temp Probe	Yes[2]	Yes	Yes	Yes, except E2373	No
40653B Thermistor Surface Sensor Assembly	Yes[2]	Yes	Yes	Yes, except E2373	No
34302A Clamp-on ac/dc Current Probe	Yes	Yes	Yes	Yes	No
34330A 30 A Current Shunt	Yes	Yes	Yes	Yes	No
34397A 12 Vdc to 115V ac inverter	Yes	Yes	Yes	N/A	Yes
34131A Basic Instrument Transit Case	Yes	No	No	No	Yes
34161A Accessory Pouch	Yes	No	No	No	Yes
E2304A Handheld Multimeter Carrying Case	No	No	No	Yes	No

[1] Many accessories are listed as incompatible with HP 34420A because of the specialized termination. Many of these accessories may be rewired onto the low thermal input connector 34104A.

[2] Need HP 34812A BenchLink Meter or an external program to do temperature measurements.

[3] Compatible with voltmeter inputs, however an external program would be needed for temperature calculations.

HP 34397A

HP 34161A

HP 34131A

HP E2304A

HP 34397A 12 Vdc to 115 Vac Inverter

Hit the road and power your instruments from a cigarette lighter with this dc-to-ac inverter. Accepts inputs from 10.5 to 15 V and provides 100 W max. power at 115 Vac. Optional 230 Vac output is available as Option OE3230 Vac output.

HP 34161A Accessory Pouch

Cordura pouch fits on top of the HP 34401A and HP 34420A voltmeters as well as the HP 54131/32/81A counter and the HP 33120A function/arb generator.

HP 34131A Basic Instrument Transit Case

Heavy-duty hard-cover carrying case is constructed from rugged A.B.S. and has rubber-grip steel handles and steel latches. The case can be padlocked. For use with HP 34401A and HP 34420A voltmeters as well as the HP 53131/32/81A counter and the HP 33120A function/arb generator.

HP E2304A Handheld Multimeter Carrying Case

Padded case with dual zipper and snap-on belt strap. For use with HP 970 series handhelds.

HP 11060A

HP 11059A

HP 34302A

HP 34330A

HP 40653B

HP E2301A with HP 2302A

HP E2307A

HP E2308A

Test Leads

HP 11060A Surface-Mount Device Probe

Designed for SMD testing. Tweezer design provides an easy method to access and measure SMD resistive networks. Length: 1.2 m. Max. current: 3 A. Max. voltage: 42 V peak. Contact tip is gold-plated beryllium-copper.

HP 11053A Low Thermal Lug-Lug Jumper Set

Used to minimize error in low voltage measurements. Length: 1.2 m (48 in.). Includes: 2 test leads, 1 black, 1 red.

HP 11174A Low Thermal Lug-Banana Jumper Set

Used to minimize error in low voltage measurements. Length: 1.2 m (48 in.). Includes: 2 test leads, 1 black, 1 red.

HP 11058A Low Thermal Banana-Banana Jumper Set

Used to minimize error in low voltage measurements. Length 1.2 m (48 in.). Includes: 2 test leads, 1 black, 1 red.

HP 11059A Kelvin Probe Set

Gold-plated flat tweezers ensure precise contact to the components being measured. An alligator clip and lead are provided for either grounding or guarding. Instrument connection is through banana plugs. Not to be used over 42 V peak. Works with any DMM with 4-wire ohm function.

HP 11062A Kelvin Clip Set

Silver-plated flat tweezer clips for constructing your own Kelvin probe set for 4-wire ohm measurements. One jaw provides the current path for the source, and the other provides the current path for the sense. Use with any voltmeter that makes 4-wire ohm measurements. Wires are attached to the tweezers by slotted screws. Maximum jaw opening: 7.9 mm (.31 in.). Maximum wire size: #18 AWG.

Current Measurement

HP 34302A Clamp-on ac/dc Current Probe

A clamp-on probe used for measuring ground currents, power supply ripple, or current distribution in systems. This probe measures ac, dc and ac+dc currents without breaking the circuit. Ranges: ±10 A and ±100 A. Frequency response: dc to 1 kHz. Recommended load: ≥3.0 kOhm. Rated output: ±1.0 Vdc at 10 A, ±1.0 Vdc at 100 A. Aperture size: 19 mm. Accuracy: ±2% of rated output.

HP 34330A 30A Current Shunt

This current shunt can be used to extend the current measurement range. Precision .001 ohm resistor. Output is 1 mV per amp of current passing through the shunt. 15 A continuous; 30 A for 15 minutes maximum.

Temperature Measurement

HP 40653B Thermistor Surface Sensor Assembly

10,000 Ohm thermistor with fast response gives real-time temperature measurements. Temperature range: –10° C to 100° C. Accuracy: ±1° C. Termination: bare wire.

HP E2301A Surface Type-K Thermocouple Probe/ HP E2303A SMP-to-Dual Banana Plug Adapter

This probe is especially suitable for measuring surface temperature on PC boards. Accuracy ±2.2° C or ±.75%, whichever is greater. Tip is 0.25-in. diameter. Temperature range: –130° C (–200° F) to 260° C (500° F). Less than 2 second response time. Thermocouple: Chromel-Alumel. Must use with E2303A thermocouple probe adapter, uncompensated.

HP E2307A Type-K Thermocouple Bead Temperature Probe

General-purpose thermocouple temperature probe. Accuracy: –260° C to –110° C (–436° F to –200° F) ±2% of reading. –110° C to 260° C (–200° F to 500° F) ±2.2° C (4° F). Length: 0.9 m (36 in.), terminated in dual banana plug.

HP E2308A Thermistor Temperature Probe

General-purpose thermistor temperature probe. 5 kOhm @ 25° C encapsulated in a stainless steel case. Temperature range: –80° C (–112° F) to 150° C (302° F). Accuracy: 0 to 70° C (32° to-158° F) ±.2° C (±.4° F). Time constant: 3 seconds typical.

- 3-slot data acquisition and switching mainframe
- 6½-digit (22 bit) internal DMM
- 11 built-in measurement functions
- 8 switch and control plug-in modules
- HP BenchLink data logger software included

HP 34970A (Front Panel)

HP 34970A (Back Panel)

HP 34970A Data Acquisition/Switch Unit

The HP 34970A is a high performance, low-cost data acquisition and switching mainframe ideal for data logging, data acquisition, and general-purpose switching and control applications. It consists of a half-rack mainframe with an internal 6½-digit (22 bit) digital multimeter. Three module slots are built into the rear of the unit to accept a combination of switch and control modules. Whether you need a few channels of simple data logging or a hundred channels of ATE performance, the HP 34970A meets your data acquisition needs at a price that meets your budget.

Measurements You Can Trust

The HP 34970A incorporates the measurement engine from our best-selling benchtop digital multimeter (DMM). You get the benefit of proven HP performance, universal inputs with built-in signal conditioning, and modular flexibility, all in a low-cost, compact data acquisition package. The HP 34970A features 6½ digits (22 bits) of resolution, 0.004% basic dcV accuracy, and ultra-low reading noise. Combine that with scan rates of up to 250 channels/sec, and you've got the speed and accuracy you need to get the job done.

Powerful Flexibility

The HP 34970A's unique design allows per-channel configurability for maximum flexibility and quick, easy setup. The internal autoranging DMM measures 11 different functions directly, eliminating the need for expensive external signal conditioning. Temperature conversion routines are built-in to display raw thermocouple, RTD, or thermistor inputs in degrees C, F, or Kelvin. Use Mx+B scaling to convert linear transducer outputs directly into engineering units. You can even set high/low alarm limits to warn you of out-of-tolerance conditions.

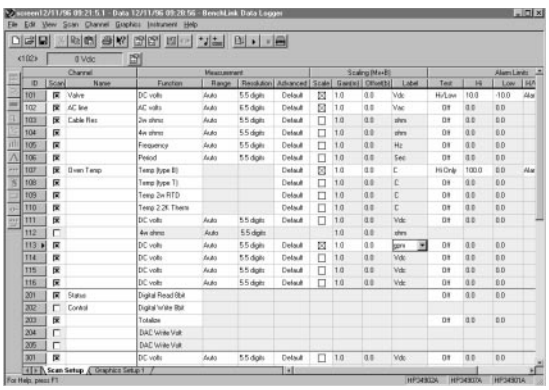
Custom Configurations That Grow With You

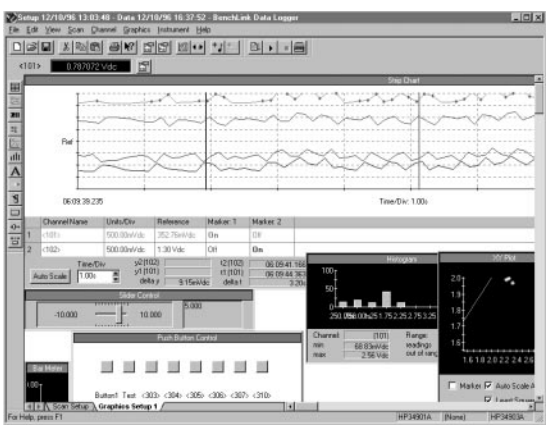
Three module slots and eight switch and control modules allow you to customize the HP 34970A to meet your unique requirements. Buy only what you need, and add more modules later as your application grows. Measure up to 120 inputs with a single half-rack unit.

Free HP BenchLink Software Simplifies Your Data Gathering

If you want PC-based data logging capabilities, but don't want to spend hours programming, HP BenchLink Data Logger is the answer. Use it to set up your test, acquire and archive measurement data, and perform real-time display and analysis of the incoming measurements.

A familiar spreadsheet environment makes it easy to configure and control your tests. A rich set of colorful graphics provides many options for displaying your data—all with point-and-click ease. Set up multiple graphics using strip charts, histograms, X-Y scatter charts, alarm lights and more. Also use HP BenchLink Data Logger to easily move data to other applications for further analysis, or for inclusion in your presentations and reports.





Free HP BenchLink Data Logger makes PC-based setup and analysis easy.

Applications

Data Logging

Configured with the HP 34901A 20-channel relay multiplexer, the HP 34970A becomes a rugged, low-cost data logger that's ideal for quick tests in the lab or in the field. An intuitive front panel with self-guiding menus and a bright, easy-to-read vacuum flourescent display make standalone set-up fast and easy. All readings are automatically time stamped and stored in a 50,000 reading memory — enough memory to hold a week's worth of data (20 channels scanned every five minutes). The non-volatile memory holds your data even after power is removed, so you can use the HP 34970A to collect data at a remote location for later uploading to a PC. The system configuration is also held in non-volatile memory, so in the event of a power failure the unit automatically resumes scanning when power is returned. And for PC-based testing, HP BenchLink Data Logger software is included to simplify your test configurations, data analysis and data managament.

Automated Testing

For automated test and benchtop automation applications, the HP 34970A's three slots and choice of eight plug-in switch and control modules allow easy customization. The 6½-digit internal DMM brings you the power and performance of a world-class standalone DMM, but in a fraction of the space and at a fraction of the cost. Software drivers that support HP VEE and National Instruments LabVIEW are available to make an easy integration of the HP 34970A into your test sytem. Standard RS-232 and HP-IB interfaces and SCPI programming language make integration even easier. A three-year warranty is also standard, as is our proprietary relay maintenance system which automatically counts and stores every individual switch closure to help you predict relay end-of-life and avoid costly production line downtime.

Switching

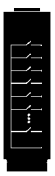
For test applications that don't require the built-in measurements of the HP 34970A, the unit can be ordered without the internal DMM. This provides an ultra low-cost solution for routing test signals to and from your device-under-test and assorted instruments, including external DMMs, scopes, counters and power supplies. Plus, you can add the DMM later if your needs change.

Module Overview

Up to three modules, in any combination, can be inserted into a single mainframe. The HP 34970A's internal DMM connections are accessible only through the HP 34901A, HP 34902A, and HP 34908A multiplexers. The HP 34970A accuracy specifications already include the switching offset and reference junction errors shown in the table below; these errors are listed separately for determining system error with external measurement devices.

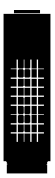
The **HP 34901A** 20-channel multiplexer is the most versatile module for general-purpose scanning. It combines dense, multifunction switching with 60 channel/second scan rates to address a broad spectrum of data acquisition applications.

The **HP 34902A** 16-channel high-speed multiplexer employs reed relays to achieve scan rates of up to 250 channels-per-second. This module is ideal for high-throughput automated test applications, as well as high-speed data logging and monitoring tasks.

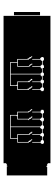


Use the **HP 34908A** 40-channel single-ended multiplexer for the greatest density in common-low applications, such as battery test, component characterization, and benchtop testing.

Use the **HP 34903A** 20-channel general-purpose switch module to cycle power to products-under-test, control indicator and status lights, actuate external relays requiring large drive signals, and to build custom switch configurations.



The **HP 34904A** is a two-wire, 4x8 full cross-point matrix that gives you the most flexible connection path between your device-under-test and your test equipment, allowing different instruments to be connected to multiple points on your DUT at the same time.



The **HP 34905A** and **HP 34906A** RF multiplexers offer broadband switching capabilities for high-frequency and pulsed signals to 2 GHz. Use them to route test signals between your device-under-test and your signal generator, oscilloscope, spectrum analyzer, video amplifier, or receiver.

The **HP 34907A** multifunction module allows great flexibility for a variety of sense and control applications. It combines two 8-bit ports of digital input and output, a 100 kHz gated totalizer, and two ±12 V analog outputs—all on a single module.

Module Specifications

Module Description	Type	Connects to internal DMM	Speed (ch./sec.)	Maximum Input Voltage	Current	Power	Offset Voltage	Bandwidth	Comments
HP 34901A 20-ch. Multiplexer	2-wire armature (4-wire selectable)	yes	60	300 V	1 A	50 W	< 3 μV	10 MHz	2 current channels (22 ch. total) Built-in cold junction reference
HP 34902A 16-ch. Multiplexer	2-wire reed (4-wire selectable)	yes	250	300 V	50 mA	2 W	< 6 μV	10 MHz	Built-in cold junction reference
HP 34903A 20-ch. Actuator/GP Switch	SPDT / form C	no	120	300 V	1 A	50 W	< 3 μV	10 MHz	—
HP 34904A 4 x 8 Matrix	2-wire armature	no	120	300 V	1 A	50 W	< 3 μV	10 MHz	Full crosspoint
HP 34905A Dual 1: 4 RF Mux, 50 Ω	Common Low (unterminated)	no	60	42 V	0.7 A	20 W	< 6 μV	2 GHz	1 GHz through provided BNC-to-SMB adapter cables
HP 34906A Dual 1: 4 RF Mux, 75 Ω	Common Low (unterminated)	no	60	42 V	0.7 A	20 W	< 6 μV	2 GHz	1 GHz through provided BNC-to-SMB adapter cables
HP 34907A Multifunction Module	Two 8-bit digital I/O ports 26-bit Event Counter Two Analog Outputs	no no no	— — —	42 V 42 V ± 12 V	400 mA — 10 mA	— — —	— — —	— 100 kHz dc	Open drain Gated; selectable input threshold 16-bit, earth referenced
HP 34908A 40-ch. single-ended Mux	1-wire armature (common low)	yes	60	300 V	1 A	50 W	< 3 μV	10 MHz	No 4-wire measurements Built-in cold junction reference

These are abbreviated specifications. For more detailed information on the HP 34970A, refer to HP publication number 5965-5290.

Accuracy Specifications ± (% of reading + % of range)[1]

Includes measurement error, switching error and transducer conversion error

Function	Range[2]	Frequency, etc.	1 Year 23° C ±5° C
DC Voltage	100.0000 mV		0.0050 + 0.0040
	1.000000 V		0.0040 + 0.0007
	10.00000 V		0.0035 + 0.0005
	100.0000 V		0.0045 + 0.0006
	300.000 V		0.0045 + 0.0030
True RMS AC Voltage[3]	100.0000 mV to 100.0000 V	3 Hz–5 Hz	1.00 + 0.04
		5 Hz–10 Hz	0.35 + 0.04
		10 Hz–20 kHz	0.06 + 0.04
		20 kHz–50 kHz	0.12 + 0.05
		50 kHz–100 kHz	0.60 + 0.08
		100 kHz–300 kHz[4]	4.00 + 0.50
	300.0000 V	3 Hz–5 Hz	1.00 + 0.08
		5 Hz–10 Hz	0.35 + 0.08
		10 Hz–20 kHz	0.06 + 0.08
		20 kHz–50 kHz	0.12 + 0.12
		50 kHz–100 kHz	0.60 + 0.20
		100 kHz–300 kHz[4]	4.00 + 1.25
Resistance[5]	100.0000 Ω	1 mA current source	0.010 + 0.004
	1.000000 kΩ	1 mA	0.010 + 0.001
	10.00000 kΩ	100 μA	0.010 + 0.001
	100.0000 kΩ	10 μA	0.010 + 0.001
	1.000000 MΩ	5.0 μA	0.010 + 0.001
	10.00000 MΩ	500 nA	0.040 + 0.001
	100.0000 MΩ	500 nA//10 MΩ	0.800 + 0.010
Frequency and Period[6]	100 mV to 300 V	3 Hz–5 Hz	0.10
		5 Hz–10 Hz	0.05
		10 Hz–40 Hz	0.03
		40 Hz–300 kHz	0.01
DC Current (HP 34901A only)	10.00000 mA	<0.1 V burden	0.050 + 0.020
	100.0000 mA	<0.6 V	0.050 + 0.005
	1.000000 A	<2 V	0.100 + 0.010
True RMS AC Current (HP 34901A only)	10.00000 mA and 1.00000 A[3]	3 Hz–5 Hz	1.00 + 0.04
		5 Hz–10 Hz	0.30 + 0.04
		10 Hz–5 kHz	0.10 + 0.04
	100.0000 mA[7]	3 Hz–5 Hz	1.00 + 0.5
		5 Hz–10 Hz	0.30 + 0.5
		10 Hz–5 kHz	0.10 + 0.5

Temperature	Type	Best Range Accuracy[8]	
Thermocouple	B	1100° C to 1820° C	1.2° C
	E	–150° C to 1000° C	1.0° C
	J	–150° C to 1200° C	1.0° C
	K	–100° C to 1200° C	1.0° C
	N	–100° C to 1300° C	1.0° C
	R	300° C to 1760° C	1.2° C
	S	400° C to 1760° C	1.2° C
	T	–100° C o 400° C	1.0° C
RTD	R_0 from 49 Ω to 2.1 kΩ	–200° C to 600° C	0.06° C
Thermistor	2.2 k, 5 k and 10 k	–80° C to 150° C	0.08° C

Measurement Characteristics[9]

DC Voltage	
Measurement Method	Continuously integrating multi-slope III A–D Converter
A–D Linearity	0.0002% of reading + 0.0001% of range
Input Resistance	
100 mV, 1 V, 10 V ranges	Selectable 10 MΩ or > 10,000 MΩ
100 V, 300 V ranges	10 MΩ ± 1%
Input Bias Current	< 30 pA at 25° C
Input Protection	300 V all ranges
True RMS AC Voltage	
Measurement Method	AC coupled True RMS—measures the AC component of the input with up to 300 Vdc of bias on any range
Crest Factor	Maximum of 5:1 at full scale
Additional Crest Factor Errors (non-sinewave)	Crest Factor 1–2 0.05 % of reading Crest Factor 2–3 0.15 % of reading Crest Factor 3–4 0.30 % of reading Crest Factor 4–5 0.40 % of reading
Input Impedance	1 MΩ ± 2% in parallel with 150 pF
Input Protection	300 Vrms all ranges
Resistance	
Measurement Method	Selectable 4-wire or 2-wire Ohms. Current source referenced to LO input.
Offset Compensation	Selectable on 100 Ω, 1k Ω, 10k Ω ranges
Maximum Lead Resistance	10% of range per lead for 100 Ω and 1 k Ω ranges. 1 kΩ on all other ranges.
Input Protection	300 V on all ranges
Frequency and Period	
Measurement Method	Reciprocal counting technique
Voltage Ranges	Same as AC voltage function
Gate Time	1s, 100 ms, or 10 ms
Measurement Timeout	Selectable 3 Hz, 20 Hz, 200 Hz LF limit
DC Current	
Shunt Resistance	5 Ω for 10 mA, 100 mA; 0.1 Ω for 1 A
Input Protection	1A 250 V fuse on HP 34901A module
True RMS AC Current	
Measurement Method	Direct coupled to the fuse and shunt. AC coupled True RMS measurement (measures the ac component only).
Shunt Resistance	5 Ω for 10 mA; 0.1 Ω for 100 mA, 1 A
Input Protection	1A 250 V fuse on HP 34901A module
Thermocouple	
Conversion Conformity	ITS-90 based software routines
Reference Junction Type	Internal, Fixed, or External
Open Thermocouple Check	Selectable per channel. Open >5k Ω.
RTD	Type α = .00385 (DIN) and α = .00392
Thermistor	44004, 44007, 44006 series
Measurement Noise Rejection 60 (50) Hz[10]	
dc CMRR	140 dB
ac CMRR	70 dB
Integration Time	**Normal Mode Rejection**[11]
200 plc / 3.33s (4s)	110 dB[12]
100 plc / 1.67s (2s)	105 dB[12]
20 plc / 334 ms (400 ms)	100 dB[12]
10 plc / 167 ms (200 ms)	95 dB
2 plc / 33.3 ms (40 ms)	90 dB
1 plc / 16.7 ms (20 ms)	60 dB
< 1 plc	0 dB

[1] Specifications are for 1-hour warm-up and 6½ digits, slow ac filter
[2] 20% over range on all ranges except 300 Vdc and ac ranges and 1 A dc and ac current ranges
[3] For sinewave input > 5% of range. For inputs from 1% to 5% of range and < 50 kHz, add 0.1% of range additional error.
[4] Typically 30% of reading error at 1 MHz, limited to 1 x 108 V Hz
[5] Specifications are for 4-wire ohms function or 2-wire ohms using scaling to remove the offset. Without scaling, add 1 Ω additional error in 2-wire ohms function.
[6] Input > 100 mV. For 10 mV inputs, multipy % of reading error x 10.
[7] Specified only for inputs >10 mA
[8] 1 year accuracy. For total measurement accuracy, add temperature probe error.
[9] 300 Vdc, ac rms isolation voltage (ch-ch, ch-Earth)
[10] For 1 KΩ unbalance in LO lead
[11] For power line frequency ±0.1%
[12] For power line frequency ±1%, use 40 dB or ±3% use 30 dB

Specifications

Operating Characteristics[1]

Single Channel Measurement Rates[2]

Function	Resolution	Reading/s
dcV, 2-wire resistance	6½ digits (10 plc) 5½ digits (1 plc) 4½ digits (0.02 plc)	6 (5) 57 (47) 600
Thermocouple	0.1° C (1 plc) (0.02 plc)	57 (47) 220
RTD, Thermistor	0.01° C (10 plc) 0.1° C (1 plc) 1° C (0.02 plc)	6 (5) 57 (47) 220
acV	6½ Slow (3 Hz) 6½ Med (20 Hz) 6½ Fast (200 Hz) 6½[3]	0.14 1 8 100
Frequency, Period	6½ digits (1s gate) 5½ digits (100 ms) 4½ digits (10 ms)	1 9 70

System Speeds[4]	Channel/s
INTO Memory	
Single channel dcV	600
34902A scanning dcV	250
34907A scanning digital in	250
34902A scanning dcV with scaling and 1 alarm fail	220
34907A scanning totalize	170
34902A scanning temperature	160
34902A scanning acV[3]	100
34902A scanning dcV/Ohms on alternate channels	90
34901A/34908A scanning dcV	60
INTO and OUT of memory to HP-IB or RS-232 (init/fetch)	
34902A scanning dcV	180
34902A scanning dcV with timestamp	150
OUT of memory to HP-IB	
Readings	800
Readings with timestamp	450
Readings with all format options ON	310
OUT of memory to RS-232	
Readings	600
Readings with timestamp	320
Readings with all format options ON	230
DIRECT to HP-IB or RS-232	
Single channel dcV	440
34902A scanning dcV	200
Single channel MEAS DCV10/MEAS DCV 1	25
Single channel MEAS DCV/ MEAS OHMS	12
HP BenchLink Performance	
Scan and save to disk with 2 strip-charts displayed	100

System Characteristics

Scanning Inputs	
Analog	HP 34901A, 34902A, and 34908A multiplexer channels
Digital	HP 34907A digital in and totalize
Scan list	Scans channels in ascending order
Triggering	
Source	Interval, external, button press, software, or on monitor channel alarm
Scan count	1 to 50,000 or continuous
Scan interval	0 to 99 hours; 1 ms step size
Channel delay	0 to 60 seconds per channel; 1 ms step size
External trig delay	< 2 ms. With monitor on < 200 ms.
External trig jitter	< 2 ms
Alarms	
Analog inputs	Hi, Lo, or Hi + Lo evaluated each scan
Digital inputs	34907A digital in: maskable pattern match or state change 34907A totalize: Hi limit only
Monitor channel	Alarm evaluated each reading
Alarm outputs	4 TTL compatible; selectable TTL logic Hi or Lo on fail
Latency	5 ms (typical)

Memory (Battery backed, 4 year typical life[5])	
Readings	50,000 with timestamp Readable during scan
States	5 instrument states with user label
Alarm queue	Up to 20 events with channel number, reading, and timestamp
System Features	
Per-channel math	Individual Mx + B scaling and Min/Max/Average calculated real time
Power fail recovery	Resumes scanning automatically
Relay maintenance	Counts each relay closure and stores on module. User resettable.
Real time clock	Battery-backed, 4 year typical life[5]

HP BenchLink Data Logger software (not included with Option 001)	
System Requirements[6]	
PC Hardware	486, 66 MHz, 16 MB RAM, 12 MB disk space
Operating Systems	Windows 3.1, Windows 95, Windows NT 4.0
Computer Interfaces[7]	
HP-IB	HP 82335B, 82340A/B/C, 82341A/B/C/D National Instruments AT-GPIB/TNT, PCI-GPIB
LAN -to- HP-IB	HP E2050A (Windows 95 and NT only)
RS-232 (Serial Port)	PC COM 1-4

[1] Reading speeds for 60 Hz and (50 Hz) operation
[2] For fixed range and function, readings to memory, scaling and alarms off, autozero off
[3] Maximum limit with default settling delays defeated
[4] Speeds are for 4½ digits, delay 0, display off, autozero off. Using 115 kB RS-232 setting.
[5] Storage at temperatures above 40° C will decrease battery life
[6] Software provided on CD-ROM and includes utility to create floppy disks for installation
[7] Interface and driver must be purchased separately

General

Power Supply: 100 V/120 V/220 V/240 V ±10%
Power Line Frequency: 45 Hz to 66 Hz automatically sensed
Power Consumption: 12 W (25 VA peak)
Operating Environment:
Full accuracy for 0° C to 55° C
Full accuracy to 80% R.H. at 40° C
Storage Environment: –40° C to 70° C
Weight: Net: 3.6 kg (8.0 lbs)
Safety: Conforms to CSA, UL-1244, IEC 1010 Cat I
RFI and ESD: CISPR 11, IEC 801/2/3/4
Warranty: 3 years

Ordering Information

HP 34970A Data Acquisition/Switch Unit
Includes internal 6½ digit DMM, operating and service manuals, test report, power cord, and Quick Start package (includes HP Benchlink Data Logger software, RS-232 cable, thermocouple, and screwdriver). Modules are purchased seperately and are required to operate.
Opt 001 Delete Internal DMM
Same as above but deletes DMM and quick start package. Order 34970-80010 to retrofit DMM at a later time.
Opt 1CM Rackmount Kit
Opt 0B0 Delete Manual Set
HP 34901A 20-Channel Armature Multiplexer
HP 34902A 16-Channel Reed Multiplexer
HP 34903A 20-Channel Actuator/General Purpose Switch
HP 34904A 4 x 8 Two-Wire Matrix Switch
HP 34905A Dual 4-Channel RF Multiplexer, 50 Ohms
Includes (10) SMB-to-BNC(f) 50 Ω adapter cables
HP 34906A Dual 4-Channel RF Multiplexer, 75 Ohms
Includes (10) SMB-to-BNC(f) 75 Ω adapter cables
HP 34907A Multifunction Module
HP 34908A 40-Channel Single-Ended Multiplexer
Accessories
HP 34161A Accessory Pouch
HP 34131A Hard Carrying Case
HP 34397A dc-to-ac Inverter
HP E2050A LAN/HP-IB Gateway
34970-80010 DMM Field Installation Kit
Fully calibrated with Test Report and Quick Start Kit

For more information on high-performance data acquisition products from Hewlett-Packard, refer to the Data Acquisition Systems section of this catalog starting on page 563.

HP 33120A's functions and arbitrary waveforms are accurate and convenient to set up. Also, available software makes it easy to download modeled or captured waveforms.

Find Your Fit in the HP Family

Besides producing sine waves accurate in frequency and amplitude, function generators and waveform synthesizers are versatile signal sources that can produce some or all of the following waveforms: square, triangle, ramp and pulse. Tuning is continuous over wide bands, and many models can modulate these waveforms and sweep them across a range of frequencies. Some function generators and all waveform synthesizers use frequency synthesis techniques to generate their outputs. Applications for these general purpose signal sources are diverse. Examples include speed sensor characterization, communications receiver design and test, and earthquake testing.

Some waveform synthesizers can also produce arbitrary waveforms, programmable at the front panel or on a PC and downloaded. This capability allows creating signals that mimic noise, vibration, control pulses, whatever signal is needed for realistic tests. A typical use for arbitrary waveforms is to simulate specific ECG waveforms to verify that an electronic hospital patient monitor responds in the proper manner.

From complex signals to simple waveforms, there is an HP generator that is right for the job. See the table and the individual product pages for more detail.

HP 33120A

The HP 33120A uses the latest direct digital synthesis techniques to bring you a full-featured 15 MHz function generator that also has arbitrary waveform capability built in. The HP 33120A offers both linear and log sweep, internal AM, FM, FSK, and burst modulation, and a 12-bit, 40 MSa/s, 16,000 point deep arb generator. Option 001 phase lock/timebase increases the HP 33120A frequency stability and allows multiple HP 33120A's to produce precise phase-offset signals. Fully programmable, the HP 33120A includes both HP-IB and RS-232 interfaces standard. An optional software package, the HP 34811A BenchLink/Arb, facilitates creating, modifying, and downloading arbitrary waveform to the HP 33120A.

HP 3324A and HP 3325B

The HP 3324A and HP 3325B provide standard functions with synthesizer stability. In addition to the usual sweep modes, they also offer sequences so that, for example, acceleration profiles can be modeled. Any number of channels can be set up by master-slaving, and an option is available for the HP 3324A which allows multi-phase signals to be set up with 0.1 degree resolution automatically, deskewed at the device.

HP 8904A

The HP 8904A creates complex signals from six simple waveforms. The instrument offers standard functions, dc, and noise. Option 001 adds three modulation channels, and Option 002 adds a second independent synthesizer output. Modulation capabilities include AM, FM, PM, DSB, and pulse. These features address VOR, FM, communications signaling, and stereo applications.

4

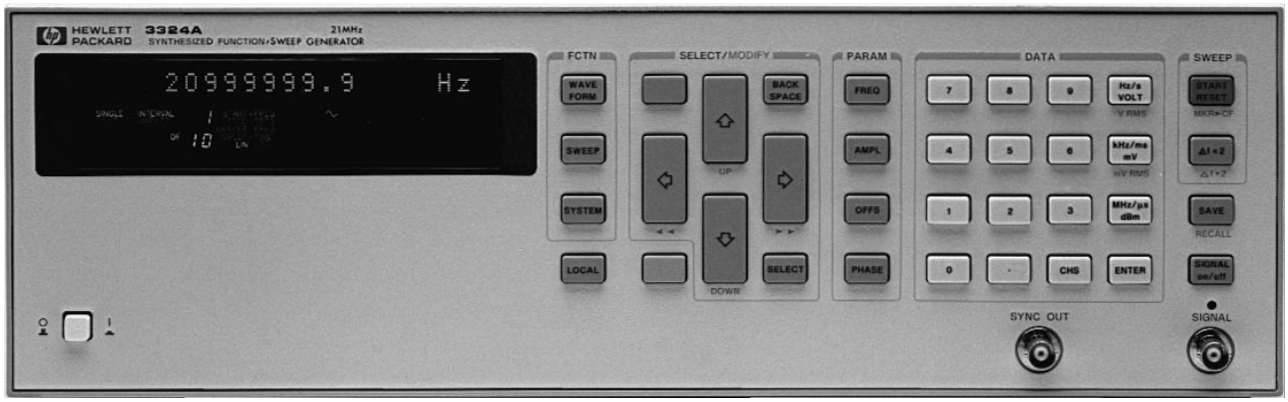
Function and Arbitrary Waveform Generator Specifications

	HP 33120A	HP 3324A	HP 3325B	HP 8904A
Sine wave				
Min. frequency	dc	1 mHz	1 µHz	dc
Max. frequency	15 MHz	21 MHz	21 MHz	600 kHz
Waveforms				
Square	100 µHz to 15 MHz	1 mHz to 11 MHz	1 µHz to 11 Mhz	0.1 Hz to 50 kHz
Triangle	100 µHz to 100 kHz	1 mHz to 11 kHz	1 µHz to 11 kHz	0.1 Hz to 50 kHz
Ramp	100 µHz to 100 kHz	1 mHz to 11 kHz	1 µHz to 11 kHz	0.1 Hz to 50 kHz
Arbitrary	16,000 points		--	--
Modes				
Trigger	int./ext.			Creates signals from six basic waveforms
Gate	int./ext.			
Counted burst	1 to 50,000 or ∞			
Modulation				
AM	int./ext., and Arbitrary	--	int./ext.	int.
FM	int., including Arbitrary	--	--	int.
PM	--	--	int./ext.	int.
Sweep				
Lin.	int.	int.	int.	int.
Log.	int.	int.	int.	none
VCO	--		int.	int.
Output (into 50 Ω)				
Amplitude (p-p)	10 V	10 V	10 V	10 V
DC offset (±)	5 V	5 V	5 V	5 V
Output Impedance Ω	50	50	50	50
Programmability	HP-IB and RS-232	HP-IB	HP-IB	HP-IB
Notes	12 bit, 40 MS/s ARB, also has FSK, SCPI commands, 3-year warranty	60 MHz TTL clock, multi-interval and multi-marker sweep	Also has PWM. Modulation source can be used separately	4 internal channels; one is modulated or sequenced
Catalog page	171	168	173	169

1 mHz to 21 MHz Synthesized Function/Sweep Generator

HP 3324A

- Multi-interval sweep
- Master/slave capability
- ±719.9° variable phase
- Additional 60 MHz output
- Outputs and HP-IB isolated
- HP 3325B software-compatible



HP 3324A

HP 3324A Synthesized Function/Sweep Generator[1]

HP-IB

The HP 3324A provides synthesizer performance and multi-segment sweep at a moderate price for applications such as speed sensors. Additionally, multi-phase signals can be set up because variable-phase and master/slave capabilities can be used together.

Brief Specifications (50 Ω Load, 0° to 55°C)

For detailed specifications, please request Data Sheet 5952-9678 Synthesized Function/Sweep Generator HP 3324A

Frequency and Waveforms

1 mHz to: 11 kHz (triangle, ramps), 11 MHz (square), 21 MHz (sine), 60 MHz (auxiliary 0 dBm output)
Accuracy: 5 ppm
Stability: 5 ppm, Option 001; 0.1 ppm
Resolution: 1 mHz (0.1 Hz above 1 MHz)

Main Output (50 Ω source)

Amplitude: 1 mV to 10 V in eight 1-3-10 sequence ranges
Offset: 5 V; voltages double into open
Accuracy: 0.2 dB/2% typical
Resolution: 4 digits
Phase: 719.9° relative to start phase; 0.1° resolution

Sine Wave Characteristics

Phase Noise: – 50 dB
Spurious: – 55 dB
Harmonics: – 60 dBc (< 200 kHz), – 40 dBc (< 2 MHz); –30 dBc (< 15 MHz), – 25 dBc (< 20 MHz)

Square Wave Characteristics

Transitions: < 20 ns
Overshoot/Ringing: < 5%
Duty Cycle: 50% fixed

Triangle/Ramp Characteristics

Linearity: 0.05%

Sweep Capabilities

Cycling: Single or continuous
Modes: Multi-interval, multi-marker
Sweeps: Linear (up, down, constant, tone), log up
Intervals: 50, sequence length 100 (in multi-interval mode)
Markers: One per interval (9 in multi-marker mode)
Sweep Time: Programmable up to 100.00 s

Auxiliary Outputs

Sync: 50 Ω source, 1.2 Vp-p square wave, same phase as main output
Auxiliary 0 dBm Output: 50 Ω source, square wave
Z-Axis Drive Output: Sweep-time ramp, 10 Vp-p, 10 kΩ source
Z-Axis Output: TTL blanking signal during sweep return, 10 mA sink
Sweep Marker Ouput: TTL pulse at selected marker frequency
1 MHz Reference Output: 0 dBm, 50 Ω source

Reference Input

For phase-locking connect the HP 3324A to an external frequency reference, signal 0 dBm to 20 dBm into 50 Ω.

Option 002, High Voltage Output

Amplitude: 4 mVp-p to 40 Vp-p into 500 Ω
Frequency: 1 mHz to 1 MHz

Options 003 and 004, Automatic Phase Calibration

Calibration: Refers slave phase to master. Interconnect cables are supplied. If there are two or more slaves, a VHF switch HP 59307A is required. Master/slaving does not apply to sweep mode.

General Specifications

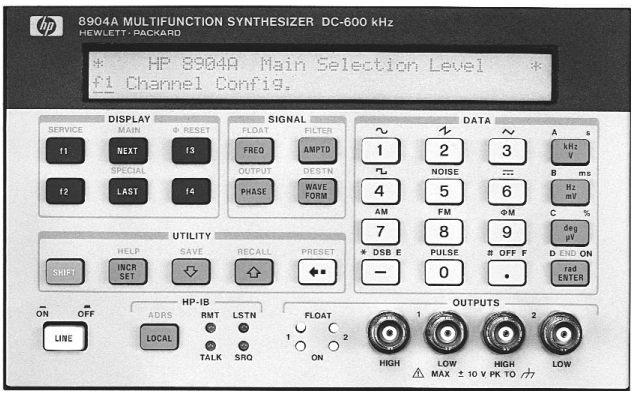
Power: 100/120/220/240 V, 48 to 66 Hz, max. 100 VA
Size: 425.5 mm W x 132.6 mm H x 497.8 mm D (16.75 in x 5.25 in x 19.625 in)
Weight: Net, 11 kg; shipping, 16.5 kg

Ordering Information

HP 3324A Synthesized Function/Sweep Generator
Opt 001 High Stability Frequency Reference
Opt 002 High Voltage Output
Opt 003 Automatic Phase Calibration, Slave
Opt 004 Automatic Phase Calibration, Master
Opt 907 Front Handle Kit (5062-3989)
Opt 908 Rack Flange Kit (5062-3977)
Opt 909 Rack Flange and Handle Combination Kit (5062-3983)
Extended warranty options (see page 584) available on request
Opt 1 BP MIL-STD-45622A Calibration
Opt 915 Service Manual
Opt 916 Additional Users' Guide
Opt UK6 Commercial Calibration Certificate

For more information, visit our website: **http://www.hp.com/go/dvt**

- Sine to 600 kHz, square, ramp, triangle to 50 kHz
- 12-bit direct digital synthesis
- Tone, DTMF, digital, Hop Ram sequence modes
- One or two outputs
- One to four internal channels
- AM, FM, ØM, DSBSC, and pulse modulation
- Unit-to-unit phase synchronization
- Optional 600 Ω high power, balanced output



HP 8940A

HP 8904A Function Synthesizer

The standard HP 8904A multi-function synthesizer generates accurate sine waves from 0 Hz to 600 kHz with 0.1 Hz resolution. The HP 8904A also has five other standard functions: square, triangle, ramp, from 0 Hz to 50 kHz plus dc, and Gaussian white noise. All waveform values in the HP 8904A are digitally calculated in real time by Hewlett-Packard's Digital Waveform Synthesis IC yielding 12-bit digital accuracy. Full HP-IB programmability is also included standard on the HP 8904A.

Two Outputs

Option 002 adds a second, identical synthesizer and floating 50 Ω output section to the HP 8904A. Frequency, amplitude, waveform, and phase can be independently set for the two sources. Either synthesizer can be precisely varied in phase relative to each other from 0 degrees to 359.9 degrees with a resolution of 0.1 degree.

Complex Signal Generation

Option 001 adds internal synthesizers (for a total of four) which can modulate channel A or be summed to give complex waveform generating capabilities to the HP 8904A. All four synthesizers are independent with precise phase offset capabilities. These synthesizers can be digitally summed before being output. In addition to summing, Option 001 allows channels B, C, and D to modulate channel A with AM, FM, ØM, DSBSC, or pulse modulation.

FM Stereo Composite Mode

Option 001 also includes a mode for generating FM stereo composite signals. Test signals in this mode include Left = Right, Left = – Right, Left Only, and Right Only. Single keystrokes select test-tone frequency, composite level, test signal mode, and pilot tone level. Stereo separation is typically greater than 65 dB.

Communication Signaling

Option 001 also adds four sequence modes to the HP 8904A: tone, DTMF, digital, and Hop Ram sequence modes. These modes make the HP 8904A a powerful tool for use in communications signaling. Tone and DTMF modes allow creation of single or dual tone sequences up to 750 states in length. Digital sequence mode can generate bit streams up to 3000 bits in length with 100 µs resolution. Hop Ram sequence mode allows sequencing of 16 tones, each with an associated amplitude, frequency, and phase value.

Fast Hop

Option 003 adds the ability to externally hop channel A in frequency, phase, or amplitude. Up to 16 frequency/phase/amplitude states can be entered into the Hop Ram memory. To hop, an external device must address the four-bit wide, TTL-level address bus provided on the rear panel. Phase continuous switching can be done in as little as 20 µs.

Unit-to-Unit Phase Synchronization

With Option 005, multiple HP 8904As can be phase synchronized to provide more than two phase-related outputs. In the synchronous mode, one unit is specified to be the master clock unit and all others are designated slaves. Two signals are then routed from the clock master unit to all slave units through external low-loss power splitters. To synchronize the units, a phase reset command is given to the master HP 8904A via HP-IB or from the front panel. The total phase error between units will be the larger of ± 0.1 degree or 60 ns for frequencies from 0.1 Hz to 100 kHz. Up to eight HP 8904As may be synchronized.

600 Ω Balanced Output

Option 006 changes output 1 from a 50 Ω electronically-floating output to a transformer-coupled, 600 Ω -balanced output. Option 006 provides high power, balanced signals into 600 Ω loads. Maximum output is 10 volts rms into 600 Ω. The Option 006 output restricts the frequency range of output 1 to 30 Hz to 100 kHz. In addition, complex wave forms such as square, ramp, and triangle waveforms are degraded and dc cannot be passed through the Option 006 output. In many applications, however, the HP 8904A Option 006 is a direct replacement for the HP 200CD wide range oscillator.

HP 8904A Specifications (for 50 Ω output only)

Frequency
Range: Sine wave: 0 Hz to 600 kHz
Square, triangle, ramp: 0 Hz to 50 kHz
Resolution: 0.1 Hz
Accuracy (internal 10 MHz timebase): 50 ppm

AC Amplitude (sine wave only)
Range: 0 to 10 V p-p into a 50 Ω load
Accuracy (> 40 mV p-p into open circuit):
1%, 0.1 Hz to 100 kHz; 3%, 100 kHz to 600 kHz
Flatness (> 630 mV p-p into 50 Ω):
± 0.1% (± 0.009 dB), 0.1 Hz to 100 kHz

DC Amplitude
Range: 0 to ±10 V p-p open circuit
Accuracy: Larger of ± 20 mV or ± 2.1%

Spectral Purity (sine wave only)
THD + N (including spurs, amplitude > 50 mV rms into 50 Ω):
– 63 dBc rms (0.07%), 20 Hz to 7.5 kHz, 30 kHz BW
– 63 dBc rms (0.07%), 7.5 kHz to 20 kHz, 80 kHz BW

Gaussian Noise
Spectral Characteristic: Equal energy per unit bandwidth ("white")
Time-Domain Characteristic: Gaussian distribution
Flatness (>100 mV p-p): Typically ±0.5 dB, 0.1 Hz to 100 kHz

Option 001 Specifications

Modulation is for channel A only, and specified for sine-wave carrier and modulation. External modulation is NOT possible.

Modulation

Amplitude
Rate: 0 to 600 kHz
Depth Range: 0% to 100 % of carrier amplitude
Frequency
Rate: 0 to 600 kHz
Deviation Range: 0 to 600 kHz
Phase
Rate: 0 to 600 kHz
Deviation Range: 0° to 179.9°/channel
Pulse or DSBSC
Rate: 0 Hz to 50 kHz (up to 600 kHz for DSBSC)

Summation

Two, three, or four channels may be summed.
Channel to Channel Phase Accuracy (equal amplitude sine waves): Larger of ± 0.1° or 30 ns, 0.1 Hz to 100 kHz

Modes

FM Stereo Composite
Test Modes: Left = Right, Left = –Right, Left Only, Right Only
Composite Signal Level: Up to 10 V_{p-p} into 50 Ω
Pre-Emphasis Modes: Off, 25 μs, 50 μs, and 75 μs
Channel Separation: Typically > 65 dB, 20 Hz to 15 kHz rates
Tone Sequence
Number of Frequencies: 16 tones each with user-definable frequency, on-time and off-time
On/Off Time Duration Range: 0 ms, 0.80 ms to 655.35 ms
Timing Accuracy: ± 0.02 ms (± 20 μs)
Sequence Length: 750 steps, user-definable
DTMF Sequence
Number of Tone Pairs: 16 standard DTMF tone pairs (0-9, A-D, #, *) with user-definable on-time and off-time
On/Off Time Duration Range: 0 ms, 1.00 ms to 655.35 ms
Timing Accuracy: ± 0.02 ms (± 20 μs)
Sequence Length: 750 steps, user-definable
Digital Sequence
User Definable: On level, off level, and bit period
Bit Period Duration Range: 0.10 ms to 655.35 ms
Timing Accuracy: ± 0.02 ms (± 20 μs)
Sequence Length: Up to 3000 bits, user-definable
Hop Ram Sequence
Number of Frequencies: 16 tones each with user-definable frequency, phase, and amplitude
Sequence Clock Frequency Range: 0.1 Hz to 10 kHz
Sequence Length: 750 steps (all 16 tones used) or 3000 steps (tones 0 and 1 used), user-definable

Option 002 Specifications (50 Ω outputs)

Output 1 to Output 2 Phase Accuracy (sine waves at the same frequency): ± 0.1° or 30 ns, 0.1 Hz to 100 kHz, whichever is greater

Option 003 Specifications (Fast Hop)

Direct Hopping of Channel A: 16 phase-frequency-amplitude states may be addressed with four TTL-compatible inputs
Switching Speed (via digital port): Typically < 20 μs

Option 005 Specifications (50 Ω outputs)

Unit-to-Unit Phase Accuracy (sine waves only): Larger of ± 0.1° or 60 ns, 0.1 Hz to 100 kHz
Maximum Number of Synchronized Units: 8 units

Option 006 Specifications (sine wave)

All specifications for the standard 50 Ω output HP 8904A are degraded by the accuracy, flatness, and distortion specifications of the Option 006, 600 Ω transformer coupled output.

Output Type: Fully floating/balanced transformer-coupled output
Usable Frequency Range: Typically 30 Hz to 200 kHz
AC Amplitude Range: 0 to 10 Vrms into 600 Ω
AC Amplitude Accuracy (> 40 mVrms into a balanced 600 Ω load): 6% (0.5 dB), 30 Hz to 20 kHz; 12% (1.0 dB), 30 Hz to 100 kHz
Flatness (> 40 mVrms into a balanced 600 Ω load): + 0.15 dB, – 0.75 dB, 30 Hz to 100 kHz
THD + Noise (including spurs, > 140 mVrms into a balanced 600 Ω load): – 63 dB (0.07%), 7.5 kHz to 20 kHz, 80 kHz BW

General

Store Recall: 35 non-volatile registers
Output Type (standard unit): 50 Ω electronic floating or grounded output, HP-IB programmable
Maximum Float Voltage (50 Ω output, signal + float): 10 V peak maximum from high or low output to chassis ground
External Timebase Input: 10 MHz accepted at a nominal level of 0.1 to 5 V peak, automatic switching
Operating Temperature Range: 0° to 50° C
Storage Temperature Range: – 20° to 70° C
Remote Operation: HP-IB
Size: 213 mm W x 133 mm H x 513 mm D (8.36 in x 5.25 in x 20.2 in)
Weight: Net, 5.9 kg (12.8 lb); shipping, 13 kg (28.6 lb)

Key Literature

HP 8904A Technical Specifications, p/n 5965-9456E
HP 8904A Brochure, p/n 5965-9457E

Ordering Information

HP 8904A Multifunction Synthesizer[1]
Opt 001 Adds three (two when ordered with Option 002) internal channels, Channel A modulation, summation, FM stereo mode, and sequence capability
Opt 002 Adds second internal synthesizer and output
Opt 003 Adds fast hop and digital modulation
Opt 004 Connectors on rear panel only (not available with Option 005 or 006)
Opt 005 Adds unit-to-unit phase synchronization
Opt 006 Changes output 1 from a 50 Ω output to a transformer-coupled, 600 Ω balanced output
Opt 910 Provides an additional operation and calibration manual (08904-90007) and two service manuals (08904-90008)
Opt 915 Adds Service Manual (08904-90008)
Opt W30 Extended Repair Service
Opt W32 Calibration Service
08904-61024 Rackmount Kit for a single HP 8904A
08904-61025 Rackmount Kit for mounting two HP 8904A's side by side
HP 8904A Retrofit Kits (customer retrofittable)
HP 11816A Retrofit Kit for Option 001
HP 11817A Retrofit Kit for Option 002
HP 11818A Retrofit Kit for Option 003
HP 11827A Retrofit Kit for Option 005[2]
HP 11837A Retrofit Kit for Option 006[2]

[1] HP-IB cables not included.
[2] Not available for units with serial prefix less than 2948A.

Indicates QuickShip availability.

- 15 MHz sine- and square-wave outputs
- Sine, triangle, square, ramp, noise, and more
- 12-bit, 40 MSa/s, 16,000 point deep arbitrary waveforms
- Direct digital synthesis for excellent stability
- Linear and log sweeps built-in
- AM, FM, FSK, and burst modulation built-in
- HP-IB and RS-232 interfaces both standard
- Optional BenchLink Arb software

HP 33120A

HP 33120A Function/Arbitrary Waveform Generator

The HP 33120A is a high-performance, full-function 15 MHz synthesized function generator. It features sine, triangle, square, ramp, and noise waveforms, a 12-bit, 40 MSa/s, 16,000 point deep arbitrary waveform generator, and both internal sweep and modulation capabilities. The HP 33120A is ideal for both bench and system applications. Both HP-IB and RS-232 interfaces are standard, as is a full three-year warranty. All this is available for a surprisingly affordable price.

Unprecedented Functionality

The HP 33120A will fill all your basic signal source needs by giving you a full complement of standard functions. But this source goes beyond the basics. You get both linear and log sweeps to 15 MHz, plus full-modulation capabilities. AM, FM, FSK, and burst modulation are just a button push away. You can internally modulate with any of the standard waveforms, including Arb. You can even use an external source for AM, FSK, and burst modulation, if desired. Finally, you get near-infinite custom waveform capability with the inclusion of a 12-bit, 40 MSa/s, 16,000 point deep arbitrary waveform generator.

Superb Performance

The performance of the HP 33120A was designed in, not left out. This means that you get clean, low-distortion sine waves, fast rise- and fall-time squarewaves, and linear triangle and ramp waveforms. Further, due to the latest direct digital synthesis techniques utilized in the HP 33120A, you can get down to 10 μHz frequency resolution.

Built-In Versatility

You will find that the HP 33120A will fit equally well into your bench or your system applications. Designed with the bench user in mind, operation of the HP 33120A from the front panel is straightforward and intuitive. The inclusion of a knob makes adjusting frequency, amplitude, and offset extremely convenient. Or enter these values directly. You can even enter amplitude values directly in V peak-to-peak, V rms, or dBm. For system applications, the HP 33120A includes both HP-IB and RS-232 interfaces standard, and uses commands that are in total compliance with the Standard Commands for Programmable Instrumentation (SCPI).

Quality and Reliability

Not only does the HP 33120A offer you performance and features unheard of at this price, you also get the advantages of owning Hewlett-Packard. A full three-year warranty is standard with the HP 33120A. The rugged construction and conservative design of the HP 33120A ensures many years of trouble-free operation. Just as price was designed out of the HP 33120A, quality and reliability were designed in.

Option 001 Phase Lock Loop

Option 001 adds a high-stability timebase, the ability to lock to an external timebase, and the ability to phase lock two or more HP 33120As together. This option is especially useful if your application requires higher-frequency stability and accuracy, if you need to lock to an external-frequency standard, or if you need two or more phase-locked outputs.

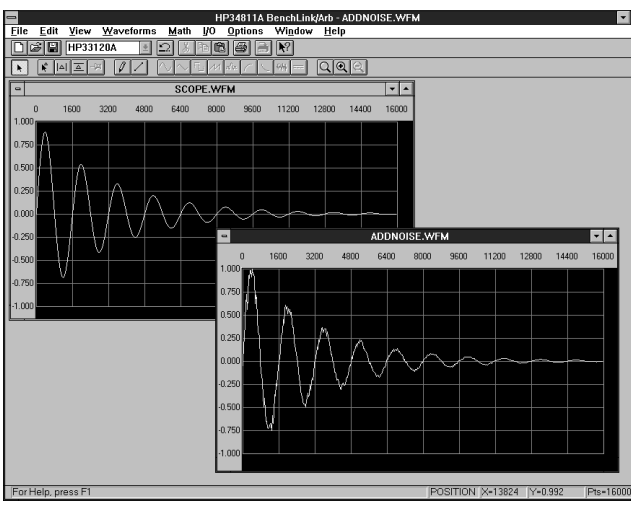
HP BenchLink Arb Software Helps the 33120A Work for You

HP BenchLink Arb lets you use your Windows-based PC (3.1, 95, NT 4.0) to easily create and edit arbitrary waveforms for output on the HP 33120A.

HP BenchLink Arb software application lets you create waveforms in a variety of ways:

- Select and edit a standard waveform from the HP BenchLink Arb library, and change its amplitude and frequency characteristics as desired.
- Use HP BenchLink Arb's drawing tools to draw and edit your own custom waveform.
- Bring in and edit a waveform captured or created elsewhere.

HP BenchLink Arb accepts time/voltage pairs in ASCII format, or you can use waveforms captured with HP BenchLink Scope and an HP oscilloscope. Once your waveform is ready, downloading to the HP 33120A generator is simple. Make your arbitrary waveforms quickly and easily with HP BenchLink Arb.



HP 34811A BenchLink Arb lets you take control of arbitrary waveforms on the HP 33120A function/arbitrary waveform generator.

HP 33120A

Abbreviated Technical Specifications

Waveforms
Standard: Sine, square, triangle, ramp, noise, sin(x)/x, exponential rise, exponential fall, heartbeat, dc volts
Arbitrary
- **Waveform Length:** 8 to 16,000 points
- **Amplitude Resolution:** 12 bits (including sign)
- **Sample Rate:** 40 MSa/s
- **Non-Volatile Memory:** Four (4) 16,000 point waveforms

Frequency Characteristics
Sine: 100 μHz to 15 MHz
Square: 100 μHz to 15 MHz
Triangle: 100 μHz to 100 kHz
Ramp: 100 μHz to 100 kHz
Noise (Gaussian): 10 MHz bandwidth
Resolution: 10 μHz or 10 digits
Accuracy: 10 ppm in 90 days, 20 ppm in 1 year, 18° C to 28° C
- **Temp. Co-eff.:** 2 ppm/°C
- **Aging:** 10 ppm/yr.

Sine-wave Spectral Purity
Harmonic Distortion:
- DC to 20 kHz: – 70 dBc
- 20 kHz to 100 kHz: – 60 dBc
- 100 kHz to 1 MHz: – 45 dBc
- 1 MHz to 15 MHz: – 35 dBc

Spurious (non-harmonic):
- DC to 1 MHz: < – 65 dBc
- 1 MHz to 15 MHz: < – 65 dBc + 6 dB/octave

Total Harmonic Distortion: < 0.04% (dc to 20 kHz)
Phase Noise: < – 55 dBc in a 30 kHz band

Signal Characteristics
Squarewave
- **Rise/Fall Time:** < 20 ns
- **Overshoot:** < 4%
- **Asymmetry:** <1% + 5 ns
- **Duty Cycle:** 20% to 80% (to 5 MHz)
  40% to 60% (to 15 MHz)

Triangle, Ramp, Arb
- **Rise/Fall Time:** 40 ns (typical)
- **Linearity:** <0.1% of peak output
- **Settling Time:** < 250 ns to 0.5% of final value
- **Jitter:** < 25 ns

Output Characteristics
Amplitude (into 50 Ω): 50 mV p-p to 10 V p-p
- **Accuracy** (at 1 kHz): 1% of specified output

Flatness	(sine wave relative to 1 kHz)
<100 kHz	±1% (0.1 dB)
100 kHz to 1 MHz	±1.5% (0.15 dB)
1 MHz to 15 MHz	±2% (0.2 dB) Ampl ≥3 Vrms ±3.5% (0.3 dB) Ampl <3 Vrms

Output Impedance: 50 Ω (fixed)
Offset (into 50 Ω): ± 5 Vpk ac + dc
- **Accuracy:** ± 2% of setting + 2 mV

Resolution: 3 digits, amplitude and offset
Units: V p-p, V rms, dBm
Isolation: 42 Vpk maximum to earth
Protection: Short circuit protected, ±15 Vpk overdrive <1 minute

HP 33120A Option 001

Modulation
AM
- **Carrier 3dB Freq.:** 10 MHz (typical)
- **Modulation:** Any internal waveform including Arb
- **Frequency:** 10 mHz to 20 kHz
- **Depth:** 0% to 120%
- **Source:** Internal/external

FM
- **Modulation:** Any internal waveform including Arb
- **Frequency:** 10 mHz to 10 kHz
- **Peak Deviation:** 10 mHz to 15 MHz
- **Source:** Internal only

FSK
- **Internal Rate:** 10 mHz to 50 kHz
- **Frequency Range:** 10 mHz to 15 MHz
- **Source:** Internal or external (1 MHz max)

Burst
- **Carrier Freq.:** 5 MHz max.
- **Count:** 1 to 50,000 cycles or infinite
- **Start Phase:** –360° to + 360°
- **Internal Rate:** 10 mHz to 50 kHz ±1%
- **Gate Source:** Internal or external gate
- **Trigger Source:** Single, external, or internal rate

Sweep
Type: Linear or logarithmic
Direction: Up or down
Start F/Stop F: 10 mHz to 15 MHz
Speed: 1 ms to 500 s ± 0.1%
Trigger: Internal, external, single

Rear Panel Inputs
Ext. AM Modulation: ± 5 Vpk =100% modulation, 5 kΩ input resistance
External Trigger/FSK/Burst Gate: TTL low true

General Specifications

State Storage Memory: Power off state automatically saved.
3 user-configurable stored states.
Interface: IEEE-488 and RS-232 standard
Language: SCPI–1991
Warranty: 3 years standard

Option 001 Phase Lock/TCXO Timebase

Stability: ±1 ppm, 0° to 50°C
Aging: < 2 ppm in first 30 days (continuous operation);
0.1 ppm/month (after first 30 days)
Ext. Reference Input Lock Range: 10 MHz ± 50 Hz
Int. Reference Output Frequency: 10 MHz
Phase Offset: –360° to + 360°, 0.001° resolution

Ordering Information

HP 33120A Function Generator
- **Opt 001** Phase Lock Loop
- **Opt 106** BenchLink/Arb Software
- **Opt 1CM** Rackmount Kit

HP 34811A BenchLink/Arb Software
HP 34161A Accessory Pouch
HP 34397A DC to AC Power Inverter

Indicates QuickShip availability.

The HP 3325B is designed for MATE systems

HP 3325B Synthesizer/Function Generator

HP-IB

HP 3325B frequency accuracy is determined by a precision frequency reference, and output can be set with a resolution of 1 μHz. The phase of the output signal can be precisely controlled ±719.9° with 0.1° resolution, and multiple HP 3325s can be locked together for multi-phase applications.

Use the modulation source as an arbitrary function generator via HP-IB to provide user-defined waveshapes. Save-recall memory includes ten nonvolatile memory locations for simple and rapid access to frequently used test setups.

A built-in programmable modulation source provides sine, square and arbitrary waveshapes for internal amplitude or phase modulation, or for use as a second source. A rear panel sync output provides a TTL compatible dc to 60 MHz signal.

All functions including frequency, amplitude, phase, modulation, sweep, and waveshapes, are programmable via HP-IB or RS-232 interface. The HP 3325B is fully compatible in form, fit and function with the HP 3325A. All HP-IB programs written for the HP 3325A are fully compatible with the HP 3325B.

Specifications

Waveforms: Sine, square, triangle, negative and positive ramps
Frequency
Range:
Sine: 1 μHz to 20.999 999 999 MHz
Square, Triangle/Ramps: 1 μHz to 10.999 999 999 MHz
Resolution: 1 μHz < 100 kHz; 1 mHz ≥ 100 kHz
Accuracy: ±5 x 10^{-6}, 20° to 30° C at time of calibration
Warm-up Time: 20 minutes to within specified accuracy
Main Signal Output (all waveforms)
Impedance: 50 Ω
Connector: BNC; switchable to front or rear panel, nonswitchable with Opt 002, except by internal cable change.
Amplitude
Range: 1 mV to 10 V p-p in 8 amplitude ranges, 1-3-10 sequence (10 dB steps), into 50 Ω load

Function	Sine		Square		Triangle/ramps	
Units Displayed	Min	Max	Min	Max	Min	Max
Peak-peak	1.000 mV	10.00 V	1.000 mV	10.00 V	1.000 mV	10.00 V
Rms	0.354 mV	3.536 V	0.500 mV	5.000 V	0.289 mV	2.887 V
dBm (50 Ω)	–56.02	+23.98	–53.01	+26.99	–57.78	+22.22

Resolution: 0.03% of full range or 0.01 dB (4 digits)
Amplitude Accuracy
(without dc offset, relative to programmed amplitude and accuracy)
Sine Wave Amplitude Accuracy
1 mHz to 100 kHz: ±0.1 dB, ≥3 V p-p; ±0.2 dB, <3 V p-p
100 kHz to 20 MHz: ±0.4 dB, ≥3 V p-p; ±0.6 dB, 0.1 to 3 V p-p
Sine Wave Spectral Purity
Phase Noise: –60 dB for a 30 kHz band centered on a 20 MHz carrier (excluding ±1 Hz about the carrier) with high-stability Opt 001 installed
Spurious: All non-harmonically related output signals will be more than 70 dB below the carrier (60 dB with dc offset) or less than –90 dBm, whichever is greater.
Sine Wave Harmonic Distortion: Harmonically related signals will be less than the following levels (relative to the fundamental) at full output for each range:

0.1 Hz-50 kHz	50 kHz-200 kHz	200 kHz-2MHz	2MHz-15 MHz	15 MHz-20 MHz
–65dB	–60 dB	–40 dB	–30 dB	–25 dB

Square Wave Characteristics
Rise/Fall Time: ≤20ns, 10% to 90% at full output
Overshoot: ≤5% of peak-to-peak amplitude, at full output
Settling Time: <1 μs to settle to within .05% of final value
Offset
Range: dc only (no ac signal): 0 to ±5.0 V/50 Ω
DC + ac: Maximum dc offset ±4.5 V on highest range, decreasing to ±4.5 mV on lowest range.
Resolution: 4 digits
Sine Wave Amplitude Modulation
Modulation Depth at Full Output for Each Range: 0 to 100%
Modulation Frequency Range: DC to 400 kHz (for 0 to 21 MHz carrier)
Sensitivity: ±5 V peak for 100% modulation
Sine Wave Phase Modulation
Range: ±850°, ±5 V input
Modulation Frequency Range: DC to 5 kHz

Frequency Sweep

Sweep Time
Linear: 0.01 to 1000s
Logarithmic: 1 s to 1000s single, 0.1 s to 1000s continuous
Discreet Sweep
Number of Segments: 100 maximum
Time/Segment: 0.01 s to 1000s, 0.01 s resolution
Maximum Sweep Width: Full frequency range for the waveform in use; minimum log start frequency 1 Hz.
Phase: Continuous over the full frequency range

Modulation Source

Frequency Range: Sine 0.1 Hz to 10 kHz, square 0.1 Hz to 2 kHz
Frequency Accuracy: 0.1%, typical
Impedance: Drives 10 kΩ or greater load
Sinewave Purity: –34 dBc or better, typical
Waveforms: Sine, square, arbitrary

Auxiliary Inputs and Outputs

Auxiliary Frequency Output: 21 MHz to 60.999 999 999 MHz; 0 dBm; output impedance 50 Ω.
Sync Output: Square wave with V (high) ≥1.2 V, V (low) ≤0.2 V into 50 Ω. Frequency range is the same as main signal for front panel sync and dc to 60 MHz for rear panel sync.
X-Axis Drive: 0 to >+10 Vdc linear ramp proportional to sweep frequency, linearity, 10-90%, ±0.1% of final value

Option 001 High Stability Frequency Reference

Aging Rate: ±5 x 10^{-8}/week (72 hr warm up); ±1 x 10^{-7}/month (after 15 days continuous operation)
Ambient Stability: ±5 x 10^{-8} (0° C to +55° C)
Warm-Up Time: Reference will be within ±1 x 10^{-7} of final value 15 minutes after turn-on for an off time of less than 24 hours.

Option 002 High Voltage Output

Frequency Range: 1 μHz to 1 MHz
Amplitude
Range: 4.00 mV p-p to 40.00 V p-p (≥500 Ω, ≤500 pF load)
Accuracy: ±2% of full output for each range at 2 kHz
Output Impedance: <2 Ω at dc, <10 Ω at 1 MHz
DC Offset Range: Four times the specified range of the standard instrument.

General Specifications

Weight: Net, 9 kg (20 lb); shipping, 14.5 kg (32 lb)
Size: 425.5 mm W x 132.6 mm H x 497.8 mm D (16.75 in x 5.25 in x 19.63 in)

Key Literature

HP 3325B Synthesizer/Functional Generator, Data Sheet, p/n 5954-7986

For more information, visit our website:
http://www.tmo.hp.com/tmo/datasheets/English/HP3325B.html

Ordering Information*

HP 3325B Frequency Synthesizer, DC-21 MHz
Opt 001 High Stability Frequency Reference
Opt 002 High Voltage Output
Opt H05 Internal MATE Programming
Opt W30 Extended Repair Service

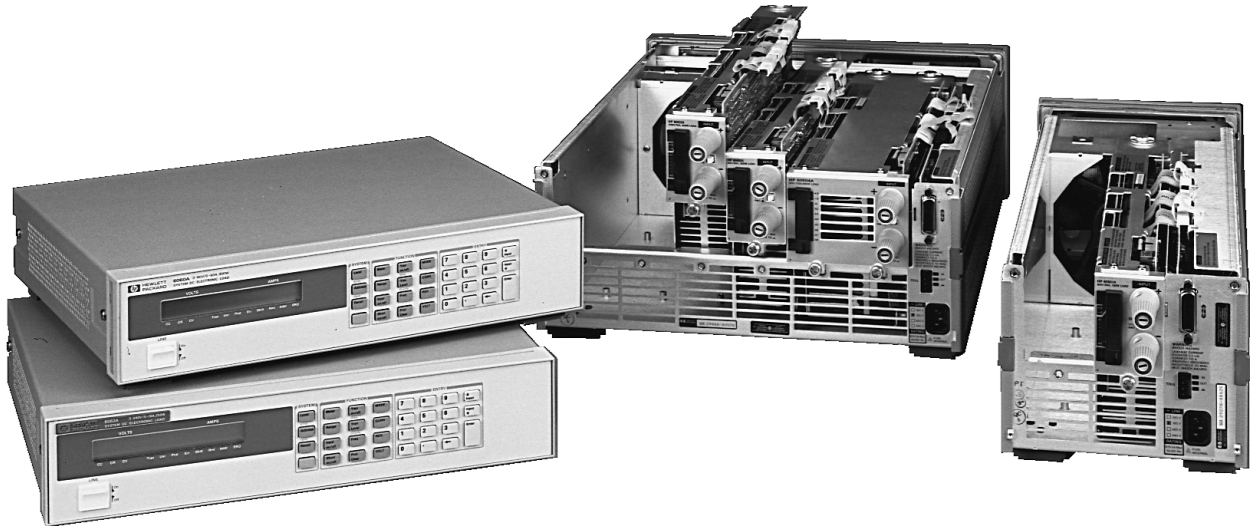
*HP-IB cable not supplied

DC Electronic Loads

Electronic Load Family

HP 6050A
HP 6051A
HP 6060B
HP 6063B
HP 60501B to 60507B

- Programmable control of current, voltage, and resistance
- Accurate readback of current, voltage, and power
- Built-in waveform generation for transient simulation
- Continuous and pulse loading operation
- Full protection features
- Trigger input for external synchronization
- Parallel operation for higher power
- Up to 240 V loads available
- Single-input or multiple-input mainframes available
- Three-year standard warranty



HP 6060B and 6063B

HP 6050A with HP 60500 Series Modules

HP 6051A with HP 60500 Series Module

HP dc Electronic Loads

HP dc electronic loads are ideal for testing and evaluating dc power sources, power components, and battery capacity testing.

Everything You Need in an HP One-Box Solution

HP dc electronic loads feature an integrated HP-IB programmer, pulse generator, current shunt, and DMM. The HP one-box solution saves space, cost and time while making HP dc electronic loads easy to integrate into automated test systems.

Performance and Ease-of Use

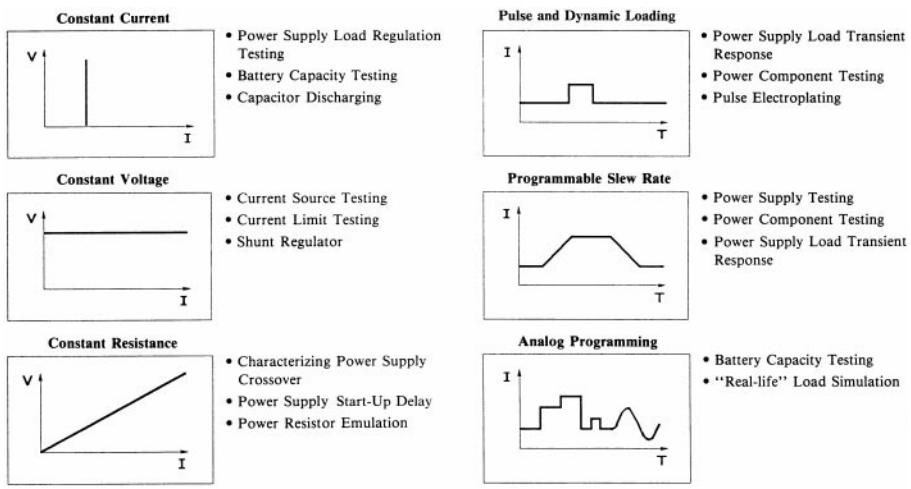
HP dc electronic loads are optimized for a broad range of dynamic loading applications. They offer high stability for applications where fast transients are applied to the load inputs, such as during dc power supply startup characterization or transient response testing. Dynamic load performance can be further tailored to specific application needs with programmable amplitudes, frequency, duty cycle, and slew rate.

Programmable Capabilities

HP-IB and analog programmable interfaces are standard features. HP dc electronic loads are fully compatible with industry-standard SCPI command set. The HP-IB interface allows complete control of all load functions as well as measurement readback of input voltage, current, power and detailed operating status. HP dc electronic loads also include analog voltage inputs for real life simulation of load current.

Versatile Solutions

HP dc electronic loads are equally suitable for manual use on the bench. The front-panel LCD meters indicate voltage, current and power readings. The full function keypad allows easy, repeatable and reliable control of the load. User-definable power-up state and fix volatile states allow you to easily save settings for later recall.



DC Electronic Load Applications

Single-Input Products

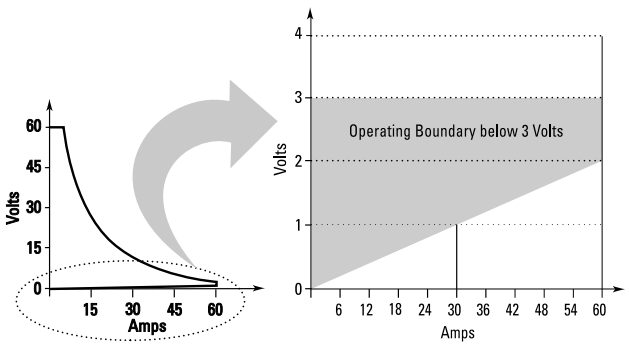
HP 6060B and HP 6063B are single-input dc electronic loads. HP 6060B is a 300W, 60V, 60A load and HP 6063B is a 250W, 240V, 10A load.

Mainframe Products

HP 6050A 1,800W and HP 6051A 600W electronic loads accept the user-installable HP load modules for easy system configuration. The HP 6050A holds up to six HP 60501B, 60502B, and 60503B load modules, or three HP 60504B load modules. The HP 6051A holds up to two load modules.

Operating Below the Minimum Input Voltage

HP electronic loads meet all specifications when operated above 3V; however, the dc operating characteristics also extend below this minimum-input voltage for static tests. The figure below shows the operating range of a typical HP dc electronic load. Low voltage operation, down to zero volts, is possible at correspondingly-reduced current levels, depending on the minimum resistance of the load. HP electronic loads, therefore, can be used in many applications that previously required zero-volt loads.



Battery Testing

HP 6050A option J10, HP 6051A option J10 and HP 6060B option J10 electronic loads are modified for battery testing. These products provide tri-level pulse loading to simulate accurate conditions on batteries. They also feature a programmable minimum battery voltage threshold. If the voltage of the battery under test falls below this threshold, the load will automatically turn off.

Key Literature

1998/99 HP Power Products Catalog, p/n 5966-1706

For more information, visit our website: **http://www.hp.com/go/loads**

Ordering Information

HP 6050A Six-slot, 1800 W dc Electronic Load Mainframe
- **Opt 908** Rackmount kit (p/n 5062-3978)
- **Opt 909** Rackmount kit with handles (p/n 5062-3984)

HP 6051A Two-slot, 600W dc Electronic Load mainframe
- **Opt 800** Rackmount kit for two units mounted side-by-side (p/n 5061-9694 and 5062-3978)
- **Opt 908** Rackmount kit (p/n 5062-3960)

HP 6060B Single-input, 300 W dc Electronic Load

HP 6063B Single-input, 600 W dc Electronic Load
- **Opt 020** Front panel inputs
- **Opt 908** Rackmount kit (p/n 5062-3974)
- **Opt 909** Rackmount kit with handles (p/n 5062-3975)

HP 60501B 150 W dc Electronic Load Module

HP 60502B 300 W dc Electronic Load Module

HP 60503B 250 W dc Electronic Load Module

HP 60504B 600 W dc Electronic Load Module

HP 60507B 500 W dc Electronic Load Module

Standard Options
- **Opt 100** 87 to 106 Vac, 47 to 66 Hz (for Japan only)
- **Opt 220** 191 to 233 Vac, 47 to 66 Hz
- **Opt 240** 209 to 250 Vac, 47 to 66 Hz
- **Opt 910** Extra manual set for HP 6050A, 6051A For HP 6060B, 6063B, 60501-60507

Specifications

Abbreviated Technical Specifications and Characteristics

Hewlett-Packard Model	HP 6060B, 60502B	HP 6063B, 60503B	HP 60501B	HP 60504B	HP 60507B
Amperes	0 to 60 A	0 to 10 A	0 to 30 A	0 to 120 A	0 to 60 A
Volts	3 to 60 V	3 to 240 V	3 to 60 V	3 to 60 V	3 to 150 V
Maximum power (at 40° C)	300 W	250 W	150 W	600 W	500 W
Constant current mode					
Ranges	0 to 6 A, 0 to 60 A	0 to 1 A, 0 to 10 A	0 to 3 A, 0 to 30 A	0 to 12 A, 0 to 120 A	0 to 6 A, 0 to 60 A
Accuracy	0.1% ±75 mA	0.15% ±10 mA	0.1% ±40 mA	0.12% ±130 mA	0.1% ±80 mA
Regulation	10 mA	8 mA	10 mA	10 mA	10 mA (w/≥3 V at the point)
Constant voltage mode					
Accuracy	0.1% ±50 mV	0.12% ±120 mV	0.1% ±50 mV	0.1% ±50 mV	0.1% ±125 mV
Regulation (w/remote sense)	10 mV	10 mV	5 mV	20 mV	10 mV
Constant resistance mode	0.033 to 1.0 Ω	0.20 to 24.0 Ω	0.067 to 2 Ω	0.017 to 0.5 Ω	0.033 to 2.5 Ω
Ranges	1 to 1,000 Ω	24 to 10,000 Ω	2 to 2,000 Ω	0.5 to 500 Ω	2.5 to 2,500 Ω
	10 to 10,000 Ω	240 to 50,000 Ω	20 to 10,000 Ω	5 to 5,000 Ω	25 to 10,000 Ω
Accuracy (with ≥10% of rated current at input)	1 Ω: 0.8% ±8 mΩ 1 KΩ: 0.3% ±8 mS 10 KΩ: 0.3% ±8 mS	24 Ω: 0.8% ±200 mΩ 10 KΩ: 0.3% ±0.3 mS 50 KΩ: 0.3% ±0.3 mS	2 Ω: 0.8%, ±16 mΩ 2 KΩ: 0.3% ±5 mS 10 KΩ: 0.3% ±5 mS	0.5 Ω: 0.8% ±5 mΩ 500 Ω: 0.3% ±18 mS 5 KΩ: 0.3% ±18 mS	2.5 Ω: 0.8% ±16 mΩ 2.5 KΩ: 0.3% ±5 mS 10 KΩ: 0.3% ±5 mS
Transient generator					
Frequency range	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz
Accuracy	3%	3%	3%	3%	3%
Duty cycle range	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)
Accuracy	6% of setting ±2%	6% of setting ±2%	6% of setting ±2%	6% of setting ±2%	6% of setting ±2%
Readback measurement					
Current accuracy	± (0.05% ±65 mA)	± (0.12% ±10 mA)	± (0.06% ±40 mA)	± (0.1% ±110 mA)	± (0.1% ±65 mA)
Voltage accuracy	± (0.05% +45 mV)	± (0.01% +150 mV)	± (0.5% +45 mV)	± (0.1% +45 mV)	± (0.1% +90 mV)
Display resolution	20 mV	100 mV	20 mV	20 mV	100 mV
Ripple and noise (20-Hz to 10-MHz noise)	4 mA rms/40 mA p-p	1 mA rms/10 mA p-p	2 mA rms/20 mA p-p	6 mA rms/60 mA p-p	4 mA rms/40 mA p-p
Voltage	6 mV rms	6 mV rms	5 mV rms	8 mV rms	10 mV rms
Constant current mode	60-A range: 16 mA	10-A range: 2.6 mA	30-A range: 8 mA	120-A range: 32 mA	60-A range: 16 mA
Resolution	6-A range: 1.6 mA	1-A range: 0.26 mA	3-A range: 0.8 mA	12-A range: 3.2 mA	6-A range: 1.6 mA
Constant voltage mode					
Resolution	16 mV	64 mV	16 mV	16 mV	40 mV
Constant resistance mode	1 Ω: 0.27 mΩ	24 Ω: 6 mΩ	2 Ω: 0.54 mΩ	0.5 Ω: 0.14 mΩ	2.5 Ω: 0.67 mΩ
Resolution	1 KΩ: 0.27 mS	10 KΩ: 0.011 mS	2 KΩ: 0.14 mS	500 Ω: 0.54 mS	2.5 KΩ: 0.10 mS
	10 KΩ: 0.027 mS	50 KΩ: 0.001 mS	10 KΩ: 0.014 mS	5 KΩ: 0.054 mS	10 KΩ: 0.01 mS
Transient generator					
Frequency range	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz
Resolution	4% or less	4% or less	4% or less	4% or less	4% or less
Duty cycle range	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)
Analog programming bandwidth	10 kHz (–3 dB frequency)	10 kHz (–3 dB frequency)	10 kHz (–3 dB frequency)	10 kHz (–3 dB frequency)	10 kHz (–3 dB frequency)
Analog programming accuracy					
Current (low range)	4.5% ±75 mA	3% ±8 mA	4.5% ±40 mA	4% ±200 mA	4.5% ±75 mA
Current (high range)	4.5% ±250 mA	3% ±20 mA	4.5% ±130 mA	4% ±400 mA	4.5% ±200 mA
Voltage	0.8% ±200 mV	0.5% ±150 mV	0.8% ±200 mV	0.8% ±200 mV	0.8% ±375 mV
Analog programming voltage	0 to 10 V	0 to 10 V	0 to 10 V	0 to 10 V	0 to 10 V
Analog monitor accuracy					
Current monitor (0 to 10 V out)	4% ±85 mA	3% ±10 mA	4% ±40 mA	4% ±170 mA	3% ±85 mA
Voltage monitor (0 to 10 V out)	0.25% ±40 mV	0.4% ±240 mV	0.25% ±40 mV	0.4% ±60 mV	0.4% ±120 mV
Remote sensing	5-Vdc maximum between sense and load input				
Minimum operating voltage	2 volts (1.2 V typical)	2 volts (1.2 V typical)	2 volts (1.2 V typical)	2 volts (1.4 V typical)	2 volts (1.4 V typical)
Programmable short	0.033 Ω (0.020 Ω typical)	0.20 Ω (0.10 Ω typical)	0.066 Ω (0.040 Ω typical)	0.017 Ω (0.012 Ω typical)	0.033 Ω (0.025 Ω typical)
Programmable open (typical)	20 kΩ	80 kΩ	20 kΩ	20 kΩ	20 kΩ
dc isolation voltage	±240 Vdc, between any input and chassis ground				

Notes:
1. Operating temperature range is 0° to 55° C. All specifications apply for 25° C ±5° C, except as noted.
2. Maximum continuous power available is derated linearly from 40° C to 75% of maximum at 55° C.
3. DC current accuracy specifications apply 30 seconds after input is applied.

Regulatory Compliance: VL-1244, listed, CSA 556B certification, IEC 348
RFI Suppression: CISPR-11, Group 1, Class B

Weight
HP 6050A: 9.5 kg (21 lb)
HP 6051A: 5.5 kg (12 lb)
HP 6060B, 6063B: 6.12 kg (13.5 lb)
HP 60501B, 60502B, 60503B: 3.2 kg (7 lb)
HP 60504B, 60507B: 5.4 kg (13 lb)

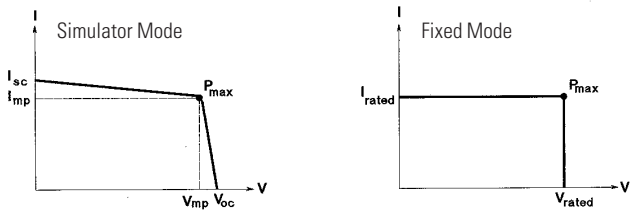
The E4350B/E4351B simulates the output characteristic of a satellite's solar panels as it moves from darkness to light.

HP Solar Array Simulator

The HP one-box Solar Array Simulator (SAS) is a dc power source that simulates the output characteristics of a solar array. The HP SAS is primarily a current source with very low output capacitance and is capable of simulating the I-V curve of different arrays under different conditions (i.e., temperature, age, etc.). The I-V curve is programmable over the IEEE-488.2 bus and is conveniently generated within the HP SAS.

The HP SAS provides three current operating modes:

1. Simulator Mode: An internal algorithm is used to approximate a SAS I-V curve. Four input parameters: Voc (open circuit voltage), Isc (short circuit current), Imp and Vmp (current and voltage at the peak power point on the curve) are needed to establish a curve in this mode.



2. Table Mode: For a fast and accurate I-V simulation, the HP SAS provides a table mode. The I-V curve is set by a user-defined table of points. A table can have any length up to 4000 points (a point corresponds to a specific value of I and V). As many as 30 tables may be stored in the HP SAS built-in volatile and non-volatile memory.

Non-volatile memory can store a maximum of 3500 points. The tables (I-V curves) are easily stored and recalled with an IEEE-488.2 command. The table(s) stored in this memory will be retained when the power is turned off.

Volatile memory greatly increases the flexibility by saving up to 30,000 points. Multiple tables are easily accessed with IEEE-488.2 command. These tables will be erased after power is removed.

In Table Mode, current and voltage offsets can be applied to the selected table to simulate a change in the operating conditions of the solar array.

3. Fixed Mode: This is the default mode when the unit is powered on. The unit has the rectangular I-V characteristics of a standard power supply, when an output capacitor is added in this mode.

Specifications

	HP E4350B	HP E4351B
For simulator and table modes		
Max. Power	480 W	480 W
Voc, Max.*	65 V	130 V
Isc, Max.*	8 A	4 A
For fixed mode		
Max. Power	480 W	480 W
V rated*	0–60 V	0–120 V
I rated*	0–8 A	0–4 A

*Other voltage/current combinations may be configured to meet your unique requirements.

Programming Accuracy: at 25°C + 5°C (SAS and Table Mode)
- **Voltage:** (Fixed Mode)
  - 0.075% + 10 mV (E4350B)
  - 0.075% + 20 mV (E4351B)
- **Current:** (Simulator and Fixed Mode)
  - 0.2% + 20 mA (E4350B)
  - 0.2% + 10 mA (E4351B)

Ripple and Noise: (20 Hz to 20 MHz) with outputs ungrounded or with either terminal grounded (Simulator and Table Mode)
- **Voltage:** rms 0.025% of rated voltage; p-p 0.2% of rated voltage
- **Current:** rms 0.05% of rated current

Load Switching Recovery Time: < 5μs when switched from short circuit to variable load to within 1.5 A of an operating point on the I-V curve.

Load/Line Regulation: Change in output voltage or current for any load or line change within ratings (Fixed Mode)
- **Voltage:** 2 mV
- **Current:** 1 mA

ac Input: 104 to 127 Vac

Voltage	100 Vac	120 Vac	220 Vac	240 Vac
Current	12 A	10 A	5.7 A	5.3 A

Supplemental Characteristics

Supplemental characteristics are intended to provide information useful in applying the HP SAS by describing nonwarranted performance that has been determined by design or type testing.

Remote Sensing: Up to 5% of the rated output voltage can be dropped in each load lead. The drop in the load leads subtracts from the voltage available for the load. Add 3 mV to the voltage load regulation specification for each 1 volt change in the positive output lead due to load current change.

Analog Programming of Output Voltage and Current
- **Input Signal:** 0 to –4 V
- **Input Impedance:** 20 k Ohms nominal

Shunt Regulation: Switching frequency up to 50 kHz

Series Regulation: Switching frequency up to 50 kHz

OVP and OCP: Overvoltage and overcurrent protection triggers in <100 μs

Capacitive Load: In fixed mode, the maximum load capacitance (without causing instability) is 2000μF. In simulator and table mode, it is unconditionally stable at all capacitive loads.

Inductive Load: The maximum load capacitance (without causing instability) is 200μH

Size: 425.5 mm W x 132.6 mm H x 497.8 mm D (16.75 in x 5.25 in x 19.6 in)

Weight: Net, 25 kg (54 lb): shipping, 28 kg (61 lb)

Warranty: Three years

Key Literature

1998/99 HP Power Products Catalog, p/n 5966-1706

For more information, visit our web site:
http://www.hp.com/go/solarsimulator

Ordering Information

Simulators can be ordered as individual modules or as a fully customized system.
- **Opt 0BN** Service Manual and extra Operating Guide
- **Opt 100** 87 to 106 Vac, 47 to 63 Hz
- **Opt 220** 191 to 233 Vac, 47 to 63 Hz
- **Opt 240** 209 to 250 Vac, 47 to 63 Hz
- **Opt 908** Rackmount Kit, HP p/n 5062-3977
- **Opt 909** Rackmount Kit with Handles, HP p/n 5062-3983

Accessories
HP p/n 1252-3698 7-pin Analog Plug
HP p/n 1252-1488 4-pin Digital Plug
HP p/n 5080-2148 Serial Link Cable 2 m (6.6 ft)
HP p/n 1494-0059 Accessory Slide Kit

HP-IB System Power Supplies

Single Output

Max. volts (dc)	Max. amps (dc)	Max. watts	Output Operating Boundary	HP Model Number	Page
5	875	4400	Rectangular	6680A	190
6.7	30	200	Autoranging	6033A	191
7	120	1000	Autoranging	6031A	191
8	5	40	Rectangular	6611C	184
8	10	80	Rectangular	6631B	186
8	20	160	Rectangular	6641A	187
8	50	400	Rectangular	6651A	188
8	220	1760	Rectangular	6671A	189
8	580	4600	Rectangular	6681A	190
20	2	40	Rectangular	6612B	184
20	2	40	Rectangular	66312A	183
20	5	100	Rectangular	6632B	186
20	5	100	Rectangular	66332A	183
20	10	200	Autoranging	6033A	191
20	10	200	Autoranging	6038A	191
20	10	200	Rectangular	6642A	187
20/8	10/20	200/160	Rectangular	E3633A	193
20	25	500	Rectangular	6652A	188
20	50	1000	Autoranging	6031A	191
20	50	1200	Autoranging	6032A	191
20	100	2000	Rectangular	6672A	189
21	240	5000	Rectangular	6682A	190
30/15	4/7	120/105	Rectangular	E3632A	193
32	160	5100	Rectangular	6683A	190
35	6	210	Rectangular	6643A	187
35	15	525	Rectangular	6653A	188
35	60	2100	Rectangular	6673A	189
40	128	5100	Rectangular	6684A	190
50	1	50	Rectangular	6613C	184
50	2	100	Rectangular	6633B	186
60	3.3	200	Autoranging	6038A	191
60	3.5	210	Rectangular	6644A	187
60	9	540	Rectangular	6654A	188
60	17	1200	Autoranging	6030A	191
60	17.5	1200	Autoranging	6032A	191
60	30	150	Rectangular	60501B	179
60	35	2100	Rectangular	6674A	189
60	60	300	Rectangular	6060B	179
60	60	300	Rectangular	60502B	179
60	120	600	Rectangular	60504B	179
65	8	480	Rectangular	E4350B	177
100	0.5	50	Rectangular	6614C	184
100	1	100	Rectangular	6634B	186
120	1.5	180	Rectangular	6645A	187
120	4	540	Rectangular	6655A	188
120	18	2160	Rectangular	6675A	189
130	4	480	Rectangular	E4351B	177
150	60	500	Rectangular	60507B	179
200	5	1000	Autoranging	6035A	191
200	5	1200	Autoranging	6030A	191
240	10	250	Rectangular	6063B	179
240	10	250	Rectangular	60503B	189
500	2	1000	Autoranging	6035A	191

Available on Special Order

Single Output 100 to 5000 watts per output

Max. volts (dc)	Max. amps (dc)	Max. watts	Output Operating Boundary	HP Model Number
4	1000	4000	Rectangular	6680A-J03
5	250	1000	Rectangular	6671A-J14
6	60	360	Rectangular	6651A-J03
8	250	2000	Rectangular	6671A-J05
10	50	500	Rectangular	6651A-J01
10	200	2000	Rectangular	6671A-J04
14	150	2000	Rectangular	6671A-J03
15	30	450	Rectangular	6651A-J05
15	120	1800	Rectangular	6671A-J17
18	280	5000	Rectangular	6682A-J01
24	85	2000	Rectangular	6672A-J04
30	3.3	100	Rectangular	66332A-J01
30	17.5	500	Rectangular	6653A-J17
30	65	2000	Rectangular	6673A-J09
32	16	500	Rectangular	6653A-J16
36	15	500	Rectangular	6653A-J09
36	55	2000	Rectangular	6673A-J04
37.5	45	1700	Rectangular	6673A-J03
38	55	2000	Rectangular	6673A-J07
40	5	200	Rectangular	6643A-J11
40	12.5	500	Rectangular	6653A-J04
40	50	2000	Rectangular	6673A-J08
45	12	500	Rectangular	6654A-J29
50	10	500	Rectangular	6654A-J05
50	42	2000	Rectangular	6674A-J07
50	100	5000	Rectangular	6684A-V50
55	38	2000	Rectangular	6674A-J03
70	3	200	Rectangular	6644A-J09
70	7.5	500	Rectangular	6654A-J04
70	30	2000	Rectangular	6674A-J06
80	6	500	Rectangular	6654A-J12
80	26	2000	Rectangular	6674A-J05
100	22	2000	Rectangular	6675A-J08
110	20	2000	Rectangular	6675A-J09
135	16	2000	Rectangular	6675A-J06
150	1.2	150	Rectangular	6645A-J05
150	3.2	500	Rectangular	6655A-J05
150	15	2000	Rectangular	6675A-J11
156	3	500	Rectangular	6655A-J10
160	13	2000	Rectangular	6675A-J04
200	11	2000	Rectangular	6675A-J07

Key Literature

1998/99 *HP Power Products Catalog,* p/n 5966-1706

For more information, visit our web site:
http://www.hp.com/go/power

Multiple Output

Range 1		Range 2			Outputs for each HP model number											
Max. volts (dc)	Max. amps (dc)	Max. volts (dc)	Max. amps (dc)	Max. watts per output	6621A page 185	6622A page 185	6623A page 185	6624A page 185	6625A page 185	6626A page 185	6627A page 185	6628A page 185	6629A page 185	E3631A page 193	E3632A page 193	E3633A page 193
6	5	—	—	—	—	—	—	—	—	—	—	—	—	Output 3	—	—
7	0.015	50	0.5	25	—	—	—	—	Output 1	Outputs 1–2	—	—	—	—	—	—
7	5	20	2	40		—	Output 1	Outputs 1–2	—	—	—	—	—	—	—	—
7	10	20	4	80	Outputs 1–2	—	Output 3	—	—	—	—	—	—	—	—	——
8	20	20	10	200	—	—	—	—	—	—	—	—	—	—	—	Output 1
15	7	30	4	120	—	—	—	—	—	—	—	—			Output 1	—
16	0.2	16	2	50	—	—	—	—	Output 2	Outputs 3–4	—	Outputs 1–2	Outputs 1-4	—	—	—
16	0.2	50	1	50	—	—	—	—	Output 2	Outputs 3–4	—	Outputs 1–2	Outputs 1-4	—	—	—
20	2	50	0.8	40	—		Output 2	Outputs 3–4	—	—	Outputs 1-4	—	—	—	—	—
20	4	50	2	100	—	Outputs 1–2	—	—	—	—	—	—	—	—	—	—
±25	1			25	—	—	—	—	—	—	—	—		Outputs 1–2	—	—
Output Operating Boundary					Rectangular											

Manually-Controlled and Analog-Programmable Power Supplies

Single Output

Max. volts (dc)	Max. amps (dc)	Max. watts	Type	Manually controlled analog-prog	HP Model Number	Page
6.7	30	200	Autoranging	MC/AP	6023A	191
7	120	840	Autoranging	MC/AP	6011A	191
8	3	24	Dual-range	MC	E3610A	195
8	6	48	Rectangular	MC/AP	E3614A	195
8	20	160	Rectangular	MC/AP	6541A	187
8	50	400	Rectangular	MC/AP	6551A	188
8	220	1760	Rectangular	MC/AP	6571A	189
15	2	30	Dual-range	MC	E3610A	195
20	1.5	30	Dual-range	MC	E3611A	195
20	3	60	Rectangular	MC/AP	E3615A	195
20	10	200	Autoranging	MC/AP	6023A	191
20	10	200	Autoranging	MC/AP	6024A	191
20	10	200	Rectangular	MC/AP	6542A	187
20	25	500	Rectangular	MC/AP	6552A	188
20	50	1000	Autoranging	MC/AP	6011A	191
20	50	1000	Autoranging	MC/AP	6012B	191
20	100	2000	Rectangular	MC/AP	6572A	189
35	0.85	30	Dual-range	MC	E3611A	195
35	1.7	60	Rectangular	MC/AP	E3616A	195
35	6	210	Rectangular	MC/AP	6543A	187
35	15	525	Rectangular	MC/AP	6553A	188
35	60	2100	Rectangular	MC/AP	6573A	189
40	5.7	228	Autoranging	MC/AP	6028A	191
40	30	1200	Autoranging	MC/AP	6012B	191
60	0.5	30	Dual-range	MC	E3612A	195
60	1	60	Rectangular	MC/AP	E3617A	195
60	3.3	200	Autoranging	MC/AP	6028A	191
60	3.5	210	Rectangular	MC/AP	6544A	187
60	9	540	Rectangular	MC/AP	6554A	188
60	17	1020	Autoranging	MC/AP	6010A	191
60	17.5	1050	Autoranging	MC/AP	6012B	191
60	35	2100	Rectangular	MC/AP	6574A	189
120	0.25	30	Dual-range	MC	E3612A	195
120	1.5	180	Rectangular	MC/AP	6545A	187
120	4.5	540	Rectangular	MC/AP	6555A	188
120	18	2160	Rectangular	MC/AP	6575A	189
200	5	1000	Autoranging	MC/AP	6010A	191
200	5	1000	Autoranging	MC/AP	6015A	191
500	2	1000	Autoranging	MC/AP	6015A	191

Modules for HP 66000 Modular Power System

Up to 8 per mainframe

Max. volts (dc)	Max. amps (dc)	Max. watts	HP Model Number	Page
8	16	128	66101A	180
20	7.5	150	66102A	180
35	4.5	150	66103A	180
60	2.5	150	66104A	180
120	1.25	150	66105A	180
200	0.75	150	66106A	180

Available on Special Order

Max. volts (dc)	Max. amps (dc)	Max. watts	HP Model Number
5.7	20	100	66101A-J03
12	12	150	66101A-J03
15	10	150	66102A-J05
24	6	100	66103A-J12
28	5	1400	66103A-J09
35	1.25	40	66105A-J01
37	4	150	66103A-J01
40	3.6	100	66103A-J02

Multiple Output

Max. volts (dc)	Max. amps (dc)	Max. watts per output	Outputs for each HP model number: E3620A MC Page 194	Outputs for each HP model number: E3630A MC Page 194
6	2.5	1.5		Output 1
±20	0.5	10		Outputs 2 & 3
25	1	25	Outputs 1 & 2	
40	0.3	25	Output 3	

*MC=Manually controlled. AP=Analog programmable.

Single Output

Available on Special Order

Max. volts (dc)	Max. amps (dc)	Max. watts	Output Operating Boundry	Manually controlled analog-prog	HP Model Number
10	200	2000	Rectangular	MC/AP	6571A-J04
13	15.3	200	Rectangular	MC/AP	6541A-J04
14	150	2000	Rectangular	MC/AP	6571A-J03
30	65	2000	Rectangular	MC/AP	6573A-J09
35	8	280	Rectangular	MC/AP	6553A-J21
36	55	2000	Rectangular	MC/AP	6573A-J04
37.5	45	1500	Rectangular	MC/AP	6573A-J03
40	50	2000	Rectangular	MC/AP	6673A-J08
40	5	200	Rectangular	MC/AP	6543A-J11
50	42	2000	Rectangular	MC/AP	6574A-J07
55	38	2000	Rectangular	MC/AP	6574A-J03
70	7.5	500	Rectangular	MC/AP	6554A-J04
70	30	2000	Rectangular	MC/AP	6574A-J06
100	22	2000	Rectangular	MC/AP	6575A-J08
110	20	2000	Rectangular	MC/AP	6675A-J09
135	16	2000	Rectangular	MC/AP	6575A-J06
150	1.2	150	Rectangular	MC/AP	6545A-J05
150	3	500	Rectangular	MC/AP	6555A-J10
160	13	2000	Rectangular	MC/AP	6675A-J04
200	11	2000	Rectangular	MC/AP	6575A-J07

For more information, visit our web site:
http://www.hp.com/go/power

Modular Power System

HP 66000A
HP 66001A
HP 66101A
to 66106A

- High density 1200W mainframe in 7 inches of rack space
- 8-slot modular power system
- Stable, low ripple and noise power source
- High-accuracy readback of voltage and current
- Advanced programmable voltage and current control
- Sequence up to 20 voltage and current setting per output
- Optional isolation and polarity-reversal relays
- Three-year standard warranty

HP 66000 Modular Power System

HP 66000 Modular Power System is ideal for automated testing environments for supplying bias power and stimulus to subassemblies and final products.

Key Features

- HP-IB programmable voltage and current
- Series and parallel operation
- Programmable over-voltage and over-current protection
- Self-test initiated at power-up or from HP-IB command
- Electronic calibration over HP-IB or from keyboard
- Over-temperature protection
- Discrete fault indicator/remote inhibit (DFI/RI)
- Five nonvolatile store-recall states per output
- User-definable power-on state

Abbreviated Specification and Characteristics

		HP 66101A	HP 66102A	HP 66103A	HP 66104A	HP 66105A	HP 66106A
Output ratings (at 40° C)	Output Voltage	0 to 8 V	0 to 20 V	0 to 35 V	0 to 60 V	0 to 120 V	0 to 200 V
	Output Current	0 to 16 A	0 to 7.5 A	0 to 4.5 A	0 to 2.5 A	0 to 1.25 A	0 to 0.75 A
	Output Power	128 W	150 W	150 W	150 W	150 W	150 W
Programming accuracy (at 25° C ±5° C)	Voltage 0.03%+	3 mV	8 mV	13 mV	27 mV	54 mV	90 mV
	Current 0.03%+	6 mA	3 mA	2 mA	1.2 mA	0.6 mA	0.4 mA
Readback accuracy (via HP-IB or keyboard display at 25° C ±5° C)	Voltage 0.02%+	2 mV	5 mV	8 mV	16 mV	32 mV	54 mV
	Current 0.02%+	6 mA	3 mA	2 mA	1 mA	0.6 mA	0.3 mA
Ripple and noise (20 Hz to 20 MHz)	Constant voltage rms	2 mV	3 mV	5 mV	9 mV	18 mV	30 mV
	peak to peak	5 mV	7 mV	10 mV	15 mV	25 mV	50 mV
	Constant current rms	8 mA	4 mA	2 mA	1 mA	1 mA	1 mA
Line Regulation	Voltage	0.5 mV	0.5 mV	1 mV	2 mV	3 mV	5 mV
	Current	0.75 mA	0.5 mA	0.3 mA	0.1 mA	50 µA	30 µA
Load Regulation	Voltage	1 mV	1 mV	1 mV	2 mV	4 mV	7 mV
	Current	0.2 mA	0.2 mA	0.2 mA	0.1 mA	50 µA	30 µA

Transient Response Time: Less than 1 ms for the output voltage to recover within 100 mV of its previous level following any step change in load current up to 10 percent of rated current

Average resolution	Voltage	2.4 mV	5.9 mV	10.4 mV	18.0 mV	36.0 mV	60.0 mV
	Current	4.6 mA	2.3 mA	1.4 mA	0.75 mA	0.39 mA	0.23 mA
	Output voltage programming (OVP)	50 mV	120 mV	200 mV	375 mV	750 mV	1.25 mV
OVP accuracy		250 mV	500 mV	800 mV	1 V	1.5 V	2.5 V

dc Floating Voltage: Output terminals can be floated up to ±240 Vdc from chassis ground
Remote Sensing: Up to half the rated output voltage can be dropped across each load lead. Add 2 mV to the voltage load regulation specification for each 1–V change in the negative output lead caused by a load current change.
Command Processing Time: The average time for the output voltage to change after getting an HP-IB command is 20 ms
Output Programming Response Time (with full resistive load): The rise and fall time (10/90% and 90/10%) of the output voltage is less than 20 ms. The output voltage change settles within 1 LSB (0.025% x rated voltage) of the final value in less than 120 ms.
Down Programming: An active down-programmer sinks approximately 10% of the rated output current
Calibration Interval: One year

ac Input of System Mainframe

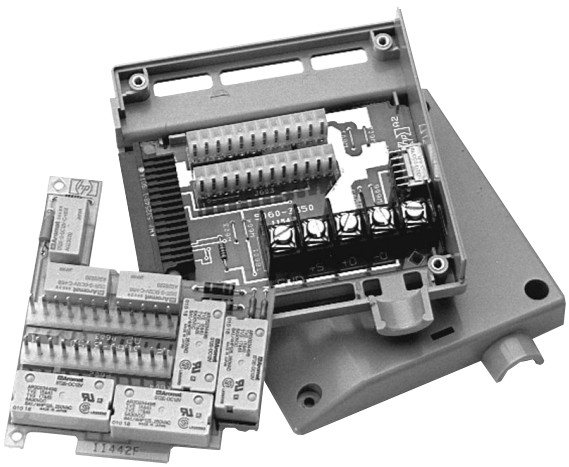
Voltage	100 Vac	120 Vac	200 Vac	220 Vac	230 Vac	240 Vac
Maximum current	29 A	24 A	16 A	16 A	15 A	15 A

Input Power of System Mainframe: 3200 VA (max.), 1800 W (max.), 1600 W (typ.)
Regulatory Compliance: Listed to UL-1244; certified to CSA 22.2 No. 231; conforms to IEC 1010, carries the CE mark
RFI Suppression: Complies with CISPR-11, Group 1, Class A
Weight:
Net: HP 66000A, 15 kg (33 lb); HP 66001A, 1.05 kg (2.3 lb); HP 66101–66106A, 2.8 kg (6 lb).
Shipping: HP 66000A, 19 kg (42 lb); HP 66001A, 1.34 kg (2.95 lb); HP 66101–66106A, 4.1 kg (9 lb).
Size: HP 66000A: 425.7 mm W x 184.94 mm H x 677.93 mm D (16.76 in x 7.28 in x 26.69 in), including feet and rear connectors
Warranty Period: Three years

Key Literature

1998/99 *HP Power Products Catalog*, p/n 5966-1706

For more information, visit our web site:
http://www.hp.com/go/modularPS



Isolation and polarity reversal relays are available as an option to the modules. The relay assembly fits into the module connector and can be fully controlled and sensed over the HP-IB.

Simple Way to Integrate Multiple Power Sources

A single HP 66000A mainframe can hold up to eight modules. Six modules are available with voltage ranges up to 200 V and current ranges up to 16 A. The built-in HP serial link feature can control up to 16 outputs at one HP-IB address by connecting an auxiliary mainframe.

System assembly is simplified thanks to a quick-disconnect connector assembly on each module. Once your wires are connected to the load, the connector design permits the modules to be removed from the front of the mainframe without disconnecting cabling or removing the mainframe from the rack. One connector assembly is shipped with each module.

No Compromise Performance with Modular Convenience

HP 66000 MPS offers high performance and reliability and the advantages of modularity. The HP 66000 MPS offers high stability for applications that need precise output control, accurate readback measurements, and low output noise.

Advanced Programmable Control

HP 66000 MPS features a powerful output capability, precise control of voltage and current, programmable protection features, user-definable power-on state and five non-volatile store-recall states per output. An optional keyboard offers full control of all programmable features. HP-IB interface is a standard feature fully compatible with the industry-standard SCPI command set.

Increase test throughput by using the output sequencing feature of the HP 66000 MPS. This powerful feature allows you to download up to 20 voltage, current, and dwell-time parameter sets per output. This sequence can be paced by the programmed dwell times. As an alternative, triggers can be used to step through the output list. The output sequences can be executed without controller intervention, thereby increasing overall test system throughput.

Ordering Information

HP 66000A MPS Mainframe
- **Opt 908** Rackmount Kit (HP p/n 5062-3978)
- **Opt 909** Rackmount Kit with Handles (HP p/n 5062-3984)
- **Note: Options 908 and 909** require cabinet rails or a slide kit (HP p/n 1494-0059) to support the loaded mainframe's weight.
- **Opt 910** Extra Manual Set (Standard unit is shipped with Installation Guide only.)

HP 66001A MPS Keyboard includes 2m (6 ft) cables (Order HP66002A to rackmount)
HP 66002A (Rack Kit for HP 66001A keyboard)
Module Options
HP 66101A dc Power Module 8 V, 16 A
HP 66102A dc Power Module 20 V, 7.5 A
HP 66103A dc Power Module 35 V, 4.5 A
HP 66104A dc Power Module 60 V, 2.5 A
HP 66105A dc Power Module 120 V, 1.25 A
HP 66106A dc Power Module 200 V, 0.75 A
- **Opt 760** Open/Close and Polarity Reversal Relays
- **Opt 910** Extra Manual Set: User's Guide, Programming Guide and Service Manual (Standard unit is shipped with Installation Guide only.)

Accessories
HP p/n 5060-3351 Field-Installable Relay Kit
HP p/n 5060-3386 Standard Connector Assembly
HP p/n 5060-3387 Standard Connector Assembly with installed relays (Option 760)
HP p/n 66000-90001 Mainframe Installation Guide
HP p/n 5959-3360 dc Power Module User's Guide
HP p/n 5959-3362 dc Power Module Programming Guide
HP p/n 66000-90003 Mainframe Service Manual
HP p/n 5959-3364 dc Power Module Service Manual
HP p/n 1252-1488 4-Pin FLT/Inhibit Connector
Line Cord Options
A line cord option must be specified. For details, refer to page 192.

182 Mobile Communications dc Source, Single-Output: 45 W

HP 66311A

NEW

Sourcing tailored to digital phone test
- 5 A peak current sourcing for next generation data transmission formats
- Excellent transient voltage response characteristics prevent test interruptions due to triggering low voltage phone shutdown
- Up to 2.8 A current sinking to test build in battery chargers
- Fast transient response, rapid command processing, and high speed output programming time maximize manufacturing test throughput
- Low power supply output noise assures less interference with phone operations

Measurement tailored to digital phone test
- Precision uA measurement for "sleep mode" characterization
- Dynamic current pulse measurements for battery loading information
- Precision voltage measurement for accurate tracking of charger voltage levels

The "One-Box" Solution designed for digital phone test.

Abbreviated Specifications and Characteristics

Output ratings	Voltage Average current at 45° C, derates linearly to 2.5 A at 55° C Peak Current for 7 ms, average current cannot exceed 3 A		15 V 3 A 5 A
Programming accuracy at 25° C ± 5° C	Voltage/+Current	0.05% +	10 mV/1.33 mA
Ripple and noise (20 Hz to 20 MHz, with outputs ungrounded or with either terminal grounded)	Voltage Current	(rms/p-p) (rms)	1 mV/6 mV 2 mA
DC measurement accuracy via HP-IB or front panel meters with respect to actual output at 25° C ± 5° C	Voltage Low current range -20 mA to + rated I High current range +20 mA to + rated I -20 mA to - rated I	0.03% + 0.1% + 0.2% + 0.2% +	5mV 2.5 μA 0.5mA 1.1mA
Load regulation	Voltage/Current		2 mV/0.75 mA
Line regulation	Voltage/Current		0.5 mV/0.75 mA
Transient Response Time: Less than 35 us for the output voltage to recover to within 20 mV of final value after 0.1 to 1.5 A load change when operating in the high mode compensation (loads from 5-12,000) μF).			
Average programming resolution	Voltage/Current		3.75 mV/0.67 mA
Sink current			2 A @ 7.5 V

Dynamic Measurements: Accuracy of the instantaneous voltage measurement is 0.03% + 5 mV. Accuracy of the instantaneous current measurement is 0.6% + 2 mA. The dc, rms, maximum, minimum, high-level and low-level voltage and current measurements are calculated from the instantaneous voltage and current readings. Up to 4096 data points can be aquired. The sampling interval can be varied from 15.6 us to 32,000 s. The instantaneous data points can also be read back from the storage buffer. Dynamic measurements on current waveforms with frequency content up to 1 kHz can be made on the low- or high-current range. Above 1 kHz, accurate current measurements must be made in the high range.
dc Floating Voltage: Output terminals can be floated up to 50 Vdc maximum from chassis ground.
Remote Sensing: Up to 4 V dropped in each lead. Add 2 mV to the voltage load regulation specification for each one volt change in the positive output lead due to load current change.
Command Processing Time: Average time required for the output voltage to begin to change following receipt of digital data is 4 ms for the power supplies connected directly to the HP-IB.
Output-Programming Response Time: The rise and fall time (10/90% and 90/10%) of the output voltage is less than 200 us. The output voltage change settles within 1 LSB (0.025% x rated voltage) of final value in less than 2 ms.
Measurement Time: Average time to process query, calculate measurement parameter and return data is 20 ms. The buffer data aquisition time which is user-programmable must be added. For the default condition (2048 data points and 15.6 us sampling interval), this time is 32 ms.
HP-IB Interface Capabilities: IEEE-488.2, SCPI command set, and 6630x series programming capability with a limited feature set.
Regulatory Compliance: UL-3111-1;certified to CSA 22.2. No. 1010-1, conforms to IEC 1010-1, complies with EMC directive 89/336/EEC (ISM Group 1, Class B).

Input Power (full load): 160 VA, 100 W
Warranty Period: Three years
Size: 212.8 mm W x 88.1 mm H x 425.8 mm D (8.4 in x 3.5 in x 16.8 in)
Weight: 9.07 kg (20 lb) net; 11.1 kg (24.5 lb) shipping

Key Literature

1998/99 HP Power Products Catalog, p/n 5966-1706

For more information, visit our website : **www.hp.com/go/dynamicPS**

Ordering Information

Standard: 104 to 127 Vac, 47 to 63 Hz
Opt 100 87 to 106 Vac, 47 to 63 Hz
Opt 220 191 to 233 Vac, 47 to 63 Hz
Opt 230 207 to 253 Vac, 47 to 63 Hz
Opt 8ZJ Delete instrument feet
Opt 1CM Rackmount kit
Opt AXS Rackmount kit for side-by-side mounting
Locking kit HP p/n 5061-9694;
Flange kit HP p/n 5062-3974
Opt OBN Service manual and extra operating guide

Accessories
Rack mount kit and slide for side-by-side mounting of two different depth instruments (HP p/n 5062-3966 and 1494-0015)
Rackmount, slide and filler panel for mounting one instrument (HP p/n 5062-3996,1494-0015, 5062-4022)
14575A Multiplexing remote front panel, up to six inputs per display

HP 66312A
HP 66332A

- Ideal for portable product test
- Dynamic pulse measurement
- Precision low current measurement
- Low-output noise
- High-speed programming
- SCPI (Standard Commands for Programmable Instruments)
- HP-IB and RS-232 interface
- HP VXI *plug&play* drivers

HP 66312A, top; HP 66332A, bottom

Abbreviated Specifications and Characteristics

			HP 66312A	HP 66332A
Output ratings	Voltage/Current		0 to 20 V/0 to 2 A	0 to 20 V/0 to 5 A
Programming accuracy at 25° C ±5° C	Voltage/+Current	0.05%+	10 mV/1mA	10 mV/2 mA
Ripple and noise (20 Hz to 20 MHz, with outputs ungrounded or with either terminal grounded)	Voltage normal mode Voltage fast mode Current	(rms/p-p) (rms/p-p) (rms)	0.5 mV/3 mV NA 1 mA	0.3 mV/3 mV 1 mV/10 mV 2 mA
DC measurement accuracy	Voltage	0.03% +	3 mV	3 mV
via HP-IB or front-panel meters with respect to actual output at 25°C ± 5°C	Low current range –20 mA to +20 mA	0.1% +	2.5 μA	2.5 μA
	High current range +20 mA to + rated I –20 mA to – rated I	 0.2% + 0.2% +	 0.25 mA 0.85 mA	 0.5 mA 1.1 mA
Load regulation	Voltage/Current		2 mV/0.5 mA	2 mV/1 mA
Line regulation	Voltage/Current		0.5 mV/0.5 mA	0.5 mV/1 mA
Transient Response Time: Less than 100 μs (50 μs in the fast mode) for the output voltage to recover to its previous level (within 0.1% of the voltage rating of the supply), following any step change in load current of up to 50% of the output current rating of the supply				
Average programming resolution	Voltage/Current		5 mV/0.5 mA	5 mV/1.25 mA
OVP accuracy		2.4% +	240 mV	240 mV
Sink current*	—		1 A	5 A

*For the HP 66332A, the sink current tracks the programmed current to within 2 mA for programmed currents greater than 5 mA. Below 5 mA, the sink current remains at 5 mA. The sink current does not track the programmed current for the 66312A.

Dynamic Measurements: Accuracy of the instantaneous voltage measurement is 0.03% +5 mV. Accuracy of the instantaneous current measurement is 0.6% +1 mA (2 mA for HP 66332A). The dc, rms, maximum, minimum, high-level and low-level voltage and current measurements are calculated from the instantaneous voltage and current readings. Up to 4096 data points can be acquired. The sampling interval can be varied from 15.6 μs to 31,200 s. The instantaneous data points can also be read back from the storage buffer. Dynamic measurements on current waveforms with frequency content up to 10 kHz can be made on the low- or high-current range. Above 10 kHz, accurate current measurements can only be made in the high range.
dc Floating Voltage: Output terminals can be floated up to ±240 Vdc maximum from chassis ground (50 volts for HP 66312A)
Remote Sensing: Up to two volts dropped in each load lead. Add 2 mV to the voltage load regulation specification for each one volt change in the negative output lead (positive output lead for the HP 66312A) due to load current change.
Command-Processing Time: Average time required for the output voltage to begin to change following receipt of digital data is 4 ms for the power supplies connected directly to the HP-IB.(Display disabled.)
Output-Programming Response Time: The rise and fall time (10/90% and 90/10%) of the output voltage is less than 2 ms (400 μs for the HP 66332A in the fast mode). The output voltage change settles within 1 LSB (0.025% x rated voltage) of final value in less than 6 ms (2 ms in the fast mode).
Measurement Time: Average time to process query, calculate measurement parameter and return data is 20 ms. The buffer data aquisition time which is user-programmable must be added. For the default condition (2048 data points and 15.6 μs sampling interval), this time is 32 ms.
Input Power (full load): HP 66312A: 160 VA, 100 W;
HP 66332A: 350 VA, 250 W
Regulatory Compliance: Listing pending to UL-3111-1; certified to CSA 22.2. No. 1010-1, conforms to IEC 1010-1, complies with EMC directive 89/336/EEC (ISM Group 1, Class B)
Warranty Period: Three years

Size: HP 66312A: 212.8 mm W x 88.1 mm H x 425.8 mm D (8.4 in x 3.5 in x 16.8 in);
HP 66332A: 425.5 mm W x 88.1 mm H x 364.4 mm D (16.75 in x 3.5 in x 14.3 in)
Weight: HP 66312A: 8.85 kg (19.5 lb) net; 11.1 kg (24.5 lb) shipping;
HP 66332A: 12.7 kg (28 lb) net, 15.0 kg (33 lb) shipping

Key Literature

1998/1999 HP Power Products Catalog, p/n 5966-1706

For more information, visit our web site:
http://www.hp.com/go/dynamicPS

Ordering Information

Standard: 104 to 127 Vac, 47 to 63 Hz
Opt 100 87 to 106 Vac, 47 to 63 Hz
Opt 220 191 to 233 Vac, 47 to 63 Hz
Opt 230 207 to 253 Vac, 47 to 63 Hz
Opt 020 Front-panel Binding Posts (HP 66332A only)
Opt 760 Isolation and Reversal Relays
Opt 8ZJ Delete instrument feet
Opt 1CM Rackmount Kit,
HP 66312A: HP p/n 5060-3972
HP 66332A: HP p/n 5062-3974
Opt 1CP Rackmount Kit with Handles,
HP p/n 5062-3975 (HP 66332A only)
Opt AXS Rackmount Kit for side-by-side mounting (66312A only), Locking Kit HP p/n 5061-9694;
Flange Kit HP p/n 5062-3974
Opt 0BN Service Manual and extra Operating Guide (Standard unit is shipped with operating guide and programming guide only.)
Accessories
HP p/n 1494-0060 Rack Slide Kit (HP 66332A only)

Power Supplies

Precision Measurement Single-Output System: 50 W

HP 6611C
HP 6612C
HP 6613C
HP 6614C

- Precision low current measurement
- Low-output noise
- High-speed programming
- HP-IB and RS-232 interface
- SCPI (Standard Commands for Programmable Instruments)
- HP VXI *plug&play* drivers

Abbreviated Specifications and Characteristics

			HP 6611C	HP 6612C	HP 6613C	HP 6614C
Output ratings	Voltage/Current		0 to 8 V/0 to 5 A	0 to 20 V/0 to 2 A	0 to 50 V/0 to 1 A	0 to 100 V/0 to 0.5 A
Programming accuracy at 25° C ±5° C	Voltage/+ Current	0.05% +	5 mV/2 mA	10 mV/1 mA	20 mV/0.75 mA	50 mV/0.05 mA
Ripple and noise (20 Hz to 20 MHz, with outputs ungrounded or with either terminal grounded)	Voltage Normal mode	rms/p-p	0.5 mV/3 mV	0.5 mV/3 mV	0.5 mV/4 mV	0.5 mV/6 mV
	Current	rms	2 mA	1 mA	1 mA	1 mA
DC measurement accuracy: via HP-IB or front-panel meters with respect to actual output at 25° C ±5° C	Voltage	0.3% +	2 mV	3 mV	6 mV	12 mV
	Low current range –20 mA to +20 mA	0.1% +	2.5 μA	2.5 μA	2.5 μA	2.5 μA
	High current range +20 mA to + rated I	0.2% +	0.5 mA	0.25 mA	0.2 mA	0.1 mA
	–20 mA to –rated I	0.2% +	1.1 mA	0.85 mA	0.8 mA	0.7 mA
Load regulation	Voltage/Current		2 mV/1 mA	2 mV/0.5 mA	4 mV/0.5 mA	5 mV/0.5 mA
Line regulation	Voltage/Current		0.5 mV/0.5 mA	0.5 mV/0.5 mA	1 mV/0.25 mA	1 mV/0.25 mA
Transient Response Time: Less than 100 μs for the output voltage to recover to its previous level (within 0.1% of the voltage rating of the supply or 20 mV, whichever is greater) following any step change in load current of up to 50% of the output current rating of the supply						
Average programming resolution	Voltage/Current		2 mV/1.25 mA	5 mV/0.5 mA	12.5 mV/0.25 mA	25 mV/0.125 mA
Sink current			3 A	1.2 A	0.6 A	0.3 A

dc Floating Voltage: Output terminals can be floated up to ±240 Vdc maximum from chassis ground
Remote Sensing: Up to two volts dropped in each load lead. Add 2 mV to the voltage load regulation specification for each one volt change in the positive output lead due to load current change.
Command-Processing Time: Average time required for the output voltage to begin to change following receipt of digital data is 4 ms for the power supplies connected directly to the HP-IB.
Output-Programming Response Time: The rise and fall time (10/90% and 90/10%) of the output voltage is less than 2 ms. The output voltage change settles within 1 LSB (0.025% x rated voltage) of final value in less than 6 ms.
Measurement Time: Average time to make a voltage or current measurement is 50 ms.
Input Power (full load)**:** 160 VA, 100 W
Regulatory Compliance: Listing pending to UL 3111-1; certified to CSA 22.2 No. 1010.1; conforms to IEC 1010-1; complies with EMC directive 89/336/EEC (ISM Group 1, Class B)
Warranty Period: Three years
Size: 212.8 mm W x 88.1 mm H x 348.3 mm D (8.4 in x 3.5 in x 13.7 in)
Weight: 8.85 kg (19.5 lb) net; 11.1 kg (24.5 lb) shipping

Key Literature

1998/99 *HP Power Products Catalog,* p/n 5966-1706

For more information, visit our web site:
http://www.hp.com/go/singlePS

Ordering Information

Standard: 104 to 127 Vac, 47 to 63 Hz
Opt 100 87 to 106 Vac, 47 to 63 Hz
Opt 220 191 to 233 Vac, 47 to 63 Hz
Opt 230 207 to 253 Vac, 47 to 63 Hz
Opt 760 Isolation and Reversal Relays
Opt 8ZJ Delete instrument feet
Opt ICM Rackmount Kit, HP p/n 5062-3972
Opt AXV Rackmount, slide and support shelf for mounting 1 HP 6610 Series instrument (HP p/n 1494-0015, 5062-3996 and 5062-4022)
Opt 0BN Service Manual and extra Operating Guide (Standard unit is shipped with operating guide and programming guide only.)

HP 6621A
HP 6622A
HP 6623A
HP 6624A
HP 6625A
HP 6626A
HP 6627A
HP 6628A
HP 6629A

- Multiple sources in an integrated one-box solution
- 2, 3 or 4 independent isolated outputs
- Precision models available, 14-bit programming and readback
- Stable, low ripple and noise power source
- Faster testing with fast up-and down- programming
- Full protection features
- Three-year standard warranty

HP multiple-output power supplies are an ideal solution for automated testing environments that require multiple voltage sources.

Abbreviated Specifications and Characteristics

		25-watt output	40-watt output	40-watt output	50-watt output	80-watt output	80-watt output
Output Power	Low-range volts, amps High range volts, amps	0 to 7 V, 0 to 15 mA 0 to 50 V, 0 to 500 mA	0 to 7 V, 0 to 5 A 0 to 20 V, 0 to 2 A	0 to 20 V, 0 to 2 A 0 to 50 V, 0 to 0.8 A	0 to 16 V, 0 to 200 mA 0 to 50 V, 0 to 1 A or 0 to 16 V, 0 to 2 A	0 to 7 V, 0 to 10 A 0 to 20 V, 0 to 4 A	0 to 20 V, 0 to 4 A 0 to 50 V, 0 to 2 A
Output combinations for each HP model (total number of outputs)	HP 6621A (2)	—	—	—	—	2	—
	HP 6622A (2)	—	—	—	—	—	2
	HP 6623A (3)	—	1	1	—	1	—
	HP 6624A (4)	—	2	2	—	—	—
	HP 6625A (2) Precision	1	—	—	1	—	—
	HP 6626A (4) Precision	2	—	—	2	—	—
	HP 6627A (4)	—	—	4	—	—	—
	HP 6628A (2) Precision	—	—	—	2	—	—
	HP 6629A (4) Precision	—	—	—	4	—	—
Programming accuracy (at 25° C ±5° C)	Voltage	1.5 mV + 0.016% (low) 10 mV + 0.016% (high)	19 mV + 0.06%	50 mV + 0.06%	3 mV + 0.016% (low) 10 mV + 0.016% (high)	19 mV + 0.06%	50 mV + 0.06%
	Current	15 μA + 0.04% (low) 100 μA + 0.04% (high)	50 mA + 0.16%	20 mA + 0.16%	185 μA + 0.04% (low) 500 μA + 0.04% (high)	100 mA + 0.16%	40 mA + 0.16%
Ripple and noise (peak-to-peak, 20 Hz to 20 MHz; rms, 20 Hz to 10 MHz)	Constant voltage rms	500 μV	500 μV	500 μV	500 μV	500 μV	500 μV
	peak-to-peak	3 mV	3 mV	3 mV	3 mV	3 mV	3 mV
	Constant current rms	0.1 mA	1 mA	1 mA	0.1 mA	1 mA	1 mA
Load regulation	Voltage	0.5 mV	2 mV	2 mV	0.5 mV	2 mV	2 mV
	Current	0.005 mA	1 mA	0.5 mA	0.01 mA	2 mA	1 mA
Load cross regulation	Voltage	0.25 mV	1 mV	2.5 mV	0.25 mV	1 mV	2.5 mV
	Current	0.005 mA	1 mA	0.5 mA	0.01 mA	2 mA	1 mA
Line regulation	Voltage	0.5 mV	0.01% + 1 mV	0.01% + 1 mV	0.5 mV	0.01% + 1 mV	0.01% + 1 mV
	Current	0.005 mA	0.06% + 1 mA	0.06% + 1 mA	0.01 mA	0.06% + 1 mA	0.06% + 1 mA
Transient Response Time: Less than 75 μs for the output to recover to within 75 mV of nominal value following a load change within specfications							
Average programming resolution	Voltage	460 μV (low)/ 3.2 mV (high)	6 mV	15 mV	1 mV (low)/ 3.2 mV (high)	6 mV	15 mV
	Current	1 μA (low)/ 33 μA (high)	25 mA	10 mA	13 μA (low)/ 131 μA (high)	50 mA	20 mA
	OVP	230 mV	100 mV	250 mV	230 mV	100 mV	250 mV
Output setting time		6 ms	2 ms	6 ms	6 ms	2 ms	6 ms

dc Floating Voltage: All outputs can be floated up to ±240 Vdc from chassis ground
Remote Sensing: Up to 1 V (HP 6621–24A, 6627A); up to 10 V (HP 6625A, 6626A, 6628A, 6629A) drop per load lead.
Command Processing Time: 7 ms typical
Down Programming: Current sink approximately 110% of the rated output current for operating voltage above 2.5 V (HP 6621A, 6622A, 6623A, 6624A, 6627A)
Input Power: 550 W max., 720 VA max.
Regulatory Compliance: Listed to UL-1244; certified to CSA 556B; conforms to IEC 348; carries the CE mark
RFI Suppression: Complies with CISPR-11, Group 1, Class B
Size: 425.5 mm W x 132.6 mm H x 497.8 mm D (16.75 in x 5.22 in x 19.6 in)
Weight:
HP 6621A–24A, 6626A, 6627A, 6629A
Net: 17.4 kg (38 lb); Shipping: 22.7 kg (50 lb)
HP 6625A, 6628A
Net: 15.5 kg (34 lb); Shipping: 20.8 kg (46 lb)

Key Literature

1998/99 HP Power Products Catalog, p/n 5966-1706

For more information, visit our web site:
http://www.hp.com/go/multiple PS

Ordering Information

HP 6621A Dual-Output System Power Supply
HP 6622A Dual-Output System Power Supply
HP 6623A Triple-Output System Power Supply
HP 6624A Quad-Output System Power Supply
HP 6625A Precision Dual-Output System Power Supply
HP 6626A Precision Quad-Output System Power Supply
HP 6627A Quad-Output System Power Supply
HP 6628A Precision Dual-Output System Power Supply
HP 6629A Precision Quad-Output System Power Supply
Standard: 104 to 127 Vac, 47 to 66 Hz, 5.4 A
Opt 100 87 to 106 Vac, 47 to 66 Hz Input, 6.3 A (Japan only)
Opt 220 191 to 233 Vac, 47 to 66 Hz, 3.0 A
Opt 240 209 to 250 Vac, 47 to 66 Hz, 3.0 A
Opt 750 Relay Control and DFI/RI
Opt 908 Rackmount Kit (HP p/n 5062-3977)
Opt 909 Rackmount Kit w/Handles (HP p/n 5062-3983)
Opt 910 Service Manual and extra Operating Guide
Accessories
Rack Slide Kit (HP p/n 1494-0059)
14852A Bias Cable to connect either the HP 6626A or 6629A to a 3-terminal device test fixture

Precision Measurement Single-Output System: 100 W

HP 6631B
HP 6632B
HP 6633B
HP 6634B

- Precision low current measurement
- Low-output noise
- High-speed programming
- HP-IB and RS-232 interface
- SCPI (Standard Commands for Programmable Instruments)
- HP VXI *plug&play* drivers

Abbreviated Specifications and Characteristics

			HP 6631B	HP 6632B	HP 6633B	HP 6634B
Output ratings	Voltage/Current		0 to 8 V/0 to 10 A	0 to 20 V/0 to 5 A	0 to 50 V/0 to 2 A	0 to 100 V/0 to 1 A
Programming accuracy at 25° C ±5° C	Voltage/+ Current	0.05% +	5 mV/4 mA	10 mV/2 mA	20 mV/1 mA	50 mV/0.5 mA
Ripple and noise (20 Hz to 20 MHz, with outputs ungrounded or with either terminal grounded)	Voltage Normal mode	rms/p-p	0.3 mV/3 mV	0.3 mV/3 mV	0.5 mV/3 mV	0.5 mV/3 mV
	Voltage Fast mode	rms/p-p	1 mV/5 mV	1 mV/10 mV	1 mV/15 mV	2 mV/25 mV
	Current	rms	5 mA	2 mA	2 mA	2 mA
DC measurement accuracy: via HP-IB or front-panel meters with respect to actual output at 25° C ±5° C	Voltage	0.3% +	2 mV	3 mV	6 mV	12 mV
	Low current range –20 mA to +20 mA	0.1% +	2.5 μA	2.5 μA	2.5 μA	2.5 μA
	High current range +20 mA to + rated I	0.2% +	1 mA	0.5 mA	0.25 mA	0.25 mA
	–20 mA to –rated I	0.2% +	1.6 mA	1.1 mA	0.85 mA	0.85 mA
Load regulation	Voltage/Current		2 mV/2 mA	2 mV/1 mA	4 mV/1 mA	5 mV/1 mA
Line regulation	Voltage/Current		0.5 mV/1 mA	0.5 mV/0.5 mA	1 mV/0.25 mA	1 mV/0.25 mA
Transient Response Time: Less than 100 μs (50 μs in the fast mode) for the output voltage to recover to its previous level (within 0.1% of the voltage rating of the supply) following any step change in load current of up to 50% of the output current rating of the supply						
Average programming resolution	Voltage/Current		2 mV/2.5 mA	5 mV/1.25 mA	12.5 mV/0.5 mA	25 mV/0.25 mA
Sink current*			10 A	5 A	2 A	1 A
Minimum current in constant current mode**			40 mA	20 mA	8 mA	4 mA

* For the HP 6631B–6634B, the sink current tracks the programmed current to within 2 mA for programmed currents greater than 5 mA. Below 5 mA, the sink current remains at 5 mA. When programming in the HP 6630A Series language compatibility mode, the sink current for the HP 6631B–6634B tracks the programmed current with a negative 500 mA, 250 mA, 100mA and 50 mA respectively.
**When programming in the HP 6630A Series language compatibility mode.

dc Floating Voltage: Output terminals can be floated up to ±240 Vdc maximum from chassis ground
Remote Sensing: Up to two volts dropped in each load lead. Add 2 mV to the voltage load regulation specification for each one volt change in the negative output lead due to load current change.
Command-Processing Time: Average time required for the output voltage to begin to change following receipt of digital data is 4 ms for the power supplies connected directly to the HP-IB.
Output-Programming Response Time: The rise and fall time (10/90% and 90/10%) of the output voltage is less than 2 ms. The output voltage change settles within 1 LSB (0.025% x rated voltage) of final value in less than 6 ms (2 ms in the fast mode).
HP-IB Interface Capabilities: IEEE-488.2, SCPI command set, and 6630A Series programming compatability
Instrument Time: Average time to make a voltage or current measurement is 50 ms.
Input Power 350 VA, 250 W
Regulatory Compliance: Listing pending to UL-3111-1; certified to CSA 22.2 No. 1010.1; conforms to IEC 1010-1; complies with EMC directive 89/336/EEC (ISM Group 1, Class B)
Warranty Period: Three years
Size: 425.5 mm W x 88.1 mm H x 364.4 mm D (16.8 in x 3.5 in x 14.3 in)
Weight: 12.7 kg (28 lb) net; 15.0 kg (33 lb) shipping

Key Literature

1998/99 *HP Power Products Catalog,* p/n 5966-1706

For more information, visit our web site:
http://www.hp.com/go/singlePS

Ordering Information

Standard: 104 to 127 Vac, 47 to 63 Hz
Opt 100 87 to 106 Vac, 47 to 63 Hz
Opt 220 191 to 233 Vac, 47 to 63 Hz
Opt 230 207 to 253 Vac, 47 to 63 Hz
Opt 020 Front-panel Binding Posts
Opt 760 Isolation and Reversal Relays (HP 6632B-6634B only)
Opt 8ZJ Delete instrument feet
Opt ICM Rackmount Kit, HP p/n 5062-3974
Opt 1CP Rackmount Kit with Handles, HP p/n 5062-3975
Opt 0BN Service Manual and extra Operating Guide (Standard unit is shipped with operating guide and programming guide only.)
Accessories
HP p/n 1494-0060 Rack Slide Kit

HP 6541A
HP 6542A
HP 6543A
HP 6544A
HP 6545A
HP 6641A
HP 6642A
HP 6643A
HP 6644A
HP 6645A

- Linear output regulation
- Fast up- and down-programming
- SCPI (Standard Commands for Programmable Instruments)
- Complete front-panel control calibration and display
- Remote programming and sensing
- Fan-speed control to minimizes acoustic noise
- Low ripple and noise
- Over-voltage and over-current protection

Abbreviated Specifications and Characteristics

System Power Supplies (HP-IB)			HP 6641A	HP 6642A	HP 6643A	HP 6644A	HP 6645A
Manually Controlled Power Supplies (w/o HP-IB)			**HP 6541A**	**HP 6542A**	**HP 6543A**	**HP 6544A**	**HP 6545A**
Output ratings	Output voltage Output current (40° C) Maximum current (50° C/55° C)		0 to 8V 0 to 20 A 18 A/17 A	0 to 20 V 0 to 10 A 9A/8.5 A	0 to 35 V 0 to 6 A 5.4 A/5.1 A	0 to 60 V 0 to 3.5 A 3.2 A/3 A	0 to 120 V 0 to 1.5 A 1.4 A/1.3 A
Programming accuracy (at 25° C ±5° C)	Voltage Current	0.06% + 0.14% +	5 mV 26 mA	10 mV 13 mA	15 mV 6.7 mA	26 mV 4.1 mA	51 mV 1.7 mA
Ripple and noise (from 20 Hz to 20 MHz)	Voltage Current	rms peak-peak rms	300 µV 3 mV 10 mA	300 µV 3 mV 5 mA	400 µV 4 mV 3 mA	500 µV 5 mV 1.5 mA	700 µV 7 mV 1 mA
Readback accuracy at 25° C ±5° C (percent of reading plus fixed) System models only	Voltage +Current –Current	0.07% + 0.10% + 0.35% +	6 mV 18 mA 40 mA	15 mV 9.1 mA 20 mA	25 mV 5 mA 12 mA	40 mV 3 mA 6.8 mA	80 mV 1.3 mA 2.9 mA
Load regulation	Voltage Current		1 mV 1 mA	2 mV 0.5 mA	3 mV 0.25 mA	4 mV 0.25 mA	5 mV 0.25 mA
Line regulation	Voltage Current		0.5 mV 1 mA	0.5 mV 0.5 mA	1 mV 0.25 mA	1 mV 0.25 mA	2 mV 0.25 mA
Transient Response Time: Less than 100 µs for the output voltage to recover to its previous level (within 0.1% of the voltage rating of the supply, or 20 mV, whichever is greater) following any step change in load current of up to 50% of rated current							
Average resolution	Voltage Current OVP		2 mV 6 mA 13 mV	5 mV 3 mA 30 mV	10 mV 2 mA 54 mV	15 mV 1.0 mA 93 mV	30 mV 0.5 mA 190 mV
OVP accuracy			160 mV	400 mV	700 mV	1.2 V	2.4 V
System Power Supplies (HP-IB) Manually Controlled (w/o HP-IB)			HP 6641A/ HP 6541A/	HP 6642A/ HP 6542A/	HP 6643A/ HP 6543A/	HP 6644A/ HP 6544A/	HP 6645A/ HP 6545A/

dc Floating Voltage: Output terminals can be floated up to ±240 Vdc from chassis ground
Remote Sensing: Up to half the rated output voltage can be dropped in each load lead. The drop in the load leads subtracts from the voltage available for the load.
Command Processing Time (HP 6641A, 6642A, 6643A, 6644A, 6645A only)**:** Average time required for the output voltage to begin to change following receipt of digital data is 20 ms for the power supplies connected directly to the HP-IB
Output Programming Response Time: The rise and fall time (10/90% and 90/10%) of the output voltage is less than 15 ms. The output voltage change settles within 1 LSB (0.025% x rated voltage) of final value in less than 60 ms.
Down Programming: An active down programmer sinks approximately 20% of the rated output current
Modulation: (Analog programming of output voltage and current)
Input Signal: 0 to –5V
Input Impedance: 10 k Ohm nominal
ac Input: (ac input frequency 47 to 63 Hz)

Voltage	100 Vac	120 Vac	220 Vac	240 Vac
Current	4.4 A	3.8 A	2.2 A	2.0 A

Input Power: 480 VA, 400 W at full load; 60 W at no load
Regulatory Compliance: Conforms to UL-1244 and IEC 1010; certified to CSA 22.2 No. 231; carries the CE mark
RFI Suppression: Complies with CISPR-11, Group 1, Class B
Size: 425.5 mm W x 88.1 mm H x 439 mm D (16.75 in x 3.5 in x 17.3 in)
Weight: Net, 14.2 kg (31.4 lb); shipping, 16.3 kg (36 lb)
Warranty Period: Three years

Key Literature

1998/99 *HP Power Products Catalog,* p/n 5966-1706

For more information, visit our web site:
http://www.hp.com/go/singlePS

Ordering Information

Standard: 104 to 127 Vac, 47 to 63 Hz
Opt 100 87 to 106 Vac, 47 to 63 Hz
Opt 220 191 to 233 Vac, 47 to 63 Hz
Opt 240 209 to 250 Vac, 47 to 63 Hz
Opt 908 Rackmount Kit (HP p/n 5062-3974)
Opt 909 Rackmount Kit w/Handles (HP p/n 5062-3975)
Opt 910 Service Manual, extra Operating Guide and Programming Guide
Accessories
HP p/n 1494-0060 Accessory Slide Kit
The following accessories for HP 6641A, 6642A, 6643A, 6644A and 6645A only:
HP p/n 1252-3698 7-pin Analog Plug
HP p/n 1252-1488 4-pin Digital Plug
HP p/n 5080-2148 Serial Link Cable 2 m (6.6 ft)

Power Supplies

Single-Output System and Manually Controlled: 500 W

HP 6551A
HP 6552A
HP 6553A
HP 6554A
HP 6555A
HP 6651A
HP 6652A
HP 6653A
HP 6654A
HP 6655A

- Complete front-panel control, calibration and display
- Remote programming and sensing
- Fan-speed control to minimize acoustic noise
- Low ripple and noise
- Over-voltage and over-current protection
- Linear output regulation
- Fast up- and down-programming
- SCPI (Standard Commands for Programmable Instruments)

Abbreviated Specifications and Characteristics

System Power Supplies (HP-IB)			HP 6651A	HP 6652A	HP 6653A	HP 6654A	HP 6655A
Manually Controlled Power Supplies (w/o HP-IB)			**HP 6551A**	**HP 6552A**	**HP 6553A**	**HP 6554A**	**HP 6555A**
Output ratings	Output voltage Output current (40° C) Maximum current (50° C/55° C)		0 to 8 V 0 to 50 A 45 A/42.5 A	0 to 20 V 0 to 25 A 22.5 A/21.3 A	0 to 35 V 0 to 15A 13.5 A/12.8 A	0 to 60 V 0 to 9 A 8.1 A/7.7 A	0 to 120 V 0 to 4 A 3.6 A/3.4 A
Programming accuracy (at 25° C ±5° C)	Voltage Current	0.06% + 0.15% +	5 mV 60 mA	10 mV 25 mA	15 mV 13 mA	26 mV 8 mA	51 mV 4 mA
Ripple and noise (from 20 Hz to 20 MHz)	Voltage Current	rms peak-peak rms	300 µV 3 mV 25 mA	300 µV 3 mV 10 mA	400 µV 4 mV 5 mA	500 µV 5 mV 3 mA	700 µV 7 mV 2 mA
Readback accuracy at 25° C ±5° C (percent of reading plus fixed) System models only	Voltage +Current –Current	0.07% + 0.15% + 0.35% +	6 mV 67 mA 100 mA	15 mV 26 mA 44 mA	25 mV 15 mA 24 mA	40 mV 7 mA 15 mA	80 mV 3 mA 7 mA
Load regulation	Voltage Current		1 mV 2 mA	2 mV 1 mA	3 mV 0.5 mA	4 mV 0.5 mA	5 mV 0.5 mA
Line regulation	Voltage Current		0.5 mV 2 mA	0.5 mV 1 mA	1 mV 0.75 mA	1mV 0.5 mA	2 mV 0.5 mA
Transient Response Time: Less than 100 µs for the output voltage to recover to its previous level (within 0.1% of the voltage rating of the supply, or 20 mV, whichever is greater) following any step change in load current of up to 50% of rated current							
Average resolution	Voltage Current OVP		2 mV 15 mA 12 mV	5 mV 7 mA 30 mV	10 mV 4 mA 54 mV	15 mV 2.5 mA 93 mV	30 mV 1.25 mA 190 mV
OVP accuracy			160 mV	400 mV	700 mV	1.2 V	2.4 V
System Power Supplies (HP-B) General Purpose (w/o HP-B)			HP 6651A/ HP 6551A/	HP 6652A/ HP 6552A/	HP 6653A/ HP 6553A/	HP 6654A/ HP 6554A/	HP 6655A/ HP 6555A/

dc Floating Voltage: Output terminals can be floated up to ±240 Vdc from chassis ground
Remote Sensing: Up to half the rated output voltage can be dropped in each load lead. The drop in the load leads subtracts from the voltage available for the load.
Command Processing Time (HP 6651A, 6652A, 6653A, 6654A, 6655A only)**:** Average time required for the output voltage to begin to change following receipt of digital data is 20 ms for the power supplies connected directly to the HP-IB
Output Programming Response Time: The rise and fall time (10/90% and 90/10%) of the output voltage is less than 15 ms. The output voltage change settles within 1 LSB (0.025% x rated voltage) of final value in less than 60 ms.
Down Programming: An active down programmer sinks approximately 20% of the rated output current
Modulation: (Analog programming of output voltage and current)
Input signal: 0 to –5 V
Input impedance: 10 k Ohm nominal
ac Input: (ac input frequency 47 to 63 Hz)

Voltage	100 Vac	120 Vac	220 Vac	240 Vac
Current	12 A	10 A	5.7 A	5.3 A

Input Power: 1,380 VA, 1,100 W at full load; 120 W at no load
Regulatory Compliance: Listed to UL-1244; certified to CSA 556B; conforms to IEC 348; carries the CE mark
RFI Suppression: Complies with CISPR-11, Group 1, Class B
Size: 425.5 mm W x 132.6 mm H x 497.8 mm D (16.75 in x 5.22 in x 19.6 in)
Weight: Net, 25 kg (54 lb); shipping, 28 kg (61 lb)
Warranty Period: Three years

Key Literature

1998/99 *HP Power Products Catalog,* p/n 5966-1706

For more information, visit our web site:
http://www.hp.com/go/singlePS

Ordering Information

Standard: 104 to 127 Vac, 47 to 63 Hz
Opt 100 87 to 106 Vac, 47 to 63 Hz
Opt 220 191 to 233 Vac, 47 to 63 Hz
Opt 240 209 to 250 Vac, 47 to 63 Hz
Opt 908 Rackmount Kit (HP p/n 5062-3977)
Opt 909 Rackmount Kit w/ Handles (HP p/n 5062-3983)
Opt 910 Service Manual.extra Operating Guide and Programming Guide

Accessories
Rack Slide Kit (HP p/n 1494-0059)
The following accessories for HP 6651A, 6652A, 6653A, 6654A and 6655A only:
HP p/n 1252-3698 7-pin Analog Plug
HP p/n 1252-1488 4-pin Digital Plug
HP p/n 5080-2148 Serial Link Cable 2 m (6.6 ft)

HP 6571A
HP 6572A
HP 6573A
HP 6574A
HP 6575A
HP 6671A
HP 6672A
HP 6673A
HP 6674A
HP 6675A

- Low ripple and noise
- Fast up- and down-programming
- SCPI (Standard Commands for Programmbale Instruments)
- Complete front-panel control, calibration and display
- Remote programming and sensing
- Fan-speed control to minimize acoustic noise
- Low ripple and noise
- Over-voltage and over-current protection

Abbreviated Specifications and Characteristics

System Power Supplies (HP-IB)			HP 6671A	HP 6672A	HP 6673A	HP 6674A	HP 6675A
General Purpose Power Supplies (w/o HB-IB)			**HP 6571A**	**HP 6572A**	**HP 6573A**	**HP 6574A**	**HP 6575A**
Output ratings	Output voltage Output current (40° C)		0 to 8 V 0 to 220 A	0 to 20 V 0 to 100 A	0 to 35 V 0 to 60A	0 to 60 V 0 to 35 A	0 to 120 V 0 to 18 A
Programming accuracy (at 25° C ±5° C)	Voltage Current	0.04% + 0.1% +	8 mV 125 mA	20 mV 60 mA	35 mV 40 mA	60 mV 25 mA	120 mV 12 mA
Ripple and noise (from 20 Hz to 20 MHz)	Voltage Current	rms peak-peak rms	650 μV 7 mV 200 mA	750 μV 9 mV 100 mA	800 μV 9 mV 40 mA	1.25 mV 11 mV 25 mA	1.9 mV 16 mV 12 mA
Readback accuracy at 25° C ±5° C (percent of reading plus fixed) System models only	Voltage ±Current	0.05% + 0.1% +	12 mV 150 mA	30 mV 100 mA	50 mV 60 mA	90 mV 35 mA	180 mV 18 mA
Load and line regulation	Voltage Current	0.002%+ 0.005%+	300 μV 10 mA	650 μV 7 mA	1.2 mV 4 mA	2 mV 2 mA	4 mV 1 mA
Transient Response Time: Less than 900 μs for the output voltage to recover 100 mV following a change in load from 100% to 50%, or 50% to 100% of the output current rating of the supply							
Average resolution	Voltage Current OVP		2 mV 55 mA 15 mV	5 mV 25 mA 35 mV	9 mV 15 mA 65 mV	15 mV 8.75 mA 100 mV	30 mV 4.5 mA 215 mV
Output voltage programming response time* (excluding command processing time) System models only			30 ms	60 ms	130 ms	130 ms	195 ms
System Power Supplies(HP-IB) General Purpose (w/o HP-IB)			HP 6671A/ HP 6571A/	HP 6672A/ HP 6572A/	HP 6673A/ HP 6573A/	HP 6674A/ HP 6574A/	HP 6675A/ HP 6575A/

* Full load programming rise/fall time (10% to 90% or 90% to 10%) with full resistive load equal to rated output voltage/rated output current.

dc Floating Voltage: Output terminals can be floated up to ±240 Vdc from chassis ground
Output Common-Mode Noise Current: (to signal ground binding post) 500 μA rms, 4 mA peak-to-peak
Remote Sensing: Up to half the rated output voltage can be dropped in each load lead. The drop in the load leads subtracts from the voltage available for the load.
Command Processing Time (HP 6671A, 6672A, 6673A, 6674A, 6675A only): Average time required for the output voltage to begin to change following receipt of digital data is 20 ms for the power supplies connected directly to the HP-IB
Output Programming Response Time: The rise and fall time (10/90% and 90/10%) of the output voltage is less than 15 ms. The output voltage change settles within 1 LSB (0.025% x rated voltage) of final value in less than 60 ms.
Modulation: (Analog programming of output voltage and current)
Input Signal: 0 to –4V for voltage, 0 to 7 V for current
Input Impedance: 30 k Ohm or greater
Input Power: 3,800 VA, 2,600 W at full load; 170 W at no load
Regulatory Compliance: Listed to UL-1244; certified to CSA 556B; conforms to IEC 348; carries the CE mark
RFI Suppression: Complies with CISPR-11, Group 1, Class B
Size: 425.5 mm W x 132.6 mm H x 640 mm D (16.75 in x 5.22 in x 25.2 in)
Weight: Net, 28.2 kg (62 lb); shipping, 31.8 kg (70 lb)
Warranty Period: Three years

Key Literature

1998/99 *HP Power Products Catalog,* p/n 5996-1706

For more information, visit our web site:
http://www.hp.com/go/singlePS

Ordering Information

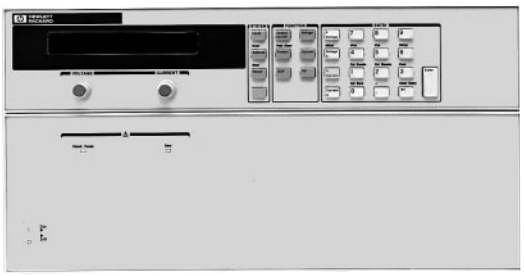
Standard: 191 to 250 Vac, 47 to 63 Hz
Opt 200 174 to 220 Vac, 47 to 63 Hz (Japan only)
Opt 908 Rackmount Kit (HP p/n 5062-3977)
Opt 909 Rackmount Kit w/ Handles (HP p/n 5062-3983)
Opt 910 Service Manual, extra Operating Guide and Programming Guide
A line cord option must be specified. See page 180 for ordering information.
Accessories
Rack Slide Kit (HP p/n 1494-0059)
The following accessories for HP 6671A, 6672A, 6673A, 6674A and 6675A only:
HP p/n 1252-3698 7-pin Analog Plug
HP p/n 1252-1488 4-pin Digital Plug
HP p/n 5080-2148 Serial Link Cable 2 m (6.6 ft)

Power Supplies

Single-Output System: 5000 W

HP 6680A
HP 6681A
HP 6682A
HP 6683A
HP 6684A

- "One-Box" solution: includes V and I read-back
- Low ripple and noise
- Fast up- and down-programming
- High-accuracy current programming and read back
- SCPI (Standard Commands for Programmable Instruments)
- Selectable compensation for inductive loads



Abbreviated Specifications and Characteristics

			HP 6680A	HP 6681A	HP 6682A	HP 6683A	HP 6684A
Output ratings	Voltage Current (derated linearly 1%/° C from 40° to 55° C)		0 to 5 V 0 to 875 A	0 to 8 V 0 to 580 A	0 to 21 V 0 to 240 A	0 to 32 V 0 to 160 A	0 to 40 V 0 to 128 A
Programming accuracy (at 25° C ±5° C)	Voltage Current	0.04% + 0.1% +	5 mV 450 mA	8 mV 300 mA	21 mV 125 mA	32 mV 85 mA	40 mV 65 mA
Ripple and noise (from 20 Hz to 20 MHz)	Constant voltage Constant current	rms peak-to-peak rms	1.5 mV 10 mV 290 mA	1.5 mV 10 mV 190 mA	1.0 mV 10 mV 40 mA	1.0 mV 10 mV 28 mA	1.0 mV 10 mV 23 mA
Readback accuracy at 25° C ±5° C (percent of reading plus fixed)	Voltage Current	0.05% + 0.1% +	7.5 mV 600 mA	12 mV 400 mA	32 mV 165 mA	48 mV 110 mA	60 mV 90 mA
Load and line regulation	Voltage Current	0.002% + 0.005% +	190 μV 65 mA	300 μV 40 mA	650 μV 17 mA	1.1 mV 12 mA	1.5 mV 9 mA
Transient Response Time: Less than 900 μs for the output voltage to recover within 150 mV following a change in load from 100% to 50%, or 50% to 100% of the output current rating of the supply							
Average programming resolution	Voltage Current OVP		1.35 mV 235 mA 30 mV	2.15 mV 155 mA 45 mV	5.7 mV 64 mA 120 mV	8.6 mV 43 mA 180 mV	10.8 mV 34 mA 225 mV
Output voltage programming response time (excludes command-processing time)	Full-load programming rise or fall time (10/90% or 90/10%, resistive load)		9 ms	12 ms	45 ms	60 ms	60 ms
Output common-mode noise current (to signal-ground binding post)		rms peak-to-peak	1.5 mA 10 mA	1.5 mA 10 mA	3 mA 20 mA	3 mA 20 mA	3 mA 20 mA

dc Floating Voltage: Output terminals can be floated up to ±60 Vdc maximum from chassis ground
Remote Sensing: Up to half the rated output voltage can be dropped in each load lead. The drop in the load leads subtracts from the voltage available for the load.
Command Processing Time: Average time required for the output voltage to begin to change following receipt of digital data is 20 ms for power supplies connected directly to the HP-IB
Modulation (analog programming of output voltage and current)
Input Signal: 0 to –5 V for voltage, 0 to +5 V for current
Input Impedance: 30 k Ohm or greater
ac Input (47 to 63 Hz)**:** 180 to 235 Vac (line-to-line, 3 phase), 27.7 A rms maximum; 360 to 440 Vac, 14.3 A rms maximum (maximum line current includes 5% unbalanced phase voltage condition.) Output voltage derated up to 95% at 50 Hz and below 200 Vac.
Input Power: 7350 VA and 6000 W maximum; 160 W at no load
Regulatory Compliance: Listed to UL-1244; certified to CSA 22.2 No. 231; conforms to IEC 1010; carries the CE mark
RFI Suppression: Complies with CISPR-11, Group 1, Class A
Size: 425.5 mm W x 220 mm H x 675.6 mm D (16.75 in x 8.75 in x 26.6 in)
Weight: Net, 51.3 kg (113 lb); shipping, 63.6 kg (140 lb)
Warranty Period: Three years

Key Literature

1998/99 *HP Power Products Catalog,* p/n 5966-1706

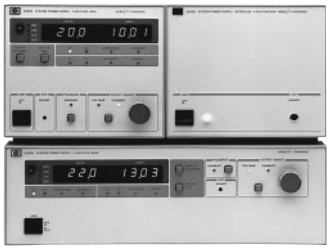
For more information, visit our web site:
http://www.hp.com/go/singlePS

Ordering Information

Opt 400 360 to 440 Vac, 3 phase, 47 to 63 Hz
Opt 601 Output Connector Kit (required for bench applications) includes bus-bar spacer, connector bolts, and output cover (HP p/n 5060-3515)
Opt 602 Two Bus-Bar Spacers for paralleling power supplies (HP p/n 5060-3514)
Opt 908 Rackmount Kit (HP p/n 5062-3977 and p/n 5062-3974)
Opt 909 Rackmount Kit with Handles (HP p/n 5062-3983 and p/n 5062-3975). Support rails required for Option 908 and 909 HP Rack: E3663A, Rack Slides p/n 1494-0058, third party rack: E3664A
Opt 910 Service Manual (HP p/n 5960-5590), extra Operating Guide and Programming Guide

Accessories
HP p/n 5060-3513 Three 30-A Replacement Fuses for 180 to 235 Vac line
HP p/n 5060-3512 Three 16-A Replacement Fuses for 360 to 440 Vac line

Above:HP 6023A, HP 6028A
Below:HP 6010A, 6011A, 6012A and 6015A



Above:HP 6033A and HP 6031A(Option 001 on right)
Below:HP 6030A, 6031A, 6032A, and 6035A,

Abbreviated Specifications and Characteristics

System Autorangers (HP-IB)			HP 6030A	HP 6031A	HP 6032A	HP 6033A	HP 6035A	HP 6038A
Autorangers (w/o HP-IB)			**HP 6010A**	**HP 6011A**	**HP 6012B**	**HP 6023A**	**HP 6015A**	**HP 6028A**
Output ratings	Voltage Current		0 to 200 V 0 to 17 A	0 to 20 V 0 to 120 A	0 to 60 V 0 to 50 A	0 to 20 V 0 to 30 A	0 to 500 V 0 to 5 A	0 to 60 V 0 to 10 A
Maximum power	Watts		1,200 W	1,064 W	1,200 W	242 W	1,050 W	240 W
Autoranging output	V1, P1 V2, P2 V3, P3		200 V, 5 A 120 V, 10 A 60 V, 17 A	20 V, 50 A 14 V, 76 A 7 V, 120 A	60 V, 17.5 A 40 V, 30 A 20 V, 50 A	20 V, 10 A 14 V, 17.2 A 6.7 V, 30 A	500 V, 2 A 350 V, 3 A 200 V, 5 A	60 V, 3.3 A 40 V, 6 A 20 V, 10 A
Programming accuracy (at 25° C ±5° C) System models only	Voltage Current		0.035% +145 mV 0.2% +25 mA	0.035% +15 mV 0.25% +250 mA	0.035% +40 mV 0.2% +85 mA	0.035% +9 mV 0.15% +20 mA	0.25% +400 mV 0.3% +63 mA	0.035% +40 mV 0.09% +10 mA
Ripple and noise, (20 Hz to 20 MHz)	Voltage Current	rms p-p rms	22 mV 50 mV 15 mA	8 mV 50 mV 120 mA	8 mV 40 mV 25 mA	3 mV 30 mV 15 mA	50 mV 160 mV 50 mA	3 mV 30 mV 5 mA
Readback accuracy (at 25° C ±5° C) System models only	Voltage Current		0.08% + 80 mV 0.36% +15 mA	0.08% +7 mV 0.4% +100 mA	0.08% +20 mV 0.36% +35 mA	0.07% +6 mV 0.3% +25 mA	0.5% +300 mV 0.5% +50 mA	0.07% +50 mV 0.2% +11 mA
Load regulation	Voltage Current	0.01%+ 0.01%+	5 mV 10 mA	3 mV 15 mA	5 mV 10 mA	2 mV 9 mA	40 mV 35 mA	3 mV 5 mA
Line regulation System models only	Voltage Current	0.01%+ 0.01%+	5 mV 5 mA	2 mV 25 mA	3 mV 10 mA	1 mV 6 mA	13 mV 18 mA	2 mV 2 mA
Transient response time 10% step change	Time Level		2 ms 150 mV	2 ms 100 mV	2 ms 100 mV	1 ms 50 mV	5 ms 200 mV	1 ms 75 mV
dc floating voltage (either terminal can be grounded or floated from chassis ground)			±550 V	±240 V	±240 V	±240 V	±550 V	±240 V
ac input current	100 Vac (system only) 120 Vac 220 Vac 240 Vac		24 A 24 A 15 A 14 A	24 A 24 A 15 A 14 A	24 A 24 A 15 A 14 A	6 A 6.5 A 3.8 A 3.6 A	24 A 24 A 15 A 14 A	6 A 6.5 A 3.8 A 3.6 A
Weight	Net Shipping		16.3 kg (36 lb) 21.8 kg (48 lb)	17.2 kg (38 lb) 22.7 kg (50 lb)	16.3 kg (36 lb) 21.8 kg (48 lb)	9.6 kg (21 lb) 11.4 kg (25 lb)	16.3 kg (36 lb) 21.8 kg (48 lb)	9.6 kg (21 lb) 11.4 kg (25 lb)
System Autorangers (HP-IB) Autorangers (w/o HP-IB)			HP 6030A/ HP 6010A/	HP 6031A/ HP 6011A/	HP 6032A/ HP 6012B/	HP 6033A/ HP 6023A/	HP 6035A/ HP 6015A/	HP 6038A/ HP 6028A/

Remote Sensing: Up to 2 V drop in each lead. Voltage regulation degrades for greater than 0.5 V drop.
Regulatory Compliance: Listed to UL-1244; certified to CSA 556B; conforms to IEC 348, carries the CE mark
RFI Suppression: Complies with CISPR-11, Group 1, Class B
Inductive Load: HP 6023A, 6028A are stable in CC mode for loads up to 1 H. HP 6010A–6012B, 6015A are stable in CC mode for loads up to 100 mH.
Size:
HP 6030A–32A, 6035A: 425.5 mm W x 132.6 mm H x 503.7 mm D (16.75 in x 5.25 in x 19.83 in).
HP 6033A, 6038A, 6023A, 6028A: 212.3 mm W x 177.0 mm H x 516.4 mm D (8.36 in x 6.97 in x 17.87 in).
HP 6010A–12B, 6015A: 425.5 mm W x 132.6 mm H x 516.4 mm D (16.75 in x 5.25 in x 20.33 in).

Key Literature

1998/99 HP Power ProductsCatalog, p/n 5966-1706
For more information, visit our web site:
http://www.hp.com/go/autorangingPS

Ordering Information

Standard: 104 to 127 VAC, 48 to 63 Hz
Opt 001 Front panel has only line switch, line indicator, and OVP adjust (HP 6030A–33A and 6038A only)
Opt 002 Provides extra programming and monitoring capabilities (HP 6010A–12B, 6023A, 6028A only)
Opt 100 87 to 106 Vac, 48 to 63 Hz (power supply output is derated to 75%) HP 6030A–33A, 6035A, 6038A only
Opt 220 191 to 233 Vac, 48 to 63 Hz
Opt 240 209 to 250 Vac, 48 to 63 Hz
Opt 800 Rackmount Kit for Two Half-rack Units Side by Side. HP p/n 5061-9694 and 5062-3978
Opt 908 Rackmount Kit for a Single Half-rack Unit
HP Models 6023A, 6028A, 6033A and 6038A (with blank filler panel); HP p/n 5062-3960
HP Models 6010A–12B, 6015A, 6030A–32A and 6035A; HP p/n 5062-3977
Opt 909 Rackmount Kit with Handles. For HP 6010A–12B, 6015A, 6030A–32A, 6035A; HP p/n 5062-3983
Opt 910 Service Manual and extra Operating Guide
For HP Models 6010A–12B, 6015A, 6023A, 6028A
For HP Models 6030A–33A, 6035A, 6038A
A line cord option must be specified for HP 6010A–12B, 6015A, 6030A–32A, 6035A. See page 180 for ordering information.
Accessories
HP 5080-2148 Serial Link Cable, 2 m (6.6 ft) for HP 6030A, 6031A, 6032A, 6033A, 6035A, and 6038A
HP 1494-0060 Rack Slide Kit

Power Supply Relay Devices and AC Line Cord Options

HP 59510A
HP 59511A

- Relay accessories to isolate load from dc output
- Switch and sequence power and sense leads
- DC output polarity reversal (HP 59511A only)

HP 59511A

HP 59510A and HP 59511A Relay Devices

The HP 59510A and 59511A are designed for control from 66XXA and 603XA series power supplies. These can be configured to switch dc power in multiple test fixtures or provide extra protection when a fault condition requires an emergency shutdown. Each unit switches one power supply output and can be used with any dc power supply within the voltage and current limits. The HP 59511A has all of the features of the HP 59510A, plus relays for reversing polarity. Using the PEM fasteners provided, both models can be mounted to a flat surface on any of the three sides.

Specifications

Operating Ranges: 200 V at 20 A, 120 V at 30 A, or 48 V at 60 A
dc Floating Voltage: Input to output, 200 Vdc; input or output to ground, 500 Vdc; TTL control to ground, 240 Vdc
Settling Time (TTL control)**:** Connect, 440 ms; disconnect, 160 ms; polarity reversal, 600 ms
dc Voltage Drop (at 60 A)**:** 0.5 V maximum on each relay
ac Input: Can be set for 100, 120, 220, or 240 Vac (–13%, +6%) at 48 to 63 Hz
Weight:
HP 59510A: Net, 2.3 kg (5 lb); shipping, 3.6 kg (8 lb); shipping with Option 850, 4.1 kg (9 lb)
HP 59511A: Net, 3.6 kg (8 lb); shipping, 5.0 kg (11 lb); shipping with Option 850, 5.5 kg (12 lb)
Mounting Orientation: Within ±10° from vertical
Size: 185.4 mm W x 130.6 mm H x 198.6 mm D (7.26 in x 5.14 in x 7.81 in)

Key Literature

1998/99 *HP Power Products Catalog,* p/n 5966-1706

For more information, visit our web site: **http://www.hp.com/go/power**

Ordering Information

HP 59510A Output Isolation Relay Accessory
HP 59511A Output Isolation, Polarity Reversal Accessory
Opt 850 Rackmount Kit (side-by-side mounting of two units requires two kits)
Opt 910 Extra Operating and Service Manual, HP p/n 5957-6382

Power-Supply AC Line Cord Options

Power distribution regulations and techniques vary greatly among geographic regions. For this reason, line cord type must be specified for high-power (1000- to 5000-W) dc power supplies at the time of ordering. The HP 66000A modular power system mainframe is included because one line cord might supply ac power for up to eight 150-W modules. If no line cord option is specified for these models, an unterminated cable will be shipped with the unit.

Option Descriptions

Order the correct option according to local electrical codes. All the cords listed are 2.5 m (about 8.2 ft) long.

Unterminated Line Cords (user supplies plug)

Option 831: 12 AWG; UL-listed, CSA-certified; unterminated. Suggested for use in North and South America. Note for HP 6670 and 6570 Series: intended for use on a dedicated branch circuit and not intended for use in Canada. Note for HP 6030 and 66000 Series: intended for connection to 200- to 240-Vac service.
Option 832: 4-mm² wire size; harmonized cordage; unterminated. Suggested for use in Europe and other areas not listed.
Option 833: 1.5-mm² wire size; harmonized cordage; unterminated. For use in Europe and other areas not listed. Note for HP 6030 and 66000 Series: intended for connection to 200- to 240-Vac service.
Option 834: 10 AWG; UL-listed, CSA-certified; unterminated. Suggested for use in North and South America. Note for HP 6030 and 66000 Series: intended for connection to 100- to 120-Vac service.

Options Available

Options	6010A Series 6030A Series (1000 W)	6570A 6620A Series	66000A Mainframe	6812A 6841A	6813A 6842A
831	•	•	•	•	•
832		•			•
833	•		•	•	
834	•	•	•	•	•
841	•	•	•	•	•
842		•			•
844		•			•
845	•		•	•	
846	•		•	•	
847	•		•	•	
848	•		•	•	

•available — not available

Terminated Line Cords Line cords with plugs

Option 841
12 AWG; UL-listed, CSA-certified; with NEMA 6-20P, 20-A, 250-V plug. Suggested for use in North and South America and Japan. Note for HP 6670 and 6570 Series: not intended for use in Canada. Intended for use on a dedicated branch circuit.

Option 842
4-mm² wire size; harmonized cordage with IEC 309, 32-A, 220-V plug. Suggested for use in Europe and other areas not listed.

Option 844
10 AWG; UL-listed, CSA-certified; with NEMA L6-30P, 30-A, 250-V locking plug. Suggested for use in North and South America.

Option 845
1.5-mm² wire size; harmonized cordage with IEC 309, 16-A, 220-V plug. Suggested for use in Denmark, Switzerland, Austria, China, and other countries not listed.

Option 846
10 AWG; UL-listed, CSA-certified; with NEMA L5-30P, 30-A, 120-V locking plug. Suggested for use in North America.

Option 847
1.5-mm² wire size; harmonized cordage with CEE 7/7, 16-A, 220-V plug. Suggested for use in continental Europe.

Option 848
1.5-mm² wire size; harmonized cordage with BS 546, 15-A, 240-V plug. Suggested for use in India and South Africa.

HP E3631A
HP E3632A
HP E3633A

NEW

HP E3631A Triple-output Features
- 80 watts of power
- Triple outputs
- HP-IB/RS-232 standard
- Dual voltage and current meters
- SCPI (Standard Commands for Programmable Instruments)

HP E3632A Single-output Features
- 15 V, 7 A/30 V, 4 A single output dual range
- Low noise/excellent regulation
- HP-IB/RS-232 standard
- Two digital meters
- Remote sense, OVP and OCP capability
- 16-bit programming resolution and high accuracy
- 105/120 watts of power

HP E3633A Single-output Features
- 160/200 watts of power
  Front and rear panel terminals
- Low noise/excellent regulation
- Remote sense, OVP and OCP capability
- 16-bit programming resolution and high accuracy
- HP-IB/RS-232 standard

Above: HP E3632A, Below: HP E3631A HP E3633A

HP E3631A-HP E3633A

The HP E3631A is a triple-output programmable dc power supply designed to meet the most exacting engineering requirements with traditional HP quality and reliability designed in.

This power supply lets you program both voltage and current. You can monitor the output terminals for voltage and current, and query command lets you read the programmed voltage and current.

The HP E3632A and E3633A are 120 W/200 W single-output dual range programmable dc power supplies designed to meet the most exacting engineering requirements with traditional HP quality and reliability designed in.

Low Noise/Excellent Regulation

0.01% load and line regulation keep the output steady. The linear supply specifies both normal-mode voltage noise and common-mode current noise. The low normal-mode specification assures clean power for precision circuitry and the low common-mode current provides isolation from power line current injection.

Front Panel Operation

Both voltage and current can be monitored simultaneously for output from the front panel on an easy-to-read vacuum fluorescent display. A knob allows you to set the output at the resolution you need for the most exacting adjustments, quickly and easily. Store and recall key enables you to save and recall up to three frequently-used states. The output on/off button enables/disables the output.

Isolated

All the outputs are isolated from the chassis ground and from the remote interface. In the E3631A, 6 V supply is isolated from the ±25 V supply to minimize any interference between circuits-under-test.

4

Abbreviated Specifications and Characteristics at 0° to 55° unless otherwise specified

		HP E3631A			HP E3632A Low Range/ High Range	HP E3633A Low Range/ High Range
dc outputs	Voltage Current	0 to +25 V/ 0 to 1 A	0 to –25 V/ 0 to 1 A	0 to 6 V/ 0 to 5 A	0 to 15 V, 7A/ 0 to 30 V, 4 A	0 to 8 V, 20A/ 0 to 20 V, 10 A
Load regulation	Voltage Current	<0.01% + 2 mV <0.01% + 250 μA	<0.01% + 2 mV <0.01% + 250 μA	<0.01% + 2 mV <0.01% + 250 μA	<0.01% + 2 mV <0.01% + 250 μA	<0.01% + 2 mV <0.01% + 250 μA
Line regulation	Voltage Current	<0.01% + 2 mV <0.01% + 250 μA	<0.01% + 2 mV <0.01% + 250 μA	<0.01% + 2 mV <0.01% + 250 μA	<0.01% + 2 mV <0.01% + 250 μA	<0.01% + 2 mA <0.01% + 250 μA
Ripple and noise	Normal-mode voltage Normal-mode current Common-mode current	<350 μV rms/ 2 mV p-p <500 μA rms <1.5 μA rms	<350 μV rms/ 2 mV p-p <500 μA rms <1.5 μA rms	<350 μV rms/ 2 mV p-p <2 mA rms <1.5 μA rms	<350 μVrms/ 2mVpp <2 mA rms <1.5 μA rms	<350 μVrms/ 3mVpp <2 mA rms <1.5 μA rms
Programming accuracy (25° C ±5° C)	Voltage Current	0.05% + 20 mV 0.15% + 4 mA	0.05% + 20 mV 0.15% + 4 mA	0.1% + 5 mV 0.2% + 10 mA	0.05% + 10 mV 0.2% +10 mA	0.05% + 10 mV 0.2% +10 mA
Readback accuracy (25° C ±5° C)	Voltage Current	0.05% + 10 mV 0.15% + 4 mA	0.05% + 10 mV 0.15% + 4 mA	0.1% + 5 mV 0.2% + 10 mA	0.05% + 5 mV 0.15% + 5 mA	0.05% + 5 mV 0.15% + 5 mA
Resolution	Program/ readback Meter	1.5 mV/0.1 mA 10 mV/1 mA	1.5 mV/0.1 mA 10 mV/1 mA	0.5 mV/0.5 mA 1 mV/1 mA	1mV//0.5 mA/ 0.5 mV/0.1 m A 1 mV/1 mA	1mV//1mA (<10A) 1 mV/10 mA (≥10A)
					🚗	🚗

Transient Response Time: 50 μsec for output to recover to within 15 mV following a change in output current from full load to half load or vice versa

🚗 Indicates QuickShip availability.

ac Input:
110 Vac ± 10%, 47 to 63 Hz (Option OE9)
115 Vac ± 10%, 47 to 63 Hz (Standard)
230 Vac ± 10%, 47 to 63 Hz (Option OE3)
Product Regulation: Designed to comply with UL-1244, IEC 1010-1; certified with CSA 22.2; meets requirements for CE regulation

Warranty: Three years
Size: **E3631A** 13 mm W x 132 mm H x 360 mm D (8.4 in x 5.2 in. x 14.2 in)
E3632A, E3633A 13 mm W x 132 mm H x 348 mm D (8.4 in x 5.2 in. x 13.7 in)
Weight:
E3631A 6.9 kg (15 lbs)
E3632A, E3633A 9.5 kg (21 lbs)

Laboratory: Multiple Output 35 W to 50 W

HP E3620A
HP E3630A

HP E3620A Features

- Low noise, excellent regulation
- Two isolated power supplies
- Two digital meters
- Linear power supply
- 10-turn potentiometer

HP E3630A Features

- Triple output
- Low noise, excellent regulation
- Auto-tracking
- Two digital meters
- Linear power supplies

HP E3620A, E3630A

These multiple-output power supplies have 0.01% load and line regulation which keeps the outputs steady with changes of the power line and load. These supplies specify both normal-mode voltage noise and common-mode current noise. The low normal-mode noise specification of 350 μV rms assures clean power for precision circuitry, and the low common-mode current specification of 1 μA rms minimizes line frequency current injection.

Both power supplies have separate digital panel meters to monitor both the voltage and current of any output simultaneously. An LED indicator for each output lets the user know when any supply is overloaded. All the outputs on these models are protected against overload and short-circuit damage. Protection circuits prevent output voltage overshoot when supply is turned on and off. The +6 V output of E3630A employs current foldback; all others are current limited.

4

HP E3630A

This general-purpose power supply provides three outputs, one 0 to 6 V output to power logic or other circuitry and one 0 to +20 V and 0 to –20 V to power linear circuits. The 0 to +20 V and 0 to –20 V outputs track to within 1%. The 0 to –20 V output can be set to any value less than the 0 to +20 V output. One voltage control may be used to vary both simultaneously.

The HP E3630A is 213 mm W x 88 mm H x 213 mm D (8.4 in x 3.6 in x 12.6 in) and weighs 3.8 kg (8.4 lbs).

HP E3620A

This general-purpose power supply provides two separate, independent and isolated power supplies in one small package. Each output has a ten-turn potentiometer for fine adjustment. Convenient meter selection allows the user to read voltage and current of either output. Each output can deliver up to 25 watts.

The HP E3620A is 213 mm W x 88 mm H x 400 mm D (8.4 in x 3.6 in x 15.8 in) and weighs 5.5 kg (12.1 lbs).

Specifications at 0° to 55° C unless otherwise specified

		E3620A	E3630A
Number of outputs		2	3
Number of output ranges		1	1
Output ratings	Output 1 Output 2 Output 3 Power (max.)	0 to 25 V, 0 to 1 A 0 to 25 V, 0 to 1A 50 W	0 to 6 V, 0 to 2.5 A* 0 to +20 V, 0 to 0.5 A 0 to –20 V, 0 to 0.5 A 35 W
Load regulation		0.01% +2 mV	0.01% +2 mV
Ripple and noise	rms peak-to-peak	350 μV 1.5 mV	350 μV 1.5 mV
Control mode		CV/CL	CV/CL (±20 V) CV/CF (+6 V)
Resolution (minimum change using front-panel controls)	Voltage Current	10 mV 1 mA	(0–20) 10 mV 100 mV (>20 V) 1 mA
Input power		115 Vac ±10% 47 to 63 Hz	115 Vac ±10% 47 to 63 Hz
Options available		OE3, OE9	OE3, OE9
		🚗	🚗

* Derate max., output current from 2.5 A at 0 V, to 1A at 6 V.

🚗 Indicates QuickShip availability.

Key Literature

1998/99 *HP Power Products Catalog,* p/n 5966-1706
HP Basic Instrument Catalog, p/n 5968-0124

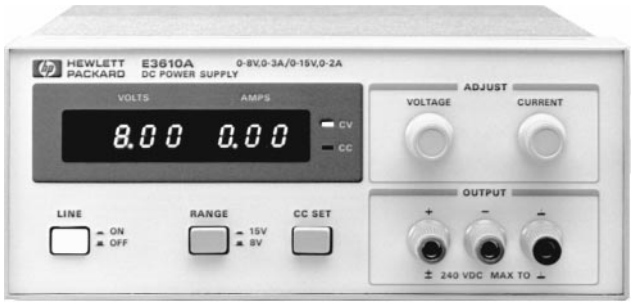
Ordering Information

(See tables for which options are available on specific models)

Opt 0E3 230 Vac ±10%, 47 to 63 Hz Input
Opt 0E9 100 Vac ±10%, 47 to 63 Hz Input
For use in Japan

HP E3610A, E3611A, and E3612A Features
- Dual ranges
- Digital voltage and current meters
- 10-turn potentiometer
- Linear power supply

HP E3614A, E3615A, E3616A, and E3617A Features
- Digital voltage and current meters
- Front and rear output terminals
- Over-voltage protection
- Remote sensing
- Remote analog programming
- Linear power supply



HP E3610A–E3617A

HP E3610A, E3611A, E3612A

These popular low-cost CV/CC bench supplies are designed for general laboratory use. The constant-voltage, constant-current output allows operation as either a voltage source or current source. The changeover occurs automatically, based on the load. This feature also provides an adjustable current limit, allowing you to set the safest current limit level for a particular DUT. Also, a CC-set button lets you set the current limit without your having to short the output.

Each model has two ranges, allowing more current at a lower voltage. For a higher-output voltage, supplies can be connected in series. Either the positive or negative terminal can be connected to ground, providing a positive or negative voltage output. Either terminal can also be floated up to 240 V from ground.

Dual digital meters monitor current and voltage simultaneously. Adjustments are made with the 10-turn voltage control and the 10-turn current control. Each power supply is 212 mm W x 88 mm H x 318 mm D (8.4 in x 3.5 in x 12.5 in) and weighs 3.8 kg (8.4 lb).

HP E3614A, E3615A, E3616A, E3617A

These flexible single range CV/CC power supplies can be used as either voltage sources or current sources. The CC-set button allows you to quickly set the current limit when operating in the CV mode, without shorting the output. 10-turn controls allow accurate adjustment of voltage and current output settings. The output voltage and current can also be controlled with external 0 to 10 volt analog signals or variable resistance.

Output connections can be made on either the front or rear panel. Remote sensing is available to eliminate the errors in voltage regulation due to voltage drops in the load leads. Either the positive or negative output terminal may be connected to ground to provide positive or negative output voltage. Either terminal can also be floated to a maximum of 240 volts. Multiple units can be combined in auto-parallel, auto-series and auto-tracking configurations to obtain more voltage or current output.

The load is protected with the over-voltage protection feature, which is easily monitored and adjusted from the front panel. The digital voltage and current meters provide continuous and accurate readings of the output levels. The HP E3614A–E3617A are 212 mm W x 88 mm H x 373 mm D (8.5 in x 3.5 in x 14.7 in).

Key Literature

1998/99 *HP Power Products Catalog,* p/n 5966-1706
HP Basic Instrument Catalog, p/n 5968-0124

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Specifications at 0° to 55° C unless otherwise specified

Single-output models		HP E3610A	HP E3611A	HP E3612A	HP E3614A	HP E3615A	HP E3616A	HP E3617A
Number of output ranges		2	2	2	1	1	1	1
Output ratings[1]	Range 1	0 to 8 V, 0 to 3 A[1]	0 to 20 V, 0 to 1.5 A[1]	0 to 60 V, 0 to 0.5 A[1]	0 to 8 V, 0 to 6 A	0 to 20 V, 0 to 3 A	0 to 35 V, 0 to 1.7 A	0 to 60 V, 0 to 1 A
	Range 2	0 to 15 V, 0 to 2 A[1]	0 to 35 V, 0 to 0.85 A[1]	0 to 120 V, 0 to 0.25 A[1]	—	—	—	—
	Power (max.)	30 W	30 W	30 W	48 W	60 W	60 W	60 W
Load and line regulation		0.01%+2 mV	0.01%+2 mV	0.01%+2 mV	0.01%+2 mV	0.01%+2 mV	0.01%+2 mV	0.01%+2 mV
Ripple and noise	rms	200 μV	200 μV	200 μV	200 μV	200 μV	200 μV	200 μV
	peak-to-peak	2 mV	2 mV	2 mV	1 mV	1 mV	1 mV	1 mV

Supplemental Characteristics Non-warranted characteristics determined by design and useful in applying the product

Control mode		CV/CC	CV/CC	CV/CC	CV/CC	CV/CC	CV/CC	CV/CC
Resolution (minimum change using front-panel controls)	Voltage	10 mV	10 mV	100 mV	10 mV	10 mV	10 mV	100 mV
	Current	5 mA	5 mA	2 mA	10 mA	5 mA	5 mA	5 mA
Power (115 Vac ±10%)		47 to 63 Hz	47 to 63 Hz	47 to 63 Hz	47 to 63 Hz	47 to 63 Hz	47 to 63 Hz	47 to 63 Hz
Options available		0E3, 0E9	0E3, 0E9	0E3, 0E9	0E3, 0E9	0E3, 0E9	0E3, 0E9	0E3, 0E9

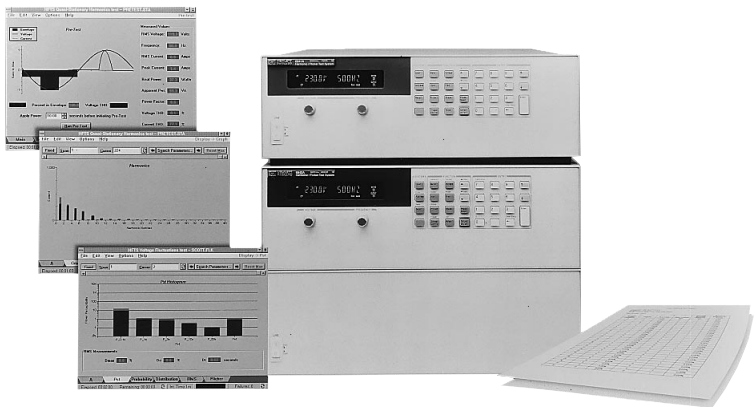
[1] Maximum current is derated 1% per °C between 40° to 55° C.

Indicates QuickShip availability.

HP 6800 Series Regulatory Test Solutions

HP 6812B
HP 6813B
HP 6843A

- One-box solution tests products for compliance to EN 60555-2, EN-60555-3, EN 61000-3-2, EN 61000-3-3, IEC 61000-4-11, IEC 61000-4-13, IEC 6100-4-14, IEC 61000-4-28
- Full 1-phase coverage at 230 Vrms and 16 Arms
- Measurement and generation implementation compliant with IEC 868, IEC 1000-4-7, and IEC 725
- Compliant-level harmonic current measurements for the fundamental through the 40th harmonic
- Windows software for IEC/EN testing capability
- Real-time and off-line test data review and analysis
- Test report generation
- Advanced diagnostic capabilities for failure analysis
- Standard ac source operating mode (normal mode)
- Standard three-year warranty



HP 6812B, 6813B, top right HP 6843A, bottom right

Testing for emissions and immunity standards is now even easier. The 6812B and 6813Bnow come ready to become Regulatory Test Solutions (RTS). With the purchase of test software (HP 14761A, 14762A, 14763A), you are quickly able to start full compliance testing.

See the HP 6840 Regulatory Testing Solutions page for more details. If you already own a 6812A or 6813A, you can upgrade to a "B" unit by contacting the factory directly.

HP Regulatory Test Solutions

The HP Regulatory Test Solutions are specifically designed for testing products for compliance to the low-frequency emissions and immunity regulations. Testing applications, in conjunction with enhanced units and a PC, provide full power coverage of single-phase regulatory standard requirements.

HP 14769A: Gives you all three applications (HP 14761A, HP 14762A, and HP 14763A)

HP 14761A: Harmonic and Flicker–Emissions Test (IEC 61000-3-2/3). Tests emissions of quasi-stationary current harmonics, fluctuating current harmonics, and voltage fluctuations and flicker.

HP 14762A: Voltage and Frequency Disturbance–Immunity Tests (IEC 61000-4-11/14/28). Tests immunity to voltage dips, interruptions, and fluctuations and frequency variations.

HP 14763A: Interharmonic–Immunity Test (IEC 61000-4-13). Tests immunity to harmonic, interharmonic, and mains signaling voltages.

These applications in conjunction with:

HP 6812B: 230 Vrms, 3.3 Arms, 750VA(compliance testing); 300Vrms, 6.5 Arms, 750 VA (maximum ratings); panel height: 5.25 inch

HP 6813B: 230 Vrms, 7.6 Arms, 1750 VA (compliance testing); 300 Vrms, 13 Arms, 1750 VA (maximum ratings); panel height: 5.25 inch

HP 6843A*: 230Vrms, 16 Arms, 4800 VA (compliance testing); 300Vrms, 16 Arms, 4800 VA (maximum ratings); panel height: 10.5 inch

*The HP 14761A comes automatically with the HP 6843A.

Reduce Cost and Integration Time with the HP One-Box Test System

The HP 14760A tests eliminates the time and cost required to research, specify and integrate individual instruments, and offers a more cost effective solution than multiple-box test systems. These fully-integrated test systems combine all of the generation and measurement functionality required for full compliance-level testing in one compact unit.

Each one-box test system contains the capabilities of a standalone ac source, power analyzer, flickermeter, and line impedance network. All regulatory testing functionality is available via the HP-IB and HP 14760A series test software.

High Performance Ensures Compliance-Level Testing Capability

Low distortion power generation, low- and programmable-output impedance, and an accurate measurement system assure compliance-level performance. The HP 6812B and HP 6813B were enhanced and the HP 6843A was designed according to the normative references for voltage and current harmonic measurement techniques (IEC 61000-4-7), flicker measurements (IEC 868), and reference impedance requirements (IEC 725).

Unlike multiple-box ac source and measurement configurations, the power generation and measurement of the HP 6812B, HP 6813B, and HP 6843A are controlled by a common internal timebase and are truly synchronized. This allows precise measurement of harmonics since they will fall directly within the center of the FFT bins with a synchronization accuracy better than 1 ppm.

Easy-to-Use Windows Graphical User Interface

Each HP 14760A series test is a Windows based software package what provides a fast and easy way to access the IEC/EN testing capabilities. The software provides the following test capabilities:

- Test set-up and execution
- Full control of the EUT ac mains power during testing
- Data archiving of all parameters
- Real-time test data display (graphical and tabular)
- On-line/off-line test data review with user-specified search criteria
- Diagnosis of test results via advanced features
- Pass/Fail indication for emissions tests. Immunity tests require user determination of EUT response.
- Report generation

Recommended PC Configuration

- 486DX4 100 MHz or Pentium
- 16 MB of RAM
- 1.2 GB IDE PCI hard disk (13 ms access time) [1,2]
- Windows 3.1, Windows for Work Groups 3.11, Windows 95 or WindowsNT[3]
- Networking disabled

[1] The HP 14761A requires ~4 MB of hard disk space for installation
[2] The recommended hard disk space accommodates data storage for the maximum possible test length (7 days). Less disk space is required for shorter test lengths.
[3] The HP 14761A Harmonic and Flicker-Emissions Test is also available on Windows 3.1 or Windows for Work Groups 3.11.

Supported GPIB Interfaces

HP82335B, 82340B and HP 82341C HP-IB Interfaces and the National Instruments AT-GPIB/TNT Interface

For more information, visit our web site:
http://www.hp.com/go/acregtest

Specifications

Specifications are warranted over the ambient temperature range of 0° to 40°C. For specifications pertaining to standard ac source operation and ac input requirements, see the HP 6800 AC Power Source/Analyzer Specifications and Supplemental Characteristics.

	HP 6812B	HP 6813B	HP 6843A
Number of phases	1	1	1
Output ratings			
Power (VA)	750 VA	1750 VA	4800 VA
Maximum rms voltage	300 V	300 V	300 V range
Maximum rms current	6.5 A	13 A	32 A
Output frequency range	50 Hz/60 Hz	50 Hz/60 Hz	50 Hz/60 Hz
Reference impedance accuracy	3% (at 0.4 Ω and 796 μH)/ 1% (at 0.4 Ω and 796 μH at 25°C)		
Constant voltage ripple and noise (20 kHz to 10 MHz)			
rms relative to full scale	–60 dB	–60 dB	–60 dB
rms	300 mV	300 mV	300 mV
Load regulation	0.5% of full scale	0.5% of full scale	0.5% of full scale
Line regulation	0.1% of full scale	0.1% of full scale	0.3% of full scale
Maximum total harmonic distortion	0.25%	0.25%	1%
Output voltage harmonic content[1]	Compliant with IEC 868 and IEC 61000-3-2		
Programming accuracy (25°C ± 5°C)			
Voltage (rms)	0.15% +0.3 V	0.15% +0.3 V	0.15% +0.3 V
Frequency	0.01% +10 mHz	0.01% +10 mHz	0.01% +10 mHz
Measurement accuracy (25°C ± 5°C)			
Current magnitude (low range)			
Fundamental	0.03% + 1.5 mA	0.03% + 1.5 mA	0.03% + 3 mA
Harmonics 2-49	0.03% + 1 mA + 0.2%/kHz	0.03% + 1 mA + 0.2%/kHz	0.03% + 2 mA + 0.2%/kHz
Current magnitude (low range)			
Fundamental	0.05% + 5 mA	0.05% + 5 mA	0.05% + 6 mA
Harmonics 2-49	0.05% + 3 mA + 0.2%/kHz	0.05% + 3 mA + 0.2%/kHz	0.05% + 3 mA + 0.2%/kHz
Flicker	Compliant with IEC 868	Compliant with IEC 868	Compliant with IEC 868
Flicker perceptibility (pst)	Compliant with IEC 868	Compliant with IEC 868	Compliant with IEC 868
Synchronization accuracy	< 1 ppm	< 1 ppm	< 1 ppm
Current shunt burden	0 volts	0 volts	0 volts
Current harmonic smoothing filter time constant	1.5 seconds	1.5 seconds	1.5 seconds
Pst integration time	1, 5, 10 or 15 minutes	1, 5, 10 or 15 minutes	1, 5, 10 or 15 minutes

[1] Output voltage harmonic content specification is limited for the HP 6843A for half-wave rectified/Class C loads. Compliance will be tested, verified and reported by the HP HFTS software for all DUTs.

IEC Mode Measurement System Characteristics for the HP 6812B, 6813B, and 6843A

	Sample rate	Window width	Acquisition overlap
50 Hz Operation			
Rectangular measurement window	12.8 kHz	16 cycles	None
Hanning measurement window	8.533 kHz	24 cycles	50%
60 Hz Operation			
Rectangular measurement window	15.360 kHz	16 cycles	None
Hanning measurement window	7.680 kHz	32 cycles	50%

Ordering Information

See page 200 for HP6812B and HP 6813B ordering information

HP 6843A Harmonic and Flicker Test with Regulatory Test Solution
- **Opt OBN** Extra Documentation
- **Opt ICM** Rackmount Kit
- **Opt 002** Voltage & Frequency-Immunity Test Software
- **Opt 003** Interharmonics-Immunity Test Software
- **Opt 009** Voltage & Frequency and Interharmonics Test Software
- **Opt 400** 360 to 440 Vac L-L, 48 to 63 Hz operation (required for Europe)

HP E3664A cabinet rails must be ordered with Option 1CM for rackmounting the HP 6843A.
HP p/n 5063-2310 Heavy duty rack slide kit

HP 6800 Series
HP 6811B
HP 6812B
HP 6813B
HP 6814B
HP 6834B

- Versatile ac power test solutions
- Generate stable or distorted ac and dc power
- 50/60 Hz power up to 300 Vrms
- 400 Hz avionics power up to 300 Vrms
- Arbitrary waveform generation
- Built-in precision power analyzer
- Easy to order, ready to use
- Easy to integrate into ATE systems
- HP VEE and National Labview drivers available
- Drop-in replacement - Elgar PIP9012 code built in
- Electronic calibration
- Full protection features (OV, OI, OP, OT)
- Three year warranty
- CE mark

HP 6811A, 6812A, 6813A, top; HP 6814B, 6834B, bottom

4

HP 6800 Series AC Power Source/ Analyzers

HP 6811B 300 V_{rms}, 375 VA
Single phase model
HP 6812B 300 V_{rms}, 750 VA
Single phase model
HP 6813B 300 V_{rms}, 1750 VA
Single phase model
HP 6814B 300 V_{rms}, 3000 VA
Single phase model
HP 6834B 300 V_{rms}, 4500 VA_{total}
One/three phase model

Hewlett-Packard ac power source/analyzers are designed for applications which require precise control, accurate measurement, and analysis of single- and three-phase ac power. The feature set and performance levels of this product family provide the flexibility necessary to power and test a wide variety of devices. These products are ideal for applications such as power supply testing, UPS testing, avionics, air traffic control equipment, testing power-factor-corrected equipment and telecom equipment.

The HP 6800 series utilizes a low noise switching topology, which delivers high performance and reduced size. These products can output dc (HP 6811B, 6812B, 6813B), ac complex and user-defined waveforms for exceptional application flexibility over the bus.

Key Features

- High peak current capability
- Programmable voltage, frequency, phase, output impedance, distortion and current limit
- Voltage and frequency slew control
- Power line disturbance simulation
- Avionics power disturbance simulation (over/under voltage, over/under frequencies, ac and dc transients)
- Measurement of Vrms, Irms, Ipeak, frequency, phase, VA, watts, PF and THD
- Two current measurement ranges. Low range increases sensitivity 10:1 (6811B, 6812B, 6813B)
- Harmonic analysis of V and I
- Programmable 1 phase/3 phase mode (6834B)
- Built-in HP-IB and RS-232 interfaces
- "Free" graphical user interface software
- Built-in output isolation relays
- MIL-STD 704 and RTCA DO160 (Section 16) testing capability
- Built-in 26 Vrms AUX output option
- Remote shutdown via TTL signal

Performance and Features to Meet Critical Testing Needs

Powerful Direct Digital Synthesis (DDS) Waveform Generation

The HP 6800 series offers the ultimate in waveform generation versatility. For testing products under ac line distortion conditions, clipped sine waves can be generated with 0% to 43% distortion. Up to twelve user-defined arbitrary waveforms can be defined and stored in non-volatile memory. These waveforms can be used to generate steadystate outputs or can be combined for more complex transient generation schemes. Testing for compliance to ac line harmonic immunity standards can easily be achieved. Sine waves with harmonic content specified by this standard can be downloaded into non-volatile memory and generated as needed.

For testing that requires dc output capability, dc transients or waveforms with a dc offset, the output of the HP 6811B, 6812B, and 6813B can be configured in ac or dc mode.

Flexible Transient Generation

When testing requires precise synchronization between waveform generation and measurement of the device under test, the HP 6800 series transient generation capability provides a powerful tool. The output voltage amplitude, frequency, phase, waveform shape, voltage slew rate, and frequency slew rate can be controlled in response to an input trigger generated from an internal or external event. The Step and Pulse modes offer an easy and convenient method of executing single-step and continuous-output changes. The List transient mode further extends this capability for more complex waveform generation needs. Up to 100 sequences of output settings can be precisely executed in response to a trigger or paced by programmed dwell times without computer intervention.

Extensive Measurement and Analysis

NEW

The HP 6800 series has measurement functionality equivalent to commercially available high-accuracy power analyzers. This eliminates the need for this standalone instrument for most applications, and lowers systems cost, increases available rack space, and simplifies cabling. All measurements are made with 16-bit resolution, suitable for even the most demanding applications.

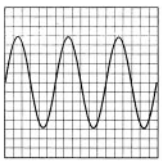
The HP 6800 series has built-in voltage and current waveform digitization combined with harmonic analysis capability. Amplitude, phase, and total harmonic distortion results up to the 50th harmonic are provided for output frequencies equal to or less than 250 Hz. This measurement feature, accessible via the front panel graphical user interface software or over the bus, provides a sophisticated solution for testing during product development.

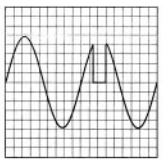
Testing for emissions and immunity standards is now even easier. The 6812B and 6813B now come ready to become Regulatory Test Solutions (RTS). With the purchase of test software (HP 14761A, 14762A, 14763A), you are quickly able to start full compliance testing.

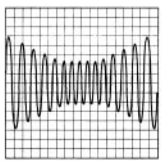
See the HP 6840 Regulatory Test Solutions page for more details.

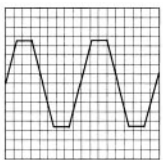
For more information, visit our web site:
http://www.hp.com/go/hpacpower

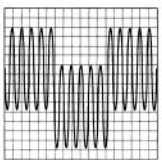
HP 6800 Series Waveform Examples with a Resistive Load

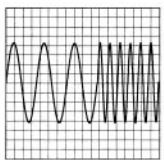

Low distortion sinewave

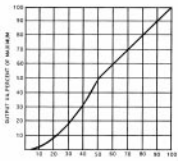

Phase referenced cycle dropout


Voltage amplitude change


Programmable distortion with programmable slew rate


Waveform with a dc offset (clipped sinewave)


Frequency change


VA Capabilities for the 6814B, 6834B, 6843A

Specifications

Per phase for a sine wave with a resistive load at 0° to 40° C, within an output frequency range of 45 Hz to 1000 Hz, and in ac coupled mode unless otherwise noted[1]

	HP 6811B	HP 6812B	HP 6813B	HP 6814B	HP 6834B
Number of phases	1	1	1	1	1/3
Output frequency range	dc; 45 Hz to 1 kHz	dc; 45 Hz to 1 kHz	dc; 45 Hz to 1 kHz	45 Hz to 5 kHz	45 Hz to 5 kHz
Output ratings					
Power	375 VA	750 VA	1750 VA	3000 VA	4500 VA
Maximum rms voltage	300 V	300 V	300 V	300 V_{1-n} (high range) 150 V_{1-n} (low range)	300 V_{1-n} (high range) 150 V_{1-n} (low range)
Maximum rms current	3.25 A	6.5 A (real-time mode)	13 A (real-time mode)	[2]10 A (300 V range) [2]20 A (150 V range)	[2]15 A/5 A (300 V range) [2]30 A/10 A (150 V range)
Maximum repetitive and nonrepetitive peak current	40 A	40 A	80 A	40 A (300 V range) 80 A (150 V range)	60 A/20 A (300 V range) 120 A/40 A (150 V range)
Crest factor	12	6	6	4	4
DC voltage range	±425 V	±425 V	±425 V	N/A	N/A
Maximum dc current	2.5 A	5 A	10 A	N/A	N/A
Constant voltage ripple and noise (20 kHz to 10 MHz)	–60 dB (relative to full scale)	–60 dB (relative to full scale)	–60 dB (relative to full scale)	–60 dB (relative to full scale)	–60 dB (relative to full scale)
Line regulation	0.1%	0.1%	0.1%	0.1%	0.1%
Load regulation	0.5%	0.5%	0.5%	0.5%	0.5%
Maximum total harmonic distortion	0.25% at 50 Hz/60 Hz 1% worst case 45 Hz to 1 kHz	0.25% at 50 Hz/60 Hz 1% worst case 45 Hz to 1 kHz	0.25% at 50 Hz/60 Hz 1% wort case 45 Hz to 1KHz	1% (45–1000 Hz) 1% + 1% kHz (>1 kHz – 5 kHz)	1% (45–1000 Hz) 1% + 1% kHz (>1 kHz – 5 kHz)
Programming accuracy (25° C ±5° C)					
rms voltage	0.15% + 0.3V (45 to 100 Hz) 0.5% + 0.3V (>100 to 500 Hz) 1% + 0.3V (>500 to 1000 Hz)	0.15% + 0.3V (45 to 100 Hz) 0.5% + 0.3V (>100 to 500 Hz) 1% + 0.3V (>500 to 1000 Hz)	0.15% + 0.3V (45 to 100 Hz) 0.5% + 0.3V (>100 to 500 Hz) 1% + 0.3V (>500 to 1000 Hz)	0.15% + 0.3V (45 to 100 Hz) 0.5% + 0.3V (>100 to 500 Hz) 1% + 0.3V (>500 to 5000 Hz)	0.15% + 0.3V (45 to 100 Hz) 0.5% + 0.3V (>100 to 500 Hz) 1% + 0.3V (>500 to 5000 Hz)
DC voltage	0.1% + 0.5V	0.1% + 0.5V	0.5% + 0.3V	N/A	N/A
Frequency	0.01% + 10 μHz	0.01% + 10 μHz	0.01% + 10 μHz	0.01% + 10 μHz	0.01% + 10 μHz
(HP 6834B in 3Φ mode)					
Phase	N/A	N/A	N/A	N/A	0.1° (45–100 Hz) 1° (>100–1 kHz) 1% + 1%/ 1 kHz (>1 kHz–5 kHz)
Measurement accuracy (25° ± 5° C)					
rms voltage (45–100 Hz)	0.03% + 100 mV[3] + 250 mV	0.03% + 100 mV[3]	0.03% + 100 mV[3]	0.05% + 250 mV (45 Hz–1kHz) 0.05% + 0.05%/ kHz + 250 mV	0.05% + 250 mV (45 Hz–1kHz) 0.05% + 0.05%/ kHz + 250 mV
DC voltage	0.03% + 150 mV[3]	0.03% + 150 mV[3]	0.03% + 150 mV[3]	N/A	N/A
rms current[4] (45–100 Hz)	0.05% + 10 mA[3]	0.05% + 10 mA[3]	0.05% + 10 mA[3]	0.1% + 50 mA	0.1% + 25 mA 0.1% + 50 mA[5]
Frequency	0.01% + 0.01 Hz[3]	0.01% + 0.01 Hz[3]	0.01% + 0.01 Hz[3]	0.01% + 0.01 Hz	0.01% + 0.01 Hz
Power (VA)[4] (45–100 Hz)	0.1% + 1.5 VA + 12 mVA/V[3]	0.1% + 1.5 VA + 12 mVA/V[3]	0.1% + 1.5 VA + 12 mVA/V[3]	0.15% + 5 VA	0.15% + 5VA 0.15% + 3 VA
Power (watts)[4] (45–100 Hz)	0.1% + 0.3 W + 12 mW/V[3]	0.1% + 0.3 W + 12 mW/V[3]	0.1% + 0.3 W + 12 mW/V[3]	0.15% + 5 W	0.15% + 5 W 0.15% + 0.3W[5]
Power factor[4]	0.01	0.01	0.01	0.01	0.01
Isolation to ground	300 Vrms	300 Vrms	300 Vrms	300 Vrms	300 Vrms

30-minute warm-up period
Specifications subject to change without notice

[1] It is possible to program the output frequency of HP 6812B and 6813B from dc to 45 Hz (see note 3).
[2] Full current is available at voltages between 50% and 100% of the output voltage range.
[3] Product may be operated between dc and 45 Hz subject to the following conditions: measurements may be extended to 4.5 Hz at full accuracy only by selecting a digitization rate of 250 μ seconds per point; frequency content of the measured signal must be limited to 4 kHz or less to avoid aliasing effects.
[4] High current measurement range shown
[5] Single-phase operation

Supplemental Characteristics Non-warranted characteristics determined by design that are useful in applying the product

	HP 6811B	HP 6812B	HP 6813B	HP 6814B	HP 6834B
Average programming resolution					
rms voltage	125 mV	125 mV	125 mV	80 mV	80 mV
DC voltage	250 mV	250 mV	250 mV	N/A	N/A
Overvoltage programming (OVP)	2 V peak	2 V peak	2 V peak	2 V peak	2 V peak
rms current	2 mA	4 mA	4 mA	5 mA	7.5 mA/2.5 mA
Peak current	12.5 mA	12.5 mA	25 mA	N/A	N/A
Output frequency	10 µHz	10 µHz	10 µHz	10 µHz	10 µHz
Phase	N/A	N/A	N/A	N/A	0.001° (45 Hz to 5 kHz)
Average measurement resolution					
rms voltage	10 mV	10 mV	10 mV	10 mV	10 mV
rms current	2 mA	2 mA	2 mA	3 mA	2 mA/6 mA
Net weight	28.2 kg (62 lb)	28.2 kg (62 lb)	32.7 kg (72 lb)	79.5 kg (175 lb)	87.7 kg (193 lb)
Shipping weight	31.8 kg (70 lb)	31.8 kg (70 lb)	36.4 kg (80 lb)	119.1 kg (262 lb)	127.3 kg (280 lb)
Size	136.2 mm H x 425.5 mm W x 574.7 mm D (5.2 in x 16.75 in x 18.22 in)			266.7 mm H x 425.5 mm W x 262.6 mm D (10.5 in x 16.75 in x 10.3 in)	

Remote Sensing: Up to 10 Vrms can be dropped across each load lead.
Command Processing Time: The average time for the output rms voltage to start to change after receiving an HP-IB command is 10 milliseconds.
Calibration Interval: One year
HP-IB Capabilities: SH1, AH1, T6 L4, SR1, RL1 PPO, DC1, DT1, E1, and CO, and a command set compatible with IEEE-488.2 and SCPI

Regulatory Compliance: Listed to UL-1244; certified to CSA 22.2 No. 231; conforms to IEC 1010
RFI Suppression: Complies with CISPR-11, Group 1, Class A
Warranty Period: Three years

4

AC Input Ratings

	HP 6811B	HP 6812B	HP 6813B	HP 6814B	HP 6834B
Voltage range (Vac)	87 to 106 Vac *104 to 127 Vac 174 to 220 Vac 191 to 254 Vac	87 to 106 Vac *104 to 127 Vac 174 to 220 Vac 191 to 254 Vac	174 to 220 Vac *191 to 254 Vac	*180 to 254 L-L (3Φ) 360 to 440 L-L (3Φ)	*180 to 254 L-L (3Φ) 360 to 440 L-L (3Φ)
Maximum input Current (rms)[1]	12 A (at 100 Vac) 10 A (at 120 Vac) 7.5 A (at 200/208 Vac) 6.5 A (at 230 V)	28 A (at 100 Vac) 24 A (at 100, 120 Vac) 15 A (at 200, 208 Vac) 13 A (230 Vac)	22 A (at 200/208 Vac) 20 A (at 220/230/240 Vac)	18 A 10 A	24 A 15 A
Input power (max)[2]	100 VA/ 700 W	2500 VA/1400 W	3800 VA/2600 W	5800 VA/4100 W	8900 VA/5900 W
Input frequency	47 to 63 Hz	47 to 63 Hz	47 to 63 Hz	47 to 63 Hz	47 to 63 Hz

*Input power configuration for the standard unit
[1] Measured at low line
[2] Measured at high line

Ordering Information

Opt 0BN Extra Documentation
Opt 1CM Rackmount Kit (p/n 5062-3977)
Opt ICP Rackmount Kit with Handles, HP 6811B, 6812B, 6813B only (p/n 5062-3983)
Opt 001 Harmonic Flicker – Emissions Test Software (6812B, 6813B)
Opt 002 Voltage & Frequency – Immunity Test Software (6812B, 6813B)
Opt 003 Interharmonics – Immunity Test Software (6812B, 6813B)
Opt 009 Harmonic & Flicker, Voltage & Frequency and Interharmonics Test Software (6812B, 6813B)
Opt 100 87 to 106 Vac, 48 to 63 Hz (Japan only), HP 6811B, 6812B
Opt 200 174 to 220 Vac, 47 to 63 Hz. If Option 200 is not ordered, the ac source will be configured to operate at 191 to 254 Vac, 47 to 63 Hz. (HP 6813B)
Opt 230 191 to 254 Vac, 48 to 63 Hz (HP 6811B, 6812B)
Opt 831 12 AWG, 200 to 240 Vac, unterminated (HP 6811B, 6812B, 6813B)
Opt 832 4 mm^2 wire size, unterminated (HP 6813B)
Opt 833 1.5 mm^2 wire size, 200 to 240 Vac, unterminated (HP 6811B, 6812B)
Opt 834 10 AWG, 100 to 120 Vac, unterminated (HP 6811B, 6812B)
Opt 841 Line Cord with NEMA 6-20P; 20 A, 250 V Plug (HP 6811B, 6812B, 6813B)
Opt 842 Line Cord with IEC 309, 32 A, 220 V Plug (HP 6813B)
Opt 844 Line Cord with NEMA L6-30P, 30 A, 250 V Locking Plug (HP 6813B)
Opt 845 Line Cord with IEC 309; 16A, 220 V Plug (HP 6811B, 6812B)
Opt 846 Line Cord with NEMA L5-30P; 30 A, 120 V Plug (HP 6811B, 6812B)
Opt 847 Line Cord with CEE 7/7; 16 A, 220 V Plug (HP 6811B, 6812B)
Opt 848 Line Cord with BS 546; 15 A, 240 V Plug (HP 6811B, 6812B)
Support rails (p/n 12679B) required when rackmounting the HP 6812B and 6813B Opt 1CM and Opt 1CP
Opt 400 360 to 440 Vac, 3-phase, 47 to 63 Hz operation (HP 6814B, 6834B)
Support rail kit p/n 5064-0001 must be ordered with Opt 1CM for rackmounting the HP 6814B and 6834B

Accessories

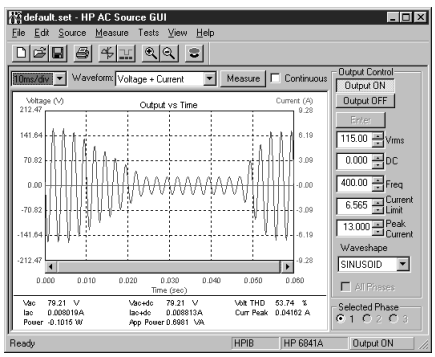
HP p/n 5060-3513 Three 30-A replacement fuses for 180 to 235 Vac line (HP 6814B, 6834B)
HP p/n 5060-3512 Three 16-A replacement fuses for 360 to 440 Vac line (HP 6814B, 6834B)
HP p/n 5063-2310 Heavy-duty rack slide kit (HP 6814B, 6834B)
Available modification:
Opt J01 26 Vrms/100 mA Aux output
HP 6811B, 6812B, 6813B
HP 6834B

- "Free" software
- Fast and easy ac source setup
- Easy-to-use table for transient generation
- "Click and drag" graphical creation of transients
- "Oscilloscope" view of dynamic and static voltage and current measurements shown in a single window
- Quickly develop, view, and download harmonic and arbitrary waveforms
- Command view window shows all SCPI commands being sent to the ac source and parameters received from the ac source
- Configure and save ac source states, arbitrary waveforms and transient generation files for convenient recall
- Automatic setup of inrush, dropout, surge and sag

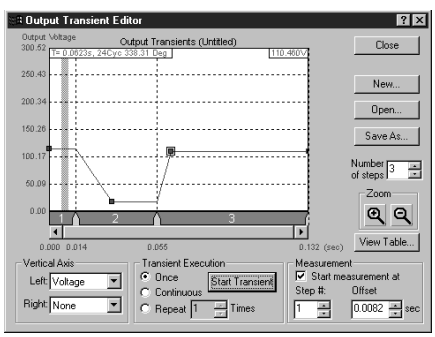
Graphical User Interface

Increase Your Testing Productivity at No Additional Cost

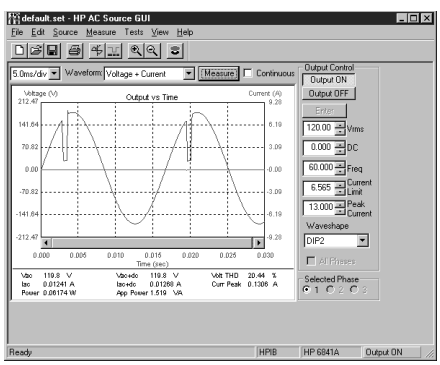
Simplify your ac power testing with the new ac source graphical user interface. This new product provides easy access to the capabilities of the HP ac source products, and allows you to get up and running quickly in your application. The HP ac source graphical user interface is shipped with every HP 6800 series ac source and Regulatory Test Solution on 3.5-inch floppy disk media.



Voltage slewing



Click and drag cursors



Voltage dips

Access the Powerful Capabilities of the HP 6800 Series Products

The graphical user interface allows you to easily perform key tests such as inrush characterization with the built-in data acquisition capability of HP's ac source and harmonic/flicker test system products.

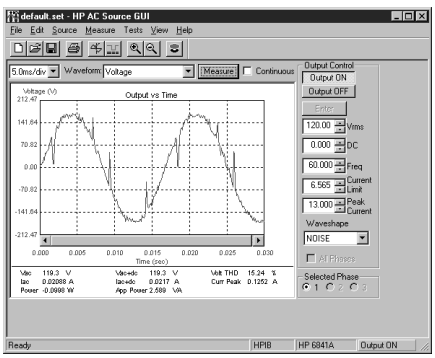
Graphical and numeric test results can be saved for future analysis or reporting. Create arbitrary waveforms that can be easily downloaded to the HP 6800 products' non-volatile memory—without writing a line of software code. These waveforms can be saved in PC-based files so that you can accumulate a customer library of waveforms specifically tailored to your applications. These waveforms can be later recalled and downloaded to the HP 6800 products at your convenience.

Minimum PC Configuration
486DX33 or faster
8 MB of Ram
2 MB of hard disk space

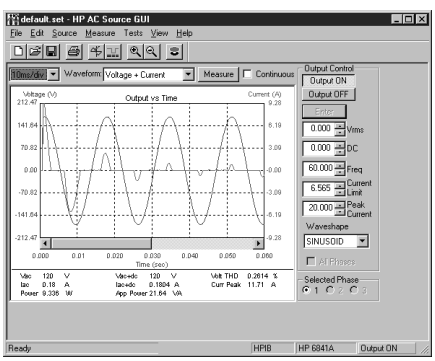
Supported Interfaces
HP 82335B, HP 82340B, HP 82341C,
HP 82341D, National AT-GPIB/TNT, RS-232

Software Platforms
Windows 95 and NT 4.0

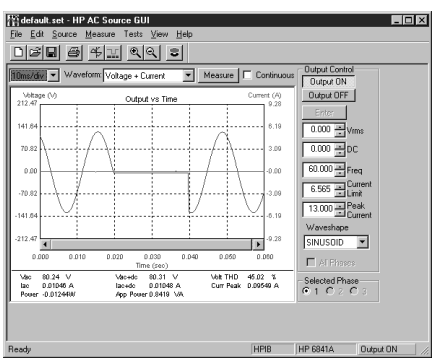
"Free" copy of the Graphical User Interface Software available on the web site: **http://www.hp.com/go/acsource**



Noise added to waveform



Measure inrush current



Cycle dropouts

Oscilloscopes

HP Basic Instruments Catalog
5968-0124EN/EUS
HP 54600-Series 60 to 500 MHz Oscilloscope Data Sheet
5964-9339EN/EUS
HP 54645A 1 Meg Memory Oscilloscope Data Sheet
5964-9630EN/EUS
HP 54645D Mixed Signal Oscilloscope Data Sheet
5964-9634EN/EUS
HP 54700-Series Modular Oscilloscope Brochure
5091-6979 E
Data Sheet
5091-9256E/EUS
HP 54750 Modular Oscilloscope Data Sheet
5962-0097E
HP Infiniium Oscilloscopes: 54810A, 54815A, 54820A, 54825A, 54845A Data Sheet
5966-3542EN/EUS
Brochure
5967-5392EN/EUS

(PN 54600-3) HP 54600 Series Oscilloscopes—FFT Lab Experiments Notebook
5966-4711E
(PN 54600-4) Using the Fast Fourier Transform in HP 54600 Series Oscilloscopes
5091-7227E
(PN 54720A-1) Bandwidth and Sampling Rate in Digitizing Oscilloscopes
5091-3757E
(PN 54720A-2) Measuring Time Intervals Accurately and Precisely with the HP 54720A
5091-3756E
(PN 54720A-3) Selecting Oscilloscope Probes for High-Speed Digital Circuit Measurements
5091-3758E
(PN 54720A-4) Triggering an Oscilloscope
5091-3755E
HP Infinium CD ROM
5966-0958E

Oscilloscope Probes & Accessories

HP Wedge: A hands-free solution for probing fine-pitch ICS
5966-4179E
HP Basic Instruments Catalog
5968-0124EN/EUS
Oscilloscope Probes and Accessories
5091-6195E
HP 1141A 200 MHz Differential Probe Data Sheet
5952-3291D
HP 1144A 800 MHz Active Probe Data Sheet
5091-7935E
HP 1145A 750 MHz Active Probe Data Sheet
5962-8537E
HP 54701A 2.5 GHz Active Probe Data Sheet
5091-3594EUS
HP 1180/81/82A Testmobile Data Sheet
5091-2520E
Probes and Accessories for Infiniium Oscilloscopes
5966-0343

Logic Troubleshooting Tools

HP 54620 A/C Logic Analyzer Data Sheet
5964-4062E/EUS
HP LogicDart Advanced Logic Probe E2310A Data Sheet
5966-0434EN/EUS

Electronic Counters

(PN 5370B-2) Better than 100 ps Accuracy in HP 5370B Time Interval Measurements
5952-7834

Digital Multimeters

HP Basic Instruments Catalog
5968-0129EN/EUS
HP 34401A 6½ Digital DMM Data Sheet
5964-0145EN/EUS
HP 34420A Nanovolt/Micro-ohm Meter Data Sheet
5963-7535EN/EUS
HP 3458A 8½ Digital DMM Technical Data
5965-4971E

Data Acquisition & Switching

HP 34970A Data Acquisition/Switch Unit Product Overview
5965-5290EN/EUS

Function Generators & Waveform Synthesizers

HP Basic Instruments Catalog
5968-0124EN/EUS
HP 33120A 15 MHz Function/Arb Generator Data Sheet
5964-0146EN/EUS
Phase Lock Option
5963-2174EN/EUS
HP 3325B 21 MHz Function Generator Data Sheet
5954-7986

(PN 8904A-1) Using the HP 8904A Multifunction Synthesizer as a Communications Signaling Source
5951-6748
(PN 8904A-2) Using the HP 8904A Multifunction Synthesizer as an FM Stereo Composite Generator
5953-8487
(PN 8904A-3) Using the HP 8904A Multifunction Synthesizer as a Modulation Source for Navigation Applications
5953-8488

Software

HP Basic Instruments Catalog
5968-0124EN/EUS
HP BenchLink Scope, Arb, Meter Data Sheet
5965-1511EN/EUS

Digital Timing Analyzers

HP Basic Instruments Catalog
5968-0124EN/EUS

DC Electronic Loads

Electronic Loads Mainframes
5962-6858E
Single Input Electronic Load Family
5962-6857E
1998/99 Power Products Catalog
5966-1706EN/EUS
150-Watt Electronic Load Module
5962-6856E
240-Watt Electronic Load Module
5962-6854E
300-Watt Electronic Load Module
5962-6855E
600-Watt Electronic Load Module
5962-6853E

Power Supplies

Models 6541A–6545A, 6551A–6555A and 6571A–6575A Analog Programmable DC Power Supplies
5962-6946E
HP's Answer To Your High Performance, High Power Burn-in Needs
5091-6952E
HP Basic Instruments Catalog
5966-4712EN/EUS
HP Model 66000A Modular Power System Mainframe
5962-6861E
HP Model 66001A-66006A Modular Power System Power Modules
5962-6860E
HP Models 6625A, 6626A, 6628A and 6629A Multiple Output Linear System DC Power Supplies
5962-6864E
HP Models 6621A-6624A, 6627A System DC Power Supplies
5091-9510E
HP 6671A-6675A HP-IB System DC Power Supplies
5962-8774E
HP 6015A Autoranging DC Power Supply
5962-6863E
HP 6030A-6033A, 6035A, 6038A Autoranging System DC Power Supplies
5962-6862E
HP 6050A, 6051A Electronic Load Mainframes
5962-6858E
HP 60501B 150-Watt Electronic Load Module
5962-6856E
HP 60502B 300-Watt Electronic Load Module
5962-6855E
HP 60503B 240-Watt Electronic Load Module
5962-6854E
HP 60504B 600-Watt Electronic Load Module
5962-6948E
HP 6060B, 6063B Single-Input Electronic Load Family
5962-6857E
HP 6812A-6814A, 6834A Using the HP 6800 Series AC Source for AC Power Measurement and Generation
5963-7044E
HP-IB System DC Power Supplies, HP Models 6631B-6634B
5966-1108
HP-IB System DC Power Supplies, HP Models 6641A-6645A
5962-6947E
HP-IB System DC Power Supplies, HP Models 6651A-6655A
5962-8775E
HP-IB System DC Power Supplies, HP Models 6671A-6675A
5962-8774E
12 Factors to Consider When Selecting a System Power Supply Brochure
5952-4199E
HP 66101A, 66102A, 66103A, 66104A, 66105A, 66106A Modular Power System Power Modules Technical Specifications Brochure
5962-6860E
1998/99 Power Products Catalog
5966-1706EN/EUS
HP E3600 Series Low Cost Bench Supply
5964-0383/EUS
HP E3631A Triple Output Programmable DC Power Supply, Data Sheet
5965-7031EN/EUS
HP Power Products Modification Services
5952-4299
HP E4350A, E4351A Solar Array Simulator
5966-0711EN/EUS
HP 6611C-6614C System DC Power Supplies
5966-1109EN/EUS
HP 6631BC-6634B System DC Power Supplies
5966-1108
HP 66312A, 66332A Dynamic Measurement DC Source
5965-1679EN/EUS

(PN 6285A) MPEG-2 Digital Video Encoder Stress Test Patterns – E6285A
5965-6492E
(PN 66000) HP 66000 Modular Power System
5091-2497E

Regulatory Test Systems

1998/99 Power Products Catalog
5966-1706EN/EUS
Application Note 1273, Regulatory Testing
5964-1917E

AC Source/Analyzers

HP 6800 Series AC Power Source/Analyzers, **HP Models 6812A-6814A, 6834A**
5962-7088E

(PN) HP 6800 Series AC Power Source/Analyzer
5963-7044E

1998/99 Power Products Catalog
5966-1706EN/EUS

Signal Sources Hewlett-Packard offers the widest variety of signal generators from dc to 110 GHz. They cover every application from low-frequency navigation signals, through cellular mobile radio, to millimeter-wave satellite systems. A variety of modulations are available, as well as pulse and digital formats for testing the latest communications systems.

Economy RF Signal Generators
Digital I/Q Modulation
High-Performance RF Signal Generators
CW Microwave Sources
High Performance Microwave Sources
Swept Frequency Microwave Sources

Signal Analyzers These instruments provide frequency-domain, time-domain, and modulation-domain measurement capability. Some of the key measurements that can be made with a signal analyzer are absolute and relative frequency, absolute and relative amplitude, scalar, noise, distortion products, amplitude modulation (AM), frequency modulation (FM), pulsed RF, and digital modulation.

Spectrum Analyzers
Dynamic Signal Analyzers
Distortion and Audio Analyzers
Vector Signal Analyzers
Modulation Analyzers
Measuring Receivers
Modulation Domain Analyzers

Network/Spectrum Analyzers These analyzers are high-performance, cost-effective, intelligent analyzers with combined vector network and spectrum analysis capabilities.

RF Network
Spectrum
Impedance Analyzer
Baseband
IF Network
Spectrum Analyzers

Network Analyzers Vector network analyzers accurately characterize the linear and nonlinear electrical performance of components and circuits. They measure the effect of devices on the amplitude and phase of swept-frequency and swept-power test signals. Network analyzers provide the ability to measure the input characteristics of each port of a device as well as the transfer characteristics from one port to another.

RF Network Analyzers
Microwave Network Analyzers
Scalar Network Analyzers
S-Parameter Test Sets
Vector Voltmeters

Power Meters New generation power meters and sensors feature DSP technology, fast measurement speed, improved absolute accuracy and repeatability, and ease of use and portability. Peak power meters provide complete and accurate characterization of today's complex pulsed signals. Full-featured models are available for MMS and VXI systems.

Power Meters
Power Sensors
EPM Power Meters
ECP Power Sensors
Peak Power Meters
MMS and VXI Power Meters

Noise Figure Meters Automatic noise figure meters from 10 to 2047 MHz provide accurate and simple, swept or CW measurements with second-stage correction. Microwave noise figure measurement systems are fully specified and eliminate the time designing and building a test system and are as easy to operate as a noise figure meter.

Automatic Noise Figure Meter
Microwave Noise Figure Measurement System
Noise Figure Test Set
Broadband Noise Sources

RF and Microwave Test Accessories Hewlett-Packard offers a complete line of RF and microwave test accessories for use in test and measurement systems from dc to 110 GHz. Products include step and fixed alternators, amplifiers, detectors, couplers, switches, switch drivers, adapters and waveguide devices.

Signal Sources

Signal Sources to 110 GHz

Hewlett-Packard offers the widest selection of high-performance signal sources from dc to 110 GHz. They cover every application range from low-frequency navigation signals, through cellular mobile radio, to millimeterwave satellite systems. Each offers synthesized frequency accuracy and stability as well as calibrated level and remote programmability. Modulation capabilities range from general purpose AM, ΦM, FM, pulse, and I/Q modulation to specific formats such as PSK, QPSK, OQPSK, GMSK, π/4 DQPSK, FSK, and QAM.

For more information, visit our web site:
http://www.hp.com/go/signal_sources

Signal Sources

Economy RF Signal Generators

Frequency	Model	Characteristics	Page
0.25 to 1000 MHz 0.25 to 2000 MHz 0.25 to 3000 MHz 0.25 to 4000 MHz	HP E4400B HP E4420B HP E4421B HP E4422B	**ESG series analog signal generator platform.** Flexible architecture for upgrade paths. Superior level accuracy. Step sweep (frequency, power and list). Electronic attenuator to 4 GHz. Built-in function generator.	208
0.25 to 1000 MHz	HP 8647A	**HP's lowest cost synthesized source with electronic attenuator.** ±1.5 dB level accuracy. Remote sequencing capability. 10 Hz frequency resolution. –110 dBc/Hz @ 20 kHz SSB phase noise.	210
0.1 to 1000 MHz 0.009 to 2000 MHz 0.009 to 3200 MHz 0.009 to 4000 MHz	HP 8648A HP 8648B HP 8648C HP 8648D	**Economy signal generator family.** ±1 dB level accuracy up to 2.5 GHz. Provides HP 8647A performance plus improved residual FM, output power, switching speed and phase noise. Electronic attenuator on HP 8648A. HP 8648B/C/D offer pulse modulation and high power options. All four models offer variable frequency modulation generator (Option 1E2).	210
0.1 to 1040 MHz	HP 8657A	**Spectral purity and electronic attenuator at an affordable price.** < –130 dBc/Hz @ 500 MHz SSB phase noise. < –60 dBc spurious. Electronic attenuator. ±1 dB level accuracy. AM and FM.	212
0.1 to 2060 MHz	HP 8657B	**Spectral purity and pulse to 2 GHz at an affordable price.** < –130 dBc/Hz @ 500 MHz SSB phase noise. < –60 dBc spurious. ±1 dB level accuracy. AM, FM and pulse with >90 dB on/off at 1030 MHz.	212

Digital I/Q Modulation

dc to 6 MHz	HP E2747A HP E2748A	**Vector waveform generator in a PC-format instrument with a maximum of 3 channels, or a module assembly designed for use with a compatible DSP carrier for developing ATE or large channel systems.** Open platform based around a digital transmitter architecture. Accepts data input and generates live messages with protocol. Provides both I and Q outputs (or composite IF). Support new, unique and standard digital modulation formats.	237
0.25 to 1000 MHz 0.25 to 2000 MHz 0.25 to 3000 MHz 0.25 to 4000 MHz	HP E4430B HP E4431B HP E4432B HP E4433B	**ESG-D series digital and analog signal generator platform.** Flexible architecture for upgrade paths. Excellent modulation accuracy and stability. Analog I and Q. Optional digital modulation formats for single and multichannel CDMA, DECT, GSM, NADC, PDC, PHS, and TETRA. Data generation and burst capabilities. Optional internal bit-error rate analyzer and dual arbitrary waveform generator.	214

High-Performance RF Signal Generators

0.252 to 1030 MHz 0.252 to 2060 MHz	HP 8643A HP 8644B	**Performance signal generator for RF design.** < –130 dBc/Hz @ 1 GHz SSB phase noise HP 8643A; < –137 dBc/Hz HP 8644B. < –100 dBc spurious. AM, FM and pulse modulation. Advanced modulation source. Lowest specified leakage. Avionics option available (Option 009).	217
0.01 to 1280 MHz	HP 8662A	**Low close-in noise.** 0.1 Hz frequency resolution, 5 x 10^{-10}/day stability. Calibrated and leveled output from +13 to –140 dBm. Digital sweep. Completely HP-IB programmable. AM/FM modulation. Fast switching.	219
0.1 to 2560 MHz	HP 8663A	**Low close-in noise with complex modulation.** 0.1 Hz frequency resolution, 5 x 10^{-10}/day stability. Calibrated and leveled output from +16 to –130 dBm. Digital sweep. Completely HP-IB programmable. AM, ΦM, FM and pulse modulation. Fast switching.	219
0.1 to 3000 MHz 0.1 to 4200 MHz 0.1 to 6000 MHz	HP 8664A HP 8665A HP 8665B	**Performance signal generators for 3.0 GHz, 4.2 GHz and 6 GHz testing.** Excellent spectral purity. AM and FM. High-performance pulse modulation. Advanced modulation source.	217
0.252 to 1030 MHz 0.252 to 2060 MHz	HP 8645A	**Performance signal generator for testing frequency-agile radios and surveillance receivers.** 15 µs switching speed. Spectral purity. AM, FM, pulse modulation. FM deviation to 20 MHz. Flexible control of frequency.	223

CW Microwave Sources

Frequency	Model	Characteristics	Page
1 to 20 GHz 0.01 to 20 GHz	HP 83711B HP 83712B	**Precision CW signals, pure and simple.** +10 to –90 dBm, < –50 dBc harmonics, < 1.5 x 10^{-9}/day stability, optional 1 Hz frequency resolution. Noise figure meter and millimeter source module compatible. HP-IB and SCPI programming. < 35 lbs.	222

High-Performance Microwave Sources

1 to 20 GHz 0.01 to 20 GHz	HP 83731B HP 83732B	**Optimum choice for high-performance microwave receiver and subsystem test.** +10 to –90 dBm, harmonics, < –55 dBc, spurious < –60 dBc. < 1.5 x 10^{-9}/day stability, optional 1 Hz frequency resolution. Built-in multi-mode pulse generator, <10 ns pulse rise/fall time, < 25 ns pulse width. Logarithmic AM with > 60 dB depth. FM with >300 modulation index 10 MHz peak deviation. HP-IB and SCPI programming. < 35 lbs.	223
0.01 to 50 GHz	HP 8360B Series	**Versatile synthesized sweeper.** Covers many application needs, including signal simulation with pulse, scan, amplitude, and frequency modulation requirements. General-purpose sweeper with full network analyzer capability.	226

Swept Frequency Microwave Sources

0.01 to 20 GHz	HP 83751A/B HP 83752A/B	**Synthesized microwave sweeper.** Fully synthesized sweep. Continuous analog or digital step sweep, 2 MHz swept frequency accuracy, +17 dBm output power available. SCPI and HP-IB programmable, HP 8350 HP-IB mnemonics for drop-in replacement. Optimized for HP 8757 scalar network analyzers.	225
0.01 to 50 GHz	HP 8360L Series	General-purpose synthesized swept CW generator with full network analyzer compatibility. + 15 dBm output power available.	226

High-Performance Modular

1 to 20 GHz	HP 70340A	**Modular signal generator for MMS.** Full performance signal source in half-rack width (4/8 MMS). Logarithmic AM, FM, and pulse modulation. Optional 1 Hz frequency resolution and internal multimode pulse generator. < 10 ns pulse rise/fall times, < 25 ns pulse width. HP-IB, SCPI, and CIIL programming.	228
0.01 to 1 GHz	HP 70341A	**Companion low-frequency module to HP 70340A.** 1/8 MMS module adds 0.01 to 1 GHz frequency coverage when used with the HP 70340A. Extend high performance AM, FM, and pulse modulation to RF frequencies.	228

Frequency-Agile/Complex Signal Simulation

10 to 2500 MHz	HP E2507B and E2508A	**Multi-format communications signal simulator.** Generates the multi-channel signals you need to accurately test your amplifiers and related products. They also provide background environments that simulate field conditions for BER and other tests in the laboratory.	229
0.252 to 1030 MHz 0.252 to 2060 MHz	HP 8645A	**Performance signal generator for testing frequency-agile radios and surveillance receivers.** 15 µs switching speed. Spectral purity. AM, FM, pulse modulation. FM deviation to 20 MHz. Flexible control of frequency.	223
DC to 50 MHz	HP 8791 Model 7	**Baseband FASS.** Architecturally equivalent to the Model 11, the Model 7 provides exceptional baseband performance to 50 MHz. Full arbitrary control of AM, FM and pulse make this high-performance ΦM direct-digital synthesizer an excellent fit for entry-level FASS users in applications such as communications, digital, video, radar target simulation and exciter design. Fully upgradeable to Model 11 or 21.	233
0.01 to 3 GHz	HP 8791 Model 11	**Reconfigureable frequency agile-signal simulator for radar, EW, and communications simulation.** Advanced frequency-agile signal simulation for EW, radar and communication receiver test. 100 ns - frequency hopping over 3 GHz. Arbitrary control over AM, FM, pulse modulation and agile carrier. 40 MHz ΦM modulation bandwidth. Easy-to-use application-specific instrument-on-a-disk software. Optional upconversion available to 18 GHz, upgradeable to Model 21.	233
0.05 to 18 GHz	HP 8791 Model 21	**Microwave-agile simulator.** Same as Model 11 (above), but uses state-of-the-art microwave-agile upconverter with 100 ns (typical) switching time for the entire range from 50 MHz to 18 GHz. Intended for "exotic" modulation requirements in radar/EW, and secure communication applications.	233

Millimeter Modules

26.5 to 40 GHz 33 to 50 GHz 40 to 60 GHz 50 to 75 GHz 75 to 110 GHz	HP 83554A HP 83555A HP 83556A HP 83557A HP 83558A	**Efficient frequency multipliers.** Effectively extends the performance of an 11 to 20 GHz microwave source HP 8673B/C/D, 8340, 8341, 8350B, 83751/52 or 8360 to the millimeter-wave frequency ranges.	235

Economy RF Signal Generators

HP E4400B
HP E4420B
HP E4421B
HP E4422B

- 250 kHz up to 4.0 GHz
- Flexible architecture, upgrade paths for options
- 4 GHz electronic attenuator for reliability and repeatability
- Superior level accuracy
- Wideband FM and Phase Modulation
- Step sweep (frequency, power and list)
- Built-in function generator
- 3 year warranty

HP ESG series HP E4422B

HP ESG Series Analog Signal Generators

HP-IB

The HP ESG Series of analog RF signal generators offer excellent in-channel performance with superior quality and reliability, at an affordable price. The first in a new generation of signal generators, they provide excellent frequency and level control, and wide modulation capabilities. They are ideally suited to meet the demanding requirements of today's receiver test, component test and local oscillator applications.

Adaptable to Tomorrow's Requirements

The innovative design of the HP ESG series provides a flexible architecture that can be tailored to meet the changing demands of evolving markets. These signal generators provide upgrade paths for options (current or future), and analog to digital.

Low Cost of Ownership

Lower initial cost, high reliability three-year warranty and a two-year calibration cycle, all strive to minimize the cost of ownership. The HP ESG series of RF signal generators are designed for long-term dependability, maximizing production throughput and uptime.

For more information, visit our web site: **http://www.hp.com/go/esg**

Specifications

Frequency

HP E4400B: 250 kHz to 1000 MHz
HP E4420B: 250 kHz to 2000 MHz
HP E4421B: 250 kHz to 3000 MHz
HP E4422B: 250 kHz to 4000 MHz
Resolution: 0.01 Hz
Switching Speed:
Modulation On: < 45 ms, typical
Modulation Off: < 35 ms, typical
Accuracy: Stability x fc timebase

Sweep Modes

Operating modes: Step: frequency and power, and arbitrary list
Dwell Time: 1 ms to 60 sec
Number of points: 2 to 401

Internal Reference Oscillator

Timebase Stability:

	Standard	High Stability (Option 1E5)
Aging Rate	< ± 1 ppm/yr.	< ± 0.1 ppm/yr. or < ± 0.0005 ppm/day after 45 days
Temperature (0° to 55° C)	< ± 1ppm, typical	< ± 0.05 ppm, typical
Line Voltage	< ± 0.1 ppm (+5%, –10%), typical	< ± 0.002 ppm, typical (+5%, –10%)

Timebase Reference Output:
Frequency: 10 MHz
Amplitude: > 0.35 V_{rms} into 50 Ω load

External Reference Input:
Frequency: 1, 2, 5, 10 MHz ± typ. 10 ppm (1 ppm, Option 1E5)
Amplitude: > 0.15 V_{rms}
Input Impedance: 50 Ω

Output

Range	Standard	Option UNB
250 kHz to 1000 MHz	+13 to –136 dBm	+17 to -136 dBm
> 1000 MHz to 3000 MHz	+10 to –136 dBm	+16 to -136 dBm
> 3000 MHz to 4000 MHz	+7 to –136 dBm	+13 to -136 dbm

Resolution: 0.02 dB

Level Accuracy (at 23° ± 5° C):	**+7 to –127 dBm**	**< –127 dBm**
250 kHz to 2 GHz	± 0.5 dB	± 1.5 dB
2 GHz to 4 GHz	± 0.9 dB	± 2.5 dB

Attenuator Hold Level Range: > 17 dB (>23 dB Option UNB)
Switching Speed: < 25 ms typical (30 ms, Option UNB)
With Power Search Mode: < 235 ms typical (245 ms, Option UNB)
Reverse Power Protection[1]:
250 kHz to 2000 MHz: 50 watts
> 2000 MHz to 4000 MHz: 25 watts
Max. DC Voltage: 50 V

SWR (typical):	**Standard**	**Option UNB**
250 kHz to 2000 MHz	< 1.4:1	< 1.25:1
> 2000 to 4000 MHz	< 1.9:1	< 1.35:1

Output Impedance: 50 Ω

Frequency Bands

Band	Frequency Range	N #
1	250 kHz to ≤ 249.999 MHz	1
2	> 249.999 to ≤ 500 MHz	0.5
3	> 500 MHz to ≤ 1 GHz	1
4	> 1 to ≤ 2 GHz	2
5	> 2 to ≤ 4 GHz	4

Spectral Purity

SSB Phase Noise (typical, at 20 kHz offset)
at 500 MHz: < –120 dBc/Hz
at 1000 MHz: < –116 dBc/Hz
at 2000 MHz: < –110 dBc/Hz
at 3000 MHz: < –104 dBc/Hz
at 4000 MHz: < –104 dBc/Hz
Residual FM (CW mode, 0.3–3 kHz BW, CCITT, rms)
Phase Noise Mode 1: < N x 2 Hz
Phase Noise Mode 2: < N x 4 Hz
Harmonics (≤ + 4 dBm [≤ +7.5 dBm, Option UNB] output level): < – 30 dBc
Nonharmonics (> 3 kHz offset, < + 7 dBm; [< +10 dBm, Option UNB] output level)[2]
250 kHz to 1000 MHz: < – 65 dBc
> 1000 MHz to 2000 MHz: < – 59 dBc
> 2000 MHz: < – 53 dBc
Subharmonics
≤ **1000 MHz:** None
> 1000 MHz: < – 40 dBc

Frequency Modulation

Maximum Deviation: N x10 MHz
Resolution: 0.1% of deviation or 1 Hz, whichever is greater
Deviation Accuracy (1 kHz rate, dev. < N x 100 kHz):
< ± (3.5% of FM deviation + 20 Hz)

Modulation Frequency Response (deviation = 100 kHz)

Path	Rates	
	1 dB Bandwidth	**3 dB Bandwidth, typical**
FM1	dc/20 Hz to 100 kHz	dc/5 Hz to 10 MHz
FM2	dc/20 Hz to 100 kHz	dc/5 Hz to 1 MHz

Distortion (1 kHz rate, THD, dev.=N x 100 kHz): < 1%

[1]The reverse power protection circuitry triggers at nominally 1 watt.
[2]Specifications apply for FM deviations < 100 kHz and are not valid for ΦM.

HP E4400B
HP E4420B
HP E4421B
HP E4422B

Phase Modulation

Maximum Deviation: N x 90 radians
Resolution: 0.1% of set deviation
Deviation Accuracy (1 kHz rate): < ± (5% of deviation + 0.01 radians)

Modulation Frequency Response:

ΦM Mode	Maximum Deviation	Rates (3 dB BW)	
		ΦM1	ΦM2
Normal	N x 90 rad	dc–100 kHz	dc–100 kHz
High Bandwidth	N x 2π rad N x π/2 rad	dc–1.5 MHz (typ.) dc–4 MHz (typ.)	dc–1 MHz (typ.) dc–0.9 MHz (typ.)

Distortion (1 kHz rate, THD, dev < N x 90 radians): < 1%

Amplitude Modulation[3] f_c > 500 kHz

Range (envelope peak ≤ max. specified power): 0 to 100%
Resolution: 0.1%
Rates (3 dB bandwidth): dc/10 Hz to 10 kHz
Distortion (1 kHz rate, THD): 30% AM: < 1.5%, 90% AM: < 4% (typical)
Accuracy (1 kHz rate): < ± (6% of setting + 1%)

Pulse Modulation

On/Off Ratio: ≤ 3 GHz: > 80 dB; > 3 GHz: > 60 dB
Rise/Fall Times: 150 ns, typical
Minimum Width (typical): ALC On: 2µs; ALC Off: 0.4µs
Pulse Repetition Frequency (typical):
- **ALC On:** 10 Hz–250 kHz
- **ALC Off:** DC–1.0 MHz

Level Accuracy (relative to CW)[4]: ± 0.5 dB, typical
Internal Pulse Generator
- **Squarewave Rates:** 0.1 Hz–50 kHz

Pulse
- **Period:** 16 µs to 30 sec
- **Width:** 8 µs to 30 sec

Resolution: 4 µs

Internal Modulation Source

Provides FM, ΦM, and AM Modulation Signals and LF Out
Waveforms: Sine, square, ramp, triangle, pulse, and noise
Rate Range:
- **Sine:** 0.1 Hz–50 kHz
- **Square, Ramp, Triangle:** 0.1 Hz–10 kHz

Resolution: 0.1 Hz
- **Pulse Only:** 4 µs

Frequency Accuracy: 0.005%
Swept Sine Mode (Frequency, Phase Continuous)
- **Operating Modes:** Triggered or Continuous Sweeps
- **Frequency Range:** 0.1 Hz to 50 kHz
- **Sweep Time:** 1 ms to 65 sec
- **Resolution:** 1 ms

Dual Sinewave Mode
- **Frequency Range:** 0.1 Hz to 50 kHz
- **Amplitude Ratio:** 0 to 100%
- **Amplitude Resolution:** 0.1%

LF Out (Internal Modulation Source)

Amplitude: 0 to 3 V_{peak} into 50 Ω
Output Impedance: < 1 Ω

External Modulation Inputs

Modulation Types:
- **Ext1:** FM, ΦM, AM, and Burst Envelope
- **Ext2:** FM, ΦM, AM, and Pulse

High/Low Indicator (100 Hz to 10M Hz BW, AC coupled inputs only): Activated when input level error exceeds 3% (normal)

Simultaneous Modulation

All modulation types may be simultaneously enabled, except: FM with ΦM, AM with Burst Envelope. AM, ΦM and FM can sum simultaneous inputs from any two sources (INT, EXT1, and EXT2). Any given source (INT, EXT1 or EXT2) may only be routed to one activated modulation type.

Remote Programming

Interface: HP-IB (IEEE-488.2-1987) with Listen and Talk. RS-232.
Control Languages: SCPI version 1992.0, also compatible with HP 8656B and 8657A/B/D/J mnemonics
Functions Controlled: All front-panel functions except power switch and knobs
IEEE-488 Functions: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, E2

General

Power Requirements: 90 to 254 V; 50, 60, or 400 Hz; 200 W maximum
Operating Temperature Range: 0 to 55° C
Leakage: Conducted and radiated interference meets MIL-STD-461B RE02 Part 2 and CISPR 11
Storage Registers: Up to 100 storage registers, up to 10 sequences available
Weight: < 12.7 kg (28 lb) net, < 21 kg (46 lb) shipping
Dimensions: 133 mm H x 426 mm W x 432 mm D (5.25 in H x 16.8 in W x 17 in D)

Key Literature

HP ESG and ESG-D Series Brochure, p/n 5966-3696E
ESG Series Technical Specifications, p/n 5965-3096E
Source Selection Guide, p/n 5965-3094E

Ordering Information

HP E4400B
HP E4420B
HP E4421B
HP E4422B
- **Opt 1EM** Move Connectors to Rear Panel
- **Opt 1E5** Add High-Stability Timebase
- **Opt UNB** High Power with mechanical attenuator

Accessories
Transit Case p/n 9211-1296
HP 83300A Remote Interface

[3] AM is typical above 3 GHz.
[4] With ALC on, specifications apply for repetition rates < 10 kHz and pulse widths ≥ 5 ms.

Economy RF Signal Generators

HP 8647A
HP 8648A
HP 8648B
HP 8648C
HP 8648D

- ±1 dB level accuracy through 2.5 GHz
- 4 Hz residual FM at 500 MHz
- Electronic attenuator (1 GHz models)
- +10/+13 to –136 dBm output power
- Simple, dependable operation
- Pager signaling (HP 8648A Option 1EP)

HP 8648A/B/C/D

HP 8647A and HP 8648A/B/C/D Synthesized Signal Generators

HP-IB

5

Superior Value in Economy Signal Generators

The HP 8647A and 8648A/B/C/D family of synthesized signal generators delivers solid performance and reliability at an affordable price. These signal generators provide the features and performance needed for semi-automated receiver testing and for use in a variety of general-purpose applications over a 9 kHz to 4000 MHz frequency range.

High Reliability and Simplicity

Designed to Hewlett-Packard's stringent quality specifications, these signal generators provide consistent performance. The all-electronic attenuator in the HP 8647A and 8648A easily handles millions of amplitude cycles with highly repeatable output levels.

An easy-to-use front panel interface shortens the operator's learning curve and increases productivity. A front panel organized in functional blocks speeds identification of the task and simplifies operation.

Ideal for Manufacturing and Semi-Automated Test

The HP 8647A and 8648 series are ideal for manufacturing high-volume products such as cordless telephones, pagers and two-way radios. The HP 8647A is the basic model providing essential performance. The HP 8648 series provides enhancements in frequency range, residual FM, level accuracy, and phase noise, in addition to optional high power, pulse modulation, and waveform modulation. The HP 8648 series provides ±1 dB absolute amplitude accuracy up to 2.5 GHz. All of the models offer ultra stable dc FM, with ±500 Hz carrier frequency accuracy below frequencies of 1001 MHz, and low RF leakage.

Applications such as receiver tuning and alignment benefit from the simple user interface. These signal generators are so easy to learn and use that experienced operators are no longer required. With 300 full storage registers and ten user-definable sequences, the signal generator easily adapts to any test procedure. Once setups are stored in registers, operators can quickly sequence through them, either from the front panel or through a remote keypad (HP 83300A). In addition, the HP 83301A memory interface provides the means to transfer register information from one HP 8647/48 to another.

For automated test applications, the HP 8647/48 offers full HP-IB programmability and uses SCPI programming codes. In addition, the HP 8648 series reduces software development costs by providing full HP-IB code compatibility with the HP 8656B and 8657A/B signal generators.

New Cost-Effective Pager Testing

The HP 8648A with Option 1EP provides an economical, one-box solution for pager test. Option 1EP adds the pager encoding capability for POCSAG, FLEX, and FLEX-TD formats to the HP 8648A. Ideal for pager test applications, the HP 8648A with Option 1EP offers superior frequency accuracy, deviation accuracy, and dc FM performance.

Specifications

Frequency
HP 8647A: 250 kHz to 1000 MHz
HP 8648A: 100 kHz to 1000 MHz
HP 8648B: 9 kHz to 2000 MHz
HP 8648C: 9 kHz to 3200 MHz
HP 8648D: 9 kHz to 4000 MHz

Resolution
HP 8647A: 1 Hz; HP 8648A/B/C/D: 0.001 Hz
Display: 10 Hz

Switching Speed (typical)
HP 8647A: < 120 ms
HP 8648A/B/C/D: <1001 MHz: < 75 ms; ≥ 1001 MHz: < 100 ms

Accuracy (after one hour warm-up and within one year calibration): Typically ± 3 x 10^{-6} x carrier frequency in Hz, ± 0.15 x 10^{-6} x carrier frequency in Hz for Option 1E5 (typically ± 0.072 x 10^{-6} x fc)

Internal Reference Oscillator
Accuracy and Stability (calibration adjustment dependent; after one hour warm-up and within one year of calibration), ± aging rate ± temperature effects ± line voltage effects

	Standard Timebase	Option 1E5
Aging	< ± 2 ppm/yr	< ± 0.1 ppm/yr; < ± 0.0005 ppm/day
Temperature	< ± 1 ppm	< ± 0.01 ppm (typ.)
Line Voltage (± 5%)	< ± 0.5 ppm	N/A

Output: 10 MHz, typically > 0.5 V_{rms} into 50 Ω
External Reference Oscillator Input: Accepts 2, 5, 10 MHz ±5 ppm and a level range of 0.5 V to 2 V_{rms} into 50 Ω

Spectral Purity
Harmonics (output ≤ 4 dBm): < –30 dBc
Subharmonics (output ≤ +4 dBm) < 1001 MHz: –60 dBc; ≥ 1001 MHz: –50 dBc; > 3200 MHz: –40 dBc
Nonharmonics (≥ 5 kHz offset, ≤ +4 dBm output level)
HP 8647A: < –60 dBc (–55 dBc from 220 to 250 MHz)
HP 8648A/B/C/D
< 249 MHz: < –55 dBc; < 2001 MHz: < –54 dBc
< 1001 MHz: < –60 dBc; ≤ 4000 MHz: < –48 dBc
Residual FM (CCITT, rms)
HP 8647A
< 249 MHz: < 20 Hz, typically < 11 Hz
< 501 MHz: < 10 Hz, typically < 6 Hz
≤ 1000 MHz: < 20 Hz, typically < 11 Hz
HP 8648A/B/C/D
< 249 MHz: < 7 Hz, typically < 4 Hz
< 501 MHz: < 4 Hz, typically < 2 Hz
< 1001 MHz: < 7 Hz, typically < 4 Hz
< 2001 MHz: < 14 Hz, typically < 8 Hz
≤ 4000 MHz: < 28 Hz, typically < 12 Hz
SSB Phase Noise (at 20 kHz offset, typical)
HP 8647A
@ fc 500 MHz: < –110 dBc/Hz; @ fc 1000 MHz: < –106 dBc/Hz
HP 8648A/B/C/D
@ fc 500 MHz: < –120 dBc/Hz; @ fc 3000 MHz: < –106 dBc/Hz
@ fc 1000 MHz: < –116 dBc/Hz; @ fc 4000 MHz: < –104 dBc/Hz
@ fc 2000 MHz: < –110 dBc/Hz

Output Range
HP 8647A and 8648A: +10 to –136 dBm
HP 8648B/C/D: ≤ 2500 MHz: +13 to –136 dBm; > 2500 MHz: +10 to –136 dBm

Max. Power with Option 1EA (High Power) on HP 8648B/C/D only

Freq. (MHz)	< 0.1	≤ 1000	≤ 1500	≤ 2100	≤ 2500	≤ 4000
Power (dBm)	+17	+20	+19	+17	+15	+13

Display Resolution: 0.1 dB
Accuracy (specified power < 13 dBm to –127 dBm)
HP 8647A: ± 1.5 dB
HP 8648A/B/C/D (applies at 25° ± 5° C):
≤ 2500 MHz: ± 1.0 dB
≤ 3200 MHz: ± 1.5 dB (≥ –100 dBm; ± 3.0 dB < –100 dBm)
≤ 4000 MHz: ± 2.0 dB (≥ –100 dBm; ± 3.0 dB < –100 dBm)
Reverse Power Protection (watts into 50 Ω)
HP 8647A and 8648A/B: 50 watts
HP 8648C/D: 50 watts ≤ 2000 MHz; 25 watts > 2000 MHz

SWR: (output < –6 dBm, typical)
HP 8647A: < 2.0:1
HP 8648A/B/C/D:
< 249 kHz: < 2.5:1
≤ 2500 MHz: < 1.5:1
≤ 3200 MHz: < 2.0:1
Output Impedance: Nominally 50 Ω

Frequency Modulation

Peak Deviation (rates > 25 Hz ac FM)	8647A	8648A/B/C/D
< 249 MHz	0 to 100 kHz	0 to 200 kHz
< 501 MHz	0 to 50 kHz	0 to 100 kHz
< 1001 MHz	0 to 100 kHz	0 to 200 kHz
< 2001 MHz	N/A	0 to 400 kHz
≤ 4000 MHz	N/A	0 to 800 kHz

Resolution
For ≤ 10% peak deviation
< 2001 MHz: 10 Hz
≥ 2001 MHz: 20 Hz
For > 10% to maximum peak deviation
< 2001 MHz: 100 Hz
≥ 2001 MHz: 200 Hz
Deviation Accuracy (internal 1 kHz rate)
HP 8647A: ± 7.5% of FM deviation ± 30 Hz
HP 8648A/B/C/D
< 1001 MHz: ± 3% of deviation ± 30 Hz
< 2001 MHz: ± 3% of deviation ± 60 Hz
≤ 4000 MHz: ± 3% of deviation ± 120 Hz
HP 8648A Option 1EP only:
50 Hz at 276 to 284 MHz, 406 to 512 MHz, and 929 to 932 MHz
Rates
HP 8647A
Internal: 400 Hz or 1 kHz
External dc: DC to 75 kHz (typical, 3 dB BW)
External ac: 20 Hz to 75 kHz (typical, 3 dB BW)
HP 8648A/B/C/D
Internal: 400 Hz to 1 kHz (10 Hz to 20 kHz for Option 1E2)
External dc: dc to 150 kHz (typical, 3 dB BW)
External ac: 1 Hz to 150 kHz (typical, 3 dB BW)
Distortion (1 kHz rate, THD + N, 0.3 to 3 kHz BW)
< 1001 MHz: < 1% at deviations > 4 kHz
< 2001 MHz: < 1% at deviations > 8 kHz
≤ 4000 MHz: < 1% at deviations > 16 kHz
HP 8648A/B/C/D 88 to 108 MHz: < 0.5% at deviations ≥ 75 kHz
Carrier Frequency Accuracy (relative to CW in dc FM, at 25° ± 5° C)
< 1001 MHz: ± 100 (typ. 40*) Hz, deviations < 10 kHz
< 2001 MHz: ± 200 (typ. 80*) Hz, deviations < 20 kHz
≤ 4000 MHz: ± 400 (typ. 160*) Hz, deviations < 40 kHz
FM + FM: Internal 1 kHz to 400 Hz source plus external. In internal plus external FM mode, the internal source produces the set level of deviation. The external input should be set to ≤ ±0.5 V peak or 0.5 Vdc (one-half the set deviation).

Phase Modulation
Peak Deviation
< 249 MHz: 0 to 10 radians
< 501 MHz: 0 to 5 radians
< 1001 MHz: 0 to 10 radians
< 2001 MHz: 0 to 20 radians
≤ 4000 MHz: 0 to 40 radians
Resolution
< 2001 MHz: 0.01 radian
≥ 2001 MHz: 0.02 radian
Deviation Accuracy (internal 1 kHz rate, typical)
HP 8647A: ± 7.5% of deviation ± 0.05 radians
HP 8648A/B/C/D
< 1001 MHz: ± 3% of deviation ± 0.05 radians
< 2001 MHz: ± 3% of deviation ± 0.1 radians
≤ 4000 MHz: ± 3% of deviation ± 0.2 radians
Rates
Internal: 400 Hz or 1 kHz (10 Hz to 20 kHz for Option 1E2, 8648A/B/C/D only)
External: 20 Hz to 10 kHz (typical, 3 dB BW)
Distortion (1 kHz rate)
HP 8647A < 2% at deviations ≥ 3 radians
HP 8648A/B/C/D
< 1001 MHz: < 1% at deviations ≥ 3 radians
< 2001 MHz: < 1% at deviations ≥ 6 radians
≤ 4000 MHz: < 1% at deviations ≥ 2 radians

*Within one hour after dc FM calibration

Amplitude Modulation
(AM is not specified below 1.5 MHz and is typical above 1001 MHz.)
Range: 0 to 100%; output ≤ +4 dBm
Resolution: 0.1%
Accuracy (1 kHz rate): ± 5% of setting ± 1.5% (for HP 8648B/C/D, specification is applicable at 25° ±5° C and < 70% depth)
Rates
Internal: 400 Hz or 1 kHz (10 Hz to 20 kHz for Option 1E2, 8648A/B/C/D only)
External dc: dc to 25 kHz (typical, 3 dB BW)
External ac: 1 Hz to 25 kHz (typical, 3 dB BW)
Distortion (1 kHz rate, THD+ N, 0.3 to 3 kHz BW)
HP 8647A and 8648A: @ 30% AM: < 2%; @ 90% AM: < 3%
HP 8648B/C/D: @ 30% AM: < 2%; @ 70% AM: < 3%
Pager Test Option 1EP (HP 8648A only)
Signaling Formats: POCSAG, FLEX, and FLEX-TD (RCR-43)
Pulse Option 1E6 (HP 8648B/C/D only)
On/Off Ratio: > 80 dB < 2000 MHz; > 70 dB ≥ 2000 MHz
Rise/Fall Times: < 10 ns
Modulation Generator Option 1E2 (HP 8648A/B/C/D only)
Adds variable frequency modulation generator.
Frequency Range: Sine: 10 Hz to 20 kHz;
Square, Triangle, Sawtooth: 100 Hz to 2 kHz
Frequency Accuracy: ± 0.01% typical
Frequency Resolution: 1 Hz (3 digits displayed)

Modulation Source
Internal: 400 Hz or 1 kHz, front panel BNC connector provided at nominally 1 V (p-p) into 600 Ω
External: 1 V peak into 600 Ω (nominal) required for full scale modulation. (High/Low indicator provided for external signals ≤ 10 kHz.)

Remote Programming
Interface: HP-IB (IEEE-488.2-1987) with Listen and Talk
Control Languages: SCPI version 1992.0. The HP 8648A/B/C/D are code compatible with the HP 8656B and 8657.
Functions Controlled: All front panel functions except power switch and knobs
IEEE-488: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, E2

ISO Compliant
The HP 8647A and 8648A/B/C/D signal generators are manufactured in an ISO 9002 registered facility in concurrence with HP's commitment to quality.

General

Power Requirements: 90 to 264 V, 48 to 440 Hz; 170 VA max.
Operating Temperature: 0° to 50° C
Leakage: Conducted and radiated interference meets MIL-STD-461B RE02 and FTZ 1046. Typically < 1 µV.

Key Literature

HP 8647A and 8648A/B/C/D Data Sheet, p/n 5965-3432E
Signal Generator Selection Guide, p/n 5965-3094E
HP 8647A and 8648A/B/C Brochure, p/n 5962-6191E
HP 8648A Option 1EP Pager Encoder Datasheet, p/n 5964-4116E

Ordering Information

HP 8647A Synthesized Signal Generator
HP 8648A Synthesized Signal Generator
HP 8648B Synthesized Signal Generator
HP 8648C Synthesized Signal Generator
HP 8648D Synthesized Signal Generator
Opt 1EA High Power (HP 8648B/C/D only)
Opt 1EP Pager Encoder (HP 8648A only)
Opt 1E6 Pulse (HP 8648B/C/D only)
Opt 1E2 Modulation Generator
Opt 1E5 High-Stability Timebase
Opt 1CM Rack Kit, p/n 08647-61020 (HP 8647A)
Opt 1CM Rack Kit, p/n 08648-60001 (HP 8648)
HP 83300A Remote Interface
HP 83301A Memory Interface

HP 8657A
HP 8657B

- 100 kHz up to 2060 MHz
- Electronic attenuator on HP 8657A
- ± 1.0 dB level accuracy (typically ± 0.5 dB on HP 8657A)
- 50 W reverse power protection
- AM, FM and optional pulse modulation

HP 8657A

HP 8657B

HP 8657A/B Synthesized Signal Generators

The HP 8657A and 8657B offer excellent performance at an affordable price. The HP 8657A covers a 100 kHz to 1040 MHz frequency range while the HP 8657B covers 100 kHz to 2060 MHz.

High-Performance Spectral Purity and Output Power

The low residual FM (< 4 Hz at frequencies < 1040 MHz) and the excellent phase noise performance of these signal generators make them ideal for almost all measurements requiring test signals at adjacent or out-of-channel offsets. Features such as carrier phase adjust allow you to characterize phase-sensitive devices such as phase detectors or phase interferometers, using precise 1-degree phase offsets with respect to another signal source. Display blanking and nonvolatile memory-clear are also available for operation in secure environments.

These signal generators offer wide dynamic output range, from +13 to –143.5 dBm, with unparalleled accuracy of ±1.0 dB. The solid-state electronic attenuator in the HP 8657A is so reliable, it is backed with a five-year warranty against failure. The HP 8657A/B also have extremely low radiated emissions for making sensitivity measurements on your receiver or for design work on extremely sensitive circuitry. Reverse power protection is provided standard for protection up to 50 W.

High-Performance Versatile Modulation

The HP 8657A and 8657B can combine modulation modes for AM/AM, FM/FM and AM/FM from both internal and external modulation sources. AM is ac-coupled, while FM can be either ac- or dc-coupled. The patented dc-coupling technique provides excellent long term stability (< 10 Hz/hour drift) as well as center frequency accuracy (± 500 Hz worst case). When dc FM is enabled, SSB phase noise and residual FM performance are not degraded as with other generators.

Pulse modulation is available with the HP 8657B Option 003. This option offers fast rise time and high isolation. Rise times are 35 to 50 ns (typically 10 to 18 ns) and on/off ratios are 70 to 95 dB. For pulse modulation coverage to 1040 MHz only, order the HP 8657B Option H60.

Ease of Operation for Improved Productivity

Up to 100 complete front-panel setups can be stored in the signal generator's memory for recall during testing. These setups can be accessed sequentially by pushing one front-panel key or by using the rear-panel SEQ port. The SEQ port can be connected to a foot switch or other operator-controlled device.

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HP 8656B, 8657A/B Specification Summary

Specifications	HP 8657A	HP 8657B
Frequency		
Range	100 kHz to 1040 MHz	100 kHz to 2060 MHz
Resolution	10 Hz	1 Hz
Timebase aging rate	± 2 ppm/year (typ.)	± 2 ppm/year (typ.)
Option 001	1.5×10^{-8} parts/day after 10 days (typ.)	1×10^{-9} parts/day after 45 days (typ.)
Switching speed (w/i 100 Hz)	< 35 ms (30 ms typ. at 25° C)	< 35 ms (30 ms typ. at 25° C)
Spectral Purity		
SSB phase noise		
(f_c = 500 MHz, 20 kHz offset)	< –130 dBc/Hz	< –130 dBc/Hz
Nonharmonics (> 5 kHz offset, CW)	< –60 dBc	< –60 dBc, < 1030 MHz < –54 dBc, ≥ 1030 MHz
Harmonics (at levels ≤ +7 dBm)	< –30 dBc	< –30 dBc, < 1030 MHz < –25 dBc, ≥ 1030 MHz
Subharmonics	None	None, 100 kHz to 1030 MHz < –35 dBc, 1030 to 2060 MHz
Residual FM		
(0.3 to 3 kHz f_c = 500 MHz, CW)	< 4 Hz rms	< 2 Hz rms (< 6 Hz > 1040 MHz)

Specifications (cont'd)	HP 8657A	HP 8657B
Output Level		
Range	+12 to –143.5 dBm into 50 Ω, +10 dBm, 100 kHz to 1 MHz	+13 to –143.5 dBm into 50 Ω, +10 dBm, < 1030 MHz w/Opt 003
Resolution	0.1 dB	0.1 dB
Absolute accuracy	< ±1 dB, ≥ –127 dBm < ±1.5 dB, > +7 dBm	< ±1 dB, ≥ –127 dBm < ±1.5 dB, ≥ +3.5 dBm
Reverse power protection	50 W	50 W
Amplitude Modulation		
Depth (output at ≤ +7 dBm)	0 to 99% f_c ≥400 kHz	0 to 100% f_c ≥ 400 kHz
Resolution	1%	1%
Bandwidth (1 dB)	20 Hz to 40 kHz	20 Hz to 40 kHz
Accuracy (internal rates) (< 90% AM < +7 dBm)	< ± (2% + 6% of setting)	< ± (2% + 6% of setting)
Distortion (internal rates) (0 to 30% AM, < +7 dBm)	< 1.5% THD + noise	< 1.5%, <1030 MHz < 4%, > 1030 MHz
Frequency Modulation		
Maximum peak deviation[1]	99 kHz, f_c < 130 and > 260 MHz 50 kHz, f_c 130 to 260 MHz	50 kHz to 200 kHz, f_c < 1040 MHz 400 kHz, f_c 1040 to 2060 MHz
Resolution	100 Hz, deviations < 10 kHz, 1 kHz, deviations ≥ 10 kHz	100 Hz, < 1040 MHz, dev. < 20 kHz 200 Hz, > 1040 MHz, dev. < 20 kHz
Bandwidth (1 dB)	dc/20 Hz to 50 kHz	dc/20 Hz to 50 kHz
Indicator accuracy	< ± 5% of setting	< ±5% of setting
Distortion (internal rates, deviation 3 kHz)	< 0.5% THD + noise	< 0.5% THD + noise, (≥ 6 kHz dev. for f_c ≥ 1040 MHz)
Pulse Modulation	Not applicable	Option 003
On/off ratio		>70 dB (> 95 dB, f_c ≥ 1030 MHz)
Rise/fall time, 10% to 90%		< 35 ns (< 50 ns, f_c ≥ 1030 MHz)
Repetition rate		dc to 30 MHz, typical
Duty cycle		0% to 100%
Remote Programming		
Interface	HP-IB (HP's implementation of IEEE-488)	
IEEE-488 functions	SH0, AH1, T0, L2, SR0, RL1, PP0, DC1, DT0, C0, E1	
General		
Save/recall/sequence registers	100 nonvolatile registers to save front-panel settings	
Operating temperature	0° to 55° C	
Power requirements	100 V, 120 V, 220 V or 240 V (+ 5, –10%) from 48 to 440 Hz HP 8657A: 175 VA maximum; HP 8657B: 200 VA maximum	
Size	HP 8657A: 133 mm H x 425 mm W x 520 mm D (5.25 in x 16.75 in x 20.5 in) HP 8657B: 133 mm H x 425 mm W x 574 mm D (5.25 in x 16.75 in x 22.6 in)	
Weight	HP 8657A: 18.2 kg (40 lb); HP 8657B: 20.5 kg (45 lb)	

[1] Deviations reduced for low-rate modulation; not specified for $f_c - (f_{pk}) < 100$ kHz.

Key Literature

HP 8657 Series Economy Synthesized Signal Generators
Technical Data, p/n 5091-1556E
HP 8657 Series Economy Synthesized Signal Generators
Brochure, p/n 5091-1555E

Ordering Information

Base Price		HP 8657A		HP 8657B	
Options					
001	High-Stability Timebase				
002	RF Connectors on Rear Panel Only				
003	Pulse Modulation				
H60	Pulse Modulation, Frequencies to 1040 MHz				
907	Front Handle Kit (5061-9689)		🚗		🚗
908	Rack Flange Kit (5061-9677)		🚗		🚗
909	Combined Front/Rack Flange Kit (5061-9683)		🚗		🚗
910	Extra Operation/Calibration and Two Service Manuals		🚗		🚗
915	Add Service Manual	(08657-90004)	🚗	(08657-90007)	🚗
W30	Three-year Repair Service				
W32	Three-year Calibration Service				
W34	Three-year Standard Compliant Cal. Service				
W50	Five-year Repair Service				

🚗 Indicates QuickShip availability.

HP E4430B
HP E4431B
HP E4432B
HP E4433B

NEW

- 250 kHz up to 4 GHz
- Personalities for single and multichannel CDMA
- 20 MHz RF bandwidth for I and Q
- Superior level accuracy
- Step sweep (frequency, power and list)
- Wideband AM, FM and phase modulation
- Internal data generator and burst capabilites (Option UN8)
- Flexible creation of custom modulation (Option UN8, UND)
- Built-in TDMA formats for DECT, GSM, NADC, PDC, PHS and TETRA (Option UN8)
- Internal dual arbitrary waveform generator (Option UND)
- Internal bit-error-rate analyzer (Option UN7)
- 3 year warranty

HP ESG-D Series Digital and Analog Signal Generators

HP-IB

The HP ESG-D series of RF signal generators provide a wide range of digital modulation capabilities, in addition to a comprehensive feature set and excellent analog performance–all at an affordable price. They provide excellent modulation accuracy and stability, as well as unprecedented level accuracy. The HP ESG-D series is ideally suited to meet the demanding requirements of today's digital receiver test, component test and local oscillator applications.

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Customized Modulations and DECT, GSM, NADC, PDC, PHS, TETRA Standards (Option UN8)

Internally generate signals for common standards to test receivers. Change modulation types, data, symbol rate, filter type and filter factor to generate customized signals for component and system margin testing. Create custom signals by mapping I/Q values and building a unique FIR filter. Easily configure timeslots to simulate different types of traffic, control or synchronization channels (or bursts). Generate mobile or base station transmissions with the internal burst capabilities. Also reduce the need for external equipment with comprehensive data generation capabilities.

Internal Dual Arbitrary Waveform Generator (Option UND)

Playback virtually any mathematically generated waveform. Download long or multiple waveforms (up to 1 Msample) to play or store in non-volatile RAM for later use. The 14 bits of DAC resolution enhance dynamic range and noise performance. Optimized for I/Q generation, the dual arbitrary option simplifies setup.

Single and Multichannel CDMA

The HP ESG-D series supports CDMA (Option UN5) and W-CDMA (Option H97, H98) personalities. Test CDMA mobile components and transmitters by generating forward and reverse single-channel. Fully characterized CDMA basestation amplifiers or perform transmitter test by simulating multiple coded channels with individually adjustable power, data and PN offsets.

Internal Bit Error Rate Analyzer (Option UN7)

Perform bit-error-rate analysis for sensitivity and selectivity measurements. Option UN7 provides analysis capabilities for PN9 and PN15 bit sequences and indicates pass or fail conditions for user-specified test limits.

Broadband I and Q Modulation

Use the analog I and Q inputs to generate complex modulation formats required for the development and testing of RF digital communications systems. A built-in quadrature modulator processes the I and Q input signals to provide superior modulation accuracy and stability over 10 MHz (1dB) baseband bandwidth.

Excellent Level Accuracy

Make sensitivity tests accurately and efficiently with the wide power range (+13 dBm to –136 dBm, +17 dBm to –136 dBm with Option UNB) and superior level accuracy of the HP ESG-D series RF signal generators. Level accuracies of better than +1.1 dB (+0.6 dB typical) for built-in modulation formats ensures precise measurement of even the most sensitive digital receivers.

HP ESG Series E4433B

Specifications

Frequency
HP E4430B: 250 kHz to 1000 MHz
HP E4431B: 250 kHz to 2000 MHz
HP E4432B: 250 kHz to 3000 MHz
HP E4433B: 250 kHz to 4000 MHz

For Analog Remote Programming and General Specifications, see ESG Series on page 208.

Level Accuracy with Digital Modulation

(With ALC on; relative to CW; with PRBS-modulated data)[1]
π/4 DQPSK or QPSK Formats
± 0.15 dB (with raised cosine or root-raised cosine filter and $\alpha \geq 0.35$; with 10 kHz ≤ symbol rate ≤ 1 MHz; at RF freq. ≥ 25 MHz; power ≤ max. specified –3 dBm or –6 dBm with Option UNB.
Constant Amplitude Formats
(FSK, GMSK, etc.): No degradation in power level accuracy
Level Accuracy with ALC Off[2]
± 0.3 dB, typical (After power search is executed; relative to CW level accuracy with ALC on; if external I/Q is enabled: $\sqrt{I^2 + Q^2} = 0.5\ V_{rms}$)

I/Q Modulation

I&Q Inputs:
Input Impedance: 50 Ω
Full Scale Input: $\sqrt{I^2 + Q^2} = 0.5\ V_{rms}$
Adjustments/Impairments (nominal)**:**
DC Offset: (I and Q independently adjustable) +100%
I/Q Gain Ratio: ± 4 dB
I/Q Quadrature: ± 10°

DC Vector Accuracy
Relative to full scale, power ≤ + 7 dBm (≤ +10 dBm for Option UNB)

Frequency (GHz)	< 0.6	0.6 to 2	2 to 3.7	≤ 4
Static EVM[1] (rms)	< 0.75%	< 0.5%	< 0.75%	< 1%
Magnitude Error[1] (rms)	< 0.5%	< 0.35%	< 0.5%	< 0.75%
Phase Error[1] (rms)	< 0.35°	< 0.25°	< 0.35°	< 0.5°
Origin Offset (dBc)	< –46	< –46	< –40	< –40

Burst Envelope

On/Off Ratio: V_{IN}: ≤ –1.05 V
≤ 3 GHz: > 75 dB
> 3 GHz: > 60 dB
Rise/Fall Time: < 2 μs, typical
Minimum Burst Rate:
ALC On: 10 Hz, typical
ALC Off: DC
External Input: Ext 1
Input Impedance: 50 Ω
Input Voltage
RF Off: –1.0 V
RF On: 0 V

Coherent Carrier Out[3]

Range: 250 MHz to maximum carrier frequency
Level: 0 dBm ± 5 dB, typical
Impedance: 50 Ω

For more information, visit our website: **http://www.hp.com/go/esg**

[1] Typically, level accuracy with ALC on will be maintained with drive levels between 0.25 and 1.0 V_{rms}.
[2] When applying external I/Q signals with ALC off, output level will vary directly with I/Q input level.
[3] Coherent carrier is modulated by FM or ΦM when enabled.

HP E4430B
HP E4431B
HP E4432B
HP E4433B

Optional Real-Time I/Q Baseband Generator (Option UN8)

Modulation Formats
PSK: BPSK, QPSK, OQPSK, π/4DQPSK, 8PSK, 16PSK, D8PSK
MSK: User-defined phase offset
QAM: 4, 16, 32, 64, 256
FSK: Symmetric 2, 4, 8, 16
Custom FSK: User-defined asymmetric
Custom I/Q: Map of 16 unique values for I and Q
Filters: Nyquist, Root Nyquist, Gaussian, Custom FIR
Filter Rate: α: 0 to 1; BT 0.1 to 1
Symbol Rate: Adjustable up to 12 Msymbols/sec
Data Structure
Frames and timeslots may be configured as different types of traffic or control channels. The data field of a timeslot can accept user file, PRBS or external data with the appropriate clock.
Internal Data
Pseudo-Random Patterns: Continuous PN9, PN11, PN15, PN20 or PN23
Repeating Sequence: Any 4-bit sequence

Downdoadable Data
Maximum Size (Pattern RAM)**:** 1 Mbits, 8 Mbits (Option UN9)
Maximum Size (User File)**:** 128 kbytes
External Data
Inputs: Data, bit/symbol clocks (accepts rates ± 5% of specified data rate)
Reference Frequency: Internal or external 1, 2, 5, 10 MHz reference. Data clock can be locked to an external 13 MHz GSM reference
Frame Trigger Delay Control
Range: 0 to 65,535 bits
Resolution: 1 bit
Internal Burst Shape Control
Rise/Fall Time Range: Up to 30 bits
Rise/Fall Delay Range: 0 to 63.5 bits (varies w/standard)
I/Q Outputs
EVM (NADC, PDC, PHS, TETRA)**:** 1% rms
Global Phase Error (GSM)**:** 0.75° rms
Deviation Accuracy (DECT)**:** 1 kHz

	NADC		PDC		PHS		TETRA[5]		DECT	GSM (DCS, PCS)	
Error Vector Magnitude[4] (% rms)	**Cont.**	**Burst**	**Cont.**	**Burst**	**Cont.**	**Burst**	**Cont.**	**Burst**			
Low EVM Mode	0.7	1.4	0.9	1.3	0.9	0.9	0.8	1.7	N/A	N/A	
Low EVM Mode (typical)	0.4	1.1	0.6	0.9	0.6	0.7	0.5	1.3	N/A	N/A	
Low ACP Mode (typical)	1.0	1.4	0.8	1.0	0.9	0.9	0.9	1.5	N/A	N/A	
Global Phase Error[4] (rms/pk)	N/A		N/A		N/A		N/A		N/A	0.6° / 2.2° 0.3° / 1.3°(typ.)	
Deviation Accuracy[4] (kHz)	N/A		N/A		N/A		N/A		3 (2, typ)	N/A	
Adjacent Channel Power[4] (ACP) (Low ACP Mode dBc, typical)	**Cont.**	**Burst**	**Cont.**	**Burst**	**Cont.**	**Burst**	**Cont.**	**Burst**	**N/A**	**Cont.**	**Burst**
at Adjacent Channel[6]	–35	–34	—	—	—	—	–69[7]	–64	N/A	–37	–37
at 1st Alternate Channel[6]	–80	–78	–74	–72	–80	–78	–80	–78	N/A	–72	–71
at 2nd Alternate Channel[6]	–82	–81	—	—	–80	–79	–81	–80	N/A	–82	–80
at 3rd Alternate Channel[6]	–84	–83	–81	–79	—	—	–81	–80	N/A	–82	–81
Supported Burst Types	Custom, Up/Down TCH		Custom, Up/Down TCH, Up Vox		Custom, TCH, Sync		Custom, Up Control 1 & 2, Up Normal, Down Normal, Down Sync		Custom, Dummy B 1 & 2, Traffic B, Low Capacity	Custom, Normal, FCorr, Sync, Dummy, Access	
Scramble Capabilities	—		—		Yes		Yes		—	—	

[4] Specifications apply for the frequency range, symbol rates, root raised cosine filter, filter factors (∝ or B_bT) and default scaling factor specified for each standard, and at power levels ≤ + 7 dBm (≤ 4 dBm for TETRA), (≤ + 10 dBm for Option UNB).
[5] ACP for TETRA is measured over a 25 kHz bandwidth, with an 18 kHz root raised cosine filter applied at power levels ≤ 4 dBm (≤ +8 dBm for Option UNB).
[6] The "channel spacing" determines the offset size of the adjacent and alternate channels: Adjacent Chan. offset = 1 x channel spacing, 1st Alt. Chan. = 2 x channel spacing, 2nd Alt. Chan. = 3 x channel spacing, etc.
[7] TETRA ACP performance is typically –72 dBc with Option H99 in continuous modulation mode.

HP E4430B
HP E4431B
HP E4432B
HP E4433B

Optional Dual Arbitrary Waveform Generator (Option UND)

Channels: 2
Resolution: 14 bits (1/6384)
Waveform Memory Length
Playback: 1 Msample/channel
Storage (non-volatile RAM)**:** 1 Msample/channel
Waveform Segments
Length: 16 samples to 1 Msample
Number of Segments: 128
Sequencing: Continuously repeating
Sample Rate: 1 Hz to 40 MHz
Output Reconstruction Filters
Type: Elliptic
Fcutoff (nominal, 3 dB): 250 kHz, 2.5 MHz, 8 MHz and Through
Baseband Spectral Purity
(typical, full scale sinewave, >20x oversampling)
Harmonic distortion:
< 100 kHz: <-80 dBc
100 kHz to 2 MHz: <-65 dBc
Non-Harmonic spurious: <-80 dBc
Phase Noise: <-120 dBc/Hz
(baseband output of 1 MHz sinewave at 20kHz offset)
IM Performance: <-69 dB
(two sinewaves at 950 kHz and 1050 kHz at full scale)

Optional Bit-Error-Rate Analyzer (Option UN7)

Clock Rate: 100 Hz to 10 MHz
Supported Data Patterns: PN9, PN15
Resolution: 10 digits
Minimum Synchronization Length: 9 bits (PN9 <2 MHz)
Bit Sequence Length: 100 bits to 4.294 Gbits after synchronization

5

Multichannel CDMA Personalities (Option UN5)

Spurious Emissions (typical dBc, with high crest factor on)

Reverse Channel (≤0 dBm)

	Offset 885 to 1.25 MHz			Offset 1.25 to 1.98 MHz			Offset 1.98 to 5 MHz		
	Std.	UNB	H99	Std.	UNB	H99	Std.	UNB	H99
30-200 MHz	-72	-75	-73	-76	-78	-74	-79	-79	-77
700- 1000 MHz	-73	-76	-79	-76	-79	-82	-79	-79	-79
1000-2000 MHz	-66	-74	-79	-70	-78	-82	-79	-79	-79

9/64 Channels (<-2 dBm)

	Offset 885 to 1.25 MHz			Offset 1.25 to 1.98 MHz			Offset 1.98 to 5 MHz		
	Std.	UNB	H99	Std.	UNB	H99	Std.	UNB	H99
30-200 MHz	-68	-71	-72	-73	-76	-72	-78	-78	-77
700- 1000 MHz	-70	-73	-75	-75	-77	-79	-79	-79	-79
1000-2000 MHz	-63	-71	-74	-68	-75	-78	-78	-78	-78

Chip (symbol) Rate: Adjustable from 1 Hz to 10 MHz with 4x oversampling
Predefined Channel Configurations: Pilot, 9, 32, 64, reverse
Rho: 0.9996
(<4 dBm, IS-95 filter, < 2 GHz, typical)
User-Defined Channels
Number of Channels: 1 to 256
Walsh Codes: 0 to 63
Channel Power: 0 to –40 dB
PN Offset: 0 to 511
Data: 00-FF (HEX) or random

Key Literature

HP ESG and ESG-D Series Brochure, p/n 5966-3696E
HP ESG Series Technical Specifications, p/n 5965-3096E
HP ESG Configuration Guide, p/n 5965-4973E
Source Selection Guide, p/n 5965-3094E
Using the HP ESG-D Series and the HP 8922 GSM Test Set for GSM Applications, p/n 5965-7158E
Generating and Downloading Data to the HP ESG-D Series for Digital Modulation, p/n 5966-101E
Controlling TDMA Timeslot Power Levels in the HP ESG-D Series, p/n 5966-4472E
Generate Digital Modulation with the HP ESG Series Internal Dual Arbitrary Waveform Generator, p/n 5966-4097E
Customize Digital Modulation with the HP ESG-D Series Real-time I/Q Baseband Generator, p/n 5966-4096E
Making Bit-Error-Rate Measurements with the HP ESG-D Series, p/n 5966-4098E

Ordering Information

HP E4430A
HP E4431A
HP E4432A
HP E4433A
Opt 1CM Rackmount kit, p/n 5063-9214
Opt 1CN Front handle kit, p/n 5063-9227
Opt 1CP Rackmount kit with handles, p/n 5063-9221
Opt 1E5 Add high stability time base
Opt 1EM Move all front panel connectors to rear panel
Opt UNA Alternate timeslot power level control option for UN8
Opt UNB High power with mechanical attenuator
Opt UND Internal dual arbitrary waveform generator
Opt UN5 Single and multichannel CDMA personality for UND
Opt H03 Single channel CDMA personality
Opt UN7 Internal bit-error-rate analyzer
Opt UN8 Real-time I/Q baseband generator with TDMA standards
Opt UN9 Additional 7Mbits RAM memory for UN8
Opt H97 W-CDMA personality for UND
Opt H98 W-CDMA receiver test baseband generator
Opt H99 Improved ACP performance for W-CDMA, CDMA, TETRA
Opt W50 Five-year warranty
Accessories
Transit Case p/n 9211-1296
HP 83300A Remote Interface

HP 8643A
HP 8644B
HP 8664A
HP 8665A
HP 8665B

- Frequency ranges of 1 GHz, 2 GHz, 3 GHz, 4.2 GHz, or 6 GHz
- Lowest overall noise and spurious
- AM, FM, and pulse modulation
- Lowest specified leakage (optional)
- Internal modulation source for complex waveforms
- Onsite repair and calibration

HP 8643A, 8644B, 8665B

These signal generators offer RF designers and manufacturers a selection of frequency range and high performance. The HP 8643A, 8644B, and 8664A are for traditional out-of-channel receiver test applications. The HP 8665A/B are for high-performance applications up to 6 GHz, particularly radar, telemetry and spurious testing of UHF receivers. All signal generators within this performance family have options that allow them to be configured to meet specific application needs.

HP 8643A 1 GHz/2 GHz Signal Generator

HP has optimized the HP 8643A's configuration with the performance necessary for out-of-channel receiver tests while maintaining a low price. Options have been limited on the HP 8643A, but many performance/feature capabilities have been included as standard.

Standard Electronic Attenuator and Advanced Modulation Source

Reliability is enhanced by the use of an electronic attenuator on the 1 GHz version. Instead of using mechanical relays for setting levels, the HP 8643A uses solid-state components accurate to within ±1.0 dB. The HP 8643A comes standard with an advanced internal modulation synthesizer that provides coverage to 400 kHz and two-tone capability with the selection of sine, square, sawtooth, and white Gaussian noise waveforms.

HP 8644B 1 GHz/2 GHz High-Performance Signal Generator

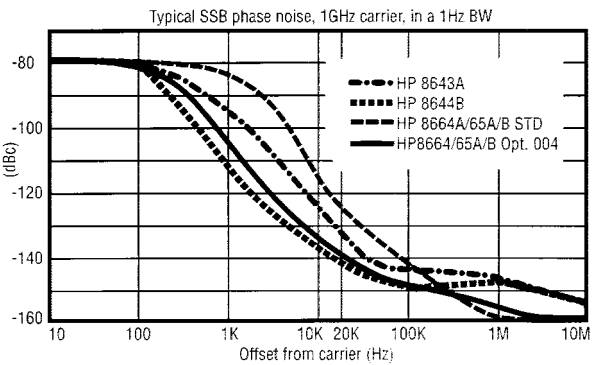
The HP 8644B represents the highest overall performance in HP's line of 1 GHz and 2 GHz signal generators. The HP 8644B builds on the HP 8643A's performance by lowering SSB phase noise (–136 dBc/Hz versus –130 dBc/Hz) and lowering spurious (–105 dBc versus –100 dBc). The HP 8644B can be used either for specific tests that require the lowest SSB phase noise or for applications with diversified performance requirements.

HP 8664A 3 GHz, HP 8665A 4.2 GHz and HP 8665B 6 GHz High-Performance Signal Generators

These three signal generators offer identical performance except for frequency coverage and price. Your application will dictate which instrument is required. The HP 8664A and HP 8665A/B are suited for out-of-channel receiver measurements through the use of Option 004 (low-noise enhancement) and for such applications as radar testing through the use of Option 008 (pulse modulation).

Wideband FM and Optional Pulse Modulation

FM rates of up to 2 MHz and deviations to 20 MHz peak are suitable for many applications such as higher-rate digital communications. An optional pulse modulator with on/off ratio of > 80 dB and rise/fall times of < 5 ns is available. Pulse width and delay can be internally adjusted between 50 ns and 999 ms, eliminating the need for an external pulse generator.



Typical SSB Phase Noise, at 1 GHz Carrier, in a 1 Hz BW

Specifications

	HP 8643A	HP 8644B	HP 8664A; HP 8665A/B
Frequency			
Range	0.252 to 1030 MHz 0.252 to 2060 MHz (Option 002)	0.252 to 1030 MHz 0.252 to 2060 MHz (Option 002)	0.1 to 3000 MHz (HP 8664A) 0.1 to 4200 MHz (HP 8665A) 0.1 to 6000 MHz (HP 8665B)
Resolution	0.01 Hz	0.01 Hz	0.01 Hz
Accuracy	Timebase stability x f_c	Timebase stability x f_c	Timebase stability x f_c
Switching speed (typical)	< 90 ms; < 200 ms with FM on	< 350 ms	< 100 ms (Option 004)

Internal Reference Oscillator

Output: 10 MHz, > 0.15 V_{rms} into 50 Ω; (IES) > I V_{rms} into 50 Ω

Timebase Stability

	Standard Timebase	High Stability (Opt. 001)
Aging Rate:	1.5×10^{-8}/day	3×10^{-10}/day
Temperature Effects:	7×10^{-10}	6×10^{-10}
Line Voltage Effects:	2×10^{-10}	1×10^{-10}

Specifications, cont'd

	HP 8643A	HP 8644B	HP 8664A; HP 8665A/B
Spectral Purity			
SSB phase noise @ 1 GHz (20 kHz offset)	–130 dBc/Hz	–136 dBc/Hz	–117 dBc/Hz; –134 dBc/Hz (Option 004)
Nonharmonics: (>10 kHz offset)	< –100 dBc, 0.252 to 1030 MHz < –94 dBc, 1030 to 2060 MHz	< –105 dBc, 0.252 to 1030 MHz < –100 dBc, 1030 to 2060 MHz	< –100 dBc, 187.5 to 2060 MHz < –90 dBc, 2060 to 6000[1] MHz, 0.1 to 187.5 MHz
Harmonics	< –30 dBc, output ≤ +8 dBm	< –25 dBc, output ≤ +10 dBm	< –30 dBc, output ≤ +10 dBm
Subharmonics	None, 0.252 to 515 MHz < –52 dBc, 515 to 1030 MHz < –40 dBc, 1030 to 2060 MHz	None, 0.252 to 515 MHz < –52 dBc, 515 to 1030 MHz < –40 dBc, 1030 to 2060 MHz	< –75 dBc, 0.1 to 1500 MHz < –40 dBc, 1500 to 3000 MHz < –50 dBc, 3000 to 6000 1 MHz
Residual FM @ 1 GHz: 0.3 to 3 kHz post det. BW	< 2 Hz rms	<1 Hz rms	< 7.5 Hz rms; <1.2 Hz rms (Option 004)
Output Level			
Range	+ 13 to –137 dBm	+ 16 to –137 dBm, + 13 dBm (Option 002, 005)	+ 13 to –139.9 dBm, + 9 dBm (Option 008)
Resolution	0.1 dB	0.1 dB	0.1 dB
Absolute accuracy	± 1 dB, output ≥ –127 dBm	± 1 dB, output ≥ –127 dBm	± 1 dB, output ≥ –119.9 dBm, 1 to 1000 MHz ± 1.5 dB, output ≥ –119.9 dBm, 1000 to 3000 MHz ± 2 dB, output ≥ –119.9 dBm, > 3000[1] MHz, < 1 MHz
Reverse power protection	50 W	50 W	25 W[2], 0.1 to 2060 MHz; 1 W, > 2060[1] MHz
Amplitude Modulation			
Depth: (@ ≤ + 7 dBm)	0 to 100%	0 to 100%	0 to 100%
Resolution	0.1%	0.1%	0.1%
Bandwidth (3 dB) ≤ + 7 dBm	dc to 100 kHz, 128 MHz < f_c < 1030 MHz	dc to 100 kHz, 128 MHz < f_c < 1030 MHz	dc to > 10 kHz, > 10 MHz
Accuracy: 1 kHz rate	± (7% of setting + 1%) up to 80% depth	± (7% of setting + 1%) up to 80% depth	± (6% of setting + 1%) up to 90% depth
Distortion: 30% depth, 1 kHz rate	< 2%; < 4% (Option 002)	< 2%; < 4% (Option 002)	< 4%
Frequency Modulation			
Maximum peak deviation (Deviation halves per lower octave)	2 MHz, 1030 to 2060 MHz; 1 MHz, 515 to 1030 MHz	20 MHz/200 kHz[3], > 1030 MHz; 10 MHz/100 kHz[3], > 515 MHz	20 MHz, 3000 to 6000[1] MHz; 10 MHz, 1500 to 3000 MHz
Resolution	2.5% of setting	2.5% of setting	2.5% of setting
Bandwidth (3 dB)	dc to 100 kHz	dc to 100 kHz	dc to 800 kHz
Carrier accuracy in FM	± 0.5% of setting	± 0.5% of setting	± 0.6% of setting
Indicator accuracy	< 5%, < 30 kHz rate; < 10%, < 100 kHz rates	< 5%, < 30 kHz rates; < 10%, < 100 kHz rates	± 9%, < 20 kHz rates
Distortion	< 5%, 20 Hz to 100 kHz rates	< 5%, 20 Hz to 100 kHz rates	< 1%, 20 Hz to 20 kHz rates
Pulse Modulation			**Option 008**
On/off ratio	> 50 dB; > 80 dB, > 1030 MHz	> 35 dB; > 80 dB, > 1030 MHz	> 80 dB
Rise/fall time, 10 to 90%	< 100 ns	< 100 ns	< 8 ns
Repetition rate	dc to 1 MHz	dc to 1 MHz	dc to 10 MHz
Internal width/delay	N/A	N/A	Variable, 50 ns to 1s
Internal Modulation Source			
Waveforms and rates	Sine; white Gaussian noise (0.1 Hz to 400 kHz); Triangle, sawtooth, square (0.1 Hz to 50 kHz)		
Frequency accuracy	Same as timebase		
Output level (into 600 Ω)	1 V pk, 2 V pk for HP 8643A and 8644B		
Output resolution	2 mV pk		
Frequency Sweep			
Digital sweep	Digitally stepped sweep over entire frequency range. Linear/log selection. 0.5 to 1000 s sweeps.		
Markers/Z-axis output	3 markers available/Z-axis output nominally + 5 V/X-axis output nominally 0 to 10 V		
Phase continuous sweep	40 MHz of span available at maximum carrier frequency. 20 ms to 10 s sweep times.		
Remote Programming			
Interface	HP-IB (IEEE 488.2-1987)		
Control language	Hewlett-Packard Systems Language (HP-SL). All functions controlled except power.		
IEEE-488 functions	SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, E2		
General			
Power requirements	± 10% of 100 V, 120 V, 220 V, or 240 V; 48 to 440 Hz; 500 VA (except HP 8643A/44B: 400 VA)		
Operation temperature	0° to 55° C		
Leakage	Conducted and radiated interference meets MIL-STD-461B RE0 <None> 2 and FTZ 1046		
Calibration interval	Recommended 3 years (MTBC)		
Weight	HP 8643A: 23 kg (50 lb). HP 8644B: 30 kg (67 lb). HP 8664A/65A/B: 35 kg (78 lb).		
Size	177 mm H x 426 mm W x 624 mm D (7 in x 16.8 in x 24.6 in). Option 010 adds 35 mm (1.4 in) to D.		

[1] 3000 MHz for HP 8664A, 4200 MHz for HP 8665A, 6000 MHz for HP 8665B
[2] N/A to HP 8665B
[3] Low-noise mode

Ordering Information

	HP 8643A	HP 8644B	HP 8664A	HP 8665A	HP 8665B
Options					
001 High-Stability Timebase					
002 2 GHz Doubled Output					
004 Low-Noise Option					
005 Electronic Attenuator (N/A with Option 002)					
008 Pulse Modulation					
009 Specified VOR/ILS[2]					
011 2 GHz Internal Frequency Counter					
Service Kit	(08645-61116)	(08645-61116)	(08665-61116)	(08665-61116)	(08665-61116)
003 Rear-Panel Input/Output					
010 Reduced-Leakage Configuration					
W30 Add 3 Years to Return Warranty					
907 Front-Handle Kit (5062-3990)	🚚	🚚	🚚	🚚	
908 Rack Flange Kit (5062-3978)	🚚	🚚	🚚	🚚	🚚
909 Combined Front/Rack Flange Kit (5061-9684)					

[1] See Specifications
[2] Not compatible with Options 002 or 005

🚚 Indicates QuickShip availability.

HP 8662A
HP 8663A

- 10 kHz to 1280 MHz frequency range
- < – 147 dBc/Hz SSB phase noise at 10 kHz offset
- 0.1 Hz frequency resolution

HP 8662A

- 100 kHz to 2560 MHz frequency range
- AM/FM/ΦM/pulse in one generator
- Internal variable modulation oscillator

HP 8663A

HP 8662A/HP 8663A Synthesized Signal Generators

Spectral purity is the key contribution of both the HP 8662A and 8663A, making them ideal for many radar, satellite communication, and phase noise measurement applications. Typical absolute phase noise performance of these generators at a 1 kHz offset is as low as –135 dBc/Hz, depending on the band of operation.

The frequency range of the HP 8662A is 10 kHz to 1280 MHz. It offers versatile AM/FM, using either internal 400 Hz and 1 kHz rates or externally applied modulating signals which can be either ac- or dc-coupled. It also has simultaneous modulation capability.

The HP 8663A and 8662A provide the U.S. Air Force MATE (Modular Automatic Test Equipment) capability, via Option 700. This option is an external translator that allows the signal generator to be controlled by the MATE language CIIL (Control Interface Intermediate Language).

HP 8662A Specifications

Frequency

Range: 10 kHz to 1280 MHz (1279.9999998 MHz)
Resolution: 0.1 Hz (0.2 Hz above 640 MHz)
Accuracy and Stability: Same as reference oscillator
Internal Reference Oscillator: 10 MHz quartz oscillator. Aging rate < 5 x 10^{-10}/day after 10-day warmup (typically 24 hrs. in normal operating environment).

Spectral Purity

Front-Panel Absolute SSB Phase Noise (dBc/Hz):

	Frequency range (MHz)					
	0.01 to 119.9[1]		120 to 159.9[2]		160 to 319.9[2]	
	Spec	Typ	Spec	Typ	Spec	Typ
1 Hz	– 68	– 78	– 66	– 76	– 60	– 70
10 Hz	– 98	– 108	– 96	– 106	– 90	– 100
100 Hz	– 116	– 126	– 115	– 125	– 109	– 119
1 kHz	– 126	– 132	– 129	– 135	– 124	– 130
3 kHz	– 126	– 135	– 129	– 138	– 124	– 133
5 kHz	– 128	– 138	– 131	– 141	– 126	– 136
10 kHz	– 132	– 138	– 142	– 148	– 136	– 142
100 kHz	– 132	– 139	– 142	– 148	– 136	– 142

	Frequency range (MHz)					
	320 to 639.9[2]		640 to 1279.9[3]		1280 to 2559.9[4]	
	Spec	Typ	Spec	Typ	Spec	Typ
1 Hz	– 54	– 64	– 48	– 58	– 42	– 52
10 Hz	– 84	– 94	– 78	– 88	– 72	– 82
100 Hz	– 103	– 114	– 97	– 108	– 92	– 102
1 kHz	– 118	– 125	– 112	– 119	– 106	– 113
3 kHz	– 118	– 127	– 112	– 121	– 106	– 115
5 kHz	– 120	– 130	– 114	– 124	– 108	– 118
10 kHz	– 131	– 136	– 124	– 130	– 118	– 124
100 kHz	– 131	– 136	– 124	– 130	– 118	– 124

Residual SSB Phase Noise (dBc/Hz):

	Frequency range (MHz)					
	0.01 to 119.9[1]		120 to 159.9[2]		160 to 319.9[2]	
	Spec	Typ	Spec	Typ	Spec	Typ
10 Hz	– 108	– 114	– 112	– 119	– 106	– 113
100 Hz	– 121	– 126	– 122	– 129	– 118	– 124
1 kHz	– 128	– 133	– 131	– 138	– 127	– 134
3 kHz	– 128	– 136	– 131	– 139	– 127	– 135
5 kHz	– 129	– 138	– 133	– 141	– 129	– 136
10 kHz	– 132	– 137	– 142	– 147	– 136	– 142
100 kHz	– 132	– 137	– 142	– 147	– 136	– 142

	Frequency range (MHz)					
	320 to 639.9[2]		640 to 1279.9[3]		1.28 to 2559.9[4]	
	Spec	Typ	Spec	Typ	Spec	Typ
10 Hz	– 100	– 107	– 93	– 101	– 88	– 95
100 Hz	– 112	– 119	– 105	– 112	– 100	– 106
1 kHz	– 121	– 128	– 115	– 122	– 109	– 116
3 kHz	– 121	– 129	– 115	– 123	– 109	– 117
5 kHz	– 123	– 130	– 117	– 124	– 111	– 118
10 kHz	– 131	– 136	– 124	– 130	– 118	– 124
100 kHz	– 131	– 136	– 124	– 130	– 118	– 124

[1] HP 8663A band begins at 0.1 MHz; specifications extend up to and including 119.9999999 MHz.
[2] Specifications extend up to and including 0.1 Hz less than the starting frequency of the next band.
[3] Specifications extend up to and including 1279.9999998 MHz.
[4] This band available on HP 8663A only; specifications extend up to and including 2559.9999996 MHz.

Option 003 Specified SSB Phase Noise for Rear-Panel 640 MHz Output:

	Spec	Typ
1 Hz	– 54	–64
10 Hz	– 84	–94
100 Hz	– 104	–114
1 kHz	– 121	–126
3 kHz	– 121	–127
5 kHz	– 129	–138
10 kHz	– 145	–149
100 kHz	– 157	– 159

SSB Broadband Noise Floor in 1 Hz BW at 3 MHz Offset From Carrier:
< –146 dBc for fc between 120 and 640 MHz at output levels above +10 dBm.

HP 8662A
HP 8663A

Spurious Signals:

	Frequency Range (MHz)				
	0.01 to 120	**120 to 160**	**160 to 320**	**320 to 640**	**640 to 1280**
Spurious non-harmonically related[1,2]	–90 dBc	–100 dBc	–96 dBc	–90 dBc	–84 dBc
Sub-harmonically related $\left(\frac{1}{2}, \frac{3f}{2}, \text{etc.}\right)$	none	none	none	none	–75[3] dBc
Power-line (60 Hz) related or microphonically generated (within 300 Hz)[4]	–90 dBc	–85 dBc	–80 dBc	–75 dBc	–70 dBc
Harmonics	< –30 dBc				

Output

Level Range: +13 to –139.9 dBm (1V to 0.023 μV_{rms} into 50 Ω)
Resolution: 0.1 dB
Absolute Level Accuracy: (+15° to +45° C): ±1 dB between +13 and –120 dBm; ± 3 dB between –120 and –130 dBm
SWR: Typically from 1.5 to 1.8, depending on output level and frequency
Reverse Power Protection: Typically up to 30 W or ± 8 Vdc

Amplitude Modulation

Depth: 0 to 95% at output levels of +8 dBm and below (+10 dBm in uncorrected mode). AM available above these output levels but not specified.
Resolution: 1%, 10 to 95% AM; 0.1%, 0 to 9.9% AM
Incidental PM: (at 30% AM): 0.15 to 640 MHz, < 0.12 radian peak; 640 to 1280 MHz, < 0.09 radian peak
Incidental FM: (at 30% AM): 0.15 to 640 MHz, < 0.12 x f_{mod}; 640 to 1280 MHz, < 0.09 x f_{mod}
Indicated Accuracy: ± 5% of reading ± 1% AM. Applies for rates given in table below, internal or external mode, for depths ≤ 90%.

Rates and Distortion with Internal or External Modulating Signal:

		AM Distortion		
Frequency Range	**AM Rate**	**0 to 30% AM**	**30 to 70% AM**	**70 to 90% AM**
0.15 to 1 MHz	dc to 1.5 kHz	2%	4%	5.75%
1 to 10 MHz	dc to 5 kHz	2%	4%	5.75%
10 to 1280 MHz	dc to 10 kHz	2%	4%	5.75%

Frequency Modulation

FM Rates: (1 dB bandwidth): External ac, 20 Hz to 100 kHz; external dc, dc to 100 kHz
FM Deviation: 25 to 200 kHz, depending on carrier frequency
Indicated FM Accuracy: ± 8% of reading plus 10 Hz (50 Hz to 20 kHz)
FM Resolution: 100 Hz for deviations < 10 kHz, 1 kHz for deviations ≥ 10 kHz
Incidental AM: (AM sidebands at 1 kHz rate and 20 kHz deviation): < –72 dBc, f_c < 640 MHz; < –65 dBc, f_c ≥ 640 MHz
FM Distortion: < 1.7% for rates < 20 kHz, < 1% for rates < 1 kHz
Center Frequency Accuracy and Long-Term Stability in AC Mode: Same as CW mode

Supplemental Characteristic

Frequency-Switching Speed:[5] From 420 µs to 12.5 ms, depending on the programming mode

HP 8663A Specifications

The HP 8663A signal generator is related to the HP 8662A in both concept and structure. Like the HP 8662A, the HP 8663A is an extremely low phase noise signal source, incorporating signal generator modulation capabilities and output characteristics. The HP 8663A also offers increased frequency range to 2560 MHz, increased output level to +16 dBm, and the addition of phase and pulse modulation while maintaining high spectral purity. The result is a highly flexible and powerful signal generator that uses and extends the proven circuitry of the HP 8662A. Thus, the HP 8662A and HP 8663A share many of the same specifications.

Frequency

Range: 100 kHz to 2560 MHz (2559.9999996 MHz)
Resolution: 0.1 Hz (f_c < 640 MHz);
0.2 Hz (640 MHz to 1280 MHz);
0.4 Hz (f_c ≥ 1280 MHz)
Accuracy, Stability, and Internal Reference Oscillator: Identical to HP 8662A

Spectral Purity

(See HP 8662A specifications)
Spurious Signals: Identical to HP 8662A, except that for f_c between 1280 and 2560 MHz the spurious non-harmonics are –78 dBc; the sub-harmonically related (f/2, 3f/2, etc.) between 640 and 1280 MHz are –70 dBc and between 1280 and 2560 MHz are –40 dBc; and the power-line (60 Hz) or microphonically generated spurious are –65 dBc.
Harmonics: < –30 dBc, ≤ + 13 dBm output; < –25 dBc, + 13 dBm to + 16 dBm output, f_c < 1280 MHz; < –25 dBc, f_c ≥ 1280 MHz

Output

Level Range: + 16 dBm to –129.9 dBm
Resolution: 0.1 dB
Absolute Level Accuracy: (+ 15° to + 45° C): ± 1 dB, + 16 dBm to –119.9 dBm; ± 3 dB, –120 dBm and below
SWR: < 1.5

Amplitude Modulation

Depth: 0 to 95% at levels of + 10 dBm and below
Resolution: 0.1%
Incidental FM: (at 30% AM): Identical to HP 8662A except: < 0.3 x f_{mod} for 1280 ≤ f_c < 2560 MHz
Indicated Accuracy: ± 6% of reading ± 1% AM (400 Hz and 1 kHz, depth 90%)
AM Bandwidth: (1dB): dc to > 1.5 kHz, 0.15 MHz ≤ f_c < 1 MHz; dc to > 5 kHz, 1 MHz ≤ f_c ≤ 10 MHz; dc to > 10 kHz, f_c > 10 MHz: external dc coupling. External ac coupling or internal; low-frequency coupling is 20 Hz.
Distortion: (400 Hz and 1 kHz): < 2% (0 to 30% AM); < 3% (30 to 70% AM); < 4% (70 to 90% AM)

Frequency Modulation

FM Rates: (1 dB bandwidth): External ac, 20 Hz to 100 kHz, external dc, dc to 100 kHz
Maximum Allowable Peak Deviation: Identical to HP 8662A for f_c between 100 kHz and 1280 MHz. Up to 400 kHz for f_c between 1280 and 2560 MHz.
Indicated FM Accuracy: (50 Hz to 20 kHz): ± 7% of setting +10 Hz
FM Resolution: 100 Hz to 1 kHz, depending on f_c and deviation setting
Incidental AM: (AM sidebands at 1 kHz rate and 20 kHz deviation): < –72 dBc (10 ≤ f_c < 2560 MHz)
FM Distortion: < 1% (400 Hz and 1 kHz rates); < 1.7% (rates less than 20 kHz)

[1] In the remote mode it is possible to have microprocessor clock-related spurious signals spaced 3 MHz apart at an absolute level of typically less than –145 dBm.
[2] Spurious signals can be up to 3 dB higher in the dc FM mode.
[3] f/2 spurs not specified for carrier frequencies above 850 MHz.
[4] At a 50 Hz line frequency, power-line or microphonically-related spurious signals may be up to 3 dB higher and appear at offsets as high as 1 kHz from the carrier.
[5] Due to automatic leveling loop bandwidth changes, brief (30 ms) level inaccuracies may occur when switching through 150 kHz and 1 MHz RF output frequencies.

5

Phase Modulation (Option 002)

Maximum Peak Phase Deviation: From ± 25° for f_c between 120 and 160 MHz to ± 400° for f_c between 1280 and 2560 MHz
Maximum Rate: From 10 kHz for f_c between 0.15 and 10 MHz to 10 MHz for f_c between 640 and 2560 MHz
Phase Deviation Resolution: 1° (0.1 ≤ f_c < 640 MHz); 2° (640 ≤ f_c < 1280 MHz); 4° (1280 ≤ f_c < 2560 MHz)
Phase Modulation Distortion: 10% at maximum rate

Biphase Modulation (BPSK)

Biphase modulation is available on the standard HP 8663A for f_c less than 640 MHz and available for all f_c with Option 002.
Deviation: ± 90°
Carrier Null when Modulated with 1 MHz, 50% Duty Cycle Square Wave: > 25 dBc
Modulation Input Required: TTL positive true. The internal modulation oscillator can be used for 50% duty-cycle modulation. External input is on rear panel.

Pulse Modulation[1]

Pulse On/Off Ratio: > 80 dB (50 to 2560 MHz)
Pulse Rise/Fall Time: < 250 ns (50 to 120 MHz); < 800 ns (120 to 640 MHz); < 100 ns (f_c ≥ 640 MHz)
Pulse Repetition Frequency (50% duty cycle):
Internal: 10 Hz to 99.9 kHz
External: 10 Hz to 2 MHz, 50 MHz < f_c < 640 MHz; 10 Hz to 5 MHz, f_c > 640 MHz
Internal Modulation Oscillator
Rates: 10 Hz to 99.9 kHz
Frequency Resolution: 3 digits
Frequency Accuracy: Same as reference oscillator
Output Level (available on rear panel): 1 V peak into 600 Ω
Output Impedance: 600 Ω
Flatness (referenced to 1 kHz): < ± 1%
Distortion: < 1%

Other HP 8662A and HP 8663A Information

Remote Programming: The HP-IB interface is standard on the HP 8662A and HP 8663A signal generators. All functions controlled from the front panel, with the exception of the line switch, are programmable with the same accuracy and resolution as in manual mode.
Operating Temperature Range: 0° to + 55° C
Leakage: Meets radiated and conducted limits of MIL-STD-461A methods RE02 and CE03 as well as BVDE 0871
Power Requirements: 115 (90 to 126) V or 230 (198 to 252) V; 48 to 66 Hz; 450 VA max
Size:
HP 8662A: 425 mm W x 178 mm H x 572 mm D (16.75 in x 7 in x 22.5 in)
HP 8663A: 425 mm W x 178 mm H x 642 mm D (16.75 in x 7 in x 25.3 in)
Note: depth includes front panel depth of 45 mm (1.75 in).
Weight: HP 8662A: net, 30 kg (65.5 lb); shipping, 36 kg (80 lb)
HP 8663A: net, 33.8 (74 lb); shipping, 40 kg (88 lb)

Key Literature

Synthesized Signal Generator 10 kHz to 1280 MHz
Technical Data, p/n 5953-8402
Synthesized Signal Generator 100 kHz to 2.56 GHz
Technical Data, p/n 5953-8376

Ordering Information

HP 8662A 1280 MHz Signal Generator[2]
Opt 001 RF Connectors on Rear Panel Only
Opt 003 Specified SSB Phase Noise for 640 MHz Output
Opt 700 External MATE Translator
Opt 907 Front Handle Kit (5062-3990)
Opt 908 Rack Flange Kit (5062-3978)
Opt 909 Rack Flange Kit w/Front Handles(5062-3984)
Opt 910 Two Sets of Operating and Service Manuals (08662-90069)
Opt W30 Extended Repair Service (see page 70)
Opt W32 Calibration Service (see page 70)

HP 11721A

HP 8663A 2560 MHz Signal Generator[2]
Opt 001 RF Connectors on Rear Panel Only
Opt 002 Wideband Linear Phase Modulation
Opt 003 Specified SSB Phase Noise for 640 MHz Output
Opt 700 External MATE Translator
Opt 907 Front Handle Kit (5061-9690)
Opt 908 Rack Flange Kit (5061-9678)
Opt 909 Rack Flange Kit w/Front Handles (5061-9684)
Opt 910 Additional Operation and Calibration Manual (08663-90069) and Service Manuals (08663-90071)
Opt 915 Add Service Manual (08663-90071)
Opt W30 Extended Repair Service (see page 70)
Opt W32 Calibration Service (see page 70)
HP 11714A Service Support Kit (required for servicing HP 8662A/8663A)

[1] Pulse modulation is available for f_c < 50 MHz but is unspecified.
[2] HP-IB cables not supplied. For description and price, see page 568.

Indicates QuickShip availability.

HP 11721A Frequency Doubler

The HP 11721A doubler is an ideal accessory for extending the usable frequency range of signal generators, frequency synthesizers, or other signal sources. Operating on input frequencies of 50 MHz to 1300 MHz, it provides a doubled output in the range of 100 MHz to 2600 MHz. The HP 11721A will work well with any RF source with an output in the range of 50 to 1300 MHz.

The 50 Ω passive circuit of the HP 11721A offers low conversion loss, low spurious, and excellent flatness over its entire frequency range when operated above +10 dBm.

HP 11721A Specifications

Input Frequency Range: 50 to 1300 MHz
Output Frequency Range: 100 to 2600 MHz
Conversion Loss (+13 dBm input, 50 to 1280 MHz): < 15 dB
Spurious Referenced to Desired Output Frequency f:
(+ 13 dBm input with harmonics < – 50 dBc, 50 to 1280 MHz):
f/2, –15 dB; 3f/2, –15 dB
Input SWR: 1.5 typical
Input/Output Impedance: 50 Ω nominal
Operating Temperature Range: 0° to 50° C
Connectors: Input, type-N male; output, type-N female
Size: 161 mm L x 30 mm W x 20.5 mm H (6.38 in x 1.19 in x .19 in)
Weight: Net, .02 kg (0.5 lb); shipping, 0.4 kg (1 lb)

Ordering Information

HP 11721A Frequency Doubler
Opt W30 Extended Repair Service (see page 584)

HP 83711B
HP 83712B
HP 83731B
HP 83732B

Typical single-sideband phase noise at 50 MHz, 1 GHz and 20 GHz, 25° C, CW mode. Offsets less than 100 Hz require the high stability timebase, Option 1E5.

HP 83711B/12B and HP 83731B/32B Signal Sources

The HP 83711B/12B synthesized CW generators and HP 83731B/32B synthesized signal generators set new standards for performance at prices that are surprisingly affordable. No longer will you have to give up frequency coverage, modulation, or reliability to meet your budget. These signal sources will perform beyond your expectations at a price within your reach.

Clean Signals with Plenty of Power

Choose the HP 83711B/83731B, 1 to 20 GHz, or the HP 83712B/ 83732B, 10 MHz to 20 GHz, for your receiver and system test applications. Fundamental oscillators and switched low-pass filters deliver < –55 dBc harmonics, eliminate subharmonics, and suppress spurious to < –60 dBc. These signal sources provide plenty of output power (typically > + 14 dBm), while spectral purity is maintained even at high power levels (typical output power at frequencies below 1 GHz is + 20 dBm). These signal sources deliver >100 dB dynamic range. Level resolution is 0.01 dB with typical accuracy of ± 1.0 dB at any frequency or power level. User Level Correction simplifies generating accurate, leveled power at distant test ports.

HP 83731B and HP 83732B Provide Unmatched Modulation Performance

Sophisticated modulation lets you simulate real-world signals. Test state-of-the-art radar and EW receivers with high-fidelity pulse modulation. < 10 ns pulse rise/fall times, < 25 ns pulse width, and > 80 dB pulse on/off ratio give you the performance you need to verify modern receivers. A built-in multimode pulse generator adds the flexibility to generate triggered, doublet and gated burst pulse modes.

In addition, logarithmic and linear AM is a standard feature in the HP 83731B/32B. Use the > 60 dB depth log AM and the fast pulse modulation simultaneously (scan modulation) for accurate simulation of antenna scanning patterns, or sweep power linearly and accurately to test power-sensitive devices.

The HP 83731B/32B offer unmatched performance for testing satellite communications and telemetry receivers. 10 MHz peak FM and optional 100 radians peak phase modulation deviations, combined with the highest-modulation index available (> 300 for FM), simplify simulation of these difficult-to-generate signals. The HP 83731B/32B remain fully synthesized even at high-modulation indices, eliminating the troublesome frequency drift of other signal sources.

Real-world signals often combine two or more modulations. The HP 83731B/32B let you use all three modulations simultaneously with optional independent internal modulation generator without any degradation in performance. FM and phase modulation cannot be applied simultaneously.

Versatile and Reliable

The HP 83711B/12B and HP 83731B/32B signal sources are the recommended local oscillators for the HP 8970B noise figure meter. Low broadband noise minimizes errors in measurements of low gain devices. Use these signal sources with the HP 83550 series millimeter-wave modules to generate signals to 110 GHz. All front-panel functions are completely HP-IB-programmable and SCPI-compatible.

These signal sources are designed to remain within factory specifications for the entire life of the instrument. The recommended two-year performance verification cycle minimizes downtime and cost of ownership. If a unit ever drifts, automated adjustment routines can be run to return the unit to factory performance in less than six hours. Extensive use of surface-mount technology and a minimum number of adjustments combine to deliver an estimated MTBF of more than 20,000 hours. Built-in functional verification routines speed servicing.

Key Literature

HP 83711B/12B and HP 83731B/32B Technical Data Sheet, p/n 5963-6615E

Specifications

Frequency Characteristics
Frequency Range:
HP 83711B, 1.0 to 20 GHz
HP 83712B, 10 MHz to 20 GHz
HP 83731B, 1.0 to 20 GHz
HP 83732B, 10 MHz to 20 GHz
Frequency Resolution: 1 kHz, 1 Hz with Option 1E8

Internal Reference Oscillator

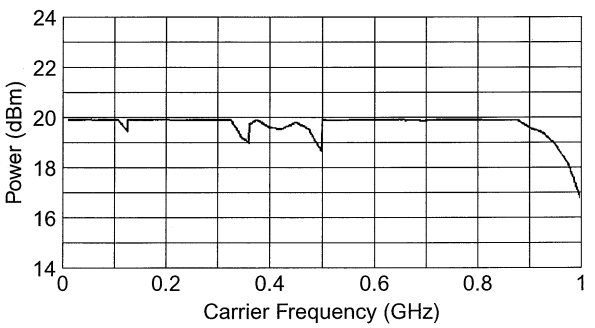
Frequency: 10 MHz
Timebase Stability:

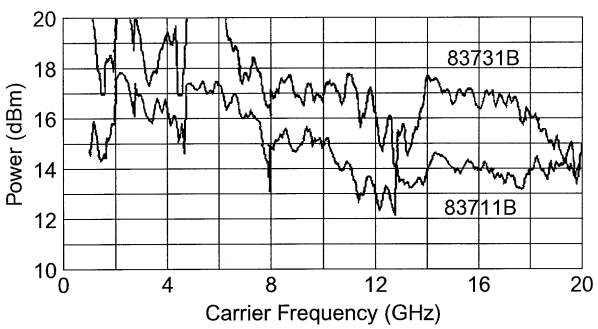
	Standard Timebase	Option 1E5
Aging Rate	< 1.0×10^{-8}/day	< 1.5×10^{-9}/day
Temperature	< 5×10^{-6}	< 1×10^{-7}
Line Voltage	N/A	< 5×10^{-10} (10% change in voltage)

Timebase Accuracy = ± aging rate ± temperature effects ± line voltage effects

Output Characteristics

Output Power (with Option 1E1): 0.01 to 1 GHz + 13 dBm
Maximum Leveled Output Power: 1 to 18 GHz + 10 dBm; 18 to 20 GHz + 8 dBm
Minimum Leveled Output Power: –4 dBm; with Option 1E1, –110 dBm

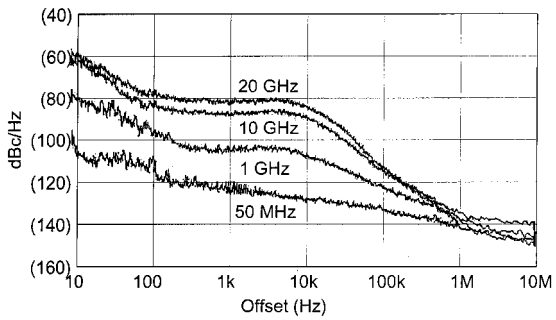




Resolution: 0.01 dB
Accuracy (–4 dBm to maximum specified leveled output power):
10 MHz to 50 MHz, ± 1.3 dB
50 MHz to 20 GHz, ± 1.0 dB
Accuracy (over all specified temperatures, and power levels):
10 MHz to 50 MHz, ± 2.3 dB
50 MHz to 20 GHz, ± 2.0 dB
Flatness: ± 0.5 dB

Spectral Purity

Harmonics:
HP 83711B/83712B, < –50 dBc (at levels < + 6 dBm)
HP 83731B/83732B, < –55 dBc (at levels < + 6 dBm)
Sub-Harmonics: None
Non-Harmonic Spurious (> 3 kHz): –60 dBc
Phase Noise (@ 10 kHz offset): 500 MHz: –103 dBc/Hz;
2 GHz: –92 dBc/Hz; 18 GHz: –76 dBc/Hz
(Phase noise decreases 6 dB/octave below 500 MHz and reaches a floor of < –140 dBc/Hz)



Typical single-sideband phase noise at 50 MHz, 1 GHz, 10 GHz and 20 GHz, 25° C, CW mode. Offsets less than 100 Hz require the high-stability timebase, Option 1E5.

SSB phase noise (dBc/Hz, CW mode):

	Offsets			
Carrier Freq.	**100 Hz**	**1 kHz**	**10 kHz**	**100 kHz**
0.5 to <1 GHz	-78	-92	-103	-115
1 to <2 GHz	-73	-83	-92	-107
2 to <5 GHz	-70	-78	-83	-100
5 to <10GHz	-69	-78	-82	-100
10 to 20 GHz	-65	-73	-76	-100

Phase noise decreases 6 dB/octave below 500 MHz and reaches a floor of <-140 dBc/Hz.

General Specifications

Operating Temperature Range: 0° to + 55° C
Size: 426 mm W x 133 mm H x 498 mm D (16.8 in x 5.2 in x 19.6 in)
Weight: < 16 kg (35 lb)
Power: 90 to 132 V, 48 to 440 Hz; 198 to 264 V, 48 to 66 Hz; 400 VA max.
EMC: Meets or exceeds EN55011/CISPR 11/1990, Class A and MIL-STD-461C Part 2 RE02, CE03, CS02, RS03

HP 83731B, 83732B Modulation Specifications

Pulse Modulation

On/Off Ratio: > 80 dB
Rise/Fall Times: < 10 ns
Minimum Pulse Width: < 25 ns, 1 to 20 GHz

Internal Multimode Pulse Modulation Source

Modes: Internal free-run, triggered, doublet, and gated burst modes
Pulse Repetition Frequency: 3 Hz to > 3 MHz
Pulse Width: 25 ns to 419 ms
Pulse Delay: –419 ms to +419 ms, free-run mode; 225 ns to 419 ms, triggered mode
Minimum Pulse Parameter Resolution: 25 ns

Frequency Modulation

Rates: 1 kHz to 1 MHz
Maximum Deviation: 10 MHz pk, 2 to 20 GHz; 5 MHz pk, 1 to 2 GHz; decreases by a factor of 2 for each octave below 1 GHz
Maximum Modulation Index: > 300

Option 800 Analog Phase Modulation

Sensitivity: Two ranges

Maximum Deviation:

Frequency	Low range	High range
2 to 20 GHz	4 rad	200 rad
1 to 2 GHz	2 rad	100 rad
0.5 to 1 GHz	1 rad	50 rad
0.256 to 0.5 GHz	0.5 rad	25 rad

Logarithmic Amplitude Modulation

Depth: > 60 dB
Sensitivity: –10 dB/V
Step Response: < 5 μs for 50 dB step

Linear Amplitude Modulation

Sensitivity: Two ranges selectable: 30% V_{pk} + 100% V_{pk}
Maximum Depth: 90% (> 90% typical)

Key Literature

HP 83711B/12B and HP 83731B/32B Technical Data, p/n 5963-6615E

Ordering Information

HP 83711B Synthesized CW Generator
HP 83712B Synthesized CW Generator
HP 83731B Synthesized Signal Generator
HP 83732B Synthesized Signal Generator
The following options apply to all models:
Opt 1E1 Add 110 dB Output Step Attenuator
Opt 1E2 Add High-Performance Modulation Generator[1]
Opt 1E5 Add High-Stability Timebase
Opt 1E8 Add 1 Hz Frequency Resolution
Opt 1E9 3.5 mm RF Output Connector
Opt 800 Add Analog Phase Modulation[1]
Opt 0B0 Delete Manual Set
Opt 0B1 Extra User's Guide
Opt 0BV Service Manual (Component Level)
Opt 0BW Service Manual (Assembly Level)
Opt 0BX Service Manual (Assembly and Component Level)
Opt 1CM Rackmount Kit (HP p/n 5062-3977)
Opt 1CP Rackmount and Handle Kit (HP p/n 5062-3983)
Opt 1CR Rack Slide Kit (HP p/n 1494-0059)
Opt W30 Three Additional Years Return-to-HP Service:
HP 83711B
HP 83712B
HP 83731B
HP 83732B

[1] Available on the HP 83731B/32B only.

HP 83751A
HP 83751B
HP 83752A
HP 83752B

- Fully synthesized (phase-locked) CW, step, and ramp modes
- 2 MHz swept frequency accuracy
- Power flatness correction
- Broad 20 GHz frequency coverage
- +17 dBm output power at 20 GHz
- Internal pulse generator

HP 83753B

HP 83750 Series Sweepers

The HP 83750 sweepers bring outstanding synthesized performance to the component-test marketplace. They deliver the best performance for the price in general-purpose benchtop, swept test, or scalar applications.

The latest technological advances in fundamental oscillator design provide up to 20 GHz of frequency coverage with superior harmonic suppression and no subharmonics. When this excellent spurious performance is combined with high-output power capabilities, high-measurement dynamic range is achieved.

The HP 83750 synthesized sweepers provide superior accuracy and stability while maintaining the speed of analog sources. Fully-synthesized CW, stepped, and ramp sweep modes are available in broadband and narrowband operation. The synthesis capabilities are particularly useful for the characterization of narrowband devices, in which the frequency instabilities of open-loop sources become most apparent.

Excellent output-power flatness and accuracy can be translated to the input port of the device-under-test with the power flatness correction feature of these sources. This feature uses a power meter to create an array of power corrections that compensate for power variations in the measurement path between the source and the test device.

Swept testing of frequency translation devices can be achieved simply and economically with the HP 83570 series synthesized sweepers. A traditionally difficult measurement, sweeping the RF and local oscillator (LO) input ports at a fixed offset over a wide frequency span, is easy to implement with superior frequency accuracy by positioning two synchronously tracking HP 83750s in a two-tone configuration. With broadband frequency coverage and excellent performance, the HP 83750 synthesized sweepers are ideal stimuli for frequency translation measurements.

The HP 83750 series make optimal companion sources for scalar-measurement applications. Full compatibility is available via the HP 8757 system interface bus. The HP 8757D scalar analyzer and HP 83750 series have a complementary design that achieves superior frequency accuracy, power accuracy and flatness while significantly reducing measurement uncertainty. In addition, the HP 83750's high-power and low-harmonic capabilities increase the spurious-free measurement dynamic range of scalar systems. Ten independent, continuously variable markers and a marker sweep function allow fast, efficient analysis of the test device at or between critical measurement frequencies. CW, stepped, ramp, or power sweep modes are available for device characterization. A 25 dB power sweep range is particularly useful for compression measurements of active devices such as amplifiers and mixers.

The high-power models HP 83751B and 83752B provide +17 dBm output power with –20 dBc harmonics from 2 to 20 GHz. This high-power capability eliminates the need to externally amplify the signal for test devices that require high-input power levels. When Option 1EE (source module interface connector and extension cable) is added, these sources can directly drive the HP 83550 series mm-wave source modules to provide waveguide frequency coverage up to 110 GHz. All HP 83750 sweepers with Option 1EE automatically provide bias, power flatness correction, and internal leveling for the HP 83550 series source modules.

HP 83750 sweepers offer two operating languages to ensure compatibility with instruments today and in the future. The default language is SCPI (Standard Command for Programmable Instruments), an industry standard. The second operating language employs HP 8350 mnemonics to provide programming compatibility with HP 8350-based measurement systems.

HP 83751A
HP 83751B
HP 83752A
HP 83752B

Specifications

Frequency Characteristics

Frequency Range
HP 83751B: 2 to 20 GHz
HP 83752B: 0.01 to 20 GHz

Internal Reference Oscillator

Frequency: 10 MHz

Timebase Stability
Standard Timebase: ± 10 x 10^{-6}
High-Stability Timebase (Option 1E5)
Aging Rate: 5 x 10^{-10}/day; 1 x 10^{-7}/year
Temperature Effects: 1 x 10^{-10}/ °C
Line Voltage Effects: 5 x 10^{-10} (10° change in voltage)
CW and Manual Modes
Accuracy: Stability x f_c time base
Resolution: 1 Hz
Switching Time (typical)**:** 70 ms max.
Ramp Sweep Mode
Accuracy[1,2]**:** The greater of ± 0.01% of span ± timebase stability x f_c or ± 75 k Hz ± timebase stability x f_c
Sweep Time: 10 ms to 100 s; 50 ms for full span
Resolution: 1 kHz
Step Sweep Mode
Accuracy: Timebase stability x f_c
Number of Points: 2 to 1601
Switching Time (typical)[3]**:** 7 ms ± 8 ms/GHz step

Output Power Characteristics

Maximum Leveled Power[1,4]
HP 83751A, 83752A: 10 dBm
HP 83751B, 83752B: 17 dBm (16 dBm < 2 GHz on HP 83752B)
Minimum Settable Power
HP 83751A, 83752A: –15 dBm (–85 dBm w/Option 1E1)
HP 83751B, 83752B: –10 dBm (–80 dBm w/Option 1E1)
Resolution: 0.01 dB settable
Accuracy[1]
HP 85751A, 83752A only: ± 1.0 dB (levels > –10 dBm)
HP 83751A/B, 83752A/B: ± 1.5 dB (levels > –75 dBm)
Flatness
HP 85751A, 83752A only: ± 0.7 dB (levels > –10 dBm)
HP 85751A/B, 83752A/B: ± 1.3 dB (levels > –75 dBm)
Power Sweep Range: 25 dB/sweep
Power Slope Range: 0 to ± 2 dB/GHz, 25 dB max
Source Match (typical)**:** < 1.7:1 SWR

Spectral Purity

Harmonics
HP 83751A, 83752A: –45 dBc (–30 dBc < 1.5 GHz on HP 83752A)
HP 83751B, 83752B: –20 dBc
Subharmonics: None
Non-Harmonic Spurious[5]**:** –50 dBc
Residual FM: 1 kHz RHS in CW mode (0.05 to 15 kHz BW)
Phase Noise (typical)**:** < –75 dBc/Hz at 10 GHz in CW mode, 10 kHz offset

Modulation

External AM (typical)
Sensitivity: 1 dB/V
3 dB Bandwidth: > 100 kHz, usable to 1 MHz
Depth
HP 83751A, 83752A: 20 dB (–10 to + 10 dBm)
HP 83751B, 83752B: 22 dB (–5 to + 17 dBm)
Input Impedance: 3.5 Ω
External FM (typical)
DC/Unlocked Mode
Rates: dc to 10 MHz
Maximum Deviation
dc to 100 Hz Rates: ± 75 MHz
100 Hz to 1 MHz Rates: ± 7 MHz
1 to 2 MHz Rates: ± 5 MHz
2 to 10 MHz Rates: ± 1 MHz
AC/Locked Mode
Rates: 50 kHz to 10 MHz
Maximum Deviation: Same as unlocked mode up to 25 x rate
Pulse (typical)
On/Off Ratio: 60 dB
Rise/Fall Times
50 MHz to 2 GHz: 15 ns
2 to 20 GHz: 100 ns rise/50 ns fall
Minimum Pulse Width: 2 µs
Internal Pulse Generation
Width Range: 1 µs to 65 ms
Period Range: 2 µs to 65 ms
Resolution: 1 µs
Internal Square Wave: 1 kHz and 27.8 kHz (scalar analyzer mode)

General

Bandwidth Points: 2 GHz, 3.75 GHz, 6.75 GHz, and 11 GHz. The 3.75 and 6.75 GHz synthesizer switch will disappear if sweep is < 0.8 of an octave in the 2 to 11 GHz band.
RF Output Connector: 3.5 mm
Option 1ED: Type-N
Operating Temperature Range: 0° to 55° C
Weight: Net 16 kg (35 lb)
Size: 425 W mm x 133 H mm x 483 D mm (16.75 in x 5.25 in x 19 in)

Key Literature

HP 83751A/B and HP 83752A/B Synthesized Sweepers
Technical Data, p/n 5091-5908E

Ordering Information

HP 83751A 2 to 20 GHz Synthesized Sweeper
HP 83751B 2 to 20 GHz Synthesized Sweeper (High Power)
HP 83752A 0.01 to 20 GHz Synthesized Sweeper
HP 83752B 0.01 to 20 GHz Synthesized Sweeper (High Power)
The following options apply to all models:
Opt 1E1 70 dB Step Attenuator
Opt 1E4 Rear-Panel RF Output
Opt 1E5 High-Stability Time Base
Opt 1ED Type-N Connector Output
Opt 1EE Source Module Interface Connector and Extension Cable

[1] For operating temperatures of 25 ± 5° C.
[2] For 100 ms sweep times; improves with slower sweeps.
[3] Up to 50 ms switching times can occur when crossing the 2 GHz band switch point.
[4] Option 1E1 reduces output power up to 1 dB.
[5] For spurs > 500 kHz from output frequency.

5

Synthesized Swept Signal and CW Generator Family, 10 MHz to 50 GHz (or 110 GHz)

HP 8360B Series
HP 8360L Series

- +20 dBm (HP 83624B) to –110 dBm (Option 001) calibrated output power
- –50 dBc harmonics < 26.5 GHz typical
- SSB phase noise < –80 dBc at 10 GHz and 10 kHz offset
- Complete analog sweeper
- 1Hz frequency resolution (Option 008)
- Pulse, amplitude and frequency modulation (HP 8360B series only)

The HP 8360B/L series for the winning combination of precision, versatility and flexibility

HP 8360B/L Synthesized Swept Signal and CW Generator Series

The HP 8360 family consists of the general-purpose B-model series and the L-model (without modulation) series. They combine the excellent frequency resolution, level control, signal purity, and modulation capabilities you expect of a high-performance synthesized signal generator with the speed and convenience of a sweep oscillator. They are ideal for the demanding requirements of signal simulation, local oscillator, and stimulus/response component or subsystem test applications.

The HP 8360 family offer a choice of models to meet a variety of application requirements. Ultra-broadband frequency coverage for 10 MHz to 50 GHz is available in coax using a 2.4-mm precision connector. High-power models with up to +20 dBm are also available. The HP 8360 can also be customized with 1 Hz frequency resolution, fast pulse, a synthesized internal modulation generator and a blank front panel for automated test applications.

Flexible and Upgradeable for Growth

The HP 8360 is designed to facilitate future growth. The hardkey and softkey front-panel design offers easily-accessible functions that are simple to use. Softkey flexibility and modular architecture provide upgrade capability, while retaining system compatibility. The family delivers the cost-effective and state-of-the-art performance you need today, while protecting your investment in the future.

Pulse, Scan, Amplitude, and Frequency Modulation (HP 8360B series only)

High-performance pulse modulators with > 80 dB on/off ratio, and rise/fall times < 10 ns (Option 006), make the HP 8360B suitable for the most demanding pulse modulation applications.

In addition to its linear AM mode (100%/V), the HP 8360B offers a scan modulation mode (10 dB/V). Both modes have dc-coupled amplitude modulation capability with a 3 dB bandwidth of 100 kHz, and 99.7% (50 dB) of modulation depth. Pulse and amplitude modulation capabilities can be used independently and simultaneously.

The HP 8360B also offers dc-coupled frequency modulation capabilities with rates up to 8 MHz.

Specifications Summary

Frequency
Range (by model):
HP 83620B 10 MHz to 20 GHz
HP 83622B 2 GHz to 20 GHz
HP 83623B 10 MHz to 20 GHz (high power)
HP 83624B 2 GHz to 20 GHz (high power)
HP 83630B 10 MHz to 26.5 GHz
HP 83640B 10 MHz to 40 GHz
HP 83650B 10 MHz to 50 GHz
HP 83623L 10 MHz to 20 GHz
HP 83630L 10 MHz to 26.5 GHz
HP 83640L 10 MHz to 40 GHz
HP 83650L 10 MHz to 50 GHz
Resolution: 1 kHz (1 Hz with Option 008)

Internal Reference Oscillator

Frequency: 10 MHz
Timebase Stability
Aging Rate: 5×10^{-10}/day; 1×10^{-7}/year
Temperature Effects: 1×10^{-10}/°C
Line Voltage Effects: 5×10^{-10} (10° C change in voltage)

CW and Manual Modes

Accuracy: Timebase stability xf_c
Switching Time
For Steps Within a Frequency Band: 15 ms + 5 ms/GHz step size
Maximum, or Across Band Switch Points: 50 ms
Step or List Modes Within a Frequency Band: 5 ms + 5 ms/GHz step size

Step Sweep Mode

Accuracy: Timebase stability xf_c
Minimum Step Size: Same as frequency resolution
Number of Points: 2 to 801
Switching Time: Same as CW
Dwell Time: 100 µs to 3.2 s

List Mode

Accuracy: Timebase stability xf_c
Minimum Step Size: Same as frequency resolution
Number of Points: 1 to 801
Switching Time: Same as CW
Dwell Time: 100 µs to 3.2 s

Ramp Sweep Mode

Accuracy: (Sweep time ≥ 100 ms and ≤ 5 s)
Sweep Widths ≤ n x 10 MHz: 0.1% of sweep width ± timebase stability xf_c
Sweep Widths > n x 10 MHz: Lesser of 1% of sweep width or n x 1 MHz + 0.1% of sweep width
Sweep Time: 10 ms to 100 s, 300 MHz/ms maximum rate

RF Output

Output Power

Maximum Leveled (dBm)	Standard	Option 006 (B models only)
HP 83620B, 83622B	+13	+13
HP 83623B	+17	+17
HP 83623L	+15	N/A
HP 83624B	+20	+17
HP 83630B/L		
Output Frequencies < 20 GHz	+13	+13
Output Frequencies ≥ 20 GHz	+10	+10
HP 83640B/L		
Output Frequencies < 26.5 GHz	+10	+10
Output Frequencies ≥ 26.5 GHz	+6	+6
HP 83650B/L		
Output Frequencies < 26.5 GHz	+10	+10
Output Frequencies ≥ 26.5 GHz and < 40 GHz	+5	+5
Output Frequencies ≥ 40 GHz	+2.5	+2.5

Minimum Settable Output Power
Standard: –20 dBm
Option 001: –110 dBm
Resolution: 0.02 dB
RF Output Connector
Nominal output impedance 50 ohms (precision 3.5-mm male on 20 and 26.5 GHz models, 2.4-mm male on 40 and 50 GHz models, front panel)

Spectral Purity

Spurious Signals (dBc)

Output Frequencies	83620B 83622B	83623B 83624B	83623L	83630B/L	83640B/L 83650B/L
Harmonics					
< 2.0 GHz					
Standard	–30	–25[1]	–25[1]	–30	–30[1]
Option 006	–30[1]	–25[1]	—	–30[1]	–30[1]
≥ 2.0 GHz and < 26.5 GHz					
Standard	–50	–25	–45	–50	–50
Option 006	–60	–60	—	–60	–50
≥ 26.5 GHz					
Standard	—	—	—	—	–40
Option 006	—	—	—	—	–40
Subharmonics					
< 7 GHz	None	None	None	None	None
≥ 7 and ≤ 20 GHz	–50	–50	–50	–50	–50
≥ 20 GHz and ≤ 40 GHz	—	—	—	–50	–40[2]
> 40 GHz	—	—	—	—	–35[2]

[1] Specification is –20 dBc below 50 MHz.
[2] Specifications typical below 0 dBm.

Nonharmonically Related
10 MHz to < 2.0 GHz[3]: –60
≥ 2.0 to < 20 GHz: –60
> 20 GHz to ≤ 26.5 GHz: –58
> 26.5 to ≤ 40 GHz: –54
≥ 40 GHz to ≤ 50 GHz: –52

Single-Sideband Phase Noise (dBc/Hz)

	Offset from Carrier			
Frequency Range	**100 Hz**	**1 kHz**	**10 kHz**	**100 kHz**
10 MHz to < 7 GHz	– 70	– 78	– 86	–107
7 GHz to < 13.5 GHz	– 64	– 72	– 80	–101
13.5 GHz to 20 GHz	– 60	– 68	– 76	– 97
> 20 GHz to < 26.5 GHz	– 58	– 66	– 74	– 95
26.5 GHz to < 38 GHz[4]	– 54	– 62	– 70	– 91
38 GHz to 50 GHz	– 52	– 60	– 68	– 89

Modulation (HP 8360B series only)

All modulation specifications are only applicable to the HP 8360B series. Pulse modulation specifications apply for output frequencies 400 MHz and above.

Pulse (HP 8360B only)	Standard	Option 006
On/Off Ratio	80 dB	80 dB
Rise/Fall Times	25 ns	10 ns
Minimum Width		
Internally Leveled	1 µs	1 µs
Search Mode		
Output Frequencies < 2.0 GHz	50 ns	50 ns
Output Frequencies ≥ 2.0 GHz	50 ns	15 ns
ALC Off Mode		
Output Frequencies < 2.0 GHz[4]	50 ns	50 ns
Output Frequencies ≥ 2.0 GHz	50 ns	15 ns

AM and Scan (HP 8360B only)
Bandwidth
(3 dB, 30% depth, modulation peaks 3 dB below maximum rated power): dc to 100 kHz
Modulation Depth
Normal Mode: –20 dBm to maximum available power
Deep Mode: 50 dB below maximum available power
Sensitivity
Linear: 100%/volt
Exponential: 10 dB/volt

FM (HP 8360B only)
Locked Mode
Maximum Deviation: ± 8 MHz
Rates (3 dB bandwidth, 500 kHz deviation)**:** 100 kHz to 8 MHz

[3] Specification applies at output levels 0 dBm and below.
[4] This band is 26.5 GHz to 40 GHz on the HP 83640A.
[5] Frequency range is 26.5 GHz to 40 GHz on the HP 83640B/L.

Unlocked Mode
Maximum Deviation
At rates ≤ 100 Hz: ± 75 MHz
At rates > 100 Hz: ± 8 MHz
Rates (3 dB bandwidth, 500 kHz deviation)**:** dc to 8 MHz
Sensitivity: 100 kHz, 1 MHz, or 10 MHz/volt, switchable
Accuracy (1 MHz rate, 1 MHz deviation)**:** 10%

Internal Modulation Generator (Option 002)

AM, FM Modulation Signals (HP 8360B only)
Internal Waveforms: Sine, square, triangle, ramp, noise

Rate
Range:
Sine: 1 Hz to 1 MHz
Square, triangle, ramp: 1 Hz to 100 kHz
Resolution: 1 Hz

Depth, deviation
Range: Same as the base instrument
Resolution: 0.1%
Accuracy: Same as the base instrument

Pulse (HP 8360B only)
Modes: Free-run, gated, triggered, delayed
Period Range: 300 ns to 400 ms
Width Range: 25 ns to 400 ms
Resolution: 25 ns
Accuracy: 5 ns
Video Delay
Internal sync pulse: 0 to 400 ms
Externally-supplied sync pulse: 225 ns to 400 ms

Weight and Dimensions
Net Weight: 27 kg (60 lb)
Dimensions: 178 H x 425 W x 648 mm D (7.0 x 16.75 x 25.5 inches)

Additional Key Literature

Brochure, p/n 5964-6793E
Technical Specifications, p/n 5964-6162E
Configuration Guide, p/n 5964-6062E

Ordering Information

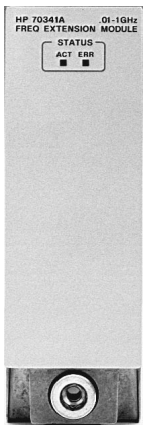
HP 83620B 10 MHz to 20 GHz
HP 83622B 2 GHz to 20 GHz
HP 83623B 10 MHz to 20 GHz (high power)
HP 83624B 2 GHz to 20 GHz (high power)
HP 83630B 10 MHz to 26.5 GHz
HP 83640B 10 MHz to 40 GHz
HP 83650B 10 MHz to 50 GHz
HP 83623L 10 MHz to 20 GHz
HP 83630L 10 MHz to 26.5 GHz
HP 83640L 10 MHz to 40 GHz
HP 83650L 10 MHz to 50 GHz
The following options apply to all models:
Opt 001 Adds Step Attenuator[1]
Opt 002 Adds Internal Modulation Generator (HP 8360B only)
Opt 004 Rear-Panel RF Output
Opt 006 Fast-Pulse Modulation (HP 8360B only)[1]
Opt 008 1 Hz Frequency Resolution
Opt 700 MATE System Compatibility
Opt 806 Rack Slide Kit
Opt 908 Rack Flange Kit
Opt 910 Extra Operating and Service Manuals
Opt 913 Rack Flange Kit
Opt W30 3 Years of Customer Return Repair Service*
Upgrades
Model and frequency upgrades are available. Please contact your Hewlett-Packard sales representative for details (listed on page 591).
Dedicated HP 8510 System Source Models[1]
HP 83621B 45 MHz to 20 GHz
HP 83631B 45 MHz to 26.5 GHz
HP 83651B 45 MHz to 50 GHz

[1] No modulation, no front panel. Price of this option varies for different HP 8360 series models.

HP 70340A
HP 70341A

- Broadband frequency coverage: 10 MHz to 20 GHz
- High-performance modulation: AM, FM, and Pulse
- Excellent spectral purity: –55 dBc harmonics, –60 dBc spurious
- Outstanding output level accuracy and flatness
- Industry-standard programming: SCPI

HP 70340A



HP 70341A

5

HP 70340A Modular Synthesized Signal Generator
HP 70341A Frequency Extension Module

All the Performance of Traditional Rack-and-Stack Sources in Half the Rack Space

Test receivers and subsystems from 10 MHz through 20 GHz with confidence knowing that even at full specified power the HP 70340/41A provides superior harmonic (–55 dBc) and spurious (–60 dBc) performance. Excellent output-power accuracy (± 1 dB) and flatness (± 0.5 dB) is maintained across the HP 70340/41A's > 100 dB dynamic range. Sweep power linearly and accurately to test power sensitive devices. Generate real world signals using the FM, pulse and logarithmic AM modulations. The HP 70340/41A modular signal generator satisfies the demands of tomorrow's ATE for a downsized, high-performance modular signal source.

Extend Your Capabilities to 10 MHz with HP 70341A

The HP 70341A frequency extension module brings microwave performance to RF and IF testing. Now the HP 70340A's powerful modulation, low-harmonics (–55 dBc) and zero subharmonics are available at frequencies from 10 MHz to 1 GHz with higher-output power (+13 dBm) and lower phase noise. Digital frequency dividers lower phase noise 6 dB/octave as the output frequency is reduced making the HP 70340A/41A combination a powerful in-channel receiver test stimulus. Elimination of downconversion mixers reduces broadband noise while switched low pass filters generate fast, high-fidelity pulse modulation. Logarithmic AM provides capability not found in conventional RF signal sources. Full 10 MHz to 20 GHz coverage is yours from a single RF output connector without a sacrifice in level accuracy or flatness. The HP 70341A is slaved to the HP 70340A so all your system software runs on the combination without any change.

Setting the Standard for Modular Signal Sources

The HP 70340A/41A are ideal in modern ATE systems. Their small size, light weight, excellent reliability, and high performance make them the signal sources of choice for downsized and portable ATE. Their high MTBF (> 20,000 hours, extended calibration cycle (two years) and low calibration time (< six hours for full cal) reduce system downtime in high-throughput commercial ATE. A wide selection of options adds extra capability where you need it and saves money in less stringent systems. SCPI programming assures that system software designed around the HP 70340A/41A will remain compatible and upgradeable for years to come.

Specification Summary

(For complete specifications, refer to the HP 70340A/41A Technical Data Sheet, HP p/n 5091-4649E.)
Frequency Range: 1 to 20 GHz; 10 MHz to 20 GHz with HP 70341A
Frequency Resolution: 1 kHz; 1 Hz with Option 1E8
Leveled Output Power (with Option 1E1 installed)
10 MHz to 1 GHz: + 13 dBm to –90 dBm
1 GHz to 18 GHz: + 10 dBm to –90 dBm
18 GHz to 20 GHz: + 8 dBm to –90 dBm
Resolution: 0.01 dB
Accuracy: ± 2 dB (all frequencies, power levels, and temperatures)
Flatness: ± 0.5 dB
Harmonics: < –55 dBc
Sub-Harmonics: None
Non-Harmonic Spurious: -60 dBc
SSB Phase Noise (10 kHz offset)**:** 500 MHz: –103 dBc/Hz; 2 GHz: –91 dBc/Hz; 18 GHz: –73 dBc/Hz
External Pulse Modulation
On/Off Ratio: > 80 dB
Minimum Pulse Width: < 25 ns 500 MHz to 20 GHz; < 100 ns 64 to 500 MHz; < 1 µs 10 to 64 MHz
Maximum Rise/Fall Time: < 10 ns 1 to 20 GHz; < 20 ns 500 to 1000 MHz; < 35 ns 128 to 500 MHz
External Frequency Modulation
Rates: 1 kHz to > 1 MHz
Maximum Deviation: 10 MHz
Maximum Modulation Index: > 300
External Amplitude Modulation
Type: Logarithmic AM
Depth: 0 to 60 dBc
Sensitivity: –10 dB/V
Step Response: < 5 µs for 50 dB step
Size: 4-slot wide MMS module HP 70340A; 1-slot wide MMS module HP 70341A
Weight: < 9 kg (20 lbs.) HP 70340A; < 4 kg (10 lbs.) HP 70341A

Key Literature

HP 70000 Family Modular Measurement System Catalog, p/n 5965-2818E

Ordering Information

HP 70340A Modular Signal Generator
Opt 1E1 Add Output Step Attenuator
Opt 1E2 Internal Pulse Modulation Source
Opt 1E8 1 Hz Frequency Resolution
Opt 1E9 3.5-mm RF Output Connector
Opt 0B2 Operation Manual
Opt 0B3 Service Manual
Opt W30 Two Add'l Years HP Service Warranty
HP 70341A Frequency Extensions Module

- Arbitrary number of carriers or tones
- Arbitrary, yet precisely controlled, phase relationships between carriers or tones
- Precision active channel modulations for spectral regrowth measurements
- Multichannel background signals found in field testing
- Multiple Walsh channels for CDMA

HP E2507B

HP E2507B, E2508A Multi-Format Communications Signal Simulator (MCSS)

HP-IB

Generate the Precise Test Signals You Need for Testing Today's Wireless Communications Components and Products

Ensuring that new digital-communications designs and products meet system standards and customer specifications is a critical part of your development process. With the HP-MCSS (multi-format communications signal simulator) you can have the confidence that your designs will work as intended in the multi-signal environments of real use. The MCSS is personal computer controlled with an easy-to-use MS-Windows interface. The digital signal synthesis of the MCSS delivers outstanding signal purity and fidelity and allows easy expansion of system capabilities via software upgrades. The MCSS simplifies your test process by replacing several signal sources with one cost-effective solution.

Accurate and Easy Distortion Testing

The MCSS generates the multiple-carrier (multi-tone) signals you need to accurately test your multi-channel amplifiers and related products. Such multi-tone signals test the intermodulation performance of multi-channel amplifiers much more realistically than traditional TOI tests. The MCSS precisely controls the amplitude and relative phase of each tone individually to deliver the most realistic and accurate results in multi-tone testing. The relative phase can be random. This specific random pattern can then be repeated on other MCSS systems to give great consistency from measurement to measurement. Generate multiple sets of signals with different phase relationships to simulate the varying phase conditions encountered in actual use. The multiple sets of multi-tone signals give the necessary degree of randomness to predict the intermodulation distortion in the final environment. The MCSS generates these multiple phase relationships quickly, easily and repeatably to speed your testing.

In Adjacent Channel Power (ACP) measurements the MCSS delivers the highest signal purity available today. Digital signal synthesis eliminates those errors common in traditional I/Q signal generators and provides maximum ACP dynamic range. All of today's digital wireless modulations are provided (including CDMA). Use standard signal specifications or build your own custom signals for maximum signal generation flexibility. The MCSS Error Vector Magnitude is typically <0.5 percent.

Active Channel Signal Generation Is Fast and Easy

PHS, NADC, GSM, DECT, PDC, CT2, and TETRA signals have been pre-programmed for fast, easy generation. Or customize your own signal with user-selectable parameters. Apply spectral masks using the Nyquist and Gaussian filters with variable rolloff factors. Bit rates to 10,000 kb/s are available. As new signal formats emerge, count on HP to include them in MCSS system-software upgrades.

You can even generate a new modulation format. All you need to do is build a text file containing the I and Q data file, perhaps using a spreadsheet program or various mathematical programs. MCSS can create a new active channel by accepting those data files for modulating the carrier.

Generate CDMA Signals with Up to 64 Simultaneous Walsh Codes

CDMA signals have never been easier to generate. Combine one, several, or all Walsh code channels for realistic forward link simulation. The MCSS CDMA application is ideal for testing base station power amplifiers for distortion and spectral regrowth. MCSS uses a truncated Short Code with no degradation of spectral purity or signal fidelity. You can control the relative power of each Walsh channel as well as which channels are active with the user-friendly MCSS interface.

Dynamic Signal Environments Replicate Field Test Conditions in Your Lab

The MCSS Dynamic Signal Environment (DSE) application replicates the time-varying, multi-signal environments your design will encounter in actual field use. Now you can minimize the time and expense associated with field testing by generating these test environments quickly and easily in the lab. Up to 125 simultaneous channels can be generated with complete and independent control of all the parameters of each signal. Control the frequency, amplitude, modulation, and data pattern on each channel. Generate up to 20 multi-signal environment states and sequence through them to simulate time-varying conditions such as fading or base station handoff. Any and all of the signals you can generate with the Active Channel application can be combined and used in your DSE environments. With a single MCSS you can simulate mixed-mode systems such as AMPS and CDMA.

Generate Signals for Noise Power Ratio Testing

The Noise Power Ratio (NPR) application of the MCSS allows you to fill your selected frequency band with pseudo-random noise. Then you can create notches in that noise spectrum. When that signal stimulates a DUT, distortion in the DUT tends to fill in the notches. The ratio of the amplified output noise power level to the noise power level in the notches is the NPR. For satellite payloads where power consumption is critical, a higher-than-necessary NPR often means that too much power is being consumed by the output amplifiers. MCSS is very useful for testing that the satellite hardware adjusts the power consumed but still achieves the required NPR.

Digital Signal Precision and Flexibility

The heart of the MCSS is the HP 8770 arbitrary waveform synthesizer. This advanced digital signal synthesizer uses 8-ns sample rates, 12-bit architecture, and 125-MHz internal clock to generate precise wideband (50 MHz) signals. HP proprietary DAC "deglitching" circuitry provides superior spectral purity. The 512K memory depth delivers sufficient randomness in your signals' data patterns. The control architecture for the memory is very flexible. It allows disconnected portions of memory to be played in sequence. It also allows any of the portions of the sequence to be repeated an arbitrary number of times. The HP 8770A assures that your MCSS will produce consistently precise test stimuli, today and tomorrow, anytime, and anywhere.

Repeatability from System to System

The MCSS signal data, even the random data, can be saved and transferred to other MCSS systems. This gives a degree of repeatability to random testing that eliminates testing conflicts between vendors and customers that are otherwise so common.

Plenty of Coverage with Room for Expansion

A two-stage upconverter maintains the HP 8770's clean signal and provides the MCSS frequency coverage to 2.5 GHz (MCSS Model 100). Testing intermodulation distortion is easy with the lower than –65 dBc distortion of the MCSS. The 80-dB dynamic range, 1-dB resolution, ± 0.05-dB power accuracy (after calibration with external power meter) and ± 0.5-dB flatness give you precise control of your test signal. Low phase noise and broadband noise floor deliver improved test-system dynamic range.

MCSS Models 60 and 100 Technical Specifications

Frequency

Range: Model 60: 800 to 1000 MHz, 1400 to 1600 MHz, 1600 to 1800 MHz, 1800 to 2000 MHz; Model 100: 800 to 1000 MHz, 1400 to 1600 MHz, 1600 to 1800 MHz, 1800 to 2000 MHz, 2100 to 2300 MHz, 2300 to 2500 MHz
Resolution: 1 Hz

RF Output

Power Level: 0 dBm (external amplifiers available) to –70 dBm
Resolution: 0.1 dB (signal generation mode), 1.0 dB (output control mode)
Flatness: ± 1.5 dB across modulation bandwidth typical
Accuracy: ± 0.05 dB typical after calibration with power meter

Spectral Purity

Spurious: –65 dBc within 4 MHz bandwidth of a single carrier (using the default HP 8770 center frequency) –50 dBc elsewhere

Multitone Stimulus

Number of Tones: 1 to 1000 tones within 25 MHz bandwidth
Spacing: 238 Hz to 10 MHz
Resolution: 238 Hz with 1 phase set; 12.2 kHz using 50 phase sets
Magnitude Distribution: Constant, linear, custom
Phase Distribution: Constant, random (1 to 50 phase sets), custom
IM Distortion: –65 dBc average distortion relative to individual tone powers (measured at 0 dBm total signal power for 16 tones spaced 100 kHz with a 100-pattern random-phase stimulus)

Active Channel Stimulus

Signals: PHS, NADC, PDC, GSM, DECT, CT2, TETRA, Custom (user-selectable parameters)
Modulations: BPSK, QPSK, pi/4DQPSK, OQPSK, MSK, FSK, None, and Custom (user-definable I/Q waveform files)
Filter Shapes: Nyquist (alpha: 0 to 1), Square Root Nyquist (alpha 0 to 1), Gaussian (cut-off frequency: 0 to 10 times bit rate), None
Data Sequences: PRBS (four patterns available), All 1s, All 0s, Alternate, AAAA's, 5555's, Custom (user-defined data sequence file)
Bit Rate: 1k bps to 10 Mb/s
Signal Length: 4 ms (repeating)
Adjacent Channel Power: PHS RCR-28: adjacent channel: –65 dBc, alternate channel: –65 dBc typical
Error Vector Magnitude: 0.5% typical

Dynamic Signal Environment

Channels: 1 to 125 simultaneous within 25 MHz bandwidth (depending on context size)
Modulations: All active channel standard and custom formats, CDMA, base and mobile, and noise power ratio signals
Channel Spacing: 5 kHz to 5 MHz
Channel States: Up to 20 with reduced signal lengths
Configuration: Any combination of channels on, off, or modulated: modulated channels may have same or different modulations and same or different data sequences
Magnitude Distribution: Constant, Linear, or Custom
Phase Distribution: Constant, Parabolic, Random, or Custom

CDMA Signal Stimulus

Number of Walsh Channels: 1 to 64 simultaneous
Data: None, random
Relative Channel Amplitudes: ± 40 dB
Short Code Length: 4 k bits (truncated)

Noise Power Ratio Stimulus

Noise Bandwidth: 10 kHz to 25 MHz (50 MHz typical)
Spectral Line Spacing: 238 Hz to 7.6 kHz, Custom
Phase Distribution: Random, Parabolic, Constant, Custom
Magnitude Distribution: Constant, Linear, Custom
Number of Notches: 0–10
Notch Width: 480 Hz to 25 MHz
Notch Depth: 0 to 80 dB

Remote Image Control

Recall images, set power levels, change frequencies, and control trigger types from file inputs. These files can be provided from the PC hard disk or on a network server.

General

Size: 426 mm W X 661 mm H x 623 mm D (16.75 in x 26 in x 24.5 in), without monitor or keyboard
Weight: 120 lb
Power: 1500 VA max

Key Literature

HP E2507B/2508A Multiformat Communications Signal Simulator Model 60 and 100 Brochure, p/n 5964-1604E
Technical Data Sheet, p/n 5964–1603E

Ordering Information

HP E2507B MCSS Model 60
HP E2508A MCSS Model 100
MCSS models include:
HP 8770A Arbitrary Waveform Synthesizer
HP 8648C Synthesized Signal Generator
HP Vectra Personal Computer
MCSS Software
MCSS Upconverter

- 252 kHz to 1030 MHz frequency range with optional coverage to 2060 MHz
- 15 µs frequency switching
- Standalone control of frequency agility
- Specified performance while fast hopping
- FM rates to 10 MHz, deviations to 20 MHz
- Low spurious and phase noise

HP 8645A

HP 8645A Agile Signal Generator

The HP 8645A agile signal generator combines high performance with frequency agility for new fast-switching test requirements. These capabilities are important for performance testing of such devices as frequency agile radios and surveillance receivers. Besides extending traditional receiver testing to agile applications, the HP 8645A can be used to create complex signal simulations involving several modulation types and frequency agility. These complex RF signals can quantitatively exercise a receiver's vulnerability to a jamming transmission. The HP 8645A can also be a fast-switching stimulus needed to decrease production test times. The high performance and frequency agility of the HP 8645A provide capability for both static and agile test requirements with just one calibrated signal generator.

Specified Agile Performance

The HP 8645A provides specified signal performance in both static and agile operation. Fully-synthesized outputs with high timebase accuracy are standard when not frequency hopping. The Fast Hop mode activates a frequency-lock loop to allow frequency switching as fast as 15 µs from 128 to 2060 MHz. Over the frequency range of 8 to 2060 MHz, the fastest switching time is 85 µs and outputs below 8 MHz require 500 µsec. Frequency accuracy of each output is better than ± 2 ppm while in Fast Hop mode. At each frequency, a specific amplitude can be assigned within a 20 dB range for performance tests versus amplitude while frequency hopping. For a full test of a receiver, up to 4000 frequencies can be entered and sequences of up to 8000 frequency settings can be specified. Performance parameters such as phase noise, spurious, amplitude accuracy and modulation remain high-quality and are completely specified while fast hopping to insure confident test results.

Flexible, High-Performance Modulation

For receiver measurements, the HP 8645A offers independent or simultaneous FM and AM for both static and hopped frequency tests. The modulating signal can be the internal 0.1 Hz to 400 kHz synthesizer or an external input that allows FM deviations up to 20 MHz at rates up to 10 MHz. In Fast Hop operation, maximum deviation is 3.5 MHz with 10 MHz rates. AM is available with up to 100 kHz rates and 99% depth. Pulse modulation allows a 35 dB on/off ratio with 100 ns rise/fall times.

Complete Control of Frequency Hopping

The HP 8645A offers flexible and comprehensive control of the frequency hopping output. Parameters can be entered from the front panel, through the HP-IB port or using TTL inputs on the rear panel. Extensive hopped-frequency simulations including hop frequencies, amplitude, dwell times, hop rate, modulation and so forth can be entered into nonvolatile memory from the front panel. Activating a hop sequence requires only a press of the Hop key. Agile control is available by a computer with the added advantage of using the Hewlett-Packard Systems Language (HP-SL). For real-time control, rear-panel inputs accept TTL signals for triggering, dwell time and frequency selection to allow direct connection with the hardware under test. With this wide choice of control, use of the HP 8645A can be readily customized to a wide variety of test situations from benchtop use to ATE systems.

HP 8645A Specifications

Frequency

Range: 251.46485 kHz to 1030 MHz; 251.46485 kHz to 2060 MHz with Option 002 or with HP 11845A 2 GHz retrofit kit installed
Frequency Bands: The exact endpoints of each frequency band can be determined by dividing the 1030 to 2060 MHz band by two for each band decrease. The specifications use approximate endpoints.
Phase Offset: Adjustable in 1 degree increments
Reference Oscillator Stability, Option 001: < 5 x 10^{-10}/day aging

Fast-Hop Operation

Frequency Switching Time: 128 to 1030 MHz: < 15 µs, 8 to 1030 MHz: < 85 µs, 0.25 to 1030 MHz: < 500 µs. Option 002: add 5 µs.
Frequency Hop Range: 0.25 to 2060 MHz. With FM on, limited to any three consecutive frequency bands.
Frequency Accuracy[1]**:** ± 2 ppm of carrier frequency
Amplitude Accuracy: ± 1 dB, > –127 dBm output
(± 1.5 dB, > –127 dBm output when amplitude level is varied up to –5 dB from the constant learned value during Fast Hop)
Channel and Sequence Tables: In Fast Hop, each specific frequency and amplitude to be output is entered into a Channel Table. The order of channels to be output is entered into a Sequence Table.
Maximum Number of Channels: 4000
Maximum Number of Channels in Sequence Table: 8000
Hop-Rate Range: Fixed rates from 8 Hz to 50 kHz using internal timer. An external input allows more range and variable rates.
Dwell-Time Range: Fixed times of 6.4 µsec to 99 ms using the internal timer. External input allows longer and variable dwell.
Learn-Cycle Time: Typically, 10 seconds to 3.5 minutes, depending on sequence size
Fast-Hop Bus: Allows real-time selection of any channel for output. Typically, frequency switching time increases by 5 µs.
Modulation: Internal or external AM, FM, or simultaneous AM/FM
Output Level: Allowed amplitude variation of all channels entered is 0 to 20 dB. Output level is reduced by > 60 dB while switching between channels. External dc AM can be used to shape the output.

Spectral Purity

SSB Phase Noise (CW, AM, or FM[2] operation)**:**

Carrier frequency (MHz)	Standard operation 20 kHz (dBc/Hz)	100 kHz (dBc/Hz)	Fast Hop 20 kHz (dBc/Hz)
1030 to 2060	–120	–127	–116
515 to 1030	–127	–134	–123
257 to 515	–132	–137	–128
128 to 257	–136	–140	–133
64 to 128	–139	–141	–137
32 to 64	–141	–141	–139
16 to 32	–142	–142	–141
8 to 16	–143	–143	–142
4 to 8	–144	–144	–143
Less than 4 MHz	–144	–144	–144

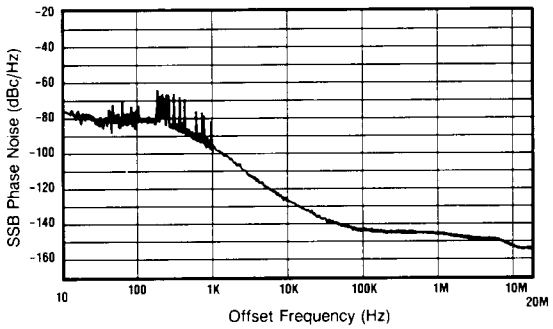
Harmonics: < –30 dBc, output ≤ 10 dBm. Option 002, output > 8 dBm: < –30 dBc, 0.25 to 1030 MHz; < –25 dBc, 1030 to 2060 MHz.
Subharmonics: None, < 515 MHz; < –60 dBc, 515 to 1030 MHz; < –40 dBc, > 1030 to 2060 MHz
Nonharmonics: > 20 kHz offset[3]: < –100 dBc, < 1030 MHz; < –94 dBc, > 1030 to 2060 MHz

[1] Typically, + 2 ppm of carrier frequency multiplied by the temperature change in °C must be added if ambient temperature changes occur between the learn operation and the conclusion of frequency hopping. FM at minimum deviation.
[2] FM at minimum deviation.
[3] Typically, nonharmonic spurs at all offsets are < 30 dB above the instrument's phase noise level as measured in a 1 Hz bandwidth.

Residual FM[1] (CW, AM, FM[2] operation):

Carrier Frequency (MHz)	Post Detection Bandwidth 0.3 to 3 kHz (Hz rms)	0.05 to 15 kHz (Hz rms)
0.25 to 257	< 1	< 1.2
257 to 515	< 1.2	< 2
515 to 1030	< 2	< 4
1030 to 2060	< 4	< 8

Typical SSB Phase Noise and Spurs at 1 GHz:



Residual AM: < 0.01% AM rms, 0.3 to 3 kHz post detection BW
Typical SSB AM Noise Floor, Offsets > 100 kHz: < –157 dBc/Hz at +16 dBm output, 0.25 to 1030 MHz. < –150 dBc/Hz at +13 dBm output, 1030 to 2060 MHz.

Output
Maximum Level: +16 dBm, 0.25 to 1030 MHz; Option 002: +14 dBm, 0.25 to 1030 MHz. +13 dBm, above 1030 MHz.
Minimum Level: –137 dBm
Absolute Accuracy: ± 1 dB, output ≥ –127 dBm
Reverse Power Protection: 50 watts from a 50 Ω source, 25 Vdc
Typical Third Order Intermodulation: < – 50 dBc, outputs < 8 dBm
Typical Output Level Overrange: 2 dB more than maximum level
Typical SWR and Output Impedance: < 1.7:1 at < – 2 dBm; 50 Ω

Modulation
External Modulation Input: Coupling is ac or dc for AM, FM, and phase modulation. Pulse modulation input is dc coupled. Displayed deviation or depth corresponds to ± 1 V external input.
Simultaneous Modulation: AM/FM, AM/Phase, AM/Pulse, FM/Pulse, Phase/Pulse, AM/FM/Pulse, AM/Phase/Pulse
Simultaneous Internal/External Modulation: FM and Phase

Amplitude Modulation
Depth: 0 to 99.9%, for output < ± 7 dBm
AM Indicator Accuracy: ± (6% of setting + 2%, AM), up to 90% depth and 1kHz rate for carrier frequencies > 1 MHz. When amplitude level is varied up to – 5 dB from the constant learned value during Fast Hop: ± (7% of setting +1% AM) up to 80% depth, 1 kHz rate.

Distortion, at 400 Hz and 1 kHz Rates:

Depth	Carrier Frequency 0.25 to 1030 MHz	1030 to 2060 MHz
0 to 30%	< 2%	< 5%
30 to 70%	< 3%	< 5%
70 to 90%	< 5%	< 8%

3 dB Bandwidth[3]: > 5 kHz, 0.25 to 8 MHz. > 50 kHz, 8 to 128 MHz; > 100 kHz, 128 to 2060 MHz
Incidental Phase Modulation: < 0.2 rad peak, at 30% depth and1 kHz
Typical External Input Impedance: 600 Ω

Frequency Modulation
FM Deviation and Rate: In the highest frequency band of 1030 to 2060 MHz, the maximum FM peak deviation is 20 MHz for standard operation and 3.52 MHz for Fast Hop. Maximum FM rate (3 dB bandwidth) in the 515 to 1030 MHz band and above is 10 MHz. Divide rate and deviation by two for each frequency band decrease.
FM Indicator Accuracy: ± 10%, < 50 kHz rate and < 10% of maximum deviation (< 50% of maximum deviation in Fast Hop)
FM Distortion: Rates 20 Hz to 100 kHz: < 2.7%, deviation < 2% of maximum available (Fast Hop: < 10% of maximum deviation)
Carrier Frequency Accuracy in FM: ± 0.4% of deviation setting, ac- or dc-coupled. Typically add 1% of deviation in Fast Hop.
Incidental AM: < 0.5%, deviation limited to < 6% of max. or 20 kHz
Typical External FM Group Delay: 30 µs for rates 20 Hz to 20 kHz, decreases to < 1 µs at rates > 200 kHz. Fast Hop: < 1 µs.
Typical External FM Input Impedance: 50 or 600 Ω

Pulse Modulation
On/Off Ratio: > 35 dB
Rise/Fall Time: < 100 ns, between 10% and 90% response points
Maximum Pulse Repetition Frequency: 1 MHz
Minimum Pulse Width: 0.5 µs
Typical Output Level Accuracy: ± 2 dB
Typical External Input Levels and Impedance: On: > 3.0 V peak; Off: < 0.8 V peak. Damage level: ≥ ± 10 V peak. 600 Ω.

Internal Modulation Source
Waveforms: Sine, square, sawtooth, and white Gaussian noise
Frequency Range: Sine, white Gaussian noise: 0.1 Hz to 400 kHz. Square, sawtooth: 0.1 Hz to 50 kHz.
Frequency Accuracy: Same as internal reference oscillator
Output Level: Typically, 1 V_{pk} max. into 600 Ω. Accuracy: ± 20 mV.
Output Level Resolution: 2 mV. Typical impedance: 600 Ω.
Distortion: < 0.1%, output at 1 V peak and ≤ 15 kHz

Frequency Sweep
Phase Continuous Sweep: Linear sweep with times from 10 ms to10 s, not dependent on span. Maximum span is 40 MHz from 1030 to 2060 MHz frequency band, divided by two for each band decrease.
Fast Hop Sweep: Linear or log stepped with times from 10 ms to100 s. Number of steps varies with time selected. Typical time per step is 30 µs for outputs within 128 to 2060 MHz, 170 µs for 8 to 2060 MHz, and 650 µs for 0.25 to 2060 MHz.
Sweep Control and Markers: X-axis: 0 to +10 V. Z-axis: +5 V retrace, +1 V trace, 0 V markers. Three markers available.

General
Remote Control: HP-IB (IEEE-488.2-1987). The control language used is the Hewlett-Packard Systems Language (HP-SL). All front-panel functions except power switch and knob. A unique Fast Hop bus interface accepts TTL levels for frequency agile control.
Operating Temperature Range: 0° to +55° F
Leakage: Meets MIL-STD-461B-RE02 and FTZ 1046
Storage Registers: 10 full function and 40 freq./ampl. locations
Memory Erasure: All memory contents according to MIL-STD-380-380
Size: 426 mm W x 177 mm H x 624 mm D (16.8 in x 7 in x 24.6 in)
Weight: Net, 31 kg (69 lb); shipping, 42 kg (95 lb)

Key Literature
HP 8645A Agile Signal Generator Data Sheet, p/n 5953-8498E
HP 8645-1 Communications-Agile Operation of the HP 8645A Product Note, p/n 5951-6711

Ordering Information
HP 8645A Agile Signal Generator[4]
Opt 001 High-Stability Timebase
Opt 002 2 GHz Output
Opt 003 RF Connectors on Rear Panel Only
Opt 907 Front Handle Kit (5062-3990)
Opt 908 Rack Flange Kit (5062-3978)
Opt 909 Rack Flange Kit with Front Handles (5062-3984)
Opt 910 Provides an additional operation/calibration manual (08645-90023) and 2 service manuals
Opt 915 Add Service Manual (08645-90104)
08645-61116 Service Kit
9211-2662 Transit Case
1494-0059 Non-Tilting Rack Slide Kit
1494-0063 Tilting Rack Slide Kit

[1] Specified for 48 to 63 Hz power line. Typical for 400 Hz power line and Fast Hop operation.
[2] Deviation < 0.1% of maximum available.
[3] Lower 3 dB bandwidth limit is 0 Hz for dc coupling and typically 20 Hz for ac coupling.
[4] HP-IB cables not included. For description and price, see page 568.

Indicates QuickShip availability.

HP 8791 Models 7, 11, 21, 100, 200

- Advanced dynamic control
- 100 ns frequency agility
- 40 MHz instantaneous modulation bandwidth
- Arbitrary control over AM, FM, ΦM, pulse, and frequency hop
- Easy-to-use application-specific software
- Precise synthesized signal control
- Standalone or subsystem operation
- 40 GHz operation with optional upconverters
- Phase-coherent frequency hopping

HP 8791 Model 11 with optional external upconverter

HP 8791 Model 21 (0.05 to 18 GHz), HP 8791 Model 11 (10 to 3000 MHz), HP 8791 Model 7 (DC to 50 MHz), Frequency Agile Signal Simulators

HP-IB

High-Precision Signals for EW, Radar, and Advanced Communications

The HP 8791 family of Frequency Agile Signal Simulators (FASS) generate the complex yet realistic test signals needed for today's sophisticated signal simulation and system test. Whether you're simulating advanced EW threats, radar target returns, satellite transponder traffic, or cellular radio's multiple-signal environments, FASS combines powerful modulation capability with digitally-generated signal precision. The 40 MHz instantaneous modulation bandwidth can be switched anywhere across the 0.05 to 18 GHz coverage of Model 21 (3 GHz for Model 11) in 100 nanoseconds to generate spread spectrum formats, radar chirps, video, pseudo-noise, multiple carriers, QAM and FSK. Comprehensive application software harnesses the power of FASS, giving the system an easy-to-use, mouse-driven front panel.

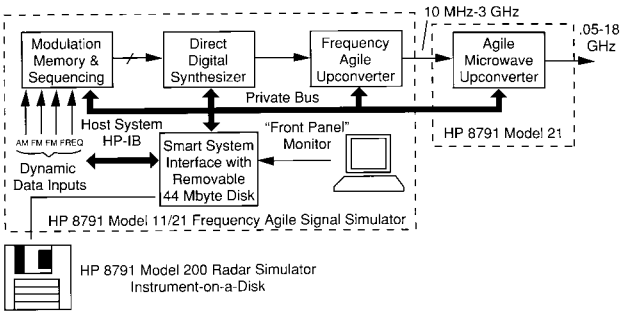
Application-specific Instrument-on-a-Disk (ID) software includes the HP 8791 Model 100 precision signal generator which provides quick access to all FASS modulation and signal capability in the easy-to-use format of a traditional signal generator. The Model 200 radar simulator features various pulse modulations and antenna scans that simplify radar target return simulations. Optional upconversion extends FASS coverage to 40 GHz.

Description

The Frequency Agile Signal Simulator uses high-speed memory, signal processing, digital-to-analog conversion and direct digital and analog synthesis for precise signal simulation with unprecedented flexibility. The Frequency Agile Signal Simulator is characterized by:

- High-performance modulation and agility
- Instrument-grade quality, repeatability, accuracy
- Easy-to-use, software-reconfigurable user interface
- Low cost of ownership
- Off-the-shelf instrumentation

The modulation data source's digital memory and sequencers store signal characteristics, namely carrier frequency and hop patterns, amplitude, frequency, phase and pulse modulation data. This data is supplied to the agile carrier synthesizer, where it is processed and converted to an analog signal made up of a carrier and its modulation. Model 7 outputs this dc to 50 MHz signal directly, while Model 11 translates it anywhere between 10 and 3000 MHz using the agile upconverter. A second agile upconverter, used in the HP 8791 Model 21 FASS, translates the signal between 0.05 and 18 GHz. The smart interface manages data flow and signal generation functions within FASS, as specified by inputs from its menu-driven front panel or over HP-IB.

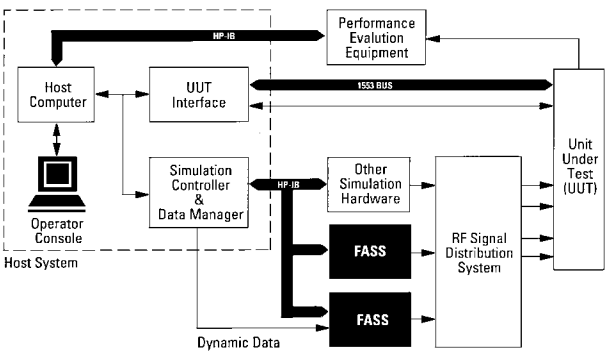


Application Overview

5

Electronic Warfare

FASS is ideal for simulating advanced threats with intrapulse modulation, PRI stagger, frequency agility and antenna scan modulation. Being fully synthesized, FASS is especially well suited for pulse Doppler radar simulation.



Communications

FASS can produce a variety of sophisticated signals for testing satellite, terrestrial, and mobile communications systems and components. In parametric testing, FASS's high clock rate, frequency agility and digital precision can significantly shorten test times for tests like NPR, group delay and gain flatness. More importantly, FASS can simulate actual link traffic and signal environments, increasing accuracy and realism while eliminating the need for time-consuming and costly field testing. Link FASS with your computer simulation software to generate production test signals identical to the test vectors used in your design simulations. Add signal impairments and propagation effects to evaluate system operating margins. Complex signals like TDMA and CDMA are easily generated using FASS dynamic sequencing.

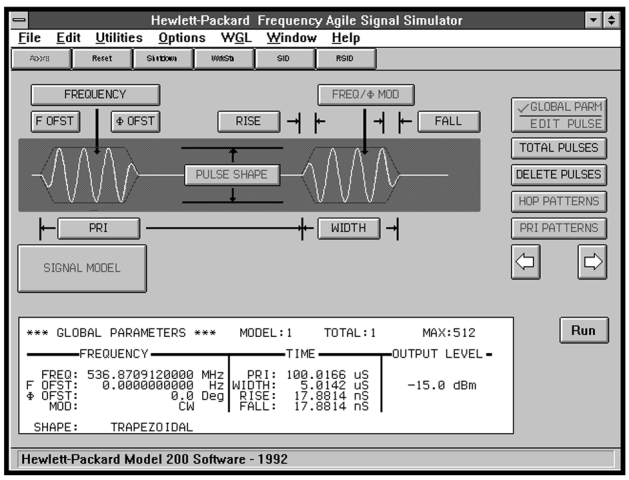
Radar

FASS can simulate target returns for testing and calibrating radar receivers. FASS can also be used as a major subsystem for instrumentation radars, serving as a complex waveform exciter or a frequency agile STALO for coherent systems.

Modes of Operation

Instruments-on-a-Disk (IDs)

Instruments-on-a-Disk (IDs) make this otherwise complex system easy to use and give FASS the front panel personality of specific applications. By clicking clearly-labeled softkeys with the mouse, users can modify sophisticated signal characteristics like PRI stagger quickly and easily.



HP 8791 Model 200 screen

Remote HP-IB

Remote HP-IB commands in FASS come in two varieties. There are the commands that mimic front-panel keystrokes of an ID and the general-purpose commands that give access to all the functions of FASS. Whichever set of standard HP-IB commands is used, integrating FASS's high-integrity, advanced signal simulation capability into an existing simulation system is very convenient.

Waveform Generation Language (WGL)

For advanced applications where existing ID software is insufficient, users can program FASS with the Waveform Generation Language (WGL) software. WGL could be used to generate nonstandard signals such as nonlinear chirps or complex signal environments such as TDMA or CDMA.

Dynamic Data/Dynamic Sequence

Dynamic data mode allows selective, external control of instantaneous frequency, FM, ΦM, and AM, as well as pulse modulation and level. In dynamic data mode, data maps are downloaded to the modulation data source's frequency and modulation memories. Dynamic data supplied at rates of up to 33 MHz addresses desired locations in memory. The output of FASS is determined by the values mapped at that location. Dynamic sequence allows external real-time selection of up to 1024 unique waveform sequences.

Performance Characteristics

HP 8791 Model 21 Frequency Agile Signal Simulator

Frequency
- **Range:** 0.05 to 18 GHz (to 40 GHz with upconversion)
- **Resolution:** 0.125 Hz
- **Switching Speed:** < 100 ns typical over full 18 GHz BW

Amplitude
- **Fast-Level Control Switching Speed:** < 100 ns typical in 6.02 dB steps
- **Output Power:** +10 to –107 dBm

Modulation Capabilities
- **Instantaneous Bandwidth:** 40 MHz
- **Formats:** Arbitrary FM, ΦM, AM, Pulse, Frequency Hopping

Spectral Purity
- **Spurious Response:** –55 dBc, typical
- **Phase Noise:** < –110 dBc/Hz @ 10 kHz offset, 9.77 GHz, typical

Remote Operation
HP-IB compatible
- **Dynamic Data:** AM, FM, ΦM, carrier frequency, pulse
- **Dynamic Data Rates:** Up to 33 megawords/sec/channel

General
Size: Rack: 600 mm W x 1237 mm H x 803 mm D (23.6 x 48.7 in x 31.6 in); console: 754 mm W x 1064 mm H x 756 mm D (29.7 in x 41.9 in x 29.8 in)
Weight: Shipping, rack 319 kg (700 lb); console 75 kg (165 lb)

HP 8791 Model 11 Frequency Agile Signal Simulator

Same specifications as Model 21 except:
Frequency Range: 0.01 to 3 GHz (to 18.5 GHz with upconversion)
Switching Speed: < 100 ns typical over full 3 GHz BW

HP 8791 Model 7 Frequency Agile Signal Simulator

Same specifications as Model 21 except:
Frequency Range: DC to 50 MHz (other output frequencies available using external upconverters)
Switching Speed: 8 ns to within 10° of final frequency
Amplitude
- **Output Power:** +10 to –100 dBm

Spectral Purity
- **Phase Noise:** ± 127 dBc/Hz at 10 kHz offset at 40 MHz typical

Instantaneous Modulation BW: 50 MHz p-p
Weight: Shipping, rack 258 kg (568 lb); console 75 kg (165 lb)

HP 8791 Model 100 Precision Signal Generator

The HP 8791 Model 100 Precision Signal Generator Instrument-on-a-Disk (PSID) software configures FASS to be a high-precision signal generator.
Carrier: Amplitude, phase, frequency
AM: Modulation index: 0 to 100% (80 dB DSB-SC);
Modulation frequency: 0.0625 Hz to 20 MHz
PM: Peak phase deviation: 0° to 180°;
Modulation frequency: 0.0625 Hz to 20 MHz typical
FM: Frequency deviation: 0.125 Hz to 20 MHz;
Modulation frequency: 0.0625 Hz to 20 MHz;
0 to approximately 2 MHz typical
Modulation Waveforms
- **Sine:** AM, PM, FM
- **Rectangle:** 0 to 100% duty cycle AM (allows for pulse modulation)
- **Arbitrary User-defined:** ≤ 8192 points

HP 8791 Model 200 Radar Simulator

The Model 200 Radar Simulator Instrument-on-a-Disk (RSID) software configures FASS to simulate advanced pulsed radar emitters.
Frequency Hopping: Constant, linear, scheduled, user-defined
Intrapulse Modulation: Coherent, noncoherent, chirp, Barker, user-defined
Pulse Width: 29.8 ns to 100 ms
Rise and Fall: 29.8 ns to 230 µs
Pulse Shapes: Trapezoidal, Gaussian, exponential, user-defined
Pulse Repetition Frequency: 1 Hz to 625 kHz
PRF Patterns: Constant, burst, stagger, jitter, wobbulation, user-defined
Antenna Scan Rate: 4 to 100,000 RPM
Main Beam Width: 0.1 to 360°
Antenna Scan Patterns: Circular, conical, raster, sector, user-defined
Antenna Radiation Patterns: Rectangular, Hamming, Hanning, Blackman, 3-term, $\cos^n$, programmable

Key Literature

HP 8791 Models 11 and 21 FASS Technical Data Sheet, p/n 5091-4425E
HP 8791 Model 7 FASS Technical Data Sheet, p/n 5091-2914E

Ordering Information

HP 8791
Model 21 Frequency Agile Signal Simulator (E2505A)
Model 11 Frequency Agile Signal Simulator (E2500B)
Model 7 Frequency Agile Signal Simulator (E2506A)
Model 100 Precision Signal Generator (E2502A Option 012)
Model 200 Radar Simulator (E2501A Option 012)

HP 83554A
HP 83555A
HP 83556A
HP 83557A
HP 83558A

- 26.5 to 110 GHz frequency range
- Leveled high output power
- Can be driven by many HP microwave sources
- Source module remotable up to one meter length
- Low entry cost

HP 83558A mm-wave source module. 75GHz to 110 GHz

HP 83550 Series Millimeter-Wave Source Modules

The five HP 83550 series millimeter-wave source modules provide a simple approach to extend the frequency range of 11 to 20 GHz sources to cover 26.5 to 40 GHz (HP 83554A) 33 to 50 GHz (HP 83555A), 40 to 60 GHz (HP 83556A), 50 to 75 GHz (HP 83557A) and 75 to 110 GHz (HP 83558A) bands. The HP 83550 series source modules offer leveled high output power, full waveguide band frequency coverage and the high-frequency accuracy and resolution of the driving microwave source.

As shown in the figure in the right column, there are two basic ways of configuring a millimeter-wave source to best suit your specific needs. You can choose between an individual synthesized sweeper (HP 83623B/L, HP 83624B, HP 83751B, or HP 83752B) or a combination of an HP 8349 amplifier and another HP 8360 B/L series or HP 8370 series synthesized sweeper.

Pulse, AM, and FM Modulation

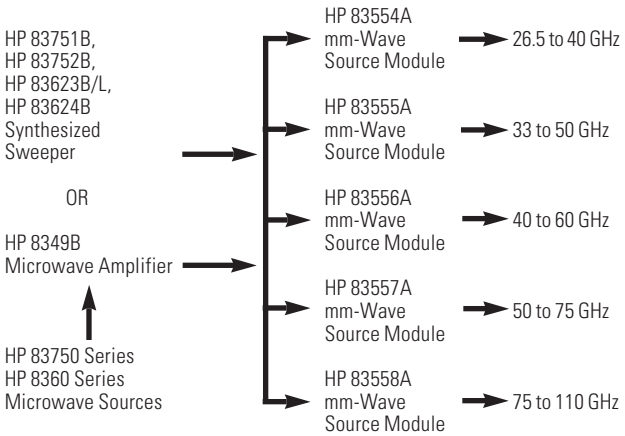
The high-performance pulse modulators of the Hewlett-Packard synthesized sources offer > 80 dB on/off ratio and < 50 ns rise and fall times. Pulse amplitudes are leveled for pulse widths as narrow as 1 µs.

The HP 8360 B-series also feature dc-coupled AM with a 3 dB bandwidth of 250 kHz. Pulse and amplitude modulation can be used to simultaneously simulate antenna scan patterns.

FM rates between 100 kHz and 8 MHz may be applied to the HP 8360 B-series synthesizer input to achieve deviations up to 16 MHz (HP 83554A) and 24 MHz (HP 83555A, 83556A), 32 MHz (HP 83557A), and 48 MHz (HP 83558A) at millimeter-wave frequencies.

High-Output Power

Leveled-output power from the source modules is rated at +8 dBm for the HP 83554A, +3 dBm for the HP 83555A, +3 dBm for the HP 83556A, +3 dBm for the HP 83557A, and 0 dBm for the HP 83558A. This high-output power can permit the source module to serve as a mixer LO in some applications and also expands the available dynamic range in frequency response measurements.



All at a Lower Cost

The HP 83550 series source modules combine performance and quality with a low cost of entry. This is possible because the source modules are backward-compatible with existing HP microwave sources. Thus you can generate a full waveguide band of millimeter-wave frequencies for just the cost of a source module and an HP 8349B amplifier (where required). Also, the cost of ownership is reduced even further by the two-year warranty on the microcircuits of the HP 83550 series source modules and the HP 8349B microwave amplifier.

HP 83554A Output Characteristics

	HP 8360 Series/8349B, HP 83623B/L, 83624B	HP 8370 Series/8349B, HP 83751B, 83752B
Maximum leveled power (25° ± 5° C) **Minimum settable power**	+ 8 dBm – 5 dBm	+ 8 dBm – 5 dBm
Power level accuracy[2] (25° ± 5° C) **Power flatness** (at max. leveled power)	± 2.00 dB ± 1.50 dB[3]	± 2.00 dB ± 1.50 dB[3]
Source output SWR	< 2.0	< 2.0
Spurious signals[4] Harmonically related spurious: 26.5 to 26.7 GHz 26.7 to 40.0 GHz	 < – 25 dBc < – 40 dBc	 < – 25 dBc < – 20 dBc

[1] All specifications apply to internally leveled operation only.
[2] Specified with respect to HP 83550A or HP 8349B power display. Includes power level flatness.
[3] Must have 0.5 V/GHz modification on microwave source.
[4] Expressed in dB relative to the carrier level (dBc).

HP 83550 Series Millimeter-Wave Source Modules (cont'd)

HP 83555A Output Characteristics[1]

	HP 8360 Series/8349B, HP 83623B/L, 83624B	HP 8370 Series/8349B, HP 83751B, 83752B
Maximum leveled power (25° ±5° C)	+3 dBm	+3 dBm
Minimum settable power	–5 dBm	–5 dBm
Power level accuracy[2] (25° ± 5° C)	±2.00 dB	±2.00 dB
Power flatness (at max. leveled power)	±1.50 dB[3]	±1.50 dB[3]
Source output SWR	< 2.0	< 2.0
Spurious signals[4]		
Harmonically related spurious:		
33.0 to 37.5 GHz	< –20 dBc	< –20 dBc
37.5 to 49.5 GHz	< –40 dBc	< –50 dBc
49.5 to 50.0 GHz	< –20 dBc	< –20 dBc

HP 83556A Output Characteristics[1]

	HP 8360 Series/8349B, HP 83623B/L, 83624B	HP 8370 Series/8349B, HP 83751B, 83752B
Maximum leveled power (25° ± 5° C)	+3 dBm	+3 dBm
Minimum settable power:	–5 dBm	–5 dBm
Power level accuracy[2] (25° ±5° C)	±2.25 dB	±2.25 dB
Power flatness (at max. leveled power)	±1.75 dB[3]	±1.75 dB[3]
Source output SWR	< 2.0	< 2.0
Spurious signals[4]		
Harmonically related spurious:		
40.0 to 45.0 GHz	< –20 dBc	< –20 dBc
45.0 to 60.0 GHz	< –40 dBc	< –50 dBc

HP 83557A Output Characteristics

	HP 8360 Series/8349B, HP 83623B/L, 83624B	HP 8370 Series/8349B, HP 83751B, 83752B
Maximum leveled power (25° ± 5° C)	+3 dBm	+3 dBm
Minimum settable power	–2 dBm	–2 dBm
Power level accuracy (25° ± 5° C)	±2.0 dB	±2.5 dB
Power flatness (at max. leveled power)	±1.5 dB	±2.0 dB
Source output SWR		
Leveled:	< 2.0	< 2.0
Unleveled:	< 3.0	< 3.0
Spurious signals[4]		
Harmonically related spurious:	< –20 dBc	< –20 dBc

HP 83558A Output Characteristics

	HP 8360 Series/8349B, HP 83623B/L, 83624B	HP 8370 Series/8349B, HP 83751B, 83752B
Maximum leveled power (25° ± 5° C)	0 dBm	0 dBm
Minimum settable power	–5 dBm	–5 dBm
Power level accuracy (25° ± 5° C)	±2.0 dB	±2.5 dB
Power flatness (at max. leveled power)	±1.5 dB	±2.0 dB
Source output SWR		
Leveled:	< 2.0	< 2.0
Unleveled:	< 3.0	< 3.0
Spurious signals[4]		
Harmonically related spurious:	< –20 dBc	< –20 dBc

[1] All specifications apply to internally leveled operation only.
[2] Specified with respect to HP 83550A or HP 8349B power display. Includes power level flatness.
[3] Must have 0.5 V/GHz modification on microwave source.
[4] Expressed in dB relative to the carrier level (dBc).

General Specifications

Waveguide Output Connector
HP 83554A: EIA size WR 28 waveguide; JAN UG-599 flange
HP 83555A: EIA size WR 22 waveguide; JAN UG-383 flange
HP 83556A: EIA size WR 19 waveguide; JAN UG-383 (mod.) flange
HP 83557A: EIA Size WR 15 waveguide; JAN UG-385 flange
HP 83558A: EIA Size WR 10 waveguide; JAN UG-387 flange
Weight: Net, 1.7 kg (4 lb)
Size: Module, 80 mm W x 80 mm H x 210 mm D (3.15 in x 3.15 in x 8.27 in)
Furnished with Each Source Module: Operating and Service Manual, Modification Procedures for 0.5 V/GHz Output, Type-N RF Cable, Module Base Assembly, Synthesizer Interface Cable

Key Literature

HP 83557A/83558A Data Sheet, p/n 5958-0398
HP 83554A/83555A/83556A, MM-Wave Source Modules Data Sheet, p/n 5954-8364D

Ordering Information

HP 83554A 26.5 to 40.0 GHz mm-Wave Source Module
HP 83555A 33.0 to 50.0 GHz mm-Wave Source Module
HP 83556A 40.0 to 60.0 GHz mm-Wave Source Module
HP 83557A 50.0 to 75.0 GHz mm-Wave Source Module
HP 83558A 75.0 to 110.0 GHz mm-Wave Source Module
Opt 910 Extra Service Manual
Opt W30 Extended Repair Service (see page 70)
HP 83554/5/6
HP 83557/8
Opt W32 Calibration Service (see page 70)
HP 83554/5/6
HP 83557/8

HP E2747A
HP E2748A

NEW

- Digital transmitter architecture
- Open platform for new or unique modulation formats
- Generate messages, including protocol
- Real-time signal generation from data
- Simulate realistic spectral environments with multiple channels
- Modulated IF and baseband I/Q outputs
- PC instrument or VXI system form factor

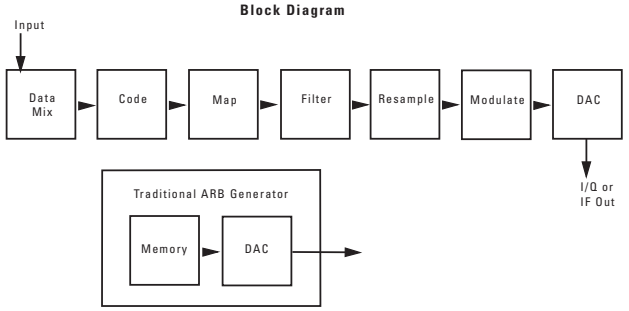
HP E2747A Vector Waveform Generator
HP E2748A Vector Waveform Generator Module

NEW

Virtual Transmitter for Rapid Prototyping

The HP E2747/48A family of baseband vector waveform generators lets digital communications designers generate a wide range of digitally modulated signals. The HP E2747A is a preconfigured PC-format instrument. The HP E2748A vector waveform generator module is a system builder's element which plugs into one of two supported carriers.

HP E2747A/E2748A Vector Waveform Generator
Block Diagram



Both the HP E2747A and HP E2748A use a generalized digital transmitter architecture. Unlike arbitrary waveform generators, which can only play back pre-computed samples stored in memory, the vector waveform generator can also accept data as input, then apply the required coding, filtering, mapping and modulation, just as a digital transmitter does. This allows real-time signal generation from data.

You have complete control over all the parameters of each block of the architecture, such as modulation type, symbol rate, number of symbol bits, etc. There are two means of accessing these: a "soft-panel" user interface which provides "fill-in-the-blanks" simplicity of operation, and a function library interface for programmatic control. Both user interfaces run in a Windows NT/95 environment on a PC controller.

Real-World Signals for Real-World Testing

Because you have complete control of message formatting, you can generate signals which contain protocol fields and payload. Messages have 16 fields, each of varying length. You can direct the vector waveform generator to fill each field with data from one of several data sources, including a data register for fixed data, a RAM file, or a COM port for real time message creation. You can also use the onboard random noise generator as a data source.

Generate even more realistic test signals with a multi-channel system. With independent control of each channel's frequency, modulation format, symbol rate, and more, use it for simulating realistic spectral environments, including impairments. You can vary the parameters without reloading your message data.

PC and VXI Format

Choose the form factor which best meets your needs. The PC-based HP E2747A allows a maximum of 3 channels. More channels are possible with the HP E2748A in its VXI-based carrier (the HP SCMVX008 with options -001 and -082.) Each VXI carrier accepts 6 HP E2748A modules, and you can use multiple carriers per VXI mainframe.

Specifications

Form Factor
HP E2747A: Pre-configured PC-format instrument
HP E2748A: Module assembly to be used in a separate carrier (VXI or PCI) for system builder applications

Hardware
Carrier Frequency: dc to 6 MHz
Signal Bandwidth: 6 MHz in playback mode; 2 MHz typical, real time
Level Accuracy: ±0.5 dB at 10 kHz
Flatness (relative to 10 kHz): ±0.75 dB
Spurious Distortion: –70 dB below full scale
Harmonic Distortion: –55 dBc

Software
Operating System: Compatible with Windows NT or Windows 95
User Interface: Graphical soft front panel, or function library calls
Configurable Parameters: Data source for message fields; message fields descriptions; coder; filter modes and shapes, including wizard to synthesize custom filters; symbol mapping; modulation format; carrier frequency, and more.

Key Literature

HP E2747A & E2748A Product Overview, p/n 5966-4764E
HP E2747A & HP E2748A Technical Specifications, p/n 5968-1047E
HP E2747A & HP E2748A Configuration Guide, p/n 5967-5509E

Ordering Information

HP E2747A Vector Waveform Generator
- **Opt 001** Add one additional channel
- **Opt 002** Add two additional channels
- **Opt 003** Single channel upconversion to 3 GHz via HP ESG Series Model E4432B
- **Opt 004** Multi-channel upconversion to 2.65 GHz via HP 89431A

HP E2748A Vector Waveform Generator Module

5

Hewlett-Packard offers a complete line of signal analyzers to provide frequency-, time-, order-, angle- and modulation-domain measurement capability. This section is devoted primarily to the frequency domain. It includes spectrum analyzers, distortion analyzers audio analyzers, modulation analyzers and measuring receivers. Each type of instrument has distinctive capabilities that make it the preferred instrument for a particular measurement application.

The spectrum analyzer is a swept-tuned, superheterodyne receiver that provides a display of amplitude versus frequency. It is essentially a frequency-selective, peak-responding voltmeter calibrated to display the rms value of a sine wave. The spectrum analyzer can show the individual frequency components that make up a complex signal. (It does not provide phase information about a signal, however.) The swept receiver technique used in Hewlett-Packard spectrum analyzers enables frequency-domain measurements to be made over a large dynamic range and a wide frequency range (30 Hz to 325 GHz).

The Fourier analyzer uses digital sampling and mathematical transformation techniques to form a Fourier spectrum of a signal. This method is useful for measuring signals from a few µHz to 100 kHz, and provides frequency, amplitude and phase information. With its real-time signal analysis capability, the Fourier analyzer is able to capture periodic as well as random transient events.

Distortion analyzers and audio analyzers employ broadband detectors and notch filters to measure signal properties such as total harmonic distortion. These tunable filters enable the analyzer to selectively display the level and frequency of harmonic and distortion products. Measurement results are shown on a meter or digital display. Audio analyzers include a signal source, making possible measurements such as SINAD, which include signal and distortion levels. The frequency range covered by HP distortion and audio analyzers extends from 5 Hz to 600 kHz.

Modulation analyzers and measuring receivers are designed to capture and analyze a fundamental signal and its entire modulation envelope. Modulation analyzers use independent AM and FM detection circuits for simultaneous analysis of complex modulated signals. When these analyzers are combined with a downconverter and local oscillator, accurate measurements of frequency, power and modulation characteristics can be made on signals from 150 kHz to 26.5 GHz. All measurement results are presented on a digital display.

Spectrum Analyzers

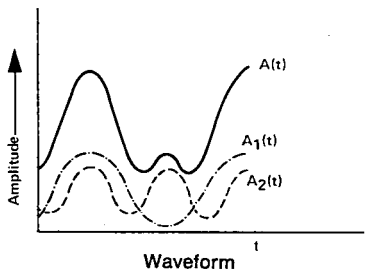
Spectrum analyzers take advantage of the frequency-conversion properties of the swept-tuned heterodyne receiver to make significant contributions to frequency-domain signal analysis. The following are some of the measurements that can be made with spectrum analyzers:

- Absolute and relative frequency
- Absolute and relative amplitude
- Scalar
- Noise
- Distortion products
- AM, FM, pulsed RF, and digital modulation
- Stimulus response
- Electromagnetic compatibility (EMC)

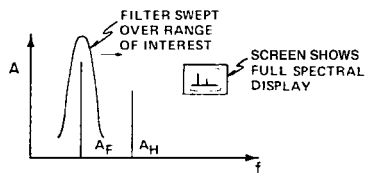
These measurements are possible because spectrum analyzers have the following characteristics:

- Broad frequency coverage from 30 Hz to 325 GHz
- Wide amplitude range from –156 dBm to +30 dBm
- Tracking generators for scalar measurements
- Excellent sensitivity for low signal detection
- Excellent frequency stability
- High resolution of frequency and amplitude
- Digital demodulation capability

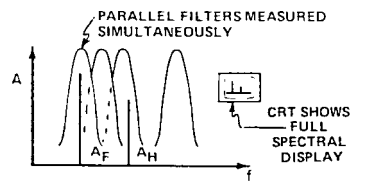
These capabilities allow spectrum analyzers to provide frequency-domain signal analysis for numerous applications, including the manufacture and maintenance of microwave communication links, radar, telecommunications equipment, CATV systems and broadcast equipment, mobile communication systems, EMI diagnostic testing, component testing, lightwave measurements and signal surveillance.



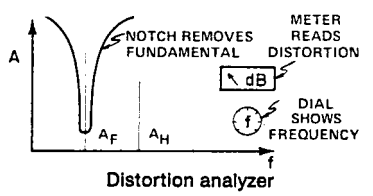
Waveform



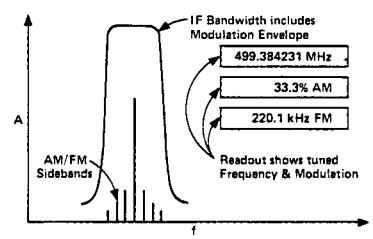
Spectrum analyzer



Fourier analyzer



Distortion analyzer



Modulation analyzer

In addition to the swept-tuned frequency mode, spectrum analyzers can also be used in the fixed-tuned mode (zero span) to provide time-domain measurement capability much like that of an oscilloscope.

Vector signal analyzers extend the capabilities available in a spectrum analyzer. Though similar to Fourier analyzers, vector signal analyzers provide capabilities through the RF range, offering fast, high-resolution spectrum measurements, demodulation and advanced time-domain analysis. They are especially useful for characterizing complex signals such as burst, transient, or modulated signals used in communications, video, broadcast, sonar, and ultrasound imaging applications.

With the addition of computers, the capability of spectrum analyzers can be greatly enhanced. Computers can be used to directly control the operation of spectrum analyzers over HP-IB. Computers can also be used to develop downloadable programs (DLPs) for spectrum analyzers with the capability to store such programs in non-volatile memory. These custom measurement routines are then as easy to use as any of the standard instrument features. Custom measurement "personality" cards are available for many spectrum analyzers.

In addition, spectrum analyzers can directly control a plotter or printer, enabling a hard copy of the display to be made without the use of a computer. Application areas that require accurate, high-speed, repetitive routines, physical separation of the operator and the analyzer, unattended operation or operation by personnel with limited technical skills are all candidates for automation.

Areas that benefit significantly from automated spectrum analysis include:

- EMC testing
- frequency spectrum monitoring
- production testing of RF or microwave components, subsystems, or systems
- remote-site testing

The basic measurement capabilities of the spectrum analyzer, combined with its ability to automate and to interface with other HP-IB instruments and peripherals, make this instrument ideal for many general-purpose and specialized applications.

Fourier Analyzers

Fourier analyzers offer fast, high-resolution spectrum and network analysis. Unlike conventional swept analyzers, Fourier-based analyzers can measure dynamic signals because they measure all frequencies simultaneously, not one at a time.

Fourier analyzers characterize signals using digital signal-processing techniques based on the Discrete Fourier Transform. For a complete description of these techniques, see Application Note 243, *The Fundamentals of Signal Analysis.*

Fourier analyzers are especially useful on low-frequency signals (< 100 kHz) or where very fast measurements are desired. They can improve measurement speed from a factor of 10 to 100, and allow accurate measurements on frequencies as low as a few µHz. Signal components as closely spaced as 20 µHz can be clearly resolved and accurately measured.

Since both the magnitude and phase of each frequency component are measured, the Fourier analyzer can measure the statistical properties of signals, or the joint properties or relationships of two or more signals. Applications include acoustic, modal, vibration, or rotating machine analysis. In addition, various types of modulation can be detected and measured.

Simultaneous measurement of magnitude and phase on two or more channels provides high-quality network measurements. Transfer functions or frequency response can be easily measured, and the use of band-limited or band-translated random noise as the stimulus allows the entire frequency span of interest to be measured at once. Measurement of the coherence function can provide an indication of the validity of many network measurements.

Distortion and Audio Analyzers

The Hewlett-Packard distortion and audio analyzers consist of narrow-band rejection filters and broadband detectors. Before the fundamental is rejected, the analyzer first measures the amplitude of the fundamental, all the harmonic components, and the noise. Then the rejection filter is employed to remove the fundamental. The ratio of the two measurements is total harmonic distortion plus noise.

Audio Analyzers

The audio analyzer performs several basic low-frequency measurements in addition to distortion, making it a general-purpose audio test set. The audio analyzer includes the SINAD function for testing mobile radio receiver sensitivity. It contains a low-distortion audio oscillator for stimulus-response testing in combination with its distortion analyzer. It has a true rms voltmeter and dc voltmeter for accurate measurement of complex waveform levels. Swept ac level and swept distortion measurements can be made using the internal source and rms voltmeter. A reciprocal frequency counter is included that continuously counts the frequency of the input signal.

True Harmonic Distortion Measurements

Computer-controlled spectrum analyzers provide a rapid means of measuring true harmonic distortion levels. The fundamental and its harmonic components are rapidly measured one at a time, and the distortion is computed and either stored or printed.

Modulation Analyzers/ Measuring Receivers/ Vector Signal Analyzers

A modulation analyzer is a precision receiver designed to detect the entire modulation envelope of a signal under test. It can measure and display the carrier characteristics of RF frequency and power, as well as AM, FM and phase modulation characteristics such as AM depth, peak deviation, residual modulation, and various associated ratios. The modulation analyzer faithfully recovers the actual modulation signal for further analysis such as distortion testing.

In addition to having all the capabilities of the modulation analyzer, the measuring receiver can measure power down to –127 dBm. With very high accuracy, it can look at signals up to millimeter-wave frequencies. This makes it ideal for the calibration of signal generators and attenuators.

Vector Signal Analyzers

The vector signal analyzer is also capable of modulation analysis. Similar to Fourier analyzers, vector signal analyzers extend the capabilities of DSP through the RF range. Since both the magnitude and the phase of signals are captured, vector signal analyzers can provide a broad range of measurements including spectrum, modulation and power on baseband, IF, or RF signals. Vector or I and Q formats can be analyzed in addition to AM, FM and PM formats. Vector signal analyzers are especially useful when a broad range of measurements is required, for example, in the development of digital communication systems.

Microwave Modulation Analyzers

Most modern microwave communication and radar/EW system designers are turning to the use of complex modulations, which involves the use of quadrature or vector modulation formats such as QPSK or 16 QAM in the case of communication systems or complex, coded formats in the case of radar/EW systems.

In all these receivers, the signal processing is not handled in the traditional one-channel, amplitude-only mode, but instead is demodulated into in-phase and quadrature-phase signals that provide dynamic phase and amplitude information about the modulation of the carrier.

Modulation-domain analyzers represent an extension of Hewlett-Packard's counter/timer technology. They provide helpful views of the frequency, phase, or timing of a signal versus time. They also provide histograms and statistical analyses, making it easy to quickly analyze large amounts of measurement data. Modulation-domain analyzers allow you to directly view frequency switching and settling of VCOs, PLLs and synthesizers. They also make it easy to analyze complex phase and frequency modulations found in modern communications systems. See page 137 for a complete overview.

Peak Power Analysis

For comprehensive measurement and analysis of RF and microwave pulsed power, the HP 8990/91A peak power analyzer measures eight time parameters and five amplitude parameters. Its powerful waveform math routines can measure ratios and differences and can determine the statistics of parameters measured with two RF channels or two video (100 MHz) channels.

Signal Analyzer Selection Guide

Spectrum Analyzers[1]

Frequency range	Frequency accuracy (±)[2]	Resolution bandwidth range	Average noise level (narrowest RBW)	Optimum dynamic range 2nd/3rd order	Amplitude accuracy (±)[3]	HP model number	Page
Low frequency							
122 MHz to 102.4 kHz	30 ppm	61 MHz to 1024 Hz	<–140 dBVrms/$\sqrt{\text{Hz}}$	90 dB typical	0.25 dB	35665A/35670A	547
dc to 10 MHz	30 Hz	312 µHz to 3 MHz	–170 dBm	75 dB/75 dB	0.7 dB	89410A[4]	264
RF (data given for CF = 1 GHz)							
9 kHz to 1.5 GHz	2.0 kHz	1 kHz to 3 MHz	–116 dBm	78 dB/85 dB	1.5 dB	ESA-L1500A	242
9 kHz to 1.8 GHz	2.1 kHz	1 kHz to 3 MHz	–115 dBm	70 dB/80 dB	1.7 dB[5]	8590L	247
1 MHz to 1.8 GHz	210 Hz	30 Hz to 3 MHz[6]	≤ – 88 dBmV	76 dB/88 dB[6]	1.7 dB	8591C	528
9 kHz to 1.8 GHz	210 Hz[6]	30 Hz to 3 MHz[6]	–130 dBm[6]	77 dB/90 dB[6]	1.7 dB[5]	8591E	247
dc to 2.65 GHz	180 Hz	312 µHz to 3 MHz	–185 dBm	75 dB/75 dB	1.1 dB	89441A	264
9 kHz to 2.9 GHz	2.1 kHz	1 kHz to 3 MHz	–112 dBm	71 dB/78 dB	1.7 dB[5]	8594L	247
9 kHz to 2.9 GHz	210 Hz[6]	30 Hz to 3 MHz[6]	–127 dBm[6]	78 dB/88 dB[6]	1.7 dB[5]	8594E	247
30 Hz to 2.9 GHz + mm	106 Hz	1 Hz to 2 MHz	–145 dBm	88 dB/103 dB	1.85 dB	8560E	254
100 Hz to 2.9 GHz	110 Hz	10 Hz to 300 kHz (3 MHz)[6]	–134 dBm (–156 dBm)[6]	82 dB/92 dB	1.5 dB (0.9 dB)[7]	71100C/P	259
30 Hz to 6.5 GHz + mm	106 Hz	1 Hz to 2 MHz	–145 dBm	88 dB/103 dB	1.85 dB	8561E	255
9 kHz to 6.5 GHz	210 Hz[6]	30 Hz to 3 MHz[6]	–125 dBm[6]	77 dB/86 dB[6]	2.2 dB[5]	8595E	247
9 kHz to 12.8 GHz	210 Hz[6]	30 Hz to 3 MHz[6]	–125 dBm	77 dB/86 dB[6]	2.7 dB[5]	8596E	247
30 Hz to 13.2 GHz	103 Hz	1 Hz to 2 MHz	–151 dBm	95 dB/108 dB	2.1 dB	8562E	255
Microwave (data given for CF = 10 GHz)							
100 Hz to 26.5 GHz + mm	1 kHz	10 Hz to 3 MHz	–137 dBm (–155 dBm)[6]	99 dB/96 dB	2 dB (0.9 dB)[7]	71209A/P	259
100 Hz to 22 GHz + mm[6] + lightwave	1 kHz	10 Hz to 3 MHz	–136 dBm (–153 dBm)[6]	96 dB/98 dB	2.5 dB(0.9 dB)[7]	71210C/P	259
50 kHz to 22 GHz + mm[6]	1 kHz	10 Hz to 3 MHz	–109 dBm (–135 dBm)[6]	84 dB/91 dB	2 dB (0.9 dB)[7]	71200C/P	259
9 kHz to 22 GHz (26.5 GHz)[6]	20 kHz	1 kHz to 3 MHz	–102 dBm	96 dB/71 dB	2.7 dB[5]	8592L	247
9 kHz to 22 GHz (26.5 GHz)[6]	1.2 kHz[6]	30 Hz to 3 MHz[6]	–117 dBm[6]	103 dB/81 dB[6]	2.7 dB[5]	8593E	247
9 kHz to 26.5 GHz + mm (30 Hz to 26.5 GHz)[6]	1 kHz	1 Hz to 2 MHz	–145	117 dB/102 dB	3 dB	8563E	255
100 Hz to 40 GHz + mm[6]	1 kHz	10 Hz to 3 MHz	–136 dBm (–155 dBm)[6]	99 dB/96 dB	2 dB (0.9 dB)[7]	71209A/P Z40	259
9 kHz to 40 GHz	1 kHz	1 Hz to 2 MHz	–143	117 dB/100 dB	3 dB	8564E	255
9 kHz to 50 GHz	1 kHz	1 Hz to 2 MHz	–143	117 dB/100 dB	3 dB	8565E	255

[1] Data shown here is for comparison purposes only. Consult data sheets for more complete specifications.
[2] Accuracy includes 1-year aging. Settability and temperature drift not included.
[3] Relative accuracy consists of relative frequency response plus the lesser of either scale fidelity or IF gain accuracy.
[4] Combination vector-network and spectrum analyzer.
[5] Based on IF gain accuracy specified over 60 dB range.
[6] Includes optional performance.
[7] Transfer accuracy using HP 70100A-H01 power meter.

Dynamic Signal Analyzers

Frequency range	Channel match	Frequency resolution in lines	Real-time bandwidth*	Dynamic range	Amplitude** accuracy (+)	HP model number	Page
0.000122 Hz to 102.4 kHz	± 0.04 dB, ± 0.5°	100 to 1600	25.6 kHz	80 dB, 90 dB typ.	0.15 dB	35670A	546
0.000244 Hz to 102.4 kHz	± 0.04 dB, ± 0.5°	100 to 800	12.8 kHz	< –72 dB	0.25 dB	35665A	547
0.000122 Hz to 102.4 kHz	± 0.1 dB, ± 0.5°	25 to 3200	25.6 kHz	80 dB	0.15 dB	3567A	547
0.000122 Hz to 12.8 kHz	± 0.1 dB, ± 0.5°	25 to 3200	12.8 kHz (4 ch.)	72 dB	0.15 dB	3566A	547
0.0325 Hz to 40 kHz	± 0.2 dB, ± 0.5°	50 to 1600	> 2.0 kHz	60 dB	0.5 dB	3560A	545
dc to 4 MHz	NA	51 to 12,800	1 MHz	80 to 110 dBFS	0.03 dB	3587S	342
0.0002 Hz to 10 MHz	± 0.25 dB, ± 2.0°	51 to 3201	78.125 kHz (1 ch.)	75 dB, 85 dB typ.	0.5 dB	89410A	264
0.0325 - 25.6 µHz	± 0.1 dB, ± 1.0°	50 to 1600, Octaves	> 6.4 kHz, 20 kHz Octaves	72 dB	0.5 dB	3569A	544

*One-year aging; settability and temperature drift included.
**Relative accuracy = relative frequency response + lesser of either scale fidelity or IF gain accuracy.

Distortion/Audio Analyzers

Fundamental frequency range	Minimum distortion	Auto set level	Auto nulling	True RMS	AM detector	Filters	Internal source	HP-IB	HP model number	Page
20 Hz to 100 kHz	0.01% (–80 dB)	•	•	•	See Note	•	•	•	8903B*	489
20 Hz to 100 kHz	0.01% (–80 dB)	•	•	•	See Note	•	—	•	8903E**	489

*The HP 8903B also performs frequency count, signal/noise, SINAD, watts and ac/dc voltage measurements.
**The HP 8903E also performs frequency count, SINAD and ac/dc voltage measurements.
Note: The HP 8901A modulation analyzer provides complete demodulation of AM, FM and ΘM signals.

Modulation Analyzers/Measuring Receivers/Vector Signal Analyzers

Frequency range	Modulation measurements	Amplitude measurement range	Audio frequency count + distortion measurement	HP model number	Page
150 kHz to 1300 MHz	AM, FM, ΘM	+30 to 0 dBm	No	8901A	491
150 kHz to 1300 MHz	AM, FM, ΘM	+30 to –20 dBm	Yes	8901B	491
150 kHz to 1300 MHz	AM, FM, ΘM	+30 to –127 dBm	Yes	8902A	245
150 kHz to 18 GHz or 26.5 GHz	AM, FM, ΘM	+30 to –100 dBm	Yes	8902S	310
dc to 2650 MHz	Baseband, IF, RF, I, Q, mag/phase, AM, FM, ΘM	+25 to –160 dBm	No	89441A	264

*50 to 200 MHz standard. Operation above 200 MHz available as specials.

Modulation Domain Analyzers

Frequency range	Resolution freq./time	Sample rate	Memory size	Analysis and displays	HP model number	Page
10 Hz to 200 MHz (2.5 GHz option)	10 digits/200 ps	2.5 M (8 M rep.)	8 K (32 K option)	Frequency and time interval vs. time, histograms, statistics (digital RF communications option)	53310A	149
50 Hz to 150 MHz	10 digits/100 ps	80 M	512 K	Frequency, time interval, time stamp, histograms, statistics (application specific software solutions available)	E1740A (VXI)	150

Peak Power Analysis

Frequency range	Time parameters	Amplitude parameters	Functions available	HP model number	Page
50 MHz to 40 GHz	Rise time, fall time, pulse width, off time, PRI, PRF, delay	Pulse-top amplitude, pulse-base amplitude, peak power, overshoot, average power	2 RF power, 2 video channels, ratios, differences, statistical averages, means, glitch-finding triggering	8990A 8991A	304 304

VCO/PPL Signal Test System

Frequency range	Maximum sensitivity (depends on offset frequency)	Functions available	HP model number	Page
10 MHz to 3 GHz	–147 dBc/Hz @ offset freq. 100 kHz to 10 MHz (as phase noise measurement performance)	Frequency, power level, C/N ratio, FM deviation and dc consumption current	4352S VCO/PLL Signal Test System	348

HP ESA-L1500A

- Frequency range of 9 kHz to 1.5 GHz
- Frequency accuracy of ± 2.0 kHz at 1 GHz (without temperature)
- 5 minute warmup
- Rugged, portable package follows you from lab, to factory, to field

HP ESA-L1500A

HP ESA-L1500A 1.5 GHz Portable Spectrum Analyzer

HP introduces the ESA-L1500A, our new, low-cost, fully synthesized spectrum analyzer. Now get quick and accurate results every time, at an affordable price. It has the performance of a high-quality spectrum analyzer and the rugged ease of use expected in a field instrument.

Fast measurements
The HP ESA-L1500A gives you a rapid display update rate and state-of-the-art 5 ms sweep time that reduces test time and increases throughput.

Accurate results
The phase-locked synthesizer adds stability and repeatability to frequency measurements, and the automatic background alignment offers continuous calibration. Plus, you'll have specified performance only 5 minutes after power-up.

Reliable operation
Increase your manufacturing up-time: costly repairs can be avoided with the automatic input overload protection, and the use of component integration reduces the probability of failure.

Rugged packaging and construction
Ideal for field environments, the HP ESA-L1500A has a sealed front panel, louvered air vents and side-mounted fan to protect the instrument in a wide range of weather conditions. Rubber-encased front and rear frames resist the rigors of transportation.

Easy to use
The combination hard key/soft key front panel offers simple operation for basic measurements while providing access to sophisticated features. In addition, testing is simplified with built-in limit lines and pass/fail messages.

Low cost
All this at a very affordable price.

PC Software for the HP ESA-L1500A
The new HP BenchLink Spectrum Analyzer PC software provides an easy-to-use communications link between your PC and the HP ESA-L1500A spectrum analyzer. Taking full advantage of the Windows® interface, you can easily transfer screen images or trace data via HP-IB or RS-232 interfaces, thereby making it easy to capture, analyze and document measurement results in your PC. For more information, see page 231.

Specifications

Frequency
Frequency Range
50 ohms: 9 kHz to 1.5 GHz
75 ohms (Option 1DP): 1 MHz to 1.5 GHz
Frequency Reference
Aging: ± 2 x 10^{-6}/year
Settability: ± 0.5 x 10^{-6}
Temperature Stability: ± 5 x 10^{-6}

Frequency Readout Accuracy
(Start, Stop, Center, Marker): ± (frequency readout x frequency reference error[1] + span accuracy +20% of RBW)
Marker Frequency Counter
Resolution: Selectable from 1 Hz to 100 kHz
Accuracy: ± (marker frequency x frequency reference error[1] + counter resolution)
Frequency Span
Range: 0 Hz (zero span), 100 Hz to 1.5 GHz
Resolution: Four digits or 2 Hz, whichever is greater
Accuracy: ± 1% of span
Sweep Time
Range: 5 ms to 2000 s
Accuracy (5 ms to 2000s): ± 1%
Sweep Trigger: Free Run, Single, Line, Video, External
Resolution Bandwidth
Range (–3 dB width): 1 kHz to 3 MHz, in 1-3-10 sequence. 5 MHz, characteristic
Accuracy (1 kHz to 3 MHz RBW): ± 20%
Shape (1 kHz to 3 MHz RBW): Approximately Gaussian shape
Selectivity (1 kHz to 3 MHz RBW) (60 dB/3 dB bandwidth ratio): < 15:1, characteristic
Video Bandwidth (–3 dB)
Range: 30 Hz to 1 MHz in 1-3-10 sequence. 3 MHz, characteristic.
Stability (noise sidebands, offset from CW signal with 1 kHz RBW, 30 Hz VBW and sample detector)
≥ 10 kHz: ≤ –90 dBc/Hz
≥ 20 kHz: ≤ –98 dBc/Hz
≥ 30 kHz: ≤ –102 dBc/Hz
≥ 100 kHz: ≤ –112 dBc/Hz
Residual FM
1 kHz RBW, 1 kHz VBW: ≤ 100 Hz peak-to-peak in 100 ms
System-Related Sidebands, offset from CW signal:
≥ 30 kHz: ≤ –65 dBc

Amplitude

Measurement Range
50 ohms: –120 dBm to +30 dBm
75 ohms (Option 1DP): –65 dBmV to +72 dBmV
Input Attenuator Range: 0 to 60 dB, in 5 dB steps
Maximum Safe Input Level (Input attenuator setting ≥ 15 dB)
Average Continuous Power: +30 dBm (1 W); +72 dBmV (0.2 W) for 75 Ω (Option 1DP)
Peak Pulse Power: +30 dBm (1 W); +72 dBmV (0.2 W) for 75 Ω (Option 1DP)
dc: 100 Vdc
1 dB Gain Compression: Total power at input mixer[2]: 0 dBm; 75 Ω (Option 1DP): +54 dBmV
Displayed Average Noise Level (Input terminated, 0 dB attenuation, 30 Hz VBW, sample detector, 1 kHz RBW)
400 kHz to 1 MHz: ≤ –116 dBm
1 MHz to 500 MHz: ≤ –120 dBm
500 MHz to 1.2 GHz: ≤ –116 dBm
1.2 GHz to 1.5 GHz: ≤ –113 dBm
75 Ω (Option 1DP):
1 MHz to 500 MHz: ≤ –65 dBmV
500 MHz to 1 GHz: ≤ –61 dBmV
1 GHz to 1.5 GHz: ≤ –55 dBmV
Display Range
Log Scale: 0 to –85 dB from reference level is calibrated; 0.1, 0.2, 0.5 dB/division and 1 to 20 dB/division in 1 dB steps; ten divisions displayed
Linear Scale: ten divisions
Scale Units: dBm, dBmV, dBµV, V, and W
Frequency Response (Relative to 50 MHz, 9 kHz to 1.5 GHz)
10 dB attenuation
20 to 30° C: ± 0.75 dB
0 to 55° C: ± 1.0 dB
0 dB, 5 dB, 15 to 60 dB atten.: ± 1.0 dB, characteristic
Input Attenuation Switching Uncertainty at 50 MHz
0 dB to 5 dB attenuation: ± 0.3 dB
10 dB attenuation: Reference
15 dB attenuation: ± 0.3 dB
20 to 60 dB attenuation: ± (0.1 dB + 0.01 x attenuator setting)

Absolute Amplitude Accuracy at reference settings[3]: ± 0.3 dB
RF Input VSWR (characteristic)
9 kHz to 1.5 GHz (50 ohms) or 1 MHz to 1 GHz (75 ohms (Option 1DP)):
0 to 5 dB attenuation: 1.55:1
10 to 60 dB attenuation: 1.35:1
1 GHz to 1.5 GHz (75 ohms):
0 to 60 dB attenuation: 2.0:1
Resolution Bandwidth Switching Uncertainty (at reference level)
3 kHz RBW: Reference
1 kHz, 10 kHz to 3 MHz RBW: ± 0.4 dB

Reference Level

Range: Adjustable over amplitude measurement range
Resolution
Log Scale: ± 0.01 dB
Linear Scale: ± 0.12% of reference level
Accuracy: (at a fixed frequency, a fixed attenuation, and referenced to (–35 dBm + attenuation setting))
≥ –70 dBm + atten. setting: ± (0.3 dB + 0.01 x absolute value (ref level – atten. setting + 35 dBm))
< –70 dBm + atten. setting: ± (0.6 dB + 0.01 x absolute value (ref level – atten. setting + 35 dBm))
Accuracy, 75 Ω (Option 1DP) (at a fixed frequency, a fixed attenuation, and referenced to (+16.76 dBmV + atten. setting))
≥ –21.24 dBmV[4] + atten. setting: ± (0.3 dB + 0.01 x absolute value [ref level – atten. setting–16.76 dBmV])
< –21.24 dBmV[4] + atten. setting: ± (0.6 dB + 0.01 x absolute value [ref level – atten. setting–16.76 dBmV])
Display Scale Switching Uncertainty
Linear to Log Switching: ± 0.25 dB at reference level
Log Scale Switching: No error
Display Scale Fidelity
Log Maximum Cumulative
0 to –85 dB from reference level: ± (0.3 dB + 0.01 x dB from reference level)
Log Incremental Accuracy
0 to –70 dB from reference level: ± 0.4 dB/4 dB
Linear Accuracy: ± 3% of reference level)
Spurious Responses
Second Harmonic Distortion
2 MHz to 1.5 GHz: < –75 dBc for –40 dBm (+14 dBmV, 75 Ω) signal at input mixer[2] +35 dBm SHI (second harmonic intercept)
Third Order Intermodulation Distortion
2 MHz to 5 MHz; +5 dBm (+57.76 dBmV, 75 Ω) characteristic TOI (third order intercept)
5 MHz to 900 MHz; <-74 dBc for two –30 dBm (+22.46 dBmV, 75 Ω) signals at input mixer[2] and >50 kHz separation +7 dBm (+59.46 dBmV, 75 Ω) TOI
900 MHz to 1.5 GHz; <-74 dBc for two –30 dBm (+20.76 dBmV, 75 Ω) signals at input mixer[2] and >50 kHz separation +7 dBm (+57.76 dBmV, 75 Ω) TOI
Other Input Related Spurious
30 kHz ≤ offset ≤ 1200 MHz: < –65 dBc, for –20 dBm (+34 dBmV, 75 Ω) signal at input mixer[2] ≤ 1.5 GHz
Offset > 1200 MHz;<-45 dBc, for -20 dBm (+34 dBmV, 75 Ω) signal at input mixer[2] <=1.5 GHz
Residual Responses (Input terminated and 0 dB attenuation)
150 kHz to 1.5 GHz: < –90 dBm
1 MHz to 1.5 GHz (75 Ω): < –36 dBmV
AM Demod: Tune and listen to AM signals

Options

Tracking Generator Specifications (Option 1DN or IDQ)

Output Frequency Range
50 Ω (Option 1DN): 9 kHz to 1.5 GHz
75 Ω (Option 1DQ): 1 MHz to 1.5 GHz
Residual FM
1 kHz RBW, 1 kHz VBW: ≤ 100 Hz peak-to-peak in 100 ms, characteristic

[1] Frequency reference error = (aging rate x period of time since adjustment + settability + temperature stability)
[2] Mixer power level (dBm) = input power (dBm) –input attenuation (dB). For Res BW ≤ 30 kHz, input signal amplitude must be ≤ reference level +10 dB (Option 1DP: ≤ reference level +5 dB)
[3] Settings are: reference level –25 dBm; input attenuation 10 dB; center frequency. 50 MHz; Res BW 3 kHz; video BW 10 kHz; scale linear; span 2 kHz; sweep time coupled, sample detector, signal at reference level
[4] –16.24 dBmV if frequency is > 1 GHz and resolution bandwidth is 30 kHz.

Output Power Level

Range
50 Ω (Option 1DN): 0 to –70 dBm
75 Ω (Option 1DQ): +42.76 to –27.24 dBmV
Resolution: 0.1 dB
Absolute Accuracy (at 50 MHz with coupled source attenuator)**:**
50 Ω (Option 1DN): ± 0.5 dB, referenced to 0 dBm
75 Ω (Option 1DQ): ± 0.5 dB, referenced to +42.76 dBmV
Vernier
Range: 10 dB
Accuracy (with coupled source attenuator)**:**
50 Ω (Option 1DN): ± 0.75 dB, for 0 to –10 dBm, referenced to 0 dBm
75 Ω (Option 1DQ): ± 0.75 dB, for +42.76 to +32.76 dBmV, referenced to +42.76 dBmV
Output Attenuator Range: 0 to 60 dB in 10 dB steps

Output Power Sweep

Range
50 Ω (Option 1DN): (–15 dBm to 0 dBm) – (source attenuator setting)
75 Ω (Option 1DQ): (+27.76 to +42.76 dBmV) – (source attenuator setting)
Resolution: 0.1 dB
Accuracy (zero span)**:** < 1.5 dB peak-to-peak
Output Flatness (referenced to 50 MHz, 0 dB attenuator)
9 kHz to 10 MHz (50 Ω) and 1 MHz to 10 MHz (75 Ω): ± 2 dB
10 MHz to 1.5 GHz: ± 1.5 dB
Spurious Outputs
50 Ω (Option 1DN), 0 dBm output, 9 kHz to 1.5 GHz;
75 Ω (Option 1DQ), +42.76 dBmV output, 1 MHz to 1.5 GHz
Harmonic Spurs: < –25 dBc
Non-Harmonic Spurs: < –35 dBc
Dynamic Range
50 Ω (Option 1DN):
400 kHz to 1 MHz: ≥ 118 dB
1 MHz to 500 MHz: ≥ 120 dB
500 MHz to 1.2 GHz: ≥ 116 dB
1.2 GHz to 1.5 GHz: ≥ 113 dB
75 Ω (Option 1DQ):
1 MHz to 500 MHz: ≥ 107.76 dB
500 MHz to 1 GHz: ≥ 103.76 dB
1 GHz to 1.5 GHz: ≥ 97.76 dB
Output Tracking
Drift: No error
Swept Tracking Error: No error for coupled sweep times
Output VSWR: < 2.5:1, characteristic

General

Temperature Range
Operating: 0 °C to + 55° C
Storage: –40 °C to + 75° C
Audible Noise (ISO 7779)
Sound pressure at 25° C: < 33 dB (< 4.8 Bels power)
Military Specification: Has been type tested to the environmental specifications of MIL-PRF-28800F Class 3
EMI Compatibility: Conducted and radiated emission is in compliance with CISPR Pub.11/1990 Group 1 Class A
Power Requirements (Uses CUKonvertor® topology in the power supply)
Voltage: 90 to 250 Vac rms
Frequency: 47 to 440 Hz
Power Consumption, On: < 200 W
Power Consumption, Standby: < 5 W
Weight (without options)
Net: 12.3 kg (27 lb), characteristic
Shipping: 25 kg (55 lb), characteristic
Dimensions
Height: 222 mm (8.75 in)
Width: 373 mm (14.7 in) w/o handle, 408 mm (16.1 in) w/handle
Depth: 409 mm (16.1 in) w/o handle, 516 mm (20.3 in) w/handle

Inputs and Outputs

Internal
50 MHz oscillator
Frequency: 50 MHz
Frequency Accuracy: Frequency reference error[1]
Amplitude: –27 dBm, nominal (+24.8 dBmV, nominal for 75 Ω)

Front Panel
Input
Connector/Impedance: Type N (f), 50 ohm, nominal; BNC (f), 75 ohm, nominal (Option 1DP)
RF Out
Option 1DN, Connector/Impedance: Type N (f), 50 ohm, nominal
Option 1DP, Connector/Impedance: BNC (f), 75 Ω, nominal
Probe Power
Voltage/Current: +15 Vdc, –12.6 Vdc at 150 mA max., characteristic
Ext. Keyboard: 6-pin mini-DIN, PC keyboards
Speaker: Front-panel knob controls volume
Headphone: 3.5-mm (⅛ inch) miniature audio jack

Rear Panel
10 MHz Ref Out: BNC (f), 50 ohm, > 0 dBm, characteristic
10 MHz Ref In: BNC (f), –15 to +10 dBm, characteristic
Ext.Trig In: BNC (f), (5 V TTL)
Hi Swp Out: BNC (f), (5 V TTL)
VGA Output: VGA-compatible monitor, 15-pin mini D-SUB, (31.5 kHz horizontal, 60 Hz vertical sync rates, non-interlaced)
Analog RGB, Resolution: 640 x 480
Aux IF Out (Option A4J): BNC (f), 21.4 MHz, nominal (–10 to –70 dBm (uncorrected), characteristic
Aux Video Out (Option A4J): BNC (f), 0 to 1 V (uncorrected), characteristic
Hi Swp in (Option A4J): BNC (f), low stops sweep, (5 V TTL)
Hi Swp out (Option A4J): BNC (f), (5 V TTL)
Swp Out (Option A4J): BNC (f), 0 to +10 V ramp, characteristic
HP-IB Interface (Option A4H): IEEE-488 bus connector
Serial Interface (Option 1AX): RS-232, 9-pin D-SUB
Parallel Interface (Option A4H or 1AX): 25-pin D-SUB, printer port only

[1] Frequency reference error = (aging rate x period of time since adjustment + settability + temperature stability)

Key Literature

HP ESA-L1500A 1.5 GHz Portable Spectrum Analyzer, Product Overview p/n 5965-6309E

For more information on compatible printers, visit our web site:
http://www.hp.com/go/pcg

Ordering Information

HP ESA-L1500A (E4411A) 9 kHz to 1.5 GHz Portable Spectrum Analyzer
Opt A4H HP-IB and parallel (Centronics) interfaces (cannot combine with Option 1AX)
Opt 1AX RS-232 and parallel (Centronics) interfaces (cannot combine with Option A4H)
Opt A4J IF, Sweep, and Video Ports
Opt 1DN 50 Ohm Tracking Generator (9 kHz to 1.5 GHz)
Opt 1DP 75 Ohm Input Impedance (1 MHz to 1.5 GHz)
Opt 1DQ 75 Ohm Tracking Generator (1 MHz to 1.5 GHz) (requires Option 1DP)
Opt A5D 12 Vdc power cable
Opt 1D7 50 to 75 Ohm matching pad (type N(m) to BNC (f))
Opt UK9 Front panel protective cover
Opt 1CP Rackmount kit with handles and slides
Opt 0B1 Additional user and calibration guides
Opt 0BX Assembly level service guide and schematics
Opt UK6 Commercial calibration certificate with data
Opt 0B0 Delete manuals
Opt AXT Add transit case
Opt AYT Grey soft carrying/operating case
Opt AYU Yellow soft carrying/operating case
Opt B70 HP BenchLink Spectrum Analyzer

Accessories

HP 10833A HP-IB cable (1 meter)
HP 24542U RS-232 cable (3 meter, 9 pin F to 9 pin F) (for serial 9 pin PC connection to analyzer)
HP 24542G RS-232 cable (3 meter, 25 pin M to 9 pin F) (for serial 25 pin PC or printer connection to analyzer)
HP 24542M RS-232 cable (3 meter, 25 pin M to 9 pin F) (for serial 25 pin modem connection to analyzer)
HP 87405A Preamplifier (10 MHz to 3 GHz, 24 dB gain) (fastened to RF input, powered from analyzer)
HP 85905A 75 Ohm preamplifier (45 MHz to 1 GHz, 20 dB gain) (powered from analyzer)
HP 41800A Active probe (5 Hz to 500 MHz)
HP 85024A High frequency active probe (300 kHz to 3 GHz)
HP E1779A Snap-on battery pack
HP 34397A DC-to-AC power inverter for operating ESA-L1500A from 11 to 15 Vdc power sources such as automotive batteries

HP E4444A BenchLink Spectrum Analyzer Software

HP BenchLink Spectrum Analyzer provides an easy-to-use communications link between your PC and the HP 856x, 859x and ESA-L1500A spectrum analyzer families. HP BenchLink Spectrum Analyzer is a member of the HP BenchLink family of PC/basic instrument connectivity solutions, and takes full advantage of the Windows interface to easily transfer screen images or trace data via HP-IB or RS-232 interfaces.

HP BenchLink Spectrum Analyzer makes it easy to capture, analyze and document measurement results in your PC. HP has done all the programming for you.

You'll be able to transfer:

- Screen images–you can transfer a picture of the spectrum analyzer screen to your PC for viewing , annotation, storage, or printing. HP BenchLink Spectrum Analyzer provides convenient annotation tools, and Windows makes it easy to cut and paste your annotated image into other applications like word processing, presentation, and graphics packages or E-mail. You can also save your image in PCX, TIF, GIF, and BMP formats. You'll find documenting measurement results to be fast and simple.
- Trace data–HP BenchLink Spectrum Analyzer transfers the trace frequency/amplitude pairs of data from your spectrum analyzer to your PC for further review and analysis. Once the trace data is captured, you can use pan and zoom and trace markers in BenchLink to analyze the trace. Additionally, the frequency/amplitude pairs of trace data can be easily copied as comma-separated-values to spreadsheets or other analysis programs using files or the Windows clipboard.

The software runs on Windows 3.1, Windows 3.11, Windows 95, and Windows NT 4.0 and includes a complete context-sensitive on-line help system. System requirements are IBM PC compatible with at least 486-25 MHz processor, 8 MB ram, and 2 MB disk space available.

Ordering Information

E4444A BenchLink Spectrum Analyzer Software

Remote Operation Software

iPanels software for Windows 95/NT provides remote operation for HP8590 series spectrum analyzers (with HP-IB or RS-232 interface). The virtual HP8590 series instrument panel created on your PC monitor is easily controlled with a mouse as if you were sitting in front of the analyzer. Remote functionality through modem or LAN varies for different analyzer models and options. Contact Hamilton Software for analyzer compatibility and product details.

Hamilton Software
2270 Northpoint Parkway
Santa Rosa, CA 95407
800.704.0085
707.542.2700
http://www.hamsoft.com

- RF power: digital power meter accuracy
- Tuned RF level: 0 to –127 dBm dynamic range
- Carrier noise: AM and phase noise measurements to –140 dBc/Hz
- AM and FM: 1% accuracy; ØM: 3% accuracy
- RF frequency: 10 Hz resolution
- Audio: level, frequency, and distortion

HP 8902A

HP 8902A Measuring Receiver

The HP 8902A measuring receiver combines 6 precise measurement functions into one fully automatic, HP-IB programmable instrument. It accurately measures RF power, tuned RF level , carrier noise/adjacent channel power, modulation, and RF frequency, and it characterizes audio signals. For precise signal analysis, the HP 8902A measuring receiver provides the performance you need.

Metrology and Calibration

The HP 8902A measuring receiver makes signal generator and attenuator calibration easier than ever before. The HP 8902A provides exceptional accuracy, wide dynamic range, and a broad range of measurements.

It quickly and accurately measures your signal generator's RF frequency, RF level flatness, output level accuracy to –127 dBm, AM and FM with 1% accuracy, incidental and residual AM, FM and phase modulation, and carrier noise down to –140 dBc/Hz, and characterizes the demodulated audio signals.

For attenuator calibration and other relative measurements, the HP 8902A gives you great accuracy and dynamic range. Option 050 provides ±(0.015 db + 0.005 dB/10 dB) relative power accuracy to test attenuators to the most stringent specificaations.

RF Signal Characterization

The HP 8902A measuring receiver is an excellent lab and production tool for accurately characterizing RF signals from 150 kHz to 1300 MHz.

Level measurements down to –127 dBm with superb accuracy make the HP 8902A ideal for testing devices such as multiplexers, log/linear amplifiers, filters, and mixers. Unlike diode detectors, the HP 8902A's power meter accurately measures signals with harmonics and spurious.

The HP 8902A makes accurate AM-to-ØM and FM-to-AM conversion measurements of phase- and amplitude-sensitive devices, such as bandpass filters and multiple-channel receivers. Excellent isolation between AM and FM makes it simple to separate the AM and ØM of AM stereo, the incidental AM of FM transmitters, and the AM, FM, and ØM components of complex signals.

Automatic Test Systems

The HP 8902A is an important component of automatic RF test systems. All functions—power, level, frequency count, carrier noise, modulation, audio analysis—are fully automatic and easily programmed. With these measurements combined in one instrument, interfacing requirements, hardware costs, and software development time are reduced.

HP 8902A Specifications

RF Power (with HP 11722A Sensor Module)

Range: + 30 dBm (1W) to –20 dBm (10 μW)
Frequency Range: 0.1 MHz to 2.6 GHz
Linearity: ± 0.02 dB (within range) ± 0.02 dB per range change from reference range ± 1 count LSD
Input SWR: < 1.15

Tuned RF Level

Range: 0 to –127 dBm
Frequency Range: 2.5 to 1300 MHz
Relative Accuracy: ± 0.02 dB ± 0.02 dB per IF range change
± 0.04 dB per RF range change ± 1 digit
Worst-Case Cumulative Relative Power Accuracy (with Option 050[1,2]):
± 0.005 dB/10 dB step (0 to –100 dBm)
± 0.050 dB/10 dB step (–100 to –120 dBm)
± 0.015 dB ± 1 digit

Selective Power Measurements (Carrier Noise, Options 030 to 037)

Frequency Range: 10 to 1300 MHz
Carrier Power Range:
+ 30 dBm to –20 dBm: 12.5 kHz, 25 kHz and 30 kHz filters
± 30 dBm to –10 dBm: carrier noise filter
Relative Measurement Accuracy:
± 0.5 dB; levels > –95 dBc: 12.5 kHz, 25 kHz and 30 kHz filters
± 0.5 dB; levels > –129 dBc/Hz: carrier noise filter
Filter Bandwidths: 2.5 kHz, carrier noise filter; 8.0 kHz, 12.5 kHz filter; 16.0 kHz, 25 kHz filter; 30.0 kHz, cellular radio filter

RF Frequency

Range: 150 kHz to 1300 MHz
Maximum Resolution: 10 Hz

Amplitude Modulation

Rates: 20 Hz to 100 kHz
Depths: To 99%
Accuracy: ± 1% of reading ± 1 digit, for rates 50 Hz to 50 kHz and depths ≥ 5%

Frequency Modulation

Rates: 20 Hz to 200 kHz
Deviations: To 400 kHz
Accuracy: ± 1% of reading ± 1 digit, for rates 50 Hz to 100 kHz

Phase Modulation

Rates: 200 Hz to 20 kHz
Deviations: To 400 radians
Accuracy: ± 3% of reading ± 1 digit

Audio Level, Frequency, and Distortion Capability

Audio Level Accuracy: ± 4% of reading, 100 mV to 3 V
Audio Frequency Display Resolution: 6 digits, to 250 kHz
Audio Distortion Accuracy: ± 1 dB, 400 Hz and 1 kHz

[1] Specifications are warrented when using a Hewlett-Packard synthesized source with less than 100 Hz peak residual FM measured in a 3 kHz post-detection bandwidth over a 30-second period.
[2] Accuracy specifications do not include mismatch uncertainty.

Ordering Information

HP 8902A Measuring Receiver
- **Opt 001** Rear-Panel Instead of Front-Panel Connectors for Input, Modulation Output, and Calibrators
- **Opt 002** 1x10^{-9}/Day Internal Reference Oscillator
- **Opt 003** Rear-Panel External LO Connectors
- **Opt 004** Operation from 48 to 440 Hz Power Line (temp. < 40° C)
- **Opt 021** Add HP 11722A Sensor Module
- **Opt 030** High Selectivity (select only two filter options) Options 032 to 037 require Option 030. Option 030 includes Option 003 connections for external local oscillator.
- **Opt 032** 12.5 kHz Filter
- **Opt 033** 25.0 kHz Filter
- **Opt 035** Cellular Radio Filter
- **Opt 037** Carrier Noise Filter
- **Opt 050** Increased Power Measurement Accuracy
- **Opt 907** Front Handle Kit (5061-9690)
- **Opt 908** Rack Flange Kit (5061-9678)
- **Opt 909** Rack Flange Kit (5061-9684) with Front Handles
- **Opt 910** Additional Operation and Calibration Manual (08902-90029) and 2 Service Manuals (08902-90031)
- **Opt 915** Add Service Manual (08902-90031)
- **Opt W30** Extended Repair Service
- **Opt W32** Calibration Service

Indicates QuickShip availability.

HP 11812A

HP 11812A Verification Kit

The HP 11812A verification kit is available to verify the performance of the HP 8902A Option 050 tuned RF level function to ±(0.015 dB + 0.010 dB/10dB step). The kit consists of a step attenuator, two 10 dB pads semi-permanently attached, a cable, and a case.

HP 11812A Specifications

Frequency: 30 MHz
HP 11812A Accuracy: ± (0.003 dB + 0.003 dB/10 dB step)
Option 050 Worst-Case Cumulative Tuned RF Level Accuracy Verified with the HP 11812A:
± 0.010 dB/10dB step (0 to –100 dBm)
± 0.050 dB/10 dB step (–100 to –120 dBm)
± 0.015 dB ±1 digit

Ordering Information

HP 11812A Verification Kit

HP 11722A Sensor Module (100 kHz to 2.6 GHz)[1]

The HP11722A sensor module was designed for use with the HP 8901B modulation analyzer and the HP 8902A measuring receiver. The HP 11722A contains a silicon monolithic thermocouple as a power-sensing element.

With the HP 11722A sensor module, you get all the performance of the HP 8901B or HP 8902A, plus superb power-measurement accuracy, at a single connector. You can characterize a signal without switching back and forth between the power sensor and the analyzer's RF input.

Ordering Information

HP 11722A Sensor Module (100 kHz to 1300 MHz)

Extend the HP 8902A to Microwave with the HP 11792A and HP 11793A Converter

HP 11792A and HP 11793A

The HP 11793A microwave converter and the HP 11792A sensor module combined with an external signal generator extends the HP 8902A's measurement range into the microwave region. They allow the HP 8902A to deliver accuracy and resolution of a high performance power meter up to 26.5 GHz from +30 to –100 dBm. The extended system counts signals to 26.5 GHz with 10 Hz resolution and excellent long-term frequency stability.

HP 11793A Microwave Converter

The HP 11793A microwave converter downconverts microwave signals to the frequency range of the HP 8902A measuring receiver. For signals above 1.3 GHz, the HP 11793A routes the signal through its internal mixer. Below 1.3 GHz, signals are routed directly to the input of the HP 8902A. The HP 11793A requires an external signal generator with +8 dBm leveled output. For signal generators with insufficient power above 18 GHz, the HP 11793A offers an optional 18 to 25.5 GHz amplifier to provide the necessary mixer drive.

HP 11792A Sensor Module (50 MHz to 26.5 GHz)[1]

The HP 11792A sensor module gives you all the performance of the HP 8902S system, plus superb power-measurement accuracy, at a single connector. You can characterize a signal without manually switching between the power sensor and the receiver input.

Ordering Information

HP 8902S Measuring System
HP 11793A Microwave Downconverter
- **Opt 001** Add 18 to 26.5 GHz Amplifier
- **Opt 010** Front Right LO Input Connector
- **Opt 011** Amplifier and Front Right LO Connector
- **Opt 020** Rear-Panel Connector
- **Opt 021** Amplifier and Rear-Panel Connector
- **Opt 907** Front Handle Kit (5062-3988)
- **Opt 908** Rackmount Flange Kit (5062-3974)
- **Opt 909** Handles w/Rackmount Flange Kit (5062-3975)

HP 11792A Sensor Module (50 MHz to 26.5 GHz)[1]

For complete ordering information, see HP 8902S Measurement System Ordering Information Guide, or contact the HP Call Center in your region.

[1] Each HP 11722A and HP 11792A sensor module is individually calibrated, traceable to the U.S. National Institute of Standards and Technology. The calibration factors are printed on the sensor module for fast reference. Enter these factors into the HP 8902A's non-volatile memory and the instrument automatically compensates for the power sensor's efficiency and mismatch loss at each frequency.

- Easy-to-use, expandable, portable spectrum analyzers
- Full range of price and performance options
- One-button measurements for FFT, TOI, ACP, and more
- Expanded memory and trace-storage capability
- Optional narrow resolution bandwidths
- New custom measurement personalities

HP 8590 Series Spectrum Analyzers

The HP 8590 E-Series and 8590 L-Series spectrum analyzers offer a wide range of performance, features, and prices designed to fit your budget. Choose from low-cost, basic performance analyzers or from higher-performance models. Whatever your choice, you'll find HP 8590 series spectrum analyzers easy to use and reliable. Their expandable feature sets allow them to be easily configured to meet your growing measurement needs.

Application measurement personalities customize the analyzer for tasks such as cable TV, EMC, digital cellular radio, RF communication, noise-figure and scalar network analysis measurements (see page 235). You can also add a variety of printers, plotters and other accessories.

One Spectrum Analyzer for Many Applications

You can change the test capabilities of these spectrum analyzers to fit specific measurement needs. A memory card reader enables you to load application measurement personalities. Complex measurement routines are reduced to a keystroke. An option cardcage, unique to the HP 8590 E-series, allows you to add circuit-card options for additional capability. Optional built-in tracking generators provide a synchronously swept signal source for stimulus-response measurements. Operating any HP 8590 series spectrum analyzer requires only minimal training.

Easy-to-Use Features

Numerous features make it easier to control measurements and to analyze the results. These spectrum analyzers have built-in, automatic calibration to ensure measurement consistency. Frequency panning lets you quickly reposition signals without repeated sweeps. The internal memory allows over 50 traces to be stored, and more can be stored on RAM cards using the memory-card reader. Time and date stamping come standard. Direct output to printer or plotter is available with either the HP-IB/parallel or the RS-232/parallel interface option. Both Hewlett-Packard and selected Epson printers are supported.

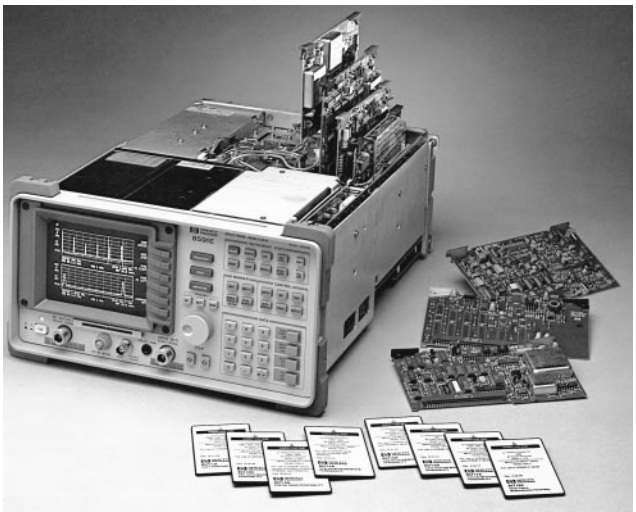
PC Software for HP 8590 Series

The new HP BenchLink Spectrum Analyzer PC software provides an easy-to-use communications link between your PC and the HP 8590 Series spectrum analyzers. Taking full advantage of the Windows interface, you can easily transfer screen images or trace data via HP-IB or RS-232 interfaces, thereby making it easy to capture, analyze, and document measurement results in a PC environment. For more information, see page 244.

HP 8591E, 8593E, 8594E, 8595E and 8596E Spectrum Analyzers

These portable spectrum analyzers bring powerful, comprehensive measurement capabilities to RF, microwave and digital applications. Five models offer a choice of frequency coverage starting at 9 kHz and extending to 26.5 GHz.

Performance specifications include low phase noise of –105 dBc at 30 kHz offset and frequency-synthesized accuracy of 2.1 kHz at 1 GHz, which can be improved to 210 Hz with an optional precision frequency reference. Second- and third-order dynamic ranges are 77 and 90 dB, respectively. Calibrated amplitude range is +30 to –130 dBm with Option 130, and calibrated onscreen display range is 70 dB. Narrow resolution bandwidths of 30, 100, 200 EMI and 300 Hz are available on an optional circuit card, which can be added to these analyzers at any time.



HP 8591E with measurement personality and circuit card options

Standard Features

A window capability divides the display into two horizontal areas, allowing you to zoom in on critical areas of a measurement trace or to display test data and the trace simultaneously. Many one-button measurements are standard, including a marker table, FFT, N dB bandwidths, third-order intercept, percent AM and adjacent-channel power. A built-in memory card reader allows you to load measurement personalities, your own custom programs and measurement data on 32-, 128-, 256-, and 512-K memory cards.

Option Flexibility

A growing number of circuit-card options provides even more measurement capability. Circuit cards are installed easily into a built-in cardcage, and most are retrofittable.

Circuit-card options include:

- Narrow resolution bandwidths of 30, 100, 200 EMI and 300 Hz
- Time-gated spectrum analysis
- "Analog+" display and fast time-domain sweeps
- AM/FM demodulator
- TV receiver/video tester
- Quasi-peak detector
- Noise-figure measurements
- Demodulators for CT2-CAI and DECT
- Digital demodulators and/or digital signal processing for GSM900, DCS-1800, PCS-1900, NADC-TDMA, PHS, CDMA and PDC wireless communication formats

A built-in 1.8 GHz tracking generator (retrofittable) is available for the HP 8591E, and a 2.9 GHz tracking generator (retrofittable) for the HP 8593E, 8594E, 8595E and 8596E. The HP 85902A burst carrier trigger provides a TTL timing reference for digital wireless communication measurements. See page 262.

HP 8590L, 8592L and 8594L Spectrum Analyzers

These models offer general-purpose RF and microwave measurement performance with frequency accuracy at a low cost. The HP 8590L has a frequency range of 9 kHz to 1.8 GHz, amplitude range of –115 to +30 dBm. The HP 8594L has a frequency range of 9 kHz to 2.9 GHz, amplitude range of –112 to +30 dBm. The HP 8592L extends the frequency range to 22/26.5 GHz.

For more information, visit our web site: **http://www.hp.com/go/8590**

HP 8590
E-Series

- One button measurement solutions
- Save time, money and training
- Customized for your application
- Easy to use

Easy-to-install measurement personalities

Measurement Personalities

Measurement personalities are software programs provided on ROM-based memory cards. They customize your HP 8590 analyzer to perform complex tests simply and quickly with the push of a button from easy-to-follow screen menus. The personalities automatically set the analyzer controls and perform calculations required by application standards, improving accuracy and repeatability.

Cable TV and Broadcast

(See page 528 for more information.)

HP 85721A Cable TV Measurements and System Monitor Personality

The HP 85721A measurement personality customizes the HP 8591C and 8590 E-series analyzers for easy, noninterfering proof-of-performance measurements on NTSC-, PAL-, or SECAM-format signals. The personality includes the capability to measure power levels for digital carriers. This software adds dedicated cable TV test functions and measurements for channel and system operation. Three video measurements as well as differential gain and phase and chrominance-to-luminance delay inequality can be performed if the spectrum analyzer has Option 107 TV receiver/video tester.

HP 85724A Broadcast Measurement Personality

The HP 85724A adds measurements for testing TV broadcast transmitters and relays. It allows selection of PAL-I/B/G, NTSC-M and SECAM-D/K systems, channel bands CCIR VHF, UHF, S, M & B, FCC-AIR and PRC and channel number. Tests include carrier level, chroma level, vision, three-tone intermodulation, depth of modulation, spurious signals, NICAM carrier power and intermodulation and FE deviation. Three video measurements as well as differential gain and phase, and chrominance-to-luminance delay inequality can be performed if the spectrum analyzer has Option 107 TV receiver/video tester.

Lightwave

(See page 428 for more information.)

HP 11982A Option 001 Lightwave Converter Personality

The HP 11982A Option 001 personality provides frequency response correction and amplitude conversion of the optical marker for lightwave signals when used with the HP 11982A amplified lightwave converter and an HP 8590 series analyzer.

Component Test

(See page 258 for more information.)

HP 85714A Scalar Measurement Personality

An HP 85714A measurement personality and HP 8590 series analyzer with optional built-in tracking generator make fast, accurate scalar transmission measurements from 100 kHz to 2.9 GHz. Features include guided calibration, pass/fail limit line testing, 120 dB display, bandwidth, Q factor, and shape factor. The HP 85630A scalar test set adds simultaneous transmission/reflection display.

HP 85719A Noise Figure Measurement Personality

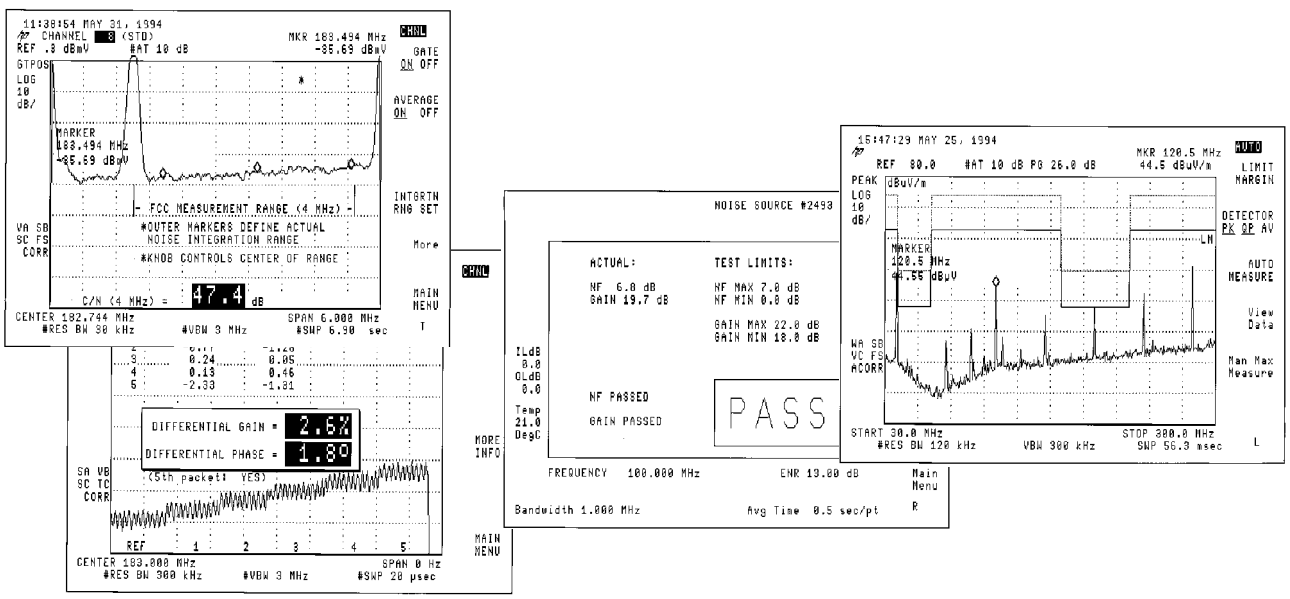
The HP 85719A noise figure measurement personality customizes an HP 8590 Option 119 E-series spectrum analyzer for displayed swept noise figure and gain measurements from 10 MHz to 2.9 GHz.

Electromagnetic Compatibility

(See page 336 for more information.)

HP 85712D EMC Auto-Measurement Personality

The HP 85712D simplifies precompliance EMI measurements. The spectrum analyzer is set up automatically with the correct limit lines, transducer factor corrections, frequency range, and bandwidths which are supplied on the personality card. It can perform automatic peak, quasi-peak, and average on up to 20 signals at a time and print the results directly, or store them to a RAM card for future viewing.



Wide selection of measurement personalities

Wireless Communications

(See page 481 for more information.)

HP 85715B GSM 900 Measurement Personality

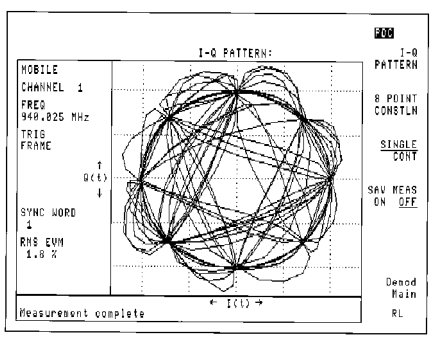
The HP 85715B provides all the GSM900 transmitter tests specified in the GSM 11.10 (mobile) and GSM 11.21 (base) recommendations. Measurements include those for power, frequency, timing and modulation accuracy. GSM Phase II specification limits are used and the extended GSM (E-GSM) frequency bands are supported.

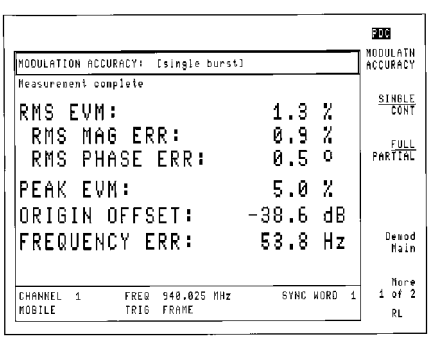
HP 85717A CT2-CAI Measurement Personality

The HP 85717A personality provides all transmitter measurements in the MPT 1375 and I-ETS 300-131 specifications for second generation cordless telephone with common air interface. In addition, it has the flexibility to allow you to define your own custom channel tuning plan and band edges as well as spurious parameters. Transmitter tests include: mean carrier power, carrier-off power, adjacent channel power, out-of-band power, spurious emissions, intermodulation attenuation and frequency error and deviation.

HP 85718B NADC-TDMA Measurement Personality

Based on EIA/TIA IS-54 and IS-136 standards, the HP 85718B simplifies testing of time-division multiple access (TDMA) transmitters for North American Dual-Mode Cellular (NADC) and PCS IS-136 radio systems. The personality provides nine power, frequency and timing tests as well as seven modulation accuracy tests.





HP 85720C PDC Measurement Personality

The HP 85720C provides transmitter measurements for Personal Digital Cellular (PDC) time-division multiple access radio systems. Tests are based on the RCR STD-27C standard. There are 11 power, frequency and timing tests as well as six modulation accuracy tests.

HP 85722B DCS1800 Measurement Personality

The HP 85722B provides all the DCS1800 transmitter tests specified in the GSM 11.10 (mobile) and GSM 11.21 (base) recommendations. Measurements include those for power, frequency, timing and modulation accuracy. Phase II specification limits are used. GSM-based PCS measurements at 1900 MHz may be made using the HP 85722B special Option H19.

HP 85723A DECT Measurement Personality

The HP 85723A adds the key DECT transmitter measurements to the HP 8590 E-series analyzers. With the measurement personality, DECT power, frequency, timing and modulation accuracy tests can be made. An optional DECT source built-in to the analyzer can be used as a stimulus for module testing or sensitivity measurements.

HP 85725C CDMA Measurement Personality

Simplify your measurements of cellular, PCS and other spread spectrum transmitters based on EIA/TIA IS-95, -97, -98 and J-STD-008 with the HP 85725C. Frequency- and time-domain measurements are provided. The new C version of this personality adds the adjacent channel power ratio (ACPR) measurement, as well as tuning plans for Japan and Korea. The HP 85725C is designed with a great amount of flexibility, including on-screen help messages, enabling measurements to be easily configured to meet your special needs.

HP 85726B PHS Measurement Personality

Measure Personal Handy Phone System (PHS) personal and cell station transmitters operate easily, quickly and reliably. The HP 85726B PHS personality provides tests based on RCR STD-28. Measurements included are antenna power, adjacent channel power, burst ramp-up and ramp-down power versus time, carrier-off time leakage power, spurious emission, occupied bandwidth and modulation accuracy (EVM).

HP 85727A GSM Multi-Band Measurement Personality

For GSM systems operating in more than one GSM band, the HP 85727A provides all the GSM transmitter tests specified in the GSM 11.10 (mobile) and GSM 11.21 (base) recommendations. Measurements include those for power, frequency, timing and modulation accuracy. GSM phase II specification limits are used and the extended GSM (E-GSM), R-GSM, DCS1800 and PCS1900 frequency bands are supported.

Digital Radio Measurements

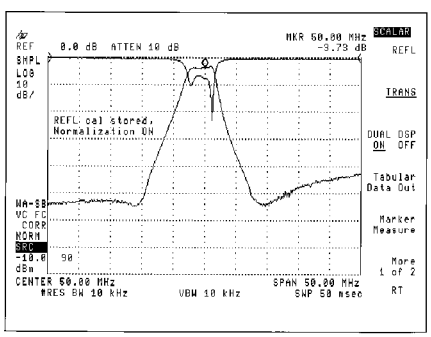
(See page 465 for more information.)

HP 85713A Digital Radio Measurement Personality

The HP 85713A measurement personality for microwave spectrum analyzers includes five major agency masks for testing to US, UK, and FRG digital radio specifications. Automatic compare-to-mask and mean power level measurements are made on the modulated signal. Functions include transient analysis monitoring and frequency response measurement. You can create and store your own masks for later use. For additional digital radio tests, see the HP 11758V digital radio test system.

HP 11770A Link Measurement Personality

The HP 11770A enables group delay and amplitude flatness measurements on systems that carry digital data, such as microwave radio systems, coax cable and satellite links. Capability includes end-to-end link, DADE, and IF return loss measurements.



HP 8591E

HP 8591E, 8593E, 8594E, 8595E, 8596E

Specifications

Specifications apply to any of these analyzers unless otherwise noted.

Frequency

Frequency Range
HP 8591E:
50 Ω: 9 kHz to 1.8 GHz
75 Ω: 1 MHz to 1.8 GHz
HP 8594E: 9 kHz to 2.9 GHz, dc-coupled; 100 kHz to 2.9 GHz, ac-coupled
HP 8595E: 9 kHz to 6.5 GHz, dc-coupled; 100 kHz to 6.5 GHz, ac-coupled

	Band	LO harmonic = N	Center frequency
HP 8596E	0	1	9 kHz to 2.9 GHz (dc-coupled)
	0	1	100 kHz to 2.9 GHz (ac-coupled)
	1	1	2.75 to 6.5 GHz
	2	2	6.0 to 12.8 GHz
HP 8593E	0	1	9 kHz to 2.9 GHz
	1	1	2.75 to 6.5 GHz
	2	2	6.0 to 12.8 GHz
	3	3	12.4 to 19.4 GHz
	4	4	19.1 to 22 GHz
	4	4 (Option 026/027)	19.1 to 26.5 GHz

Frequency Reference
Aging: ± 2 x 10^{-6}/year; ± 1 x 10^{-7}/year (Option 004)
Temperature Stability: ± 5 x 10^{-6}; ± 1 x 10^{-8} (Option 004)
Initial Achievable Accuracy: ± 0.5 x 10^{-6}; ± 2.2 x 10^{-8} (Option 004)
Frequency Readout Accuracy (start, stop, center, marker):
± (freq. readout x freq. ref error + span accuracy + 1% of span + 20% of RBW + 100 Hz x N)
Marker Count Accuracy
Span ≤ 10 MHz x N: ± (marker freq. x freq. ref error + counter resolution + 100 Hz x N)
Span > 10 MHz x N: ± (marker freq. x freq. ref error + counter resolution + 1 kHz x N)
Counter Resolution
Span ≤ 10 MHz x N: Selectable from 10 Hz to 100 kHz
Span > 10 MHz x N: Selectable from 100 Hz to 100 kHz
Frequency Span
Range: 0 Hz (zero span) and
HP 8591E: 10 kHz to 1.8 GHz; 1 kHz min (Option 130)
HP 8594E: 10 kHz to 2.9 GHz; 1 kHz min (Option 130)
HP 8595E: 10 kHz to 6.5 GHz; 1 kHz min (Option 130)
HP 8596E: [10 x N] kHz to 12.8 GHz; [1 x N] kHz min (Option 130)
HP 8593E: [10 x N] kHz to 19.25 GHz; [1 x N] kHz min (Option 130)
Resolution: Four digits or 20 Hz x N, whichever is greater
Accuracy
Span ≤ 10 MHz x N: ± 2% of span
Span > 10 MHz x N: ± 3% of span
Sweep Time
Range
Span = 0 Hz or > 1 kHz: 20 ms to 100 s
Span = 0 Hz (Option 101): 20 µs to 100 s
Accuracy
20 ms to 100 s: ± 3%
20 µs to < 20 ms (Option 101): ± 2%
Sweep Trigger: Free run, single, line, video, external
Resolution Bandwidth: 1 kHz to 3 MHz (3 dB) in 1, 3, 10 sequence; 9 kHz and 120 kHz (6 dB) EMI bandwidths. Option 130 adds 30, 100 and 300 Hz (3 dB) bandwidths and 200 Hz (6 dB) EMI bandwidth.
Accuracy: ± 20%
Selectivity (characteristic)
–60 dB/–3 dB: 3 kHz to 10 kHz, 15:1
100 kHz to 3 MHz, 15:1
1 kHz, 30 kHz, 16:1
–40 dB/–3 dB: 30 Hz to 300 Hz, 10:1
Video Bandwidth Range: 30 Hz to 1 MHz in 1, 3 sequence (1 Hz to 1 MHz with Option 130)
Stability
Noise Sidebands (1 kHz RBW, 30 Hz VBW, sample detector)
> 10 kHz offset from CW signal: ≤ –90 dBc/Hz + 20 log N
> 20 kHz offset from CW signal: ≤ –100 dBc/Hz + 20 log N
> 30 kHz offset from CW signal: ≤ –105 dBc/Hz + 20 log N
Residual FM
HP 8591E:
1 kHz RBW, 1 kHz VBW: ≤ 250 Hz pk-pk in 100 ms
30 Hz RBW, 30 Hz VBW: ≤ 30 Hz pk-pk in 300 ms
HP 8593E, 8594E, 8595E, 8596E:
1 kHz RBW, 1 kHz VBW: ≤ (250 x N) Hz pk-pk in 100 ms
30 Hz RBW, 30 Hz VBW: ≤ (30 x N) Hz pk-pk in 300 ms
System Related Sidebands (> 30 kHz offset from CW signal): ≤ –65 dBc + 20 log N
Comb Generator Frequency (HP 8593E, 8596E): 100 MHz fundamental frequency; ± 0.007% frequency accuracy

Amplitude

Amplitude Range: Displayed average noise level to +30 dBm
HP 8591 Option 001: Displayed average noise level to +72 dBmV
Maximum Safe Input Level (input attenuator ≥ 10 dB)
Average Continuous Power: +30 dBm (1 W)
HP 8591E Option 001: +72 dBmV (0.2 W)
Peak Pulse Power
HP 8591E: ± 30 dBm (1 W)
HP 8591E Option 001: +72 dBmV (0.2 W)
HP 8593E, 8594E, 8595E, 8596E: +50 dBm (100 W) for < 10 µs pulse width and < 1% duty cycle, input atten. ≥ 30 dB
DC
HP 8591E: 25 Vdc
HP 8591E Option 001: 100 Vdc
HP 8593E: 0 Vdc
HP 8594E, 8595E, 8596E: 0 V (dc-coupled); 50 V (ac-coupled)
Gain Compression (> 10 MHz): ≤ 0.5 dB (total power at input mixer = –10 dBm)

Displayed Average Noise Level (input terminated, 0 dB atten., 30 Hz VBW or 1 Hz VBW with Option 130, sample detector)

	30 Hz RBW	1 kHz RBW
HP 8591E		
400 kHz to 1 MHz	≤ –130 dBm	≤ –115 dBm
1 MHz to 1.5 GHz	≤ –130 dBm	≤ –115 dBm
1.5 GHz to 1.8 GHz	≤ –128 dBm	≤ –113 dBm
HP 8591E Option 001		
1 MHz to 1.5 GHz	≤ –78 dBmV	≤ –63 dBmV
1.5 GHz to 1.8 GHz	≤ –76 dBmV	≤ –61 dBmV
HP 8594E		
400 kHz to 5 MHz	≤ –122 dBm	≤ –107 dBm
5 MHz to 2.9 GHz	≤ –127 dBm	≤ –112 dBm
HP 8595E		
400 kHz to 2.9 GHz	≤ –125 dBm	≤ –110 dBm
2.75 to 6.5 GHz	≤ –127 dBm	≤ –112 dBm
HP 8596E		
400 kHz to 2.9 GHz	≤ –125 dBm	≤ –110 dBm
2.75 to 6.5 GHz	≤ –127 dBm	≤ –112 dBm
6.0 to 12.8 GHz	≤ –115 dBm	≤ –100 dBm
HP 8593E		
400 kHz to 2.9 GHz	≤ –127 dBm	≤ –112 dBm
2.75 to 6.5 GHz	≤ –129 dBm	≤ –114 dBm
6.0 to 12.8 GHz	≤ –117 dBm	≤ –102 dBm
12.4 to 19.4 GHz	≤ –113 dBm	≤ –98 dBm
19.1 to 22 GHz	≤ –107 dBm	≤ –92 dBm
HP 8593E Option 026/027		
19.1 to 26.5 GHz	≤ –102 dBm	≤ –87 dBm

Specifications (cont'd)

Spurious Responses
- **Second Harmonic Distortion**
- **HP 8591E** (5 MHz to 1.8 GHz): < –70 dBc for –45 dBm tone at input mixer
- **HP 8593E** (10 MHz to 2.9 GHz): < –70 dBc for –40 dBm tone at input mixer
- **HP 8594E, 8595E, 8596E** (> 10 MHz): < –70 dBc for –40 dBm tone at input mixer
- **HP 8593E, 8595E, 8596E** (> 2.75 GHz): < –100 dBc for –10 dBm tone at input mixer (or below DANL)
- **Third-Order Intermodulation**
- **HP 8591E** (5 MHz to 1.8 GHz): < –70 dBc for two –30 dBm tones at input and > 50 kHz separation
- **HP 8593E, 8594E, 8595E, 8596E** (> 10 MHz): < –70 dBc for two –30 dBm tones at input and > 50 kHz separation
- **Other Input-Related Spurious** (≥ 30 kHz offset, –20 dBm tone at input mixer)
- **HP 8591E, 8594E, 8595E, 8596E:** < – 65 dBc
- **HP 8593E:** < –65 dBc (applied frequency ≤ 18 GHz); < –60 dBc (applied frequency ≤ 22 GHz)

Residual Responses (input terminated, 0 dB attenuation)
- **1 MHz to 1.8 GHz** (HP 8591E Option 001): < –38 dBmV
- **150 kHz to 1.8 GHz** (HP 8591E): < –90 dBm
- **150 kHz to 2.9 GHz** (HP 8594E): <–90 dBm
- **150 kHz to 6.5 GHz** (HP 8593E, 8595E, 8596E): < –90 dBm

Display Range
- **Log Scale:** 0 to –70 dB from ref level is calibrated; 0.1, 0.2, 0.5 dB/div and 1 to 20 dB/div in 1 dB steps; 8 div displayed
- **Linear Scale:** 8 divisions
- **Scale Units:** dBm, dBmV, dBμV, V, W

Marker Readout Resolution
- **Log Scale:** 0.05 dB
- **Linear Scale:** 0.05% of ref level
- **Fast Time Sweep for Zero Span** (Option 101 or 301, 20 μs to 20 ms)
- **≤ 1 GHz:** 0.7% of ref level for linear scale
- **> 1 GHz:** 1.0% of ref level for linear scale

Reference Level
- **Range:** Same as amplitude range
- **Resolution:** ± 0.01 dB for log scale; ± 0.12% of ref level for linear scale
- **Accuracy:** ± 0.3 dB at –20 dBm; 0 to –59.9 dBm: ± (0.3 dB + 0.01 x dB from –20 dBm)

Frequency Response (10 dB input attenuation)
- **Absolute** (referenced to 300 MHz CAL OUT)
- **HP 8591E, 8594E:** ± 1.5 dB
- **HP 8595E:** ± 1.5 to ± 2.0 dB
- **HP 8596E:** ± 1.5 to ± 2.5 dB
- **HP 8593E:** ± 1.5 to± 5.0 dB (preselector peaked)
- **Relative Flatness** (referenced to midpoint between highest and lowest frequency response deviations)
- **HP 8591E, 8594E:** ± 1.0 dB
- **HP 8595E:** ± 1.0 to ± 1.5 dB
- **HP 8596E:** ± 1.0 to ± 2.0 dB
- **HP 8593E:** ± 1.0 to ± 2.0 dB (preselector peaked)

Calibrator Output Amplitude: –20 dBm ± 0.4 dB; + 28.75 dBmV ± 0.4 dB, HP 8591 Option 001

Resolution Bandwidth Switching Uncertainty (ref to 3 kHz RBW, at ref level)
- **3 kHz to 3 MHz RBW:** ± 0.4 dB
- **1 kHz RBW:** ± 0.5 dB
- **30 Hz to 300 Hz RBW:** ± 0.6 dB

Log to Linear Switching: ± 0.25 dB at ref level

Display Scale Fidelity
- **Log Incremental Accuracy** (0 to –60 dB from ref level): ± 0.4 dB/4 dB
- **Log Maximum Cumulative** (0 to –70 dB from ref level)
- **3 kHz to 3 MHz RBW:** ± (0.3 + 0.01 x dB from ref level)
- **30 Hz to 1 kHz RBW:** ± (0.4 + 0.01 x dB from ref level)
- **Linear Accuracy:** ± 3% of ref level

General Specifications

MIL-T-28800: Has been type-tested to the environmental specifications of MIL-T-28800 Class 5

Temperature
- **Operating:** 0° to +55° C
- **Storage:** – 40° to +75° C

EMI Compatibility: Conducted and radiated interference CISPR Pub. 11 and Messempfaenger Postverfuegung 526/527/79

Audible Noise: < 37.5 dBA pressure and < 5.0 Bels power (ISODP7779)

Power Requirements
- **On** (line 1): 90 to 132 V rms, 47 to 440 Hz
- 195 to 250 V rms, 47 to 66 Hz
- Power consumption < 500 VA; < 180 W
- **Standby** (line 0): Power consumption < 7 W

User Program Memory (nominal): 238 KB nonvolatile RAM

Data Storage (nominal)
- **Internal:** 24 traces or 32 states
- **External:** 50 traces, 8 states
- **Memory Cards:** HP 85700A (32 KB), 24 traces or 32 states; HP 85702A (128 KB), 99 traces or 128 states
- **Video Cassette Recorder** (VCR): Continuous video recording of display supported through composite video output

Size (nominal, without handle, feet, or cover): 325 mm W x 163 mm H x 427 mm D

Weight: 14.5 kg (HP 8591E); 16.4 kg (HP 8593E, 8594E, 8595E, 8596E)

Option 010 and 011 Built-In Tracking Generators

Option 010 (50 Ω) is available for all HP 8590 series spectrum analyzers except the HP 8592L. Option 011 (75 Ω) is available for the HP 8590L and 8591E only.

Frequency Range
- **Option 010:** 100 kHz to 1.8 GHz (HP 8590L, 8591E); 9 kHz to 2.9 GHz (HP 8593E, 8594E, 8595E, 8596E)
- **Option 011:** 1 MHz to 1.8 GHz (HP 8590L, 8591E)

Output Level
- **Range**
- **Option 010:** 0 to –15 dBm (HP 8590L); 0 to –70 dBm (HP 8591E); –1 to – 66 dBm (HP 8593E, 8594E, 8595E, 8596E)
- **Option 011:** +42.8 to +27.8 dBmV (HP 8590L); +42.8 to –27.2 dBmV (HP 8591E)
- **Resolution:** 0.1 dB
- **Absolute Accuracy:** ± 1.5 dB (HP 8590L); ± 1.0 dB (HP 8591E); ± 0.75 dB (HP 8593E, 8594E, 8595E, 8596E)

Vernier
- **Range:** 15 dB (HP 8590L); 10 dB (HP 8591E); 9 dB (HP 8593E, 8594E, 8595E, 8596E)
- **Accuracy:** ±1.0 dB (HP 8590L); ± 0.75 dB (HP 8591E); ± 0.5 dB (HP 8593E, 8594E, 8595E, 8596E)

Output Flatness: ± 1.75 dB (HP 8590L, 8591E); ± 2.0 dB, > 10 MHz (HP 8593E, 8594E, 8595E, 8596E)

Spurious Output
- **Harmonic Spurs:** 0 dBm +42.8 dBmV output, < –25 dBc (HP 8590L, HP 8591E); –1 dBm output, < –25 dBc (HP 8593E, 8594E, 8595E, 8596E)
- **Nonharmonic Spurs:** < –30 dBc (HP 8590L, 8591E); ≤ –27 dBc, 300 kHz to 2.0 GHz, ≤ –23 dBc, 2.0 GHz to 2.9 GHz (HP 8593E, 8594E, 8595E, 8596E)

Dynamic Range (characteristic; max. output level –TG feedthrough)
- **Option 010:** 106 dB (HP 8590L, 8591E); 106 dB (HP 8594E, > 400 kHz); 109 dB (HP 8595E, 8596E, > 400 kHz); 111 dB (HP 8593E, > 400 kHz)
- **Option 011:** 100 dB

Power Sweep
- **Range**
- **Option 010:** –15 dBm to 0 dBm (HP 8590L); –75 dBm to 0 dBm (HP 8591E); –66 dBm to –1 dBm in 8 dB increments (HP 8593E, 8594E,8595E, 8596E)
- **Option 011:** +27.8 dBmV to +42.8 dBmV (HP 8590L); –32.2 to +42.8 dBmV (HP 8591E)
- **Resolution:** 0.1 dB

HP 8590L
HP 8592L
HP 8594L

- Low-cost general purpose spectrum analysis with frequency accuracy

HP 8590L, HP 8592L and HP 8594L Specifications

Specifications apply to either analyzer unless otherwise noted.

Frequency

5

Frequency Range
HP 8590L:
50 Ω: 9 kHz to 1.8 GHz
75 Ω (Option 001): 1 MHz to 1.8 GHz
HP 8594L:
dc coupled 9 kHz to 2.9 GHz
ac coupled 100 kHz to 2.9 GHz
HP 8592L: 9 kHz to 22 GHz
HP 8592L (Option 026/027): 9 kHz to 26.5 GHz

Band	LO harmonic=N	Center frequency
0	1	9 kHz to 2.9 GHz
1	1	2.75 to 6.5 GHz
2	2	6.0 to 12.8 GHz
3	3	12.4 to 19.4 GHz
4	4	19.1 to 22.0 GHz
4	4 (Option 026/027)	19.1 to 26.5 GHz

Frequency Reference
Aging: ± 2 x 10^{-6}/year
Temperature Stability: ± 5 x 10^{-6}
Initial Achievable Accuracy: ± 0.5 x 10^{-6}
Frequency Readout Accuracy (start, stop, center, marker):
± (freq. readout x freq. ref. error + span accuracy + 1% of span + 20% of RBW + 100 Hz x N)
Marker Count Accuracy
Span ≤ 10 MHz x N: ± (marker freq. x freq. ref. error + counter resolution + 100 Hz x N)
Span > 10 MHz x N: ± (marker freq. x freq. ref. error + counter resolution + 1 kHz x N)
Counter Resolution
Span ≤ 10 MHz x N, selectable from 10 Hz to 100 kHz
Span > 10 MHz x N, selectable from 100 Hz to 100 kHz
Frequency Span
Range
HP 8590L: 0 Hz (zero span), 10 kHz to 1.8 GHz
HP 8592L: 0 Hz (zero span), [50 kHz x N] to 19.25 GHz
HP 8594L: 0 Hz (zero span), 10 kHz to 2.9 GHz
Resolution: Four digits
Accuracy:
HP 8590L: ± 3% of span
HP 8592L: Span ≤ 10 MHz x N[1] ± 2% of span; span > 10 MHz x N[1] ± 3% of span
Sweep Time
Range: 20 ms to 100 s
Accuracy: ± 3%
Sweep Trigger: Free run, single, line, video, external
Resolution Bandwidth (characteristic): 1 kHz to 3 MHz (3 dB) in 1, 3, 10 sequence, 9 kHz and 120 kHz (6 dB) EMI bandwidths
Accuracy: ± 20%
Video Bandwidth Range: 30 Hz to 1 MHz in 1, 3, 10 sequence
Stability (same as for HP 8590E series)
Noise Sidebands (1 kHz RBW, 30 Hz VBW and sample detector): ≤ –105 dBc/Hz + 20 log N at > 30 kHz offset from CW signal
System-Related Sidebands: ≤ – 65 dBc + 20 log N at > 30 kHz offset from CW signal
Comb Generator Frequency (HP 8592L): 100 MHz fundamental frequency
Accuracy: ± 0.007%

Amplitude

Amplitude Range: Displayed average noise level to +30 dBm
HP 8590L Option 001: Displayed average noise level to +75 dBmV
Maximum Safe Input Level (input attenuator ≥ 10 dB)
Average Continuous Power: +30 dBm (1 W)
HP 8590L Option 001: +75 dBmV (0.4 W)
Peak Pulse Power
HP 8590L: +30 dBm (1 W); +75 dBmV (0.4 W) (Option 001)
HP 8592L, HP 8594L: +50 dBm (100 W) for < 10 µs pulse width and < 1% duty cycle, input atten. ≥ 30 dB
DC
HP 8590L: 25 Vdc; 100 Vdc (Option 001)
HP 8592L: 0 Vdc
HP 8594L: 0 V (dc coupled); 50 V (ac coupled)
Gain Compression (> 10 MHz)**:** ≤ 0.5 dB (total power at input mixer= –10 dBm)
Displayed Average Noise Level (input terminated, 0 dB atten., 1 kHz RBW, 30 Hz VBW, sample detector)
HP 8590L: ≤ –115 to ≤ –113 dBm; ≤ –63 to ≤ –61 dBmV (Option 001)
HP 8592L: ≤ –112 to ≤ –92 dBm; ≤ –112 to ≤ –87 dBm (Option 026)
HP 8594L: ≤ –112 to ≤ –107 dBm
Spurious Responses
Second Harmonic Distortion
HP 8590L: (> 5 MHz) < –70 dBc for –45 dBm tone at input mixer
HP 8592L, HP 8594L (10 MHz to 2.9 GHz)(>10 MHz 8594L): < –70 dBc for –40 dBm tone at input mixer; > 2.75 GHz: < –100 dBc for –10 dBm tone at input mixer (or below DANL)
Third-Order Intermodulation Distortion
HP 8590L
Distortion > 5 MHz: < –70 dBc for two –30 dBm tones at input mixer and > 50 kHz separation
Other Input-Related: < –65 dBc at ≥ 30 kHz offset, for –20 dBm tone at input mixer
HP 8592L, HP 8594L
Distortion > 10 MHz: < –70 dBc for two –30 dBm tones at input mixer and > 50 kHz separation
Other Input-Related: < –65 dBc at ≥ 30 kHz offset, for –20 dBm tone at input mixer, ≤ 2.9 GHZ (8594L) or ≤ 18 GHz (8592L); < –60 dBc for –20 dBm tone at input mixer, ≤ 22 GHz (8592L)
Display Range
Log Scale: 0 to –70 dB from ref. level is calibrated; 0.1, 0.2, 0.5 dB/div. and 1 to 20 dB/div. in 1 dB steps; 8 div. displayed
Linear Scale: 8 divisions
Scale Units: dBm, dBmV, dBµV, V, W
Marker Readout Resolution: 0.05 dB for log scale; 0.05% of reference level for linear
Reference Level
Range: Same as amplitude range
Resolution: 0.01 dB for log scale; 0.12% of ref. level for linear
Accuracy: ± 0.3 dB @ –20 dBm; 0 dBm to –59.9 dBm: ± (0.3 dB + 0.01 x dB from –20 dBm)
Frequency Response (10 dB input attenuation)
Absolute (referenced to 300 MHz CAL OUT)
HP 8590L: ± 1.5 dB
HP 8592L (preselector peaked in band > 0): ± 1.5 to ± 5.0 dB
HP 89594L (dc coupled preselector peaked)**:** ± 1.5 dB
Relative: Referred to midpoint between highest and lowest frequency response deviations
HP 8590L: ± 1.0 dB
HP 8592L (preselector peaked in band > 0): ±1.0 to ± 2.0 dB
HP 8594L (dc coupled preselector peacked)**:** ± 1.0 dB
Calibrator Output Amplitude: –20 dBm ± 0.4 dB;
HP 8590L Option 001: +28.75 dBmV ± 0.4 dB
Resolution Bandwidth Switching Uncertainty (ref. to 3 kHz RBW, at ref. level): ± 0.4 dB for 3 kHz to 3 MHz RBW; ± 0.5 dB for 1 kHz
Log to Linear Switching: ± 0.25 dB at ref. level
Display Scale Fidelity
Log Incremental Accuracy: ± 0.4 dB/4 dB, 0 to –60 dB from ref. level
Log Maximum Cumulative: ± (0.4 dB + 0.01 x dB from ref. level), 0 to –70 dB from ref. level
Linear Accuracy: ± 3% of ref. level

General

Same as for HP 8590 E-series
Built-in tracking generator (see page 251)

Key Literature

HP 8590 Series Configuration Guide, p/n 5963-6858E
HP 8590 E-Series Data Sheet, p/n 5963-6909E
HP 8590 L-Series Product Overview, p/n 5962-7275E
HP 8590 Series Brochure, p/n 5963-6908E

For information on compatible printers, visit the website:
http://www.hp.com/go/pcg

Ordering Information

HP 8590L Spectrum Analyzer (9 kHz to 1.8 GHz)
HP 8592L Spectrum Analyzer (9 kHz to 22 GHz)
HP 8594L Spectrum Analyzer (9 kHz to 2.9 kHz)
Options[1]

- **Opt 001** 75 Ω Input (HP 8590L only)
- **Opt 003** Memory Card Reader
- **Opt 010** Tracking Generator (100 kHz to 1.8 GHz, HP 8590L only)
- **Opt 011** Tracking Generator (75 Ω, HP 8590L only)
- **Opt 015** Soft Tan Carrying/Operating Case
- **Opt 016** Soft Yellow Carrying/Operating Case
- **Opt 041** HP-IB and Parallel Printer Interfaces
- **Opt 043** RS-232 and Parallel Printer Interfaces
- **Opt 026** 26.5 GHz Frequency Extension, APC-3.5 mm Connector (HP 8592L only)
- **Opt 027** 26.5 GHz Frequency Extension, Type-N Connector (HP 8592L only)
- **Opt 040** Front Panel Protective Cover With Storage
- **Opt 042** Protective Soft Carrying Case/Backpack
- **Opt 711** 50/75 Ω Matching Pad/100 Vdc Block
- **Opt 0Q8** Factory Service Training
- **Opt UK6** Commercial Calibration Certificate with Test Data
- **Opt ABX** Quick Reference Guide in Local Languages
- **Opt 908** Rackmount Without Handles
- **Opt 909** Rackmount With Handles
- **Opt 910** Additional Manual Set
- **Opt 915** Component Level Information and Service Guide
- **Opt W30** Two Additional Years Return-to-HP Service
- **Opt W32** Two Additional Years Return-to-HP Calibration

HP 8591E Spectrum Analyzer, 9 kHz to 1.8 GHz
HP 8594E Spectrum Analyzer, 9 kHz to 2.9 GHz
HP 8595E Spectrum Analyzer, 9 kHz to 6.5 GHz
HP 8596E Spectrum Analyzer, 9 kHz to 12.8 GHz
HP 8593E Spectrum Analyzer, 9 kHz to 22 GHz

Options[1]

- **Opt 001** 75 Ω Input (HP 8591E only)
- **Opt 004** Precision Frequency Reference
- **Opt 009** LO and Sweep + Tune
- **Opt 010** Tracking Generator (100 kHz to 1.8 GHz, HP 8591E only)
- **Opt 010** Tracking Generator (9 kHz to 2.9 GHz)
- **Opt 011** Tracking Generator (75 Ω, HP 8591E only)
- **Opt 012** Source for DECT Receiver Test
- **Opt 015** Soft Tan Carrying/Operating Case
- **Opt 016** Soft Yellow Carrying/Operating Case
- **Opt 026** 26.5 GHz Frequency Extension, APC-3.5 mm Connector (HP 8593E only)
- **Opt 027** 26.5 GHz Frequency Extension, Type-N Connector (HP 8593E only)
- **Opt 040** Front Panel Protective Cover With Storage
- **Opt 041** HP-IB and Parallel Printer Interfaces
- **Opt 042** Protective Soft Carrying Case/Backpack
- **Opt 043** RS-232 and Parallel Printer Interfaces
- **Opt 050** Improved Amplitude Accuracy (NADC-TDMA bands)
- **Opt 051** Improved Amplitude Accuracy for PDC Bands
- **Opt 052** Improved Amplitude Accuracy for PHS Band
- **Opt 053** Improved Amplitude Accuracy for CDMA Bands
- **Opt 101** Fast Time-Domain Sweeps and Analog+ Display
- **Opt 102** AM/FM Demodulator and TV Sync Trigger (TV Sync requires Option 101)
- **Opt 103** Quasi-Peak Detector, AM/FM Demodulator
- **Opt 105** Time-Gated Spectrum Analysis
- **Opt 107** TV Receiver Video Tester
- **Opt 110** CT2 Demodulator
- **Opt 111** Group Delay and Amplitude Flatness[4] (HP 8593/4/5/6E only) (Requires HP 11770A Link Measurement Personality)
- **Opt 112** DECT Demodulator
- **Opt 119** Noise Figure
- **Opt 130** Narrow Resolution Bandwidths (30 to 300 Hz and 200 Hz EMI)
- **Opt 140** Narrow Bandwidths and Precision Frequency Reference
- **Opt 151** DSP, FAST ADC, and Digital Demodulator
- **Opt 160** PDC, PHS, NADC, and CDMA Firmware for Option 151
- **Opt 163** GSM900/DCS1800 Firmware for Option 151
- **Opt 180** TV Picture NTSC/PAL/SECAM
- **Opt 301** TV Sync Trigger, Fast Time-Domain Sweeps, AM/FM Demodulator, Analog+ Display
- **Opt 711** 50/75 Ω Matching Pad/100 Vdc Block
- **Opt 0Q8** Factory Service Training
- **Opt BD0** Code Division Multiple Access
- **Opt BD1** Global System for Mobile Communication
- **Opt BD2** North American Digital Cellular System
- **Opt BD3** Pacific Digital Cellular System
- **Opt BD4** Personal Handyphone System
- **Opt B70** HP BenchLink Spectrum Analyzer s/w
- **Opt UK6** Commercial Calibration Certificate with Test Data
- **Opt ABX** Quick Reference Guide in Local Languages
- **Opt W30** Two Additional Years Return-to-HP Service
- **Opt W32** Two Additional Years Return-to-HP Calibration

Application Measurement Cards/Personalities[2,3]
HP 11770A Link Measurement Personality
HP 85700A Blank 32-KB Memory Card
HP 85702A Blank 128-KB Memory Card
HP 85704A Blank 256-KB Memory Card
HP 85705A Blank 512-KB Memory Card
HP 85712D EMC Measurement Personality
HP 85713A Digital Radio Measurement Personality
HP 85714A Scalar Measurement Personality
HP 85715B GSM900 Measurement Personality
HP 85717A CT2-CAI Measurement Personality
HP 85718B NADC-TDMA Measurement Personality
HP 85719A Noise-Figure Measurement Personality
HP 85720C PDC Measurement Personality
HP 85721A Cable TV Measurement Personality
HP 85722B DCS1800 Measurement Personality
HP 85723A DECT Measurement Personality
HP 85724A Broadcast Measurement Personality
HP 85725C CDMA Measurement Personality
HP 85726B PHS Measurement Personality
HP 85727A GSM Multi-band Measurement Personality

Accessories
HP 10833A HP-IB Cable (1 m)
HP 24542U RS-232 Cable 3 Meter (9 Pin F to 9 Pin F) Option 043 Only (for RS-232 9 Pin PC Connection to Analyzer)
HP 24542G RS-232 Cable 3 Meter (25 Pin M to 9 Pin F) Option 043 Only (for RS-232 25 Pin PC or Printer Connection to Analyzer)
HP C2932A RS-232 Cable 3 Meter (9 Pin M to 9 Pin F) Option 043 Only (for Serial 9 Pin LaserJet 4P/4Plus Connection to Analyzer)
HP C2950A HP IEEE-1284 A-B Parallel Cable (2 m)

[1] Most options can be retrofitted. Please contact your local HP sales representative.
[2] Some measurement personalities are not supported by all HP 8590 series models. For complete information, please contact the HP Call Center in your region.
[3] HP 8590L series requires Option 003 memory card reader.
[4] HP 11770A required.

HP 8560 E-Series

- Continuous 30 Hz to 2.9, 6.5, 13.2, 26.5, 40, or 50 GHz sweeps
- Resolution bandwidths of 1 Hz to 100 Hz digitally implemented for measurement speed
- Low phase noise and wide dynamic range
- Precision timebase and 1 Hz counter resolution
- Adjacent channel power, channel power, carrier power and gated video measurements standard
- MIL-T-28800 rugged

HP 8563E

HP 8560 E-Series Spectrum Analyzers

The HP 8560 E-series portable spectrum analyzers offer the measurement capabilities and performance traditionally found only in larger, more expensive benchtop analyzers. These spectrum analyzers combine outstanding phase noise, sensitivity, 1 Hz resolution bandwidths and wide dynamic range in a MIL-rugged package built to withstand harsh environmental conditions.

Capabilities for RF Communications

The ability to measure adjacent-channel power (ACP) on today's wireless telephones, pagers and other transmitters is critical in both R&D and manufacturing. The HP 8560 E-series spectrum analyzers offer a complete solution for ACP testing of burst carrier signals using digital modulation such as is used in NADC-TDMA, GSM, DECT, CT2-CAI, PDC and PHS systems. Many of the implementation difficulties of the established standards have been addressed, providing fast, accurate and easy-to-use ACP measurement capability. Measure W-CDMA adjacent channel power ratio (ACPR) with a dynamic range of at least 70 dB using the HP 8563E Option E35 ACPR Test Set.

Another standard feature is the ability to measure from .10 to 99.99 percent occupied bandwidth.

Time-gated signal analysis is another standard feature that allows you to easily measure time-varying signals such as pulsed RF, time-division multiple access, interleaved and burst-modulated. The HP 85902A burst carrier trigger can supply a TTL trigger signal.

HP 8560 E-series specifications have been enhanced. Now, you can get better phase noise, sensitivity, dynamic range and frequency response from this high performance portable spectrum analyzer family.

The new HP 8562E spectrum analyzer provides a 13.2 GHz frequency range with increased dynamic range and third-order intercept (TOI) capability. This allows wireless-communication engineers to test high-performance components in burst operation systems.

With the HP 85672A spurious response measurements utility, you can use HP 8560 E-series spectrum analyzers to make fast and easy spurious response tests.

For more information on RF communications measurement capabilities, refer to page 486.

Fast Digital Resolution Bandwidths

Digitally-implemented resolution bandwidths of 1, 3, 10, 30 and100 Hz allow the HP 8560 E-series spectrum analyzers to sweep from 3 to 600 times faster than is possible with comparable analog filters. A narrow 5:1 shape factor allows you to view close-in, low-level signals easily. Digital bandwidths also provide the spectrum analyzer with a full 100 dB on-screen calibrated display.

PC Software for HP 8560 Series

The new HP BenchLink Spectrum Analyzer PC software provides an easy-to-use communications link between your PC and the HP 8560 Series spectrum analyzers. Taking full advantage of the Windows interface, you can easily transfer screen images or trace data via the HP-IB interface, thereby making it easy to capture, analyze and document measurement results your PC. For more information, see page 244.

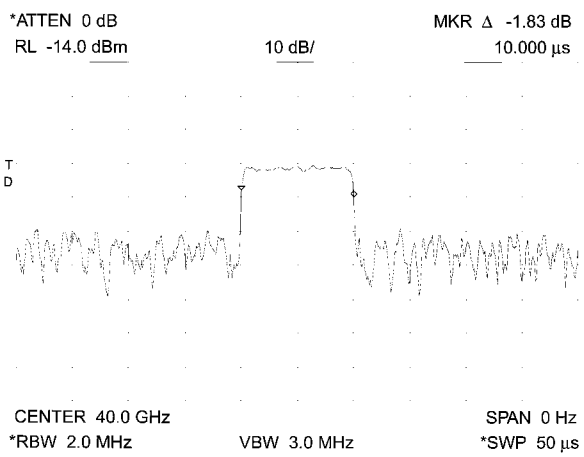
Precision Frequency and Amplitude

Measure frequencies accurately using the built-in frequency counter. A standard precision frequency reference, with an aging rate of 1×10^{-7} per year, and 1 Hz counter resolution provide confidence in measurement accuracy. At 1 GHz, frequency accuracy of ±135 Hz after a 15-minute warmup is achieved.

Amplitude measurement uncertainty can be reduced using the amplitude correction (AMPCOR) feature. AMPCOR allows you to enter up to 200 amplitude correction points to compensate for sources of amplitude uncertainty, such as cable losses, preamplifier gain and spectrum analyzer frequency response. After developing a table of correction data, amplitudes that have been referenced to a power meter can be read directly on the spectrum analyzer display.

Digitized, Fast Time-Domain Sweeps

Add digitization to fast time-domain (zero span) sweeps with Option 007. Use markers, trace math, trace storage and get hardcopy output, for measurements such as rise/fall times, pulse widths and time between events.



With Option 007 markers can be used even with the fastest time-domain (zero-span) sweep times.

HP 8560E and 8561E RF Spectrum Analyzers

The HP 8560E and 8561E offer excellent performance for RF design, manufacturing and service applications. The HP 8560E has a frequency range of 30 Hz to 2.9 GHz, and the HP 8561E extends this range up to 6.5 GHz. Both have synthesized tuning for drift-free accurate measurements.

HP 8562E RF Spectrum Analyzer

The HP 8562E is a high-performance spectrum analyzer that provides the frequency and dynamic range needed for today's high-speed digital wireless communication applications. It allows manufacturing and R&D engineers to test network components with state-of-the-art performance. The HP 8562E has a frequency range of 30 Hz to 13.2 GHz, which covers the spur-search ranges specified by leading standards organizations in Europe and in the United States.

HP 8563E Microwave Spectrum Analyzer

The HP 8563E extends the outstanding features and capabilities of the HP 8560 E-series RF spectrum analyzers into the microwave frequency range. The HP 8563E has a standard frequency range of 9 kHz to 26.5 GHz (preselected from 2.75 GHz to 26.5 GHz), with optional low-end frequency coverage to 30 Hz. The image-enhanced, double-balanced harmonic mixer of the HP 8563E achieves noise-figure performance similar to that of a fundamentally-mixed front end.

HP 8564E and 8565E Millimeter Spectrum Analyzers

Whether you want to measure the third harmonic of a 15 GHz oscillator or the noise sidebands of a 38 GHz carrier, the HP 8564E and 8565E make spectrum analysis easier than ever before. A single coaxial connection is all you need to measure signals from 30 Hz to 50 GHz. Preselection minimizes images and multiple responses at higher frequencies.

The HP 8564E has a frequency range of 9 kHz to 40 GHz, the HP 8565E of 9 kHz to 50 GHz. Both have optional low-end coverage to 30 Hz and are preselected above 2.75 GHz.

HP 8563E E35 Adjacent Channel Power Ratio Test Set NEW

Use the special option E35 with the HP 8561E/62E/63E/64E/65E spectrum analyzers to increase the dynamic range of adjacent channel power measurements. Option E35 uses an alternate first converter mixer with custom filtering to increase the spectrum analyzer's ACPR measurement dynamic range to at least 70 dB for systems with a guard band between channels of 900 kHz or greater. This meets the needs of emerging W-CDMA specifications. Control menus are integrated into the spectrum analyzer soft keys making the test set easy to use.

HP 11970 Series and 11974 Series Millimeter Mixers

For millimeter-wave measurements [1], preselection can be extended to 75 GHz using the HP 11974 mixers. Unpreselected frequency range can be extended to 110 GHz using the HP 11970 series mixers, and to 325 GHz using mixers from other manufacturers.

HP 85620A Mass Memory Module

This standard plug-in module adds measurement personality capability, enough memory to store 100 traces, memory-card capability and computer capability without an external controller. Create complex measurement routines and save them as single-key measurements stored on memory cards or in the module's 128 KB of battery-backed RAM. A clock/calendar and automatic save and execute functions let you configure the spectrum analyzer for unattended, automatic measurements.

HP 85629B Test and Adjustment Module

This accessory for the HP 8560E, 8561E, and 8563E (limited use on HP 8562E/64E) makes it easier to service your spectrum analyzer. The module plugs into the rear panel of the instrument and automates high-level diagnostics, self tests and adjustment procedures. It performs more than 1,000 troubleshooting adjustments. Readjustments are fast and accurate because the module controls internal analyzer settings as well as external test equipment.

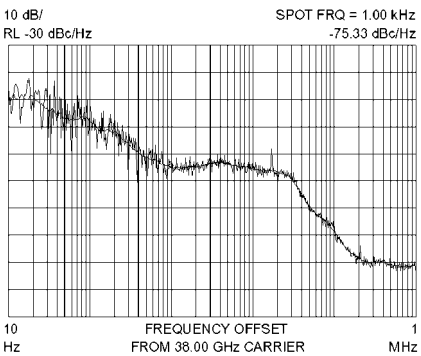
HP 85710A Digital Radio Measurement Personality

The HP 85710A Digital Radio Measurement Personality customizes the HP 8560 E-series spectrum analyzers for digital radio measurements. It contains five agency masks for testing to U.S. FCC, U.K. and FRG specifications. A compare-to-mask function allows you to characterize spectral emissions. Other functions include mean power level, transient analysis monitoring and frequency-response measurements. You can also create and store your own custom masks.

[1] Millimeter-wave coverage is not available with Option 002 on the HP 8560E.

HP 85671A Phase Noise Measurement Utility

This downloadable program transforms your HP 8560 Series spectrum analyzer into a phase noise tester. It eliminates the task of hand-drawing phase noise plots. To measure oscillator phase noise, you can generate graphs of phase noise (dBc/Hz) versus log offset frequency without having to manually tune to multiple frequency offsets. Other productivity features include direct phase noise readout, variable filtering (for controlling trade-offs between measurement repeatability and speed), calculation of RMS noise (displayed in radians and degrees), spot-frequency measurements (phase noise measurements at a single offset frequency) and digitized hardcopy and storage.



Use the HP 85671A phase noise utility to easily characterize noise sidebands of an oscillator.

HP 85672A Spurious Response Measurements Utility

The HP 85672A is a downloadable program on a card that inserts directly into any HP 8560 E-series spectrum analyzer. This new test utility provides fast and easy spurious response test capability for all of HP's high-performance spectrum analyzers. Test setup time can be drastically reduced for manufacturing and R & D engineers with this one-button solution. HP 85672A offers five preprogrammed tests: third-order intermodulation product/third order intercept (TOI), harmonics and total-harmonic distortion (THD), discrete sideband spurs, general-spur search and mixing products.

Scalar Network Analysis Capability

The HP 85640A tracking generator and the optional built-in tracking generator for the HP 8560E both cover 300 kHz to 2.9 GHz . See page 258 for details.

Specifications

Frequency

Frequency Range (internal mixing)
HP 8560E: 30 Hz to 2.9 GHz
HP 8561E: 30 Hz to 6.5 GHz
HP 8562E: 30 Hz to 13.2 GHz
HP 8563E: 9 kHz to 26.5 GHz; 30 Hz to 26.5 GHz (Option 006)
HP 8564E: 9 kHz to 40 GHz; 30 Hz to 40 GHz (Option 006)
HP 8565E: 9 kHz to 50 GHz; 30 Hz to 50 GHz (Option 006)

Frequency Range (external mixing): 18 GHz to 325 GHz in 12 waveguide bands (not available with HP 8560E Option 002)

Frequency Reference Accuracy		Option 103
Temperature Stability	$\pm 1 \times 10^{-8}$	$\pm 1 \times 10^{-6}$
Aging (per year)	$\pm 1 \times 10^{-7}$	$\pm 2 \times 10^{-6}$
Setability	$\pm 1 \times 10^{-8}$	$\pm 1 \times 10^{-6}$
	$\pm 2.2 \times 10^{-8}$ (8562E)	

Warmup (nominal), 5 minute $\pm 1 \times 10^{-7}$; 15 minute $\pm 1 \times 10^{-8}$
Frequency Readout Accuracy (N = LO Harmonic))
Span > 2 MHz x N: ± (freq. readout x freq. ref. accuracy + 5% x span +15% x RBW +10 Hz)
Span ≤ 2 MHz x N: ± (freq. readout x freq. ref. accuracy +1% x span +15% x RBW +10 Hz)

For more information, visit our web site: **http://www.hp.com/go/8560**

Marker Count Accuracy (S/N ≥ 25 dB): ± (marker freq. x freq. ref. accuracy +2 Hz x N +1 LSD)
Counter Resolution: Selectable from 1 Hz to 1 MHz
Frequency Span
Range: 0 Hz, 100 Hz to maximum frequency
Sweep Time
Range
Span = 0 Hz: 50 µs to 6,000 s
Span ≥ 100 Hz: 50 ms to 100 ks
Accuracy (span = 0 Hz)
Sweep Time > 30 ms: ± 1% digital
Sweep Time < 30 ms: ± 10% analog; ± 0.1% digital (Option 007)
Sweep Trigger: Delayed, free run, single, line, video, external
Resolution Bandwidth
Range (–3 dB): 1 Hz to 1 MHz in a 1, 3, 10 sequence and 2 MHz
Accuracy
1 Hz to 300 kHz: ± 10%; 1 MHz: ± 25%; 2 MHz: +50%, –25%
Selectivity (–60 dB/–3 dB)
RBW≥ 300 Hz: < 15:1; RBW ≤ 100 Hz: < 5:1
Video Bandwidth Range: 1 Hz to 3 MHz in a 1, 3, 10 sequence

Noise Sidebands (center frequency ≤ 1 GHz)

Offset	Non-Option 103	Option 103
100 Hz	< –88 dBc/Hz	< –70 dBc/Hz
1 kHz	< –97 dBc/Hz	< –90 dBc/Hz
10 kHz	< –113 dBc/Hz	< –113 dBc/Hz
100 kHz	< –117 dBc/Hz	< –117 dBc/Hz

Residual FM (zero span): < 1 Hz p-p in 20 ms; < 0.25 Hz p-p in 20 ms (nominal); < 10 Hz p-p in 20 µs (Option 103)

Amplitude

Range: Displayed average noise level to +30 dBm
Maximum Safe Input Level
Average Continuous Power: +30 dBm (1W, input atten. ≥ 10 dB)
Peak Pulse Power (< 10 µs pulse width and < 1% duty cycle): +50 dBm (100 W, input atten. ≥ 30 dB)
DC Volts: < ± 0.2 V (dc-coupled); < ± 50 V (ac-coupled, HP 8560E, HP 8561E and HP 8562E only)
1 dB Gain Compression
10 MHz to 2.9 GHz: mixer level ≤ –5 dBm
2.9 to 6.5 GHz (HP 8561E): mixer level ≤ –3 dBm
2.9 to 6.5 GHz (HP 8562E/63E/64E/65E): mixer level ≤ 0 dBm
> 6.5 GHz: ≤ –3 dBm (HP 8562E/63E); ≤ 0 dBm (HP 8564E/65E)

Displayed Average Noise Level (0 dB input atten., 1 Hz RBW [1])

Frequency	HP 8560E/61E	HP 8562E	HP 8563E	HP 8564E/65E
30 Hz	–90 dBm	–90 dBm	–90 dBm	–90 dBm
1 kHz	–105 dBm	–105 dBm	–105 dBm	–105 dBm
10 kHz	–120 dBm	–120 dBm	–120 dBm	–120 dBm
100 kHz	–120 dBm	–120 dBm	–120 dBm	–120 dBm
1 to 10 MHz	–140 dBm	–140 dBm	–140 dBm	–140 dBm
10 MHz to 2.9 GHz	–151 dBm[8]	–151 dBm	–149 dBm	–145 dBm
2.9 to 6.5 GHz	–145 dBm[2]	–148 dBm	–148 dBm	–147 dBm
6.5 to 13.2 GHz	—	–145 dBm	–145 dBm	–143 dBm
13.2 to 22.0 GHz	—	—	–140 dBm	–140 dBm
22.0 to 26.5 GHz	—	—	–139 dBm	–136 dBm
26.5 to 31.15 GHz	—	—	—	–139 dBm
31.15 to 40.0 GHz	—	—	—	–130 dBm
40.0 to 50.0 GHz	—	—	—	–127 dBm[3]

[1] 10 Hz RBW (Min. RBW with Option 103) add 10 dB to noise floor
[2] HP 8561E only
[3] HP 8565E only
[4] HP 8563E/64E/65E only
[5] HP 8563E only
[6] HP 8564E/65E only
[7] Except HP 8561E
[8] For HP 8561E: –145 dBm
[9] TOI reference to single tone

Spurious Responses	Mixer Level	Distortion
General Spurious	–40 dBm	< (–75+20 log N) dBc
Second Harmonic Dist.		
20 MHz to 1.45 GHz [7]	–40 dBm	<–79 dBc
1 MHz to 1.45 GHz	–40 dBm	< –72 dBc
1.45 GHz to 3.25 GHz [2]	–20 dBm	< –72 dBc
1.45 GHz to 2.0 GHz [4]	–10 dBm	< –85 dBc
2 GHz to 6.6 GHz [7]	–10 dBm	<–100 dBc
2.0 GHz to 13.25 GHz [5]	–10 dBm	< –100 dBc
2.0 to 20 GHz [6]	–10 dBm	< –90 dBc
20 GHz to 25 GHz [3]	–10 dBm	< –90 dBc
3rd Order Intermodulation [9]		
20 MHz to 2.9 GHz [7]	–30 dBm	< –82 dBc
1 MHz to 2.9 GHz	–30 dBm	< –78 dBc
2.9 GHz to 6.5 GHz	–30 dBm	< –90 dBc
6.5 GHz to 26.5 GHz	–30 dBm	< –75 dBc
26.5 GHz to 40 GHz [6]	–30 dBm	< –85 dBc (nominal)
40 GHz to 50 GHz [3]	–30 dBm	≤ –85 dBc (nominal)
Images		
10 MHz to 26.5 GHz	–10 dBm	< –80 dBc
26.5 GHz to 50 GHz	–30 dBm	< –60 dBc
Multiples and Out-of-Band Responses		
10 MHz to 26.5 GHz	–10 dBm	< –80 dBc
26.5 GHz to 50 GHz	–30 dBm	< –55 dBc

Residual Responses (> 200 kHz, N=1): < –90 dBm
Display: Viewing area — Approx. 7 cm (V) x 9 cm (H)
Scale calibration — 10 x 10 divisions
Log scale — 10, 5, 2, 1 dB per division
Linear scale — 10% of ref. level per division

Display Scale Fidelity
Log: ± 0.1 dB/dB to a maximum of ± 0.85 dB, 0 to –90 dB; maximum of ± 1.5 dB, 0 to –100 dB (RBW ≤ 100 Hz)
Linear: ± 3% of reference level
Reference Level Range: Log = –120 to +30 dBm in 0.1 dB steps; Linear = 2.2 µV to 7.07 V in 1% steps

Frequency Response, Relative (10 dB input atten.)

Frequency	HP 8560E	HP 8561E	HP 8562E	HP 8563E	HP 8564E/65E
100 MHz to 2.0 GHz	± 0.7 dB	± 1.0 dB	± 0.9 dB	± 1.0 dB	± 0.9 dB
30 Hz to 2.9 GHz	± 1.0 dB	± 1.0 dB	± 1.25 dB	± 1.25 dB	± 1.0 dB
2.9 GHz to 6.5 GHz	—	± 1.5 dB	± 1.5 dB	± 1.5 dB	± 1.7 dB
6.5 GHz to 13.2 GHz	—	—	± 2.2 dB	± 2.2 dB	± 2.6 dB
13.2 GHz to 22.0 GHz	—	—	—	± 2.5 dB	± 2.5 dB
22.0 GHz to 26.5 GHz	—	—	—	± 3.3 dB	± 3.3 dB
26.5 GHz to 31.15 GHz	—	—	—	—	± 3.1 dB
31.15 GHz to 40.0 GHz	—	—	—	—	± 2.6 dB
40.0 GHz to 50.0 GHz	—	—	—	—	± 3.2 dB[3]

Calibrator Output: 300 MHz x (1 ± freq. ref. acc'y), –10 dBm: < ± 0.3 dB
Input Attenuator
Range
HP 8560E/61E/62E/63E: 0 to 70 dB in 10 dB steps
HP 8564E/65E: 0 to 60 dB in 10 dB steps
Switching Uncertainty (ref. to 10 dB, 30 Hz to 2.9 GHz): < ± 0.6 dB/10 dB step, ± 1.8 dB max.
Repeatability: ± 0.1 dB (nominal)
IF Gain Uncertainty (10 dB atten., 0 to –80 dBm ref. level): < ± 1 dB
Resolution Bandwidth Switching Uncertainty: < ± 0.5 dB
Pulse Digitization Uncertainty (pulse response mode, PRF ≥ 720/sweep time, RBW ≤ 1 MHz): < 1.25 dB pk-pk (Log); < 4% of reference level pk-pk (Linear)

Time-Gated Spectrum Analysis

Gate Delay	Edge Mode	Level Mode
Range	3 µs to 65.535 ms	≤ 0.5 µs
Resolution	1 µs	

Accuracy (from gate trigger input to pos. edge of gate output): < ± 1 µs

Gate Length
Range: 1 µs to 65.535 ms
Resolution: 1 µs
Accuracy (from pos. edge to neg. edge of gate output): < ± 1 µs

Specifications (cont'd)

Delayed Sweep

Trigger Modes: Free run, line, external, video
Range: 2 µs to 65.535 µs; Option 007, Sweeptime < 30 µs; –9.9 µs to +65.535 µs; Sweeptime ≥ 30 µs, +2 µs to +65.535 µs
Resolution: 1 µs
Accuracy: ± 1 µs

Demodulation (Spectrum)

Modulation Type: AM and FM
Audio Output: Speaker and phone jack with volume control

Inputs and Outputs (All values nominal)

Front-Panel Connectors
- **RF Input** (50 Ω)
  HP 8560E/61E/62E/63E, Type-N female
  HP 8563E Option 026, APC-3.5 male
  HP 8564E/65E, 2.4-mm male
- **VSWR** (≥ 10 dB atten.): < 1.5:1 below 2.9 GHz; < 2.3:1, ≥ 2.9 GHz
- **LO Emission Level** (average with 10 dB atten.): < – 80 dBm
- **Second IF Input** (SMA female, 50 Ω)
  - **Frequency:** 310.7 MHz
  - **Full Screen Level:** –30 dBm
  - **Gain Compression:** –20 dBm
- **First LO Output** (SMA female, 50 Ω)
  - **Frequency:** 3.0 to 6.8107 GHz
  - **Amplitude:**+16.5 dBm ± 2 dB;+14.5 dBm ± 3 dB (Option 002)
- **Cal Output:** BNC female, 50 Ω
- **Probe Power:** +15 Vdc,–12.6 Vdc, and GND (150 mA maximum each)

Rear Panel Connectors
- **10 MHz Reference In/Out** (shared BNC female, 50 Ω)
  - **Output Freq. Accuracy:** 10 MHz ± (10 x MHz freq. ref. acc'y)
  - **Output Amplitude:** 0 dBm
  - **Input Amplitude:** –2 to +10 dBm
- **Video Output** (BNC, 50 Ω)
  - **Amplitude** (RBW ≥ 300 Hz): 0 to +1 V full scale
- **LO Sweep I FAV Output** (shared BNC female, 2 kΩ)
  - **Amplitude** (LO sweep): 0 to 10 V, no load
- **Blanking/Gate Output:** Shared BNC female, 50 Ω, TTL output
- **External/Gate Trigger Input** (shared BNC female, > 10 kΩ): settable to high TTL or low TTL
- **HP-IB** (IEEE-488 bus connector)
- **Interface Functions:** SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT0, C1, C28, E1
- **Interface Functions** (For HP 8562E): SH1, AH1, T6, LE0, RL1, PP1, DC1, DT1, C1, C28, TE0, SR1

General Specifications

Environmental
- **Military Specs:** Per MIL-T-28800
- **Calibration Interval:** Two years (HP 8560E/61E/62E/63E); one year (HP 8564E/65E)
- **Warmup Time:** 5 minutes in ambient conditions
- **Temperature:** –10° to +55° C (operating); –51° to +71° C (not operating)
- **Humidity:** 95% @ 40° C for five days
- **Rain Resistance:** Drip-proof at 16 liters/hour/sq. ft.
- **Altitude:** 15,000 ft. (operating); 50,000 ft. (not operating)
- **Pulse Shock** (half sine): 30 g for 11 ms duration
- **Transit Drop:** 8-inch drop on six faces and eight corners

Electromagnetic Compatibility: Conducted and radiated interference in compliance with CISPR Pub. 11 (1990). Meets MIL-STD-461C, part 4, with certain exceptions.

Power Requirements
- **115 Vac Operation:** 90 to 140 V rms, 3.2 A rms max., 47 to 440 Hz
- **230 Vac Operation:** 180 to 250 V rms, 1.8 A rms max., 47 to 66 Hz

Maximum Power Dissipation: 180 W (HP 8560E/61E/62E/63E); 260 W (HP 8564E/65E)
Audible Noise (nominal)**:** < 5.0 Bels power at room temp. (ISO DP7779)
Size (w/o handle, feet, cover)**:** 337 mm W (13 ¼ in.) x 187 mm H (7 ⅜ in.) x 461 mm D (18 ⅛ in.)
Weight (carrying, nominal)**:** 20 kg (44 lb)

Option 002 Built-in Tracking Generator (HP 8560E only)

Frequency
- **Range:** 300 kHz to 2.9 GHz
- **Accuracy** (after peaking): ± (freq. ref. accuracy x tuned freq. + 5% x span + 295 Hz)
- **Tracking Drift** (nominal): Usable in 1 kHz RBW after 5-min. warmup; usable in 300 Hz RBW after 30-min. warmup
- **Minimum RBW:** 300 Hz

Amplitude
- **Output Level:** –10 to +1 dBm; –10 to 2.8 dBm, typical
- **Resolution:** 0.1 dB
- **Accuracy** (25° C ± 10° C)
  - **Vernier:** ± 0.2 dB/dB, ± 0.5 dB max.
  - **Absolute:** ± 0.75 dB
  - **Level Flatness:** ± 2.0 dB
- **Dynamic Range:** 95 dB at 300 kHz to 1 MHz; 115 dB at 1 MHz to 2.0 GHz; 110 dB at 2.0 GHz to 2.9 GHz
- **Power Sweep:** 10 dB range, 0.1 dB resolution

Inputs/Outputs
- **RF Output** (front panel): Type-N female, 50 Ω (nominal)
- **Ext. ALC Input** (rear panel): BNC female; use with negative detector

Key Literature

HP 8560 E-Series Configuration Guide, p/n 5963-6831E
HP 8560 E-Series Brochure, p/n 5966-3559E
HP 8563E E35 Product Overview, p/n 5966-2913E
HP 8560 E-Series Technical Specifications, p/n 5965-8078E
HP 85671A Technical Data, p/n 5091-7089E
HP 85672A Product Overview, p/n 5965-1337E
HP 85710A Technical Data, p/n 5952-1452

For more information on compatible printers, visit our web site:
http://www.hp.com/go/pcg

Ordering Information

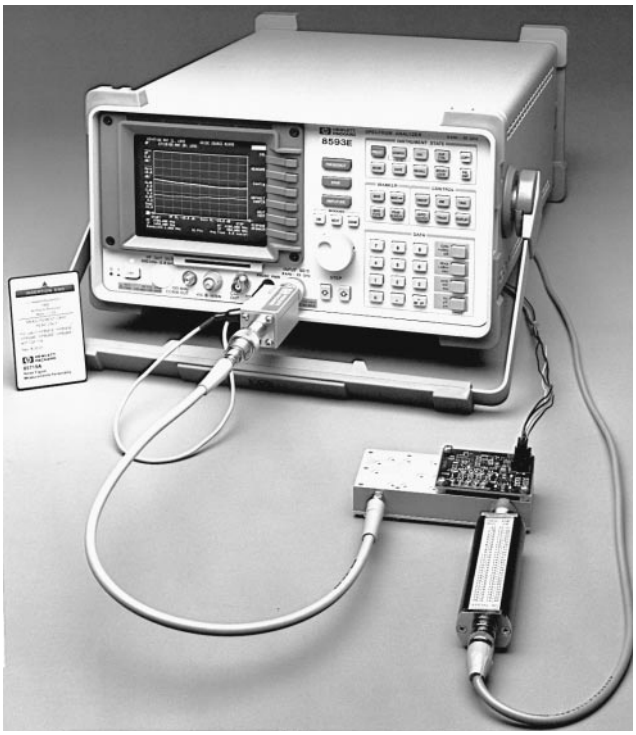
HP 8560E Spectrum Analyzer, 30 Hz to 2.9 GHz
HP 8561E Spectrum Analyzer, 30 Hz to 6.5 GHz
HP 8562E Spectrum Analyzer, 30 Hz to 13.2 GHz
HP 8563E Spectrum Analyzer, 9 kHz to 26.5 GHz
HP 8564E Spectrum Analyzer, 9 kHz to 40 GHz
HP 8565E Spectrum Analyzer, 9 kHz to 50 GHz
- **Opt 001** Second IF Output (310.7 MHz)
- **Opt 002** Built-In Tracking Generator (HP 8560E)
- **Opt 005** Alternate Sweep Out (cannot be used with Option 002)
- **Opt 006** 30 Hz to Freq. Coverage (HP8563E/64E/65E)
- **Opt 007** Digitized Fast Time-Domain Sweeps
- **Opt 008** Signal Identification
- **Opt 026** APC-3.5 mm Input Connector (HP 8563E)
- **Opt 042** Protective Soft Carrying Case/Backpack
- **Opt 0Q8** Service Training (HP 8562E)
- **Opt 103** Delete Precision Frequency Reference, and 1 Hz and 3 Hz RBWs
- **Opt 104** Delete Mass Memory Module
- **Opt 908** Rackmount Kit without Handles
- **Opt 909** Rackmount Kit with Handles
- **Opt 910** Extra Manual Set
- **Opt 915** Service Guide
- **Opt 916** Extra Quick Reference Guide (English)
- **Opt 1BN** MIL-STD-45662A Calibration (no data)
- **Opt 1BP** MIL-STD-45662A Calibration (with data)
- **Opt E35** ACPR Test Set (HP 8561E/62E/63E/64E/65E)
- **Opt UK6** Commercial Calibration (with data)

Accessories
HP 85620A Mass Memory Module
HP 85629B Test and Adjustment Module
HP 85640A Tracking Generator (300 kHz to 2.9 GHz)
HP 8449B 1 to 26.5 GHz Preamplifier
HP 83050A 2 to 50 GHz Power Preamplifier
HP 83051A 45 MHz to 50 GHz Preamplifier
HP 85700A 32 KB RAM Memory Card
HP 85702A 128 KB RAM Memory Card
HP 85671A Phase Noise Measurements Utility
HP 85672A Spurious Response Measurements Utility
HP 85710A Digital Radio Measurement Personality
HP 85901A Portable AC Power Source
HP 85902A Burst Carrier Trigger
HP 41800A Active Probe (5 Hz to 500 MHz)
HP 85024A High-Frequency Probe (300 kHz to 3 GHz)

Accessories for Noise Figure and Scalar Measurements

HP 85630A
HP 85640A
HP 85714A
HP 85719A

- Noise-figure measurement personality
- High-performance tracking sources
- Scalar measurement personality
- Scalar test set for transmission/reflection measurements



HP 85719A

HP 85630A and HP 85714A

Accessories for Noise-Figure Measurements

The HP 85719A noise-figure measurements personality adds unique capability to an HP 8590 E-series spectrum analyzer with the Option 119 noise-figure card. Combined with the HP 346B noise source and HP 87405A preamplifier, the measurement personality and spectrum analyzer provide displayed swept noise-figure and gain measurements from 10 MHz to 2.9 GHz. Features include one-point measurement capability for quick results, noise-figure and spectrum analyzer mode-switching for stray signal detection, selectable measurement bandwidths to directly measure narrowband devices, and a repeatability calculator to determine measurement time and repeatability tradeoffs.

The noise-figure personality makes use of many features found in the spectrum analyzer. For example, the save/recall functions and the memory-card reader are used to store measurement data, states, displays and ENR data tables. Marker functions make it easy to read noise-figure and gain measurements for the entire sweep, and a menu-driven interface makes the entire system easy to use.

Accessories for Scalar Network Analysis

A variety of accessories are designed to enhance HP spectrum analyzers by adding scalar measurement capability. These powerful solutions allow you to meet both your scalar-network analysis and spectrum analysis needs.

HP 85640A Portable Tracking Generator

This portable tracking generator provides the HP 8560 series spectrum analyzers with scalar measurement capability from 300 kHz to 2.9 GHz. See page 262.

HP 85714A Scalar Measurement Personality
HP 85630A Scalar Transmission/Reflection Test Set

The HP 85714A is a downloadable program that enhances an HP 8590 series spectrum analyzer and tracking generator for transmission measurements. The addition of an HP 85630A scalar test set provides the user interface with a powerful yet economical transmission/reflection measurement system.

The scalar measurement personality adds a number of useful features to the scalar/spectrum analyzer system. These include guided OPEN/SHORT and THRU calibration, pass/fail limit line testing, an enhanced 120 dB display for high, dynamic-range measurements, a tabular display format and one-button measurements for 3 or 6 dB bandwidth, insertion loss/gain, shape factor, Q, and center frequency measurements.

The scalar test set allows you to view transmission and reflection data simultaneously on the screen, so you can make adjustments on a device-under-test while monitoring the results. You can also make calibrated transmission and reflection measurements on a device using a single setup, without the usual need to recalibrate and reconfigure as with spectrum-analyzer-only systems.

Other capabilities provided by the test set include a reflection coefficient measurement marker, VSWR measurement markers, return loss measurement, automatic switching between transmission and reflection mode and source attenuation.

Ordering Information

HP 85630A Scalar Transmission/Reflection Measurement Test Set
HP 85640A Portable Tracking Generator
HP 85714A Scalar Measurement Personality
HP 85719A Noise-Figure Measurements Personality
HP 8590 E-Series Spectrum Analyzers
  Opt 119 Noise-Figure Card
HP 346B Noise Source
HP 87405A Preamplifier

- Superb performance from 100 Hz to 40 GHz
- Automated, reconfigurable systems
- HP 8566B code compatibility

HP 71209A

HP 70000 Series Spectrum Analyzers

The HP 70000 series spectrum analyzers are part of the growing modular measurement system (MMS) family at HP. Four factory-configured spectrum analyzers combine high performance, ease of use and the benefits of modularity for RF and microwave applications:

- HP 71100C/P RF spectrum analyzer, 100 Hz to 2.9 GHz
- HP 71200C/P microwave spectrum analyzer, 50 kHz to 22 GHz
- HP 71209A/P microwave spectrum analyzer, 100 Hz to 26.5 GHz, with an outstanding set of performance features
- HP 71210C/P microwave spectrum analyzer, 100 Hz to 22 GHz, with ultimate sensitivity and a dynamic tracking preselector

New "P" Series Feature PC Display

The "P" series spectrum analyzer systems replace the mainframe display with a high performance HP Vectra PC and the display software. The key features of the "P" systems are capability for output to PC printers and mass storage devices and lower system price. While performing measurements, you can copy the virtual screen and cut and paste data to spreadsheets or reports. Test data can be logged and stored in a data file limited in size only by the computer's disk capacity.

All A/C spectrum analyzers feature a color display with color editor, a custom hardkey panel with the most commonly-used spectrum-analyzer functions, downloadable programming capability and a memory card reader.

HP 71209A/P Microwave Spectrum Analyzer

The HP 71209A/P is the MMS standard for microwave spectrum analysis, offering exceptional performance for a lower price. Special features include a built-in mixer interface for completely preselected coverage from 100 Hz to 75 GHz (using HP 11974 series mixers), programming code compatibility with the HP 8566B spectrum analyzer, similar performance to that of the HP 71210C/P, an IF output with AGC, a 5 dB step attenuator and a built-in baseband limiter. Option 001 includes a preselector bypass and increases the front-end bandwidth to aid upgrading to the bandwidth receiver system.

HP 70875A Noise-Figure Measurement Personality

The HP 70875A noise-figure measurement personality customizes HP 70000 series spectrum analyzers for displayed swept noise-figure and gain measurements from 10 MHz to 26.5 GHz. Features include one-point measurement capability for quick results, noise-figure and spectrum analyzer mode switching for stray signal detection, selectable measurement bandwidths to directly measure narrowband devices and marker functions with limit lines.

Key Literature

A complete list of all MMS products with full descriptions, specifications and services is available. For a free copy of the *HP 70000 Modular Measurement System* catalog, contact the HP Call Center in your region. Ask for HP p/n 5965-2818E.

Ordering Information

HP 71100C Spectrum Analyzer, 100 Hz to 2.9 GHz
HP 71100P Spectrum Analyzer
HP 71200C Spectrum Analyzer, 50 kHz to 22 GHz
HP 71200P Spectrum Analyzer
HP 71209A Spectrum Analyzer, 100 Hz to 26.5 GHz
Opt 001 Wide Bandwidth RF Section
Opt Z40 Spectrum Analyzer, 100 Hz to 40 GHz
HP 71209P Spectrum Analyzer

HP 70000 Series Spectrum Analyzer Specification Summary

	HP 71100C HP 71100P	HP 71200C HP 71200P	HP 71209A HP 71209P	HP 71210C HP 71210P
Frequency range (tunable in 1 Hz increments)	100 Hz to 2.9 GHz (dc-coupled); 100 kHz to 2.9 GHz (ac-coupled)	50 kHz to 22 GHz	100 Hz to 26.5 GHz (100 Hz to 40 GHz Option Z40)	100 Hz to22 GHz
With external mixers	75 GHz with HP 11974 preselected mixers; 110 GHz with HP 11970 harmonic mixers; 325 GHz with other mixers			
Resolution bandwidth range	10 Hz to 300 kHz; 3 MHz option		10 Hz to 3 MHz	
Phase noise	–108 dBc/Hz at 10 kHz offset	–108 dBc/Hz at 10 kHz offset, to 6.2 GHz		
Optimum dynamic range (2nd/3rd order)	82 dB/92 dB	70 dB/88 dB	99 dB/96 dB	96 dB/98 dB
Amplitude accuracy (relative frequency + lesser of scale fidelity or IF gain accuracy)	± 2 dB (± 0.9 dB) [1]	± 2 dB (± 0.9 dB) [1]	± 2 dB (± 0.9 dB) [1]	± 2.5 dB (± 0.9 dB) [1]
Displayed average noise level, 10 Hz RBW				
at 2.9 GHz	–131 dBm	<–129 dBm	–136 dBm	–139 dBm
at 22 GHz	—	<–116 dBm	–128 dBm	–133 dBm
at 26.5 GHz	—	<–115 dBm	–126 dBm	—
Displayed average noise level with HP 70620 Series preamplifiers				
at 2.9 GHz	–156 dBm	–140 dBm	–155 dBm	–155 dBm
at 22 GHz	—	–119 dBm	–148 dBm	–150 dBm
at 26.5 GHz	—	–155 dBm	–145 dBm	—

[1] ± 0.9 dB transfer accuracy using the HP 70100A–H01 modular power meter.

HP 71910A and 71910A Option 11 configurations

HP 71910A and HP 71910P Receiver

Modular Receiver for Surveillance and Signal Monitoring

The HP 71910A/P is a receiver in the MMS format for monitoring signals from 100 Hz to 26.5 GHz. The receiver provides cost-effective combination search and wide-bandwidth collection capabilities for surveillance and signal monitoring of satellite, digital radio and radar/EW transmissions.

The wide-bandwidth receiver consists of the HP 71209A/P Option 001 spectrum analyzer plus the HP 70911A ultra-wide bandwidth IF module. System options include a preamplifier module for enhanced noise figure and smaller-size, single-mainframe configurations.

5

Search and Collection Modes of Operation

The HP 71910A/P receiver has two modes of operation: search and collection. To search for signals, the receiver relies on its fast spectrum analyzer tuning. It sweeps over user-specified spans up to 26.5 GHz wide using bandwidths up to 3 MHz. Wide dynamic range ensures that signals of various amplitudes can be quickly identified.

Once a signal is located, the receiver is fixed-tuned and the wide IF bandwidths in the HP 70911A IF module are used for signal collection. The HP 70911A provides IF bandwidths up to 100 MHz (in 10% increments) and up to 70 dB IF step gain. A linear IF signal path provides good signal fidelity with standard outputs of 321.4 MHz IF and linear video. Optional outputs include 70 and 140 MHz IF, analog I/Q and demodulated FM.

HP 71910A and HP 89410 VSA

Pulse Shape Characterization

Traditional shape measurements of pulsed microwave signals using a spectrum analyzer are significantly enhanced by the 100 MHz bandwidth. Using an oscilloscope connected to the video output, pulse rise and fall times of microwave signals are easily measured to 7 ns.

I/Q Signal Identification

The optional analog I/Q demodulator provides I and Q outputs which will produce a constellation display on an oscilloscope when the HP 71910A/P is tuned to a suitable digitally modulated signal. Sub-Hz tuning (minimum of 1 Hz resolution on-screen) allows ultrafine adjustments to compensate for phase offsets when it is not possible to phase-lockthe receiver to the source, such as in off-the-air monitoring. By stopping the spinning caused by a non-phaselocked system, modulation formats are easily identified.

HP 71910P

When more thorough analysis is required, the I and Q outputs can be connected to a dual-channel vector signal analyzer (VSA). This configuration can provide full-signal demodulation of microwave signals with double the bandwidth normally provided by the VSA alone.

Digital Demodulation and Vector Signal Analysis

Add high performance digital demodulation and vector signal analysis capability by combining the HP 71910A/P and HP 89410A VSA. Measurements such as error vector magnitude (EVM) along with constellation, eye diagram and time domain analysis as well as group delay, AM to PM and phase versus drive, for example, can be made on microwave communication signals.

System Specification Summary

Frequency Range: 100 Hz to 26.5 GHz (110 GHz with external mixers)
Noise Figure at 12 GHz: 32 dB (13 dB with preamplifier module)
TOI at 12 GHz: +2.0 dBm (without preamplifier module)
Tuning Resolution: 1 Hz
LO Phase Noise at 6 GHz: –108 dBc/Hz at 10 kHz offset
IF Bandwidths: 10 Hz to 100 MHz (continuously variable in 10% increments in most cases)
- **Spectrum Analyzer RBW:** 10 Hz to 3 MHz
- **Receiver IF Bandwidth:** 10 MHz to 100 MHz

IF Filter Type: 5-pole, synchronously tuned
Optional Filter Type: 6-pole, Chebyshev channel filters
IF Step Gain: 70 dB (in 1 dB steps)

Outputs
321.4 MHz IF
- **Bandwidth:** 10 MHz to 100 MHz (preselector bypass)
- **Bandwidth:** > 36 MHz for 2.7 to 26.5 GHz RF path (preselector ON)
- **Bandwidth:** > 48 MHz for 100 Hz to 2.9 GHz RF path

Video: AM, FM (optional), pulse (bandwidth same as 321.4 MHz IF)
- **Optional 70 MHz** IF (bandwidth ≥ 40 MHz)
- **Optional 140 MHz** IF (bandwidth ≥ 70 MHz)
- **Optional Analog I/Q** (I bandwidth ≥ 50 MHz; Q bandwidth ≥ 50 MHz)

Key Literature

MMS Catalog, p/n 5965-2818E
HP 71910A/P Wide Bandwidth Receiver, p/n 5965-7916E
HP 89410A Vector Signal Analyzer, p/n 5964-3586E

Ordering Information

HP 71910A Wide Bandwidth Receiver
HP 71910P Wide Bandwidth Receiver
- **Opt 001** 70 MHz IF Output
- **Opt 002** 140 MHz IF Output
- **Opt 004** Analog I/Q Output
- **Opt 005** FM Output
- **Opt 007** Channel Filters
- **Opt 011** Delete Display, NB IFs, PFR (71910A only)
- **Opt 016** HP 7060B Option 001 Preamplifier Module

HP 70911A Ultra-Wide Bandwidth IF Module

- Preselected mixers to eliminate signal identification
- State-of-the-art technology
- Easier automated measurements
- Low conversion loss
- Individually amplitude calibrated
- No bias or tuning adjustments
- High 100 mW safe input level

HP 11970, 11974 Series Mixers

HP 11974 Series Preselected Millimeter Mixers

Eliminate the need for signal identification at millimeter frequencies. The HP 11974 series mixers are preselected from 26.5 to 75 GHz for faster, easier testing of millimeter devices and systems. Preselection reduces mixer overload from broadband signals and reduces radiation of local oscillator harmonics back to the device-under-test. Equipment operators can quickly locate true signals, and software development for automated measurements is greatly simplified.

These mixers feature advanced barium-ferrite technology and come with a standalone power supply. They are particularly useful for broadband millimeter signal analysis, millimeter electromagnetic-interference (EMI) measurements, and unattended monitoring of millimeter signals.

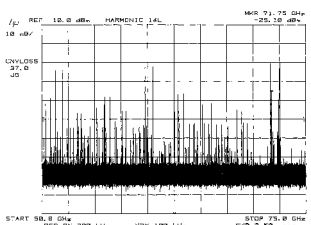
HP 11974 series preselected mixers are available in four bands

HP model	Frequency range (GHz)	Sensitivity[1] (displayed avg. noise level/10 Hz) (dBm)	Calibration accuracy[1] (dB)	Image rejection[1] (dB)	1 dB Gain compression (dBm)
11974A	26.5 to 40	–111	< ±2.3	–54	+6
11974Q	33 to 50	–106	< ±2.3	–50	+0
11974U	40 to 60	–109	< ±2.6	–50	+0
11974V	50 to 75	–100	< ±4.5	–40	+3

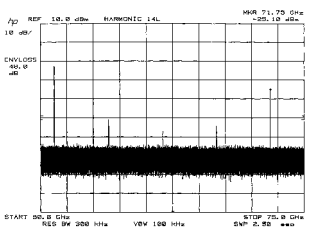
[1] Specifications apply when connected to the HP 8566B or 70000 series spectrum analyzers.

Compatibility

Upgrade kits are available to assure the compatibility of HP 8566A/B spectrum analyzers and the HP 70907A external mixer interface module. Consult your HP sales representative to determine requirements. All HP 8560 E-series spectrum analyzers and the HP 70907B external mixer interface modules are fully compatible with the HP 11974 series.



50 to 75 GHz Sweep Without Preselection



50 to 75 GHz Sweep Using HP 11974 Series Mixer

HP 11970 Series Harmonic Mixers

The HP 11970 series waveguide mixers are general-purpose harmonic mixers. They employ a dual-diode design to achieve flat-frequency response and low conversion loss. These are achieved without external dc bias or tuning stubs. Manual operation and computer-controlled hardware operation are simplified because mixer bias and tuning adjustments are not required.

HP 11970 series harmonic mixers are available in six bands

HP model	Frequency range (GHz)	LO harm number	Conversion loss (dB)	Noise level (dB) 1 kHz RBW	Freq.[1] response (dB)	Gain compression (dBm)
11970K	18 to 26.5	6+	24	–105	± 1.9	–3
11970A	26.5 to 40	8+	26	–102	± 1.9	–5
11970Q	33 to 50	10+	28	–101	± 1.9	–7
11970U	40 to 60	10+	28	–101	± 1.9	–7
11970V	50 to 75	14+	40	–92	± 2.1	–3
11970W	75 to 110	18+	47	–85	± 3.0	–1

[1] Frequency response of the mixers is reduced by 1 dB for LO range of 14 to 18 dBm.

Compatibility

The HP 11970 series mixers extend the frequency range of the HP 8560 E-series portable spectrum analyzers, of the HP 8566B spectrum analyzer (used with the HP 11975A amplifier) and of the HP 70000 modular measurement system (used with the HP 70907A/B external mixer interface modules).

HP 11970 and 11974 Series Specifications

IF Range: dc to 1.3 GHz
LO Amplitude Range: +14 dB to +16 dB; +16 dB optimum
Calibration Accuracy: +2 dB for HP 11970 series with optimum LO amplitude
Typical RF Input SWR: < 2.2:1, < 3.0:1 for HP 11974 series
Bias Requirements: None
Typical Odd-Order Harmonic Suppression: > 20 dB (does not apply to HP 11974 series)
Maximum CW RF Input Level: +20 dBm (100 mW), +25 dBm for HP 11974 series
Maximum Peak Pulse Power: 24 dBm (250 mW) with < 1 µs pulse (avg. power = +20 dBm)
Bandwidth: 100 MHz minimum (HP 11974 series only)
Environmental: Meets MIL-T-28800, Type III, Class 3, Style C
IF/LO Connectors: SMA (female)
TUNE IN Connector: BNC
LO Range: 3 to 6.1 GHz

Key Literature

HP 11970 Series Technical Data, p/n 5954-2714
HP 11974 Series Technical Data, p/n 5952-2748

Ordering Information

HP 11974A 26.5 to 40 GHz Preselected Mixer
HP 11974Q 33 to 50 GHz Preselected Mixer
HP 11974U 40 to 60 GHz Preselected Mixer
HP 11974V 50 to 75 GHz Preselected Mixer
Opt 003 Delete Power Supply (HP 11974 series only)
HP 11970K 18 to 26.5 GHz Mixer
HP 11970A 26.5 to 40 GHz Mixer
HP 11970Q 33 to 50 GHz Mixer
HP 11970U 40 to 60 GHz Mixer
HP 11970V 50 to 75 GHz Mixer
HP 11970W 75 to 110 GHz Mixer
HP 11970
Opt 009 Mixer Connection Set adds three 1-m low-loss SMA cables, wrench, Allen driver for any HP 11970 series mixer
HP 11975A 2 to 8 GHz Amplifier
HP 281A/B Coaxial to Waveguide Adapters
R281A 26.5 to 40 GHz, 2.4 mm (f)
R281B 26.5 to 40 GHz, 2.4 mm (m)
Q281A 33 to 50 GHz, 2.4 mm (f)
Q281B 33 to 50 GHz, 2.4 mm (m)

HP 85640A Portable Tracking Generator

This portable, rugged tracking generator adds scalar analysis capability from 300 kHz to 2.9 GHz to an HP 8560 series portable spectrum analyzer. Use the HP 85640A to measure gain, frequency response, compression, flatness and return loss on components and subsystems. A built-in attenuator gives output power of –80 to 0 dBm. Together, the spectrum analyzer and tracking generator have a dynamic range greater than 100 dB.

HP 85902A Burst Carrier Trigger

For performing transmitter tests, this accessory provides a TTL time reference that allows an HP 8590 A/E-series or 8560 E-series spectrum analyzer to trigger reliably off the RF signal. It has an input range of 60 dB and a separate built-in preamplifier for greater sensitivity. The HP 85902A works with all digital communication formats: NADC-TDMA, E-TDMA, PDC, GSM900, DCS-1800, PCS1900, CT2-CAI, DECT and PHS. Frequency range is 10 to 2000 MHz.

HP 85671A Phase Noise Measurement Utility

Characterize the phase noise of VCOs and varactor oscillators easily using this downloadable program with an HP 8560 series portable spectrum analyzer. It provides fast measurements of phase noise versus log offset frequency. Results are displayed graphically and can be stored in the analyzer, printed, or plotted.

HP 85672A Spurious Response Measurements Utility

This test utility provides fast and easy spurious response test capability for all of HP's high-performance spectrum analyzers. HP 85672A offers five programmed tests. These are: third-order intermodulation product/third order intercept (TOI), harmonics and total-harmonic distortion (THD), discrete sideband spurs, general-spur search and mixing products.

HP 8447 Series RF Amplifiers

These amplifiers, with a frequency range of 9 kHz to 1.3 GHz, have low noise, and wide bandwidths and improve spectrum analyzer sensitivity and noise figure while providing input isolation. See page 315.

HP 8449B, 83050A and 83051A Preamplifiers

The HP 8449B high-gain, low-noise preamplifier has a frequency range of 1 to 26.5 GHz. It increases the sensitivity of any microwave spectrum analyzer for detection and analysis of very low-level signals. Its improved sensitivity can reduce measurement time. See page 316.

The HP 83050A and HP 83051A microwave system amplifiers are compact, off-the-shelf amplifiers designed for system designers and integrators. These amplifiers provide power to recover system losses and to boost available power in RF and microwave ATE systems. The ultra broad bandwidth from 2 to 50 GHz (45 MHz to 50 GHz 83501A) allows the designer to replace several narrow bandwidth amplifiers with a single HP amplifier, eliminating the need for crossover networks or multiple bias supplies.

HP 87405A Preamplifier

The HP 87405A preamplifier has a frequency range of 0.01 to 3 GHz. Compact size, 22 to 27 dB gain, 6.5 dB noise figure and convenient probe-power bias connection make it ideal for use with a number of instruments.

HP 85901A Portable AC Power Source

This easy-to-carry power source can be used as a standalone battery for over 1 hour of operation at 100 W continuous load, or can be connected to an external 12 Vdc source for longer use. It shuts off automatically when the charge gets low, and can be recharged in six hours or less. Over-voltage, short-circuit, and overload protection on the inverter output are built in. Also included are over-voltage protection on the inverter input and over-charge and over-discharge protection on the internal battery.

HP 85629B Test and Adjustment Module

This accessory for the HP 8560E, 8561E and 8563E makes it easier to service your spectrum analyzer. The HP 85629B test and adjustment module plugs into the rear panel of the instrument and automates high-level diagnostics, self-tests and adjustment procedures. It performs more than 1,000 troubleshooting adjustments. Readjustments are fast and accurate because the module controls internal analyzer settings as well as external test equipment.

HP 11867A, 11693A and 11930B Limiters

Protect the input circuits of spectrum analyzers, counters, amplifiers and other instruments from high power levels with minimal effect on measurement performance. The HP 11867A RF limiter (dc to 1.8 GHz) reflects signals up to 10 W average power and 100 W peak power. Insertion loss is less than 0.75 dB. The HP 11693A microwave limiter (100 MHz to 12.4 GHz, usable to 18 GHz) guards against input signals over 1 mW up to 1 W average power and 10 W peak power. For information on the HP 11930 limiter, see page 293.

HP 11694A 75 Ω Matching Transformer

From 3 to 500 MHz, this transformer allows measurements in 75 Ω systems while retaining amplitude calibration with a 50 Ω spectrum analyzer input. VSWRs are less than 1.2; insertion loss is less than 0.75 dB.

HP 86205A and 86207A RF Bridges

These bridges combine the directivity and broadband frequency range of directional bridges with the low insertion loss and flat coupling factor of directional couplers. Directivity is 40 dB, and the wide RF frequency ranges are 300 kHz to 6 GHz for the 50 Ω HP 86205A and 300 kHz to 3 GHz for the 75 Ω HP 86207A. Low insertion loss is nominally ± 1.5 dB. Frequency response of the coupled arm is within ± 0.2 dB of the nominal 16 dB value. The RF bridges are ideal for use with spectrum analyzers, scalar network analyzers and vector network analyzers.

HP 41800A Active Probe

This probe offers high-input impedance from 5 Hz to 500 MHz. It works with many HP spectrum analyzers to evaluate the quality of circuits by measuring spurious level, harmonics and noise. Low-input capacitance offers probing with negligible circuit loading for precise, in-circuit measurements of audio, video, HF and VHF bands.

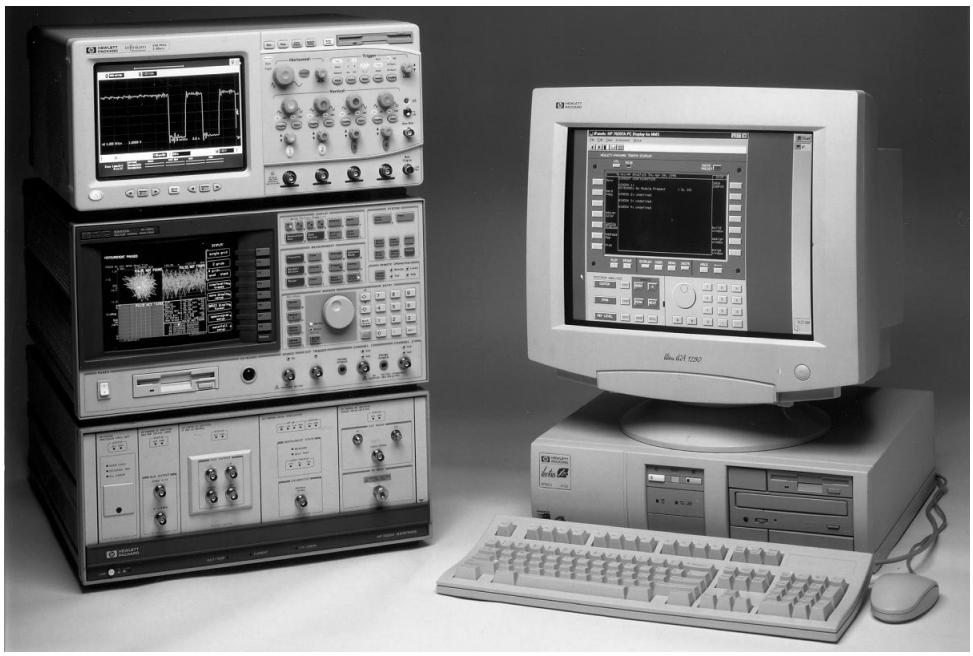
HP 85024A High-Frequency Probe

In-circuit measurements are easy with this 300 kHz to 3 GHz probe. Input capacitance of 0.7 pF shunted by 1 MΩ resistance permits high-frequency probing without adverse loading of the circuit under test. Excellent frequency response and unity gain guarantee highly-accurate swept measurements. High sensitivity and low distortion levels allow measurements that take advantage of full analyzer dynamic range. See page 290.

Ordering Information

HP 85902A Burst Signal Trigger
HP 85671A Phase Noise Measurement Utility
HP 85672A Spurious Response Measurements Utility
HP 85640A Portable Tracking Generator
HP 8444A Opt 059 Tracking Generator
HP 8447A Preamplifier (100 kHz to 400 MHz)
HP 8447D Preamplifier (100 kHz to 1.3 GHz)
HP 8447F Preamplifier-Power Amplifier (100 kHz to 1.3 GHz)
HP 8449B Preamplifier
HP 87405A Preamplifier
HP 85901A Portable AC Power Source
HP 11867A RF Limiter
HP 11693A Microwave Limiter
HP 41800A Active Probe
HP 11694A 75 Ω Matching Transformer
HP 85024A High-Frequency Probe
HP 86205A RF Bridge (50 Ω)
HP 86207A RF Bridge (75 Ω)
HP 856298 Test and Adjustment Module
HP 83050A 2 to 50 GHz Power Preamplifier
HP 83051A 45 MHz to 50 GHz Preamplifier

- High performance microwave spectrum analysis
- High performance vector signal analysis
- HP 71910 plus HP 89410 based systems
- Spectrum analysis 100 Hz to 40 GHz
- 100 MHz bandwidth on the HP 89410A
- Digital modulation analysis and EVM



Wide Bandwidth Signal Analysis System

R&D Tool for Today's Modern Signals

Many of today's wide bandwidth applications require signal analysis capability for both carrier parameter measurements and modulation quality measurements. Applications in microwave wireless include LMDS, W-CDMA and broadband satellite systems. Applications in aerospace and defense include radar development, EW and surveillance systems.

100 MHz Bandwidth on the HP 89410A

The HP 71000T series wide bandwidth signal analyzer systems are high performance custom designed systems to measure RF and microwave signals, such as those used in many wireless communication systems and in radar, EW and surveillance. The flexible architecture includes the HP 71910 wideband receiver and the HP 89410A vector signal analyzer. The HP 71910 provides high performance microwave spectrum analysis while the HP 89410A vector signal analyzer provides high performance digital modulation analysis, in custom system configurations providing 100 MHz of information bandwidth on the HP 89410A.

Full Measurement Capability

The HP 71000T series offers the following features:

- Frequency coverage from 100 Hz to 26.5 GHz, extendable to 40 GHz and higher with external mixers.
- Information bandwidths of 20 MHz or 100 MHz
- Full HP 89410A vector signal analyzer capability
- Custom system specified to your application needs

A Modular, Reusable Architecture

The HP 71000T series wide bandwidth signal analyzer systems use the industry standard HP 89410A vector signal analyzer as the measurement engine for the advanced analysis of complex signals. The HP 71910 provides flexible, high-performance spectrum analysis on the RF and microwave carrier, including out-of-band performance, interference and spurious signal measurements, as well as providing the wide bandwidth IF output to the HP 89410A or to an HP 54845A infinium oscilloscope.

Adding the HP 54845A infinium oscilloscope as a high-speed digitizer provides the 100 MHz wide bandwidth signal capture. The 100 MHz bandwidth signals are ported to the HP 89410A for complex signal analysis, providing true 100 MHz information bandwidth signal analysis on the HP 89410A. The HP 71910, 89410A and 54845A are all usable individually, providing maximum flexibility, and protecting your investment in measurement assets.

Calibration Software and Customization

System calibration software is a key feature of all HP 71000T series wide bandwidth signal analyzers. Specifications are provided for each custom application, and individual instruments are programmable via HP-IB. Custom application software is available. In addition, HP will develop, procure and integrate specialized signal routing and signal conditioning as well as other customized equipment to optimize the system for your needs.

Ordering Information

HP 71000T Series Custom Systems

Vector Signal Analyzers, DC to 10 MHz, and DC to 2.65 GHz

HP 89410A
HP 89441A
HP 89441V
HP 89411A
HP 89450A
HP 89451A

- Advanced, optimized time-gated spectrum analysis
- Digital modulation analysis (optional)
- Adaptive equalization for digital modulated signals (optional)
- W-CDMA Code Domain Power Measurement (optional)
- Precision digital AM, FM, PM demodulation
- Flexible internal RF signal source (optional)
- Narrowband spectrum speed to 60 updates/s
- Simultaneous time and frequency measurement
- 1 MSample time capture with postprocessing (optional)
- High-resolution, high-accuracy time domain
- Second 10 MHz input channel (optional)

HP 89441A DC to 2.65 GHz Vector Signal Analyzer

HP 89410A DC to 10 MHz Vector Signal Analyzer

The new W-CDMA Code Domain Power measurement capabilities allow designers to verify and test their W-CDMA base station systems.

In ATV/HDTV applications, designers of components and systems can speed design and troubleshooting with precise analysis of modulated signal quality. The HP 89441V or Option AYH characterize both QAM and VSB modulated signals, showing results with eye, constellation and other traditional displays. Advanced error magnitude measurements provide quantitative results and the new adaptive equalization capability allows measurements to be made on impaired channels.

Refer to page 487 for more information on RF communications applications and to page 526 for video applications.

HP 89400 Series Vector Signal Analyzers

Advanced Measurements on Complex Signals

Hewlett-Packard's Vector Signal Analyzers integrate frequency-domain and time-domain analysis to provide the most advanced measurements of complex and time-varying signals. Using state-of-the-art digitizing and signal processing technology, these analyzers offer complex signal analysis, such as digital modulation analysis and AM/FM/PM demodulation, vector spectrum analysis and time-gated spectrum analysis. Simultaneous time-domain and frequency-domain measurements and displays improve productivity and enhance ease of use.

The Vector Signal Analyzers are ideally suited for the following technologies:

- RF Communications
- Video Broadcast
- Satellite
- Radar
- Sonar
- Ultrasound Imaging

The HP 89400 series can easily capture and analyze the burst, pulsed, transient, hopping, analog modulated and digitally modulated complex signals from these technologies.

The HP 89410A covers baseband frequencies from dc to 10 MHz with one or two full-bandwidth input channels. The HP 89441A covers baseband through RF frequencies of dc to 2.65 GHz, with a single RF input and an (optional) dc to 10 MHz second baseband channel. The HP 89441V bundles all necessary options for digital video test.

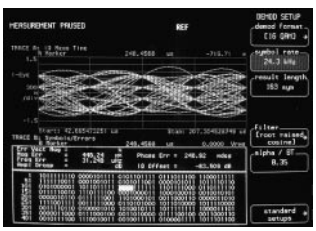
These analyzers provide unprecedented speed and power. Complex time and spectrum measurements are made and displayed up to 60 times each second. Deep time-capture RAM is available with flexible postprocessing in time and frequency domains. A variety of display types are available, including log frequency, polar and (optionally) eye and constellation diagrams.

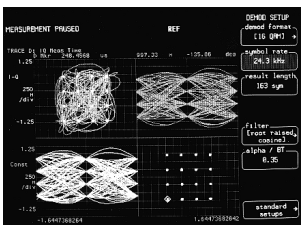
Digital Modulation Analysis

A vector signal analyzer with optional vector modulation analysis provides all the tools necessary to test throughout a system block diagram and to measure the quality of digitally modulated signals. Measurements are easy since no external filters, coherent carriers, or symbol timing signals are required.

Measurements are made on baseband, IF, or RF signals with a selection of modulation formats, variable number of symbols and a variety of filters shapes. A wide range of display formats is available including constellation, eye, or vector diagrams, in addition to numerous error and other signal quality analysis results.

Adjacent channel power, occupied bandwidth, and modulation accuracy are among the measurements that can be made with the ease of "one-button" setups using the HP 89451A Radio Test Personality. The measurements can be made on burst or continuous signals of NADC, CDMA, PDC, PHS, or user-defined systems.





Precision AM, FM, and PM Demodulation

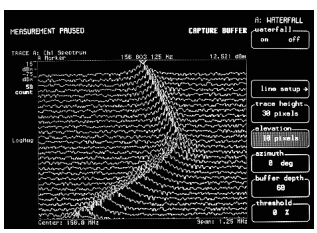
Precision, high-resolution digitized time-series data allows for advanced signal analysis, such as AM, FM and PM demodulation. Signals can be analyzed for instantaneous amplitude, frequency, or phase versus time, and the resulting time-domain results can be translated into the frequency domain for further analysis. This is useful for characterizing phenomena such as phase noise, oscillator frequency transitions and the amplitude or frequency behavior of transmitters at turn-on. Both deliberate and unintentional (or incidental) modulation can be characterized completely. Demodulation is selective, so that the type of modulation can be uniquely determined and separated from other types. FM and PM demodulation are made easier with an auto-carrier function.

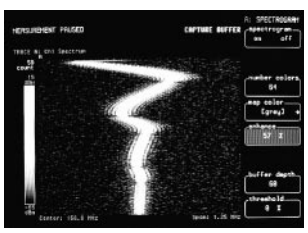
High-Speed, Narrow-Resolution Vector Spectrum

Using high-speed signal processing, these analyzers can measure both the magnitude and phase (in the frequency domain) of CW and nonstationary or burst signals. Multiple-signal processors and microprocessors display signal and circuit behavior in real time, and produce fast averaged measurements with enhanced signal-to-noise ratio.

High-measurement speed is preserved even in narrowband measurements, with display updates orders of magnitude faster than traditional analyzers performing equivalent measurements. Resolution is also better, with resolution bandwidths less than 0.001 Hz over the entire frequency range.

Optional waterfall and spectrogram display formats take full advantage of the high-measurement and display-update speed. Waterfalls display up to 300 successive spectra and scroll them through the display, while spectrograms use colors to indicate signal amplitudes. Both formats make it easy to monitor signal trends of short or long duration.





High-Resolution, High-Dynamic Range Time Domain

All measurements are made with a state-of-the-art A/D subsystem and proprietary signal processing. All frequency spans are image and alias protected, offering band-limited time-domain analysis not available in traditional oscilloscopes and waveform analyzers.

These products feature a deep-data memory of up to one million samples (optional). This memory can be used for long duration time capture, where the time-capture data can be selectively postprocessed (internally) or transferred via HP-IB to an external computer for further analysis.

Advanced Time-Selective Spectrum Analysis

For burst or time-varying signals, it may be necessary to examine only a selected part of the waveform. Time-selective spectrum analysis in the HP 89400 series vector signal analyzers allows the entire time-domain signal to be viewed and a specific portion selected for frequency-domain analysis. The selected data is identified clearly with gate markers and all of its traditional frequency-domain parameters (including noise or signal/noise) can then be measured. In addition, this time-selective analysis does not require a repetitive signal.

Powerful, Flexible Triggering

These vector signal analyzers have extremely flexible triggering to make the most of their time-selective analysis and demodulation features. Measurements can be triggered from the analyzer's own signal source, an external source, HP-IB, an input channel (HP 89410A), or the analyzer's own band-limited IF. The IF trigger allows the analyzer to establish a trigger from a selected frequency band of the input signal, ensuring that the trigger event can always be seen. Both analyzers also provide pre-trigger and post-trigger delays, along with manual, external, or automatic arming with programmable delay.

Advanced Data Analysis

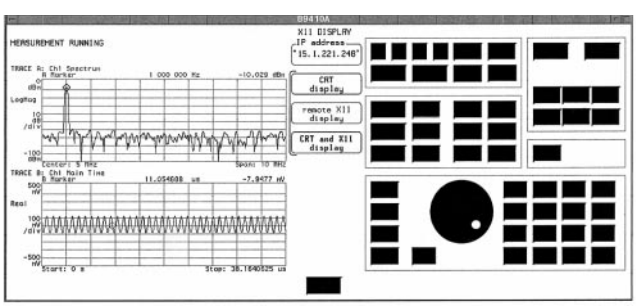
The high-resolution time-domain data of the HP 89400 analyzers allows for advanced data analysis functions. The built-in math functions can be used for scalar arithmetic and complex operations. Other advanced analysis capabilities include correlation functions, such as auto-correlation. This statistical function compares a signal with a delayed version of itself, useful in uncovering hidden periodic signals and analyzing multipath or other signal delays.

Measurement Automation and Convenience Features

Optional HP Instrument BASIC (a subset of HP BASIC) runs inside the analyzers to make repetitive measurements, to create custom displays and test sequences, and even to control other instruments in a test system. Automatic program generation is available with the "keystroke recording" feature, which creates complete executable programs by remembering keys pressed during an actual measurement.

LAN Access and Virtual Front Panel

For remote control from across the building or across the world, Option UFG allows direct transfer of instrument commands and measurement results to a LAN-equipped PC or workstation. Option UG7 adds access to instrument memory and file storage via FTP, along with an X-Windows-based "virtual front panel." This display, which can be sent to an X-compatible server anywhere on your network, shows not only the measurement display but also the complete instrument front panel. Press keys with your mouse or pointing device, and operate the analyzer just as if it were in front of you.



HP 89410A Baseband Vector Signal Analyzer

The HP 89410A covers a frequency range of dc to 10 MHz and offers an optional second channel. The second channel makes it possible to measure frequency response or perform vector network analysis, and the built-in math functions facilitate measurement calibration and correction.

Two-channel statistical measurements such as cross-correlation and coherence can also be made. Cross-correlation is similar to auto-correlation, but instead of comparing a signal with itself to see time delays or repetitions, one signal is compared with another. If the same repetitive signal is present in both waveforms, it will be discovered in the cross-correlation measurement. This technique is also useful in analyzing multipath distortions.

Coherence is a measure of the power in the output signal related to the power in the input. It is useful for troubleshooting noise or signal propagation through a circuit or system. Coherence is also a good indication of the quality of a network measurement in a noisy environment.

Flexible Source

The HP 89410A provides a flexible source for circuit stimulation. Sine waves, periodic chirps (sine-wave sweeps), and pseudo-random noise are available, along with user-definable arbitrary waveforms. The arbitrary waveforms operate on a block of up to 16,384 complex points.

Any of these signals can be used as a stimulus while spectrum measurements are made elsewhere in the circuit. Source level and dc offset of the pattern are all controllable by the user.

HP 89441A RF Vector Signal Analyzers

The HP 89441A covers baseband through RF frequencies of dc to 2.65 GHz, in scalar and vector analysis modes. The scalar RF instrument mode allows full-frequency coverage in spans to 2648 MHz in the HP 89441A. Vector RF mode offers exceptional speed and additional signal processing for enhanced time-domain characterization and demodulation. Vector spans as wide as 7 MHz (8 MHz with Option AYH) can be selected anywhere in 2.65 GHz frequency range. A vector baseband mode is also available to provide all of the features and functionality of the HP 89410A.

In vector RF mode, both phase and amplitude characteristics are captured in the time-series data. This information can be processed for narrow-resolution spectrum analysis, AM/FM/PM demodulation, time-selective analysis, vector modulation analysis (optional) and many other types of measurements.

Statistical Peak/Average Power Measurements

Precision statistical measurements of peak, average, and peak-to-average power can now be made automatically. A time domain marker function simplifies measurements by allowing direct entry of the peak percentage and quickly accumulating thousands of measurement samples.

Accurately setting signal levels is simplified by taking advantage of the analyzer's ability to recalculate results using different peak percentages without taking new data. It is even possible to simultaneously display multiple power parameters based on a single block of measured data.

This new capability is now standard with all 89400 Series Vector Signal Analyzers.

Adaptive Equalization Option AYJ

Adaptive equalization removes linear errors from I-Q modulated signals by dynamically creating and applying a compensating filter. These errors include group delay distortion, frequency response errors (tilt, ripple) and reflections or multipath distortion. Equalization allows designers to evaluate a transmitter in the same way a receiver, equipped with adaptive equalization, will see it.

Equalization allows measurement of some impaired channels and can be used to isolate linear vs. non-linear error mechanisms. This general purpose equalizer does not require symbol lock or prior knowledge of the signal (such as a training sequence). Added measurement data types include the derived channel frequency response and the impulse (time domain) response of the compensating filter.

For more information, visit our website:
http://www.hp.com/go/89400

HP 89410A
HP 89441A
HP 89441V
HP 89411A
HP 89450A
HP 89451A

RF Signal Source

In vector RF mode, the HP 89441A offers an optional flexible source with up to 7 MHz bandwidth, settable to any frequency in the 2.65 GHz frequency range. As with the HP 89410A, sine waves, periodic chirps (sine-wave sweeps), and pseudo-random noise are available, along with user-definable arbitrary waveforms.

Microwave Measurements with Downconverter

The HP 89411A IF downconverter works with the HP 89410A to provide narrowband vector signal analysis at RF and microwave frequencies. The HP 89411A converts a 21.4 MHz IF output from an external receiver to the input frequency range of the HP 89410A. This downconverter is also compatible with the HP 89441A.

This downconverter is designed for use with various HP microwave spectrum analyzers and other devices with compatible 21.4 MHz IF outputs. Frequency coverage is thus available over the complete frequency range of the microwave receiver or analyzer.

Specifications Summary

Refer to the HP 89410A/89441A/89411A technical data sheets for full specifications. The following specifications apply from 0° to 55° C.

	HP 89410A	HP 89441A
Frequency		
Frequency range	dc to 10 MHz	2 MHz to 2650 MHz
Frequency span		
Scalar mode	1.0 Hz to 10 MHz	1.0 Hz to 2648 MHz
Vector mode	1.0 Hz to 10 MHz	1.0 Hz to 7 MHz (8 MHz with Option AYH)
Center frequency tuning resolution	0.001 Hz	0.001 Hz
Accuracy-initial	± 10 ppm (± 0.2 ppm optional)	± 0.1 ppm
Resolution bandwidth	312.5 µHz to 3 MHz (1, 3, 10 sequence or arbitrary)	312.5 µHz to 3 MHz (1, 3, 10 sequence or arbitrary)
Phase noise	(at center frequency = 10 MHz)	1000 MHz ≤ center frequency ≤ 2650 MHz
100 Hz offset	–106 dBc/Hz	–87 dBc/Hz
1 kHz offset	–110 dBc/Hz	–97 dBc/Hz
10 kHz offset	–120 dBc/Hz	–116 dBc/Hz (–124 dBc/Hz typ.)
100 kHz offset	–120 dBc/Hz	–116 dBc/Hz
Amplitude		
Input range		
50 Ω –30 dBm to +24 dBm	–50 dBm to +25 dBm	—
75 Ω –31.7 dBm to +22.2 dBm	—	—
1 M Ω (referenced to 50 Ω)	–30 dBm to +24 dBm	—
Accuracy-absolute full-scale	± 0.5 dB	± 2.0 dB (±0.5 dB typical)
Accuracy-amplitude linearity		—
0 to –30 dBfs	—	< 0.10 dB
–30 to –50 dBfs	—	< 0.15 dB
–50 to –70 dBfs	—	< 0.20 dB
Input noise density (50 Ω)	–114 dBfs/Hz	–112 dBfs/Hz
Sensitivity (lowest range, 50 Ω)	–144 dBm/Hz	–159 dBm/Hz
Spurious responses		
General spurious	≤ –.75 dBfs (≥1 MHz)	< –70 dBc
Second harmonic distortion	< –75 dBc (–80 dBc typical)	< –75 dBc
Intermodulation (third order relative to two tones at –6 dBfs)	≤ –75 dBc (–85 dBc typical)	< –75 dBc
Residual responses	< –75 dBfs (<1 MHz) –80 dBfs (≥1 MHz)	< –80 dBfs —
Analog demodulation		
Maximum bandwidth (typical)	10 MHz	7 MHz
Demodulation accuracy		
–AM	± 1% (typical)	± 1% (typical)
–PM	± 3 degrees (typical)	± 3 degrees (typical)
–FM	± 1% of span (typical)	± 1% of span (typical)
Trigger		
Scalar mode HP-IB, external	Free run, input channel, internal source,	Free run, HP-IB, internal source, external
Vector mode	Free run, input channel, IF channel, internal source, HP-IB, external	Free run, IF channel, internal source, HP-IB, external
Input		
Coupling	dc/ac	ac
Source		
Scalar mode	Fixed sine, arbitrary	—
Vector mode	Fixed sine, random noise, periodic chirp, arbitrary	Fixed sine, random noise, periodic chirp, arbitrary
Arbitrary source	Up to 16,384 – 32,768-real/complex points, depending on span	Up to 16,384 – 32,768-real/complex points, depending on span
Source level (fixed sine)	–110 dBm to +23.9 dBm	–40 dBm to +13 dBm

Note: specifications apply with the RF receiver selected. All HP 89410A specifications also apply for dc to 10 MHz measurements.

Combined HP 89410A/89441A Specifications

Two Channel
Note: Requires second 10 MHz input channel (Option AY7)
Channel Match: (dc to 10 MHz): ± 0.25 dB, ± 2.0˚
Real-Time Bandwidth
Single-Channel Vector Mode Real-Time Bandwidth: 78.125 kHz (with frequency spans of 107/2 n Hz, arbitrary auto-coupled resolution bandwidth, markers off, averaging off, one displayed trace with calculations off on other traces, log-magnitude spectrum measure-ment, 1601 frequency points, channel 2 off)
Measurement Speed
Vector Mode Maximum Display Update Rate: 60 traces/second
Averaging
Scalar Mode: rms (video), rms (video) exponential, peak hold
Vector Mode: rms (video), rms (video) exponential, time, time exponential, peak hold
Number of Averages: 1 to 99,999
Time-Gating
Minimum Gate Length: < 400 ns (dependent on span and RBW window selected)
Time-Capture
Time-Capture Memory: 64 K sample (1 M sample with Option AY9)
Trace Math
Operands: Measurement data, data register, constant, other trace math functions, jv
Operations: +, –, x, ÷, cross correlation, conjugate, magnitude, phase, real, imaginary, square root, FFT, inverse FFT, natural logarithm, exponential
Marker Functions: Peak signal track, frequency counter, bandpower
Interfaces: Active probe power, sync output, external reference input/output, HP-IB, RS-232, Centronix, external multi-sync monitor (A second HP-IB and LAN interface are available with Option UFG)
Memory and Data Storage: Nonvolatile RAM disk (100 KB), volatile RAM disk (1 MB), internal 3.5-inch flexible disk (1.44 MB LIF or DOS format), external disk (HP-IB interface)
Standard Instrument Includes: Manuals, Standard Data Format Utilities (LIF to DOS conversions, SDF conversions, data and instrument state display, PC-MATLAB and MATRIXx conversions)
Vector Modulation Analysis (Option AYA)
Continuous or TDMA Formats: BPSK, QPSK, Offset QPSK, DQPSK, π/4 DQPSK, 8PSK, 16QAM, 32QAM, MSK, 2 and 4 level FSK
Digital Video Formats (Option AYH): 64-256QAM, 8-16VSB
Data Block Lengths: Adjustable up to 4096 symbols with Option UFG (2048 symbols max. with Offset QPSK demodulation)
User Selection of Filters: Raised cosine, root-raised cosine, IS-95 base phase eq., IS-95 Chebyshev, Gaussian, low pass, user-defined
Adjustable Alpha (BT): 0.05 to 100
Trace and Table Formats: Constellation, vector diagram, eye diagrams, trellis diagrams, continuous I or Q vs. time, continuous error vector magnitude vs. time, modulation quality summary, detected symbol table
Analysis Types: Error vector magnitude, phase error, magnitude error, amplitude droop, carrier frequency error, IQ offset, error vector spectrum, measured IQ spectrum, channel frequency response, impulse response of equalizer filter
One-Button Measurements (HP 89451A): Adjacent and alternate channel power, occupied bandwidth, modulation accuracy, power due to modulation (or full signal)

General Specifications

Environmental
Calibration Interval: 1 year
Warmup Time: 30 minutes
Temperature: 0˚ to 55˚ C (operating), –20˚ to 65˚ C (not operating)
Power Requirements
115 Vac Operation: 90 to 140 V rms, 47 to 440 Hz (47 to 63 Hz for HP 89441A)
230 Vac Operation: 198 to 264 V rms, 47 to 63 Hz
Maximum Power Dissipation: 750 VA (HP 89410A), 1025 VA (HP 89441A)
Audible Noise: LpA ≤ 50 dB (HP 89410A), ≤ 55 dB (HP 89441A) typical at 25˚ C
Physical
HP 89410A:
Size: 426 mm W x 230 mm H x 530 mm D (16.7 in x 9.1 in x 20.9 in)
Weight: 25 kg (55 lb)
HP 89441A IF section:
Size: 426 mm W x 230 mm H x 530 mm D (16.7 in x 9.1 in x 20.9 in)
Weight: 25 kg (55 lb)
HP 89441A RF section:
Size: 419 mm W x 173 mm H x 495 mm D (16.5 in x 6.8 in x 19.5 in)
Weight: 25 kg (55 lb)

HP 89411A 21.4 MHz Downconverter Specifications

Bandwidth
With HP 8566A/B: Approx. 3 MHz
With HP 70902A/70903A: Approx. 8 MHz
Power Requirements
115 Vac Operation: 90 to 132 V rms, 47 to 440 Hz
230 Vac Operation: 198 to 264 V rms, 47 to 63 Hz
Maximum Power Dissipation: 100 VA
Physical
Weight: 11.1 kg (25 lb)
Size: 426 mm W x 90 mm H x 520 mm D (16.7 in x 3.5 in x 20.5 in)

The HP 89400 series vector signal analyzers were designed with expandability in mind and the ability to keep up with customers' growing measurement needs. As performance is improved and features added, firmware upgrades are simple using the analyzer's internal disk drive.
Recent new features include:
- Offset QPSK demodulation and CDMA filters added to Option AYA
- Adaptive equalization added to Option AYH
- Adaptive equalization also available by adding Option AYJ to Option AYA
- 8 MHz information bandwidth for HP 89441A via Option AYH
- Peak-to-average power measurements
- Arb waveform block length expanded 4X to 16,384 complex points
- DC offset can be removed in the DC-coupled Ch1 + Ch2 mode

Key Literature

A videotaped demonstration, several Product Notes, and Technical Datasheets are available for the HP 89400 series vector signal analyzers. To receive a current literature index and order form via e-mail, send a message containing the single word "HP 89400" to: **lit_index@lsid.hp.com** or contact the HP Call Center in your region.

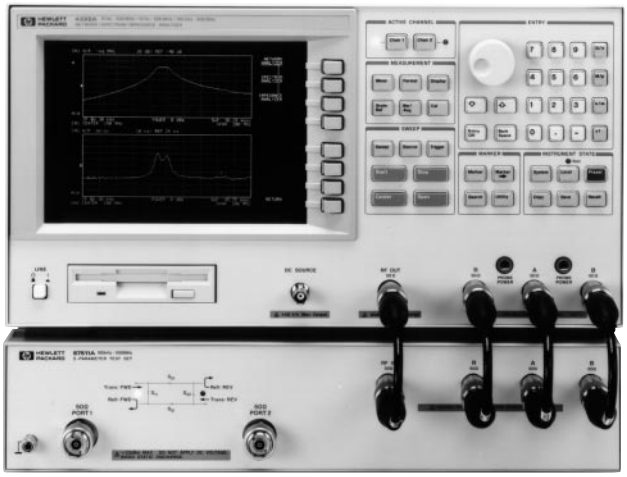
Ordering Information

HP 89410A DC to 10 MHz Vector Signal Analyzer
HP 89441A DC to 2.65 GHz Vector Signal Analyzer
Opt AY4 Delete High-Precision Frequency Reference (HP 89441A only)
Opt AY5 Precision Frequency Reference (HP 89410A only)
Opt AY7 Second 10 MHz Input Channel
Opt AY8 Internal RF Source (HP 89441A only)
Opt AY9 Extend Time Capture to 1 Msample
Opt AYA Vector Modulation Analysis
Opt AYB Waterfall and Spectrogram
Opt AYH Digital Video Modulation Analysis
Opt AYJ Adaptive Equalization
Opt UFG 4-MB Extended RAM and Additional I/O
Opt UG7 Advanced LAN Support
Opt 1C2 HP Instrument BASIC
Opt 1D7 50 to 75 Ω Minimum Loss Pad (HP 89441A only)
Opt 1F0 PC-Style Keyboard–U.S. Version (other options available for German, Spanish, French, U.K., Italian, and Swedish)
HP 89441V VSB/QAM Signal Analyzer
HP 89450A DMCA Radio Test Application Personality
HP 89451A Radio Test Personality
HP 89411A 21.4 MHz Downconverter
HP 89431A 2.65 GHz RF section (converts 89410A to 89441A)
HP 89400A +24C User Training (scheduled)
HP 89400A +24Y User Training (dedicated)
HP E9285A Opt K01 DVB-T COFDM Measurement Software

Baseband, IF Network/Spectrum/Impedance Analyzer, 10 Hz to 500 MHz/10 Hz to 500 MHz/100 kHz to 500 MHz

HP 4395A

- Full-vector network and spectrum measurement and analysis
- Wide dynamic range network measurement with fast sweep speeds
- ±0.05 dB /±0.3° dynamic magnitude/phase accuracy
- Extremely fast narrowband spectrum measurement
- Impedance analysis option and test kit available
- –145 dBm/Hz sensitivity for spectrum analysis
- Built-in HP Instrument BASIC for easy test automation
- Time-gated spectrum analysis option
- Color TFT display and built-in disk drive/RAM disk



HP 4395A with HP 87511A

HP 4395A Network/Spectrum/Impedance Analyzer

The HP 4395A provides excellent vector network, spectrum and optional impedance measurements for audio, baseband, HF, VHF, and IF applications. Gain, phase, group delay, distortion, spurious, CN ratio, and noise measurements often required for evaluating components and circuits can be measured using one instrument. When combined with a test set, the HP 4395A provides reflection measurements, such as return loss, and SWR, and S parameters. As a vector network analyzer, the HP 4395A operates from 10 Hz to 500 MHz with 1 mHz resolution and its integrated synthesized source provides –50 to +15 dBm of output power with 0.1 dB resolution. The dynamic magnitude and phase accuracy are ±0.05 dB and ±0.3° so that it can accurately measure gain and group delay flatness, which are becoming more important in modern electronics systems.

As a spectrum analyzer, the HP 4395A operates from 10 Hz to 500 MHz with resolution bandwidths (RBWs) spanning 1 Hz to 1 MHz in a 1-3-10 steps. A fully-synthesized local oscillator allows stable and accurate frequency analysis. Direct A/D conversion (no LOG amplifier is used) results in ±0.8 dB level accuracy (@50 MHz, –20 dBm). Noise sidebands fall below –110 dBc/Hz @ 100 kHz offset from carriers, while sensitivity is –145 dBm/Hz at 10 MHz.

Extremely Fast Spectrum Measurement

The HP 4395A features Fast Fourier Transform (FFT) digital-signal-processing (DSP) technique for 20 to 100 times faster narrowband spectrum measurement than swept-tuned spectrum analyzers. The stepped FFT is performed for all RBW settings. For example, with 100 Hz RBW and 100 kHz span, the HP 4395A has a sweep time of 300 ms, while swept-tuned spectrum analyzers take a few tens of seconds. The stepped FFT can greatly improve the efficiency of narrowband spectrum measurement.

Time-Gated Spectrum Analysis

With Option 1D6, the HP 4395A offers time-gated spectrum analysis capability to capture and measure repetitive burst signals in video. disk drives, communication equipment, and more. The minimum gate length is 6µ sec so that even narrow-burst signals can be analyzed.

Impedance Measurement Function and RF Impedance Test Kit

A full-featured impedance measurement function (useful for quick-check general-purpose impedance applications) can be added to the HP 4395A by adding Option 010 and the HP 43961A RF impedance test kit. Covering from 100 kHz to 500 MHz, impedance parameters |Z|, θ, C, L, Q, D, and more, are directly measured and displayed on the TFT color display. The basic impedance measurement accuracy is 3%. An APC-7® connector is mounted on this kit for easy connection to an appropriate impedance test fixture. A wide variety of HP fixtures can be used with this test kit, including the surface-mount-device (SMD) fixtures used with the HP 4291A RF impedance/material analyzer. The Option 001 DC source is useful in applying DC voltage to the device up to 40 V.

HP 4395A Specifications Summary

Network Measurement

Frequency Characteristics
Range: 10 Hz to 500 MHz
Resolution: 1 mHz
Accuracy: < ±5.5 ppm (Option 1D5: < ±0.13 ppm)

Output Characteristics
Power Range: –50 to +15 dBm
Resolution: 0.1 dB
Level Accuracy: ±1.0 dB @ 0 dBm, 50 MHz

Receiver Characteristics
Frequency Range: 10 Hz to 500 MHz
Noise Level (referenced to full scale input level, 23 ±5° C):
–85 dB (typical) @ 10 Hz ≤ f <100 Hz, IFBW=2 Hz
–85 dB @ 100 Hz ≤ f <100 kHz, IFBW=10 Hz
(–115 + f/100 MHz) dB @ 100 kHz ≤ f, IFBW=10 Hz

IF Bandwidth (Hz)**:** 2, 10, 30, 100, 300, 1k, 3k, 10k, 30k

Dynamic Accuracy

Input Level (relative to full scale input level –10 dB)	Dynamic Accuracy Frequency ≥100 Hz
Magnitude Dynamic Accuracy	
0 dB ≥ input level ≥ –10 dB	±0.4 dB
–10 dB > input level ≥ –60 dB	±0.05 dB
–60 dB > input level ≥ –80 dB	±0.3 dB
–80 dB > input level ≥ –100dB	±3 dB
Phase Dynamic Accuracy	
0 dB ≥ input level ≥ –10 dB	±3°
–10 dB > input level –60 dB	±0.3°
–60 dB > input level –80 dB	±1.8°
–80 dB > input level –100dB	±18°

@ R port input level=full scale input level –10 dB, IFBW=10 Hz, 23 ±5° C

Spectrum Measurement

Frequency Characteristics
Frequency Range: 10 Hz to 500 MHz

Frequency Reference
Accuracy: < ±5.5 ppm (Option 1D5: < ±0.13 ppm)
Resolution Bandwidth (RBW)
Range: 1 Hz to 1 MHz, 1-3-10 step @ span >0
3k, 5k, 10k, 20k, 40k, 100k, 200k, 400k, 800k, 1.5 M, 3 M, 5 MHz @ span=0
Selectivity (60 dB/3 dB)**:** <3 @ span >0

Noise Sidebands
Offset

1 kHz	–97 dBc/Hz
10 kHz	–97 dBc/Hz
100 kHz	–110 dBc/Hz
1 MHz	–110 dBc/Hz

Displayed Average Noise Level
Frequency

1 kHz ≤ f < 100 kHz	–120 dBm/Hz
100 kHz ≤ f < 10 MHz	–133 dBm/Hz
10 MHz ≤ f	(–145 + f/100 MHz) dBm/Hz

Spurious Response
Second Harmonic Distortion: –70 dBc @ –16 dB full scale
Third-Order Intermodulation Distortion: –70 dBc @ –16 dB full scale
Other Spurious: –70 dBc @ –16 dBc full scale

Scale Fidelity
±0.05 dB @ 0 to –30 dB from full scale input level –10 dB

Impedance Measurement (Option 010)

Measurement Parameters: |Z|, θz, |Y|, θy, R, X, G, B, Cp, Cs, Lp, Ls, Rp, Rs, D, Q, |Γ|, θγ, Γx, Γy
Frequency Range: 100 kHz to 500 MHz
Measurement Port: APC-7 on the HP 43961A Test Kit
Source Level at Measurement Port: –56 to +9 dBm @ 50 Ω
Calibration: OPEN/SHORT/LOAD calibration,
OPEN/SHORT/LOAD compensation on test fixtures, port extension
Accuracy (Supplemental Performance Characteristics)**:**
± 3% basic accuracy @ 23 ±5° C, after OPEN/SHORT/LOAD calibration

General Characteristics

Full Scale Input Level

Attenuator setting (dB)	Full Scale Input Level Network	Spectrum
0	–10 dBm	–20 dBm
10	0 dBm	–10 dBm
20	+10 dBm	0 dBm
30	+20 dBm	+10 dBm
40	+30 dBm	+20 dBm
50	+30 dBm	+30 dBm

Option 001 DC Voltage/Current Source
Voltage Range: –40 V to + 40 V
Current Range: –20 MA to –100 mA, 20 MA to 100 mA
Operating Temperature/Humidity
Disk Drive Non-Operating Condition: 0° to 40° C, 15% to 95% RH
Disk Drive Operating Condition: 10° to 40° C, 15% to 80% RH
Storage Temperature/Humidity: –20° to 60° C, 15% to 95% RH
Power Requirement: 100/120/220/240 V ±10%, 47 to 66 Hz, 300 VA max.
Weight: 21 kg (typical)
Size: 425 mm W x 235 mm H x 553 mm D

Key Literature

HP 4395A/96B Awareness Brochure, p/n 5965-9374E
HP 4395A Technical Data (Spec Sheet), p/n 5965-9340E

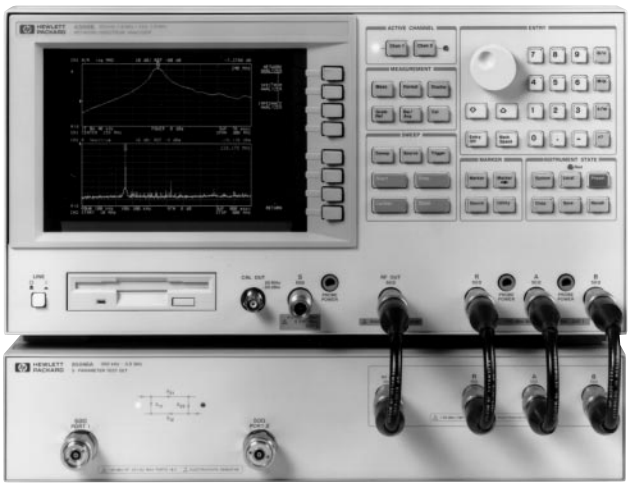
Ordering Information

HP 4395A Network/Spectrum/Impedance Analyzer
Opt 001 Add DC Source
Opt 010 Add Impedance Measurement Function (Requires HP 43961A)
Opt 1A2 Delete Keyboard
Opt 1D5 Add High Stability Frequency Reference
Opt 1D6 Add Time-Gated Spectrum Analysis
Opt 1D7 50 Ω to 75 Ω Minimum Loss Pad
HP 87511A 50 Ω S-Parameter Test Sets
HP 87511B 75 Ω S-Parameter Test Sets
HP 87512A 50 Ω Transmission/Reflection Test Kits
HP 87512B 75 Ω Transmission/Reflection Test Kits
HP 43961A RF Impedance Test Kit (add test fixture listed below)
HP 16191A Side Electrode SMD Test Fixture
HP 16192A Parallel Electrode SMD Test Fixture
HP 16193A Small Side Electrode SMD Test Fixture
HP 16092A Spring Clip Test Fixture

RF Network/Spectrum/Impedance Analyzer, 100 kHz to 1.8 GHz/2 Hz to 1.8 GHz/100 kHz to 1.8 GHz

HP 4396B

- Full-vector network and spectrum measurement and analysis
- Wide dynamic range network measurement with fast sweep speeds
- ±0.05 dB/±0.3˚ C dynamic magnitude/phase accuracy
- Extremely fast narrowband spectrum measurement
- Impedance analysis option and test kit available
- ±1.0 dB level accuracy for spectrum analysis
- –150 dBm/Hz sensitivity for spectrum analysis
- Built-in HP Instrument BASIC for easy test automation
- Time-gated spectrum analysis option
- Color TFT display and built-in disk drive/RAM disk



HP 4396B with HP 85046A

HP 4396B RF Network/Spectrum Impedance Analyzer

The HP 4396B provides excellent RF vector network, spectrum, and optional impedance measurements for lab and production applications. Gain, phase, group delay, distortion, spurious, CN, and noise measurements often required for evaluating components and circuits can be measured using one instrument. When combined with a test set, the HP 4396B provides reflection measurements, such as return loss, and SWR, and S parameters. As a vector network analyzer, the HP 4396B operates from 100 kHz to 1.8 GHz with 1 mHz resolution and its integrated synthesized source provides –60 to +20 dBm of output power with 0.1 dB resolution. The dynamic magnitude and phase accuracy are ±0.05 dB and ±0.3˚ so that it can accurately measure gain and group delay flatness, which are becoming more important in modern electronics systems.

As a spectrum analyzer, the HP 4396B operates from 2 Hz to 1.8 GHz with resolution bandwidths (RBWs) spanning 1 Hz to 3 MHz in a 1-3-10 sequence. A fully-synthesized local oscillator allows stable and accurate frequency analysis. Direct A/D conversion (no LOG amplifier is used) results in ±1.0 dB overall level accuracy. Noise sidebands fall below –105 dBc/Hz offset 10 kHz from carriers below 1 GHz, while sensitivity is –150 dBm/Hz at 10 MHz and –147 dBm/Hz at 1 GHz. In addition, with two independent display channels available, you can simultaneously view network and spectrum (or transmission and reflection) characteristics of the device under test in split-screen format. For example, an amplifier's frequency response (network measurement) and distortion (spectrum measurement) can be shown at the same time.

Extremely Fast Spectrum Measurement

The HP 4396B features a stepped Fast Fourier Transform (FFT) digital-signal-processing (DSP) technique for 20 to 100 times faster narrowband spectrum measurement than swept-tuned spectrum analyzers. The stepped FFT is performed when the resolution bandwidth (RBW) is set at 3 kHz or below. For example, with a 30 Hz RBW and 10 kHz span, the HP 4396B has a sweep time of 400 ms, while swept-tuned spectrum analyzers take a few tens of seconds. The stepped FFT can greatly improve the efficiency of narrowband spectrum measurement such as frequency tuning of a VCO or CN measurements.

Time-Gated Spectrum Analysis

With Option 1D6, the HP 4396B offers time-gated spectrum analysis capability to capture and measure repetitive burst signals in video, disk drives, communication equipment, and more. The minimum gate length is 2μ sec so that even narrow-burst signals can be analyzed.

Impedance Measurement Function and RF Impedance Test Kit

A full-featured impedance measurement function (useful for quick-check general-purpose impedance applications) can be added to the HP 4396B by adding Option 010 and the HP 43961A RF impedance test kit. Covering from 100 kHz to 1.8 GHz, impedance parameters |Z|, θ, C, L, Q, D, and more, are directly measured and displayed. The basic impedance accuracy (typical value) is 3%. The HP 43961A RF impedance test kit is designed for the HP 4396B and is required to utilize the features of Option 010. An APC-7® connector is mounted on this kit for easy connection to an appropriate impedance test figure. A wide variety of HP fixtures can be used with the test kit, including the new surface-mount-device (SMD) fixtures used with the new HP 4291A RF impedance/material analyzer. For higher accuracy, complete impedance analysis over the widest impedance ranges, and temperature effects evaluation, the HP 4291A impedance/material analyzer is recommended. See pages 356 and 357.

HP 4396B Specifications Summary

Network Measurement

Frequency Characteristics
Range: 100 kHz to 1.8 GHz
Resolution: 1 mHz
Accuracy: <±5.5 ppm (Option 1D5: <±0.13 ppm)

Output Characteristics
Power Range: –60 to +20 dBm
Resolution: 0.1 dB
Level Accuracy: ±0.5 dB

Receiver Characteristics
Frequency Range: 100 kHz to 1.8 GHz
Noise Level (10 Hz IFBW, ≥10 MHz, f=frequency in GHz):
< (–125+3 x f) dBm (A, B inputs);
< (–100+3 x f) dBm (R input)
Full Scale Input Level: –5 dBm (A, B), +20 dBm (R)
IF Bandwidth (Hz): 10, 30, 100, 300, 1k, 3k, 10k, 40k

Dynamic Accuracy

Input level (relative to full scale input level)

Magnitude Dynamic Accuracy	
0 dB	<±0.3 dB
–10 to –70 dB	<±0.05 dB
–80 dB	<±0.1 dB
–90 dB	<±0.3 dB
–100 dB	<±1.0 dB
–110 dB	<±0.7 dB typical
–120 dB	<±2.3 dB typical

Phase Dynamic Accuracy	
0 dB	<±3°
–10 dB	<±0.6°
–20 to –70 dB	<±0.3°
–80 dB	<±0.7°
–90 dB	<±2°
–100 dB	<±7°
–110 dB	<±8° typical
–120 dB	<±25° typical

@ 23 ± 5° C, IFBW 10 Hz, R input= –35 dBm

Measurement Throughput Summary (IFBW 40 kHz, ms)

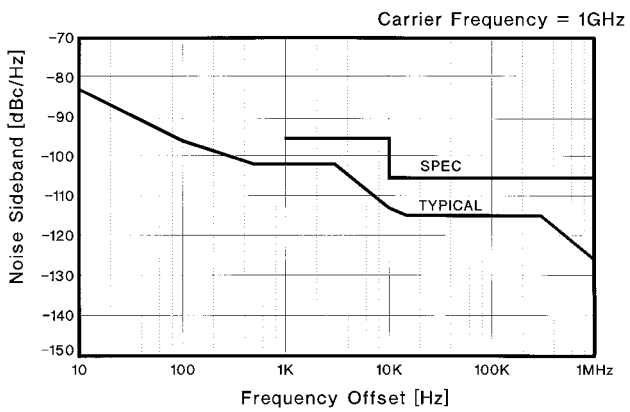
	Number of points			
Measurement (with THRU Cal)	**51**	**201**	**401**	**801**
(1) Magnitude	62	138	239	443
(2) Magnitude and phase	84	227	417	798

Spectrum Measurement

Frequency Characteristics
Frequency Range: 2 Hz to 1.8 GHz

Frequency Reference
Accuracy: <±5.5 ppm (Option 1D5: <±0.13 ppm)
Resolution Bandwidth (RBW)
Range: 1 Hz to 3 MHz, 1-3-10 step
Selectivity (60 dB/3 dB): RBW ≥10 kHz: <10; RBW ≤3 kHz: <3

Noise Sidebands



Noise sidebands normalized to 1 Hz RBW versus offset from carrier (typical)

Displayed Average Noise Level
(@ frequency ≥10 MHz, ref. level ≤–40 dBtm, att.=0 dBm):
< (–150 + 3f (GHz)) dBm/Hz
Spurious Response
Second Harmonic Distortion (@ ≥10 MHz, –35 dBm mixer input):
< –70 dBc
Third-Order Intermodulation Distortion (@ ≥10 MHz, –30 dBm, separation >20 kHz): < –75 dBc
Other Spurious (@ –30 dBm mixer input, offset ≥1 kHz): < –70 dBc
Scale Fidelity: ±0.05 dB @ 0 to –30 dB from ref. level

Impedance Measurement (Option 010)

Measurement Parameters: |Z|, θz, |Y|, θy, R, X, G, B, Cp, Cs, Lp, Ls, Rp, Rs, D, Q, |Γ|, θγ, Γx, Γy
Frequency Range: 100 kHz to 1.8 GHz
Measurement Port: APC-7 on the HP 43961A Test Kit
Source Level at RF out: –60 to +20 dBm (6 dB lower at 43961A port)
DC Bias: ±40 V (20 mA maximum). A 2 kΩ ±5% internal resistor is used for dc bias current limitation. An external dc bias source is required.
Connector: BNC (f) on HP 43961A.
Calibration: OPEN(0 S)/SHORT (0 Ω)/LOAD(50 Ω) calibration, OPEN/SHORT/LOAD compensation on test fixtures, port extension compensation
Accuracy (Supplemental Performance Characteristics):
3% basic accuracy at 23° ±5° C, after OPEN/SHORT/LOAD calibration

General Characteristics

Operating Temperature/Humidity: 0° C to 40° C, 15% < RH <95%
Storage Temperature: –20° to 60° C
Power Requirement: 90 to 132 V, 198 V to 264 V, 47 to 63 Hz, 300 VA max.
Weight: 21.5 kg (47.4 lb) typical
Size: 425 mm W x 235 mm H x 553 mm D

Key Literature

HP's Family of Combination Analyzers, p/n 5965-9374E
HP 4396B 1.8 GHz Network/Spectrum Analyzer Technical Data, p/n 5965-6311E

Ordering Information

HP 4396B RF Network/Spectrum/Impedance Analyzer
Opt 1A2 Delete keyboard
Opt 1D5 High-Stability Frequency Reference
Opt 1D6 Time-Gated Spectrum Analysis
Opt 1D7 50 Ω to 75 Ω Spectrum Input Impedance Conversion
Opt 010 Impedance Measurement Function (Requires HP 43961A)
HP 85046A 50 Ω S-Parameter Test Sets
HP 85046B 75 Ω S-Parameter Test Sets
HP 87512A 50 Ω Transmission/Reflection Test Kits
HP 87512B 75 Ω Transmission/Reflection Test Kits
HP 43961A RF Impedance Test Kit (add test fixtures listed below)
HP 16191A Side Electrode SMD fixture (dc to 2 GHz)
HP 16192A Parallel Electrode SMD fixture (dc to 2 GHz)
HP 16193A Small Side Electrode SMD fixture (dc to 2 GHz)
HP 16092A Spring-Clip Fixture (dc to 500 MHz)

HP 43961A
HP 87511A
HP 87511B
HP 87512A
HP 87512B
HP 41800A

HP 43961A

HP 43961A RF Impedance Test Kit

The HP 43961A RF Impedance Test Kit provides the capability to measure impedance parameters of 1-port devices with the HP 4395A Option 010 (100 kHz to 500 MHz) or the HP 4396B Option 010 (100 kHz to 1.8 GHz). The test port of the HP 43961A is a 7-mm connector and can be used with the HP 16191A, HP 16192A, or HP 16193A test fixture. The HP 43961A includes OPEN/SHORT/LOAD calibration standards, and the test fixtures such as HP 16192A are optional.

Frequency Range: 100 kHz to 1.8 GHz (100 kHz to 500 MHz with HP 4395A)
Measurement Parameters: |Z|, |Y|, θ, R, X, G, B, Cp, Cs, Lp, Ls, Rp, Rs, D, Q, |Γ|

HP 87511A

HP 87511A/B S-Parameter Test Sets

The HP 87511A/B S-Parameter Test Sets provide the capability to measure S-parameters of 2-port devices from 100 kHz to 500 MHz with an HP network analyzer. The test ports of the HP 87511A are 50 Ω precision 7-mm connectors (Option 001: type N(f)), and the test ports of the HP 87511B are 75 Ω type N(f) connectors. Calibration kits are not included.

Frequency Range: 100 kHz to 500 MHz
Test Port Impedance: HP 87511A, 50 Ω; HP 87511B, 75 Ω

	HP 87511A	HP 87511B
Directivity		
100 kHz to 300 kHz	30 dB	30 dB
300 kHz to 200 MHz	40 dB	33 dB
200 MHz to 500 MHz	35 dB	33 dB
Nominal Insertion Loss		
RF IN to port 1, 2	13 dB	19 dB
RF IN to R, A, B	19 dB	31 dB

Size: 432 mm W x 90 mm H x 495 mm D
Weight: Approx. 5.7 kg

HP 87512A

HP 87512A/B Transmission/Reflection Test Kits

The 87512A/B Transmission/Reflection Test Kits provide the capability to measure the reflection and transmission characteristics of 50 or 75 Ω devices up to 2 GHz with an HP network analyzer. The test port of the HP 87512A is a 50 Ω type N(f) connector, and the test port of the HP 87512B is a 75 Ω type N(f) connector. The HP 87512A/B include precision SHORT/LOAD termination for calibration.

Frequency Range: DC to 2 GHz
Test Port Impedance: HP 87512A, 50 Ω; HP 87512B, 75 Ω
Equivalent Directivity: 40 dB (typical)
Insertion Loss: 10 dB ± 1 dB

HP 41800A

HP 41800A Active Probe

The HP 41800A Active Probe provides high input impedance from 5 Hz to 500 MHz. The HP 41800A is a valuable tool when used with a network and spectrum analyzer for circuit signal analysis.

Specifications

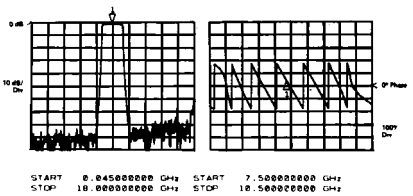
Bandwidth: 5 Hz to 500 MHz
Output Connector: 50 Ω type N male
Input R,C (typical):100 k Ω, 3 pF (probe alone); 1 MΩ, 1 pF (with 10:1, 100:1 divider)
Frequency Response relative to 50 MHz: ±1 dB @ 50 Hz to 200 MHz
Average Noise Level: 10 nV/√Hz @ ≥300 kHz
Second Harmonic Distortion (typical): <–50 dBc @ 20 dBm (250 MHz) input
Third-Order Intermodulation Distortion (typical): <–70 dBc @ –26 dBm two signal input
1 dB Gain Compression: >+3 dBm input @ 500 MHz

Why Network Analysis?

Characterizing the behavior of linear electrical networks that will be stimulated by arbitrary signals and interfaced with a variety of other networks is a fundamental problem in both synthesis and test processes. For example, the engineer designing a multi-component network must predict with some certainty the final network performance from knowledge of the individual components. Similarly, a production manager must know allowable tolerances on the products manufactured and whether the final products meet the specified tolerances. Network analysis offers a solution to these problems through complete description of linear network behavior in the frequency domain. Additionally, some network analyzers offer the capability to transform measurement data, taken in the frequency domain, to the time domain, providing further insight into the behavior of linear networks.

Network analysis accomplishes the description of both active and passive networks by creating a data model of such component parameters as impedances and transfer functions. However, these parameters not only vary as a function of frequency but are also complex variables in that they have both magnitude and phase. Swept network analyzers now measure magnitude and phase (the total complex quantity) as a function of frequency with less difficulty than conventional CW measurements. Impedance and transfer functions then can be displayed conveniently on a swept CRT, or peripherals such as a printer and/or a plotter.

Thus, network analysis satisfies the engineering need to characterize the behavior of linear networks quickly, accurately, and completely over broad frequency ranges. Hewlett-Packard manufactures a full line of scalar network analyzers (magnitude only) and vector network analyzers (both magnitude and phase).



45 MHz to 18 GHz measurement of magnitude and phase in a single sweep.

What is Network Analysis?

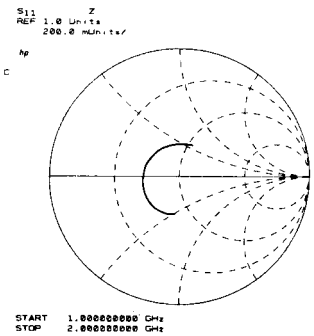
Network analysis is the process of creating a data model of the transfer and/or impedance characteristics of a linear network through stimulus-response testing over the frequency range of interest. All network analyzers in the HP product line operate according to this definition.

At frequencies above 1 MHz, lumped elements actually become "circuits" consisting of the basic elements plus parasitics like stray capacitance, lead inductance, and unknown absorptive losses. Since parasitics depend on the individual device and its construction, they are almost impossible to predict. Above 1 GHz component geometries are comparable to a signal wavelength, intensifying the variance in circuit behavior due to device construction.

Network analysis has classically been limited to the definition of linear networks. Since linearity constrains networks stimulated by a sine wave to produce a sine-wave output, sine-wave testing is an ideal method for characterizing magnitude and phase response as a function of frequency. While modern network analyzers use sine-wave power sweeps to characterize certain parameters of nonlinear behavior, such as gain compression and AM-to-PM conversion, this discussion will be limited to linear characterization of devices. For a more complete discussion of nonlinear measurements, refer to the sections on spectrum analyzers, wave analyzers (signal analyzers) and vector modulation products in this catalog.

Network Analyzers

Hewlett-Packard network analyzers are instruments that measure transfer and/or impedance functions of linear networks through sine-wave testing. A network analyzer system accomplishes these measurements by configuring its various components around the device-under-test. The first requirement of the measurement system is a sine-wave signal source to stimulate the device-under-test. Since transfer and impedence functions are ratios of various voltages and currents, a means of separating the appropriate signals from the measurement ports of the device-under-test is required. Finally, the network analyzer itself must detect the separated signals, form the desired signal ratios and display the results.



Input impedance of microcircuit amplifier is read directly with Smith Chart overlay for Polar Display.

Signal Sources and Signal Separation

In the general case, any sine-wave source meeting the network analyzer's specifications can be used to stimulate the device-under-test. If the analyzer is capable of swept measurements, great economies in time can be achieved by stimulating the device-under-test with a sweep oscillator or synthesized sweeper. This allows quick and easy characterization of devices over broad frequency ranges.

At high frequencies the problem of signal separation usually involves traveling waves on transmission lines and becomes correspondingly more difficult. Hewlett-Packard network analyzers employ both internal and external test sets applicable for separating the appropriate traveling waves in a variety of high- frequency measurements.

Broadband and Narrowband Detection

After the desired signals have been obtained from the test set, they must be detected by the network analyzer; HP network analyzers can use one of two detection methods. Broadband detection accepts the full-frequency spectrum of the input signal while narrowband detection involves tuned receivers that convert CW or swept-RF signals to a constant-IF signal. There are certain advantages to each detection scheme.

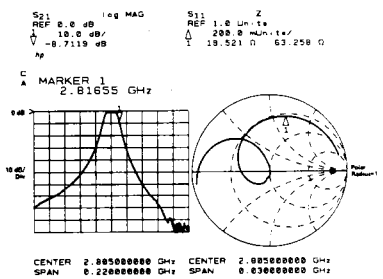
Scalar analyzers usually employ broadband detection techniques. Broadband detection reduces instrument cost by eliminating the IF section required by narrowband analyzers but sacrifices noise and harmonic rejection. However, noise is not a factor in many applications. Finally, broadband systems can make measurements where the input and output signals are not of the same frequency, as in the measurement of the insertion loss of mixers and frequency doublers.

Vector network analyzers normally employ narrowband detection techniques. Narrowband detection makes a more sensitive low noise detection of the constant IF possible. This allows increased accuracy and dynamic range for frequency-selective measurements (as compared to broadband systems).

Some newer scalar and vector network analyzers employ both broadband and narrowband detection. The detection method is selectable by the user so that device measurements can be optimized.

Signal Processing and Display

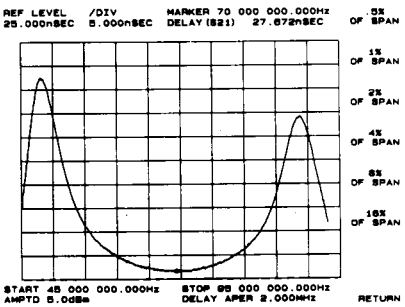
Once the RF has been detected, the network analyzer must process the detected signals and display the measured quantities. All HP network analyzers are multi-channel receivers utilizing a reference channel and at least one test channel; absolute signal levels in the channels, relative signal level (ratios) between the channels, or relative phase difference between channels can be measured, depending on the analyzer.



Simultaneous measurement of transmission response and passband reflection coefficient.

Relative ratio measurements are usually made in dB, which is the log ratio of an unknown signal (Test Channel) with a chosen reference signal (Reference Channel). This allows the full dynamic range of the instrumentation to be used in measuring variations of both high and low level circuit responses. For example, 0 dB implies the two signal levels have a ratio of unity while ± 20 dB implies a 10:1 voltage ratio between two signals.

All network analyzer phase measurements are relative measurements with the reference channel signal considered to have zero phase. The analyzer then measures the phase difference of the test channel with respect to the reference channel.



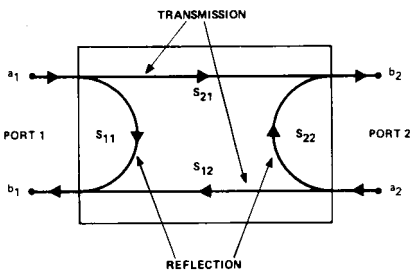
Direct measurement of group delay with digital readout at marker.

Phase information complements amplitude data in the measurement of low-frequency parameters. Phase is more sensitive to network behavior and it is a required component of complex impedance and transfer functions.

Phase data is also required to measure delay distortion or group delay of networks. Delay distortion occurs when different frequency components of a complex waveform experience nonlinear phase shifts as they are transmitted through a network. Group delay is a measure of this distortion and is defined as:

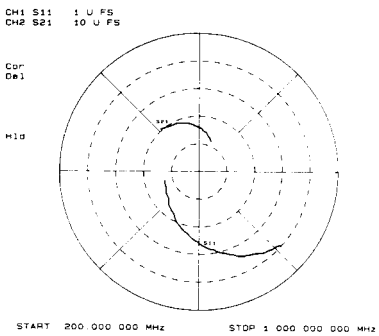
$$\text{Tgd} = \frac{-d\Theta}{d\omega}$$

An alternative method for measuring phase distortion is deviation from linear phase or differential phase. Deviations from linear phase can be measured by introducing enough electrical length in the network analyzer's reference channel to linearize a device's phase shift. This is usually accomplished by using the electrcal-delay feature of the network analyzer, which cancels the average electrical length of a device mathematically.



S-parameter model for a two-port linear network.

Scattering parameters, or S-parameters, were developed to characterize linear networks at high frequencies. S-parameters define the ratios of reflected and transmitted traveling waves measured at the network ports. A two-port device is modeled with S-parameters in Figure 5. S_{11} which is the complex reflection coefficient at port 1 and is the ratio of b_1/a_1, if $a_2 = 0$ (port 2 terminated in its characteristic impedance). S_{21} is the complex transmission coefficient from port 1 to port 2, b_2/a_1, if $a_2 = 0$. The "a" and "b" signals represent the amplitude and phase of the incident and emerging or reflected traveling waves. By reversing the ports and terminating port 1 in its characteristic impedance, S_{22} and S_{12} can be similarly defined.



Simultaneous measurement of transistor S-parameters.

Additional Capabilities

Precision design work and manufacturing tolerances demand highly-accurate measurements, but most errors in network measurements are complex quantities that vary as a function of frequency. By characterizing and virtually removing these systematic errors, measurement accuracies are improved by several orders of magnitude. Hewlett-Packard network analyzers contain built-in, high-speed computational hardware that can perform the complex mathematics required for sophisticated error correction.

Computer-controlled network analyzers can be programmed to set up and make many measurements automatically. The measurement process is further accelerated by the computer's ability to store, transform, summarize, and output data in a variety of formats to a number of peripherals. These capabilities make the computer-controlled network analyzer ideal for both computer-aided design or automatic production testing. Several products have built-in automation features, including sequencing and HP Instrument BASIC.

Network Analyzer Selection Guide

HP Model	Frequency range	Source	Measurement capabilities
HP 35670A Dynamic Signal Analyzer (page 546)	122 µHz to 102.4 kHz (2 channel) 122 µHz to 51.2 kHz (4 channel)	Swept and fixed sine, random (white and pink) noise, burst random, chirp, burst and periodic chirp, and arbitrary waveform	Transfer functions–magnitude/phase, curve fit, spectrum analysis, octave analysis, order domain spectrum analysis, order tracking, histogram analysis. HP-IB programmable.
HP 35665A Dual-Channel Dynamic Signal Analyzer (page 275)	122 µHz to 51.2 kHz	Swept and fixed sine chirp, random, burst random, and arbitrary waveform	Transfer functions–magnitude/phase, 20-pole/20-zero curve fitter, frequency-response synthesis, time domain functions, and spectrum analysis. HP-IB programmable.
HP E5100A/B Network Analyzer (page 281)	10 kHz to 180/300 MHz	Integrated synthesized source	Transfer functions–magnitude/phase, insertion loss/gain, group delay, attenuation. Impedance-magnitude/phase. Electrical delay. HP IBASIC capability. Built-in 3 ½-in flexible disk (DOS format). HP-IB capability.
HP 8751A Network Analyzer (page 284)	5 Hz to 500 MHz	Integrated synthesized source	Transfer functions–magnitude/phase, insertion loss/gain, attenuation, gain compression, S-parameters, electrical length, group delay, deviation for linear phase. Impedance-magnitude/phase, return loss, r + jx. Full accuracy enhancement. HP Instrument BASIC capability. Built-in 3½-in flexible disk (LIF/DOS format). HP-IB capability.
HP 4395A Network/Spectrum/ Impedance Analyzer (page 268)	10 Hz to 500 MHz (network) 100 kHz to 500 MHz (impedance)	Integrated synthesized source	Transfer functions–magnitude/phase, insertion loss/gain, attenuation, S-parameters, group delay, return loss, r+jx. Impedance-magnitude/ phase. Electrical delay. Spectrum analysis. Complex impedance and HP Instrument BASIC optional. Built-in 3 ½-in flexible disk (LIF/DOS format). HP-IB programmable.
HP 8712ET/8712ES HP 8714ET/8714ES RF Economy Network Analyzers (page 285)	300 kHz to 1.3 GHz (8712ET, 8712ES) 300 kHz to 3 GHz (8714ET, 8714ES)	Integrated synthesized source, T/R test set (ET models), S-parameter test set (ES models), and receiver	Transmission/reflection and S-parameter measurements of magnitude and phase. 50 Ω and 75 Ω measurements. HP Instrument BASIC (IBASIC). Narrowband/broadband receivers. Internal calibration, averaging, limit testing, internal disk, and storage registers. LAN interface. VGA output. Fault location/SRL. HP-IB programmable.
HP 4396B Network/Spectrum/ Impedance Analyzer (page 269)	100 kHz to 1.8 GHz (network) 2 Hz to 1.8 GHz (spectrum) 100 kHz to 1.8 GHz (impedance)	Synthesized source	Transfer functions–magnitude/phase, insertion loss/gain, attenuation, S-parameters, group delay, return loss, r + jx. Impedance-magnitude/ phase. Electrical delay. Spectrum analysis. Complex impedance and HP Instrument BASIC optional. Built-in 3½-in flexible disk (LIF/DOS format). HP-IB programmable.
HP 8752C Network Analyzer (page 289)	300 kHz to 1.3/3.0/6.0 GHz	Integrated synthesized source, transmission/reflection test set, and receiver	Transfer functions–magnitude/phase, insertion loss/gain, attenuation, gain compression, electrical length, group delay, deviation from linear phase. Impedance-magnitude/phase, return loss, r + jx, accuracy enhancement, time domain capability. HP-IB programmable.
HP 8753E Network Analyzer (page 291)	30 kHz to 3/6 GHz	Integrated synthesized source, S-parameter test set, and receiver	Transfer functions–magnitude/phase, insertion loss/gain, attenuation, gain compression, 50 Ω and 75 Ω measurements, 4 simultaneous S-parameter display, electrical length, group delay, deviation from linear phase. Impedance-magnitude/phase, return loss, r + jx. Full accuracy enhancement. Time-domain capability. Harmonic-measurement capability. Sequencing. VGA output. HP-IB programmable.
HP 8719D/8720D/8722D Network Analyzers (page 296)	50 MHz to 13.5 GHz (8719D) 50 MHz to 20 GHz (8720D) 50 MHz to 40 GHz (8722D)	Integrated synthesized source (1 Hz resolution optional)	Transfer functions–magnitude/phase, insertion loss/gain, attenuation, S-parameters, electrical length, group delay, deviation from linear phase. Impedance-magnitude/phase, return loss, r + jx. Full accuracy enhancement. Time domain capability. HP-IB programmable.
HP 8510 Series Network Analyzers (page 299)	45 MHz to 110 GHz (SS-SC)	HP 8360 Series Synthesized Sweepers	Transfer functions–magnitude/phase, insertion loss/gain, attenuation, S-parameters, electrical length, group delay, deviation from linear phase, impedance, return loss, r + jx. Active device characterization. Full accuracy enhancement. Time domain capability. HP-IB programmable.
HP 8757D/E Scalar Network Analyzers (page 276)	10 MHz to 110 GHz	HP 83751A/83752A Synthesized Sweepers HP 8360 Series Synthesized Sweepers	Scalar transmission/reflection measurements, 50 Ω coax measurements 10 MHz to 50 GHz, waveguide measurements 26.5 to 110 GHz, open/short averaging, normalization, averaging, limit testing, storage registers. HP-IB programmable.

Vector Voltmeter

HP Model	Frequency range	Source	Measurement capabilities
HP 8508A Vector Voltmeter (page 298)	0.1 MHz to 1 GHz 0.3 MHz to 2 GHz	None	Voltage, impedance, transfer functions, phase and amplitude, HP-IB programmable.

Scalar Network Analyzers, 10 MHz to 110 GHz

HP 8757D/E

- 75 dB dynamic range
- Optional power calibrator
- 40 dB directivity bridges
- 40 GHz in coax, 110 GHz in waveguide
- Buffered plotter/printer output
- External disk and internal register save/recall
- Built-in limit testing
- Color display

HP 8757E and HP 8757D Option 001

HP 8757D/E Scalar Network Analyzers

Measure insertion loss, gain, return loss, SWR and power quickly and accurately with either the HP 8757D or HP 8757E scalar network analyzers. With high-performance detectors and directional bridges, and a companion HP source and digital plotter, the HP 8757D and 8757E become the basis of a complete measurement system with superb performance.

A Choice of Two Analyzers

For an economical measurement solution, choose the HP 8757E scalar network analyzer. The HP 8757E features three detector inputs and two independent display channels, allowing simultaneous ratioed or nonratioed measurement of your device's transmission and reflection characteristics, 75 dB dynamic range (+20 to –55 dBm) for measuring high-rejection devices, and a choice between ac (square wave modulated) or dc detection techniques. The internal plotter/printer buffer allows you to send your measurement data directly to a plotter and then proceed to the next measurement, typically in less than five seconds. The HP 8757E includes a user-friendly interface, and menu-driven, direct-access softkeys, which simplify its operation.

When your application demands maximum system versatility, choose the HP 8757D scalar network analyzer. It offers all of the performance of the HP 8757E, plus more standard features, better measurement speed, limit testing, external disk save/recall and a color display. Limit testing reduces test time by letting the analyzer make quick and objective pass/fail decisions. External disk save/recall allows your measurement state to be preconfigured by an engineer or skilled specialist and then automatically recalled by production technicians. The result is reduced set-up time and greater test integrity at each production station. The precision color display simplifies the separation of measurement information while providing a pleasant display for the technician.

Increase Absolute Power Measurement Accuracy

For near power meter measurement accuracy, configure a system that includes the HP 8757D Option 002 and the HP 85037 series precision detectors. Option 002 on the HP 8757D adds an internal power calibrator used to characterize the HP 85037 series detectors' accuracy versus power. In addition, each HP 85037 series precision detector incorporates a dual-diode detector to improve power measurement accuracy when harmonics are present, plus internal frequency correction factors, read by the HP 8757D, for more accurate power versus frequency measurements. The result is a system optimized for swept absolute power measurements.

Systems from 10 MHz to 110 GHz

You can conveniently obtain a 20 GHz coaxial measurement system by ordering the HP 8757XC (10 MHz to 20 GHz) scalar measurement system. Or, you can configure your own system to 50 GHz in coax or to 110 GHz in waveguide.

The HP 83750 series synthesized sweeper family offers the accuracy and performance of a synthesized source at an affordable price. When you test narrowband, frequency-selective devices, choose a synthesized sweeper from the HP 8360 series. These sweepers provide excellent frequency stability and up to 1 Hz frequency resolution.

Feature	HP 8757D	HP 8757E
Display	Color	Monochrome
Display channels	4	2
Detector inputs	3 standard 4 with Option 001	3
Dynamic range	75 dB	75 dB
AC/DC detection mode	Yes	Yes
Measurement points:		
Selectable values	101, 201, 401, 801, 1601	101, 201, 401
Channels displayed	3 or 4 2 1	1 or 2
Max. points per channel	401 801 1601	401
Plotter/printer buffer	Yes	Yes
Noise figure display capability*	Yes	Yes
External disk save/recall	Yes	No
Internal save/recall registers	9	9
Limit testing (channels 1 and 2)	Yes	No
Adaptive normalization	Yes	No
Cursor search functions	Max., Min., bandwidth, n dB	Max., Min.
SWR display mode	Yes	Yes
Non-standard sweep mode	Yes	Yes
Auxiliary voltage display mode	Yes	Yes
Optional power calibrator	Yes	No
Compatible with HP 85037 series precision detectors	Yes	No

* Product Note 8970 B/S-4, HP Literature 5959-8742

Key Literature

HP 8757D/E Scalar Network Analyzers Brochure, p/n 5091-2469E
HP 8757D/E Scalar Network Analyzers Technical Data, p/n 5091-2471E

System Accuracy

Transmission Loss or Gain Measurement Accuracy

Transmission loss or gain measurements are made relative to a 0 dB reference point established at calibration. Transmission measurement uncertainty = dynamic power accuracy + mismatch uncertainty.

Dynamic power accuracy is the measurement uncertainty due to the change in power level between calibration and the measurement. Mismatch uncertainty is the uncertainty due to reflections in the measurement setup. The frequency response errors of the source, detectors, bridge and power splitter are removed via calibration.

Transmission Measurement Uncertainty Examples
Assumptions:
- Measurement frequency = 10 GHz
- DUT input/output SWR = 1.5
- Change in power after calibration <30 dB (+0 to –30 dBm range)

Uncertainty component	HP 85037B precision detector	HP 85025E detector
Dynamic accuracy (±dB)	0.11	0.40
Mismatch (±dB)	0.45	0.33
Uncertainty Total (±dB)	0.56	0.73

HP 85037 Series Precision Detectors (ac/dc)

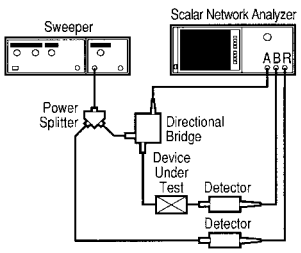
The HP 85037 series precision detectors are designed specifically for operation with the HP 8757D scalar network analyzer and may be used in either ac or dc detection modes. These dual diode detectors contain internal frequency correction factors in an internal EE PROM (read automatically by the HP 8757D) for improved measurement accuracy versus frequency. When used in conjunction with the HP 8757D's internal power calibrator (Option 002), these detectors provide the maximum absolute power measurement accuracy. The HP 85037 series detectors are not compatible with the HP 8757E, 8757A, 8756A, or 8755.

Absolute Power Measurement Uncertainty Examples
Assumptions:
- Measurement frequency = 10 GHz
- DUT input/output SWR = 1.5
- Measured power = 0 dBm

Uncertainty component	HP 85037B detector	HP 85025E detector
Absolute power accuracy at 50 MHz (±dB)	0.11	0.40
Frequency response (±dB)	0.18	0.50
Mismatch (±dB)	0.18	0.10
Uncertainty Total (±dB)	0.47	1.00

Reflection Measurement Accuracy

Uncertainties due to calibration error and the frequency response of the source, detectors, and bridges are removed via open/short averaging. The remaining uncertainties are primarily the sum of directivity uncertainty, effective source match uncertainty and dynamic power accuracy. See Technical Data Sheet for further information.



Basic scalar coaxial system configured for ratio reflection and transmission measurements.

Precision Detector Summary, HP 85037 Series For use with the HP 8757D in either ac or dc detection modes

Model	Frequency range	Connector type	Dynamic range	Frequency	Return loss	Frequency response	Power (at 50 MHz)	Dynamic accuracy[4]	Absolute accuracy[5]
HP 85037A[1]	10 MHz to 18 GHz	Type-N (m) 7 mm[2]	ac mode +20 to –55 dBm dc mode +20 to –50 dBm	0.01 to 0.04 GHz 0.04 to 18.0 GHz	10 dB 20 dB	±0.35 dB ±0.18 dB	20 dBm 10 dBm –30 dBm –50 dBm	±0.25 dB ±0.11 dB ±0.11 dB ±0.85 dB	±0.25 dB ±0.11 dB ±0.11 dB ±0.85 dB
HP 85037B[1]	10 MHz to 26.5 GHz	3.5 mm (m)	ac mode +20 to–55 dBm dc mode +20 to –50 dBm	0.01 to 0.04 GHz 0.04 to 18.0 GHz 18 to 26.5 GHz	10 dB 20 dB 18 dB	±0.35 dB ±0.18 dB ±0.22 dB	20 dBm 10 dBm –30 dBm –50 dBm	±0.25 dB ±0.11 dB ±0.11 dB ±0.85 dB	±0.25 dB ±0.11 dB ±0.11 dB ±0.85 dB

HP 85025 and 85026 Series Detectors (ac/dc)

The HP 85025 and 85026 series detectors are designed specifically for operation with the HP 8757 scalar network analyzer and are not compatible with either the HP 8756 or the 8755. The HP 85025/26 detectors detect either a modulated (ac) or an unmodulated (dc) microwave signal.

HP 85025C Detector Adapters

The HP 85025C adapter matches the scalar analyzer display to most standard crystal, silicon and gallium arsenide detectors. This enables the user to operate up to 110 GHz with the HP 8757 and 8756. The HP 85025C detector adapter is designed for use with the HP 8757 only, and can operate in either ac or dc detection modes.

Coaxial Detector Summary, HP 85025 Series For use with the HP 8757 only in either ac or dc detection modes

Model	Frequency range	Connector type	Dynamic range	Frequency	Return loss	Frequency response	Power (at 50 Mhz)	Dynamic accuracy[4]	Absolute accuracy[5]
HP 85025A[3]	10 MHz to 18 GHz	Type-N (m) 7 mm[2]	ac mode +16 to –55 dBm dc mode +16 to –50 dBm	0.01 to 0.04 GHz 0.04 to 4 GHz 4 to 18 GHz	10 dB 20 dB 17 dB	±0.8 dB ±0.5 dB ±0.5 dB	16 dBm 6 dBm –35 dBm –50 dBm	±0.8 dB ±0.4 dB ±0.4 dB ±1.3 dB	±0.8 dB ±0.4 dB ±0.4 dB ±1.3 dB
HP 85025B[3]	10 MHz to 26.5 GHz	3.5 mm (m)	ac mode +16 to –55 dBm dc mode +16 to –50 dBm	0.01 to 0.04 GHz 0.04 to 4 GHz 4 to 18 GHz 18 to 26.5 GHz	10 dB 20 dB 17 dB 12 dB	±0.8 dB ±0.5 dB ±0.5 dB ±2.0 dB	16 dBm 6 dBm –35 dBm –50 dBm	±0.8 dB ±0.4 dB ±0.4 dB ±1.3 dB	±0.8 dB ±0.4 dB ±0.4 dB ±1.3 dB
HP 85025D[3]	10 MHz to 50 GHz	2.4 mm (m)	ac mode +16 to –55 dBm dc mode +16 to –50 dBm	0.01 to 0.1 GHz 0.1 to 20 GHz 20 to 26.5 GHz 26.5 to 40 GHz 40 to 50 GHz	10 dB 20 dB 20 dB 15 dB 9 dB	±0.8 dB ±0.5 dB ±1.0 dB ±2.5 dB ±3.0 dB	16 dBm 6 dBm –35 dBm –50 dBm	±1.0 dB ±0.4 dB ±0.4 dB ±1.3 dB	±1.0 dB ±0.4 dB ±0.4 dB ±1.3 dB
HP 85025E[3]	10 MHz to 26.5 GHz	3.5 mm (m)	ac mode +16 to –55 dBm dc mode +16 to –50 dBm	0.01 to 0.1 GHz 0.1 to 18 GHz 18 to 25 GHz 25 to 26.5 GHz	10 dB 25 dB 25 dB 23 dB	±0.8 dB ±0.5 dB ±0.5 dB ±1.4 dB	16 dBm 6 dBm –35 dBm –50 dBm	±1.0 dB ±0.4 dB ±0.4 dB ±1.3 dB	±1.0 dB ±0.4 dB ±0.4 dB ±1.3 dB

HP R85026A
HP Q85026A
HP U85026A
HP 85027A
HP 85027B
HP 85027C
HP 85027D
HP 85027E

HP 8757D Option 002 Power Calibrator

The HP 8757D's internal power calibrator provides a 50 MHz reference standard for characterizing the absolute power accuracy and dynamic power accuracy of the HP 85037 series precision detectors.
Frequency: 50 MHz ±0.2 MHz
Accuracy at 0 dBm: ±0.05 dB
Linearity: (over any 10 dB range)
±0.08 dB (+20 to +10 dBm)
±0.04 (+10 to –30 dBm)
±0.06 (–30 to –50 dBm)

Waveguide Detectors and Detector Adapters Summary For use with the HP 8757 only in either ac or dc detection modes

Model	Frequency range	Connector type	Dynamic range	Return loss	Frequency response	Dynamic accuracy
HP R85026A[1]	26.5 to 40 GHz	WR-28	+10 to –50 dBm (ac mode) +10 to –45 dBm (dc mode)	12 dB	±1.5 dB	±(0.3 dB + 0.03 dB/dB)
HP Q85026A[1]	33 to 50 GHz	WR-22	+10 to –50 dBm (ac mode) +10 to –45 dBm (dc mode)	12 dB	±2.0 dB	±(0.3 dB + 0.03 dB/dB)
HP U85026A	40 to 60 GHz	WR-19	+10 to –50 dBm (ac mode) +10 to –45 dBm (dc mode)	12 dB	±2.0 dB	±(0.3 dB + 0.03 dB/dB)
HP 85025C Option K57[3]	50 to 75 GHz	WR-15	+10 to –45 dBm (typical)	9.5 dB (typical)	—	—
HP 85025C Option K71[3]	75 to 110 GHz	WR-10	+10 to –45 dBm (typical)	9.5 dB (typical)	—	—
HP 85025C[1]	[2]	SMA (m)	[2]	[2]	[2]	[2]

[1]The HP 85025 and 85026 series detectors and the HP 85025C detector adapter require HP 8757A firmware revision 2.0 or higher. To upgrade previous revisions, order the HP 11614A firmware enhancement.
[2]Depends upon the particular detector being used.
[3]Must be used with the HP 85025C detector adapter.

HP 85027 Series Directional Bridges (ac/dc)

The HP 85027 series directional bridges are designed to operate with either the HP 8757 in ac or dc detection modes or with the HP 8756 or 8755 in ac detection mode. These bridges offer high directivity, excellent test port match, and a measurement range of up to 50 GHz in coax.

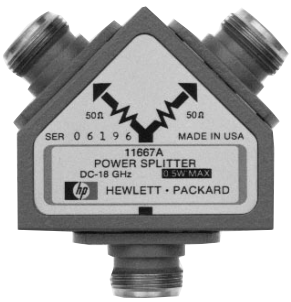
Directional Bridge Summary For use with the HP 8757 in ac or dc detection mode or with the 8756 or 8755 in ac detection mode only

Model	Frequency range	Nominal impedance	Connector–input	Connector–test port	Frequency	Directivity (dB)	Frequency	Test port match (SWR)
HP 85027A	10 MHz to 18 GHz	50 Ω	Type-N (f)	7 mm	0.01 to 18 GHz	40 dB	0.01 to 8.4 GHz 8.4 to 12.4 GHz 12.4 to 18 GHz	<1.15 <1.25 <1.43
HP 85027B	10 MHz to 26.5 GHz	50 Ω	3.5 mm (f)	3.5 mm (f)	0.01 to 20 GHz 20 to 26.5 GHz	40 dB 36 dB	0.01 to 8.4 GHz 8.4 to 20 GHz 20 to 26.5 GHz	<1.15 <1.43 <1.78
HP 85027C	10 MHz to 18 GHz	50 Ω	Type-N (f)	Type-N (f)	0.01 to 12.4 GHz 12.4 to 18 GHz	36 dB 34 dB	0.01 to 8.4 GHz 8.4 to 12.4 GHz 12.4 to 18 GHz	<1.15 <1.25 <1.43
HP 85027D	10 MHz to 50 GHz	50 Ω	2.4 mm (f)	2.4 mm (m)	0.01 to 20 GHz 20 to 26.5 GHz 26.5 to 40 GHz 40 to 50 GHz	36 dB 32 dB 30 dB 25 dB	0.01 to 16 GHz 16 to 30 GHz 30 to 40 GHz 40 to 50 GHz	<1.18 <1.27 <1.57 typically <2.00
HP 85027E	10 MHz to 26.5 GHz	50 Ω	3.5 mm (f)	3.5 mm (m)	0.01 to 20 GHz 20 to 26.5 GHz	40 dB 36 dB	0.01 to 8.4 GHz 8.4 to 20 GHz 20 to 26.5 GHz	<1.15 <1.43 <1.78

[1]The HP 85037A/B specifications are applicable when used with the HP 8757D scalar network analyzer. The absolute power accuracy and dynamic power accuracy specifications apply after a calibration via the HP 8757D Option 002's internal power calibrator.
[2]Option 001 changes to a 7-mm connector.
[3]The HP 85025 and 85026 series detectors and the HP 85025C detector adapter require HP 8757A firmware revision 2.0 or higher. To upgrade previous revisions, order the HP 11614A firmware enhancement.
[4]Dynamic accuracy refers to measurement accuracy as power varies (in dB) from a 0 dBm reference. 25° ±5°C, 50 MHz.
[5]DC mode, 25° ±5° C.

HP 11679A

HP 85022A



HP 11667A

HP 11667C

HP 11679A/B Extension Cables

Function

These cables extend the distance between the scalar network analyzer and the detector or bridge to a maximum of 200 feet without degradation of performance.

HP 11679A: 7.6 m (25 ft) extension cable
HP 11679B: 61 m (200 ft) extension cable

HP 85022A System Cable Kit

The HP 85022A contains all the BNC and HP-IB cables to connect an HP sweep oscillator (HP 8360 series, HP 83750, or 83751 synthesized sweepers), an HP computer and a printer to the HP 8757 or 8756. This kit contains three one-meter HP-IB cables (HP 10833A), three two-foot BNC (m-m) cables (HP 11170B) and one four-foot BNC (m-m) cable (HP 11170C).

BNC Impedance: 50 Ω
Weight: Net, 0.5 kg (1.2 lb); shipping, 1.2 kg (2.9 lb)

HP 8757D/E Upgrade Kits

Increase your analyzer's measurement capability and performance with an HP 8757 upgrade kit. Upgrade kits are available for the HP 8757D and 8757E.

The HP 86383C upgrade kit allows you to add the fourth detector input to your HP 8757D (86383C Option 001) and/or the internal power calibrator (HP 86383C Option 002). Installation is not included with this kit.

HP 11636A/B Power Dividers

The HP 11636A/B power dividers/combiners are recommended when making wideband comparison measurements without ratioing, and in fault location measurements with the HP 8757/85016.

HP 11613B Calibrator

The HP 11613B is a dedicated transfer standard for calibration of the HP 8757D/E scalar network analyzers. The HP 11613B provides a standard, a 27.778 kHz source and a series of precision attenuators. The calibrator includes software that verifies (and adjusts if necessary) the internal calibration parameters stored in the nonvolatile memory of the analyzer.

HP 11665B Modulator

Function:

Absorptive on-off modulator designed for and powered by the HP 8757, 8756 or 8755 scalar network analyzers

Frequency range	Return loss on and off	Insertion loss on	off
15 to 40 MHz	≥10 dB	≤7.0 dB	≥35 dB
40 MHz to 4 GHz	≥15 dB	≤3.2 dB	≥35 dB
4 to 8 GHz	≥12 dB	≤4.3 dB	≥45 dB
8 to 12.4 GHz	≥8 dB	≤3.8 dB	≥40 dB
12.4 to 18 GHz	≥8 dB	≤5.0 dB	≥45 dB

HP 11852B 50 Ω/75 Ω Minimum-Loss Pad

The HP 11852B is a low SWR minimum-loss pad required between 75 Ω devices and 50 Ω sources and detectors. For more information, see page 294.

HP 11667A/B/C Power Splitters

The HP 11667A/B/C power splitters are recommended when making wideband ratio measurements using the HP 8757, 8756 or 8755 scalar network analyzer. These two-resistor type splitters provide excellent output SWR at the auxiliary arm when used for source leveling or ratio measurement applications. The tracking between output arms over a frequency range from dc to 50 GHz allows wideband measurements to be made with a minimum of uncertainty.

Frequency Range
- **HP 11667A:** DC to 18 GHz
- **HP 11667B:** DC to 26.5 GHz
- **HP 11667C:** DC to 50 GHz

Impedance: 50 Ω nominal
Insertion Loss
- **HP 11667A/B:** 6 dB nominal
- **HP 11667C:** 8.5 dB nominal

Max. Input Power: +27 dBm
Connectors
- **HP 11667A:** N-female on all ports
- **HP 11667B:** 3.5-mm female on all ports
- **HP 11667C:** 2.4-mm female on all ports

Scalar Network Analyzers/Ordering Information

HP 8757 System
HP 8757XC

The HP 8757 scalar network analyzer is ordered with multiple line items to give you maximum flexibility in specifying a system that meets your needs. Consult your local Hewlett-Packard sales office if you would like assistance.

Ordering Information

Complete Measurement System
HP 8757XC 20 GHz Coaxial Synthesized Scalar System
Includes:
HP 8757D Scalar Network Analyzer
HP 83752A Synthesized Sweeper[1]
HP 85022A Cable Kit
- **Opt 001** Adds Fourth Detector Input to Analyzer
- **Opt 002** Adds 50 MHz Calibrator to Analyzer
- **Opt 1E1** Adds 70 dB Step Attenuator to Source
- **Opt 1E5** Adds High-Stability Timebase to Source
- **Opt 1ED** Adds Type-N Connector to Source
- **Opt 57E** Substitutes HP 8757E Analyzer
- **Opt 51A** Substitutes HP 83751A Source (2 to 20 GHz)
- **Opt 51B** Substitutes HP 83751B Source (2 to 20 GHz, high power)
- **Opt 52B** Substitutes HP 83752B Source (0.01 to 20 GHz, high power)

Analyzer
HP 8757D Scalar Network Analyzer
- **Opt 001** Fourth Detector Input
- **Opt 002** Internal Power Calibrator
- **Opt 802** HP 9122C Disk Drive and an HP 10833A HP-IB cable
- **Opt W03*** 90-Day On-Site Warranty Conversion
- **Opt W30** Two-Year Extended Service
- **Opt 1BN** MIL-STD-45662A Calibration Certificate
- **Opt 1BP** MIL-STD-45662A Calibration with Test Data

HP 8757E Scalar Network Analyzer
- **Opt 1BP** MIL-STD-45662A Calibration with Test Data

Sweepers
Choose the HP 83752A/B synthesized sweepers for applications from 10 MHz to 20 GHz, or the HP 8360 series synthesized sweepers for measurements up to 50 GHz in coax or 110 GHz in waveguide.

Precision Detectors
HP 85037A 0.01 to 18 GHz, Type-N(m)
- **Opt 001** 7-mm Connector

HP 85037B 0.01 to 26.5 GHz, 3.5 mm(m)

Directional Bridges
HP 85027A 0.01 to 18 GHz, 7 mm, 50 Ω
HP 85027B 0.01 to 26.5 GHz, 3.5 mm (f), 50 Ω
HP 85027C 0.01 to 18 GHz, Type-N (f), 50 Ω
HP 85027D 0.01 to 50 GHz, 2.4 mm (m), 50 Ω
HP 85027E 0.01 to 26.5 GHz, 3.5 mm (m), 50 Ω

[1] In addition to the options listed, the HP 83752A can be substituded with any other HP synthesized source. For more information contact the HP Call Center in your region.

Detectors
HP 85025A 0.01 to 18 GHz, Type-N (m)
- **Opt 001** 7-mm Connector

HP 85025B 0.01 to 26.5 GHz, 3.5 mm (m)
HP 85025D 0.01 to 50 GHz, 2.4 mm (m)
HP 85025E 0.01 to 26.5 GHz, 3.5 mm (m)
HP R85026A 26.5 to 40 GHz, WR-28 Waveguide
HP Q85026A 33 to 50 GHz, WR-22 Waveguide
HP U85026A 40 to 60 GHz, WR-19 Waveguide
HP 85025C Detector Adapter

System Cable Kit
HP 85022A System Cable Kit

HP-IB/Centronics Bus Converter
US/Canada Version (ITEL 45CHVUB)
International Version (ITEL 45CHVEB)

Optional Accessories
(For ratio and/or modulation measurements)
HP 11636A Power Divider dc to 18 GHz
HP 11636B Power Divider dc to 26.5 GHz
HP 11665B Modulator
HP 11667A Power Splitter dc to 18 GHz
- **Opt 001** N-male on Input Port; N-female on Output Ports
- **Opt 002** N-female on Input Port; 7 mm on Output Ports

HP 11667B Power Splitter dc to 26.5 GHz
HP 11667C Power Splitter dc to 50 GHz
HP 11679A Detector Extension Cable, 7.6 m (25 ft)
HP 11679B Detector Extension Cable, 61 m (200 ft)
HP 11852B 50 to 75 Ω Minimum Loss Pad

Upgrade Kits
HP 86383C Upgrade Kit for HP 8757D
- **Opt 001** Adds Fourth Detector Input
- **Opt 002** Adds Internal Power Calibrator

For information on compatible printers, visit:
http://www.hp.com/go/pcg

*Only where available.

Indicates QuickShip availability.

- 10 kHz to 300 MHz
- 0.04 ms/point measurement speed
- Fine resolution IFBW
- List sweep function
- Stable measurements
- High-speed evaluation using the waveform analysis commands
- Evaporation Monitoring Function (Option)
- Phase Tracking Function (Option)
- Supports active probes (Option)
- HP Instrument BASIC for easy automation

HP E5100A/B

HP E5100A/B Network Analyzers

The HP E5100A/B network analyzer is a 10 kHz to 300 MHz network analyzer best fitted for production lines of electronic component manufacturers, especially resonator and filter manufacturers, who require extra-high throughput.

The HP E5100A/B improves production line productivity with its fast measurement speed (fastest sweep speed is 0.04 ms/point), fast waveform analysis commands, and speedier processor. It provides faster measurements with lower fluctuations because of its low-noise performance and fine selection IFBW.

HP E5100A

The HP E5100A is a versatile network analyzer with many functions and options to fit your needs with a minimum investment. During final tests, both precision and high speed are required for better yield and better productivity. The HP E5100A makes high-quality and high-speed tests with its fine IFBW selection and low-noise circuitry. Its convenient analysis and processing functions improve the productivity of the final test processes.

HP E5100A 180MHz Version

The HP E5100A 180MHz version (option 118/218/318/618) is the economical solution for lower frequency applications. The frequency range is 10kHz to 180MHz. The HP E5100A 180MHz version provides the same measurement performance as the 300MHz version with lower price.

HP E5100B

The HP E5100B is best for in-process testing of filters and resonators. The requirement of in-process testing is different from that of final tests; they need fast measurements and low price. The HP E5100B has the same measurement quality and speed as the HP 5100A, but has reduced functionality. The HP E5100B reduces production costs and is a valuable tool for in-process testing.

Model	HP E5100A 300MHz version	HP E5100A 180MHz version	HP E5100B
Frequency range	10kHz to 300MHz	10kHz to 180MHz	10kHz to 300MHz
Number of receivers	1 to 4	1 to 3	1 to 2
Number of points	1601	1601	401
List sweep	yes	yes	no
Dynamic range	120dB	120dB	100dB
Phase tracking function	yes (opt 023)	yes (opt 823)	no
Evaporation monitor function	yes (opt 022)	no	yes (Opt 022)

Specifications

Source Characteristics

Frequency
Range:10 kHz to 300 MHz, 10 kHz to 180 MHz (HP E5100A with Opt. 118/218/318/618)

Output
Power range (at SINGLE): –48 to +22 dBm (option), –9 to +11 dBm (standard)
Resolution: 0.1 dB

Receiver Characteristics

Frequency
Range: 10 kHz to 300 MHz, 10 kHz to 180 MHz(HP E5100A with Opt. 118/218/318/618)
IFBW: 10 Hz to 30 kHz (1, 1.5, 2, 3, 4, 5, 8 steps)
Input Impedance (nominal): 50 Ω (std.), 50 Ω /1M Ω , 30 pF (option)
Dynamic Range: >120 dB (IFBW = 1 kHz)
Dynamic Accuracy: ±0.05 dB, ±0.3 deg
Measurement Speed: 0.04 ms/point (IFBW = 30 kHz, ramp-sweep)

General Characteristics

Measurement Parameters: Gain (Amplitude Ratio), Phase, Group-Delay, Amplitude, Gain-Phase, Gain-Delay Impedance, Admittance
Display: 6.5 inch TFT Color LCD
Programming: HP Instrument BASIC
Mass Storage: FDD and internal non-volatile memory
Parallel I/O Port: TTL, 16-bit output, 8-bit input/output (standard)
Size: 425 mm W x 177 mm H x 425 mm D
Weight: Net, 12 kg (typical); shipping, 17 kg (typical)

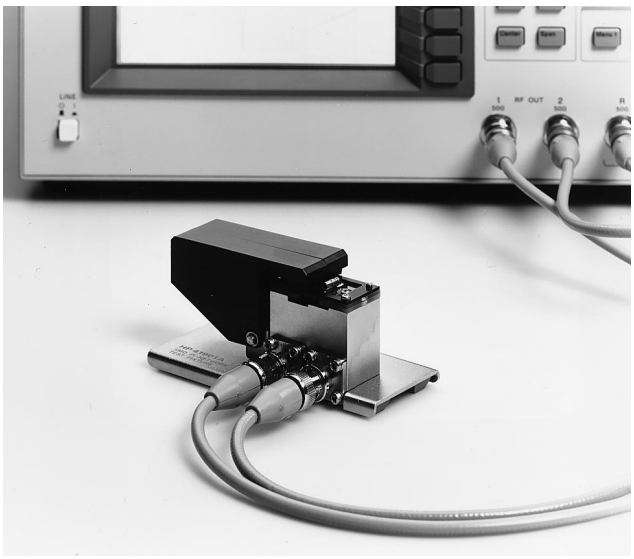
Key Literature

HP E5100A/B Network Analyzer Product Overview, p/n 5966-2889E
HP E5100A/B Technical Specifications, p/n 5966-2888E

HP E5100A/B Accessories

HP 41901A SMD PI-Network Test Fixture

The HP 41901A SMD PI-network test fixture produces the capability to measure surface-mount crystal resonator using the HP E5100A/B or the HP 87510A. Attachment kit (option) is required for measurement. The frequency range of the HP 41901A is 1 MHz to 300 MHz.



Ordering Information

HP E5100A Network Analyzer
- **Opt 100** 300MHz 1 Receiver, Port A
- **Opt 200** 300MHz 2 Receivers, Port R and A
- **Opt 300** 300MHz 3 Receivers, Port R, A and B
- **Opt 400** 300MHz 4 Receivers, Port R, A, B and C
- **Opt 600** 300MHz PI-Network Test Ready Package
- **Opt 118** 180MHz 1 Receiver, Port A
- **Opt 218** 180MHz 2 Receiver, Port R and A
- **Opt 318** 180MHz 3 Receiver, Port R, A and B
- **Opt 618** 180MHz PI-Network Test Ready Package

Note: Choose one Option from 100 to 618 depending on test frequency range and number of receivers.
Note: Options 600 and 618 include power-extended two RF OUT ports and two receivers.
PI-network fixture is not included.
- **Opt 001** One RF OUT port
- **Opt 002** Two RF OUT ports, built-in power splitter
- **Opt 003** Two RF OUT ports, switched single output

Note: Choose one Option from 001 to 003 except the case of Options 600 and 618. Option 003 cannot be ordered with Option 101 or 301.
- **Opt 101** 50ohm/1Mohm selectable input on Port A
- **Opt 102** Type-N input connector on Port A

Note: Options 101 and 102 are for Options 100, 200, 118 and 218 only. Option 101 cannot be ordered with Option 003.
- **Opt 301** 50ohm/1Mohm selectable inputs on Ports A and B
- **Opt 302** Type-N input connector on Port A and B

Note: Options 301 and 302 are for Options 300, 400 and 318 only. Option 301 cannot be ordered with Option 003.
- **Opt 010** Extended Output Power Range
- **Opt 022** Evaporation Monitoring Function

Note: Option 022 cannot be ordered with Options 118, 218, 318 and 618.
- **Opt 023** Phase Tracking Function for 300MHz version

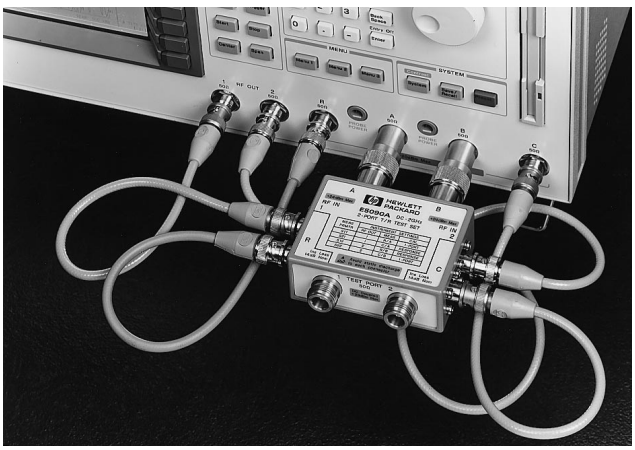
Note: Option 023 is for Options 100, 200, 300, 400 and 600 only. Option 023 cannot be ordered with Options 118, 218, 318 and 618.
- **Opt 823** Phase Tracking Function for 180MHz version

Note: Option 823 is for Options 118, 218, 318 and 618 only. Option 823 cannot be ordered with Options 100, 200, 300, 400 and 600.
- **Opt 1D5** High-stability Frequency Reference
- **Opt 005** Parallel I/O, mode A
- **Opt 006** Parallel I/O, mode B
- **Opt 007** Opto-isolated Parallel I/O

Note: 24-bit parallel I/O is furnished in standard. Select only one of Options 005, 006, 007, or choose none.
- **Opt UKR** Delete HP Instrument BASIC
- **Opt 1F0** Add IBASIC Keyboard
- **Opt UK6** Commercial Calibration Certificate with Test Data

HP E5090A 2-Port Transmission/Reflection Test Kit

The HP E5090A 2-port transmission/reflection test kit provides the capability to measure transmission and reflection characteristics of two port device in either direction with a single connection. The HP E5090A is test set for the HP E5100A with Options 003, 010, 302, and 400. The frequency range of the HP E5090A is dc to 2 GHz.



HP E5100B Network Analyzer
- **Opt 100** 1 Receiver, Port A
- **Opt 200** 2 Receivers, Ports R and A

Note: Must choose either Option 100 or 200.
- **Opt 001** Single RF OUT port
- **Opt 002** Dual RF OUT ports, built-in power splitter

Note: Must choose either Option 001 or 002.
- **Opt 010** Extended output power range, –48 to +22 dBm
- **Opt 022** Evaporation Monitoring Function
- **Opt 101** 50 Ω/1 MΩ selectable input, Port A
- **Opt 102** Type-N input connector, Port A
- **Opt 1D5** High-Stability Frequency Reference
- **Opt 005** Parallel I/O mode A
- **Opt 006** Parallel I/O mode B
- **Opt 007** Opto-isolated Parallel I/O

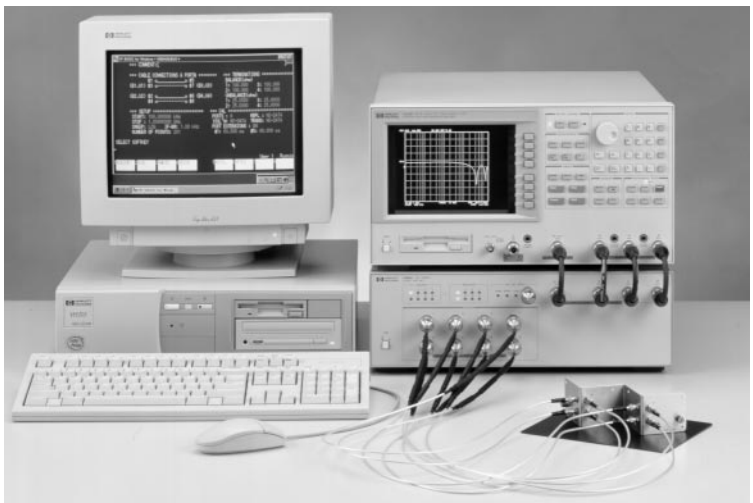
Note: 24-bit parallel I/O is furnished, select only one of Options 005, 006, 007, or choose none.
- **Opt UKR** Delete HP Instrument BASIC
- **Opt 1F0** Add DIN Keyboard
- **Opt UK6** Commercial Calibration Certificate with Test Data

Accessories
HP 41800A Active Probe
HP 41802A 1-MΩ Input Adapter
HP 41900A PI-Network Test Fixture
- **Opt 001** Adapter Kit for Load Capacitor

HP 41901A SMD PI-Network Test Fixture
- **Opt 010** to 060 Attachment Kit

HP E5090A 2-Port Transmission/Reflection Test Kit
HP 11850C 50 Ω Three-Way Power Splitter

- RF balanced characterization without physical BALUN transformers
- Mathematical BALUN provides full balanced and unbalanced parameters with a single setup
- Excellent solution for balanced component and cable evaluation
- 10kHz to 500MHz/1.8GHz system for LAB use
- Interactive easy operation on HP BASIC for Windows environment



HP 4380S

HP 4380S RF Balanced Component/ Cable Test System

HP-IB

The HP 4380S system simplifies engineering characterization of balanced components and cables up to 500MHz or 1.8GHz. The system employs a computational BALUN (BALanced to UNbalanced) transformer technique called "Modal decomposition method" instead of traditional physical BALUN. Thanks to this technique, ideal BALUN transformers are realized by mathematical calculation. And it's simplified and improved to evaluate balanced (differential mode) and unbalanced (common mode) characteristics of balanced devices and transmission lines, such as UTP/STP cables and LAN filters for category 5, 6 and 7 LAN applications, USB and IEEE1394 cables, balanced SAW filters, EMC/EMI filters and BALUN transformers.

Test Flexibility Without BALUN Problems

The HP 4380S can perform wide-frequency-range and high-quality measurements with just one setup without problems associated with physical BALUNs. Physical BALUN transformers typically degrade measurement performance or are unusable in RF frequency range. Two or more separate BALUNs are often required for a wider frequency range measurement because the frequency range of physical BALUN transformers is usually limited to about 3 decades. The HP 4380S can eliminate these problems and offer new levels of test flexibility by the mathematical BALUN method.

All Characteristics with Single Setup

The HP 4380S can calculate all characteristics of the DUT from one set of S-parameter data measured with a single cable setup to the DUT, and shows it on the network analyzer's display. This eliminates data-correlation or degradation problems caused by multiple setups and BALUN configurations in conventional method. And it improves test efficiency and data reliability. In addition, the HP 4380S can derive "from balanced to unbalanced" or "from unbalanced to balanced" characteristics sometimes necessary for engineering evaluation of LAN cable as LCL, CMRR (LCTL) and DMRR. These parameters are often difficult or impossible to obtain accurate result with other techniques.

Sytem Configuration

The HP 4380S system consists of a network analyzer, an 8-port S-parameter test set and a system controller supporting BASIC for Windows as follows:

- HP 8751A 500MHz Network Analyzer

or

- HP 4396B 1.8GHz Network/Spectrum Analyzer
- HP 4380A 8-port S-parameter Test Set
- System controller supporting HP BASIC for Windows version 6.2 or greater and HP-IB interface.

Specifications

Frequency Range: 10 kHz to 500 MHz (HP 8751A)/1.8GHz (HP 4396B)

Measurement Parameters

Balanced
- Characteristic impedance (Zc)
- Insertion loss
- Return loss
- Input impedance (Zin)
- Structural return loss (SRL)

Unbalanced
- Characteristic impedance (Zc)
- Insertion loss
- Return loss
- Input impedance (Zin)

Balanced-to-Unbalanced
- Insertion loss (DMRR: Differential Mode Rejection Ratio)
- Return loss

Unbalanced-to-Balanced
- Insertion loss (CMRR: Common Mode Rejection Ratio)
- Return loss (LCL: Longitudinal Conversion Loss)

Cross Talk
- NEXT (Near End Cross Talk)
- FEXT (Far End Cross Talk)
- Equal-level FEXT

Key Literature

HP 4380S RF Balanced Component/Cable Test System Product Overview, p/n 5966-1924E

Modal Decomposition (Non-Balun) Measurement Technique, p/n 5966-1925E

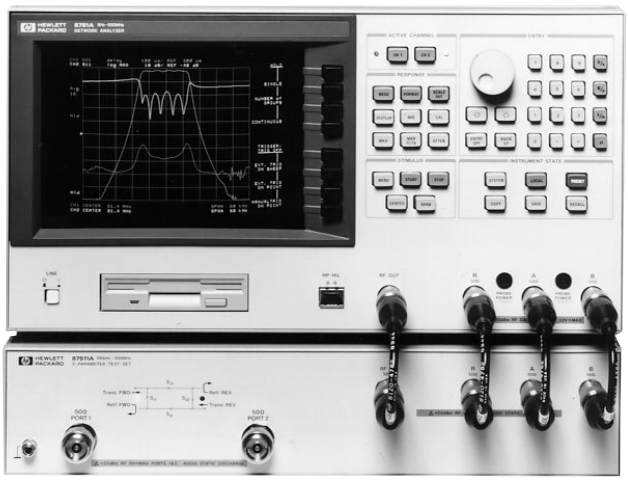
Ordering Information

HP 4380S RF Balanced Component/Cable Test System
HP 8751A Network Analyzer
HP 4396B RF Network/Spectrum/Impedance Analyzer
HP 4380A 8-port Test Set
HP 85033D 3.5mm Calibration Kit
Opt 001 Delete 7mm Adapters

Baseband, IF and RF Network Analyzer, 5 Hz to 500 MHz

HP 8751A

- 5 Hz to 500 MHz
- ±0.02 dB, ±0.12° dynamic accuracy
- 0.001 Hz, 0.001 dB, 0.001 degree, 10 ps resolution
- Full 2-port and interpolative calibration
- Conjugate matching analysis
- Built-in 1.44 MB disk drive for save/recall
- Crisp color display
- 10 updates of 201 sweep points per second
- 0.4 ms/point fast list sweep (IFBW = 4 kHz)
- Up to 4 traces simultaneous measurement/display
- Eight active trace markers per channel
- HP Instrument BASIC for customization
- HP 41802A 1 MΩ input adapter
- List sweep for efficient measurement



HP 8751A with HP 87511A

HP 8751A Network Analyzer

The HP 8751A network analyzer is a high-throughput instrument with lab precision that covers 5 Hz to 500 MHz. The HP 8751A provides resolution of 0.001 Hz, 0.001 dB, 0.001 degree, and 10 ps for characterizing the linear behavior of either passive or active networks, devices, or components in the lab and the production test areas. The built-in 1.44 MB disk drive is for direct save/recall of instrument state, calibration data, and application programs for your customization. Dedicated 50/75 Ω S-parameter test sets, 50/75 Ω T/R test kits, and the 1 M Ω input adaptors are all available.

Specifications

Source

Frequency Characteristics
Range: 5 Hz to 500 MHz
Resolution: 1 mHz
Accuracy: ± 20 ppm, ± 1.0 ppm (Option 001)
Stability: ± 2.5 x 10^{-9}/8 hours (typical 23±5° C with Option 001)

Output Characteristics

Power Range: –50 to + 15 dBm
Resolution: 0.1 dB
Flatness: ±2.0 dB @ 5 Hz ≤ freq. ≤ 500 MHz (23 ±5° C, +0 dBm, relative to 50 MHz)
Level Accuracy: ±0.5dB (50 MHz, 0 dBm)
Level Linearity: ± 0.5dB @ output level ≥ –35dBm; ±1.5dB @ output level < –35dBm (50 MHz, relative to 0 dBm)
Impedance: 50 Ω

Receiver

Frequency Range: 5 Hz to 500 MHz
Input Range: 0 dBm @ ATT = 20 dB; –20 dBm @ ATT = 0 dB
IF Bandwidth: 2 Hz, 20 Hz, 200Hz, 1 kHz, 4 kHz
Noise Level: –130 dBm @ IFBW=20 Hz, ATT=0 dB, frequency ≥100 kHz
Maximum Input Level: 0 dBm
Impedance: 50 Ω
Crosstalk: <–100 dB
Dynamic Accuracy: ±0.02 dB, ± 0.12° (input level –10 to –50 dB, 20 Hz IFBW)

Delay Characteristics

Aperture Frequency: 0.5 to 20%
Display Range: 10 ps to 500 s
Accuracy: (Phase accuracy)/(360 x aperature)
Size: 425 mm W x 235 mm H x 553 mm D (16.75 in x 9.25 in x 21.77 in)
Weight: 28 kg (61.6 lb)

Key Literature

HP 8751A Network Analyzer Data Sheet, p/n 5952-2370

Ordering Information

HP 8751A Network Analyzer
- **Opt 001** High-Stability Frequency Reference
- **Opt 002** HP Instrument BASIC and 1 MB RAM
- **Opt 907** Front Handle Kit
- **Opt 908** Rackmount Kit
- **Opt 909** Rack Flange and Handle Kit
- **Opt 910** Extra Operating Manual
- **Opt 915** Add Service Manual

HP 87511A 50 Ω S-Parameter Test Set*
- **Opt 001** N-Type Port

HP 87511B 75 Ω S-Parameter Test Set*
- **Options (common for the HP 87511A/B)**
- **Opt 907** Front Handle Kit
- **Opt 908** Rackmount Kit
- **Opt 909** Rack Flange and Handle Kit
- **Opt 910** Extra Operating Manual

HP 87512A 50 Ω Transmission/Reflection Test Kit*
HP 87512B 75 Ω Transmission/Reflection Test Kit*
HP 41802A 1 MΩ Input Adaptor
HP 41800A Active Probe

*See above literature for details.

- 300 kHz to 1.3 GHz (HP 8712ET/ES) or 3 GHz (HP 8714ET/ES)
- Narrowband and broadband detection
- 100 dB dynamic range
- Real-time sweep speeds (50 ms/sweep)
- Integrated T/R or S-parameter test set
- Synthesized source with 1-Hz resolution
- Standard LAN interface
- Standard internal HP Instrument BASIC (IBASIC)
- Standard 2, 6, and 12-port switching test sets available
- Optional fault-location and SRL measurements

HP 8712ET
HP 8712ES
HP 8714ET
HP 8714ES

NEW

RF Economy Network Analyzers

NEW HP-IB

Now with S-Parameter Capability

The HP 8712E and 8714E family of RF economy network analyzers provide speed, accuracy and automation features in a compact, integrated instrument for high-volume RF component manufacturing, inspection and maintenance. The addition of S-parameter measurement capability to this product family brings new levels of accuracy, convenience and affordability for testing both forward and reverse characteristics of components.

Family Features

An integrated synthesized source and a choice of transmission/reflection analyzers (ET models) or S-parameter analyzers (ES models) allow you to choose the optimum level of performance versus cost for your applications. All these analyzers provide fast, complete swept-frequency and swept-power characterization of RF components with a single connection. The internal synthesized source provides a fast (50 ms/sweep), stable (1-Hz resolution) stimulus for accurate measurements on a variety of RF components.

For linear and nonlinear characterization of components, these instruments have sensitive receivers with both narrowband and broadband detection. Broadband detection allows characterization of frequency-translation devices (for measuring mixer conversion loss, for example), while narrowband detection provides more than 100 dB of dynamic range for testing high-rejection, narrowband devices such as mobile-communications channel filters. Power sweeps enable testing of amplifier gain compression and AM-to-PM conversion. A built-in DOS-compatible 3.5-inch disk drive allows unlimited storage of instrument states, calibration and measurement data, and graphical screen dumps in bit-mapped or vector formats.

The instruments are equipped with a large, 9-inch monochrome display. For enhanced viewing, any VGA-compatible color monitor can easily be connected, giving operators a clear, full-color view of display information such as trace data, limit lines, pass/fail indicators and markers. This is especially useful when the instrument cannot be located near the operator. Display formats include linear and log magnitude, group delay, phase, SWR, polar, Smith chart, and real and imaginary.

Designed for Manufacturing

The HP RF economy network analyzers are optimized for high-volume manufacturing, with the speed and automation features and low cost to help reduce test times, increase throughput and lower your overall cost per component. One important feature for manufacturers is the standard TCP/IP-compliant Ethertwist LAN interface. This interface makes the simultaneous distribution of new test programs, test parameters, limit lines and custom interfaces to all the instruments on your production lines fast and reliable. With LAN capability, both R&D and manufacturing departments can readily share and analyze data, such as examining pass/fail trends by material and lot number, reviewing operator productivity or identifying test stations that require calibration. All this helps you improve the quality of your processes and components, and helps you achieve an accurate overview of production efficiency, inventory turns and cost per test.

With the standard Instrument BASIC programming language (IBASIC), custom test applications and user interfaces can easily be created, including graphical setup diagrams, user prompts, special softkey labels and much more. IBASIC can be used to provide bar-code-reading capability, which lets you efficiently track and document individual device performance along with operator and test station identification. For simpler applications, IBASIC can be used as a keystroke recorder, allowing you to easily automate manual measurements without programming expertise. IBASIC can also control other test instruments via the LAN, HP-IB, serial or parallel interfaces.

Many manufacturing tests can be accomplished by merely recalling the appropriate instrument state, eliminating the need to change measurement parameters manually. Literally hundreds of instrument states can be programmed for a variety of uses. With HP's "fast-recall" feature, any one of seven instrument states can be quickly recalled with a single softkey, or with an optional foot switch for hands-free switching during alignment or assembly operations. Instrument states can include user-defined limit lines that let you easily and consistently compare measured data to test limits, which provides automated pass/fail testing. The pass/fail results are displayed clearly on the instrument screen or external monitor to minimize operator errors or misinterpretation. Automated pass/fail testing eliminates the guesswork from your test processes and helps ensure that your components are aligned and tested to the same specifications at all test stations.

ET Models

The HP 8712ET and HP 8714ET feature built-in transmission/reflection test sets with a full range of magnitude and phase measurements. Two independent channels can measure and display two device parameters, such as transmission and reflection response, in a variety of formats including complex impedance, SWR, and delay, on rectangular, polar or Smith-chart displays. These analyzers also employ advanced vector-error-correction techniques to enhance measurement accuracy. The HP 8712ET has a frequency range of 300 kHz to 1.3 GHz, while the HP 8714ET has a frequency range of 300 kHz to 3 GHz.

For a wider range of output power levels to test active devices and components, Option 1E1 adds a 60-dB step attenuator, which extends the lowest power-level setting to -60 dBm. Both 50-ohm and 75-ohm versions are available.

ES Models

The HP 8712ES and HP 8714ES feature S-parameter test sets with full two-port vector-error correction, providing complete and accurate measurements of device S-parameters. Two independent channels can measure and display two parameters such as S21 (transmission) and S11 (reflection) in a variety of formats including delay and SWR, on rectangular, polar or Smith-chart displays. The HP 8712ES has a frequency range of 300 kHz to 1.3 GHz, while the HP 8714ES has a frequency range of 300 kHz to 3 GHz.

The ES models contain a 60-dB source attenuator as a standard feature, giving 70 dB of power-level control for testing active and passive devices. Both 50-ohm and 75-ohm versions are available.

Comprehensive, Fast Cable Test

When cable does not meet specifications, it is an expensive problem for manufacturers, installers, and maintainers. Option 100 fully tests cables that may have been invisibly damaged through shipment and verifies manufacturer's data.

Option 100 is easy to use and lowers your cost per test with faster, less error-prone measurements of loss, impedance, structural return loss (SRL), and fault location.

SRL is the ratio of incident to the reflected signal, giving the reflection coefficient referenced to the cable's impedance. Periodic disturbances that can cause SRL are usually created by manufacturing or reel-handling incidents. Too small by themselves to cause problems, reflections from each incident can sum coherently. This causes significant reflections at a frequency with a wavelength corresponding to the disturbance spacing, times two. Option 100 also gives you the capability to utilize a known short cable length and determine velocity factor and cable loss per 100 feet. Option 100's multibump correction automatically compensates for multiple reflections from cable faults or connectors that cause inaccurate measurement of subsequent faults.

HP offers optional 50- and 75-ohm 10-, 15- and 30-foot low-loss, phase-stable cables, and a complete selection of calibration kits.

HP 87075C Multiport Test Set

The HP 87075C multiport test set allows the complete characterization of multiport devices with a two-port network analyzer. The HP 87075C has a frequency range of 300 kHz to 1.3 GHz and operates with 75-ohm HP 8712ET, 8712ES, 8714ET, and 8714ES network analyzers. Three options allow you to choose the number of ports that best fit your needs—either 2, 6, or 12 ports.

The test set provides switching capability for the measurement ports, and tests all desired signal paths, with only one connection to the device-under-test. Now multiport-device manufacturers can decrease tune and test time, reduce operator fatigue and misconnection rates, and reduce the wear on cables, fixtures and connectors.

In addition to basic switching capability, the HP 87075C gives you specified performance at the test port. The test set is shipped with a factory-complete installation (default) calibration, which includes calibration of all measurement ports. You can use this default calibration, or complete your own installation calibration.

In between "installation" calibrations, the instrument can quickly "on-line" calibrate (SelfCal) the measurement ports using internal transfer standards. The network analyzer's firmware automatically controls the SelfCal process. SelfCal quickly brings the system to the same accuracy level as the installation calibration. The SelfCal capability can reduce calibration times by a factor of 20.

Calibration Kits

Accuracy enhancement removes systematic errors by measuring known devices (standards) over the frequency range of interest. Kits for the RF economy network analyzer family contain standards to characterize these errors.

HP 85032E 50 Ω Type-N Economy Calibration Kit

The HP 85032E contains 50 Ω type-N standards to calibrate network analyzers to measure devices with 50 Ω type-N connectors. Standards include a fixed termination, open circuit, and short circuit.

HP 85033D 3.5-mm Calibration Kit

The HP 85033D contains 50 Ω 3.5-mm standards to calibrate network analyzers to measure devices with 50 Ω 3.5-mm connectors. Standards include a fixed termination, open circuit, and short circuit.

HP 85036E 75 Ω Type-N Economy Calibration Kit

The HP 85036E contains 75 Ω type-N standards to calibrate network analyzers to measure devices with 75 Ω type-N connectors. Standards include a fixed termination, open circuit, and short circuit.

HP 85039B 75 Ω Type-F Calibration Kit

The HP 85039B contains 75 Ω type-F standards, both male and female, to calibrate network analyzers for measurements of common broadband and CATV components with 75 Ω type-F connectors. Standards include a fixed load, open circuit, and short circuit. The following adapters are also included: type-F (f-f), type-F (m-m), type-N (f) to type-F (m) and type-N (m) to type-F (f). A complete male set of standards (fixed-load, open, short) and (m-m) adapter can be ordered as HP 85039B Option 00M, and a complete female set as HP 85039B Option 00F.

Additional type-F adapters available: type-F (m) to type-N (m) (85039-60010), type-F (m) to type-F (f) (85039-60012), and type-F (f) to type-N (f) (85039-60014).

Key Literature

RF Economy Network Analyzers Technical Specifications, p/n 5967-6314E
RF Economy Network Analyzers Configuration Guide, p/n 5967-6315E
RF Economy Network Analyzers Brochure, p/n 5967-6316E
HP 87075C Multiport Test Set Product Overview, p/n 5965-8165E

Specifications Summary

Source Characteristics

Frequency Range
HP 8712ET/ES: 300 kHz to 1.3 GHz
HP 8714ET/ES: 300 kHz to 3 GHz
Frequency Resolution: 1 Hz
Frequency Accuracy: < 5ppm
Harmonics
< 1 MHz
HP 8712ET/ES: < -20 dBc
HP 8714ET/ES: < -30 dBc
> 1 MHz: < -30 dBc

	ET models	ES models
Power Range		
No attenuator, 50 Ω		
< 1 GHz	0 to +16 dBm	--
> 1 GHz	0 to +13 dBm	--
No attenuator, 75 Ω	reduces output by 3 dB	--
With attenuator, 50 Ω		
< 1 GHz	-60 to +11 dBm	-60 to +8 dBm
> 1 GHz	-60 to +8 dBm	-60 to +5 dBm
With attenuator, 75 Ω	reduces output by 3 dB	
Level Accuracy		
No attenuator, 50 Ω	± 1 dB	--
No attenuator, 75 Ω	± 1.5 dB	--
With attenuator, 50 Ω	± 2 dB	± 2 dB
With attenuator, 75 Ω	± 3 dB	± 3 dB

Receiver Characteristics

Minimum Frequency (all models)
Narrowband: 300 kHz
Broadband: 10 MHz
Maximum Frequency
HP 8712ET/ES: 1.3 GHz
HP 8714ET/ES: 3 GHz

	ET models	ES models
Dynamic Range		
Narrowband, 50 Ω	> 100 dB	> 92 dB
Broadband, 50 Ω	> 66 dB	> 58 dB
With 75 Ω option	reduces dynamic range by 3 dB	
Maximum input (0.5 dB compression)		
Narrowband	+20 dBm	+20 dBm
Broadband	+16 dBm	+20 dBm
Input damage level	+20 dBm	+26 dBm

System Specifications

Directivity (corrected): 40 dB
Source Match (corrected): 35 dB
Load Match (corrected, ES models only): 45 dB
Load Match (uncorrected): 16 dB
Forward Sweep (201 points, 1-port/resp cal): 40 ms
Trace Transfer (201 points, real format): 20 ms

Physical Characteristics

Test-port Connectors: 50 Ω or 75 Ω Type-N female
Size: 179 mm H x 425 mm W x 514 mm D (7.0 in x 16.75 in x 20.25 in)
Weight
Net: 20.5 kg (45 lb)
Shipping: 27 kg (59 lb)

Detectors and Bridges

External detectors (50 Ω and 75 Ω) and bridges are available for remote device measurements.

HP 86200B 50 Ω Scalar Detector

An external scalar detector for use when measuring external 50 Ω devices.

HP 86201B 75 Ω Scalar Detector

An external scalar detector for use when measuring external 75 Ω devices.

HP 86205A 50 Ω Bridge

An external directional bridge that offers high directivity and excellent port match and is designed for 50 Ω device measurements.

HP 86207A 75 Ω Bridge

An external directional bridge that offers high directivity and excellent port match and is designed for 75 Ω device measurements.

Upgrade Kits

The following upgrade kits add optional measurement capability to existing HP RF economy network analyzers.

HP 86223B Attenuator Upgrade Kit

Provides the necessary components to retrofit an HP 8712ET or HP 8714ET (RF economy network analyzer) with a 60 dB step attenuator (Option 1E1). Also available as HP p/n 08711-60067.

HP 86228C Fault Location/SRL Upgrade Kit

Does not include transport case.

HP 86226C Firmware Upgrade Kit

Upgrade to the latest revision of firmware.

HP D4950B DIN Keyboard

PC keyboard to enhance editing capability (Option 1CL).

Test Port Cables

Replacement test port cables are available as HP part numbers. One economy cable is standard for the RF economy network analyzers.
HP 8120-6469 Economy Cable; Type-N, 50 Ω (included with RF ENAs)
HP 8120-4781 Precision Cable; Type-N, 50 Ω
HP 8120-6468 Economy Cable; Type-N, 75 Ω (included with RF ENAs, Option 1EC)
HP 8120-2408 Precision Cable; Type-N, 75 Ω

Ordering Information

HP 8712ET Network Analyzer
HP 8712ES Network Analyzer
HP 8714ET Network Analyzer
HP 8714ES Network Analyzer
- **Opt 1EC** 75 Ω System Impedance
- **Opt 1E1** 60 dB Attenuator (ET models only)
- **Opt 1CL** DIN Keyboard
- **Opt 1CM** Rackmount
- **Opt 100** Fault Location/SRL
- **Opt 101** Transportable Operating Case plus Fault Location/SRL

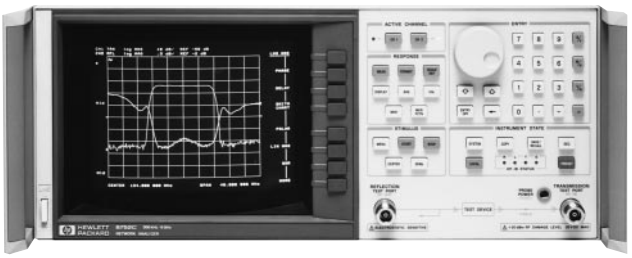
HP 85075C Multiport Test Sets
- **Opt 002** 2 ports
- **Opt 004** 4 ports
- **Opt 012** 12 ports

HP 86223B Attenuator Upgrade Kit
HP 86228C FL/SRL Upgrade Kit
HP 86226C Firmware Upgrade Kit
HP D4950B DIN Keyboard

Accessories
HP 85032E Type-N Calibration Kit, 50 Ω
HP 85036E Type-N Calibration Kit, 75 Ω
HP 85033D 3.5-mm Calibration Kit
HP 85039B 75 Ω Type-F Calibration Kit
- **Opt 00F** Female Standards Set
- **Opt 00M** Male Standards Set

HP 11853A Type-N Accessory Kit, 50 Ω
HP 11854A BNC Accessory Kit, 50 Ω
HP 11855A Type-N Accessory Kit, 75 Ω
HP 11856A BNC Accessory Kit, 75 Ω
HP 86211A Type-F Accessory Kit, 75 Ω
HP 86200B 50 Ω Scalar Detector
HP 86201B 75 Ω Scalar Detector
HP 86205A 50 Ω Bridge
HP 86207A 75 Ω Bridge
HP 8120-1839 BNC Test Port Cable, 50 Ω
HP 5063-0061 BNC Test Port Cable, 75 Ω
HP 8120-6469 Economy Type-N Cable, 50 Ω
HP 8120-6468 Economy Type-N Cable, 75 Ω
HP 8120-4781 Precision Type-N Cable, 50 Ω
HP 8120-2408 Precision Type-N Cable, 75 Ω
HP 9211-2656 Transit Case

- 300 kHz to 1.3, 3, or 6 GHz
- Integrated 1 Hz resolution synthesized source
- Integrated transmission/reflection test set
- 50 Ω or 75 Ω system impedance
- Direct save/recall to an external disk drive
- Test sequence function for repetitive test procedures
- Up to 110 dB of dynamic range
- Group delay and deviation from linear phase
- Superb uncorrected performance



HP 8752C

HP 8752C RF Network Analyzer

The new HP 8752C RF network analyzer provides simple and complete vector network measurements in a compact, fully-integrated RF network analyzer. Characterize your RF components and networks accurately and economically with the HP 8752C RF network analyzer in the 300 kHz to 1.3, 3, or 6 GHz frequency range. Integration of the swept synthesized source, test set, and receiver results in a network analyzer that is easy to set up and use, which is ideal for service, incoming inspection, production, and final test measurements.

The integrated synthesized source provides measurement port power level of +5 to –20 dBm with linear, log, list, power, and CW sweep types. A built-in step attenuator (Option 004) gives an improved power range of +10 to –85 dBm for testing power sensitive devices such as amplifiers. The sensitive tuned receivers provide up to 110 dB of dynamic range.

With two independent display channels available, you can simultaneously measure the reflection and transmission characteristics of the device-under-test on the crisp color display. Data can be displayed in log magnitude, linear magnitude, SWR, phase, group delay, polar, real, or Smith chart formats. The easy-to-use softkey measurement functions allow you to quickly measure the desired characteristic of your device-under-test.

Designed for Manufacturing

The productivity features of the HP 8752C increase your throughput in production. The test sequence function provides rapid and consistent execution of complex, repetitive tests with a single keystroke. In sequencing mode, you make the measurement once from the front panel and the instrument automatically saves the keystrokes without an external computer.

The HP 8752C offers excellent uncorrected performance, allowing simple and accurate measurements of your device-under-test without the need for measurement calibration. New productivity enhancements are faster CPU clock rate, DOS format for disk output, and expanded nonvolatile memory of 512 KB. Other helpful features include a plot/print buffer, limit testing, arbitrary frequency testing, and marker tracking functions. Up to four onscreen markers per channel are available for hardcopy outputs or for tuning at specific frequencies.

Time-Domain Analysis

The HP 8752C with Option 010 has the capability of displaying the time domain response of a network, obtained by computing the inverse Fourier transform of the frequency-domain response. Two time-domain modes are offered with the HP 8752C. The low-pass mode provides traditional time domain reflectometer (TDR) measurement capability and gives the response of a mathematically simulated step or impulse response. The bandpass mode, which has only the impulse stimulus, provides the time domain response of frequency-selective devices such as SAW filters and antennas.

Key Literature

HP 8752C RF Vector Network Analyzer Product Overview, p/n 5966-0056E

Specifications Summary

Source

Frequency Characteristics

Range: 300 kHz to 1.3 GHz (std.); 300 kHz to 3 GHz (Option 003); 300 kHz to 6 GHz (Option 006)
Resolution: 1 Hz
Accuracy: ±10 ppm at 25° ± 5° C

Output Characteristics

Power Range: –20 to +5 dBm (std), –85 to +10 dBm (Option 004), –85 to +8 dBm (Option 004 and 075)
Resolution: 0.05 dB
Level Accuracy: ±1 dB
Level Linearity relative to–5 dBm output level:
(–20 to –15 dBm) ±0.5 dB;
(–15 to 0 dBm) ±0.2 dB;
(0 to +5 dBm) ±0.5 dB

Receiver

Frequency Range: 300 kHz to 1.3 GHz (std.), 300 kHz to 3 GHz (Option 003), 300 kHz to 6 GHz (Option 006)
Noise Level: (typical)
Reflection: –75 dBm (3 kHz IF BW), –85 dBm (10 Hz IF BW)
Transmission:
–90 dBm (3 kHz IF BW), –110 dBm (10 Hz IF BW) [300 kHz to 3 GHz];
–85 dBm (3 kHz IF BW), –105 dBm (10 Hz IF BW) [3 to 6 GHz]
Damage Level: 20 dBm or 25 Vdc (Option 006: 20 dBm or 25 Vdc at reflection port, 20 dBm or 10 Vdc at transmission port)
Crosstalk: 100 dB, 300 kHz to 1.3 GHz; 100 dB (97 dB Option 075), 1.3 to 3 GHz; 90 dB, 3 to 6 GHz

Group Delay Characteristics

Range: 1/(2 x minimum aperture)
Aperture: Frequency span/(no. of points –1), up to 20% of frequency span
Accuracy (in seconds): (phase accuracy (in degrees)/ (360 x aperture in Hz)

RF Connectors

Test Ports: 50 Ω type-N (female); 75 Ω type-N (female) (Option 075)

Physical Characteristics

Size: 425 mm W x 178 mm H x 508 mm D (16.75 in x 7.0 in x 20.0 in)
Weight: Net, 25 kg (56 lb); shipping, 28 kg (63 lb)

Upgrade Kits

(Serial number of 8752C must be specified when ordering these kits.)

HP 11885A 3 GHz Frequency Upgrade Kit
The HP 11885A upgrade kit adds Option 003 to extend the operating frequency range of the HP 8752C from 1.3 GHz to 3 GHz. Installation at an HP service center is included.

HP 85019C Time-Domain Upgrade Kit
The HP 85019C upgrade kit adds time-domain analysis capability (Option 010) to an existing HP 8752C network analyzer. This kit is user installable. Installation at local HP service center is not included.

HP 11884D 6 GHz Upgrade Kit for HP 8752C
Includes installation at a local HP service center. Not for use with HP 8752C Option 075.

HP p/n 08752-60019 Step Attenuator Retrofit Kit

Accessories

HP 11878A 3.5-mm Adapter Kit
The HP 11878A adapter includes four type-N to 3.5-mm adapters for both male and female connectors for measurements of SMA or 3.5 mm devices.
HP 11853A 50 Ω Type-N Accessory Kit
The HP 11853A accessory kit furnishes the RF components required for measurement of devices with 50 Ω type-N connectors.
HP 11854A 50 Ω BNC Accessory Kit
The HP 11854A accessory kit furnishes the RF components required for measurement of devices with 50 Ω BNC connectors.
HP 11855A 75 Ω Type-N Accessory Kit
The HP 11855A accessory kit furnishes the RF components required for measurement of devices with 75 Ω type-N connectors.
HP 11856A 75 Ω BNC Accessory Kit
The HP 11856A accessory kit furnishes the RF components required for measurement of devices with 75 Ω BNC connectors.
Test Port Cables: Additional or replacement cables (24 in) for the HP 8752C:
HP p/n 8120-4781 Type-N 50 Ω (both connectors male)
HP p/n 8120-2408 Type-N 75 Ω (both connectors male)
HP p/n 8120-2409 Type-N 75 Ω (one male, one female connector)
HP 11930B RF Limiter, Type-N
Protects the HP 8752C from damage due to high power, from 5 MHz to 6 GHz. Max input power is 6 watts peak or 3 watts continuous.
HP 11852B 50 Ω /75 Ω Minimum Loss Pad
The HP 11852B is a low SWR minimum loss pad required when measurements are made on 75 Ω devices with the HP 8752 network analyzer. Measurements on two port devices require two HP 11852B pads and one 50 Ω type-N barrel.
Frequency Range: dc to 3.0 GHz
Insertion Loss: 5.7 dB
Return Loss: 75 Ω typically >30 dB, 50 Ω typically >26 dB
Connectors: 50 Ω type-N (f) and 75 Ω type-N (m) standard, 50 Ω type-N (m) and 75 Ω type-N (f) Option 004

Calibration Kits

The calibration kits in the HP 8752C family contain precision standards used in accuracy enhancement procedures to characterize the systematic errors of an HP 8752C measurement system. Standards include fixed terminations, open circuits, and short circuits.
HP 85032B 50 Ω Type-N Calibration Kit
Contains precision 50 Ω type-N standards. This kit can also be used to perform system verification. Option 001 removes the precision phase-matched 7 mm to type-N adapters.
HP 85036B 75 Ω Type-N Calibration Kit
Contains precision 75 Ω type-N standards used to calibrate the HP 8752B or 8752C Option 075. This kit also contains 75 Ω type-N adapters and can also be used to perform system verification.
HP 85033D 3.5-mm Calibration Kit
Contains precision 3.5-mm standards used to calibrate the HP 8752C network analyzer for measurements of devices with 3.5-mm or SMA connectors. Option 001 removes the precision phase-matched 7-mm to 3.5-mm adapters.
HP 85039B Type-F Calibration Kit
Contains 75 Ω type-F fixed load, and open and short circuits (both male and female) to calibrate the HP 8752C for measurements of common broadband and CATV components. Also includes type-F f-f and m-m adapters, and type-N to type-F f-m and m-f adapters. A male-only version of the cal kit can be ordered as HP 85039B Option 00M and a female-only version can be ordered as HP 85039B Option 00F.

Ordering Information

HP 8752C Network Analyzer
Opt 003 3 GHz Frequency Extension
Opt 004 Step Attenuator
Opt 006 6 GHz Frequency Extension
Opt 010 Time-Domain Capability
Opt 075 75 Ω Impedance
Opt 802 Add Dual Disk Drive and HP-IB Cable
Opt AFN Add 50 Ω Test Port Cable
Opt AFP Add 75 Ω Test Port Cable

For information on compatible printers, visit:
http://www.hp.com/go/pcg

HP 11885A 3 GHz Frequency Upgrade
HP 85019C Time-Domain Upgrade
HP 11884D 6 GHz Upgrade Kit
HP 85032B 50 Ω Type-N Calibration Kit
Opt 001 Deletes 7 mm to Type-N Adapters
HP 85036B 75 Ω Type-N Calibration Kit
HP 85033D 3.5-mm Calibration Kit
HP 85039B Type-F 75 Ω Calibration Kit
Option 00F Female Standards Only
Option 00M Male Standards Only
HP 11878A 3.5-mm Adapter Kit
HP 11853A 50 Ω Type-N Accessory Kit
HP 11854A 50 Ω BNC Accessory Kit
HP 11855A 75 Ω Type-N Accessory Kit
HP 11856A 75 Ω BNC Accessory Kit
HP 11852B 50 Ω/75 Ω Minimum Loss Pad
Opt 004 50 Ω Type-N (m) and 75 Ω Type-N (f) connectors
HP 11930B RF Limiter, Type-N
HP 8120-4781 50 Ω Type-N Test Port Cable
HP 8120-2408 75 Ω Type-N Test Port Cable
HP 08752-60019 Step Attenuator Retrofit Kit
HP 8120-2409 75 Ω Type-N (m-f) Test Port Cable
HP 85024A High-Frequency Probe

HP 85024A High-Frequency Probe

The HP 85024A high-frequency probe makes it easy to perform in-circuit measurements. An input capacitance of only 0.7 pF shunted by 1 megaohm of resistance permits high-frequency probing without adversely loading the circuit-under-test. Excellent frequency response and unity gain guarantee high accuracy in swept measurements with this probe. High probe sensitivity and low distortion levels allow measurements to be made while taking advantage of the full dynamic range of HP RF analyzers. Spectrum analyzers that supply probe power from the front panel include the HP 8568B, HP 8590 series, HP 8560 series, and the HP 70000 series. RF network analyzers such as the HP 8753E, 8752C, 8751A, 3577A, and 4195A are also directly compatible. You can use the HP 85024A with other instruments by using the HP 1122A probe power supply or any dual ±15 V, 130 mA supply.

HP 85024A

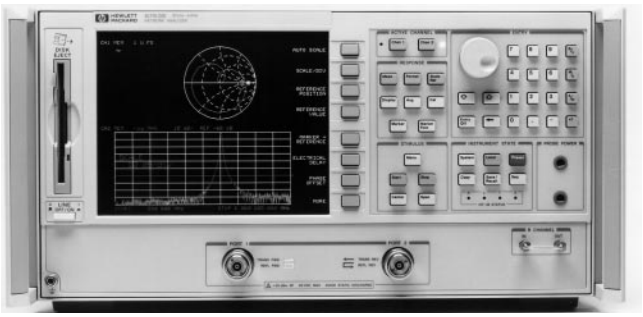
Specifications Summary

Input Capacitance (at 500 MHz): <0.7 pF (nominal)
Input Resistance: 1 MΩ (nominal)
Bandwidth: 300 kHz to 3 GHz (usable to 100 kHz)
Gain (at 500 MHz): 0 dB ±1 dB
Average Noise Level (10 Hz to 10 MHz): <1 mV
Frequency Response: ±1 dB (300 kHz to 1 GHz); +2, –3 dB (1 GHz to 3 GHz)
Input Voltage for 1 dB Compression: 0.3 V peak
Maximum Safe RF Voltage: 1.5 V peak (with 10:1 divider 15 V peak)
Noise Figure (nominal): <50 dB (<100 MHz); <25 dB (100 MHz to 3 GHz)
Distortion (at 0.3 V): <–30 dBc nominal
Includes: Type-N male adapter, 10:1 divider, spare probe tips, (5) 2½-inch ground leads, hook tip, spanner tip, and probe tip nut driver.

HP 8753E

NEW

- 30 kHz to 3 or 6 GHz frequency range
- Integrated S-parameter test set with solid-state switching
- Up to 110 dB dynamic range
- Fast measurement speeds and data-transfer rates
- Large LCD display with VGA output for external monitors
- Display all four S-parameters at the same time
- Save/recall instrument states and data to built-in floppy-disk drive
- Optional time-domain and swept-harmonic measurements



HP 8753E

HP 8753E RF Network Analyzer NEW

The HP 8753E RF network analyzer offers an unbeatable combination of speed, performance and ease-of-use to meet your measurement needs, whether in the R&D laboratory or on the production floor. With an integrated S-parameter test set covering 30 kHz to 3 or 6 GHz, up to 110 dB of dynamic range, and both frequency and power sweeps, the HP 8753E gives you a complete solution for characterizing the linear and nonlinear behavior of active and passive networks, devices, components and sub-systems. A new processor has been incorporated which makes measurement and data-transfer speeds up to seven times faster than the previous model.

The network analyzer features two independent measurement channels that can measure and display all four S-parameters simultaneously. You can choose to display any combination of reflection and transmission parameters, with magnitude, phase, group-delay, Smith-chart, polar, SWR, or time-domain formats. Easy-to-use softkeys let you access measurement functions quickly, and you can view results in overlay or split-screen format on the crisp, LCD color display using one, two or four graticules. A VGA-compatible output has been added to drive larger external monitors for optimum viewing.

Maximum Versatility and Performance

An integrated, synthesized source provides up to 10 mW of output power (100 mW for Option 011), 1 Hz frequency resolution, and linear-frequency, log-frequency, list-frequency, CW, and power sweep types. Three tuned receivers allow independent power measurements or simultaneous ratio measurements over a wide dynamic range of 105 dB at 6 GHz (with Option 006 frequency extension) or 110 dB at 3 GHz (standard). The integrated test set allows you to measure transmission and reflection characteristics of a device to 6 GHz without a frequency doubler.

TRL*/LRM* [1] calibration is available for convenient, accurate measurements in noncoaxial environments. An adapter-removal calibration technique has been added for highly-accurate measurements of non-insertable devices. A high-stability frequency reference, Option 1D5, improves the frequency accuracy of measurements of high-Q devices such as SAW and crystal resonators or dielectric-resonance filters. For configuration flexibility, Option 011 deletes the built-in test set so that you can select your own. The HP 8753E Option 011 works with the HP 85046A/B and 85047A S-parameter test sets, and other specialized test sets for specific applications. A new option for automated manufacturing has been added which deletes the internal display and lowers the cost of the instrument (Option 1DT).

Productivity Enhancements

Test sequencing allows rapid, repeated execution of complex measurements with a single keystroke. In test-sequence mode, you make a measurement once from the front panel, and the analyzer stores the keystrokes so that the measurement can be repeated without any additional programming. You can also use a test sequence to control external devices through the parallel or HP-IB port.

Other productivity enhancements include a built-in floppy-disk drive supporting LIF and DOS formats, a faster CPU clock rate, non-volatile memory of 2MB, serial and parallel interfaces, a DIN keyboard interface, and a real-time clock for time-stamping of printouts and files. Limit testing, arbitrary frequency testing, and marker-tracking functions are included. You can reduce measurement time by using swept-list mode to choose specific frequencies to test, and to set independent IF bandwidths and power levels in each frequency range. Segmented calibration and interpolated error correction allow you to apply vector-accuracy enhancement over a subset of the analyzer's calibrated frequency range. The HP 8753E is code-compatible with the HP 8753D, so your existing software does not need to be modified.

Nonlinear Device Testing

For more advanced nonlinear characterization of devices, Option 002 adds harmonic-measurement capability. Swept second- and third-harmonic levels of an amplifier can be displayed absolutely or in dBc relative to the fundamental. With the press of a button, you can measure harmonics down to -40 dBc. Power-meter calibration provides leveled absolute power to devices that are sensitive to absolute input or output levels. The HP 8753E automatically controls an HP 436A, 437B, 438A, EPM-441A or EPM-442A power meter to set the power anywhere in the test setup with power-meter accuracy, or to calibrate the network analyzer receivers for accurate absolute-power measurements.

For measurements of mixers, tuners, and other frequency-translating devices, the frequency-offset mode allows the network analyzer source to be tuned independently from the receivers. Measurements of conversion loss, phase, group-delay, and mixer-tracking can easily be done, with either fixed- or swept-IF testing.

Time-Domain Analysis

With Option 010, you can view reflection or transmission responses in the time domain. The analyzer computes the inverse FFT of the frequency-domain data to display the reflection or transmission coefficient versus time. Two time-domain analysis modes enable you to view the step or impulse response of your device. Time gating can be used to remove unwanted responses such as connector mismatch, and the gated results can be displayed in either the time or frequency domains.

Key Literature

HP 8753E Network Analyzer Brochure, p/n 5966-0053E
HP 8753E Network Analyzer Technical Specifications, p/n 5966-0054E
HP 8753E Network Analyzer Configuration Guide, p/n 5966-0055E

For more information, visit our web site: **http://www.hp.com/go/8753**

[1] TRL* and LRM* are three-sampler implementations of the through-reflect-line and line-reflect-match calibration techniques.

5

Specifications Summary

Test Set
Integrated S-parameter with complete forward and reverse measurements in 50 Ω (standard) or 75 Ω (Option 075). External test sets supported with Option 011.

Test Port Output
Frequency Characteristics
Range: 30 kHz to 3 GHz (std.);
30 kHz to 6 GHz (Option 006);
300 kHz to 3 GHz (Option 011);
30 kHz to 6 GHz (Option 011, 006)
Resolution: 1 Hz
Accuracy: ±10 ppm at 25 °C ± 5 °C
Output Characteristics
Power Range: –85 to 10 dBm; –85 to 8 dBm (Option 075)
Resolution: 0.05 dB
Sweep Range: 25 dB
Level Accuracy: ±1.0 dB relative to 0 dBm output level
Level Linearity: (–15 to +5 dBm) ±0.2 dB
(+5 to +10 dBm) ±0.5 dB
(typical 30 kHz to 300 kHz)
Impedance: 50 Ω (standard); 75 Ω (Option 075)
2nd Harmonic: <–25 dBc at +10 dBm (16 MHz to 3 GHz)
3rd Harmonic: <–25 dBc at +10 dBm (16 MHz to 2 GHz)
Nonharmonic Spurious (typical)
Mixer-Related: <–30 dBc at +10 dBm

Test Port Input Characteristics
Frequency Range: 30 kHz to 3 GHz (std.);
30 kHz to 6 GHz (Option 006)
Average Noise Level
3 kHz BW: –82 dBm (<3 GHz), –77 dBm (3 to 6 GHz)
10 Hz BW: –102 dBm (<3 GHz), –97 dBm (3 to 6 GHz)
Maximum Input Level: +10 dBm
Damage Level: +26 dBm or 35 Vdc
Impedance: 50 Ω (75 Ω with Option 075)
Harmonics: (Option 002)
2nd Harmonic: <–15 dBc at +8 dBm
3rd Harmonic: <–30 dBc at +8 dBm
Harmonic Measurement Accuracy (25 ± 5 °C):
16 MHz to 3 GHz ± 1 dB;
3 GHz to 6 GHz ± 3 dB (with Option 006)
Harmonic Measurement Dynamic Range
–40 dBc (output= –10 dBm, input < –15 dBm)

Group Delay Characteristics
Range: 1/(2 x minimum aperture)
Aperture (selectable)
Maximum: 20% of frequency span
Minimum: (frequency span)/(no. of pts. –1)
Group Delay Accuracy (in seconds): ± (phase accuracy in degrees)/(360 x aperture in Hz)

Physical Characteristics
Size: 425 mm W x 222 mm H x 457 mm D
(16.75 in x 8.75 in x 18 in)
Weight: 21 kg (46 lb) net; 35 kg (77 lb) shipping

Upgrade Kits for the HP 8753E

Upgrade kits retrofit the latest operating system or add optional measurement capability to existing network analyzers. The following kits are for upgrading an HP 8753E.

HP 8753EU Option 002 Harmonic-Measurements Upgrade
This upgrade kit adds harmonic-measurement capability (Option 002) to an HP 8753E network analyzer. This kit includes installation at an HP service center.

HP 8753EU Option 006 6 GHz Upgrade for Standard Units
This kit extends the operating frequency range of the standard HP 8753E from 3 GHz to 6 GHz. No additional test set is needed. Includes installation at an HP service center. Not compatible with Option 075 or Option 011.

HP 8753EU Option 611 6 GHz Upgrade for Option 011 Units
This kit extends the operating frequency range of the HP 8753E Option 011 from 3 GHz to 6 GHz. Includes installation at an HP service center. Not compatible with Option 075.

HP 8753EU Option 010 Time-Domain Upgrade
This upgrade kit adds time-domain-analysis capability (Option 010) to an existing HP 8753E network analyzer. This kit is user-installable.

HP 8753EU Option 099 Firmware Upgrade Kit
This kit provides the latest version of firmware for the HP 8753E network analyzer. The kit is user-installable.

HP 8753EU Option 1D5 High-Stability Frequency Reference Upgrade
This option adds a high-stability frequency reference (Option 1D5) to an HP 8753E network analyzer. Includes installation at an HP service center.

Upgrade Kits for the HP 8753C/D

HP 8753DU Option 000 Processor Upgrade
This upgrade kit replaces the CPU board in the HP 8753D Standard or Option 011 with the CPU board from the HP 8753E. This upgrade significantly improves the measurement and data-transfer speed of the HP 8753D.

HP 11883A Harmonic Measurements Upgrade
This upgrade kit adds harmonic measurement capability (Option 002) to an HP 8753C/D network analyzer. This kit includes installation at an HP service center.

HP 11884A 6 GHz Receiver Upgrade
This kit extends the operating frequency range of the HP 8753C receiver from 3 GHz to 6 GHz. To make transmission/reflection measurements above 3 GHz, the HP 85047A S-parameter test set is required. This kit includes installation at an HP service center.

HP 11884B 6 GHz Upgrade for HP 8753D Standard
This kit extends the operating frequency range of the HP 8753D from 3 GHz to 6 GHz. No additional test set is needed. Includes installation at an HP service center. Not compatible with Option 075 or Option 011.

HP 11884C 6 GHz Upgrade for HP 8753D Option 011
This kit extends the operating frequency range of the HP 8753D Option 011 from 3 GHz to 6 GHz. Includes installation at an HP service center. Not compatible with Option 075.

HP 85019B Time-Domain Upgrade Kit
This upgrade kit adds time-domain analysis capability (Option 010) to an existing HP 8753C/D network analyzer. This kit is user-installable.

S-Parameter Test Sets

The S-parameter test sets provide the capability to measure reflection and transmission characteristics (including S-parameters) of two port devices in either direction with a single connection. The test sets are controlled from the analyzer and include programmable step attenuators. These test sets are used with the HP 8753A/B/C or the HP 8753D/E Option 011 only.

HP 85046A/B S-Parameter Test Sets

The HP 85046A/B test sets provide the capability to simultaneously measure the transmission and reflection characteristics of 50 and 75 ohm devices, respectively.

Specifications Summary

	HP 85046A	HP 85046B
Impedance	50 Ω	75 Ω
Frequency Range	300 kHz to 3 GHz	300 kHz to 2 GHz
Directivity	35 dB to 1.3 GHz 30 dB to 3.0 GHz	35 dB to 1.3 GHz 30 dB to 2.0 GHz
Typical Tracking		
Transmission Magnitude, Phase [1,2,3]		
0.3 MHz to 2.0 MHz	±1.5 dB, ±20°	±1.5 dB, ±20°
2.0 MHz to F_{max}	±1.5 dB, ±10°	±1.5 dB, ±10°
Reflection Magnitude, Phase [1,2,3]		
0.3 MHz to 2.0 MHz	±1.5 dB, ±25°	±1.5 dB, ±25°
2.0 MHz to F_{max}	±1.5 dB, ±10°	±1.5 dB, ±10°
Effective Source Match[3] **(test ports)**		
0.3 MHz to 2.0 MHz	14 dB	14 dB
2.0 MHz to 1.3 GHz	20 dB	17 dB
2.0 MHz to F_{max}	16 dB	16 dB
RF Connectors		
Test Ports	Precision 7 mm	75 Ω type-N (female)
All Others	50 Ω Type-N (female)	50 Ω Type-N (female)

[1] Degrees, specified as deviation from linear phase.
[2] F_{max} is the upper frequency limit of the associated test set.
[3] Can be improved through accuracy enhancement.

Includes: Four 190-mm (7.5 in) cables with Type-N (male) connectors for connection to the HP 8753. One HP 8753 test set interconnect cable.

Physical Characteristics
Size: 426 mm W x 90 mm H x 508 mm D (16.75 in x 3.5 in x 20 in)
Weight: Net, 6.8 kg (15 lb); shipping, 9.1 kg (20 lb)

HP 85047A S-Parameter Test Set

The HP 85047A test set includes a frequency doubler that can be switched in to measure 3 MHz to 6 GHz in a single sweep or switched out to measure 300 kHz to 3 GHz in a single sweep. The HP 8753B/C controls the frequency doubler. (The HP 8753D/E Option 006 and 011 with built-in 6 GHz source does not use the frequency doubler.) Option 006 (6 GHz receiver) is required to activate the HP 85047A.

Specifications Summary

Impedance: 50 Ω
Frequency Ranges: 300 kHz to 3 GHz and 3 MHz to 6 GHz (HP 8753B/C); 300 kHz to 6 GHz (HP 8753D/E Option 006 and 011)
Directivity: 300 kHz to 1.3 GHz: 35 dB;
1.3 GHz to 3 GHz: 30 dB; 3 GHz to 6 GHz: 25 dB
Typical Tracking
Transmission Magnitude, Phase:
300 kHz to 3 GHz: ±1.5 dB, ±10°;
3 GHz to 6 GHz: +0.5, – 2.5 dB, ±20°
Reflection Magnitude, Phase:
300 kHz to 3 GHz: ±1.5 dB, ±10°;
3 GHz to 6 GHz: ±1.5 dB, ±20°
Effective Source Match: 300 kHz to 1.3 GHz: 20 dB;
1.3 GHz to 3 GHz: 16 dB; 3 GHz to 6 GHz: 14 dB
RF Connectors
Test Ports: Precision 7 mm
All Others: 50 Ω Type-N (female)
Includes: Four 190 mm (7.5 in) cables with Type-N (male) connectors for connection to the HP 8753, one HP 8753 test set interconnect cable.

Physical Characteristics
Size: 426 mm W x 90 mm H x 508 mm D (16.75 in x 3.5 in x 20 in)
Weight: Net, 10 kg (22 lb); shipping, 15 kg (33 lb)

Solid-State Switching

Solid-state switching allows for simultaneous measurement of forward and reverse parameters and continuous update of all four S-parameters as required for two-port error correction (used to achieve best possible measurement accuracy). Option 009 replaces the standard solid-state RF test port switch with a mechanical RF switch. HP 8753 system specifications for standard and Option 009 test sets are identical. Nominal insertion loss of the solid-state switch is less than 2 dB (at 3 GHz) or 3 dB (at 6 GHz), relative to a mechanical switch.

HP 86389A/B Solid-State Switch Upgrade Kits

Older HP 85046A/B and HP 85047A test sets contained a mechanical RF test port switch. The HP 86389A/B kits retrofit these S-parameter test sets by replacing the mechanical switch with a solid-state RF switch. This solid-state switch allows for simultaneous measurement of forward and reverse parameters and continuous measurement of all four S-parameters (required for two-port error correction).

The HP 86389A retrofits HP 85046A/B test sets, and the HP 86389B retrofits HP 85047A test sets. HP 8753C network analyzers with firmware revision 4.0 or higher and later HP 8753 models support solid-state test sets.

Special Test Sets

Special test sets are available to configure the HP 8753E for specific applications. Some examples are listed below. Contact HP for details about these products or for information about additional special options for HP 8753 network analyzers.

HP 8753E Option H14 Configurable Test Set
Offers access to the A and B samplers and the port 1 and 2 couplers.

HP 8753E Option H16 Low Noise Floor
Adds the ability to reverse the port 2 coupler to increase the forward dynamic range by about 12 dB.

HP 8753E Option H36 Duplexer Test Set
Adds a third test port to enable single-connection duplexer measurements. Does not provide Tx-to-Rx and Rx-to-Tx measurements.

HP 8753E Option H39 Three-Port Test Set
Adds a third test port and switching to provide all transmission and reflection measurements for three-port devices.

Accessories

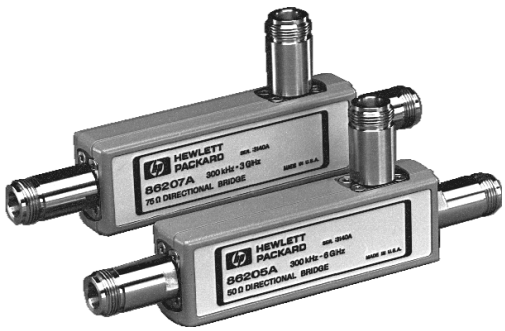
NEW

HP 11930A/B Power Limiters

The HP 11930A/B limiters protect the input circuits of network analyzers, spectrum analyzers and sources from transients and short-duration overloads.

Specifications Summary

	HP 11930A	HP 11930B
Frequency Range	DC – 6 GHz	5 MHz – 6.5 GHz
Input/output Connector	APC-7	Type-N
Insertion Loss	1.0 dB (dc - 3 GHz) 1.5 dB (3 – 6 GHz)	1.0 dB (16 MHz – 3 GHz) 1.5 dB (3 – 6.5 GHz)
Return Loss	22 dB (30 kHz – 3 GHz) 20 dB (3 – 6 GHz)	21 dB (16 MHz – 3 GHz) 17 dB (3 – 6.5 GHz)
Impedance	50 ohm nominal	50 ohm nominal
Maximum Input Power		
Continuous	3 watts	3 watts
Pulse	6 watts	6 watts



HP 86205A/86207A

HP 86205A/86207A RF Bridges

The HP 86205A/86207A high directivity RF bridges offer unparalleled performance in a variety of general-purpose applications. They are ideal for accurate reflection measurements and signal leveling applications.

Specifications Summary

	HP 86205A	HP 86207A
Impedance	50 Ω	75 Ω
Freq. Range	300 kHz to 6 GHz	300 kHz to 3 GHz
Directivity	30 dB, 0.3 MHz to 5 MHz	30 dB, 0.3 MHz to 5 MHz
	40 dB, 5 MHz to 2 GHz	40 dB, 5 MHz to 1.3 GHz
	30 dB, 2 GHz to 3 GHz	35 dB, 1.3 GHz to 2 GHz
	20 dB, 3 GHz to 5 GHz (typ.)	30 dB, 2 GHz to 3 GHz
	16 dB, 5 GHz to 6 GHz (typ.)	
Coupling Factor	(< 3 GHz) 16.0 dB, + 0.15 dB/GHz	
	(> 3 GHz) 16.5 dB, – 0.20 dB/GHz	
Insertion Loss	1.5 dB, + 0.1 dB/GHz	
Maximum Input	25 dBm	
RF Connectors	50 Ω Type-N (female)	75 Ω Type-N (female)

Physical Characteristics
Size: 93 mm H x 160 mm W x 23 mm D (3.7 in x 6.3 in x 1 in)
Weight: Net, 0.57 kg (1.3 lb); shipping, 1.8 kg (4 lb)

HP 11850C/D Three-Way Power Splitters

Specifications Summary

	HP 11850C	HP 11850D
Impedance	50 Ω	75 Ω
Frequency Range	DC to 3 GHz	DC to 2 GHz
Tracking	±0.25 dB, ±3°	±0.2 dB, ± 2.5°
Equivalent Source Match	30 dB at 1.3 GHz	30 dB at 1.3 GHz
(ratio or leveling)	20 dB at 3 GHz	20 dB at 3 GHz
Nominal Insertion Loss	9.5 dB + 1 dB/GHz	7.8 dB
Input Port Match		
DC to 1.3 GHz	20 dB	20 dB
1.3 GHz to F_{max}[1]	10 dB	10 dB
RF Connectors		
RF Input: (female)	50 Ω Type-N	50 Ω Type-N
All Others: (female)	50 Ω Type-N	75 Ω Type-N

[1] F_{max} is the upper frequency limit of the associated power splitter.

HP 11851B RF Cable Kit

This kit includes three 610-mm (24-in) 50 Ω cables phase matched to 4° at 1.3 GHz and one cable 860 mm (34-in). Connectors are type-N (male).

HP 11852B 50 Ω /75 Ω Minimum Loss Pad

The HP 11852B is a low SWR minimum loss pad required for measurements on 75 Ω devices with the HP 8753.
Frequency Range: DC to 3.0 GHz
Insertion Loss: 5.7 dB
Return Loss: 75 Ω: typically ≥ 30 dB, 50 Ω: typically ≥ 26 dB
Maximum Input Power: 250 mW (+24 dBm)
RF Connectors: 50 Ω type-N (f) and 75 Ω type-N (m) standard, 50 Ω type-N (m) and 75 Ω type-N (f) Option 004

Type-N Accessory Kits

Each kit contains a type-N (female) short, a type-N (male) short, two type-N (male) barrels, two type-N (female) barrels, and a storage case.

HP 11853A 50 Ω Type-N Accessory Kit

The HP 11853A accessory kit furnishes the RF components required for measurement of devices with 50 Ω type-N connectors using the HP 11850C, 85044A, 85046A, or 85047A.

HP 11855A 75 Ω Type-N Accessory Kit

The HP 11855A accessory kit furnishes the RF components required for measurement of devices with 75 Ω type-N connectors using the HP 11850D, 85044B, or 85046B. This kit also contains a 75 Ω type-N (male) termination.

BNC Accessory Kits

The BNC accessory kit contains two type-N (male) to BNC(female) adapters, two type-N (male) to BNC (male) adapters, two type-N (female) to BNC (female) adapters, two type-N (female) to BNC (male) adapters, a BNC (male) short, and a storage case.

HP 11854A 50 Ω BNC Accessory Kit

The HP 11854A accessory kit furnishes the RF components required for measurement of devices with 50 Ω BNC connectors using the HP 11850C, 85044A, 85046A, or 85047A.

HP 11856A 75 Ω BNC Accessory Kit

The HP 11856A furnishes RF components required for measurement of devices with 75 Ω BNC connectors using the HP 11850D, 85044B, or 85046B. This kit also contains a 75 Ω BNC (male) termination.

Test Port Cables

HP 11857D 50 Ω APC-7 Test Port Cables

The HP 11857D includes two precision 61-cm (24-in) cables, phase matched to 2° at 1.3 GHz for use with the HP 8753D/E, 85046A or 85047A S-parameter test sets. Connectors are 50 Ω APC-7.

HP 11857B 75 Ω Type-N Test Port Cables

The HP 11857B includes two precision 61-cm (24-in) cables, phase matched to 2° at 1.3 GHz for use with the HP 8753D/E Option 075 or HP 85046B S-parameter test set. One cable has 75 Ω type-N (male) connectors on both ends; the other has one type-N (male) and one type-N (female) connector.

Transit Cases

HP offers a complete line of sturdy transit cases that protect your instrument from shock, vibration, moisture, impact, and contamination, providing a secure enclosure for shipping. Model 9211-2657 fits the HP 8753E and model 9211-2656 fits the HP 8752C.

Calibration Kits

The calibration kits in the HP 8753 family contain precision standards used in accuracy enhancement procedures to characterize the systematic errors of an HP 8753 measurement system.

HP 85031B 7-mm Calibration Kit

The HP 85031B calibration kit contains a set of precision 7-mm fixed terminations, and a one-piece open/short circuit used to calibrate the HP 8753 and its 50 Ω test sets for measurement of devices with precision 7-mm connectors. This kit is specified 300 kHz to 6 GHz.

HP 85032B 50 Ω Type-N Calibration Kit
The HP 85032B calibration kit contains precision 50 Ω type-N standards used to calibrate the HP 8753 and its 50 Ω test sets for measurement of devices with 50 Ω type-N connectors. Precision phase-matched 7-mm to 50 Ω type-N adapters are included for accurate measurements of non-insertable devices. Standards include fixed terminations, open circuits, and short circuits in both sexes. This kit is specified from dc to 6 GHz.

HP 85032E 50 Ω Type-N Economy Calibration Kit
The HP 85032E calibration kit contains a type-N (m) fixed termination and a one-piece type-N (m) open/short circuit. This kit is specified from dc to 6 GHz.

HP 85033D 3.5-mm Calibration Kit
The HP 85033D calibration kit contains fixed loads and open and short circuits in both sexes to calibrate the HP 8753 and 50 Ω test sets for measurement of devices with precision 3.5-mm and SMA connectors. Phase-matched 7-mm to 3.5-mm adapters for male and female connectors are included for use with 7-mm test port cables. This kit is specified from dc to 6 GHz.

HP 85036B 75 Ω Type-N Calibration Kit
The HP 85036B calibration kit contains precision 75 Ω type-N standards used to calibrate the HP 8753 and its 75 Ω test sets for measurement of devices with 75 Ω type-N connectors. Standards include fixed terminations, open circuits, and short circuits in both sexes. Precision phase-matched adapters are included for accurate measurements of non-insertable devices. This kit is specified from dc to 3 GHz.

HP 85039B Type-F Calibration Kit
The HP 85039B contains 75 Ω type-F calibration standards, both male and female, to calibrate the HP 8753D for measurements of common broadband and CATV components. Standards include a fixed load, open circuit, and short circuit. The following adapters are also included: type-F (f-f), type-F (m-m), type-N (f) to type-F (m) and type-N (m) to type-F (f). A complete male set of standards (fixed load, open, short) and (m-m) adapter can be ordered as HP 85039B Option 00M and a complete female set as HP 85039B Option 00F.

Additional type-F adapters available: type-F (m) to type-N (m) (85039-60010), type-F (m) to type-F (f) (85039-60012), and type-F (f) to type-N (f) (85039-60014).

HP 85090 Series Electronic Calibration System

Electronic calibration (ECal) replaces the usual calibration kit standards with a solid-state calibration module. The module is controlled by PC software to present different impedances to the test ports. A full two-port calibration can be done with a single connection in just a few minutes, with less chance for error and less wear on connectors.

An ECal system requires an HP 85097A PC Interface Kit and an HP 85090 series RF calibration module of the appropriate connector type. The HP 85097A includes software for Windows 95 and NT 4.0 systems, and it is compatible with the HP 8753C/D/E.

Verification Kits

Measuring known devices, other than the calibration standards, is a convenient way of verifying that the HP 8753 measurement system is operating properly.

HP 85029B 7-mm Verification Kit
The HP 85029B verification kit contains a set of precision 7-mm devices, with data traceable to NIST, used to verify the calibrated performance of an HP 8753A/B/C/D/ measurement system. The devices have precision 7-mm connectors and include a 20-dB pad, a 50-dB pad, and a mismatch attenuator. The verification process requires only an HP 85031B calibration kit and an HP 85029B verification kit.

Option 001 is intended solely for use with the HP 8702B lightwave component analyzer. Option 001 adds verification data that is compatible with the HP 8702B.

Ordering Information

HP 8753E Network Analyzer, 30 kHz to 3 GHz
Integrated network analyzer with built-in color display, S-parameter test set, disk drive, and 30 kHz to 3 GHz synthesized source. Standard 50 Ω version has two 7-mm test ports.
- **Opt 002** Harmonic Measurement Capability
- **Opt 006** 6 GHz Frequency Extension
- **Opt 010** Time-Domain Capability
- **Opt 011** Delete Built-in Test Set
- **Opt 075** 75 Ω Impedance
- **Opt 1D5** High-Stability Frequency Reference
- **Opt 1DT** Delete Display

HP 85047A 50 Ω S-Parameter Test Set—6 GHz
- **Opt 009** Mechanical Test Port Switch
- **Opt 913** Rackmount Kit (5062-4069)

HP 85046A 50 Ω S-Parameter Test Set—3 GHz
- **Opt 009** Mechanical Test Port Switch
- **Opt 913** Rackmount Kit (5062-4069)

HP 85046B 75 Ω S-Parameter Test Set—300 kHz–2 GHz
- **Opt 009** Mechanical Test Port Switch
- **Opt 913** Rackmount Kit (5062-4069)

HP 85029B Precision 7-mm Verification Kit
- **Opt 001** Data for HP 8702B

HP 85031B Precision 7-mm Calibration Kit
HP 85032B 50 Ω Type-N Calibration Kit
HP 85032E 50 Ω Type-N Economy Calibration Kit
HP 85033D 3.5-mm Calibration Kit
HP 85036B 75 Ω Type-N Calibration Kit
HP 85039B Type-F Calibration Kit
HP 85097A ECal PC Interface Kit
HP 85090 Series Electronic Calibration Modules
HP 86205A 50 Ω Bridge
HP 86207A 75 Ω Bridge
HP 11850C 50 Ω Power Splitter
HP 11850D 75 Ω Power Splitter
HP 11851B 50 Ω/Type-N RF Cable Kit
HP 11852B 50 Ω/75 Ω Minimum Loss Pad
HP 11853A 50 Ω Type-N Accessory Kit
HP 11854A 50 Ω BNC Accessory Kit
HP 11855A 75 Ω Type-N Accessory Kit
HP 11856A 75 Ω BNC Accessory Kit
HP 11857B 75 Ω Type-N Test Port Extension Cables
HP 11857D 50 Ω APC-7 Test Port Extension Cables
HP 11930A RF Limiter, APC-7
HP 11930B RF Limiter, Type-N

HP 8753EU Upgrade Kits for the HP 8753E
- **Opt 002** Harmonic Measurements Upgrade
- **Opt 006** 6 GHz Upgrade for Standard Units
- **Opt 010** Time-Domain Upgrade
- **Opt 099** Firmware Upgrade Kit
- **Opt 1D5** High-Stability Frequency Reference Upgrade
- **Opt 611** 6 GHz Upgrade for Option 011 Units

HP 8753DU Option 000 Processor Upgrade
HP 11883A Harmonic Measurements (Option 002) Upgrade
HP 11884A 6 GHz Receiver (Option 006) Upgrade
HP 11884B 6 GHz (Option 006) Upgrade Kit for HP 8753D
HP 11884C 6 GHz (Option 006) Upgrade Kit for HP 8753D Option 011
HP 85019B Time Domain (Option 010) Upgrade
HP 86389A Solid-State Switch Upgrade Kit (for HP 85046A/B Test Sets)
HP 86389B Solid-State Switch Upgrade Kit (for HP 85047A Test Sets)

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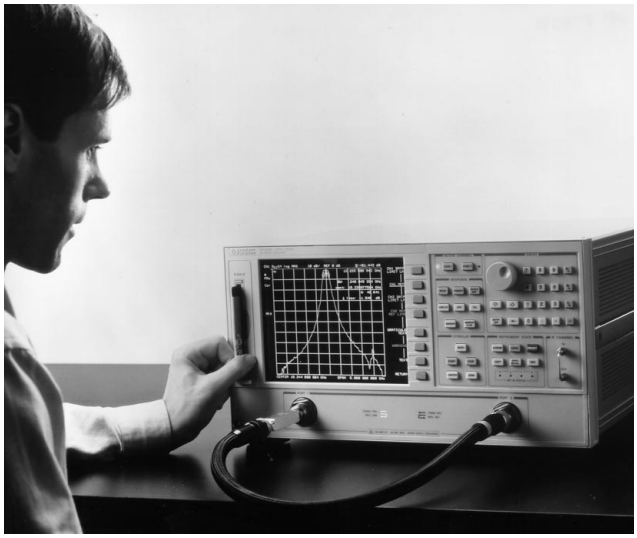
http://www.hp.com/go/pcg

Microwave Network Analyzers, 50 MHz to 40 GHz

HP 8719D
HP 8720D
HP 8722D

- 50 MHz to 13.5, 20, or 40 GHz frequency coverage
- New processor makes measurements and data transfers up to seven times faster
- Fast-sweeping, built-in synthesized source
- Integrated solid-state switching S-parameter test set
- Vector receiver, error correction, time domain
- Up to 105 dB dynamic range



HP 8720D provides flexibility, performance, and ease of use to solve your toughest device measurement problems.

HP 8720D Series Microwave Network Analyzers

HP-IB

The HP 8719D, 8720D, and 8722D vector network analyzers offer built-in source, receiver, and solid-state switching S-parameter test set covering frequencies from 50 MHz to 13.5, 20, or 40 GHz. Compact, economical, and easy to use, the 8720D family provides accurate, fast tests of microwave linear and nonlinear devices in both coaxial and non-coaxial environments, such as waveguide, in-fixture, and on-wafer. The HP 8720 family is an ideal choice for cost- and space-conscious engineers in R&D, manufacturing, or quality assurance. A new processor has been incorporated that provides measurements and data transfer speeds up to 7 times faster than earlier models, including older versions of the HP 8719D, 8720D, or 8722D.

Affordable Analyzers with Outstanding Performance

The HP 8720 analyzers have a fast source that is fully synthesized, in both swept or stepped modes, with stability and accuracy within 10 ppm (typical). Frequency resolution is 1 Hz standard for accurate measurements of narrowband or long-delay devices.

The tuned receivers with variable bandwidth IF filters provide up to 105 dB of dynamic range. A solid-state switching test set provides continuous updating of all four S-parameters as required for two-port error correction.

Two independent channels can measure and display all four S-parameters simultaneously. Reflection and transmission measurements can be displayed in a variety of formats, including magnitude, phase, group delay, SWR, and Smith charts.

Built-in vector accuracy enhancement provides excellent error-corrected accuracy in common coaxial connectors. A user kit supports user-defined standards, and allows calibration in waveguide (including effects of dispersion). Adapter-removal calibration provides greater accuracy for measurements of non-insertable devices, such as devices with the same sex connectors on both ports or different connector types on ports 1 and 2. Electronic calibration (ECal) provides fast and simple calibration with a single connection, using the HP 85097A ECal PC Interface Kit and appropriate HP 85060 series calibration modules.

Powerful Features for Active Devices

With +5 dBm at their test ports, the HP 8719D and 8720D have plenty of power for testing amplifiers. Option 007 provides 5 dB more output power by replacing the solid-state transfer switch with a mechanical switch (although Option 007 does not provide continuous updating of all four S-parameters). For sensitive small-signal devices, the built-in step attenuator can cut power back to –70 dBm. Absolute power levels can be set accurately anywhere in the system, using the power meter calibration feature. Power-sweep capability and power resolution of 0.01 dB make it easy to test the gain-compression characteristics of active components. A new sweep mode controls power during retrace for safe testing of AGC amplifiers.

In-Fixture and On-Wafer Device Characterization

Use TRL*/LRM*[1] calibration to minimize fixture errors for measuring noncoaxial devices (such as microstrip). For even better accuracy, Option 400 adds a fourth sampler and TRL/LRM calibration. Electronic port extensions and gating are also available to enhance accuracy.

Time Domain and Fault Location

Time domain capability (Option 010) computes and displays the response versus time or distance (instead of frequency) of the device under test. Use time domain to locate and quantify individual faults or discontinuities in a network. Apply the gating feature to remove the effects of unwanted reflections (separated in time), then view the device under test's true response versus frequency.

Productivity Features

Swept-list mode reduces measurement time by allowing you to choose the frequencies you want to test, and to set independent IF bandwidths and power levels in each frequency range. Fast two-port tuning mode speeds up 12-term error correction by allowing the user to specify the number of forward sweeps to take before updating the reverse sweep.

Automate repeated measurements with test sequencing. Create test sequencies with keystroke recording, then repeat the measurements with a single keystroke. No programming expertise is needed. You can also use test sequencing to control external devices such as part handlers through the parallel port.

Additional productivity features include limit testing for consistent pass/fail results, up to 5 markers per channel, serial and parallel interfaces for connecting to printers, a VGA-compatible output for adding a larger external monitor, 2 MB of internal non-volatile memory for storing up to 31 test configurations, and S2P-compatible data files for exchanging data with CAD programs such as HP Eesof's Touchstone, Libra, and jOmega.

Key Literature

HP 8719D, 8720D, 8722D Microwave Vector Network Analyzers
Brochure and Supplement, p/n 5964-6419E and 5966-4007E
HP 8719D, 8720D, 8722D Network Analyzers
Technical Specifications, p/n 5964-9133E
HP 8719D, 8720D, 8722D Network Analyzers
Configuration Guide, p/n 5964-9130E

[1] TRL* and LRM* are three-sampler implementations of the through-reflect-line and line-reflect-match calibration techniques.

Flexible Configuration for Applications

Option 007 replaces the standard solid-state transfer switch with a mechanical switch to provide 5 dB more power at the test port, and 5 dB more dynamic range. The mechanical transfer switch does not provide continuous updating of all 4 S-parameters for full two-port calibration.
Option 010 adds time-domain capability, which allows fault location and gating of fixture responses.
Option 012 provides direct sampler access, enabling the user to eliminate coupler loss and increase sensitivity by 16 dB. Option 012 allows filter rejection measurements to greater than –120 dB and allows insertion of attenuation between coupler and sampler. By using separate transmit and receive antennae, Option 012 can improve signal-to-noise in free-space measurements.
Option 085 is a high-power S-parameter test set modification allowing device test up to +43 dBm (20 watts) input and output. It deletes the bias tees, replaces the solid-state switch with a mechanical switch, and adds internal attenuators.
Option 089 offers a frequency offset mode for simple mixer conversion loss measurements without the need for a reference mixer.
Option 1D5 adds a high-stability frequency reference to improve measurement accuracy of narrowband or high Q devices.
Option 400 adds a fourth sampler to the receiver and improves TRL calibration accuracy for in-fixture and on-wafer applications.

Accessories

Configure a complete measurement system with test port cables, calibration kits, verification kits, and adapters. Waveguide calibration kits are available in X, P (Ku), K, and R (Ka) bands, covering 8.2 to 40 GHz. The HP 8720 family of network analyzers uses the same precision calibration standards, electronic calibration system, and rugged, flexible cables as the industry standard HP 8510.

Software Enhances Measurement Capability

Measure the dielectric properties of materials quickly and non-destructively with the HP 85070B dielectric probe kit (including software). For greater accuracy and flexibility, use the HP 85071B materials measurement software, for samples loaded into waveguide or coaxial fixtures, and for free space measurements.

Specifications Summary

Data applies at 23°± 3°C. See product literature for more complete specifications and for total measurement uncertainty after error correction.

	HP 8719D	HP 8720D	HP 8722D
Minimum Frequency	50 MHz	50 MHz	50 MHz
Maximum Frequency	13.5 GHz	20 GHz	40 GHz
Frequency Resolution	1 Hz	1 Hz	1 Hz
Frequency Accuracy	10 ppm	10 ppm	10 ppm
Max. Source Power (std)	+5 dBm	+5 dBm	–5 dBm, < 20 GHz –10 dBm, 20 to 40 GHz
With Option 007	+10 dBm	+10 dBm	0 dBm, < 20 GHz –5 dBm, 20 to 40 GHz
Min. Source Power (std)	–70 dBm	–70 dBm	–75 dBm
With Option 007	–65 dBm	–65 dBm	–70 dBm
Power Resolution	0.01 dB	0.01 dB	0.01 dB
Power Flatness	± 1.5 dB	± 1.5 dB	± 2 dB
Power Sweep Range	20 dB	20 dB	15 dB
System Dynamic Range (>2 GHz)	100 dB	100 dB	82 to 93 dB
With Option 007	105 dB	105 dB	86 to 98 dB
Test Port Connector	3.5 mm	3.5 mm	2.4 mm

HP-IB Functions: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, C1, C10, E2
Size: 222 mm H x 425 mm W x 457 mm D (8.75 in x 16.750 in x 18.00 in)
Weight: Net, 25 kg (54 lb); shipping, 28 kg (61 lb)

Upgrade Kits

Options may be added to an HP 8720D family analyzer after initial purchase by ordering model number HP 8719DU, 8720DU, or 8722DU with the option(s) you want to retrofit. See "Ordering Information" for more details.

Customers with older versions of the HP 8719D, 8720D, or 8722D (with firmware revisions below 7.0) can add newer capabilities to their analyzers with one of the following upgrades.

HP 8719DU, 8720DU, or 8722DU Option 000 Performance Upgrade

This upgrade kit replaces the CPU board in the HP 8719D, 8720D, or 8722D with the new updated CPU board to provide significant measurement and data-transfer speed improvements and the latest firmware features.

HP 08720-60168 Firmware Upgrade

Customers with firmware revisions below 6.12 can order this firmware upgrade to add the following key features to their analyzers: adapter-removal calibration, S2P-compatible data files, and 3.7 kHz IF bandwidth for faster measurements. This upgrade does not include the speed enhancements and newer features included in the Option 000 Performance Upgrade.

Ordering Information

HP 8719D Network Analyzer, 50 MHz to 13.5 GHz
HP 8720D Network Analyzer, 50 MHz to 20 GHz
HP 8722D Network Analyzer, 50 MHz to 40 GHz
The following options apply to all three network analyzers:
- **Opt 007** Mechanical Transfer Switch
- **Opt 010** Time Domain Capability
- **Opt 012** Direct Sampler Access
- **Opt 085** High-Power Test Set
- **Opt 089** Frequency Offset Mode
- **Opt 1D5** High-Stability Frequency Reference
- **Opt 400** Four-Sampler Test Set
- **Opt 1CM** Rackmount Kit
- **Opt 1CP** Rackmount and Handle Kit
- **Opt W01** Convert 3 yr. return to HP to 1 yr. on-site warranty

HP 85070B High-Temperature Dielectric Probe Kit
HP 85071B Materials Measurement Software
HP 1540-1695 Operating Case
HP 9211-2657 Transit Case

Upgrades and Retrofit Kits

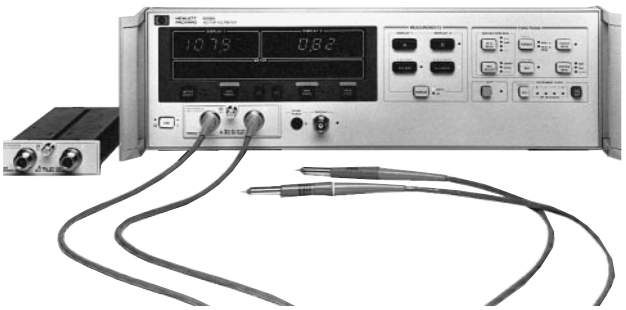
To add options to an HP 8720D family analyzer after initial purchase, order model number HP 8719DU, 8720DU, or 8722DU with the option(s) you want to retrofit. All "DU" upgrade/retrofit kits include installation at an HP service center.
HP 8719DU Upgrade Kits for HP 8719D
HP 8720DU Upgrade Kits for HP 8720D
HP 8722DU Upgrade Kits for HP 8722D
The following options are available for all three models:
- **Opt 000** Performance Upgrade
- **Opt 007** Add Mechanical Transfer Switch
- **Opt 010** Add Time Domain Capability
- **Opt 012** Add Direct Sampler Access
- **Opt 085** Add High-Power Test Capability
- **Opt 089** Add Frequency Offset Mode
- **Opt 1D5** Add High-Stability Frequency Reference
- **Opt 400** Add Four-Sampler Test Set

The following upgrades are only available for the specified models:
HP 8719DU Opt 020 Upgrades HP 8719D to HP 8720D
HP 8719DU Opt 040 Upgrades HP 8719D to HP 8722D
HP 8720DU Opt 040 Upgrades HP 8720D to HP 8722D
The following kits offer upgrades for older HP 8720 family network analyzers. Installation is NOT included unless stated otherwise.(Do not order these for the HP 8720D family.)
HP 86384A Solid-State Switch Retrofit Kit (HP 8719C)
HP 86384B Solid-State Switch Retrofit Kit (HP 8720C)
HP 86384C Solid-State Switch Retrofit Kit (HP 8722C)
HP 86380A Add Time Domain; includes installation
HP 86381A Add 1 Hz Frequency Resolution; incl. installation
HP 08720-60168 Firmware Upgrade

For information on compatible printers, visit:

HP 8508A
HP 85081B
HP 85082A
HP 11570A

- RF voltage and phase measurements
- 100 kHz to 1 GHz high-impedance probe inputs
- 300 kHz to 2 GHz 50 Ω inputs



HP 8508A Option 001

HP 8508A Vector Voltmeter

The HP8508A vector voltmeter is a fully-automatic tuned receiver that makes RF voltage and phase measurements easy. The narrowband measuring technique gives a dynamic range of over 90 dB and a sensitivity of 10 μV to trace even the smallest signal. The vector voltmeter also measures the difference between the two input channels with at least 0.1 degree resolution over a full +180 to –180 degree range, so it can be used for another complete set of measurements—such as electrical length, phase distortion, or impedance. The standard unit is supplied with the HP 85081B input module, which has two high-impedance probe inputs that operate from 100 kHz to 1 GHz. Its ability to store reference and use it in later measurements means individual circuit sections can be characterized and adjusted independently. Any CW source can be used as a stimulus—even a source that is part of the device being tested—so measurements can be made under normal operating conditions. To adapt the probe inputs for measurements in a 50 Ω environment, the HP 11570A accessory kit provides two HP 11536A probe tees, an HP 11549A power splitter, and two HP 908A 50 Ω terminations. Option 050 is supplied with the HP 85082A input module. Its 50 Ω inputs operate from 300 kHz to 2 GHz, and provide the accuracy and dynamic range to make measurements on active and passive components.

HP 8508A with HP 85081B High-Impedance Input Module Specifications

Frequency Range: 100 kHz to 1 GHz (300 kHz to 2 GHz[1])
Maximum Input: 2 V peak ac (+16 dBm[1]), ±50 Vdc
A- (ref) Channel Minimum: 10 mV (–47 dBm[1]), 100 kHz to 300 kHz 1mV (–47 dBm[1]), 300 kHz to 3 MHz 300 μV, 3 MHz to 1 GHz (–57 dBm, 3 MHz to 2 GHz[1])
B-Channel Noise Level: 10 μV (–87 dBm[1])
Input Crosstalk: >100 dB, 1 MHz to 500 MHz > 80 dB, 500 MHz to 1 GHz (>70 dB, 1 GHz to 2 GHz[1])

Magnitude Accuracy

Absolute Accuracy (A,B 100 mV, 15° to 30°C)	+1/–1.5 dB, 100 kHz to 300 kHz ±.5 dB, 300 kHz to 1 MHz ±.3 dB, 1 MHz to 100 MHz ±.6 dB, 100 MHz to 300 MHz ±1 dB, 300 MHz to 1 GHz (±1 dB, 300 MHz to 1.5 GHz[1]) (+1/–2 dB, 1.5 GHz to 2 GHz[1])
Ratio Accuracy (A,B 100 mV, 15° to 30° C)	±1 dB, 100 kHz to 300 kHz ±.4 dB, 300 kHz to 1 MHz ±.2 dB, 1 MHz to 100 MHz ±.4 dB, 100 MHz to 300 MHz ±.6 dB, 300 MHz to 1 GHz (±.6 dB, 300 MHz to 1.5 GHz[1]) (±1 dB, 1.5 GHz to 2 GHz[1])
Phase Accuracy (in degrees) (A,B 100 mV, 15° to 30° C)	±4, 300 kHz to 1 MHz ±1, 1 MHz to 100 MHz ±4, 100 MHz to 300 MHz ±6, 300 MHz to 1 GHz (±6, 300 MHz to 1.5 GHz[1]) (±12, 1.5 GHz to 2 GHz[1])

[1]Specifications apply to HP 85082A 50 Ω input module only.

Search and Lock Time: Lockup (within one range): 40 ms, frequencies up to 3 MHz; 20 ms, frequencies greater than 3 MHz

General: HP 8508A only

Power: 100, 120, 220 or 240 V +5%/–10%, 48 to 440 Hz, 40 VA
Size: 425.5 mm W x 133 mm H x 473.3 mm D (16.75 in x 5.25 in x 18.65 in)
Option 001: 524.5 mm W x 158.8 mm H x 524.5 mm D (19.75 in x 6.25 in x 20.65 in)
Weight: net, 8.1 kg (18 lb); shipping, 11 kg (24 lb).
Option 001: net, 9.4 kg (21 lb); shipping 12.5 kg (28 lb).

HP 11570A Accessory Kit

50 Ω Tees: For monitoring signals on 50 Ω transmission line. Kit contains two 50 Ω tees, both with type-N female connectors.
50 Ω Power Splitter: All connectors type-N female
HP 908A 50 Ω Termination: For terminating 50 Ω coaxial systems in their characteristic impedance. Kit contains two 50 Ω terminations, both with type-N male connectors.
HP 11512A Short: Type-N male

Ordering Information

HP 8508A Vector Voltmeter (includes HP 85081B)
  Opt 001 Bail Handle and Front Protective Cover
  Opt 801 Two each HP 11576A 10:1 Divider and HP 10216A Isolators
HP 85081B Input Module (100 kHz to 1 GHz, high-impedance probe inputs)
HP 85082A Input Module (300 kHz to 2 GHz, 50 Ω Type-N inputs)
HP 11570A Accessory Kit (for measurement of 50 Ω systems with standard HP 8508A)

- 45 MHz to 110 GHz frequency range
- Real-time error-corrected measurements
- 60 dB effective directivity and source match
- Up to 100 dB dynamic range
- 0.001 dB, 0.01 degree, 0.01 ns measurement resolution
- Time-domain analysis

HP 85107B

HP 8510 Series Microwave Network Analyzers

The HP 8510 Series Microwave Vector Network Analyzers provide a complete solution for characterizing the linear behavior of either active or passive coaxial networks over the 45 MHz to 50 GHz frequency range. A complete system consists of the HP 8510C network analyzer, an S-parameter test set, and a compatible RF source. The HP 8510E (45 MHz to 20 GHz) is an unracked system. The HP 8510SX (45 MHz to 26.5 GHz) and the HP 85107B (45 MHz to 50 GHz) systems are fully integrated in an HP 85043C system rack, tested, and verified at the factory prior to shipment. They come with a one year on-site warranty. For millimeter wave measurements the HP 8510XF (45 MHz to 110 GHz) and HP 85106D (Q, U, V, and W band) are available. For pulse measurements the HP 85108A (2 GHz to 20 GHz, specials 0.5 to 20 GHz, and 2 GHz to 50 GHz) and HP 85108L (45 MHz to 2 GHz) are available.

HP 8510C Network Analyzer

At the heart of the system is the HP 8510C vector network analyzer. Measurement results can be displayed on a large color CRT on one of two independent, yet identical, channels. The channels may be displayed individually, or simultaneously, with results presented in either log/linear magnitude, phase, or group delay format on rectangular or polar coordinates. Direct measurement of impedance is possible with the Smith chart format.

Real-Time Error Correction

The HP 8510's built-in, high-speed computer provides the capability to characterize and effectively remove the impact of systematic errors through accuracy enhancement techniques. Effective directivity and source match can be improved to as much as 60 dB. The data processing speed of the system is such that a fully error-corrected, 401 point trace of data is updated in under one second. This virtual "real-time" display of error-corrected data means that you can easily adjust your test device while it's being measured, with the assurance that you are viewing the data at the highest possible accuracy.

Time-Domain Analysis

The HP 8510 (with Option 010) has the capability of displaying the time-domain response of a network, obtained by computing the Inverse Fourier Transform of the frequency-domain response. The time-domain response displays the reflection coefficient of the network versus time, which displays the magnitude and location of each individual discontinuity, or else the transmission coefficient versus time, which displays each individual transmission path.

Pulsed-RF Measurement Capability

For the measurement of pulsed-RF devices, the HP 8510C can be equipped with wideband IF detectors (Option 008). When configured with a compatible test set (HP 85110A/L), the system can measure pulse widths as narrow as 1 μs on devices with output power up to 20 W (CW) [50 W (CW) for the HP 85110L]. Measurement formats include magnitude and phase versus frequency or time (pulse profile).

Test Sets

The test set is the system component that determines the frequency range of the system and is the main contributor to system specifications. Depending on the test set used, up to 100 dB of dynamic range is available. The precision IF processing and detection system contributes as little as ±0.05 dB and ±0.5 degree measurement uncertainty at a level of 50 dB below the reference. Meaningful resolutions of 0.001 dB, 0.01 degree, and 0.01 ns are easily available. Refer to page 300 for more information.

RF Sources

The recommended system sources for the HP 8510C are the HP 83621B (20 GHz), 83631B (26.5 GHz), and 83651B (50 GHz). These sources provide 1 Hz frequency resolution, stepped CW, phase-locked narrowband sweeps, and fully-synthesized start frequencies for broadband ramp sweeps. Other models of the HP 8360 series synthesized sweeper, the HP 8340 series synthesized sweeper, and HP 8350B series sweep oscillators, are also compatible with the HP 8510C.

System Software

HP 85161B Measurement Automation Software

The HP 85161B measurement automation software leads the operator through the measurement sequence one step at a time, from system setup and calibration, to device measurement and hardcopy output. Complete measurement configurations can be saved to disk for later recall. Also, data printout formats can be customized by the operator.

The HP 85161B software is designed for use with a PC running HP Basic Rev 6.3 or higher under Windows (3.1/95/NT), or HP 9000 Series 200 or 300 computers and Basic Operating System 5.0 or later.

Key Literature

HP 8510 Systems Solutions Brochure, p/n 5965-8837E
HP 8510C Family Network Analyzer Technical Data, p/n 5091-8484E
HP 8510C Family Network Analyzer Configuration Guide, p/n 5091-8967E
HP 8360 B/L Series Synthesized Sweeper Technical Data, p/n 5964-6062E

Ordering Information

HP 8510C Microwave Vector Network Analyzer
Opt 008 Pulsed-RF Measurement Capability
Opt 010 Time-Domain Capability
HP 85043C System Rack Kit
HP 85161B Measurement Automation Software

S-Parameter Test Sets

Several S-parameter test sets are available for the HP 8510C network analyzer for broadband coaxial measurements from 45 MHz to 50 GHz. The HP 8514B, 8515A, and 8517B test sets have an architecture that develops a separate reference channel for each incident port. RF switching is done with a built-in electronic switch. For active device measurements, the test sets include the ability to apply dc bias (external) to the test port center conductors. Also available are two 90 dB step attenuators (60 dB in the HP 8517B) which allow control of the port 1 and port 2 signal levels.

Pulsed-RF Measurement Test Sets

The HP 85110A/L test sets are specially configured for operation in pulsed-RF measurement systems (HP 85108). Four 90 dB step attenuators protect each input of the fundamentally-mixed down converter to allow measurement of test devices with output power of 20 watts CW or 50 watts CW (HP 85110L). Special options are available to 50 GHz.

Coaxial Test Set General Information

	HP 8514B	HP 8515A	HP 8517B	HP 85110A	HP 85110L
Frequency range (GHz)	0.045 to 20	0.045 to 26.50	0.045 to 50	2 to 20[2]	0.045 to 2
Test ports (port 1 or 2) Nominal operating power level (dBm)	2 to –6	–5 to –25	+2 to –29 +5 to –16[1]	0 to –3	0
Test ports (port 1 or 2) Max. power in (CW)	+20 dBm	+2 dBm	+13 dBm	+43 dBm (20 W)	+47 dBm (50 W)
Test port connector type	3.5 mm (m)	3.5 mm (m)	2.4 mm (m)	3.5 mm (m)	7 mm

[1]HP 8517B Option 007
[2]Special test sets options are available from 0.5 to 20 GHz and 2 to 50 GHz

Frequency Converters

With the HP 8511A (26.5 GHz) and 8511B (50 GHz) frequency converters, the HP 8510 becomes a general-purpose four-channel magnitude/phase receiver. Add your own power splitters for transmission measurements, and bridges or directional couplers for reflection measurements. Since one input is used for system phase-lock, the other three inputs are available for measurements of multi-port devices, subsystems, and antennas. All four inputs have precision 3.5 mm (HP 8511A) or 2.4 mm (HP 8511B) connectors.

Multiple Test Set Operation

A single HP 8510C system may be configured with two test sets. In this configuration the test sets have different addresses, and the user may select between them from the front panel of the HP 8510 without reconnections. This capability is useful, for example, when combining a microwave coaxial test set with a millimeter-wave test set in the same HP 8510 system or in manufacturing to increase throughput, one test set can be used to make a measurement while a device is being connected to a second test set.

IF switching (Option 001): In the multiple test set configuration, the 20 MHz IF signal is daisy-chained from the test sets to the HP 8510. This capability requires test set Option 001 in one of the two test sets.

The RF signal must be routed to the desired test set using a coaxial RF switch and an HP 11713A switch driver. The switch driver is controlled automatically by the HP 8510C over the HP 8510 system interface bus.

Ordering Information

HP 8511A Frequency Converter
HP 8511B Frequency Converter
HP 8514B S-Parameter Test Set
HP 8515A S-Parameter Test Set
HP 8517B S-Parameter Test Set
HP 85110A Pulsed-RF S-Parameter Test Set
HP 85110L Pulsed-RF S-Parameter Test Set
HP 85105A Millimeter-Wave Controller

Key Literature

HP 8510 Systems Solutions Brochure, p/n 5965-8837E
HP 8510C Family Network Analyzer Technical Data, p/n 5091-8484E
HP 8510C Family Network Analyzer Configuration Guide, p/n 5091-8967E

Test Port Cables and Adapters

Test port cables and adapter sets are available for various connector types. The cable/adapter configurations are described below. All cables are designed with one end that connects directly to the special rugged ports of the network analyzer test set, and one end that connects to the device-under-test.

Special test port adapter sets are also available to convert the rugged ports of the network analyzer test set to the desired connector interface. Each kit contains two adapters, one male and one female.

Both the cables and the special adapters have one special female connector which is designed to connect directly to the 3.5 mm test port (2.4 mm for HP 8517B and 8722C). This side of the cable or adapter can only be connected to the test set port, and cannot be mated to a standard 3.5 mm (or 2.4 mm) male connector. The male test set ports, however, can be mated to a standard 3.5 mm (or 2.4 mm) female connector.

For HP 8719D/8720D Network Analyzer or HP 8514B/8515A Test Sets (3.5 mm test port)

	Cable/adapters	Connector type (on device side of cables/adapter)
For 3.5 mm devices	HP 85131C Semi-rigid Cable HP 85131E Flexible Cable HP 85130D Adapter Set	3.5 mm (f) 3.5 mm (f) 3.5 mm (m and f)
For 7 mm devices	HP 85132C Semi-rigid Cable HP 85132E Flexible Cable HP 85130B Adapter Set	7 mm 7 mm 7 mm
For Type-N devices	Use 7-mm cables and the 7 mm-to-Type-N adapters included in the HP 85054B/D calibration kit. HP 85130C Adapter Set	Type-N (m and f)

For HP 8722D Network Analyzer or HP 8517B Test Set (2.4 mm test port)

	Cable/adapters	Connector type (on device side of cables/adapter)
For 2.4 mm devices	HP 85133C Semi-rigid Cable HP 85133E Flexible Cable HP 85130G Adapter Set	2.4 mm (f) 2.4 mm (f) 2.4 mm (m and f)
For 3.5 mm devices	HP 85134C Semi-rigid Cable HP 85134E Flexible Cable HP 85130F Adapter Set	3.5 mm (f) 3.5 mm (f) 3.5 mm (m and f)
For 7 mm devices	HP 85135C Semi-rigid Cable HP 85135E Flexible Cable HP 85130E Adapter Set	7 mm 7 mm 7 mm

For HP 8719D/8720D Network Analyzer or HP 8514B/8515A Test Sets (3.5 mm test port)

	Cable set	Connector type (on device side of cables/adapter)
For 3.5 mm devices	HP 85131D Semi-rigid Cable Set or HP 85131F Flexible Cable Set	3.5 mm (one male, one female) 3.5 mm (one male, one female)
For 7 mm devices	HP 85132D Semi-rigid Cable Set HP 85132F Flexible Cable Set	7 mm 7 mm
For Type-N devices	Use 7-mm cables and the 7 mm-to-Type-N adapters in the HP 85054B/D calibration kit.	

For HP 8722D Network Analyzer or HP 8517B Test Set (2.4 mm test port)

	Cable set	Connector type (on device side of cables/adapters)
For 2.4 mm devices	HP 85133D Semi-rigid Cable Set or HP 85133F Flexible Cable Set	2.4 mm (m, f) 2.4 mm (m, f)
For 3.5 mm devices	HP 85134D Semi-rigid Cable Set or HP 85134F Flexible Cable Set	3.5 mm (m, f) 3.5 mm (m, f)
For 7 mm devices	HP 85135D Semi-rigid Cable Set or HP 85135F Flexible Cable Set	7 mm 7 mm

For HP 8510XF Systems (1.0 mm test port connectors)

Cables/Adapters	Connector Type
HP 11500I 1.0 mm test port cable	1.0 mm (f-f) (88 mm long)
HP 11500J 1.0 mm test port cable	1.0 mm (m-f) (160 mm long)
HP V281C Adapter	1.0 mm (f) to V-band waveguide
HP V281D Adapter	1.0 mm (m) to V-band waveguide
HP W281C Adapter	1.0 mm (f) to W-band waveguide
HP W281D Adapter	1.0 mm (m) to W-band waveguide

Microwave Network Analyzer Accessories

Microwave accessories for the HP 8720D and the HP 8510C series network analyzers include calibration kits, verification kits, cables, and adapters for 7-mm, 3.5-mm, Type-N, 2.4-mm, 1.85-mm, and 1-mm coaxial, WR-90, WR-62, WR-42, and WR-28 waveguide. Millimeter-wave accessories for the HP 8510C series network analyzers include WR-22, WR-29, WR-15, and WR-10 waveguide connector interfaces. The standards used in the 3.5-mm, Type-N, and 2.4-mm kits use precision, slotless connectors (PSC-3.5, PSC-N, and PSC-2.4).

Calibration Kits

Error-correction procedures require that the systematic errors in the measurement system be characterized by measuring known devices (standards) on the system over the frequency range of interest. HP offers two types of calibration kits: mechanical and electronic.

Electronic Calibration (ECal)

ECal is a precision, single-connection, one or two-port calibration technique. ECal modules are used as transfer standards. They are state-of-the-art, solid state devices with highly repeatable impedance standards. They offer you fewer connections and less operator interaction. Electronic calibration utilizes one or more connector specific ECal module as well as module control via an HP 85097A (PC interface module with control software).

HP 85097A PC Interface Module with Control Software

The HP 85097A consists of a PC interface module, control software, and power supply. The PC interface module is the interface between the parallel port on your computer, the ECal module, and the external power supply. The control software has two interfaces: the graphical user interface (GUI) and the software programming interface (SPI). The GUI allows users to perform an electronic calibration in manual mode via the softkeys on your network analyzer. The SPI allows the calibration to be performed automatically by a user program. The software runs on a PC under Windows 95 or Windows NT 4.0 operating system or higher. The HP 85097A requires a PC with a HP-IB (IEEE-488) interface card connected to the network analyzer. The HP 85097A interfaces with the HP 8510B (firmware revision 6.0 or higher), 8510C, 8719C/D, 8720C/D, 8722C/D. and 8753C/D/E.

Electronic Calibration Modules

ECal modules have two-ports. Modules are available with 3.5 mm, 7 mm and Type N connectors. The Type N and 3.5 mm ECal modules have one male and one female connector. Options exist for modules with two male connectors or two female connectors. To interface the ECal module with your computer and your network analyzer, please order an HP 85097A.

Mechanical Calibration Kits

All network analyzer mechanical calibration kits contain precision standard devices to characterize the systematic errors of the HP 8720 series or 8510C network analyzer system.

Each mechanical calibration kit also contains adapters to change the sex of the test port and a torque wrench for proper connection. Each kit contains standards definitions on disk for the HP 8510C. (These definitions are already included in the HP 8720 series.)

Verification Kits

Measuring known devices, other than the calibration standards, is a straightforward way of verifying that the network analyzer system is operating properly. HP offers verification kits that include precision airlines, mismatch airlines, and precision fixed attenuators. Traceable measurement data is shipped with each kit on disk.

Verification kits may be recertified by Hewlett-Packard. This recertification includes a new measurement of all standards, as well as new data and uncertainties. Certification in compliance with MIL-STD-45662A is also available.

Verification Kit Summary

Verification kit	Connector type	Frequency range (GHz)
85051B	7 mm	0.045 to 18
85053B	3.5 mm	0.045 to 26.5
85055A	Type-N	0.045 to 18
85057B	2.4 mm	0.045 to 50
R11645A	WR-28	26.5 to 40
Q11645A	WR-22	33 to 50
U11645A	WR-19	40 to 60
V11645A	WR-15	50 to 75
W11645A	WR-10	75 to 110

Mechanical Calibration Kits

Calibration kit	Connector type	Frequency range (GHz)
85050B	7 mm	0.045 to 18
85050C	7 mm	0.045 to 18
85050D	7 mm	0.045 to 18
85052B	3.5 mm	0.045 to 26.5
85052C	3.5 mm	0.045 to 26.5
85052D	3.5 mm	0.045 to 26.5
85054B	Type-N	0.045 to 18
85054D	Type-N	0.045 to 18
85056A	2.4 mm	0.045 to 50
85056D	2.4 mm	0.045 to 50
85056K	2.92 mm	0.045 to 40
85058D	1.85 mm	0.045 to 65
85059A	1.0 mm	0.045 to 110
X11644A	WR-90	8.2 to 12.4
P11644A	WR-62	12.4 to 18.0
K11644A	WR-42	18.0 to 26.5
R11644A	WR-28	26.5 to 40
Q11644A	WR-22	33 to 50
U11644A	WR-19	40 to 60
V11644A	WR-15	50 to 75
W11644A	WR-10	75 to 110

HP 85097A PC Interface Module

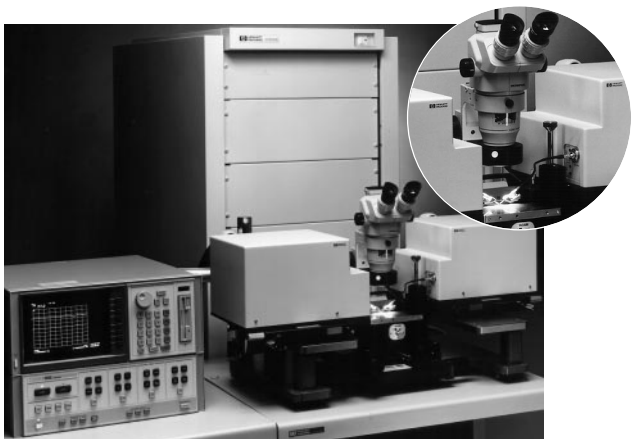
ECal Modules

ECal Module	Connector Type	Frequency Range[1]	
85091A	7 mm	30 kHz to 6 GHz	
85060B	7 mm	1 GHz to 18 GHz	
Option 001		Add 30 kHz to 6 GHz Module	
85092A	Type N	30 kHz to 6 GHz	
85064B	Type N	1 GHz to 18 GHz	
Option 001		Add 30 kHz to 6 GHz Module	
85093A	3.5 mm	30 kHz to 6 GHz	
85062B	3.5 mm	1 GHz to 26.5 GHz	
Option 001		Add 30 kHz to 6 GHz Module	

[1]The 30 kHz to 6 GHz module is specified to operate from 300 kHz, with typical performance down to 30 kHz.

Millimeter-Wave Solutions

The HP 8510C system can easily be configured for making measurements at millimeter-wave frequencies. Hewlett-Packard offers two fully integrated systems for making millimeter measurements in coax, waveguide and on-wafer. The HP 8510XF is a single-connection, single-sweep, 45 MHz to 110 GHz network analyzer system. This system is designed for on-wafer and coaxial (1.0 mm) measurements. The HP 85106D offers hardware for configuring systems in the 33 to 50 GHz, 40 to 60 GHz, 50 to 75 GHz and 75 to 110 GHz waveguide bands. These systems are fully integrated, tested and verified at the factory prior to shipment. System installation at your facility and one year, on-site service are included at no additional cost.



HP 8510XF configured with a wafer probing station and 1.0 mm probes

HP 8510XF Single-Connection, Single-Sweep, .045 to 110 GHz Network Analyzer System

Covering a broadband frequency range in millimeter-wave has been virtually impossible due to the frequency limitations of each waveguide band. The recent development from Hewlett-Packard of a broadband connector, coaxial calibration kit and directional couplers allows broadband devices to be measured over a wide frequency range, 45 MHz to 110 GHz, in one frequency sweep. All frequency band switching is performed internally by the HP 8510C, making it extremely convenient when measuring broadband devices on-wafer or in coax.

The HP 8510XF systems have been designed to measure broadband devices to 110 GHz in coax (1.0 mm) or on-wafer, fully calibrated, in a single sweep. By building on the HP 8510C network analyzer, the HP 8510XF provides excellent measurement performance in frequency coverage, dynamic range and measurement accuracy.

Broadband Calibration Improves Productivity

By performing a broadband calibration, from 45 MHz to 110 GHz, you are able to make measurements over the entire frequency range. Productivity is improved because you no longer need to connect, and disconnect banded coaxial test sets or waveguide modules as your measurements move from one frequency band to the next. In addition, the system was designed with the user in mind, making it suitable for both first-time and experienced users with minimal system training.

Convenient On-Wafer Calibration and Measurements with 1.0 mm Wafer Probes

The HP 8510XF system is designed for convenient on-wafer measurements. You no longer have to struggle with waveguide connection. The new test heads are especially designed to mount on the probe stations. A short, flexible 1.0 mm coaxial cable connects the test head to the wafer probe tip. Mounting the test heads on the probe station allows the test heads to move with the wafer probe tips so that there is no relative movement between the two. This configuration eliminates cable flexing and improves measurement performance.

Probing equipment and accessories are available from Cascade Microtech Inc., Beaverton, Oregon, USA.

Millimeter-Wave Measurements Made in 1.0 mm Coax

With the recent development and availability of the Hewlett-Packard designed 1.0 mm coaxial connectors and calibration kits, you can now make fully error-corrected measurements to 110 GHz. Measurements made in 1.0 mm coax deliver uncompromised performance with improved productivity, as compared to making measurements in waveguide. The 1.0 mm connector is a sturdy, long life, precision connector that will provide repeatable connections. It has been accepted as a worldwide standard by the IEEE and IEC (the published standards are forthcoming).

There is no longer a need to struggle with waveguide; the measurement setup for 1.0 mm coax is configured with the test heads placed close to the device-under-test (DUT). You simply connect the short, flexible 1.0 mm coax cables between the test heads and your DUT. This configuration allows maximum flexibility while minimizing cable losses at 110 GHz.

Upgrade Your Current HP 8510 System to Grow Your Measurement Capability

Your HP 8510-based system can be upgraded to an HP 8510XF to meet your new design and test challenges. HP offers pre-configured upgrades for your standard HP 85107B, 85106C/D and 85109C systems. Upgrades include hardware and firmware and are installed on-site. Customized upgrades are also available for other HP 8510 systems. Calibration kits and cables must be purchased separately.

Millimeter Subsystems Available to Protect Your Investments

If you have an HP 8510C and the appropriate sources, you can upgrade your HP 8510 by simply selecting one of the two millimeter subsystems that are available. Each subsystem includes a millimeter controller and two test heads.

Key Literature

HP 8510 System Solutions Brochure, p/n 5965-8837E
HP 8510C Family Network Analyzer Technical Data, p/n 5091-8484E
HP 8510C Family Network Analyzer Configuration Guide, p/n 5091-8967E
HP 8510XF Family, Single-Sweep Systems Product Overview, p/n 5965-9888E
HP 85106D Millimeter-wave Network Analyzer System Product Overview, p/n 5964-4229E

Ordering Information

Complete HP 8510XF Systems
HP E7340A Single-Connection, Single-Sweep Network Analyzer System (2 to 85 GHz)
- **Opt 005** Extend Low Frequency to 45 MHz
- **Opt 006** RF pass thru
- **Opt 010** Add time domain capability to 8510C

HP E7350A Single-Connection, Single-Sweep Network Analyzer System (2 to 110 GHz)
- **Opt 005** Extend Low Frequency to 45 MHz
- **Opt 006** RF pass thru
- **Opt 010** Add time domain capability to 8510C

HP 85106D Millimeter-Wave Network Analyzer Subsystem

The HP 85106D millimeter-wave network analyzer subsystem includes an HP 8510C network analyzer, an HP 85105A millimeter-wave controller, an HP 83621B synthesized source as the RF and an HP 83621B synthesized source as the LO, all mounted in a single bay rack with extendable worksurface.

Two HP 85104A series test set modules are required to complete the system. With these configurations, both forward and reverse measurements can be made with a single connection to the device under test. The greatest convenience and highest accuracy is assured through the TRL (through-reflect-line) calibration technique. Precision calibration kits and verification kits are also available for these waveguide bands.

The HP 85106D can be configured as a combination microwave/millimeter-wave S-parameter system with Option 001. This option adds an HP 8517B microwave test set, 50 GHz source (HP 83651B), HP 85133F test port return cable set, HP 85056A calibration kit and appropriate cabling for convenient switching between millimeter-wave operation and microwave operation with no re-connections required.

HP 85108A/L Pulsed-RF Network Analyzer Systems

High Power Device Characterization

The HP 8510C can be configured for convenient single-connection, multiple-measurements of high-volume, high-power and pulsed testing of IF, RF, and microwave frequency ranges. By pulsing the RF, the average power through the device is reduced, thereby reducing thermal effects on the device and making accurate characterization possible. These systems also include on-site installation, and a one-year, on-site warranty to ensure that the systems remain up and running.

HP 85108A Pulsed-RF Network Analyzer System

The HP 85108A is a factory-integrated system that provides the entire instrument configuration required to make pulsed-RF measurements from 2 to 20 GHz. Special options are available to add frequency coverage to 50 GHz.

The system is built around the HP 8510C with the pulsed-RF measurement option (Option 008) already installed. The system also includes the HP 85110A S-parameter test set. HP 83622B and HP 83624B synthesized sweepers provide, respectively, the RF and LO signals needed to operate the fundamentally mixed test set.

HP 85108L Pulsed-RF Network Analyzer System

The HP 85108L with the HP 85110L pulsed-RF test set provides improvements to pulsed-RF network analysis in many areas, but specifically extends the frequency coverage down to 45 MHz and up to 2 GHz. Special options are available to extend the upper frequency. The HP 85108L system is built around the same HP 8510C and includes two HP 83620B Option H80 synthesizers. The system is optimized for component testing in applications such as cellular, direct broadcast satellite, and VHF/UHF.

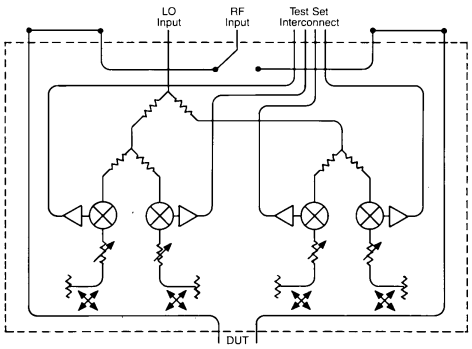
The HP 85110L has excellent pulsed-RF and CW performance with system dynamic range greater than 70 dB when using the wideband detectors and better than 95 dB when using the standard narrowband detectors. Both detectors are included in the HP 85108 systems.

HP 8510C Option 008

The HP 8510C pulsed-RF measurement capability (Option 008) consists of an additional receiver subsystem for the HP 8510. This pulsed-RF measurement capability, which exists in parallel with the standard HP 8510C operation, provides you with the ability to measure and display the relative magnitude and phase shift of the component as a function of time with equivalent bandwidth of 1.5 MHz. This allows the evaluation of the dynamic pulsed-RF characteristics for pulse widths down to 1 microsecond. Using the repetitive sampling method, point-to-point display resolution of 100 ns is available.

High Power CW or Pulsed-RF Measurements

An HP 85110A or 85110L S-parameter test set is a required system component for the HP 8510C pulsed-RF measurement capability. The figure below shows a simplified block diagram of this test set.



The block diagram provides some distinct advantages, whether using the HP 8510C for pulsed-RF or standard S-parameter measurements. Because of the coupler-based measurement path and attenuators, the test set can handle high powers, up to 20 Ω (HP 85110A) or 50 Ω (HP 85110L) CW.

Key to the pulse performance of the test sets are the fundamental mixers used to provide the low noise IF necessary to make accurate, pulsed-RF measurements with the pulsed-RF receiver subsystem. Two external synthesizers act as the RF and LO sources for the four-channel downconverter. This approach eliminates the need to dedicate one channel for phase-lock, making full two-port, pulsed-RF S-parameter measurements available. Also, the internal pulse modulator of the RF synthesizer can be used to pulse the device-under-test.

The connections available on the rear panel provide access to the measurement path, making it easy to configure test systems that use a single measurement connection for making multiple types of measurements such as spectrum analysis, noise figure and load-pull. Special versions of the HP 85110A and 85110L test sets are available for even higher power applications or other frequency ranges.

To Upgrade an Existing HP 8510C System for Pulsed-RF Measurements

Your existing HP 8510 system can be upgraded to perform pulsed-RF measurements. This upgrade can be performed on-site or integrated into a full system at the factory.

Key Literature

HP 8510 System Solutions Brochure, p/n 5965-8837E
HP 8510C Family Network Analyzer Technical Data, p/n 5091-8484E
HP 8510C Family Network Analyzer Configuration Guide, p/n 5091-8967E
HP 85108 Series Network Analyzer Systems Data Sheet, p/n 5091-8965E
HP 85106D Millimeter-Wave Network Analyzer System Product Overview, p/n 5964-4229E

Ordering Information

HP 85108A Pulsed-RF Network Analyzer System
HP 85108L Pulsed-RF Network Analyzer System
  Opt 010 Add Time-Domain Capability to HP 8510C (applies to both HP 85108A and 85108L)
HP 85106D Millimeter-Wave Network Analyzer Subsystem
  Opt 001 Add Microwave Test Set (HP 8517B), 50 GHz Source (HP 83651B), and 2.4 mm Accessories
  Opt 007 High Dynamic Range Configuration (to 50 GHz)
  Opt 010 Add Time-Domain Capability to HP 8510C
HP Q85104A Test Set Module (33 GHz to 50 GHz)
HP U85104A Test Set Module (40 GHz to 60 GHz)
HP V85104A Test Set Module (50 GHz to 75 GHz)
HP W85104A Test Set Module (75 GHz to 110 GHz)

For more information, including custom configurations, contact the HP Call Center in your region.

HP 84812A
HP 84813A
HP 84814A
HP 84815A
HP 11852B

HP 84815A, HP 81814A, HP 84813A, HP 84812A (left to right)

HP 84812A/13A/14A/15A Peak Power Sensors

The HP 84812A/13A/14A/15A peak power sensors are compatible with the now obsolete HP 8990A/91A/92A peak power analyzers. The sensors can still be ordered and give outstanding measurement accuracy in demanding situations including automatic temperature sensing and correction.

HP 84812A/13A/14A/15A Specifications

Frequency Range: HP 84812A: 500 MHz to 18 GHz
HP 84813A: 500 MHz to 26.5 GHz
HP 84814A: 500 MHz to 40 GHz
HP 84815A: 20 MHz to 18 GHz
Power Range: Dependent upon analyzer used.
Sensor Input SWR (reflection coefficient)**:**
50 MHz to 18 GHz: 1.25 (0.11)
6 to 18 GHz: 1.30 (0.13) (HP 84815A only)
18 GHz to 26.5 GHz: 1.35 (0.15)
26.5 GHz to 40 GHz: 1.60 (0.23)
Sensor Calibration Uncertainty:

Frequency	RSS uncertainty
< 4 GHz	±3.6%
< 12 GHz	±3.8%
< 18 GHz	±4.3%
< 26.5 GHz	±5.5%
< 40 GHz	±6.5%

Connector Type: HP 84812A, HP 84815A: Type-N (m);
HP 84813A: APC-3.5 mm (m); HP 84814A: 2.4 mm (m)
General Characteristics
Size: HP 84812A, HP 84815A: 37 mm W x 27 mm H x 137 mm D
(1.45 in x 1.05 in x 5.4 in)
HP 84813A, HP 84814A: 37 mm W x 27 mm H x 127 mm D
(1.45 in x 1.05 in x 5.0 in)
Weight: Net, 0.29 kg (0.64 lb); shipping, 0.64 kg (1.4 lb)

HP 11852B 50 W/75 W Minimum Loss Pad

The HP 11852B is a low SWR minimum loss pad required for measurements on 75 W devices.

HP 11852B Specifications

Frequency Range: DC to 2.0 GHz
Insertion Loss: 5.7 dB
Return Loss: 75 W typically ≥30 dB, 50 W typically ≥26 dB

Ordering Information

HP 84812A Peak Power Sensor
HP 84813A Peak Power Sensor
HP 84814A Peak Power Sensor
HP 84815A Peak Power Sensor
Opt W30 Extended Repair Service (see page 70)

- Fast measurement speed (up to 200 readings per second with the E4418A, and 100 readings per second with the E4419A, over the HP-IB, with E-series sensors)
- Speed improvement of x2 using the HP 8480-series power sensor (compared to HP 437B)
- Code-compatible with the HP 437B (E4418A) and HP438B (E4419A)
- Operates with the new E-series plus all HP 8480 series power sensors
- No range-switching delays with HP 8480-series sensors (over a 50 dB range), and only one fast-range switch point with E-series sensors (over a 90 dB range)
- High-resolution LCD display with backlighting for a wide viewing angle of data
- Same height and width as the HP 437B and the HP438A
- Conformity to CE and CSA standards

HP EPM Series Power Meters

HP E4418A Single-Channel Power Meter

The HP E4418A is a low-cost, high-performance, single-channel, programmable power meter. It is fully compatible with the HP 8480 series of power sensors and the E-series of power sensors. Depending upon which sensor is used, the HP E4418A can measure from –70 dBm to +44 dBm at frequencies from 100 kHz to 110 GHz. Designed for bench and automatic test equipment (ATE) use, the E4418A makes fast (up to 200 readings per second with E-series sensors), accurate and repeatable power measurements.

The E4418A power meter has a high-resolution LCD display with LED backlighting and contrast control. This allows users to see the power readings from a distance, at a wide viewing angle and in a variety of lighting conditions. The user interface is easy to learn and use, with hardkeys for the most frequently used functions, and softkey menus to simplify instrument configuration for different applications. Ten instrument configurations can be saved and recalled, reducing the need to repeat setup sequences.

The E4418A is ideal for service and maintainence applications. Front and rear panel bumpers protect the E4418A from everyday knocks. The meter weighs only 4 kg (9lbs), and a bail handle makes it easy to carry.

Because the E4418A power meter is designed to be code-compatible with the previous-generation HP 437B power meter, a user's investment in automatic-test procedures, software generation and verification is protected.

HP E4419A Dual-Channel Power Meter

The HP E4419A is a low-cost, high-performance, dual-channel, programmable power meter. It is fully compatible with the HP 8480 series of power sensors and the new E series of power sensors. Depending upon which sensor is used, the HP E4419A can measure from –70 dBm to +44 dBm at frequencies from 100 kHz to 110 GHz.

Designed for bench and automatic test equipment use (ATE), the E4419A makes fast (up to 100 readings per second with E-series sensors), accurate and repeatable power measurements. The HP E4419A is a true dual-channel power meter, which means that you get two simultaneous power readings on the display.

The E4419A power meter has a high-resolution LCD display with LED backlighting and contrast control. This allows users to see the power readings from a distance, at a wide viewing angle and in a variety of lighting conditions. Users can display both the digital and analog types of readout on the meter's split screen facility. The analog peaking meter allows users to make accurate adjustments.

The user interface is easy to learn and use, with hardkeys for the most frequently used functions, and softkey menus to simplify instrument configuration for different applications. Difference (A-B, B-A) and ratio (A/B, B/A) functions are provided, and ten instrument configurations can be saved and recalled, reducing the need to repeat setup sequences.

Because the E4419A power meter is code compatible with the HP 438A and is the same height (88.5 mm /3.5 in) and width (212.6 mm/8.5 in) as the HP 438A, this makes it easy to substitute into rackmount automatic-test-equipment systems.

Specifications

Frequency Range: 100 kHz to 50 GHz and 75 GHz to 110 GHz, sensor dependent
Power Range: –70 dBm to +44 dBm (100 pW to 25 W), sensor dependent
Power Sensors: Compatible with all HP 8480 series and HP E-series sensors
Single Sensor Dynamic Range:
90 dB maximum (HP E-series sensors)
50 dB maximum (HP 8480 series sensors)
Display Units:
Absolute: Watts or dBm
Relative: Percent or dB
Display Resolution: Selectable resolution of 1.0, 0.1, 0.01, and 0.001 dB in log mode, or 1 to 4 digits in linear mode
Default Resolution: 0.01 dB in log mode, 3 digits in linear mode

Accuracy
Instrumentation
Absolute: ± 0.02 dB (log) or ± 0.5% (linear). Add the corresponding power sensor linearity percentage
Relative: ± 0.04 dB (log) or ± 1.0% (linear). Add the corresponding power sensor linearity percentage

Power Reference
Power Output: 1.00 mW (0.0 dBm). Factory set to ± 0.7%, traceable to the U.S. National Institute of Standards and Technology (NIST)
Accuracy: ± 1.2% worst case (± 0.9% rss) for one year

Key Literature

EPM Power Meters and E-Series Power Sensors
Brochure, p/n 5965-6380E
EPM Power Meters and E-Series Power Sensors
Technical Specifications, p/n 5965-6382E
EPM Power Meters and E-Series Power Sensors
Configuration Guide, p/n 5965-6381E
Fundamentals of RF and Microwave Power Measurements
Application Note 64-1A, p/n 5965-6630E

Ordering Information

HP E4418A Power Meter
HP E4419A Power Meter
Opt 002 Supplies rear-panel sensor input (power reference calibrator is on front panel)
Opt 003 Supplies rear-panel sensor input (power reference calibrator is on rear panel)
Opt 004 Deletes the HP 11730A sensor cable
Opt 908 Supplies a one-instrument rackmount kit
Opt 909 Supplies a two-instrument rackmount kit
Opt 1BN Supplies MIL-STD-45662A Certificate of Calibration
Opt 1BP Supplies MIL-STD-45662A Certificate of Calibration with data
Opt UK6 Supplies commercial calibration certificate with test data

HP 8900C
HP 8900D
HP 70100A
HP E1416A
HP 84811A

HP 70100A

HP E1416A

HP 70100A and E1416A MMS and VXI Power Meters

The HP 70100A is a full-featured single-channel power meter module for the modular measurement system. It has all the capability of the HP 437B power meter in a one-eighth rack-width module. The HP 70100A features the same modern and flexible feature set as the HP 437B, the same state-of-the-art accuracy, and is also fully compatible with the HP 8480 series of power sensors. The HP E1416A power meter is a VXI version of the HP 70100A.

HP 70100A, and E1416A Specifications

Frequency Range: 100 kHz to 110 GHz, sensor dependent
Power Range: –70 to +44 dBm (100 pW to 25 W), sensor dependent
Power Sensors: Compatible with all HP 8480 series power sensors
Dynamic Range: 50 dB in 10 dB steps
Display Units: Absolute: watts, dBm; relative: percent, dB
Resolution: Selectable resolution of 0.1, 0.01, and 0.001 dB in logarithmic mode; or 1% and 0.01% of full scale in linear mode

Accuracy
Instrumentation: ±0.02 dB or ±0.5%
In REL Mode: ±0.02 dB or ±0.5% within measurement range; ±0.04 dB or 1% outside measurement range
Zero Set: ±0.5% of full scale on most sensitive range

Power Reference
Power Output: 100 mW, factory-set to ±0.7%, traceable to US National Institute of Standards and Technology
Accuracy: ±1.2% worst case (±0.9% RSS) for 1 year

Ordering Information

HP 70100A Power Meter Module
- **Opt 003** Moves Reference Oscillator from Front to Rear Panel
- **Opt 004** Deletes the HP 11730A Power Sensor Cable
- **Opt 005** Deletes Reference Oscillator
- **Opt W30** Extended Repair Service (see page 584)

HP E1416A Power Meter C-Size VXI
- **Opt 004** Delete Sensor Cable
- **Opt 915** Service Support Kit
- **Opt 916** Additional User's Manual
- **Opt W01** 3 Year Return-to-HP to 1 Year On-site Warranty
- **Opt W32** 3 Year Customer Return Calibration Service
- **Opt W34** 3 Year Customer Return Standards Compliant Calibration Service
- **Opt W50** 5 Year Return Repair Service
- **Opt W52** 5 Year Customer Return Calibration Service
- **Opt W54** 5 Year Customer Return Standards Compliant Calibration Service

HP 8900C

HP 8900D

HP 8900C/D Peak Power Meters

The HP 8900C and 8900D peak power meters directly display the peak power of RF pulses over a 100 MHz to 18 GHz frequency range. Measurements can be made on pulses with widths from 1 µs (100 ns in compare mode) to CW, and repetition rates from 100 Hz (0 Hz in compare mode) to 100 kHz.

The HP 8900C is an economical analog meter calibrated in watts and dBm. The analog display with its large, easy-to-read scale makes it simple to peak or null pulsed power systems. The HP 8900D has a high-resolution 3½-digit digital display calibrated in watts. The direct reading display and range annunciators make the digital version a good choice for production and field applications where unambiguous or frequent readings are required.

HP 84811A Peak Power Sensor

The HP 84811A peak power sensor works with the HP 8900C/D peak power meters to measure the peak power of RF pulses. It is supplied with a 4-foot flexible cable to easily reach the pulse source being measured. The HP 84811A also conveniently detaches from the meter for storage, recalibration, or replacement.

HP 8900C/D Peak Power Meters Specifications

Frequency Range: 100 MHz to 18 GHz
Dynamic Range: 20 dB (0 to +20 dBm)
- **HP 8900C:** 4 ranges of 3, 10, 30, and 100 mW full scale
- **HP 8900D:** 2 ranges of 10 and 100 mW full scale

Pulse Response:
- **Direct Mode**
  - **Pulse Width:** 1 µs to CW
  - **Repetition Rate:** 100 Hz to 100 kHz
- **Compare Mode**
  - **Pulse Width:** 100 ns (typical) limited by rise-time specification
  - **Repetition Rate:** 0 to 100 kHz
- **Rise Time:** 75 ns
- **Fall Time:** 125 ns (as measured on video output)

Power Consumption: 100 and 120 Vac +5, –10%, 48 to 66 Hz and 360 to 440 Hz; 220 and 240 Vac +5, –10%, 48 to 66 Hz

Meter accuracy	CW	Pulse	Transfer accuracy CW to pulse
Direct	±0.2 dB	±0.35 dB	±0.2 dB
Compare	±0.2 dB	±0.25 dB	±0.1 dB

HP 84811A Peak Power Sensor Specifications

Power Range: 0 to +20 dBm (1 mW to 100 mW)
Frequency Range: 100 MHz to 18 GHz
SWR: 100 MHz to 12 GHz <1.5. 12 GHz to 18 GHz <2.0
Maximum Peak Power: +24 dBm (250 mW) for 5 minutes
Connector Type: Type-N (male)
Calibration Accuracy: (+10° to +40° C), ±0.7 dB 0.1 to 12 GHz, ±1.0 dB to 18 GHz. 0° to 10° C and 40° to 55° C: add ±0.2 dB

Key Literature

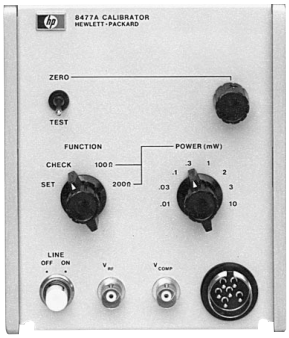
HP 8900C/D Peak Power Meters and HP 84811A Peak Power Sensor Technical Data, p/n 5952-8258

Ordering Information

HP 8900C Analog Peak Power Meter
HP 8900D Digital Peak Power Meter
- **Opt W30** Extended Repair Service (for HP 8900C/D) (see page 584)
- **Opt W32** Calibration Service (see page 70)

HP 84811A Peak Power Sensor
- **Opt W30** Extended Repair Service (see page 70)
- **Opt W32** Calibration Service (see page 70)

HP 432A



HP 8477A

HP Thermistor Mounts

HP 432A Power Meter

- High accuracy—no thermoelectric error: High accuracy over a wide temperature range is featured on the HP 432A power meter. By measuring the output voltage of the thermistor bridges and computing the corresponding power, even higher accuracy of ±0.2 percent ±0.5 µW can be obtained. Accuracy can be maintained on even the most sensitive range because the error due to thermoelectric effect is reduced to a negligible level.
- Calibrated mounts: Each thermistor mount is furnished with data stating the calibration factor and effective efficiency at various frequencies across the operating range. For easy and accurate power measurements, the front panel of the HP 432A has a calibration-factor control, calibrated in one-percent steps from 88 percent to 100 percent, that compensates for losses in the mount and eliminates the need for calculation.
- Instrument type: Automatic, self-balancing power meter for use with temperature-compensated thermistor sensor.

Specifications (Partial)

Power Range: 7 ranges with full-scale readings of 10, 30, 100, and 300 µW, 1, 3, and 10 mW; also calibrated in dBm from –20 dBm to +10 dBm full scale in 5 dB steps
Noise: Less than 0.25% of full scale peak (typical)
Response Time: At recorder output, 35 ms time constant (typical)
Fine Zero: Automatic, operated by front-panel switch
Zero Carryover: Less than 0.50% of full scale when zeroed on most sensitive range
Meter: Taut-band suspension, individually calibrated, mirror-backed scales. Milliwatt scale more than 108 mm (4.25 in) long
Calibration Factor Control: 13-position switch normalizes meter reading to account for thermistor sensor calibration factor. Range 100% to 88% in 1% steps.
Thermistor Sensor: Thermistor sensors are required for operation of the HP 432A. For microwave sensors HP 478A, 8478B, and 486 series, see next column.
Recorder Output: Proportional to indicated power with 1 volt corresponding to full scale. 1 kΩ output impedance.
BCD Output: 8, 4, 2, 1 code: "1" positive. TTL compatible logic. Operates with HP 5150A, Option 002 (BCD) digital recorder.
Power Consumption: 115 or 230 Vac ±10%, 50 to 400 Hz, 1.5 watts
Size: 130 mm W x 155 mm H x 279 mm D (5.2 in x 6.1 in x 11.0 in)
Weight: Net, 2.3 kg (5.5 lb); shipping, 4.6 kg (10 lb)

HP 8477A Power Meter Calibrator

The HP 8477A power meter calibrator is specifically designed for use with the HP 432A power meter. It allows you to verify full-scale meter readings on all ranges, and meter tracking. Simply connect three cables between the power meter and calibrator; no charts or additional instruments are required.

Power: 115 or 230 Vac ±10%, 50 to 400 Hz, 3 watts

Temperature-Compensated Thermistor Mounts

High efficiency and good radio frequency (RF) match are characteristic of the HP 478A and 8478B coaxial and 486A series waveguide thermistor mounts. Used in conjunction with the HP 432A power meter, they provide high accuracy even in routine power measurements. These thermistor mounts are temperature compensated for low drift, even in the presence of thermal shocks, permitting measurement of microwave power as low as one microwatt. Each mount contains data showing calibration factor and effective efficiency at six frequencies, directly traceable to the U.S. National Institute Standards and Technology at those frequencies where NIST provides calibration service.

HP 486A, 478A, 8478B Specifications

HP model	Frequency range, GHz	Maximum SWR	
478A	10 MHz to 10 GHz	1.75, 10 to 25 MHz 1.3, 25 MHz to 7 GHz 1.5, 7 to 10 GHz	
8478B[1]	10 MHz to 18 GHz	1.75, 10 to 30 MHz 1.35, 30 to 100 MHz 1.1, 0.1 to 1 GHz 1.35, 1 to 12.4 GHz 1.6, 12.4 to 18 GHz	🚗
X486A	8.20 to 12.4	1.5	
P486A	12.4 to 18.0	1.5	
K486A	18.0 to 26.5	2.0	
R486A	26.5 to 40.0	2.0	

[1] Option 011: Furnished with APC-7 RF connector

Ordering Information

HP 432A Power Meter
Opt 001 Rechargeable battery installed, provides up to 20 hours of continuous operation (HP 432A only)
Opt 002 Input connector placed on rear panel in parallel with front
Opt 003 Input connector on rear panel only
Opt 009 3.1 m (10 ft) Cable for 100 Ω or 200 Ω Sensor
Opt 010 6.1 m (20 ft) Cable for 100 Ω or 200 Ω Sensor
Opt 011 15.2 m (50 ft) Cable for 100 Ω or 200 Ω Sensor
Opt 012 30.5 m (100 ft) Cable for 100 Ω or 200 Ω Sensor
Opt 013 61 m (200 ft) Cable for 100 Ω or 200 Ω Sensor
Opt 100 100 Vac Operation, 48 to 66 Hz
Opt 910 Extra Operating and Service Manual (HP432A: p/n 00432-90009)
Opt W30 Extended Repair Service (see page 70)
Opt W32 Calibration Service (see page 70)
HP 8477A Power Meter Calibrator
Opt W30 Extended Repair Service (see page 70)
Opt W32 Calibration Service (see page 70)

🚗 Indicates QuickShip availability.

HP E-Series Power Sensor Family

HP E4412A
HP E4413A

- Operates with the new HP E4418A and HP E4419A power meters
- Wide dynamic range sensors (–70 dBm to +20 dBm)
- Fast measurement speed (up to 200 readings per second, over the HP-IB, with the HP E4418A power meter)
- Calibration factors stored in EEPROM

HP E-Series Power Sensors

HP E-Series Power Sensors

The E-series power sensors, comprising the HP E4412A (10 MHz to 18 GHz) and HP E4413A (50 MHz to 26.5 GHz) are wide dynamic range (–70 dBm to +20 dBm) CW sensors and only operate with the EPM-series power meters.

Some of the new performance features provided by the HP E-series sensors and HP EPM series power meters are fast measurement speed (up to 200 readings per second with the E4418A single channel power meter), 90 dB dynamic range (–70 dBm to +20 dBm) and sensor calibration factors stored in EEPROM.

5

Specifications

Wide Dynamic Range CW Sensors:
100 pW to 100 mW (–70 dBm to +20 dBm)
Zero Set (digital settability of zero)**:** ±50 pW.
This applies to a ZERO performed when the sensor input is not connected to the POWER REF.

HP E4412A

Frequency Range	Maximum SWR	Maximum Power	Connector Type
10 MHz to 18 GHz	10 MHz to 30 MHz: 1.34 30 MHz to 10 GHz: 1.22 10 GHz to 18 GHz: 1.27	200 mW (+23 dBm)	N (m)

HP E4413A

Frequency Range	Maximum SWR	Maximum Power	Connector Type
50 MHz to 26.5 GHz	50 MHz to 2 GHz: 1.25 2 GHz to 18 GHz: 1.21 18 GHz to 26.5 GHz: 1.26	200 mW (+23 dBm)	APC-3.5 mm (m)

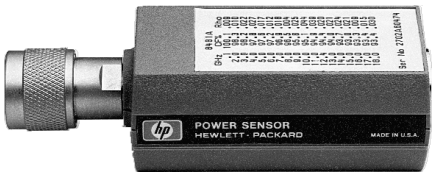
Power Linearity
100 pW to 10 mW (–70 dBm to +10 dBm)**:**
Temperature: (25° C ± 5° C): ±4%; (0 to 55° C): ±8%
10 mW to 100 mW (+10 dBm to +20 dBm)**:**
Temperature: (25° C ± 5° C): ±5.5%; (0 to 55° C): ±11%
Size
E4412A: 130 mm L x 38 mm W x 30 mm H (5.1 in x 1.5 in x 1.2 in)
E4413A: 102 mm L x 38 mm W x 30 mm H (4 in x 1.5 in x 1.2 in)
Weight
E4412A: 0.47 kg (1.04 lb)
E4413A: 0.45 kg (1.0 lb)

Key Literature

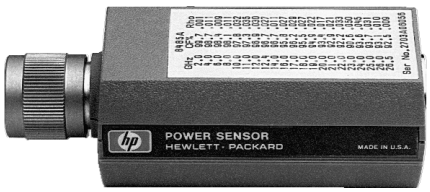
EPM Power Meters and E-Series Power Sensors Technical Specifications, p/n 5965-6382E
EPM Power Meters and E-Series Power Sensors Brochure, p/n 5965-6380E
EPM Power Meters and E-Series Power Sensors Configuration Guide, p/n 5965-6381E
Fundamentals of RF and Microwave Power Measurements Application Note 64-1A, p/n 5965-6630E

Ordering Information

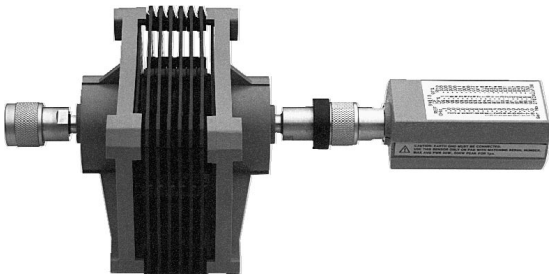
HP E4412A Power Sensor (10 MHz to 18 GHz)
HP E4413A Power Sensor (50 MHz to 26.5 GHz)
Opt 0B1 Extra Operation and Service Guide
Opt 1BN MIL-STD-45662A Certification of Calibration
Opt ABD German Operation and Service Guide
Opt ABE Spanish Operation and Service Guide
Opt ABF French Operation and Service Guide
Opt ABJ Japanese Operation and Service Guide
Opt ABZ Italian Operation and Service Guide



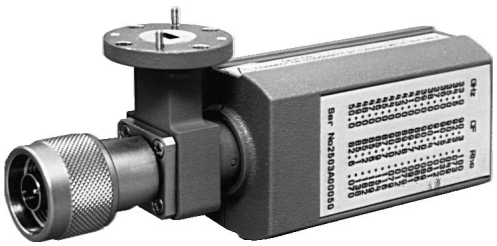
HP 8481A



HP 8485A



HP 8481A



HP Q8485A

HP 8480 Power Sensor Family

The HP 8480 power sensors are designed for use with the E4418A, E4419A, HP 435B, 436A, 437B, 438A, 70100A and E1416A power meters. These thermocouple and diode power sensors provide extraordinary accuracy, stability, and SWR over a wide range of frequencies (100 kHz to 110 GHz) and power levels (–70 to +44 dBm).

Best SWR in the Industry

Mismatch uncertainty is usually the largest single source of error in power measurements. The HP 8480 power sensor family gives you extremely low SWR even at mm-wave frequencies. For example, the HP W8486A power sensor has a specified SWR of less than 1.08:1 over its entire 75 to 110 GHz frequency range. This low SWR translates into minimum mismatch uncertainty and optimum measurement accuracy.

Accurate Calibration and Traceability

Each power sensor in the HP 8480 family is individually calibrated and traceable to the U.S. National Institute of Standards and Technology (NIST, formerly NBS). The uncertainty in this calibration factor is your link to NIST. The cal factor measurement system used by HP Standards Lab provides you with minimum cal factor uncertainty.

True-RMS Reading Sensors

HP high-sensitivity diode power sensors (HP 8481D/85D/86D/87D) are always operated inside the square-law region. This means that the sensor will act as a true-RMS reading device over its entire –70 to –20 dBm dynamic range. The benefit to you: HP sensors provide you with accurate readings even if your test signal is subjected to multi-tone environments, modulated carriers, or carriers with high harmonics.

Millimeter-Wave Sensor Calibration

A 50 MHz calibration port is included in HP waveguide power sensors for calibration with the power meter. This calibration provides traceability to NIST at millimeter-wave frequencies, and it eliminates the uncertainties due to temperature changes and the variance in making measurements with different meter/sensor combinations.

Accurate Accessories Included

With HP power sensors, you can start making measurements right away. No more hunting around for attenuators or adapters. HP sensors include all the accessories you need to optimize accuracy and save time.

HP 11683A Range Calibrator

The HP 11683A range calibrator is specifically designed for use with the E4418A, E4419A, HP 435B, 436A, 437B, 438A, 70100A and E1416A power meters. It allows verification of full-scale meter readings on all ranges, as well as meter tracking. Simply connect the cable between the power meter and calibrator. The CAL ADJ control on the power meter is used to set the meter to full scale on the 1 mW range. The calibrator and meter are then stepped through the other ranges verifying accuracy within ±1 percent plus noise and drift. The HP 11683A also has a polarity switch that tests the auto-zero circuit. The HP 11683A is not HP-IB compatible.

HP 11683A Range Calibrator Specifications

Calibration Functions: Outputs corresponding to meter readings of 3, 10, 30, 100, and 300 µW; 1, 3, 10, 30, and 100 mW
Calibration Uncertainty: ±0.25% in all ranges
Power: 100, 120, 220, or 240 Vac + 5%, –10%, 48 –440 Hz, less than10 V · A
Size: 133 mm W x 89 mm H x 216 mm D (5.25 in x 3.5 in x 8.5 in)
Weight: Net, 1.13 kg (2.5 lb); shipping, 1.9 kg (4.2 lb)

HP 11730A-F Power Sensor Cables

The HP 11730 series power sensor cables are for use with the E4418A, E4419A, HP 435B, 436A, 437B, 438A, 70100A and E1416A power meters and the E-series and HP 8480 series of power sensors. These cables are designed to reduce RFI effects on low power readings with an improved shielding design in the cable itself. Cables may be ordered individually or in pairs in any combination desired for single- and dual-channel measurements.

The HP 11730A cable is the standard cable for the E4418A, E4419A(2 cables shipped), HP 435B, 436A, 437B, 438A (2 cables shipped), 70100A and E1416A power meters. To order a nonstandard cable, select Option 004 for the meter in question, and order the desired cable from below.

Key Literature

Thermocouple and Diode Power Sensor Family Brochure, p/n 5959-8751

Ordering Information

HP 11683A Range Calibrator
HP 11730A 1.5 Meter (5 ft) Sensor Cable
HP 11730B 3.0 Meter (10 ft) Sensor Cable
HP 11730C 6.1 Meter (20 ft) Sensor Cable
HP 11730D 15.2 Meter (50 ft) Sensor Cable
HP 11730E 30.5 Meter (100 ft) Sensor Cable
HP 11730F 61.0 Meter (200 ft) Sensor Cable

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HP 8480 Series Specifications

HP model	Frequency range	Maximum SWR	Power linearity[1]	Maximum power	Connector type	Weight	
25 Watt Sensors 1 mW to 25 W (0 to +44 dBm)							
8481B	10 MHz to 18 GHz	10 MHz to 2 GHz: 1.10 2 to 12.4 GHz: 1.18 12.4 to 18 GHz: 1.28	+35 to +44 dBm; ±4%	0° to 35° C: 30 W avg[2] 35° to 55° C: 25 W avg 0.01 to 5.8 GHz: 500 W pk	Type-N(m)	Net 0.8 kg (1.75 lb) Shipping 1.5 kg (3.25 lb)	
8482B	100 kHz to 4.2 GHz	100 kHz to 2 GHz: 1.10 2 to 4.2 GHz: 1.18		5.8 to 18 GHz: 125 W pk 500 W-µs per pulse	Type-N(m)		$
3 Watt Sensors 100 µW to 3 W (–10 to +35 dBm)							
8481H	10 MHz to 18 GHz	10 MHz to 8 GHz: 1.20 8 to 12.4 GHz: 1.25 12.4 to 18 GHz: 1.30	+25 to +35 dBm; ±5%	3.5 W avg, 100 W pk 100 W-µs per pulse	Type-N(m)	Net 0.2 kg (0.38 lb) Shipping 0.5 kg (1 lb)	
8482H	100 kHz to 4.2 GHz	100 kHz to 4.2 GHz: 1.20			Type-N(m)		
100 mW Sensors 1 µW to 100 mW (–30 to +20 dBm)							
8485A	50 MHz to 26.5 GHz	50 to 100 MHz: 1.15 100 MHz to 2 GHz: 1.10 2 to 2.4 GHz: 1.15 12.4 to 18 GHz: 1.20 18 to 26.5 GHz: 1.25	+10 to +20 dBm; +2, –4%	300 m W avg, 15 W pk 30 W-µs per pulse	APC-3.5 mm (m)	Net 0.2 kg (0.38 lb) Shipping 0.5 kg (1 lb)	
Option 033	50 MHz to 33 GHz	26.5 to 33 GHz: 1.40					
8481A	10 MHz to 18 GHz	10 to 30 MHz: 1.40 30 to 50 MHz: 1.18 50 MHz to 2 GHz: 1.10 2 to 12.4 GHz: 1.18 12.4 to 18 GHz: 1.28			Type-N(m)		
8482A	100 kHz to 4.2 GHz	100 to 300 kHz: 1.60 0.3 to 1 MHz: 1.20 1 MHz to 2 GHz: 1.10 2 to 4.2 GHz: 1.30			Type-N(m)		
8483A (75 Ω)	100 kHz to 2 GHz	100 to 600 kHz: 1.80 600 kHz to 2 GHz: 1.18		300 mW avg, 10 W pk	Type-N(m) 75 Ω		
R8486A	26.5 to 40 GHz	1.4	+10 to +20 dBm; +2, –4%	300 mW avg, 15 W pk 30 W-µs per pulse	Waveguide Flange UG-599/U	Net 0.26 kg (0.53 lb) Shipping 0.66 kg (1.3 lb)	
Q8486A	33 to 50 GHz	1.5			Waveguide Flange UG-383/U		
W8486A	75 to 110 GHz	1.08	+1, –3%	200 mW avg 40 W peak	Waveguide Flange UG-387/U	Net 0.4 kg (0.9 lb) Shipping 1.0 kg (2.1 lb)	
8487A	50 MHz to 50 GHz	50 to 100 MHz: 1.15 100 MHz to 2 GHz: 1.10 2 to 12.4 GHz: 1.15 12.4 to 18 GHz: 1.20 18 to 26.5 GHz: 1.25 26.5 to 40 GHz: 1.30 40 to 50 GHz: 1.50	+10 to +20 dBm; +2,– 4%	300 mW avg, 15 W pk 30 W-µs per pulse	2.4 mm (m)	Net 0.14 kg (0.28 lb) Shipping 0.5 kg (1 lb)	
High Sensitivity Sensors 100 pW to 10 µW (–70 to –20 dBm)							
8481D[3,4]	10 MHz to 18 GHz	10 to 30 MHz: 1.40 30 MHz to 4 GHz: 1.15 4 to 10 GHz: 1.20 10 to 15 GHz: 1.30 15 to 18 GHz: 1.35	–30 to –20 dBm; ±1%	100 mW avg 100 mW pk	Type-N(m)	Net 0.18 kg (0.41 lb) Shipping 0.9 kg (2 lb)	
8485D[3]	50 MHz to 26.5 GHz	0.05 to 0.1 GHz: 1.19 0.1 to 4 GHz: 1.15 4 to 12 GHz: 1.19 12 to 18 GHz: 1.25 18 to 26.5 GHz: 1.29	–30 to –20 dBm; ±2%	100 mW avg 100 mW pk	APC-3.5 mm (m)	Net 0.2 kg (0.38 lb) Shipping 0.5 kg (1 lb)	
Option 033	50 MHz to 33 GHz	26.5 to 33 GHz: 1.35					
8487D[3]	50 MHz to 50 GHz	0.05 to 0.1 GHz: 1.19 0.1 to 2 GHz: 1.15 2 to 12.4 GHz: 1.20 12.4 to 18 GHz: 1.29 18 to 34 GHz: 1.37 34 to 40 GHz: 1.61 40 to 50 GHz: 1.89	–30 to –20 dBm; ±2%	100 mW pk 100 mW avg	2.4 mm (m)	Shipping 0.5 kg (1 lb) Net 0.2 kg (0.38 lb)	
R8486D[3]	26.5 to 40 GHz	1.4	–30 to –25 dBm; ±3%	100 mW avg or pk 40 Vdc max	Waveguide Flange UG-599/U	Net 0.26 kg (0.53 lb) Shipping 0.66 kg (1.3 lb)	
Q8486D[3]	33 to 50 GHz	1.4	–25 to –20 dBm; ±5%		Waveguide Flange UG-383/U		

[1] Negligible deviation except for those power ranges noted.
[2] For pulses greater than 30 W the maximum average power (P_a) is limited by the energy per pulse (E) in W – µs according to P_a=30-0.02E.
[3] Includes HP 11708A 30 dB attenuator for calibrating against a 0 dBm, 50 MHz power reference. HP 11708A is factory set to 30 dB ±0.05 dB at 50 MHz, traceable to NIST. SWR <1.05 at 50 MHz.
[4] This sensor directly replaces the popular HP 8484A power sensor.

Indicates QuickShip availability.

- 10 to 1600 MHz (2047 MHz with Option 020)
- Accurate and simple, swept or CW measurements
- Second-stage correction
- Noise figure and gain display
- Calibrated display on oscilloscope, recorder, or plotter
- Powerful special-function enhancements

HP 8970B

HP 8970B Noise Figure Meter

With the HP 8970B noise figure meter, noise figure measurements are easy, accurate, and repeatable. Automatic second-stage correction makes accurate noise figure readings possible even for low-gain devices. The HP 8970B's dynamic range allows gain measurements of at least 40 dB (higher in some cases) or loss measurements to –20 dB, with no external attenuation or amplification. The HP 8970B can store up to four Excess Noise Ratio (ENR) noise source calibration tables. It also properly interpolates ENR values at each measurement frequency.

Microprocessor and Controller Functions

The HP 8970B takes the mystery out of noise figure measurements. It uses a microprocessor to make the calculations and corrections necessary for truly accurate, convenient, and flexible noise figure measurements. The meter also controls external local oscillators (such as the HP 8370 series synthesizers, the HP 8340 or HP 8360 series synthesized sweepers, or the HP 8350 sweep oscillator) and the HP 8971C noise figure test set. This makes accurate, broadband microwave measurements of amplifiers, mixers, and transistors as simple as RF measurements.

Virtually all of the HP 8970B's front-panel keys and functions are accessible over HP-IB, Hewlett Packard's enhanced version of IEEE-488. The noise figure meter has an independent system interface bus (SIB) to control the HP 8971C and local oscillator. This additional bus frees you from having to write computer code to control an instrument on the SIB (such as the local oscillator) when used in an automated setup. Pass-through capability allows other instrument controllers to send messages through the noise figure meter to any other instrument on the SIB.

Simple Calibration and Second-Stage Correction

Noise figure measurement accuracy is enhanced because the meter measures its own noise figure (and that of the rest of the measurement system) at up to 181 points. It stores this information, interpolates where necessary, and corrects for it when displaying the device under test noise figure. It also measures the test device gain.

Display

The HP 8970B's front-panel LEDs display frequency, gain, and noise figure. Rear-panel BNC connectors allow swept display of noise figure and gain versus frequency on an oscilloscope or x-y recorder. You can also have the noise figure and gain vs. frequency display sent to a digital plotter over the HP 8970B's system interface bus. All display modes are easily and accurately scaled to the desired resolution from the meter's front panel. The swept oscilloscope display allows you to optimize your test device in real time for both noise figure and gain. You can easily change the noise figure display from noise figure to effective noise temperature (Te) or Y factor.

Front Panel and Special Functions

The HP 8970B front-panel keys control number entry, calibration, and measurement. STORE, RECALL, and SEQ keys allow up to nine front-panel settings to be stored and sequenced automatically or manually to save setup time. Smoothing INCREASE and DECREASE keys are used to average up to 512 readings before display. This increases accuracy and eliminates display flicker.

For those who need greater measurement power than that provided by the HP 8970B's simple front panel, more than 200 special functions can be selected by pressing a numerical code and a special function key. Two examples are hot-cold measurements and automatic compensation for losses at the input of the test device. One of the special functions is a catalog that quickly shows you the current special functions being used. Three pull-out cards serve as a mini-reference manual for the instrument. They include most of the special functions, the HP-IB formats and codes, error messages, and typical measurement setups.

HP 8970B Partial Specifications

(See Technical Data Sheet p/n 5091-6049E for complete specifications.)
Noise Figure (Gain) Measurement Range: 0 to 30 dB (–20 to at least 40 dB)
Noise Figure (Gain) Instrumentation Uncertainty: ± 0.1 dB for 0° to 55° C (±.15 dB)
Noise Figure Resolution: 0.01 dB (0.001 dB over HP-IB)
Gain Resolution: 0.01 dB (0.001 dB over HP-IB)
Frequency Range: Tunable from 10 to 1600 MHz (2047 MHz with Option 020)
Tuning Accuracy (from 10° to 40° C): ± (1 MHz + 1% of frequency), ±6 MHz maximum
Frequency Resolution: 1 MHz
Noise Figure (for input power levels below –60 dBm): <7 dB + 0.003 dB/MHz (+0.002 dB/MHz with option 020)
Input SWR, 50 Ω reference impedence:
<1.7 10 MHz to 1600 MHz (SWR< 1.8 with Opt 020)
<2.0 1600 MHz to 2047 MHz
Maximum Operating Input Power: –10 dBm
Maximum Net External Gain: >65 dB between noise source and HP 8970B RF input
Noise Source Drive: 28.0 ± 0.1 V
Operating Temperature: 0° to 55° C
Storage Temperature: – 55° to 75° C
Power: 100, 120, 220, or 240 V (+ 5%, – 10%); 48 to 66 Hz; 150 VA maximum
Size: 425 mm W x 143 mm H x 476 mm D (16.75 in x 5.68 in x 18.38 in)
Weight: net, 15.5 kg (34 lb); shipping, 18.5 kg (40 lb)

Key Literature

HP 8970B, 8970S/V, 8971C Noise Figure Measurement Products Technical Data, p/n 5091-6049E

HP 8970S
HP 8970V
HP 8971C

HP 8970S/V

- 10 MHz to 26.5 GHz
- Fully specified system
- Removes double-sideband inaccuracies
- As easy to operate as the HP 8970B

HP 8971C

HP 8970S/V Microwave Noise Figure Measurement Systems

The HP 8970S/V systems remove the burden of designing, building, and supporting a microwave noise figure measurement system. You can now spend your time designing and building products, not test systems.

Each system consists of the HP 8970B noise figure meter, the HP 8971C noise figure test set, and a synthesized local oscillator. The HP 8970V system, which operates 10 MHz to 20 GHz, uses the HP 83711B synthesized CW generator as its local oscillator. The HP 8970S allows you to select the LO from the list below. Frequency operation depends on the LO selected, but can be configured to measure 10 MHz to 26.5 GHz with the HP 83630B synthesized sweeper. The HP 8971C with Option 001 is recommended for operation above 20 GHz.

The HP 8970B acts as the controller, so all system operation is transparent to the user. To ensure specified performance, the HP 8970S/V systems are given specifications just like an RF noise figure meter (i.e., the HP 8970B).

HP 8970S/V Partial Specifications

(See HP 8970S/V Technical Data for complete specifications.)
Frequency Range:
HP 8970S: 10 MHz to 26.5 GHz
HP 8970V: 10 MHz to 20 GHz
Noise Figure Measurement Range: 0 to 30 dB
Noise Figure Instrumentation Uncertainty (for a 14 to 16 dB ENR noise source in a 10° to 40° C environment and for device under test noise figure plus gain greater than 10 dB):
10 MHz to 18 GHz: ±0.2 dB (plus typical drift of ±0.015 dB/° C)
18 to 26.5 GHz: ±0.4 dB (plus typical drift of ±0.08 dB/° C)
Gain Instrumentation Uncertainty: ±0.28 dB (plus typical drift of ±0.05 dB/° C), 10 MHz to 18 GHz; ±0.07 dB/° C, 18 to 26.5 GHz
Noise Figure (maximum):
10 to 30 MHz: 18 dB
30 to 100 MHz: 13 dB
0.1 to 12 GHz: 10 dB
12 to 18 GHz: 11.5 dB
18 to 26.5 GHz: 14 dB
Input SWR: 10 MHz to 18 GHz: 2.25; 18 to 26.5 GHz: 2.7
Recommended Local Oscillators: HP 83620B, 83622B, 83623B/L, 83624B, 83630B/L, 83640B/L, 83650B/L, 83711B, 83712B, 83731B, 83732B, 83751A/B, 83752 A/B

HP 8971C Noise Figure Test Set

The HP 8971C noise figure test set brings the simplicity of double-sideband measurements and the accuracy of single-sideband measurements together in one package. Careful design and high-performance components, including a stable YIG filter, allow broadband single-sideband measurements from 10 MHz to 26.5 GHz with a single calibration and sweep. A low-noise preamplifier built into the noise figure test set lowers the second-stage noise figure, thereby reducing a major source of measurement uncertainty.

Measurement modes in the HP 8970B allow for double downconversion using the HP 8971C as the second downconverter. These modes can be used for millimeter-wave measurements of amplifiers and transistors and measurements of receivers and mixers with IFs above 1.6 GHz.

HP 8971C Partial Specifications

(See HP 8971C Technical Data for complete specifications.)
Frequency Range: 10 MHz to 26.5 GHz
Input SWR: 10 MHz to 18 GHz: 2.25; 18 to 26.5 GHz: 2.7
Image and Odd-Harmonic Rejection: 20 dB
Accessories Supplied:
One LO-to-HP 8971C cable, SMA(female), 300 mm
One HP 8971C-to-HP 8970B cable, Type-N (male), 190 mm
One Type-N (male)-to-SMA (male) adapter
Two HP-IB cables, 0.5 m

Key Literature

HP 8970B, 8970S/V, 8971C Noise Figure Measurement Products Technical Data, p/n 5091-6049E

HP 346A, 346B, 346C

HP 346A/B/C Broadband Noise Sources

The ideal companion to HP's noise figure meter and systems is the HP 346 family of noise sources. Since they are broadband (10 MHz to either 18 or 26.5 GHz), they eliminate the necessity for several sources at different frequency bands. Each source has individually-calibrated ENR values at specific frequencies. The calibration is printed on its label (see illustration) for easy loading into the HP 8970B. The low SWR of each noise source reduces a major source of measurement uncertainty—reflections of test signals. In addition, the variety of available connectors reduces the need for degrading accuracy with connector adapters.

The HP 346 family of noise sources are designed for a broad range of measurement applications. The HP 346C covers the broadest frequency range—10 MHz to 26.5 GHz. The HP 346B's high ENR, low SWR, and variety of connectors make it a general-purpose noise source. The HP 346A is designed especially for accurate characterization of input-impedance-sensitive devices (like GaAsFETs and many UHF amplifiers). Its very small change in reflection coefficient (<0.01) from ON to OFF minimizes errors when measuring noise figure and gain as a function of input impedance.

HP 346A/B/C Partial Specifications

(See Technical Data Sheet for complete specifications.)
Frequency Range:
HP 346A/B: 10 MHz to 18 GHz
HP 346C: 10 MHz to 26.5 GHz
Excess Noise Ratio (ENR) Limits:
HP 346A: 5 to 7 dB
HP 346B: 14 to 16 dB
HP 346C: 12 to 16 dB (10 MHz to 12 GHz) and
14 to 17 dB (12.0 to 26.5 GHz)
Maximum SWR (reflection coefficient) On and Off:
HP 346A/B: 10 to 30 MHz – 1.3 (0.13); 30 to 5000 MHz – 1.15 (0.07);
5 to 18 GHz – 1.25 (0.11)
HP 346C: 10 MHz to 18 GHz – 1.25 (0.11); 18 to 26.5 GHz – 1.35 (0.15)
Power Required: 28 ±1 Vdc
Size: 21 mm W x 140 mm H x 30 mm D (0.8 in x 5.5 in x 1.2 in)
Weight: net, 0.108 kg (3.5 oz); shipping, 0.5 kg (1 lb)
Standard Connector: APC-3.5 (male)

HP 346C Option K01 Broadband Noise Source

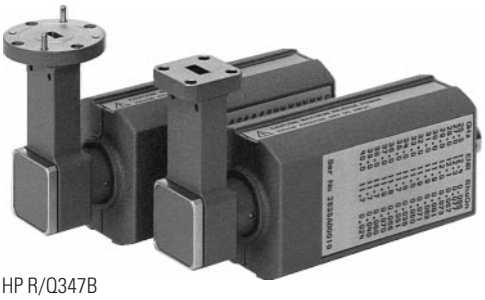
This coaxial noise source features coverage from 1 to 50 GHz with the 2.4-mm coaxial connector. ENR is nominally 20 dB at 1 GHz and 7 dB at 50 GHz. Contact Hewlett-Packard for technical specifications.

HP 346B Option H01 High ENR Noise Source

The HP 346B Option H01 has high ENR (21 dB typical), suitable for measuring high noise figure devices. Contact Hewlett-Packard for technical specifications.

HP 346B Option H42 DBS Noise Source

The 346B Option H42 was developed especially to test low noise block converters (LNB) used for Direct Broadcast Satellite (DBS). WR75 waveguide output, 5 dB ENR, low ENR calibration uncertainty, and low SWR improve the noise figure measurement accuracy of DBS LNBs. Contact HP for technical specifications.



HP R/Q347B

HP R347B and Q347B Noise Sources Partial Specifications

(See Technical Data Sheet for complete specifications.)
Frequency Range:
HP R347B: 26.5 to 40 GHz
HP Q347B: 33 to 50 GHz
Excess Noise Ratio (ENR) Range:
HP R347B: 10 to 13 dB
HP Q347B: 10 to 13 dB (33 to 42 GHz); 6 to 12.5 dB (42 to 50 GHz)
Maximum SWR (reflection coefficient):
HP R347B: <1.42 (0.17)
HP Q347B: <1.57 (0.22)

Key Literature

HP 346A/B/C Broadband Noise Sources Technical Data,
p/n 5953-6452

Ordering Information

HP 8970B Noise Figure Meter
Opt 020 2047 MHz Upper Frequency
Opt 907 Front-Panel Handle Kit (5061-9689)
Opt 908 Rackmounting Flange Kit (5061-9677)
Opt 909 Both Options 907 and 908 (5061-9683)
Opt 915 Service Manual (08970-90023)
Opt 916 Additional Operating Manual (08970-90048)
Opt 700 External Mate Translator
Opt W30 Extended Repair Service
Opt W32 Calibration Service
HP 8971C Noise Figure Test Set
Opt 001 Add L.O. Power Amplifier
Opt 002 Delete RF Preamplifier
Opt 907 Front-Panel Handle Kit (5062-3988)
HP 8970S Noise Figure Measurement System
HP 8970V Noise Figure Measurement System
(10 MHz to 20 GHz)
Opt W30 Extended Repair Service
Opt W32 Calibration Service
HP 346A Noise Source
Opt 001 Type-N (male) Connector
Opt 002 APC-7 Connector
Opt 004 Type-N (female) Connector
Opt 910 Extra Operating Manual
Opt W30 Extended Repair Service
Opt W32 Calibration Service
HP 346B Noise Source
Opt 001 Type-N (male) Connector
Opt 002 APC-7 Connector
Opt 004 Type-N (female) Connector
Opt H01 High ENR
Opt H42 DBS Noise Source
Opt 910 Extra Operating Manual
Opt W30 Extended Repair Service
Opt W32 Calibration Service
HP 346C Noise Source
Opt 910 Extra Operating Manual
Opt W30 Extended Repair Service
Opt W32 Calibration Service
HP 346C Opt K01 Noise Source
HP R347B Noise Source
HP Q347B Noise Source

Indicates QuickShip availability.

Amplifiers

Microwave System Amplifiers

Various Models

- Ultra broadband to 50 GHz
- Up to 1 watt output power
- Compact size

HP Microwave System Amplifiers

Use these amplifiers to increase output power from microwave sources and to increase test system measurement speed with improved dynamic range. Drive a variety of narrowband travelling wave tubes with a single driver solution that is highly reliable and low in cost to maintain year after year. With excellent noise figure relative to its broad bandwidth and high gain, these amplifiers can make significant improvement to system noise figure. By using feedback to an external source ALC input, system designers can level output power at the test port, negating the effects of post sweeper reflections and losses. Place power where you need it with a remotely-locatable dc power supply. The amplifier and the power supply are provided with a 2-m dc bias cable.

Specifications (+20° to +30° C)

HP Model	Frequency (GHz)	Power out Psat (dBm)	Power out P1dBC (dBm)	Gain dB (min)	Noise figure (dB typ.)	Detected output	DC bias volt/amp	RF connectors (Input/Output)
83006A	0.01 to 26.5	+18 typ. 0.01 to 10 +16 typ. 10 to 20 +14 typ. 20 to 26.5	+13, 0.01 to 20 +10, 20 to 26.5	20	13, 0.01 to 0.1 GHz 8, 0.1 to 18 GHz 13, 18 to 26.5 GHz	No	+12 V at 450 mA –12 V at 50 mA	3.5 mm (f)
83017A	0.5 to 26.5	+20 typ. 0.5 to 20 +15 typ. 20 to 26.5	+18, 0.5 to 20 GHz +13, 20 to 26.5	25	8, 0.5 to 18 GHz 13, 18 to 26.5 GHz	Yes	+12 V at 700 mA –12 V at 50 mA	3.5 mm (f)
83018A	2 to 26.5	+24, 2 to 20 GHz +21, 20 to 26.5 GHz	+22, 2 to 20 GHz +17, 20 to 26.5 GHz	27, 2 to 20 GHz 23, 20 to 26.5 GHz	10, 2 to 20 GHz 13, 20 to 26.5 GHz	Yes	+12 V at 2 A –12 V at 50 mA	3.5 mm (f)
83020A	2 to 26.5	+30, 2 to 20 GHz +30, 20 to 26.5 GHz*	+28, 2 to 20 GHz +28, 20 to 26.5 GHz*	30, 2 to 20 GHz 27, 20 to 26.5 GHz	10, 2 to 20 GHz 13, 20 to 26.5 GHz	Yes	+15 V at 3.2 A –15 V at 50 mA	3.5 mm (f)
83050A	2 to 50	+20, 2 to 40 GHz +19, 40 to 50 GHz**	+15, 2 to 40 GHz +13, 40 to 50 GHz	21	6, 2 to 26.5 GHz 10, 26.5 to 50 GHz	No	+12 V at 830 mA –12 V at 50 mA	2.4 mm (f)
83051A	0.045 to 50	+12, .045 to 45 GHz +10, 45 to 50 GHz	+8, .045 to 45 GHz +6, 45 to 50 GHz	23	12, 0.045 to 2 GHz 6, 2 to 26.5 GHz 10, 26.5 to 50 GHz	No	+12 V at 425 mA –12 V at 50 mA	2.4 mm (f)
87405A	0.01 to 3	+26 typ.	+4	22-27 min./max.	6.5, 0.01 to 2 GHz 7.5, 2 to 3 GHz	No	+15 V at 80 mA	N (f)/N (m)
87415A	2 to 8	+26 typ.	+23	25	13	No	+12 V at 900 mA	SMA (f)

* –0.7 dB/GHz (20<f<26.5)
** 19 dBm –0.2 dB/GHz (40<f<50)

Size:
HP 83006A, 83017A, 83050A, 83051A, 87415A: 132 mm L x 103 mm W x 45 mm H (4 in x 1.8 in x 5.2 in)
HP 83018A: 212 mm L x 114 mm W x 76 mm H (4.5 in x 3 in x 8.3 in)
HP 83020A: 275 mm L x 202 mm W x 87 mm H (8 in x 3.4 in x 10.8 in)
HP 87405A: 125 mm L x 28 mm W x 28 mm H (4.9 in x 1.1 in x 1.1 in)

Weight:
HP 83006A, 83017A, 83050A, 83051A, 87415A: .64 kg (1.4 lb);
HP 83018A: 1.8 kg (4 lb); **HP 83020A:** 3.9 kg (8.5 lb);
HP 87405A: .27 kg (0.6 lb)

Bias Cable:
2-m cable with a connector on one end and bare wires on the other, shipped with the amplifiers below
HP 83006A, 83017A, 83018A, 83050A, 83051A, 87415A:
HP p/n 83006-60004
HP 83020A: HP p/n 83020-60004
2-m cables to connect between amplifier and power supplies, shipped with power supplies below
HP 87421A: HP p/n 83006-60005
HP 87422A: HP p/n 87422-60001, 83006-60005

HP power supply	AC Input voltage	DC Output voltage/current	Output power	Size (H,W,D)
HP 87421A	100 to 240 VAC 50/60 Hz	+12 V at 2.0 A, –12 V at 200 mA	25 W max	57 mm, 114 mm, 176 mm 2.3 in, 4.5 in, 6.9 in
HP 87422A	100 to 240 VAC 50/60 Hz	+15 V at 3.3 A, –15 V at 50 mA +12 V at 2.0 A, –12 V at 200 mA	70 W max	86 mm, 202 mm, 276 mm 3.4 in, 8.0 in, 10.9 in

Key Literature

Latest *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E

For more information, visit our web site: **http://www.hp.com/go/MTA**

HP 8347A
HP 8447A
HP 8447D
HP 8349B
HP 8449B
HP 8348A

HP 8347A and HP 8447A/D Amplifiers

Specifications Summary

	HP 8347A RF Amplifier	HP 8447A Preamplifier	HP 8447D Preamplifier
Frequency range	100 kHz to 3 GHz	0.1 to 400 MHz	100 kHz to 1.3 GHz
Typical 3 dB bandwidth	—	50 kHz to 700 MHz	75 kHz to 1.7 GHz
Maximum leveled output power	≥ +20 dBm	—	—
Output power leveling range	(≥300 kHz): +2 to +20 dBm	—	—
Gain (mean, per channel)	≥25 dB	20 dB ± 1.0 dB at 10 MHz (20° to 30° C)	>25 dB (20° to 30° C)
Gain flatness across full frequency range	Internally leveled, ±300 kHz: ±1.5 dB	±1.8 dB (0° to 55° C) ±0.7 dB (20° to 30° C) characteristic	±1.5 dB
Noise figure	10 MHz to 3 GHz: 15 dB Below 10 MHz: 20 dB	<7 dB	<8.5 dB
Output power for 1 dB gain compression	+22 dBm	> +6 dBm	> +7 dBm typical
Third-order intercept	+30 dBm	—	—
Harmonic distortion	(at +20 dBm output) Internal level off (ALC off): ≤–25 dBc Internal level on (ALC on): ≤–20 dBc	–32 dB for 0 dBm output	–30 dB for 0 dBm output (typical)
Maximum input for minimum internally leveled output	–14 dBm	—	—
Output for <–60 dB harmonic distortion		–25 dBm (characteristic)	–30 dBm
VSWR	2.0: 1 input 1.5: 1 output internally leveled 2.0: 1 output unleveled below 2 GHz 3.0: 1 output unleveled 2 GHz to 3 GHz	<1.7	<2.0 input <2.2 output 1 to 1300 MHz
Reverse isolation	60 dB	>30 dB	>40 dB
Maximum dc voltage output	—	±10 V	±10 V
Size	213 mm W x 102 mm H x 298 mm D (8.4 in x 4.0 in x 11.8 in)	130 mm W x 85.8 mm H x 261 mm D (5.1 in x 3.4 in x 8.5 in)	130 mm W x 85.8 mm H x 216 mm D (5.1 in x 3.4 in x 8.5 in)
Weight	Net, 4 kg (8 lb); Shipping, 5 kg (11 lb)	Net, 1.56 kg (3.4 lb); Shipping, 2.3 kg (5.1 lb)	Net, 1.56 kg (3.4 lb); Shipping, 2.3 kg (5.1 lb)
Power requirements	—	110 or 230 Vac + 10%, 48 to 440 Hz, 15 W	110 or 230 Vac + 10%, 48 to 440 Hz, 15 W
Options available		**Option 001:** Dual-channel amp, BNC (f) connectors	**Option 001:** Dual-channel amp, BNC (f) connectors **Option 010:** Single-channel amp, Type-N (f) connectors **Option 011:** Dual-channel amp, Type-N (f) connectors

Key Literature

HP 8346A, 8347A, 8348A, 8349A Amplifiers Technical Data, p/n 5091-0370E

Ordering Information

HP 8347A RF Amplifier
HP 8447A Preamplifier
HP 8447D Preamplifier

HP 8348A Microwave Amplifier

Specifications

Frequency Range: 2.0 to 26.5 GHz
Maximum Output Power (at 0 dBm input):
1.0 to 2.0 GHz: ≥+20 dBm (typical)
2.0 to 20.0 GHz:≥+25 dBm
20.0 to 26.5 GHz: ≥+23 dBm
Power Flatness (at 0 dBm input): ±4 dB (typical)
Minimum Small Signal Gain (at –15 dBm input):
1.0 to 2.0 GHz: ≥20 dB (typical)
2.0 to 20.0 GHz: ≥25 dB
20.0 to 26.5 GHz: ≥23 dB

Spectral Purity
Harmonics (typical, at maximum specified output power):
1.0 to 2.0 GHz: <–20 dBc
2.0 to 26.5 GHz: <–15 dBc
Third-Order Intercept
2.0 to 20.0 GHz: +36 dBm, nominal
20.0 to 26.5 GHz: +31 dBm, nominal
Maximum Continuous Input
Microwave power:+22 dBm
DC voltage:±10 V
Input and Output Impedence: 50 Ω, nominal
Input SWR: 3:1 (typical)
Output SWR (typical):
1.0 to 2.0 GHz: 6:1
2.0 to 20.0 GHz: 4.5:1
20.0 to 26.5 GHz: 2:1
Reverse Isolation: >50 dB (typical)
Noise Figure (typical):
1.0 to 20 GHz: <10 dB
20 to 26.5 GHz: <13 dB

Pulse Transmission Capability
Rise/Fall Time: <5 ns (typical)
Delay Time: <5 ns (typical)

General
Input and Output Connectors: 3.5 mm male
Power Requirement: 50 to 400 Hz, 100, 120, 200, or 240 volts ac (±10%); 85 VA maximum
Size: 133 mm H x 214 mm W x 366 mm D (5.2 in x 8.4 in x 14.4 in)
Weight: Net, 7 kg (15 lb); shipping, 14 kg (31 lb)

Ordering Information

HP 8348A 2 to 26.5 GHz Microwave Preamplifier

HP 8349B Microwave Amplifier

Frequency Specifications

Frequency Range: 2 to 20 GHz

Output and Input Specifications (25° C ± 5° C)

Minimum Output Power (at +5 dBm input)

Frequency Range (HGz)	Output Leveled	Output Unleveled
2.0 to 18.6	19 dBm (80 mW)	20 dBm (100 mW)
18.6 to 20.0	17 dBm (50 mW)	18 dBm (63 mW)

1 dB Compression Point: +21 dBm, nominal
Power Flatness (leveled): ±1.25 dB
Minimum Small Signal Gain (at –5 dBm input):
2.0 to 18.6 GHz: 15 dB
18.6 to 20.0 GHz: 13 dB
Noise Figure: <13 dB, typical
Input and Output Impedence: 50 Ω, nominal

VSWR

Frequency Range (GHz)	Input	Output Leveled	Output Unleveled (typical)
2.0 to 5.0	≤2.8	≤2.5	≤4.8
5.0 to 11.0	≤2.8	≤2.5	≤3.8
11.0 to 18.0	≤2.8	≤2.5	≤3.2
18.0 to 20.0*	≤2.8	≤2.5	≤3.2

*VSWR from 18.0 to 20.0 GHz is typical

Maximum Continuous Input, to the Input or Output Ports:
+27 dBm (RF), ±10 Vdc

Spectral Purity
Harmonics (at +20 dBm output): 2.0 to 11.0 GHz: <–20 dBc;
11.0 to 20.0 GHz: <–30 dBc typical
Non-Harmonic Spurious: ≤–55 dBc
Third-Order Intercept: +33 dBm, nominal

Pulse Transmission Capability
Rise/Fall Time: <10 ns typical

General
Reverse Isolation: >50 dB, typical
RF Input and Output Connectors: Type-N female
Size: 214 mm W x 133 mm H x 366 mm D (8.36 in x 5.2 x 13.6 in)
Weight: Net, 7 kg (15 lb); shipping, 14 kg (31 lb)

Ordering Information

HP 8349B 2 to 20 GHz Microwave Amplifier
Opt 001 Rear Panel RF Input/Output
Opt 002 Rear Panel RF Input w/Front Panel RF Output
Opt W30 Extended Repair Service (see page 70)

HP 8449B Preamplifier

Specifications

Frequency range	1.0 to 26.5 GHz		
Gain (mean, per channel)	≥ 26 dB (20° to 30° C)		
Gain flatness across full freq. range	1 to 26.5 GHz ± 4.5 dB (0° to 55° C); 2 to 22 GHz ± 2.4 dB (20° to 30° C)		
Noise figure	**Band**	**Typical**	
	1.0 to 12.7 GHz	≤8.5 dB	7 dB
	12.7 to 22.0 GHz	12.5 dB	9 dB
	22.0 to 26.5 GHz	≤14.5 dB	12 dB
Output power for 1 dB gain compression	≤+7 dBm (characteristic)		
Harmonic distortion	–30 dB for 0 dBm output (characteristic)		
Output for <–60 dB harmonic distortion	–30 dBm (characteristic)		
VSWR	**Input**	1.0 to 2.0 GHz	2.0:1
		2.0 to 12.5 GHz	1.5:1
		12.5 to 26.5 GHz	2.0:1
	Output	1.0 to 26.5 GHz	2.0:1
Reverse isolation	>75 dB		
Maximum dc voltage	±20 V		

Displayed average noise level, 0 dB atten. (characteristic)

HP 8563E (1 Hz RBW)	HP 8566B (10 Hz RBW)
1.0 to 6.46 GHz, –165 dBm	1.0 to 2.5 GHz, –55 dBm
5.86 to 13.0 GHz, –163 dBm	2.0 to 5.8 GHz, –154 dBm
12.4 to 26.5 GHz, –160 dBm	5.8 to 12.5 GHz, –150 dBm
	12.5 to 18.6 GHz, –144 dBm
	18.6 to 22 GHz, –140 dBm

Size: 213 mm W x 102 mm H x 297 mm D (8.4 in x 4.0 in x 11.7 in)
Weight: Net, 4 kg (8.8 lb) nominal
Power: 100, 120, 220, or 240 V, ±10%; 47 to 63 Hz

Ordering Information

HP 8449B 1 to 26.5 GHz Preamplifier
Opt 907 Front Handle Kit
Opt 908 Rackmount Kit (half-rack width)

HP 87130A

HP 11713A Attenuator/Switch Driver

The HP 11713A attenuator/switch driver provides simple HP-IB control of up to ten, 24 Vdc solenoid-activated switch or attenuator sections. The HP 11713A supplies 24 Vdc common and ten pairs of current sinking contacts to achieve control of up to ten relays. Each HP 11713A is supplied with two plug-in drive cables to simplify connection to programmable attenuators.

HP 70611A Attenuator/Switch Driver for MMS

The HP 70611A is a one-slot MMS module capable of driving up to 248 electromechanical switches or attenuator switch sections. The HP 70611A is MSIB, SCPI, and HP-IB compatible. In addition to being programmable, the HP 70611A features an extremely user-friendly manual interface via any MMS display unit. The highlight of the manual interface is the operator's ability to customize groups of switch control lines and their settings, then identify these switch settings with user-defined alphanumeric labels. In this manner, end users of the HP 70611A can define custom menus with their own identification labels for simplified manual control.

The HP 70611A can store up to 256 user-defined labeled paths. Path definitions can be stored in non-volatile EEROM. Groups of paths can be stored in directories for easy access to similar path commands. The HP 70612A/C and 70613A/C offer compatible capacity with built-in RF switches. (Configurations vary and custom configurations are available.)

HP 87130A Attenuator/Switch Driver

The HP 87130A is a 3.5-inch, full rack width attenuator/switch driver capable of driving up to 248 electromechanical switch or attenuator sections. The HP 87130A is controlled over HP-IB via Standard Commands for Programmable Instruments (SCPI) commands. The HP 87130A has been designed for use in both ATE switching systems and computer-controlled bench top applications.

The HP 87130A is electronically identical to the HP 70611A and shares its performance characteristics, with the exception of the manual control method. The HP 87130A has no front panel controls. Manual control of the HP 87130A is realized through its ITG driver and a computer controller. The HP 87130A can drive 31 switch or attenuator sections directly, and up to an additional 217 switches via seven additional HP 84940A driver cards.

HP E1368A, E1369A and E1370A VXI Attenuator/Switch Drivers

HP's VXI family of instrumentation includes modules for microwave switching and attenuation control up to 18.0 GHz. HP E1368A contains three factory-installed SPDT switches such as the HP 8762B which features all-port termination, dc to 18.0 GHz. HP E1369A is identical to the HP E1368A except the switches are not included. This allows user-substitution of HP 8763 or HP 8764 transfer switches. HP E1370A allows the user to customize the internal configuration for HP 8766 series multi-port switches or HP 8494/95/96/97 step attenuators.

HP 84940A Switch Driver and HP 84941A Distribution Card

The HP 84940A is an expansion driver card for the HP 70611/12/13 family of MMS attenuator/switch drivers and the HP 87130A attenuator/switch driver. The HP 84940A has been designed for incorporation into large interfaces located remotely from their controller. A single HP 84940A can control up to 31 switches when located up to 150 feet (45 m) from an HP 70611/12/13 or HP 87130A. The physical interconnection to the switches or attenuators is realized via 31 four-pin output connectors, which permit quick connection and disconnection of the switches or attenuators.

Key Literature

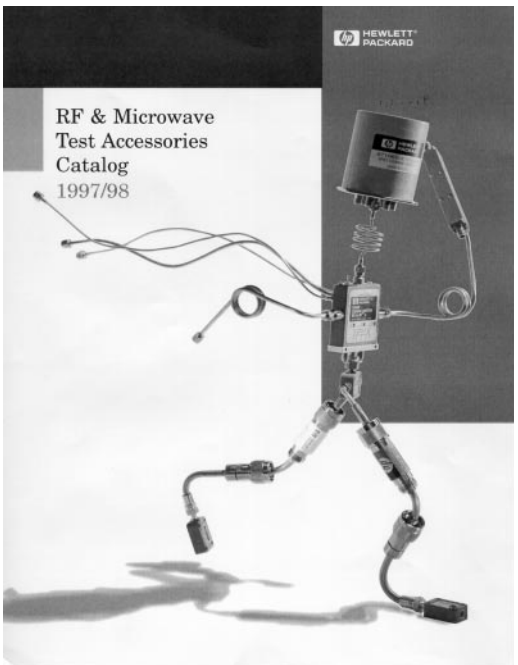
Latest *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E

For more information, visit our web site: **http://www.hp.com/go/MTA**

Ordering Information

HP 11713A Attenuator/Switch Driver
HP 11717A Attenuator/Switch Driver Rack Support Shelf
HP 11761A; HP 8765 to **HP 11713A** Adapter Cable
HP 11764A; HP 84904/6/7 to **HP 11713A** Adapter Cable
HP 11764B; HP 84904/6/7 5-ft Ribbon Cable with 10-pin DIP Connector
HP 44476B Microwave Switch Module for HP 3488A (Holds up to two HP 8762/3/4 Option 011 Switches)
HP 70611A MMS Switch Driver
HP 84940A Attenuator/Switch Driver Expansion Card
HP 84941A Distribution Expansion Card
HP 87130A Attenuator/Switch Driver
HP E1368A 18 GHz Microwave Switch
HP E1369A Microwave Switch Driver
HP E1370A Microwave Switch/Step Attenuator Driver

Indicates QuickShip availability.



RF & Microwave Test Accessories Catalog

The complete catalog of HP's microwave accessories—from adapters to waveguides and everything between, it's all here. Amplifiers, detectors, filters, step and fixed attenuators, switches and switch drivers—the entire HP product line, with all the technical specs.

To receive your free copy in the U.S., call 800-452-4844 and ask for the new *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E, contact your local HP representative, or order on the World Wide Web **http://www.hp.com/go/tmcatalogs.** The entire catalog is also viewable on the web: **http://www.tmo.hp.com/tmo/literature/English/mta98.html**

HP Coaxial Switches

HP coaxial switches feature low SWR, low insertion loss, and excellent isolation. HP offers a broad line of coaxial switches, covering up to 40 GHz, for use in test and measurement applications. All switches use magnetically-latched solenoids and break-before-make RF contacts for test simplicity.

HP 8761 Series

HP 8761A/B is a SPDT switch which operates up to 18 GHz. Each port features six connector options plus 50 Ω termination for design flexibility. These switches offer exceptional repeatability of 0.03 dB over 1 million switching cycles.

HP 8762 Series

HP 8762A/B/C switches operate up to 26.5 GHz. These switches offer exceptional repeatability of 0.03 dB over 1 million switching cycles. They provide exceptional isolation of 90 dB to 18 GHz and all-port switched terminations, so that all ports maintain a 50 Ω match. Internal loads are rated at 1 watt average (100 W peak, 10 μsec pulse width). Control voltage options T15 and T24 are compatible with TTL/5 V CMOS drive circuitry. Another model, HP 8762F is designed for 75 Ω transmission lines, making it valuable for commercial communication applications up to 4 GHz.

HP 8763 Series

HP 8763A/B/C switches operate up to 26.5 GHz. These switches offer exceptional repeatability of 0.03 dB over 1 million switching cycles. They are preferred for transfer applications because of their compact design. Transfer switches are used to automatically insert or remove a test component from a signal path. Because of their excellent isolation, they can also be used as the intersection (crosspoint) switch in full-access matrix switching applications. One port is internally terminated. Options T15 and T24 are available for TTL/5 V CMOS compatibility.

HP 8764 Series

HP 8764A/B/C switches are available in three models up to 26.5 GHz. These switches offer exceptional repeatability of 0.03 dB over 1 million switching cycles. These switches are similar to the HP 8763, but with the internal termination replaced with a fifth port. The fifth port can be utilized for signal path reversal or as a calibration port. Options T15 and T24 offer TTL/5V CMOS compatibility.

HP 8765 Series

HP 8765A/B/C/D/F are available in four models up to 40 GHz, as well as a 75 Ω model to 4 GHz. These SPDT switches offer exceptional repeatability of 0.03 dB over 5 million switching cycles. Unlike the HP 8762 switches, they do not have internal, switched RF loads or dc current interrupts. Coil voltage options cover the complete range from 5 Vdc to 24 Vdc. Since the coils are not interrupted, the coil voltage may be continuous or may be switched off after 15 ms.

The standard HP 8765 comes with ribbon cables and standard printed circuit board 0.025-inch connector for convenient assembly. The ribbon cable also connects with the HP 11761A Cable/Adapter which permits direct connection to the HP 11713A Attenuator/Switch Driver. The HP 8765 can also be driven by the HP 87130A driver, but position monitoring and reporting are not available. Optional solder terminals are available.

Key Literature

Latest *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E

Ordering Information

HP 8761A/B Coaxial Switches
Specify voltage and connectors (including built-in 50 Ω terminations) by alphabetic suffix on the switch model number and the appropriate 3-digit option number. Specify all connectors.
HP 8761A 12 to 15 V Supply Voltage
HP 8761B 24 to 30 V Supply Voltage
Connector Options (Port 1, Port 2, Port C):

Option Code	Connector Type
0	Type-N(f)
1	Type-N(m)
2	APC-7 w/threaded sleeve
3	APC-7 w/coupling nut
4	APC-7 for UT-250 coax
5	SMA(f)
6	SMA(m)
7	50 Ω termination

HP 8762, HP 8763, HP 8764 Coaxial Switches
Specify the frequency and voltage by the alphabetic suffix and option number. The standard model has 24 V supply voltage.
HP 8762A SPDT, DC to 4 GHz
HP 8762B SPDT, DC to 18 GHz
HP 8762C SPDT, DC to 26.5 GHz
HP 8762F SPDT, DC to 4 GHz, 75 Ω
HP 8763A 4-Port, DC to 4 GHz
HP 8763B 4-Port, DC to 18 GHz
HP 8763C 4-Port, DC to 26.5 GHz
HP 8764A 5-Port, DC to 4 GHz
HP 8764B 5-Port, DC to 18 GHz
HP 8764C 5-Port, DC to 26.5 GHz
Opt 011 5 Vdc Supply Voltage
Opt 015 15 Vdc Supply Voltage
Opt T15 TTL/5 V CMOS Compatible Logic with 15 Vdc Supply Voltage
Opt T24 TTL/5 V CMOS Compatible Logic with 24 Vdc Supply Voltage
Opt UK6 Commercial Calibration Test Data with Certificate
Opt UKS Commercial Calibration Certificate

HP 8765 Coaxial Switches
A voltage option must be ordered with the switch. Specify frequency, voltage, dc connectors, and ribbon cable extension options by alphabetic suffix and option number.
HP 8765A SPDT, DC to 4 GHz
HP 8765B SPDT, DC to 20 GHz
HP 8765C SPDT, DC to 26.5 GHz
HP 8765D SPDT, DC to 40 GHz
HP 8765F SPDT, DC to 4 GHz, 75 Ω
Opt 005 5 Vdc Supply Voltage
Opt 010 10 Vdc Supply Voltage
Opt 015 15 Vdc Supply Voltage
Opt 024 24 Vdc Supply Voltage
Opt 100 Solder Terminals
Opt 108 8-in Ribbon Cable Extension
Opt 116 16-in Ribbon Cable Extension
Opt 292 2.92 mm (f) Connector[1]
Opt UK6 Commercial Calibration Test Data with Certificate[2] (HP 8765A/B/C/D only)
Opt UKS Commercial Calibration Certificate

[1]Option 292 available for 8765D only.
[2]8765D Option 292 and 8765F do not have Option UK6.

Indicates QuickShip availability.

HP 8761–5 Series Specifications

HP Model	Frequency Range (GHz)	SWR 50 Ω Nominal	Insertion Loss	Isolation	Switching Speed	Repeat-ability[2]	Life[3]	RF Connectors	Dimensions W x H x D (mm)	Shipping Weight (g)	
8761A SPDT Unterminated	dc to 18	<1.2 to 12.4 GHz <1.25 to 18 GHz	<0.5 dB to 12.4 GHz <0.8 dB to 18 GHz	>50 dB to 12.4 GHz >45 dB to 18 GHz	35 to 50 mS	0.03 dB	1 x 10^6	See table on page 30.3	38 x 41 x 38	300	
8761B SPDT Unterminated	dc to 18	<1.2 to 12.4 GHz <1.25 to 18 GHz	<0.5 dB to 12.4 GHz <0.8 dB to 18 GHz	>50 dB to 12.4 GHz >45 dB to 18 GHz	35 to 50 mS	0.03 dB	1 x 10^6	See table on page 30.3	38 x 41 x 38	300	
8762A SPDT Terminated	dc to 4	<1.1 to 2 GHz <1.2 to 4 GHz	<0.2 db to 2 GHz <0.25 dB to 4 GHz	>100 dB to 4 GHz	<30 mS	0.03 dB	1 x 10^6	SMA (f)	53 x 14 x 54	220	🚚
8762B SPDT Terminated	dc to 18	<1.10 to 2 GHz <1.2 to 12.4 GHz <1.3 to 18 GHz	<0.2 dB to 2 GHz <0.5 dB to 18 GHz	>90 dB to 18 GHz	<30 mS	0.03 dB	1 x 10^6	SMA (f)	53 x 14 x 54	220	🚚
8762C SPDT Terminated	dc to 26.5	<1.15 to 2 GHz <1.25 to 12.4 GHz <1.4 to 18 GHz <1.8 to 26.5 GHz	<0.25 dB to 2 GHz <0.5 dB to 18 GHz <1.25 dB to 26.5 GHz	>90 dB to 18 GHz >50 dB to 26.5 GHz	<30 mS	0.03 dB	1 x 10^6	3.5 mm (f)	53 x 14 x 54	220	🚚
8762F SPDT, 75 Ω Terminated	dc to 4	<1.15 to 1 GHz <1.3 to 4 GHz	<0.4 dB to 4 GHz	>100 dB to 4 GHz	<30 mS	0.03 dB	1 x 10^6	75 Ω, SMB (m)	53 x 14 x 54	300	🚚
8763A Transfer Terminated	dc to 4	<1.1 to 2 GHz 1.2 to 4 GHz	<0.2 dB to 2 GHz <0.25 dB to 4 GHz	>100 dB to 4 GHz	<30 mS	0.03 dB	1 x 10^6	SMA (f)	53 x 14 x 54	220	🚚
8763B Transfer Terminated	dc to 18	<1.10 to 2 GHz <1.2 to 12.4 GHz <1.3 to 18 GHz	<0.2 dB to 2 GHz <0.5 dB to 18 GHz	>90 dB to 18 GHz	<30 mS	0.03 dB	1 x 10^6	SMA (f)	53 x 14 x 54	220	
8763C Transfer Terminated	dc to 26.5	<1.15 to 2 GHz <1.25 to 12.4 GHz <1.4 to 18 GHz <1.8 to 26.5 GHz	<0.25 dB to 2 GHz <0.5 dB to 18 GHz <1.25 to 26.5 GHz	>90 dB to 18 GHz >50 dB to 26.5 GHz	<30 mS	0.03 dB	1 x 10^6	3.5 mm (f)	53 x 14 x 54	220	
8764A Transfer Unterminated	dc to 4	<1.1 to 2 GHz <1.2 to 4 GHz	<0.2 dB to 2 GHz <0.25 dB to 4 GHz	>100 dB to 4 GHz	<30 mS	0.03 dB	1 x 10^6	SMA (f)	53 x 14 x 54	220	🚚
8764B Transfer Unterminated	dc to 18	<1.10 to 2 GHz <1.2 to 12.4 GHz <1.3 to 18 GHz	<0.2 dB to 2 GHz <0.5 dB to 18 GHz	>90 dB to 18 GHz	<30 mS	0.03 dB	1 x 10^6	SMA (f)	53 x 14 x 54	220	
8764C Transfer Unterminated	dc to 26.5	<1.15 to 2 GHz <1.25 to 12.4 GHz <1.4 to 18 GHz <1.8 to 26.5 GHz	<0.25 dB to 2 GHz <0.5 dB to 18 GHz <1.25 dB to 26.5 GHz	>90 dB to 18 GHz >50 dB to 26.5 GHz	<30 mS	0.03 dB	1 x 10^6	3.5 mm (f)	53 x 14 x 54	220	
8765A SPDT Unterminated	dc to 4	<1.2 to 4 GHz	0.2 +0.025 f (GHz) max <0.2 to 4 GHz[1]	>120 dB to 4 GHz	<15 mS	0.03 dB	5 x 10^6	SMA (f)	33 x 14 x 45	200	🚚
8765B SPDT Unterminated	dc to 20	<1.2 to 4 GHz <1.35 to 12.4 GHz <1.45 to 18 GHz <1.7 to 20 GHz	0.2 +0.025 f (GHz) max <0.2 to 4 GHz[1] <0.5 to 20 GHz[1]	>120 dB to 4 GHz >90 dB to 20 GHz	<15 mS	0.03 dB	5 x 10^6	SMA (f)	33 x 14 x 45	200	🚚
8765C SPDT Unterminated	dc to 26.5	<1.25 to 4 GHz <1.45 to 18 GHz <1.7 to 26.5 GHz	0.25 +0.027 f (GHz) max <0.2 to 4 GHz[1] <0.5 to 20 GHz[1] <0.7 to 26.5 GHz[1]	>120 dB to 4 GHz >90 dB to 20 GHz >60 dB to 26.5 GHz	<15 mS	0.03 dB	5 x 10^6	3.5 mm (f)	33 x 14 x 45	200	🚚
8765D SPDT Unterminated	dc to 40	<1.25 to 4 GHz <1.45 to 26.5 GHz <1.7 to 40 GHz	0.2 +0.23 f (GHz) max <0.2 to 4 GHz[1] <0.5 to 20 GHz[1] <0.7 to 26.5 GHz[1] 0.75 + .023 f (GHz) max <1.0 to 40 GHz1	>120 dB to 4 GHz >90 dB to 20 GHz >60 dB to 26.5 GHz >50 dB to 40 GHz	<15 mS	0.03 dB	5 x 10^6	2.4 mm (f) 2.92 mm (f) Option 292	33 x 14 x 45	200	
8765F SPDT, 75 Ω Unterminated	dc to 4	<1.15 to 1 GHz <1.20 to 4 GHz	<0.18 dB to 1 GHz <0.24 dB to 2 GHz <0.40 dB to 4 GHz	>100 dB to 1 GHz >90 dB to 4 GHz	<15 mS	0.03 dB	5 x 10^6	75 Ω, SMB (m	33 x 14 x 45	200	

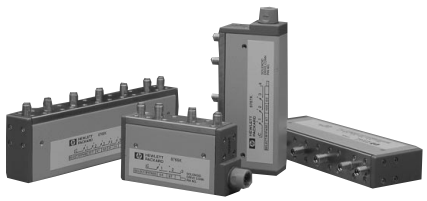
For more information, visit our web site: **http://www.hp.com/go/MTA**

🚚 Indicates QuickShip availability.

[1] Typical insertion loss
[2] Measured at 25°C
[3] Cycles per section minimum

HP 87406B

HP 87204B



HP 8766

Matrix Switches–High Performance, Terminated

HP 87406/606 Series

The HP 87406B and 87606B 6-port, coaxial matrix switches will provide a valuable tool for 3x3, 2x4, and 1x5 configurations. These high performance matrix switches offer excellent repeatability and life greater than 5 million cycles. The HP 87406B, 87606B operate from dc to 20 GHz with excellent isolation, VSWR < 2.0:1, and with an input power of 1 W avg./50 W peak (10 μs max). The standard HP 87406B/606B provide a 16-pin connector while Option 100 provides solder terminals. Option T24 is available which provides internal circuits that are compatible with external TTL/5 V CMOS digital ICs.

5

Multiport–High Performance, Terminated

HP 87104/106 and HP 87204/206 Series

HP 87104A/B/C and 87106A/B/C multiport switches are available in 3 models up to 26.5 GHz. These switches offer exceptional repeatability of 0.03 dB over 5 million switching cycles. HP 87104 is a Single-Pole-4-throw (SP4T) and HP 87106 is a SP6T function. Both switches have internal solid-state logic which automatically programs the non-used ports to a matched load when any one port is programmed to "on". This relieves the user from having to provide external logic drive pulses.

HP 87204A/B/C and 87206A/B/C switches are fully equivalent to models HP 87104/06 in their RF switching performance. However, their drive circuits are primarily designed to work with the HP 87130A/11760A switch drivers. These switches do not provide independent position indicators. The standard HP 87204/06 provides a 16-pin connector while Option 100 provides solder terminals.

Multiport–Low Profile, Unterminated

HP 8766/67/68/69K Series

HP 8766/67/68/69K series switches are modified versions of the HP 8494/95/96/97 series step attenuators (dc–26.5 GHz) for applications requiring a single-pole, 3-throw, 4-throw, 5-throw or 6-throw coaxial switch. The switch ports are unterminated. These switches offer exceptional repeatability of 0.03 dB over 5 million switching cycles. The switches are available with several optional cables and connectors to make them compatible with standard 14-pin DIP sockets. Isolation and insertion loss vary with frequency, and depend upon the port selected.

Key Literature

Latest *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E

For more information, visit our web site: **http://www.hp.com/go/MTA**

Ordering Information

HP 87104A SP4T, DC to 4 GHz
HP 87104B SP4T, DC to 20 GHz
HP 87104C SP4T, DC to 26.5 GHz
HP 87106A SP6T, DC to 4 GHz
HP 87106B SP6T, DC to 20 GHz
HP 87106C SP6T, DC to 26.5 GHz
HP 87204A[1] SP4T, DC to 4 GHz
HP 87204B[1] SP4T, DC to 20 GHz
HP 87204C[1] SP4T, DC to 26.5 GHz
HP 87206A[1] SP6T, DC to 4 GHz
HP 87206B[1] SP6T, DC to 20 GHz
HP 87206C[1] SP6T, DC to 26.5 GHz
HP 87406B SP6T, DC to 20 GHz
HP 87606B SP6T, DC to 20 GHz
Opt 100 Solder Terminals
Opt T24 TTL/5 V CMOS Compatible Logic
Opt T00[2] Solder Terminals to Replace Ribbon Cable TTL/5V CMOS compatability
Opt UK6 Commercial Calibration Test Data with Certificate
Opt UKS Commercial Calibration Certificate

HP 8766K, HP 8767K, HP 8768K, HP 8769K Coaxial Switches
Specify RF connectors (and frequency), supply voltages, dc connectors by option number. Standard unit is 24 Vdc, 3.5–mm (f) RF connectors (dc to 26.5 GHz), and Viking-type dc connector.

HP 8766K SP3T Multi-Port Switch
HP 8767K SP4T Multi-Port Switch
HP 8768K SP5T Multi-Port Switch
HP 8769K SP6T Multi-Port Switch
Opt 002 Replace 3.5 mm (f) w/ SMA (m) Connectors
Opt 008 8-inch Ribbon Cable w/DIP Connector
Opt 011 5 Vdc Supply Voltages
Opt 015 15 Vdc Supply Voltages
Opt 016 16-inch Ribbon Cable w/DIP Connector
Opt UK6 Commercial Calibration Test Data with Certificate
Opt UKS Commercial Calibration Certificate

[1]Provides sensing capability with 87130A and 70611A
[2]HP 87406B only

Indicates QuickShip availability.

HP 87104/6 Series, 87204/6, 87406B/606B, 8766/7/8/9 Series Specifications

HP Model	Frequency Range (GHz)	SWR (50 Ω Nominal)	Insertion Loss (db)	Isolation (db)	Switching Time (max)	Repeat-ability[1]	Life (min.)	RF Connectors	Dimensions W x H x D (mm)	Shipping Weight (g)
87104A/204A SP4T	dc to 4	<1.2 to 4 GHz	0.3 + .015 x f (GHz)	>100 to 4 GHz	15 ms	0.03 dB	5,000,000 cycles	SMA (f)	57 x 74 x 57	360
87104B/204B SP4T	dc to 20	<1.2 to 4 GHz <1.35 to 12.4 GHz <1.45 to 18 GHz <1.7 to 20 GHz	0.3 + .015 x f (GHz)	>100 to 12 GHz >70 at 20 GHz	15 ms	0.03 dB	5,000,000 cycles	SMA (f)	57 x 74 x 57	360
87104C/204C SP4T	dc to 26.5	<1.7 to 20 to 26.5 GHz	0.3 + .015 x f (GHz)	>65 db 20 to 26.5 GHz	15 ms	0.03 dB	5,000,000 cycles	SMA (f)	57 x 74 x 57	360
87106A/206A SP6T	dc to 4	<1.2 to 4 GHz	0.3 + .015 x f (GHz)	>100 to 4GHz	15 ms	0.03 dB	5,000,000 cycles	SMA (f)	57 x 74 x 57	380
87106B/206B SP6T	dc to 20	<1.2 to 4 GHz <1.35 to 12.4 GHz <1.45 to 18 GHz <1.7 to 20 GHz	0.3 + .015 x f (GHz)	>100 to 12 GHz >70 at 20 GHz	15 ms	0.03 dB	5,000,000 cycles	SMA (f)	57 x 74 x 57	380
87106C/206C SP6T	dc to 26.5	<1.7 to 20 to 26.5 GHz	0.3 + .015 x f (GHz)	>65 db 20 to 26.5 GHz	15 ms	0.03 dB	5,000,000 cycles	SMA (f)	57 x 74 x 57	380
87406B/606B	dc to 20	<1.21 to 4 <1.35 to 10 <1.5 to 15 <1.7 to 18 <1.9 to 20	0.34 + 0.033 x f (GHz)	<100 to 12 GHz <80 to 15 GHz <70 to 20 GHz	15 ms	0.03	5,000,000 cycles	SMA (f)	57 x 74 x 57	380
8766K SP3T	dc to 26.5 or dc to 18 for Option 002	<1.3 to 8 GHz <1.5 to 12.4 GHz <1.6 to 18 GHz <1.8 to 26.5 GHz	Port 1: 0.2 dB + 0.05 dB/GHz Port 2: 0.2 dB + 0.06 dB/GHz Port 3: 0.2 dB + 0.08 dB/GHz Port 4: 0.25 dB + 0.095 dB/GHz Port 5: 0.25 dB + 0.108 dB/GHz Port 6: 0.25 dB + 0.12 dB/GHz	Consult Technical Data Sheet	20 ms	0.03 dB	5,000,000 cycles	3.5 mm (f)	45 x 23 x 82	178
8767K SP4T	dc to 26.5 or dc to 18 for Option 002	<1.3 to 8 GHz <1.5 to 12.4 GHz <1.6 to 18 GHz <1.8 to 26.5 GHz			20 ms	0.03 dB	5,000,000 cycles	3.5 mm (f)	45 x 23 x 105	235
8768K SP5T	dc to 26.5 or dc to 18 for Option 002	<1.3 to 8 GHz <1.5 to 12.4 GHz <1.6 to 18 GHz <1.8 to 26.5 GHz			20 ms	0.03 dB	5,000,000 cycles	3.5 mm (f)	45 x 23 x 133	292
8769K SP6T	dc to 26.5 or dc to 18 for Option 002	<1.3 to 8 GHz <1.55 to 12.4 GHz <1.8 to 18 GHz <2.05 to 26.5 GHz			20 ms	0.03 dB	5,000,000 cycles	3.5 mm (f)	45 x 23 x 160	349

[1]Measured at 25° C

For more information, visit our web site: **http://www.hp.com/go/MTA**

HP 84904/6/7K and L

High-Performance Programmable Step Attenuators—dc to 40 GHz

HP 84904K/L (0-11, dB steps)
HP 84906K/L (0-90, dB steps)
HP 84907K/L (0-70, dB steps)

The HP 84904/906/907 family of programmable step attenuators offers unmatched attenuation performance to 40 GHz. The K model brings superior accuracy and reliability to 26.5 GHz, while the L model offers unparalleled performance to 40 GHz.

HP step attenuators consist of 3 or 4 cascaded sections of specific attenuation values, e.g., 1, 2, 4, 10, 20 and 40 dB. Both families offer the selection, performance, accuracy and reliability expected from HP attenuators: attenuation ranges of 11, 70, or 90 dB, 1 dB and 10 dB step sizes, 5 million cycles per section, better than 0.03 dB repeatability, connector size options and the choice of male or female connectors. RF connector choices include precision 3.5-mm or 2.92-mm on the 26.5 GHz K model, and precision 2.4-mm or 2.92-mm on the L model. While the 2.92-mm connector format is compatible with both 3.5-mm and SMA connectors, Hewlett-Packard recommends the more rugged 2.4-mm and 3.5-mm connectors.

HP programmable step attenuators feature electromechanical designs which achieve 20 milliseconds switching time, including settling time. The permanent magnet latching allows automatic interruption of the dc drive voltage to cut power consumption and simplify circuit design. They are equipped with 10-pin DIP sockets (m) with interconnect cables available.

Programmable Driver Instruments

Drive options include the HP 11713A and 87130A attenuator/switch drivers, which permit users to easily integrate the attenuator into HP-IB compatible automatic test systems, and the HP 70611 MMS attenuator/switch driver. Cabling options include 8- or 16-inch ribbon cables (HP 11764C/D) with a 10-pin DIP socket (f) and a 14-pin DIP plug for easy connection to standard 14-pin DIP IC sockets, a 5-foot Interconnect Cable (HP 11764A) with 10-pin DIP socket (f), and a "Viking" connector for the HP 11713A driver, and a 5-foot Interconnect Cable (HP 11764B) with a 10-pin DIP socket (f) and bare leads for custom applications. Option 100 series replaces one female connector with a male connector to allow end-to-end connection of 1 dB and 10 dB step attenuators.

Key Literature

Latest *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E

For more information, visit our web site: **http://www.hp.com/go/MTA**

Ordering Information

Attenuators
HP 84904K 0 to 11 dB, 1 dB steps, 26.5 GHz
HP 84904L 0 to 11 dB, 1 dB steps, 40 GHz
HP 84906K 0 to 90 dB, 10 dB steps, 26.5 GHz
HP 84906L 0 to 90 dB, 10 dB steps, 40 GHz
HP 84907K 0 to 70 dB, 10 dB steps, 26.5 GHz
HP 84907L 0 to 70 dB, 10 dB steps, 40 GHz
Opt 006 Female 2.92-mm Connectors (L models only)
Opt 100 Male 2.4-mm Connector (L models only)
Opt 104 Male 3.5-mm Connector (K models only)
Opt 106 Male 2.92-mm Connector (L models only)
Opt UK6 Commercial Calibration Test Data with Certificate
Opt UKS Commercial Calibration Certificate

Attenuator Accessories
HP 11764A Interconnect Cable with 10-pin Socket (f) to "Viking" Connector for HP 11713A
HP 11764B Interconnect Cable with 10-pin DIP Socket (f) and Bare Leads
HP 11764C Interconnect Cable with 203-mm (8 in) Ribbon Cable, 10-pin DIP Socket, 14-pin DIP Plug
HP 11764D Interconnect Cable with 406-mm (16 in) Ribbon Cable, 10-pin DIP Socket, 14-pin DIP Plug

HP 84904/6/7K/L Specifications

HP Model	Frequency Range (GHz)	Attenuation Range	Maximum SWR Std (Option 006)	Insertion Loss 0 dB Setting	Repeatability[1]	Life[2]	Shipping Weight
84904K	dc to 26.5	0 to 11 dB	1.3 (1.5) to 12.4 GHz	0.8 dB + 0.04 dB/GHz	0.03 dB	5 x 10^6	291 g
84904L	dc to 40	1 dB steps	1.7 (1.9) to 34 GHz				(10.3 oz)
			1.8 (2.0) to 40 GHz				
84906K	dc to 26.5	0 to 90 dB	1.3 (1.5) to 12.4 GHz	0.8 dB + 0.04 dB/GHz	0.03 dB	5 x 10^6	291 g
		10 dB steps	1.7 (1.9) to 34 GHz				(10.3 oz)
84906L	dc to 40		1.8 (2.0) to 40 GHz				
84907K	dc to 26.5	0 to 70 dB	1.25 (1.4) to 12.4 GH;	0.6 dB + 0.03 dB/GHz	0.03 dB	5 x 10^6	229 g
		10 dB steps	1.5 (1.7) to 34 Gz				(8.1 oz)
84907L	dc to 40		1.7 (1.9) to 40 GHz				

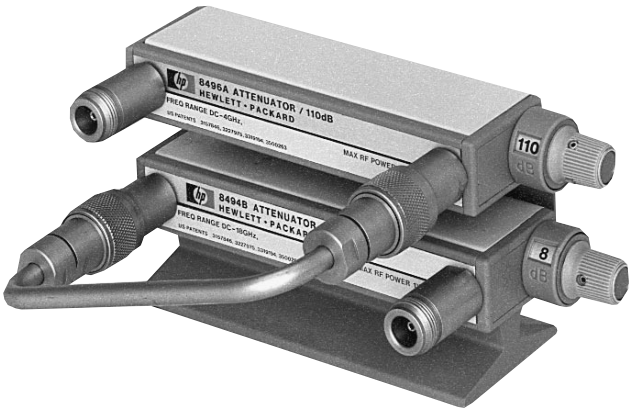
Sensitivity power: dB/watt (temperature dB/° C): 0.001 (0.0001)
Power rating: 1 W ave, 50 W peak, 10 μs max. pulse width
Supply voltage/speed/power: 20 to 30 V / <20 ms / 2.7 W

[1] Measured at 25° C
[2] Cycles per section minimum

Attenuation Accuracy DC to 26.5 GHz	26.5 to 40 GHz
1 dB: 0.4 dB	1 dB: 0.6 dB
2 dB: 0.5 dB	2 dB: 0.6 dB
3 dB: 0.7 dB	3 dB: 0.8 dB
4 dB: 0.7 dB	4 dB: 0.8 dB
5 dB: 0.7 dB	5 dB: 0.8 dB
6 dB: 0.7 dB	6 dB: 0.9 dB
7 dB: 0.8 dB	7 dB: 1.1 dB
8 dB: 0.8 dB	8 dB: 1.1 dB
9 dB: 0.85 dB	9 dB: 1.2 dB
10 dB: 0.9 dB	10 dB: 1.3 dB
11 dB: 1.10 dB	11 dB: 1.5 dB
10 dB: 0.5 dB	10 dB: 0.5 dB
20 dB: 0.6 dB	20 dB: 0.6 dB
30 dB: 0.7 dB	30 dB: 0.7 dB
40 dB: 1.0 dB	40 dB: 1.0 dB
50 dB: 1.2 dB	50 dB: 1.2 dB
60 dB: 1.6 dB	60 dB: 1.6 dB
70 dB: 1.9 dB	70 dB: 1.9 dB
80 dB: 2.7 dB	80 dB: 2.7 dB
90 dB: 2.9 dB	90 dB: 2.9 dB

HP 8495D

HP 8495K



HP 11716A

Programmable and Manual Step Attenuators DC–1000 MHz

Manual

HP 355C (0–12 dB, 1 dB steps)
HP 355D (0–120 dB, 10 dB steps)

Programmable

HP 355E (0–12 dB, 1 dB steps)
HP 355F (0–120 dB, 10 dB steps)

The manual and programmable HP 355 C/D/E/F attenuators offer exceptional attenuation accuracy to 1 GHz; +0.1 dB to 1 kHz, 0.25 dB to 500 MHz, 0.35 to 1 GHz. They feature BNC (f) RF connectors, with optional type-N (Option 001) and TNC (Option 005) also available. To achieve 1 dB steps to 132 dB range, serially connect two attenuators using a standard UG-491A/U BNC (m)-to-BNC (m) adapter. Programmable HP 355 E/F models feature a 7-pin connector (supplied). To protect your transistor driver against transients during the switching cycle, order Option 007 to install a protective diode between each solenoid and driver.

Programmable and Manual Step Attenuators DC–26.5 GHz

HP 8494A/B/G/H (0–11 dB, 1 dB steps)
HP 8495A/B/D/G/H/K (0–70 dB, 10 dB steps)
HP 8496A/B/G/H (0–110 dB, 10 dB steps)
HP 8497K (0–90 dB, 10 dB steps)

The HP 8494/95/96/97 family of step attenuators offer fast, precise signal level control in three frequency ranges, dc to 4 GHz, dc to 18 GHz and dc to 26.5 GHz. They feature exceptional repeatability and reliability in a wide range of frequency, attenuation and connector options.

Attenuation repeatability is specified to be less than 0.03 dB (0.05 dB, 18-26.5 GHz) for 5 million cycles per section. This assures low measurement uncertainty and high user confidence when designed into automatic test systems. Electromechanical step attenuators offer low SWR, low insertion loss and high accuracy required by high-performance test and measurement equipment.

Precision plated leaf-spring contacts remove attenuator sections (miniature tantalum nitride thin-film T-pads on sapphire and alumina substrates) from the signal path. Unique process controls and material selection ensure unmatched life and contact repeatability.

Programmable Models

Miniature drive solenoids in the programmable models keep switching time, including settling, down to less than 20 milliseconds. Once switched, strong permanent magnets hold the solenoids (and attenuation value) in place. Current interrupts automatically disconnect solenoid current, simplifying driver circuit design and minimizing heat dissipation. Programming is done through a 12-pin Viking socket or optional ribbon cables with DIP plugs.

To simplify connecting programmable attenuators to the drive circuit, each unit is supplied with a 5-ft. cable assembly. With an HP 11713A attenuator driver, 87130A attenuator driver, or an HP 70611A driver for MMS-based systems, automatic drive control is easy using the Hewlett-Packard Interface Bus (HP-IB) automated system.

HP 11716A/B/C Attenuator Interconnect Kits

Quickly and conveniently connect 1 dB step and 10 dB step attenuators together to achieve greater dynamic range with 1 dB steps. The 11716A/B/C interconnect kits contain a rigid RF cable, mounting bracket, and necessary hardware to connect any pair of HP 8494/95/96/97 attenuators in series (see photo above). Attenuators must be ordered separately.

Key Literature

Latest *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E

For more information, visit our web site: **http://www.hp.com/go/MTA**

Ordering Information

HP 11716A Interconnect Kit (Type-N)
HP 11716B Interconnect Kit (APC-7)
HP 11716C Interconnect Kit (SMA)
HP 11717A Attenuator/Switch Rackmount Support Kit

Indicates QuickShip availability.

HP 355 Series, 8494/5/6/7 Series Specifications

HP Model (Switching Mode)	Frequency Range (GHz)	Attenuation Range (dB)	Maximum SWR	Insertion Loss @ 0 dB	Attenuation Accuracy	Power Rating, Minimum Life	Solenoid Voltage Speed Power	Size, Shipping Weight	Connector Options	
355C (Manual) **355E** (Programmable)	dc to 1	0 to 12 1 dB steps	1.2 to 250 MHz 1.3 to 500 MHz 1.5 to 1 GHz	0.11 dB + 1.39 dB/GHz	±0.1 dB @ 1000 Hz ±0.25 dB: dc to 0.5 GHz ±0.35 dB: dc to 1.0 GHz	0.5 W avg. 350 W peak 0.5 million cycles per section	— 15 to 18 V <65 ms 3.0 W	70 mm W x 67 mm H x 152 mm D (2.75 in x 2.6 in x 6 in) 1.4 kg (3 lb)	BNC (f) See Note 1	
355D (Manual) **355F** (Programmable)	dc to 1	0 to 120 10 dB steps	1.2 to 0.25 GHz 1.3 to 0.5 GHz 1.5 to 1 GHz	0.11 dB + 1.39 dB/GHz	±0.3 dB @ 1000 Hz ±1.5 dB to 90 dB, and ±3 dB to 120 dB @ 1 GHz	0.5 W avg. 350 W peak 0.5 million cycles per section	— 15 to 18 V <65 ms 3.0 W	70 mm W x 67 mm H x 152 mm D (2.75 in x 2.6 in x 6 in) 1.4 kg (3 lb)	BNC (f) See Note 1	
8494A (Manual) **8494G** (Programmable)	dc to 4	0 to 11 1 dB steps	1.5	0.6 dB + 0.09 dB/GHz	±0.2 dB: 1 to 2 dB ±0.3 dB: 3 to 6 dB ±0.4 dB: 7 to 10 dB ±0.5 dB: 11 dB	1 W avg. 100 W peak 10 μs max. 5 million cycles per section	— 20 to 30 V <20 ms 2.7 W	73 mm W x 43 mm H x 159 mm D (2.9 in x 1.7 in x 6.2 in) 0.9 kg (2 lb) 79 mm W x 43 mm H x 168 mm D (3.1 in x 1.7 in x 6.6 in) 0.9 kg (2 lb)	001 002 003 See Note 2	
8494B (Manual) **8494H** (Programmable)	dc to 18	0 to 11 1 dB steps	1.5 to 8 GHz 1.6 to 12.4 GHz 1.9 to 18 GHz	0.6 dB + 0.09 dB/GHz	**dc to 12.4 GHz** ±0.3 dB: 1 to 2 dB ±0.4 dB: 3 to 4 dB ±0.5 dB: 5 to 6 dB ±0.6 dB: 7 to 10 dB ±0.7 dB: 11 dB **dc to 18 GHz** ±0.7 dB: 1 to 5 dB ±0.8 dB: 6 to 9 dB ±0.9 dB: 10 to 11 dB	1 W avg. 100 W peak 10 μs max. 5 million cycles per section	— 20 to 30 V <20 ms 2.7 W	73 mm W x 43 mm H x 159 mm D (2.9 in x 1.7 in x 6.2 in) 0.9 kg (2 lb) 79 mm W x 43 mm H x 168 mm D (3.1 in x 1.7 in x 6.6 in) 0.9 kg (2 lb)	001 002 003 See Note 2	$
8495A (Manual) **8495G** (Programmable)	dc to 4	0 to 70 10 dB steps	1.35	0.4 dB + 0.07 dB/GHz	±1.7% of setting or 0.4 dB, whichever is greater	1 W avg. 100 W peak 10 μs max. 5 million cycles per section	— 20 to 30 V <20 ms 2.7 W	73 mm W x 43 mm H x 130 mm D (2.9 in x 1.7 in x 5.1 in) 0.9 kg (2 lb) 79 mm W x 43 mm H x 141 mm D (3.1 in x 1.7 in x 5.5 in) 0.9 kg (2 lb)	001 002 003 See Note 2	
8495B (Manual) **8495H** (Programmable)	dc to 18	0 to 70 10 dB steps	1.35 to 8 GHz 1.5 to 12.4 GHz 1.7 to 18 GHz	0.4 dB + 0.07 dB/GHz	±3%: dc to 12.4 GHz ±4%: dc to 18 GHz % in dB from atten. setting	1 W avg. 100 W peak 10 μs max. 5 million cycles per section	— 20 to 30 V <20 ms 2.7 W	73 mm W x 43 mm H x 130 mm D (2.9 in x 1.7 in x 5.1 in) 0.9 kg (2 lb) 79 mm W x 43 mm H x 141 mm D (3.1 in x 1.7 in x 5.5 in) 0.9 kg (2 lb)	001 002 003 See Note 2	
8495D (Manual) **8495K** (Programmable)	dc to 26.5	0 to 70 10 dB steps	1.25 to 6 GHz 1.45 to 12.4 GHz 1.6 to 18.0 GHz 1.8 to 26.5 GHz	0.5 dB + 0.13 dB/GHz	±0.3 dB at 6 GHz 10 dB attenuation to ±2.8 dB at 26.5 GHz 90 dB attenuation	1 W avg. 100 W peak 10 μs max. 5 million cycles per section	— 20 to 30 V <20 ms 2.7 W	52 mm W x 43 mm H x 159 mm D (2.1 in x 1.7 in x 6.2 in) 0.9 kg (2 lb) 52 mm W x 43 mm H x 168 mm D (2.1 in x 1.7 in x 6.6 in) 0.9 kg (2 lb)	004 3.5 mm See Note 2	
8496A (Manual) **8496G** (Programmable)	dc to 4	0 to 110 10 dB steps	1.5	0.6 dB + 0.09 dB/GHz	±1.7% of setting or 0.4 dB, whichever is greater	1 W avg. 100 W peak 10 μs max. 5 million cycles per section	— 20 to 30 V <20 ms 2.7 W	73 mm W x 43 mm H x 159 mm D (2.9 in x 1.7 in x 6.2 in) 0.9 kg (2 lb) 79 mm W x 43 mm H x 168 mm D (3.1 in x 1.7 in x 6.6 in) 0.9 kg (2 lb)	001 002 003 See Note 2	
8496B (Manual) **8496H** (Programmable)	dc to 18	0 to 110 10 dB steps	1.5 to 8 GHz 1.6 to 12.4 GHz 1.9 to 18 GHz	0.6 dB + 0.09 dB/GHz	±3%: dc to 12.4 GHz ±4%: dc to 18 GHz % in dB from atten. setting	1 W avg. 100 W peak 10 μs max. 5 million cycles per section	— 20 to 30 V <20 ms 2.7 W	73 mm W x 43 mm H x 159 mm D (2.9 in x 1.7 in x 6.2 in) 0.9 kg (2 lb) 79 mm W x 43 mm H x 168 mm D (3.1 in x 1.7 in x 6.6 in) 0.9 kg (2 lb)	001 002 003 See Note 2	
8497K (Programmable)	dc to 26.5	0 to 90 10 dB steps	1.25 to 6 GHz 1.45 to 12.4 GHz 1.6 to 18.0 GHz 1.8 to 26.5 GHz	0.4 dB + 0.09 dB/GHz	±0.3 dB at 6 GHz 10 dB attenuation to ±2.8 dB at 26.5 GHz 90 dB attenuation	1 W avg. 100 W peak 10 μs max. 5 million cycles per section	5 V or 24 V	52 mm W x 43 mm H x 143 mm D (2.1 in x 1.7 in x 5.6 in) 0.9 kg (2 lb)	004 3.5 mm See Note 2	

How to Order the HP 8494/5/6/7 Series Attenuators

Each order must include basic model number, suffix letter, and connector option.

Ordering example: HP 8494 **A** Option **001**

4	**A**	**001**
4 (1 dB step, 11 dB max)	**A** (Manual, dc to 4 GHz)	**001** (N female)
5 (10 dB step, 70 dB max)	**B** (Manual, dc to 18 GHz)	**002** (SMA female)
6 (10 dB step, 110 dB max)	**D** (Manual, dc to 26.5 GHz)*	**003** (APC-7)
7 (10 dB step, 90 dB max)	**G** (Programmable, dc to 4 GHz)	**004** (3.5 mm female)[1]
	H (Programmable, dc to 18 GHz)	
	K (Programmable, dc to 26.5 GHz)*	

[1]Option 004 is only available on D and K models.

Note 1: 355C/D/E/F connector options (BNC (f) standard):
Option 001 N(f)
Option 005 TNC(f)
Option 007 Transistor protection (355E/F only)
Option UKS Commercial Calibration Certificate

Note 2: 8494/5/6/7 orders must specify connector option. See ordering example.
Option 001 N(f)
Option 002 SMA(f)
Option 003 APC-7
Option 004 3.5 mm (HP 8495D/K, 8497K only)
Option UK6 Commercial Calibration Test Data with Certificate
Option UKS Commercial Calibration Certificate

Indicates QuickShip availability.

HP 8490D


HP 8492A

HP 8493A/B/C Series

HP 8498A High Power Attenuator

The HP 8498A Option 030 is designed to meet the needs of high-power attenuation applications in the RF and microwave frequency range. It is a 25-watt average, 30 dB fixed attenuator with a frequency of dc to 18 GHz. The maximum peak power specification is 500 watts (dc to 5.8 GHz) and 125 watts (5.8 to 18 GHz). Available only in a 30 dB version, the unit offers a 1.3 SWR and ±1 dB accuracy at 18 GHz. Large heat-dissipating fins keep the unit cool even under continuous maximum input power conditions.

HP 8491A/B/C, 8492A, 8493A/B/C Fixed Attenuators

Hewlett-Packard coaxial fixed attenuators provide precise attenuation, flat frequency response, and low SWR over broad frequency ranges. Attenuators are available in nominal attenuations of 3 dB and 6 dB, as well as 10 dB increments from 10 dB to 60 dB. These attenuators are swept-frequency tested to ensure they meet specifications at all frequencies. Calibration points are provided on a nameplate chart attached to each unit (except for the HP 8491C).

HP 8490D 50-GHz Fixed Attenuator

Hewlett-Packard coaxial fixed attenuators have been the standard for accurate flat response and low SWR. The HP 8490D offers exceptional performance to 50 GHz using the 2.4-mm connector. Attenuation values available are 3, 6, 10, 20, 30 and 40 dB. Ideally suited for extending the range of sensitive power meters, or for use as calibration standards, these broadband attenuators are manufactured with the same meticulous care as their lower frequency counterparts.

HP 8490D, 8491A/B/C, 8492A, 8493A/B/C, 8498A, Specifications

HP Model	Frequency range (GHz)	SWR (max.)	Input Power (max.)		Attenuation Accuracy (+dB) 3 dB Opt 003	6 dB Opt 006	10 dB Opt 010	20 dB Opt 020	30 dB Opt 030	40 dB Opt 040	50 dB Opt 050	60 dB Opt 060	Connectors	
8490D	DC to 50	dc to 26.5 GHz: 1.15 (1.08 Opt 040 only) 26.5 to 40 GHz: 1.25 (1.15 Opt 040 only) 40 to 50 GHz: 1.45 (1.25 Opt 040 only)	2 W avg. 100 W peak	DC to 26.5 26.5 to 50	+0.9 –0.5 +1.8 –0.5	+0.9 –0.6 +1.8 –0.6	+0.9 –0.6 +1.3 –0.6	+1.3 –0.8 +1.7 –0.8	+1.3 –0.8 +1.7 –0.8	+2.5 –1.8 +2.5 –1.8			2.4 mm	
8491A 3 to 30 dB 40 to 60 dB	dc to 12.4	1.2 to 8 GHz 1.3 to 12.4 GHz	2 W avg. 100 W peak		0.3	0.3	0.5	0.5	1.0	1.5	1.5	2	N (m,f)	
8491B 3 to 30 dB 40 to 60 dB	dc to 18	1.2 to 8 GHz 1.3 to 12.4 GHz 1.5 to 18 GHz	2 W avg. 100 W peak		0.3	0.3 to 12.4 GHz 0.4 to 18 GHz	0.6	0.6 to 12.4 GHz 1.0 to 18 GHz	1.0	1.5	1.5	2	N (m,f)	
8491C 3 to 30 dB	dc to 18	1.2 to 8 GHz 1.3 to 12.4 GHz 1.5 to 18 GHz	2 W avg. 100 W peak		0.3 to 12.4 GHz 0.4 to 18 GHz	0.4 to 12.4 GHz 0.5 to 18 GHz	0.6	0.6 to 12.4 GHz 1.0 to 18 GHz	1.0	—	—	—	N (m,f)	
8492A 3 to 30 dB 40 to 60 dB	dc to 18	1.15 to 8 GHz 1.25 to 12.4 GHz 1.35 to 18 GHz	2 W avg. 100 W peak		0.3	0.3 to 12.4 GHz 0.4 to 18 GHz	0.6	0.6 to 12.4 GHz 1.0 to 18 GHz	1.0	1.5	1.5	2	APC-7	
8493A 3 to 20 dB 30 dB	dc to 12.4	1.2 to 8 GHz 1.3 to 12.4 GHz	2 W avg. 100 W peak		0.3	0.3	0.5	0.5	1.0	—	—	—	SMA (m,f)	
8493B 3 to 20 dB 30 dB	dc to 18	1.2 to 8 GHz 1.3 to 12.4 GHz 1.5 to 18 GHz	2 W avg. 100 W peak		+0.3 dB	0.3 to 12.4 GHz 0.4 to 18 GHz	0.6	0.6 to 12.4 GHz 1.0 to 18 GHz	1.0	—	—	—	SMA (m,f)	
8493C 3 to 30 dB 40 dB	dc to 26.5	1.1 to 8 GHz 1.15 to 12.4 GHz 1.25 to 26.5 GHz	2 W avg. 100 W peak		0.5 to 18 GHz 1.0 to 26.5 GHz	0.6 0.6	0.3 0.5	0.5 0.6	0.7 1	1.0 1.3	— —	— —	3.5 mm (m,f)	
8498A 30 dB	dc to 18	1.15 to 8 GHz 1.25 to 12.4 GHz 1.35 to 18 GHz	25 W avg. 500 W peak (dc to 5.8 GHz) 125 W peak 500 W/ms max. per pulse (5.8 to 18 GHz)		—	—	—	—	1.0	—	—	—	N (m,f)	

HP Models	Options UK6/UKS
8491A, 8491B, 8492A,8493A, 8493B, 8493C, 8498A	**Option UK6**-Commercial Calibration Test Data with Certificate **Option UKS**-Commercial Calibration Certificate

HP 11581A, 11582A, 11583A/C Attenuator Sets

A set of four Hewlett-Packard attenuators—3, 6, 10, and 20 dB—are furnished in a handsome walnut accessory case. The HP 11581A set consists of HP 8491A attenuators; the HP 11582A set, HP 8491B attenuators; the HP 11583A set, HP 8492A attenuators; and the HP 11583C set, HP 8493C attenuators. These sets are ideal for calibration labs or where precise knowledge of attenuation and SWR is desired.

Key Literature

Latest *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E

Ordering Information

HP 11581A 3, 6, 10, 20 dB HP 8491A Set
HP 11582A 3, 6, 10, 20 dB HP 8491B Set
HP 11583A 3, 6, 10, 20 dB HP 8492A Set
HP 11583C 3, 6, 10, 20 dB HP 8493C Set
Opt UK6 Commercial Calibration Test Data with Certificate
Opt UKS Commercial Calibration Certificate

Indicates QuickShip availability.

HP 8474 Series

HP 8471D/E

HP 83036C

Low-Barrier Schottky Diode Detectors

HP 423B, HP 8472B, HP 8473B/C

These Low-Barrier Schottky Diode (LBSD) detectors have been widely used for many years in a variety of applications including leveling and power sensing. They offer good performance and ruggedness. Matched pairs (Option 001) offer very good detector tracking. A video load option (Option 002) extends the square-law region to at least 0.1 mW (–10 dBm).

Planar-Doped Barrier Detectors

HP 8471D/E

The HP 8471D/E are economy detectors based on the Planar-Doped Barrier (PDB) diodes. The PDB diodes give them superior frequency response, square-law response, and temperature performance. The HP 8471D has a BNC (m) input connector and a frequency range of 100 kHz to 2 GHz, making it ideal for use in RF and low microwave applications. The HP 8471E has a SMA (m) input connector and a SMC (m) output connector. Its frequency range is 10 MHz to 12 GHz. Both models come standard with a negative polarity output; a positive polarity output can be specified as Option 103.

HP 8473D

The HP 8473D detector was the first gallium arsenide PDB diode introduced. It features broadband performance and excellent flatness vs. frequency, along with superior temperature stability. The HP 8473D is available with a 3.5-mm (m) RF connector and a BNC (f) output connector.

High-Performance Planar-Doped Barrier Detectors

HP 8474B/C/D/E

Utilizing a gallium arsenide PDB diode as the detecting element, these detectors offer superior performance when compared to earlier detector designs. They feature extremely flat frequency response over their entire band of operation (typically better than ±1 dB to 50 GHz) and very good frequency response stability versus temperature. For applications where broadband frequency coverage is not required, octave band options are available in specific bands.

The HP 8474 detectors are available with APC-7 (0.01 to 18 GHz), Type N (0.01 to 18 GHz), 3.5 mm (mates with SMA, 0.01 to 33 GHz), 2.92 mm (0.01 to 40 GHz), or 2.4 mm (0.01 to 50 GHz) connectors. These detectors are offered with options for optimal square-law loads (Option 102) and for positive polarity output (Option 103). Because the unit-to-unit frequency response tracking of these devices is typically better than ±0.3 dB, no matched response option is offered.

Broadband Directional Detector

HP 83036C

The HP 83036C is a broadband microwave power sampler that operates in much the same way as a directional coupler and detector combination. It is composed of a resistive bridge and PDB diode that yields a very broadband device with excellent frequency response, superior temperature response and square-law response characteristics. With a 10 MHz to 26.5 GHz frequency range, a single HP 83036C can be used in many applications where two directional couplers and detectors were once required, such as in broadband power monitoring and source leveling.

The maximum SWR is 1.7 above 50 MHz on both the input and output ports. Directivity of 14 dB matches that of most miniature couplers currently available. The maximum insertion loss is 2.2 dB.

The HP 83036C has been used with great success as the sampling element for external leveling of broadband swept frequency sources. The extended frequency range increases the usable band from 100 MHz to 26 GHz, giving the user full use of the broadband source with external leveling. Other uses include the internal leveling element for sources, and forward/reverse power monitoring.

Key Literature

Latest *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E

For more information, visit our web site: **http://www.hp.com/go/MTA**

Planar-Doped Barrier Diode Detectors Specifications

HP Model	Freq. Range (GHz)	Freq. Response (dB)	Max. SWR	Low-level Sensitivity	Max. Input (Peak or Average)	Short-term Max. Input (<1 min.)	Opt. 002/102 Optimum Square-Law Load	Opt. 003/103 Positive Polarity Output	Input/ Output Connector	
8471D	0.0001 to 2	±0.2 to 1 GHz ±0.4 to 2 GHz	1.23 to 1 GHz 1.46 to 2 GHz	>0.5 mV/μW	100 mW	0.7 W	Yes	Yes	BNC (m) BNC (f)	
8471E	0.01 to 12	±0.23 to 4 GHz ±0.6 to 8 GHz ±0.85 to 12 GHz	1.2 to 4 GHz 1.7 to 8 GHz 2.4 to 12 GHz	>0.4 mV/μW	200 mW	0.75 W	No	Yes	SMA (m) SMC (m)	
8473D	0.01 to 33	±0.25 to 12.4 GHz ±0.40 to 26.5 GHz ±1.25 to 33 GHz	1.2 to 14 GHz 1.36 to 26.5 GHz 2.96 to 33 GHz	>0.4 mV/μW	200 mW	1 W	Note 1	Note 1	3.5 mm (m) BNC (f)	
8474B[1]	0.01 to 18	±0.35 to 18 GHz	1.3 to 18 GHz	>0.4 mV/μW	200 mW	.75 W	Note 1	Note 1	Type N (m) BNC (f)	
8474C[1]	0.01 to 33	±0.45 to 26.5 GHz ±0.70 to 33 GHz	1.4 to 26.5 GHz 2.2 to 33 GHz	>0.4 mV/μW	200 mW	.75 W	No	Note 1	3.5 mm (m) SMC (m)	
8474E[1]	0.01 to 50	±0.4 to 26.5 GHz ±0.6 to 40 GHz ±1.0 to 50 GHz	1.2 to 26.5 GHz 1.6 to 40 GHz 2.8 to 50 GHz	>0.4 mV/μW	200 mW	.75 W	No	Note 1	2.4 mm (m) SMC (m)	

[1]Octave band options available (see Data Sheet).

Broadband Directional Detector Specifications

HP Model	Freq. Range (GHz)	Freq. Response (dB)	Max. SWR Input/Output (50 Ω Nom.)	Max. Thru Line Loss (dB)	Low-level Sensitivity	Min. Directivity (dB)	Max. Input (Into 50 Ω Load) w/ 2:1 Source Match	Max. Input (Into Open) w/ 2:1 Source Match	Input/ Output Connector
83036C	0.01 to 26.5	±1.0	1.7	2.2	18 mV/μW	14	32 dBm	21 dBm	3.5 mm (f)

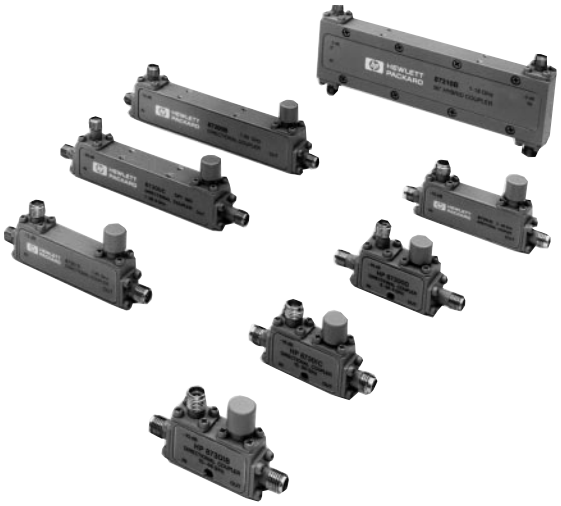
Low-Barrier Schottky Diode Detectors Specifications

HP Model	Freq. Range (GHz)	Freq. Response (dB)	Max. SWR (50 Ω Nom.)	Low-level Sensitivity (mV/μW)	Max. Input (Peak or Average)	Short-term Max. Input (<1 min.)	Matched[2] Response Opt. 001	Optimum Square-law Load[3]	Positive Polarity Output	Input/ Output Connector	
423B	0.01 to 12.4	±0.3 to 12.4 GHz	1.15 to 4 GHz 1.3 to 12.4 GHz	>0.5	200 mW	1 W (typical)	±0.2 dB to 12.4 GHz	Opt. 002	Opt. 003	N (m) BNC (f)	
8470B **8470B Option 012**	0.01 to 18	±0.3 to 12.4 GHz ±0.5 to 15 GHz ±0.6 to 18 GHz	1.15 to 4 GHz 1.3 to 15 GHz 1.4 to 18 GHz	>0.5	200 mW	1 W (typical)	±0.2 dB to 12.4 GHz ±0.3 to 18 GHz	Opt. 002	Opt. 003	APC-7 BNC (f) N (m) BNC (f)	
8472B Option 100	0.01 to 18	±0.3 to 12.4 GHz ±0.5 to 15 GHz ±0.6 to 18 GHz	1.15 to 4.5 GHz 1.35 to 7 GHz 1.5 to 12.4 GHz 1.7 to 18 GHz	>0.5	200 mW	1 W (typical)	±0.2 dB to 12.4 GHz ±0.3 to 18 GHz	Opt. 002	Opt. 003	SMA (m) BNC (f) SMA (m) OSSM (f)	
8473B	0.01 to 18	±0.3 to 12.4 GHz ±0.6 to 18 GHz	1.2 to 4 GHz 1.5 to 18 GHz	>0.5	200 mW	1 W (typical)	±0.2 dB to 12.4 GHz ±0.3 to 18 GHz	Opt. 002	Opt. 003	3.5 mm (m) BNC (f)	
8473C	0.01 to 26.5	±0.3 to 12.4 GHz ±0.6 to 20 GHz ±1.5 to 26.5 GHz	1.2 to 4 GHz 1.5 to 18 GHz 2.2 to 26.5 GHz	>0.5	200 mW	1 W (typical)	±0.2 dB to 12.4 GHz ±0.3 to 18 GHz ±0.5 to 26.5 GHz	Opt. 002	Opt. 003	3.5 mm (m) BNC (f)	

Note:
[1] Available as a special option on request. Consult your HP representative.
[2] Must order a quantity of 2 standards and 2 Option 001s for a pair of detectors with matched frequency response.
[3] Defined as ± 0.5 from ideal square law response.

For more information, visit our web site: **http://www.hp.com/go/MTA**

Indicates QuickShip availability.



HP 87300B/C/D, 87301B/C/D, 87310B, 87301E

HP 87300 Series Directional Couplers

This line of compact, broadband directional couplers are ideal for signal monitoring, or when combined with a coaxial detector, for signal leveling. Available in a variety of frequency ranges, they can be matched to specific applications. The HP 8474 series coaxial detectors are recommended if output detection is desired. The HP 87300B is supplied with SMA (f) connectors, the HP 87300C has 3.5-mm (f) connectors, and the HP 87301D has 2.4-mm (f) standard or optional 2.92-mm (f) connectors.

HP 87310B Hybrid Coupler

HP 87310B is a 3 dB hybrid coupler, intended for applications requiring a 90 degree phase difference between output ports. In that sense, it is different from typical power dividers and power splitters, which have matched signal phase at their output ports. The HP 87310B features SMA (f) connectors.

HP 87300 Series Specifications

HP Model	Freq. Range (GHz)	Nominal Coupling & (dB) Variation	Directivity (dB)	Max. SWR	Insertion Loss (dB)
87300B	1 to 20	10 ± 0.5	16	1.35	<1.5
87300C	1 to 26.5	10 ± 1	>14 to 12.4 GHz >12 to 26.5 GHz	1.40	<1.2 to 12.4 <1.7 to 26.5
87300C Opt 020	1 to 26.5	20 ± 1	>14	1.4	<1.2
87300D	6 to 26.5	10 ± 0.5	>13	1.4	<1.3
87301B	10 to 46	10 ± 0.7	>10	1.8	<1.9
87301C	10 to 50	10 ± 0.7	>10	1.8	<1.9
87301D	1 to 40	13 ± 1	>14 to 20 >10 to 40	1.5 to 20 1.7 to 40	<1.2 to 20 <1.9 to 40
87310B	1 to 18	3 ± 0.5	—	1.35	<2.0
87301E	2 to 50	10 ± 1	>13 to 26.5 >10 to 50	1.5 to 26.5 1.8 to 50	<2.0

HP 773D Directional Coupler and HP 772D Dual-Directional Coupler

The HP 772D and 773D are high-performance couplers designed for broadband swept measurements in the 2 to 18 GHz range. The HP 773D is ideal for leveling broadband sources when used with an HP 8474B detector. (See also the HP 83036C directional detector.) For reflectometer applications, the HP 772D is the best coupler to use with HP power sensors and power meters (such as the HP 438A dual power meter). Forward and reverse power measurements on transmitters, components or other broadband systems are made simpler using the HP 772D. The broadband design allows the use of a single test setup and calibration for tests spanning the entire 2 to 18 GHz frequency range.

HP 772D and HP 773D

HP 775D to 779D Dual-Directional Couplers

The economical HP 775D-778D couplers cover octave frequency spreads of more than 2:1, each centered on one of the important VHF/UHF bands. With their high directivity and mean coupling accuracy of ±0.5 dB, these are ideal couplers in reflectometer applications. The close tracking of the auxiliary arms makes these couplers particularly useful for reflectometers. Power ratings are 50 W average, 500 W peak.

HP 772-779D, 11691D, 11692D Specifications

HP Model	Freq. Range (GHz)	Nominal Coupling (dB)	Max. Coupling Variation (dB)	Min. Directivity (dB)	SWR Primary Line Max. (50 Ω Nom.)
772D	2 to 18	20	±0.9	2 to 12.4: 30 12.4 to 18: 27	2 to 12.4: 1.3 12.4 to 18: 1.4
773D	2 to 18	20	±0.9	2 to 12.4: 30 12.4 to 18: 27	1.3 1.4
775D[1]	0.45 to 0.94	20	±1	40	1.15
776D[1]	0.94 to 1.9	20	±1	40	1.15
777D	1.9 to 4	20	±0.4	30	1.2
778D	0.1 to 2	20	±1.5	0.1 to 1 GHz: 36[2] 1 to 2 GHz: 32[2]	1.1
779D	1.7 to 12.4	20	±0.75	1.7 to 4 GHz: 30 4 to 12.4 GHz: 26	1.2
11691D	2 to 18	20	±1.0	2 to 8 GHz: 30[3] 8 to 18 GHz: 26[3]	1.3 1.4
11692D	2 to 18	20	±1 incident to test port	2 to 8 GHz: 30[3] 8 to 18 GHz: 26[3]	2 to 12.4 GHz: 1.3 12.4 to 18 GHz: 1.4

[1] Maximum auxiliary arm tracking: 0.3 dB for HP 776D; 0.5 dB for HP 777D
[2] 30 dB, 0.1 to 2 GHz, input port
[3] 24 dB with Type-N connector on the test port (11692D) or on the input port (11691D)

Key Literature

Latest *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E

HP 87302C, 87303C, and 87304C Hybrid Power Dividers

The HP 87302C, 87303C, and 87304C power dividers are compact, hybrid microwave couplers designed for power splitting applications that require minimal insertion loss and high isolation.

The HP 87302C covers the entire 0.5 to 26.5 GHz frequency range with a maximum insertion loss of 1.9 dB. The HP 87303C and 87304C cover the frequency range of 1 to 26.5 GHz and 2 to 26.5 GHz with an even lower insertion loss of 1.6 dB and 1.4 dB, respectively. These hybrid power dividers are excellent for any application requiring low loss power division. They typically exhibit an insertion loss that is 1 to 2 dB lower than an equivalent resistive power divider.

HP Model	Freq. Range (GHz)	Band Segments	Insertion Loss (dB)	Isolation (dB)
HP 87302C	0.5 to 26.5	0.5 to 18 GHz 18 to 26 GHz	1.5 1.9	19 19
HP 87303C	1.0 to 26.5	1.0 to 18 GHz 18 to 26.5 GHz	1.2 1.6	19 21
HP 87304C	2.0 to 26.5	2.0 to 18 GHz 18 to 26.5 GHz	1.1 1.4	19 18

Power Rating: 10 W, CW (2:1 maximum SWR)
Connectors: 3.5 mm (f), SMA compatible

Signal Sources

HP 70340A Module Signal Generator, Brochure
5091-4649E
HP 8370 Series Color Brochure
5963-6614E
(PN ESG-1) Using the HP ESG-D series and the HP 8922 GSM Test Set for GSM Applications
5965-7158E
Generating and Downloading Data to the HP ESG-D series for Digital Modulation
5966-101E
Controlling TDMA Timeslot Power Levels in the HP ESG-D series
5966-4472E
Generate Digital Modulation with the HP ESG series Internal Dual Arbitrary Waveform Generator
5966-4097E
Customize Digital Modulation with the HP ESG-D series Real-time I/Q Baseband Generator 5966-4096E
Making Bit-error-rate Measurements with the HP ESG-D series
5966-4098E
(PN 8360-1) HP 8340/41 to HP 8360 System Conversion Guide
5952-8089
(PN 8360-2) Obtaining Flat Test Port Power with the HP 8360 User Flatness Correction Feature
5952-8090
(PN 8360-3) Generating Scan Modulation Patterns
5091-0226E
(PN 8360-4) Performing Two-Tone Measurements with the HP 8360
5091-0227E
(PN 8644) HP 8644, 8645, 8665A Performance Signal Generator Series
5951-6727
(PN 8644A-1) Phase Noise Measurements with the HP 8644A and 8655A Signal Generators
5951-6729
(PN 8645-1) Agile Operation of the HP 8645A
5951-6711
(PN 8645-2) A Catalog of HP 8645A Information
5951-6712
(PN 8791-1) Product Note Using Dynamic Data with HP 8791 10 FASS
5953-2343
(PN 8791-2) Programming HP FASS with WGL
5963-0988E
(PN 8791-3) Theory of Operation of the HP FASS
5091-4581E
(PN 8791-4) Secure Communications Testing with HP FASS
5952-0507
(PN 8791-5) Tips on External Clock Operation with HP FASS
5952-1901
(PN 8791-6) Jamming Signal Capability of the HP FASS
5952-1903
(PN 8791-7) Spectral Purity of the HP FASS
5952-1058
(PN 8791-8) Survey of Radar Test Applications Using FASS
5952-2847
(PN 8791-9) User Patterns: Your Key to Signal Customization with HP FASS
5091-0243E
(PN 8350-8) Leveling the HP 8350B Sweep Oscillator with an HP 430 Series Power Meter
5954-1507
(PN 8350-9) Improving Output Flatness
5954-8344
(PN E2507B/8A 71910A, 89410A) Noise Power Ratio (NPR) Measurements Using the HP E2507B, E2508A Multi-Format Communication Signal Simulator
5965-8533E
(PN 8648A-2) Servicing and Repairing Pagers using the HP 8648A Option 1EP
5965-1132E
(PN 8780A-1) Introductory Operating Guide to the HP 8780A Vector Signal Generator
5954-6368
(PN 8780A-2) Modulation Solutions
RF & Microwave Receivers
5952-1416

Signal Analyzers

Scalar Network Analysis with the HP 8590 Series Spectrum Analyzers, HP 85630A Scalar Transmission/Reflection Measurement Test Set and HP 85714A Scalar Measurement Personality
5091-1338E/EUS
HP 346B Noise Source Technical Data
5953-6452
HP 3587S Demo Video
5964-9460E/PAL
HP 3587S Product Overview
5964-3631E
HP 71000 Series MMS Spectrum Analyzers
5965-2818E
HP 71209A 26.5 GHz Microwave Spectrum Analyzer Product Overview
5091-2581E
HP 71910A Wide Bandwidth Receiver Technical Data
5964-3895E
HP 85719A Noise Figure Measurement Personality and 8590E Option 119 Technical Data
5091-4800E
HP 87405A Preamplifier Technical Data
5091-3661E
HP 89400 Series VSAs Configuration Guide
5964-3630E
HP 89411A 21.4 MHz Downconverter Technical Data
5962-7210E
HP 89450A DMCA Radio Test Application Personality Product Overview
5963-1835E
HP 89451A Radio Test Personality Product Overview
5964-4098E

(PN 8590-2) Time-Gated Spectrum Analysis: New Measurement Fundamentals
5952-3685
(PN 8590EM-1) Electromagnetic Compatibility–Guide to Performing Precompliance Conducted and Radiated Emissions
5964-2151E
(PN 8590E/4Q, 859X) DVB-C Solutions
5965-4991E
(PN) Add Digitized Burst Signal Measurements Capability to HP 8560 E-Series Spectrum Analyzers
5091-5837E
(PN 85719A-1) Maximizing Accuracy in Noise Figure Measurements
5091-4801E
(PN 70000) Series Spectrum Analyzer Programming Code Compatibility to the HP 8566B
5091-2583E
(PN 71910A) Extending Vector Signal Analysis to 26.5 Ghz with 20 MHz Information Bandwidth (71910A, 89400/10A/40A)
5964-3586E
(PN 8902A-2) Accurate Signal Characterization at Millimeter-Wave Frequencies
5953-8436

RF Microwave Measurement System

RF & Microwave Test Accessories Catalog
5964-9527E
HP 4352S VCO/PLL Signal Test System Product Overview
5966-0805E

Network/Spectrum Analyzers

Combining Network and Spectrum Analysis and IBASIC to Improve Device Characterization
5965-7656E
HP 4396B 1.8 GHz Network/Spectrum Analyzer
5965-6311E
Using the HP 4396B for Digital VTR Testing
5965-7658E
Wideband Microwave Spectrum Analysis and Vector Signal Analysis HP 71910A, 71910P, and 89410A, Brochure
5965-7916E

Many of these literature pieces are available at:
http://www.hp.com/go/tmc99

Network Analyzers

17 Fixtures, Test Sets and Accessories for the HP 8751A
5091-1985E
HP 4380S RF Balanced Cable Test System Product Overview
5966-1924E
HP 8751A Network Analyzer, Technical Data
5952-2373
HP 87050/75A/B Custom Multiport Test Sets, Product Overview
5964-3830E
HP 87075C Multiport Test Set, Product Overview
5965-8165E
HP 8753E RF Network Analyzer, Product Flyer
59626-2042E

(PN 8757-2) V and W Band Millimeter Scalar Measurements Using the HP 8757 Scalar Network Analyzer
5954-8380
(PN 8757-5) Measuring Voltage-Controlled Devices
5954-1537
(PN E5100A/B) Crystal Resonator Measuring Functions of HP E5100A/B Network Analyzer
5965-4972E
(PN 8751A-1) High Accuracy and High-Speed Filter Measurements
5091-0408E
(PN 8720-1) Amplifier Measurements with the HP 8720C
5091-1942E
(PN 8720-2) In-Fixture Measurements with the HP 8720C
5091-1943E
(PN 8753-5) Mixer Measurement with HP 8753C and HP 8625A Synthesized
5091-1100E
(PN 35665A) Controlling an HP-IB System with the HP 35665A Dynamic Signal Analyzer
5091-1678
(PN 35665A-2) PC Control of the HP 35665A Dynamic Signal Analyzer via HP-IB and C
5091-2767E
(PN 35665A-3) Single Plane Balancing with the HP 35665A and HP Instrument Basics
5091-2886E
(PN 35665A-4) MIL-STD-740-1 and -740-2 with the HP 35665A
5091-2943E
(PN 8510-6) On-Wafer Measurements Using Cascade Prober
5954-1579
(PN 8510-7) Measuring Chip Capacitors with the HP 8510C Network Analyzers and Inter-Continental Microwave Test Fixtures
5091-5674E
(PN 8510-8A) Applying TRL Cal to Non-coaxial Measurements
5091-3645E
(PN 8510-13) Measuring Noninsertable Devices
5956-4373E
(PN 8510-14) Using Multiple Test Sets with the HP 8510C
5967-5886E
(PN 8510-15) Lightwave Component Measurements
5952-3524
(PN 8510-16) Test Port Power Flatness
5091-0467E
(PN 8510-18) Testing Amplifiers and Active Devices with the HP 8510 Network Analyzer
5963-2352
(PN 8753-1) Amplifier Measurements Using the HP 8753 Network Analyzer
5956-4361
(PN 8753-2) Mixer Measurements Using the HP 8753B Network Analyzer
5956-4362
(PN 8753-4) Antenna Measurements Using the HP 8753C Network Analyzer
5952-2776
(PN 8753-2A) Mixer Measurements Using the HP 8753 Network Analyzer
5952-2771
(PN 4380-2) Designing Custom Fixtures for the HP 43805 Balanced Cable Test System
5965-5252E
(PN 4380A) HP 4380A Stand-Alone Control
5964-6792E
(PN 4380S) Testing 4-Pair Balance Cable/ Connectors with the HP 4380S RF Balanced Cable Test System
5963-9535E
AN 1291-1) 8 Hints for Making Better Network Analyzer Measurements
5965-8166E
(AN 1287-1) Understanding the Fundamental Principles of Vector Network Analysis
5965-7707E
(AN 1287-2) Exploring the Architectures of Network Analyzers
5965-7708E
(AN 1287-3) Applying Error Correction to Network Analyzer Measurements
5965-7709E
(AN 1287-4) Network Analyzer Measurements: Filter and Amplifier Examples
5965-7710E
(AN 1287-5) Improving Throughput in Network Analyzer Applications
5966-3317E
(AN 1287-6) Using a Network Analyzer to Characterize High-Power Components
5966-3319E

Power Meters

Thermocouple and Diode Power Sensor Family Brochure
5959-8751D
HP 70100A Power Meter Modular Measurement System Catalog
5965-2818E
HP EPM-441A/442A Power Meters, ECP-E18A/E26A Power Sensors, Brochure
5965-6380E
HP EPM-441A/442A Power Meters, ECP-E18A/E26A Power Sensors, Technical Data
5965-6382E
HP EPM Power Meters, ECP-Series Power Sensors, Configuration Guide
5965-6381E

Noise Figure Meters

HP 8970B, HP 8790S/V, 8971C Noise Figure Measurement Products
5091-6049E/EUS
Fundamentals of RF and Microwave Noise Figure Measurements
5952-8255E
HP 346A/B/C Broadband Noise Sources Technical Data
5953-6452E
HP 346B Noise Source Technical Data
5953-6452
HP 70875A Noise Figure Meter Personality for MMS Spectrum Analyzers Product Overview
5965-5022E
HP 85719A Noise Figure Measurement Personality for 8590E Series Spectrum Analyzer
5091-4800E

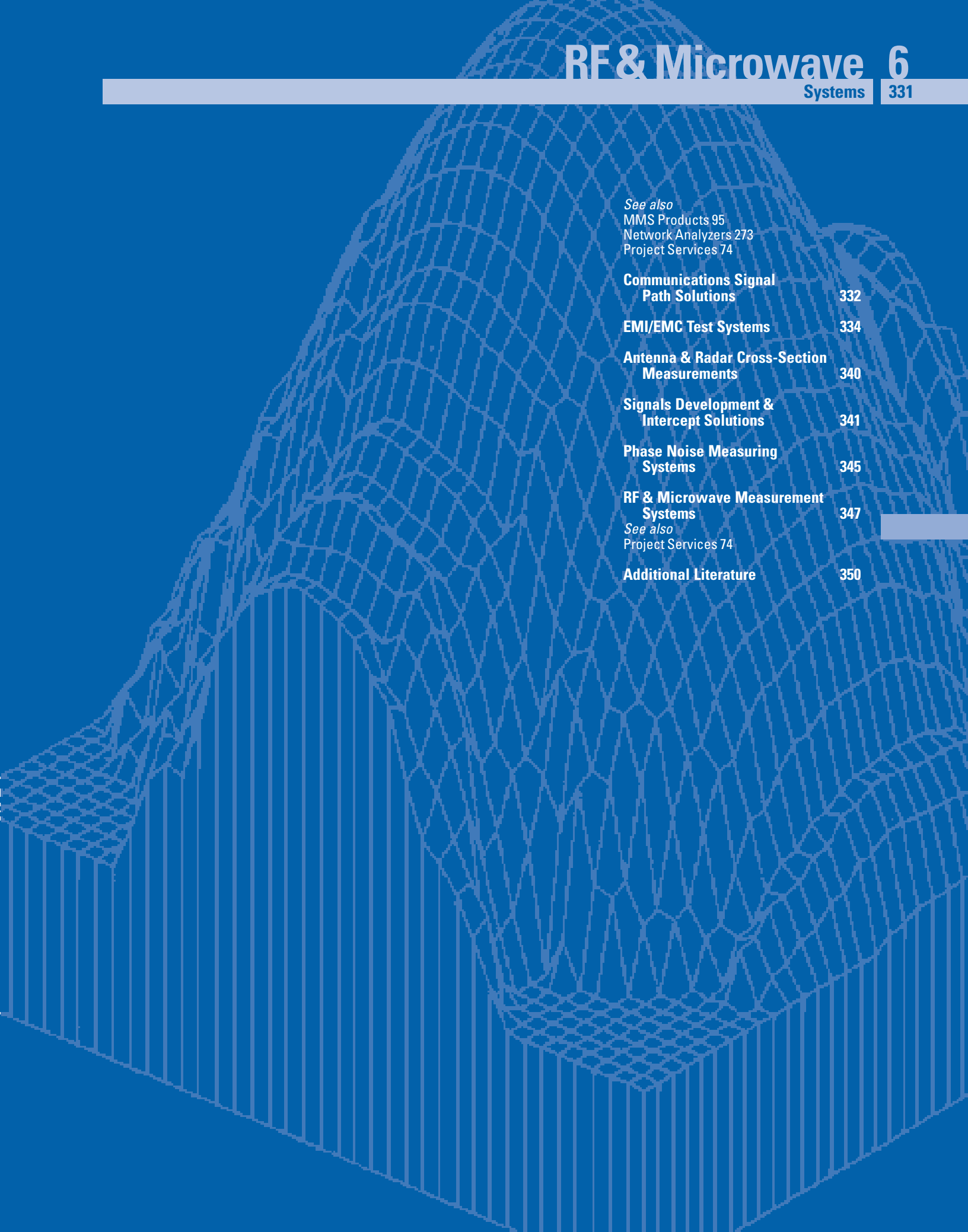
(PN 8970B/S-2) Applications and Operation of the HP 8970B Noise Figure Meter and HP 8970S MW Noise Figure Measurement System
5954-8896
(PN 8970B/S-3) Noise Parameter Measurement Using the HP 8970B Noise Figure Meter and the ATN Model NP4 Noise Parameter Test Set
5952-6639
(PN 8970B/S-4) Displaying HP 8970B Noise Figure Meter Measurements on the HP 8757 Scalar Network Analyzer
5959-8742

RF & Microwave Test Accessories

(PN 8760-1) HP 8760 Series Custom Microwave Switch Matrixes
5959-7860
(PN 8625A) Performing Two-tone Measurements with the HP 8625A
5091-2838E
(PN) ESA-L1500A 1.5 GHz Portable Spectrum Analyzer
5965-6309E

EMI/EMC Testing

Cookbook for EMC Precompliance Measurements
5964-2151E



See also
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Network Analyzers 273
Project Services 74

Communications Signal Path Solutions 332

EMI/EMC Test Systems 334

Antenna & Radar Cross-Section Measurements 340

Signals Development & Intercept Solutions 341

Phase Noise Measuring Systems 345

RF & Microwave Measurement Systems 347
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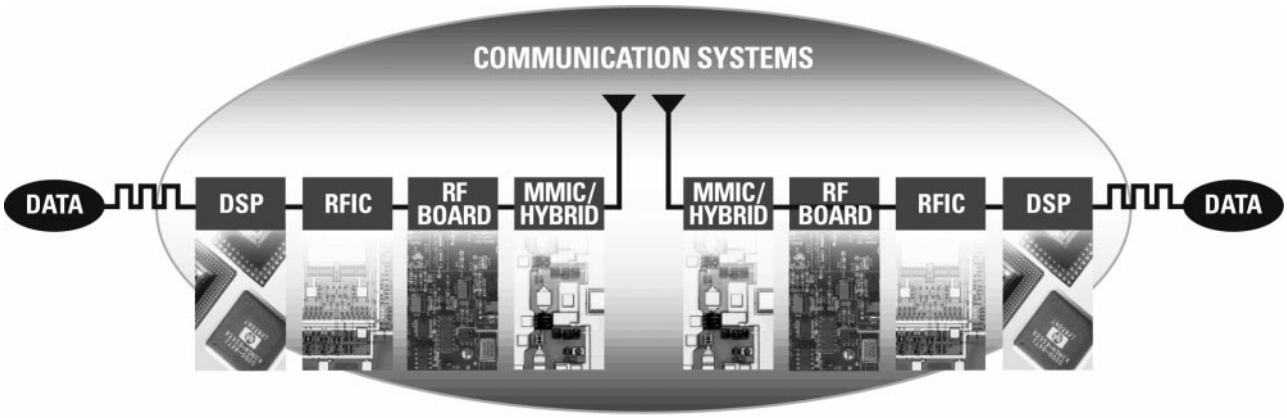


HP Advanced Design System—The First Complete Communications Signal Path Design Solution

The challenge of communications design is to shorten time to market, while making better, smaller, faster products that require less energy consumption. HP EEsof's new Advanced Design System has been developed specifically to simulate the entire communications signal path. This unique solution integrates proven RF, DSP, and electromagnetic simulators into a single, flexible design environment.

Combining Proven Technology with New Innovation

HP EEsof's industry-leading RF design products, MDS and Series IV, provided the foundation for this new software solution. For the first time, all the design technologies offered by the company are available in a single environment: system, circuit, electromagnetic simulation, synthesis, and physical design. The HP Advanced Design System provides new DSP design and synthesis technologies, and significant new design capabilities for RF, microwave, and RFIC, all integrated into one efficient, flexible design solution. The integration and co-simulation of RF and DSP analysis engines is unique in the EDA industry. The integration of multi-discipline design tools into a single environment eliminates the barriers caused by separate processes and allows design teams to reduce errors and save time. This new design environment is available for both PC and UNIX platforms. The PC version can be run on a modern laptop, creating a more flexible design environment.

System Design

The HP Advanced Design System top-level simulation solution, HP Communication Systems Designer, offers unprecedented speed and accuracy in RF system simulation. The system simulation capability of HP OmniSys has been enhanced with the use of an extremely fast harmonic balance simulator that allows engineers to compute full budget simulations on any RF topology. The software includes measurements for dozens of system-level parameters such as incident power, noise figure, third order products, signal-to-noise ratio (SNR), noise bandwidth, and more. It also offers a way to identify the source of spurious signals. These abilities allow engineers new freedom to experiment with innovative approaches to their designs.

HP Communication Systems Designer also has a new signal-processing engine that allows processing of data in both vector and matrix form and has over 300 DSP models. Bit error rate (BER) testers that have both monte carlo prediction and a faster variance reduction algorithm are included. Users can make use of advanced post-processing capabilities such as FFT, correlation, cumulative distribution function (CDF), probability distribution function (PDF), and complex math functions. HP Communication Systems Designer comes with a Matlab interface and has an optional user-friendly C code interface. An instrument server is included that lets users link to RF and communication measurement instrumentation. The software also offers an optional library of EIA-compliant antenna and propagation models for GSM, NADC, PHP, and CDMA.

RFIC Design

Circuit simulation technology in the HP Advanced Design System features dramatic enhancements resulting from patented new technologies. The software offers a complete range of integrated RFIC simulation technologies that provide the most efficient and accurate verification of RFIC performance against modern digital wireless standards, such as adjacent channel power ratio (ACPR) and error vector magnitude (EVM) of code division multiple access (CDMA) systems.

This breakthrough software includes new HP high-frequency SPICE, harmonic balance, and HP Circuit Envelope simulation technologies. Tests on the patented new harmonic balance simulation technique have shown speed enhancements from 2 to 100 times and reduction of memory usage by 8 to 15 times, enabling designers to simulate the very large RFIC circuits necessary in today's complex communications systems. HP's patented Circuit Envelope simulation technology, useful for simulation of RFICs with complex digitally-modulated signals such as CDMA, is now available for both PC and UNIX platforms.

Co-simulation of RF and DSP interactions in RFIC chipsets is possible in conjunction with HP DSP Designer, ensuring on-spec performance without costly iteration. System/DSP behavioral blocks with circuit level blocks can be simulated for optimal top-down hierarchical design.

Links to Cadence and Mentor design frameworks are enhanced to allow efficient integration into existing IC design flows.

DSP Design and Synthesis

Digital signal processing is a vital part of many communication designs, and the HP Advanced Design System addresses this need with the inclusion of two new DSP tools; HP DSP Designer and HP DSP Synthesis. These two products were developed especially to help DSP design engineers create and evaluate baseband designs.

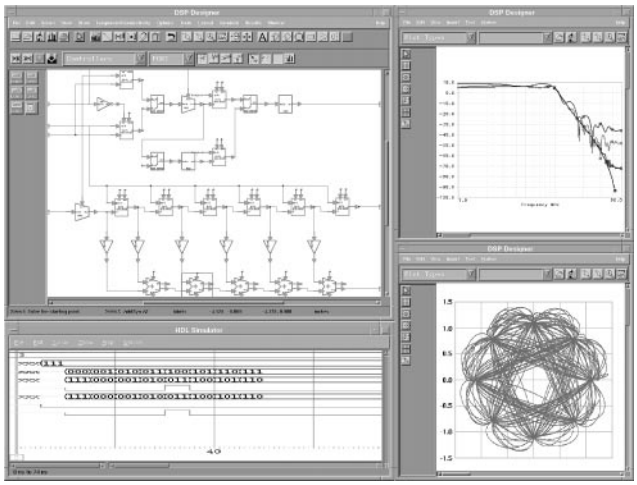
HP DSP Designer offers the most extensive environment available for communications DSP development and the largest collection of DSP, analog, RF, and digital models to ensure real-world validation. The software includes a block diagram algorithm development environment, DSP filter tool, real-time instrument controller, and powerful data post-processing capability. For the first time digital parameters such as bit width can be included in a simulation with RF parameters such as power amplifier reverse isolation.

HP Ptolemy, new simulation technology from HP EEsof, is built into HP DSP Designer. The technology was developed by merging HP research and technology with the first commercialization of the University of California at Berkeley Ptolemy project, a signal-processing framework renowned for mixing multiple simulation models. This new simulation engine facilitates co-simulation of time, frequency, and data flow technologies and significantly expands the DSP development capability for mixed RF/analog/DSP communications projects. HP is the only EDA vendor to deliver RF/DSP co-simulation capability within a complete design environment.

HP DSP Synthesis offers powerful capabilities to help both DSP and integrated circuit (IC) designers significantly improve productivity and reduce development costs. It includes both behavioral and RTL VHDL/Verilog code generation and simulation capability. The software outputs the hardware description language (HDL) in industry-standard formats for logic synthesis tools.

HP 85122A
HP 85123A
HP 85124A
HP 85190A

NEW



HP DSP Designer and HP DSP Synthesis are powered by HP Advanced Design System EDA software.

The HP 85123A RF Modeling System, together with the HP 85190A IC-CAP software, are shown extracting complete nonlinear models for RF active devices.

Microwave and RF Circuit Design

For traditional RF board-level design, the microwave/RF circuit designer benefits from the integration of system, circuit, and electromagnetic (EM) simulation, as well as full schematic and layout with library linkages to enterprise-wide PCB systems such as Mentor Board Station. RF board-level and microwave hybrid and MMIC design tools, HP RF Board Designer and HP Microwave Circuit Designer, include a DRC with an easy-to-use rules-writing interface. A Graphical Cell Compiler allows the designer to create footprints graphically without programming and to compile them into AEL macro language. There are also layout enhancements for ground-plane management and better trace handling.

The HP EM solutions, HP High Frequency Structure Simulator (HFSS) for 3D structure design and HP Momentum for 2.5D planar design, now provide geometric and material optimization via optimization capability. The HP HFSS Designer bundle includes HP Empipe3D, which allows RF and microwave designers to both design and optimize 3D structures.

Libraries

Part of the power of HP Advanced Design System lies in its extensive active- and passive-device model libraries. Palettes from HP EEsof of model data for over 90,000 popular devices from numerous vendors are instantly available for placement within the design. From surface mount technology (SMT) capacitors to behaviorally modeled RFICs, the libraries contain the popular parts needed by today's designers. The new HP W-CDMA Design Library employs pre-built models, simulation systems and test benches that speed W-CDMA product development.

Getting the Most from Your Investment

With HP EEsof product support, you receive substantial software upgrades, documentation updates, and support via telephone, fax, email, and the web. Our worldwide technical support services provide assistance to new and advanced users alike.

Key Literature

HP Advanced Design System Brochure, p/n 5966-2870E

Ordering Information

HP Advanced Design System
HP EEsof offers Advanced Design System solutions.
HP High Frequency Structure Simulator
Please call your HP sales representative for more information.

Additional information on products from HP EEsof can be obtained from our website: **http://www.hp.com/go/hpeesof**

HP Device Modeling Systems

The HP Device Modeling Systems are the first total systems specifically dedicated to active device modeling. They combine parameter extraction and test hardware (HP 85122A for microwave, HP 85123A for RF, or HP 85124A for pulsed modeling) and the HP 85190A IC-CAP modeling software. Industry-standard SPICE models as well as HP EEsof high-frequency models are available for FET, HEMT, BJT, MOS, diode, and thin-film devices.

- Use the HP 8510C or HP 8753C network analyzer for S-parameter measurements and the HP 4142B DC source/monitor for precision DC measurements and bias (custom configurations also available)
- IC-CAP software is compatible with measurement instruments and circuit simulators such as MDS
- Complete modeling solution: delivered fully configured and factory integrated
- Easy to connect and fully compatible with wafer probes from Cascade Microtech or fixtures from Inter-Continental Microwave

IC-CAP software provides the total framework environment in which standard, modified, or fully custom device models may be extracted or generated. Specific models include the HP Root FET and MOS Model Generators, as well as FET, BJT, HEMT, diode, and thin-film models. See page 538 for additional information on IC-CAP.

Ordering Information

HP 85122A Precision Modeling System
HP 85123A RF Modeling System
HP 85124A Pulsed Modeling System
HP 85190A IC-CAP Modeling Suite

Please contact the HP Call Center in your region for complete details.

Platforms

The products on these pages are available on popular PC and UNIX platforms.

Support

A complete line of support products, which include automatic software updates and telephone technical support, is also available. Please contact the HP Call Center in your region for more details.

HP 8542E
HP 8546A

- ±2 dB absolute amplitude accuracy
- Built-in PC/DOS disk drive
- Certified compliant to all CISPR Publication 16-1 recommendations by the BZT[1]

HP 8542E 2.9 GHz

Fully CISPR 16-1 Compliant

The HP 8542E and HP 8546A EMI receivers make CISPR-based EMI measurements with unprecedented accuracy, speed, and ease of use. These EMI test receivers can be used to check conformance to standards such as CISPR, EN, FCC, VCCI, and VDE.

Most Requested Features

Both receivers incorporate the features most often requested by EMI test engineers:

- Specifications that meet CISPR Publication 16-1[2] recommendations for making compliance measurements to any civilian EMI measurements standard worldwide
- ±2 dB absolute amplitude accuracy, specified
- Extended frequency coverage to test the newest high-speed ITE equipment
- Traditional receiver features, including automatic overload detection and auto-ranging
- Three tuning modes: manual, stepped, and scanning
- Large, color CRT
- Onscreen limit lines
- Automatic antenna and cable correction for direct comparison of measurement data to limits
- Automatic measurement routines
- Parallel detectors: peak, quasi-peak, and average

Upgrade from Precompliance to Full Compliance Capability

Both the HP 8542E and the HP 8546A consist of two separate sections. The receiver RF section can be purchased as a standalone precompliance tester. The RF filter section can be added later to make the complete EMI compliance receiver.

Flexible Storage of Data and Test Setups

A built-in, PC-formatted floppy disk drive allows test and data files to be stored and recalled. Stored tests can include system configurations, antenna, transducer factors, and cable losses.

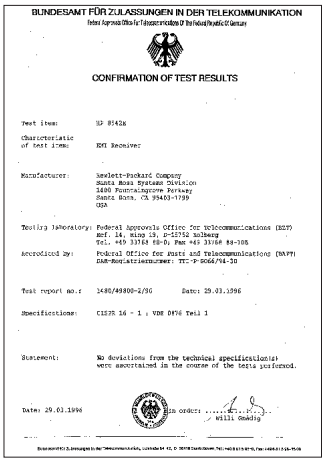
The receiver display has a powerful dual-window capability. A broad spectrum can be captured in the upper window, and the lower window can be used to examine signals of interest in greater detail.

Report Generation Software is Free

The HP 85878A Report Generator Software is included free with the purchase of an HP 8542E or a HP 8546A. The HP 85878A software can retrieve internal data from the HP 8542E or HP 8546A such as limit lines, stored lists of signals, and external device correction factors (e.g. cables and antennas) and place them into a word processing package. The HP 85878A Report Generator Software also has customizable templates to automatically generate reports for submission to regulatory bodies of countries where the tested product is to be sold.

[1] BZT is the German federal approvals office for telecommunications.

[2] CISPR Publication 16 is the Comité International Spécial des Perturbations Radioélectriques specification for radio interface measuring apparatus and measurement methods.



BUNDESAMT FÜR ZULASSUNGEN IN DER TELEKOMMUNIKATION

CONFIRMATION OF TEST RESULTS

Test item: HP 8542E

Characteristic of test item: EMI Receiver

Manufacturer: Hewlett-Packard Company
Santa Rosa Systems Division
3400 Hillview Avenue
Santa Rosa, CA 95403-1799
USA

Testing laboratory: Federal Approvals Office for Telecommunications (BZT)
Ref. 14, Ring 19, D-55752 Mörsberg
Tel. +49 33763 68-0, Fax +49 33763 68-305

Accredited by: Federal Office for Posts and Telecommunications (BAPT)
DAR-Registernummer: TTC-P-0046/94-10

Test report no.: 1480/49800-2/96 Date: 29.03.1996

Specifications: CISPR 16 - 1 ; VDE 0876 Teil 1

Statement: No deviations from the technical specification(s) were ascertained in the course of the tests performed.

Date: 29.03.1996 By order: ... Willi Gmelig

Measurement Automation

Both receivers work with new PC-based EMI measurement software—the HP 85876B and HP 85875A—to create the most powerful, easiest to use automated solution available for commercial radiated and conducted emission testing.

Specification Summary

Frequency Range: HP 8542E: 9 kHz to 2.9 GHz; HP 8546A: 9 kHz to 6.5 GHz
Frequency Reference
Aging: $<\pm 1 \times 10^{-7}$/year
Temperature Stability: $< \pm 1 \times 10^{-8}$
Frequency Readout Accuracy: ± (freq. readout x freq. reference error + 20% of IF bandwidth + 100 Hz) conforms to CISPR 16-1
Displayed Average Noise Level (with CISPR bandwidths, 0 dB attenuation) (characteristic)

	Preamp Off	Preamp On
CISPR Band A (200 Hz BW) 9 kHz to 150 kHz	3 to – 27 dBμV	– 9 to – 31 dBμV
CISPR Band B (9 kHz BW) 150 kHz to 30 MHz	– 18 dBμV	– 21 dBμV
CISPR Band C/D (120 kHz BW) 30 MHz to 1 GHz	– 5 dBμV	–10 dBμV
Noise Figure Characteristic 9 kHz to 2.9 GHz 1 GHz to 6 GHz	14 dB 24 dB	10 dB 8 dB
Gain Compression, 1dB (characteristic)	89 dBμV	77 dBμV

Absolute Amplitude Accuracy: 9 kHz to 2.9 GHz: ±2 dB (typical ±1 dB); 2.9 to 6.5 GHz (characteristic): ± 3.0 dB (HP 8546A)
IF Bandwidths
Measurement: 200 Hz, 9 kHz, 120 kHz, 1 MHz, (6 dB, conform to CISPR Publication 16-1)
Diagnostic: 30 Hz to 3 MHz (3 dB) in a 1-3-10 sequence
IF Detectors
Measurement: Peak, quasi-peak, average
Overload: RF, IF
Demodulation: AM, FM
Temperature Range: 0° to +55° C, operating; – 40° to +75° C, storage
Size: 457 mm W x 365 mm H x 645 mm D (18 in x 14.38 in x 25.38 in)
Weight: 48.6 kg (108 lb)

Key Literature

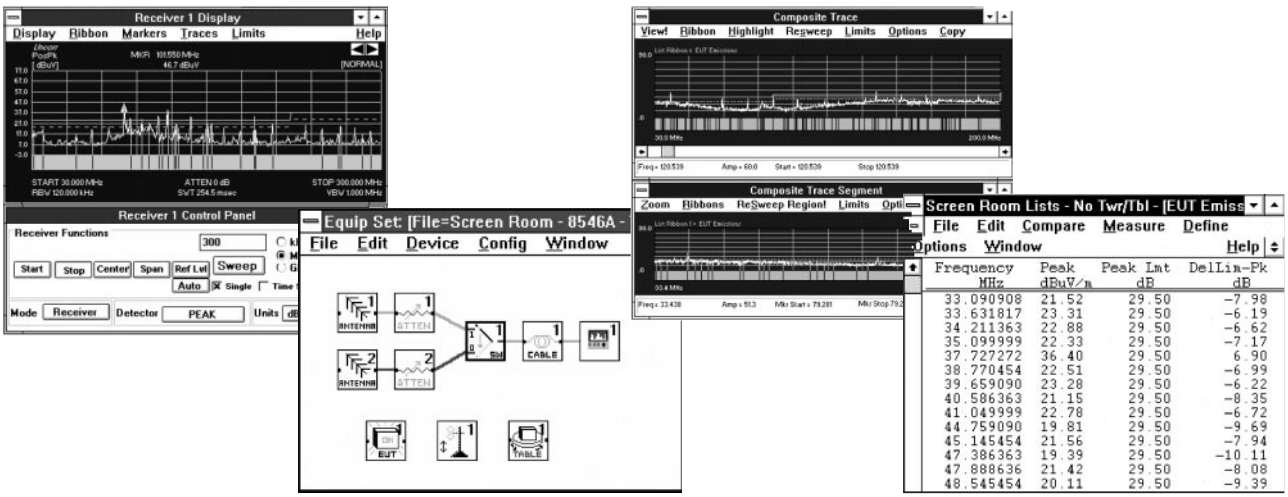
HP 8546A EMI Receiver Technical Data, p/n 5091-8314E
HP 8542E EMI Receiver Technical Data, p/n 5963-0081E

Ordering Information

HP 8542E EMI Receiver (9 kHz to 2.9 GHz)
HP 8546A EMI Receiver (9 kHz to 6.5 GHz)

- Software management of EMI measurement process
- PC and Microsoft® Windows format
- Graphical test setup and execution
- Conducted and radiated capability

HP 85875A
HP 85876B



Software That Manages the Entire EMI Measurement Process

A family of PC-based software helps you manage the entire EMI measurement process, from initial setup to final report. HP's Commercial EMI Measurement Software packages provide conducted (HP 85875A) and radiated (HP 85876B) emissions test capability.

Whether you test products for industrial, scientific, medical, or information applications, you will find that these software products meet international EMI test requirements, including FCC Part 15 regulations in the U.S. and the latest European Norms (EN).

Accurate, Simple Test Setup

The HP 85875A and 85876B software runs under Microsoft® Windows on PC-compatible platforms. The HP 85876B has a special graphical interface that allows the test equipment setup to be viewed schematically. You can make equipment changes by simply clicking the mouse.

Icons represent specific test equipment, including receivers, filters, amplifiers, antennas, switches, cables, and equipment-under-test. Calibration data is stored with icons representing specific test equipment. Graphically positioning and interconnecting the equipment icons automatically corrects for an entire measurement path.

Collect Data Easily

The software enables your PC to display and control an EMI receiver. As data points are collected, the software constructs a broad-span display of emission absolute amplitudes. An upper window on the CRT shows the complete measurement span. For better data analysis, a portion of this span may be highlighted and viewed in greater detail in a window below.

Quickly Locate Maximum Emissions

The HP 85876B includes automatic maximization routines that position an antenna tower, antenna polarization, and equipment turntable to find the worst-case radiated emissions. Antenna height and turntable positions are displayed on the PC. Using individual control panels, antenna height and turntable positions can also be controlled manually with the mouse.

A GPIB card is required to control the EMI receiver and other accessories over HP-IB. The GPIB card is available as Option 488.

Powerful Data List Editor

The software collects up to 27 predefined data parameters for each signal encountered during a test. A powerful list editor allows you to organize, view, and manipulate signal data in list formats. Data from different tests can be compared easily and the results saved in a separate list.

Transport Data and Graphics to PC Tools

The software and PC environment allow users to move information to popular spreadsheets and word-processing programs.

Computer Compatibility

Operating System
MS-DOS 5.0 or later
Microsoft Windows 3.1 or later
Microsoft Windows NT 4.0 (85876B only)
Microsoft Windows 95 (85876B only)

Recommended Hardware
Pentium 90
16 MB Free RAM (32 MB Free RAM for Windows NT 4.0)
SVGA 17-in monitor with graphics accelerator
200 MB of free hard disk memory
1.44 MB 3.5-inch floppy disk
Option 488
GPIB (National Instrument) card

Supported EMI Receivers and Analyzers:
HP 85876B: HP 8542E, 8546A, 85422E, 85462A, 8574B, 8572A, and 8566B/8568B-based systems
HP 85875A: HP 8542E, 8546A, 85422E, 85462A
The HP 85876B is installed standard on CD-ROM, with an option for 3.5-inch disks.

Key Literature

HP 85875A Commercial Conducted EMI Software
Brochure, p/n 5964-1968E
HP 85876B Commercial Radiated EMI Software
Brochure, p/n 5962-9450E

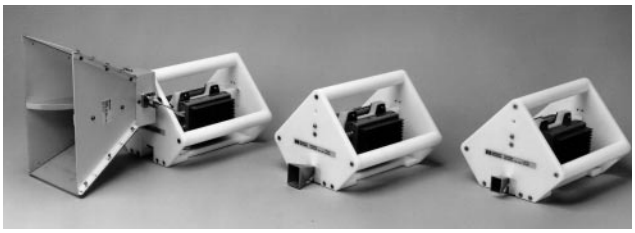
Ordering Information

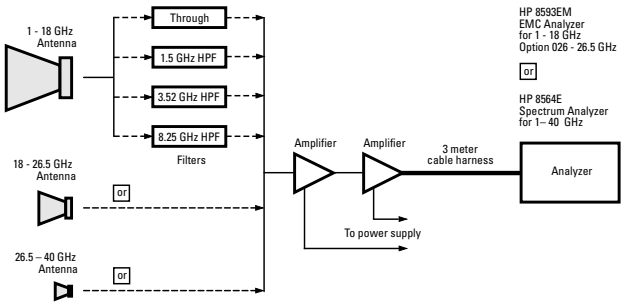
HP 85875A Commercial Conducted EMI Measurement Software
HP 85876B Commercial Radiated EMI Measurement Software
Options
Opt 001 85876B software installed on 3.5-inch disks
Opt 488 GPIB (National Instrument) card for PC
Opt 832 Free upgrade from 85876A to 85876B on 3.5-inch disks
Opt 835 Free upgrade from 85876A to 85876B on CD-Rom

6

HP 84125A
HP 84125B
HP 84125C
HP 85869PC

- Input overload protection
- Low system noise





6

HP 84125A/B/C Microwave EMI Measurement Systems

The HP 84125 family of systems are designed to measure electromagnetic emissions from intentional and unintentional radiators from 1 to 18 GHz, 26.5 GHz or 40 GHz. Each system is fully integrated and calibrated for measuring products to rigorous FCC regulations, ETSI standards and proposed European EMI standards above 1 GHz. Equipment manufacturers, EMC test laboratories, and regulatory authorities will find the HP 84125 series microwave test systems a valuable addition to their existing EMI measurement capability.

The cart-mounted equipment is connected to a microwave test set with a 3-m low-loss RF cable assembly maximizing the system sensitivity. The functionality of a HP 8593EM or HP 8564E analyzer and the microwave test set is combined using a system down-loadable program (DLP). The system DLP provides softkeys on the analyzer display allowing easy setup of the measurement parameters. The displayed data is automatically corrected for antenna, cable and filter losses, and amplifier gains allowing direct viewing of emissions field strengths in dBµ V/m.

The system test set is designed for tripod mounting, antenna mast mounting or for hand-held use for locating worst-case product emissions. Horn antennas can be interchanged in the HP 84125B and C systems for full frequency coverage from 1 to 26.5 GHz and 1 to 40 GHz. In addition, each system includes three high-pass filters that can be used to block fundamental frequencies when testing intentional radiators. The interchangeable high pass filters block signals below their respective 1.5 GHz, 3.5 GHz and 8.5 cut-off frequencies.

As clock frequencies move higher, you need to be prepared with the right equipment to perform these EMI measurements. The HP 84125 series microwave EMI measurement systems have the frequency range and sensitivity to meet your needs for today and in the future.

Note: Tripod not included. It can be ordered separately as HP 11968C.

Specifications

HP 84125A 1 to 18 GHz Frequency Range
HP 84125B 1 to 26.5 GHz Frequency Range
HP 84125C 1 to 40 GHz Frequency Range

Ordering Information

HP 84125A Microwave EMI Measurement System
HP 84125B Microwave EMI Measurement System
HP 84125C Microwave EMI Measurement System

HP 85869PC EMI Measurement Software

The EMI measurement software is a general-purpose program that makes radiated- and conducted-emission measurements automatically up to 22 GHz according to commercial and military regulations. The program works with the HP 8571A, 8572A, and 8574B EMI receivers. It takes advantage of the ability of these receivers to quickly measure wide frequency spans and locate device emissions by using peak detection. For commercial measurements, quasi-peak, and average data can be taken. Save time and effort making MIL-STD measurements by using the software to automatically discriminate between narrowband and broadband signals.

The HP 85869PC has an easy setup procedure, allowing you to design your own tests or to choose from the examples given in the software. These reside in the test library and include MIL-STD, FCC, and EN emission tests.

Ordering Information

HP 85869PC EMI Measurement Software
Opt 832 Upgrade Kit from HP 85869A

HP 8590EM Series EMC Analyzers

HP 8590 Series EMC Analyzers

Whether your industry is information technology, automotive , communication, or medical electronics, you need to evaluate the EMI performance of your designs during the development phase. The HP 8590EM series EMC analyzer allows you to evaluate this performance quickly and easily.

Compare your products' radiated and conducted emissions performance to the following regulatory agency limits:

- EN55011
- EN55014
- EN55022
- FCC Part 15
- VCCI
- VFG

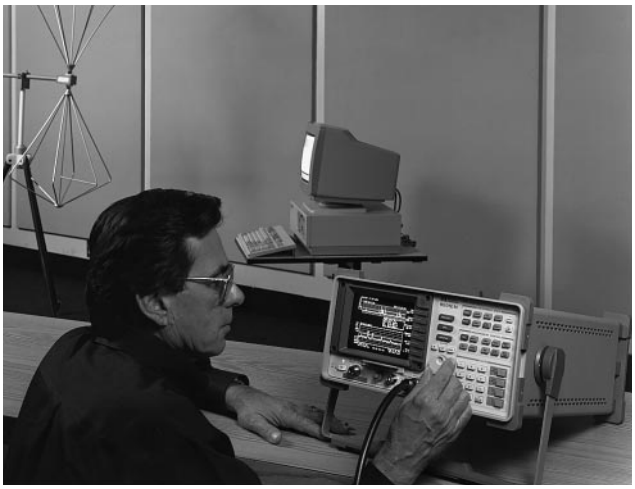
The 8590EM series EMC analyzers have the following functionality and features to speed you through your measurements:

- Complete measurement setups including span and CISPR[1] bandwidths
- Displays two limits and margins
- Corrections for antenna, cable, and amplifier
- Measure the peak, quasi-peak, and average amplitudes of 239 signals and store the results to the internal list
- The windows feature zooms in on signals while viewing the broad spectrum
- Log frequency sweep to expand signals in lower frequencies Useful for conducted emissions testing
- Sort remeasure, mark, and delete signals in the internal list
- Customize and print reports which can include two pages of text, signal list, and graphics
- Standard HP-IB and parallel ports

In addition, you can edit or customize, and store limit lines and correction factors for transducers, cables, or other devices to a RAM card.

The HP 8590EM Series EMC analyzers are offered in the following frequency ranges:
HP 8591EM 9 kHz to 1.8 GHz
HP 8593EM 9 kHz to 22 GHz
HP 8594EM 9 kHz to 2.9 GHz
HP 8595EM 9 kHz to 6.5 GHz
HP 8596EM 9 kHz to 12.8 GHz

The RF performance of the HP 8590EM series EMC analyzers is the same as the HP 8590 E-series spectrum analyzers.



HP 84100EM Design Development System

Identification, isolation, and resolution of problem emissions early in the design process is key to a successful product introduction. With the HP 84100EM design development system, you can easily isolate problem signals using the close field probes supplied with the system. The calibrated probes give very repeatable measurements ensuring that assessments of redesigns will produce meaningful results. The system is based on the HP 8591EM and the HP 11945A Option E51 close field probe set which covers 9 kHz to 1 GHz.

HP 84110EM Pre-Production Evaluation System

The HP 84110EM has everything you need to perform radiated and conducted emissions measurements on your product. The HP 84110EM system is based on the HP 8591EM which contains a quasi-peak adapter and dual I/O ports (HP-IB and parallel). The system also includes HP 11955A biconical and HP 11956A log periodic antennas, HP 11968C tripod, HP 11966L 10-meter cable, HP 11967D line impedance stabilization network, HP 11947A transient limiter and HP 11945A Option E51 close field probe kit. Also included is the HP 85878A report generator software, a 256 KB RAM card and a ROM card with regulatory limits and transducer factors.

Key Literature

EMC Precompliance Measurement System and Accessories, p/n 5964-6091E
EMC Accessories Catalog, p/n 5952-1791
HP 8590EM Series Product Note 5964-2151E

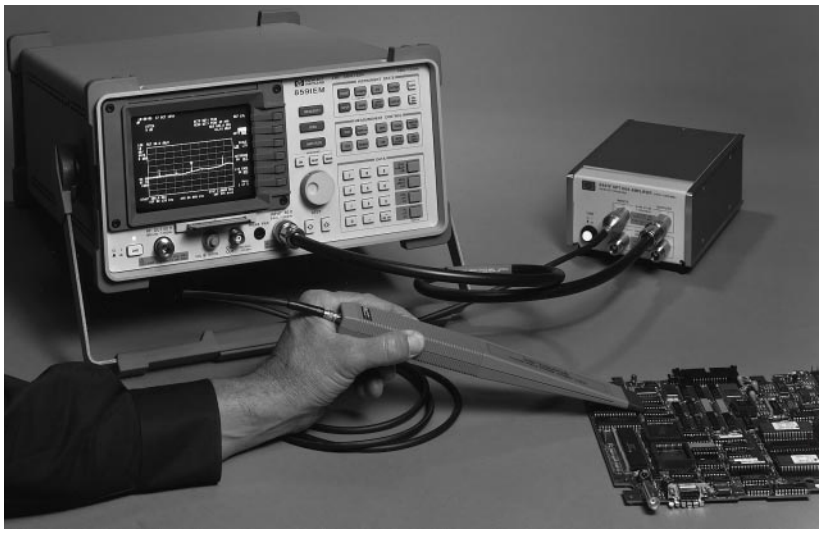
Ordering Information

HP 84100EM EMC Design Development System
HP 84110EM EMC Pre-Production Evaluation System
Opt 61A adds HP 11961A
HP 8591EM 9 kHz to 1.8 GHz
Opt 010 Tracking Generator
HP 8593EM 9 kHz to 22 GHz
HP 8594EM 9 kHz to 2.9 GHz
HP 8595EM 9 kHz to 6.5 GHz
HP 8596EM 9 kHz to 12.8 GHz
[2]**Opt 010** 9 kHz to 2.9 GHz Tracking Generator

[1]CISPR Publication 16 is the Comité International Spécial des Perturbations Radioélectriques specification for radio interference measuring apparatus and measurement methods.

[2]Available on HP 8593EM, 8594EM, 8595EM and 8596EM

Various Models



HP can show you how to design for electromagnetic capability.

HP 11950X EMC Design Course

"Designing for EMC" is a custom course for engineers who face issues of electromagnetic compatibility. Emphasis is placed on evaluating and solving EMC problems early in the design phase of a product, rather than during final EMC compliance testing. Expert instruction and many demonstrations provide EMC fundamentals, methods of measuring EMC, and principles of incorporating proven EMC design into products.

The course covers the following topics: overview of EMC design, non-conducted coupling, common impedance coupling, radiation from digital circuits, cables, advanced cables, conducted emissions, susceptibility, electrostatic discharge, shielding and diagnostics. The 11-chapter handbook used in the class becomes a permanent reference.

The HP 11950X EMC design course is offered at a fixed fee at the site of your choice. For more information, contact your local HP sales office (listed on page 582).

HP 11940A and 11941A Close-Field Probes and HP 11945A Close-Field Probe Set

These handheld probes are designed to measure magnetic-field radiation from surface currents, slots, cables, and ICs for EMC diagnostic and troubleshooting measurements. Their unique design results in a high level of electric-field rejection. This significantly reduces errors, thus allowing calibrated and repeatable measurements.

The HP 11941A operates from 9 kHz to 30 MHz, the HP 11940A, from 30 MHz to 1 GHz. Five antenna factors appear on each probe for calculating absolute magnetic-field strength (dBµA/m) from the dBµV reading of a spectrum analyzer. Each probe is calibrated and comes with a 2-meter RG-223 coaxial cable, and SMA(f)-to-type-N(m) adapter, and an SMA (f)-to-BNC(m) adapter.

The close field probe set includes both the HP 11940A and 11941A probes for full coverage from 9 kHz to 1 GHz. Option E51 adds the HP 11909A preamplifier, a 36-inch (914-mm) type-N cable, and a carrying bag for storage and protection of the entire set.

HP 11961A EMI Measurement Software

The HP 11961A EMI measurement software is used with the HP 8590EM series EMC analyzers. The software performs peak, quasi-peak, and average measurements on up to 100 selected signals and sorts and stores the results for report development. The measurements are compared to supplied limits or your own limits. Measurements are corrected for antenna factors, cable loss, and amplifier gains. The software also controls the HP 11960A RF preselector which is used to reduce RF overloading of the EMC analyzer's first mixer.

HP 85878A EMI Report Generator

Link the power of the HP 8590EM series EMC analyzer or HP 8546A/42E EMI receivers to you PC. The advanced features of the HP 85878A enables you to capture and archive measurement results from your EMC analyzer or EMI receiver including the screen, measurement list, log graph, linear graph, correction factors, instrument settings, limit lines and trace information. These items can be cut and pasted, dragged and dropped, or exported to develop comprehensive reports. Using the Word for Windows 7.0 bookmark feature, you can develop reports automatically. Four report templates are supplied.

For a demonstration, visit our web site: **http://www.hp.com/go/EMC**

HP 11960A RF Preselector

Use the HP 11960A to protect against the effects of overload. Without preselection, out-of-band signals can overload the EMC analyzer causing inaccurate measurements. The preselectors filters are designed to filter out the out-of-band signals, reducing the causes of overload. There are eight filters in the 150 kHz to 30 MHz range for conducted emissions measurements where most of the overload problems occur. In the radiated emissions bands above 30 MHz, a thirty dB gain amplifier is supplied to improve overall measurement sensitivity. A switched ten dB attenuator is supplied in radiated band for quick overload checks.

HP 119XX Series Antennas

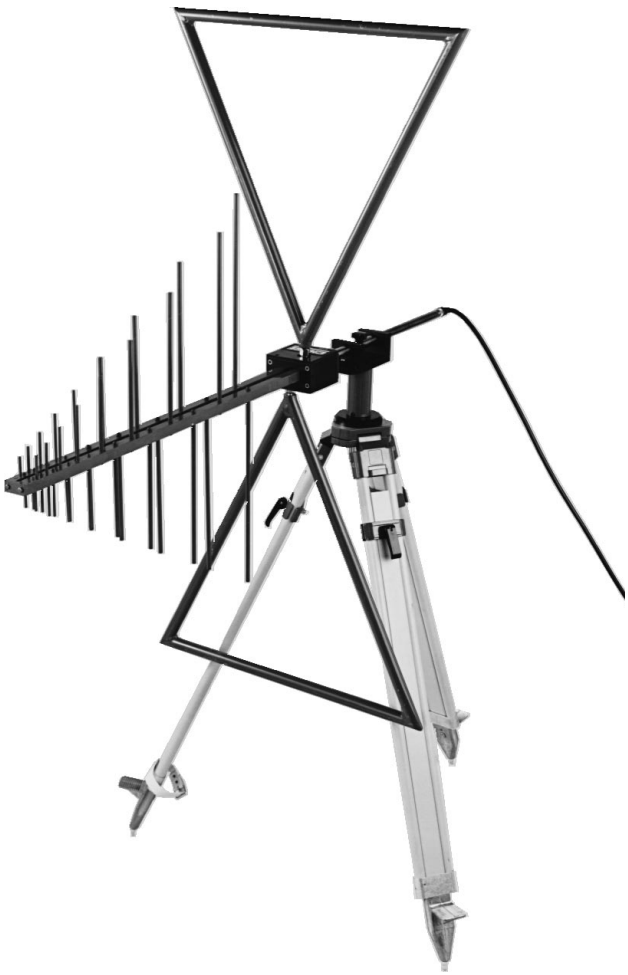
These antennas are individually calibrated and shipped with a calibration certificate showing actual performance data. The series includes the following products:

HP Model		Frequency Range
11955A	Biconical Antenna[1]	30 to 300 MHz
11956A	Log Periodic Antenna[1]	200 MHz to 1 GHz
11966A	Active Loop H-Field Antenna	10 kHz to 30 MHz
11966B	Active Rod E-Field Antenna	100 Hz to 50 MHz
11966C	Biconical Antenna	30 to 300 MHz
11966D	Log Periodic Antenna	200 MHz to 1 GHz
11966E	Double-Ridged Waveguide Horn Antenna	1 to 18 GHz
11966F	Conical Log Spiral Antenna	200 MHz to 1 GHz
11966G	Conical Log Spiral Antenna	1 to 10 GHz
11966H	Dipole Antenna Set	28 MHz to 1 GHz
11966I	Double-Ridged Waveguide Horn Antenna	200 MHz to 2 GHz
11966J	Double-Ridged Waveguide Horn Antenna	18 to 40 GHz
11966K	Magnetic Field Pickup Coil	20 Hz to 50 kHz
11966L	Coax Cable, Type-N	10 m
11966M	Coax Cable, BNC	10 m
11966N	Log Periodic Antenna	200 MHz to 5 GHz
11966P	Broadband Antenna	30 MHz to 1 GHz
11947A	Transient Limiter	9 kHz to 20 MHz

Key Literature

EMC Accessories Catalog, p/n 5966-1188E
EMC Precompliance Measurement Systems and Accessories, p/n 5964-6091E

[1] Typical cal factor supplied



HP 11966P Broadband Antenna with 11968K

HP 11967 Series Current Probes

This series is designed for MIL-STD-461/462 conducted-emission measurements on power and interconnecting leads. Used with 10 µF capacitors, HP p/n 0160-6683.

HP Model	Frequency Range
11967A Current Probe	15 kHz to 50 MHz, dc to 60 Hz powerlines
11967B Current Probe	20 Hz to 2 MHz, dc to 400 Hz powerlines

HP 11967E Line Impedance Stabilization Network

This is a single phase, 25 ampere unit used for commercial conducted emissions measurements and meets the requirements for FCC, CISPR and European Norms. The 11967E LISN is supplied with a NEMA power outlet standard or optional SCHUKO, British, and Australian power outlets.

HP 11967D Line Impedance Stabilization Network

Used for commercial conducted measurements. Maximum current 10 amps. Includes options for NEMA, SCHUKO and British power outlet connectors.

HP 11968 Series Positioning Devices

This series includes manually-operated antenna masts and turntables.

HP Model	Description
11968B	Manually-operated antenna-positioning mast
11968C	Non-metallic antenna tripod; minimizes unwanted reflections in the test environment
11968E	Manually-operated turntable

HP 11729-60014 Low-Noise Preamplifier

This amplifier provides the sensitivity needed for MIL-STD-461C CE-06 receiver/transmitter key-up testing. Frequency range is 10 Hz to 25 MHz.

HP 11909A Preamplifier

Improve receiver, EMC analyzer or spectrum analyzer sensitivity for more accurate radiated emissions measurements. This amplifier has 32 dB gain with a 1.8 dB noise figure. This amplifier is ideal for use with the HP 11940A and 11941A close field probes to detect low level signals from and device-under-test. Frequency range is 9 kHz to 1 GHz.

HP 8449B Microwave Preamplifier

This high-gain, low-noise preamplifier adds sensitivity for MIL-STD radiated measurements. Frequency range is 1 to 26.5 GHz (see page 302).

Ordering Information

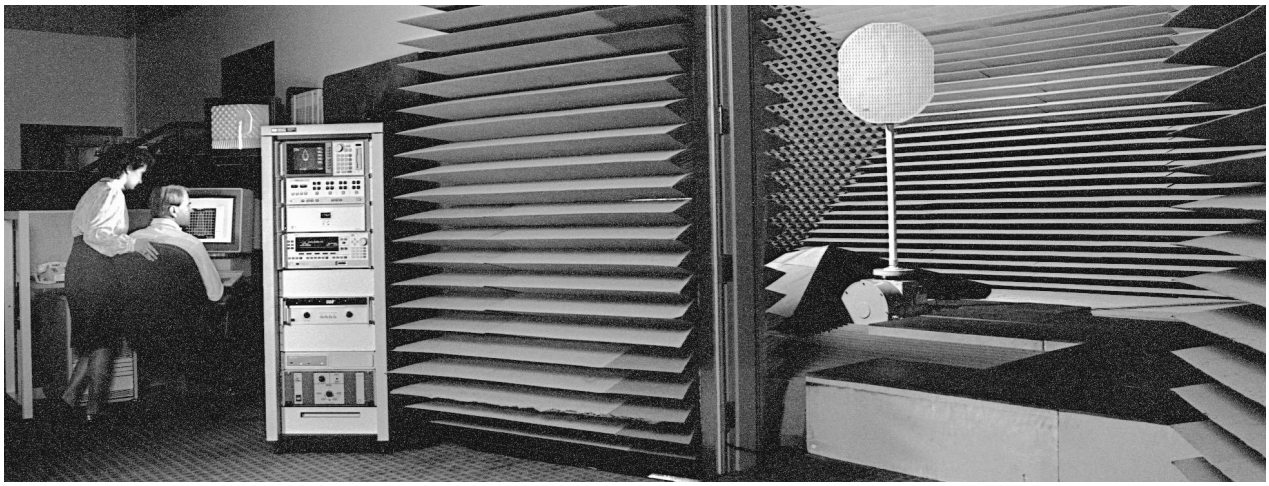
HP 11950X "Designing for EMC" Course (per site)
HP 11940A Close-Field Probe, 30 MHz to 1 GHz
HP 11941A Close-Field Probe, 9 kHz to 30 MHz
HP 11945A Close-Field Probe Set, 9 kHz to 1 GHz
  Opt 001 Rotary Joints
  Opt 003 Delete Cables and Adapters (2 sets)
  Opt E51 Add HP 11909A Preamplifier
  Carrying Bag, 36-in Type-N Cable
HP 11947A Transient Limiter, 9 kHz to 200 MHz
HP 11955A Biconical Antenna*
HP 11956C Log Periodic Antenna*
HP 11960A RF Preselector
HP 11961A EMI Software
HP 11966A Active Loop H-Field Antenna, 10 kHz to 30 MHz
HP 11966B Active Rod E-Field Antenna, 100 to 50 MHz
HP 11966C Biconical Antenna, 30 to 300 MHz
HP 11966D Log Periodic Antenna, 200 MHz to 1 GHz
HP 11966E Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz
HP 11966F Conical Log Spiral Antenna, 200 MHz to 1 GHz
HP 11966G Conical Log Spiral Antenna, 1 to 10 GHz
HP 11966H Dipole Antenna Set, 28 MHz to 1 GHz
HP 11966I Double-Ridged Waveguide Horn Antenna, 200 MHz to 2 GHz
HP 11966J Double-Ridged Waveguide Horn Antenna 18 to 40 GHz
HP 11966K Magnetic Field Pickup Coil, 20 Hz to 50 kHz
HP 11966L Coax Cable, Type-N
HP 11966M Coax Cable, BNC
HP 11966N Log Periodic Antenna, 200 MHz to 5 GHz
HP 11966P Broadband Antenna, 30 MHz to 1 GHz
HP 11967A Current Probe, 15 kHz to 50 MHz
HP 11967A Current Probe, 20 Hz to 2 MHz
HP 111967E 25 amp Line Impedance Stabilization Network
HP 11967D LISN NEMA Connector
  Opt 001 SCHUKO Connector
  Opt 002 British Connector
HP 11968B Manual Antenna-Positioning Mast
HP 11968C Antenna Tripod
HP 11968K Rugged Tripod
HP 11968E Manual Equipment-Testing Turntable
11729-60014 Low-Noise Preamplifier, 10 Hz to 25 MHz
HP 11909A Preamplifier, 9 kHz to 1 GHz
HP 8449B Microwave Preamplifier, 1 to 26.5 GHz
HP 85878A Report Generator

*Typical antenna factors supplied

Antenna & Radar Cross-Section Measurements

Antenna/RCS Measurement Systems, 45 MHz to 110 GHz

HP 85301B
HP 85301C
HP 8530A



HP 85301B antenna/RCS measurement system in HP's compact test range

- Measurement speeds of up to 5000 points/second
- Fast multiple-channel measurements
- Excellent microwave performance and accuracy
- Manual or automated operation
- Built-in graphical display and analysis capability

HP 85301B/C Antenna, RCS Measurement Systems

Systems Designed for Productivity

Maintaining a competitive edge requires a measurement system with the greatest accuracy, reliability and productivity available. HP measurement systems provide complete solutions with the excellent performance, accuracy and features you need. HP also offers complete, dependable system support.

Far-Field Antenna Measurement Systems

A complete antenna measurement solution must have the flexibility to measure a variety of antennas, and it must have features and performance to test the most challenging and complex antennas. The HP 85301B/C antenna measurement systems meet these demanding requirements.

The HP 85301B system includes an HP 8530A microwave receiver and an HP 85310A distributed frequency converter with remote mixers. (The mixers can be located directly at the antenna under test.) This system provides the best microwave performance, measurement sensitivity and measurement flexibility available. It features broadband coaxial mixers that cover the 2 to 26.5 GHz frequency range and optional coaxial mixers that cover the 0.1 to 50 GHz frequency range. It has the ability to extend frequency coverage to 110 GHz by using the HP 85325A millimeter-wave subsystems.

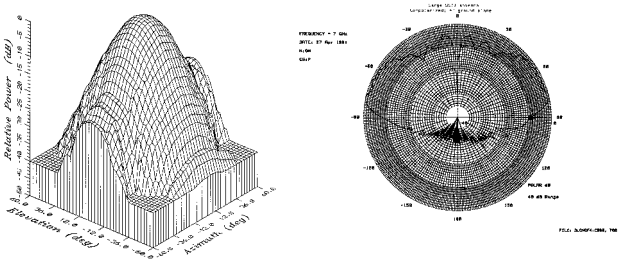
The HP 85301C antenna measurement system includes an HP 8530A microwave receiver with an HP 8511A or HP 8511B frequency converter. It features good microwave performance, an economical price, and broad frequency coverage from 45 MHz to 26.5 or 50 GHz.

Near-Field Antenna Measurement Systems

The HP 85301B/C antenna measurement system is also ideally suited for near-field antenna measurements. Its rapid data acquisition speeds, frequency agility and fast channel-switching capability make these systems ideal for the demanding requirements imposed by near-field measurement systems. HP can help you configure a near-field measurement system to meet your specific requirements.

Radar Cross-Section Measurement Systems

The HP 85301B/C measurement systems fulfill the demanding needs of RCS measurements. These systems feature broad frequency capability from 45 MHz to 110 GHz; a choice of frequency downconverters; excellent measurement sensitivity and accuracy; and fast frequency agility, data acquisition speeds and multiple-channel capability. HP instrumentation is meeting the challenges of RCS measurements in hundreds of RCS facilities worldwide.



Typical data available from the measurement systems

HP 8530A Microwave Receiver

The HP 8530A is a fast and accurate microwave receiver designed for both manual and automated antenna measurement and radar cross-section measurement applications. It features fast data acquisition speeds, excellent sensitivity, wide dynamic range, multiple test channels and fast frequency agility—without compromising measurement accuracy. The receiver provides broad frequency coverage from 45 MHz to 26.5 GHz, with extensions to 110 GHz.

Easy Upgrades for Existing Antenna Ranges

The HP 8530A microwave receiver can be a replacement receiver for existing antenna or RCS range receivers. With the HP 85370A antenna position encoder, the HP 8530A receiver can be interfaced to virtually any positioning system. Also, any HP 8510 network analyzer can be upgraded to an HP 8530A microwave receiver and still retain network analyzer capability. The HP 85395A/B/C kits provide an on-site upgrade of your existing network analyzer. Whether you upgrade one component or a complete system, HP provides the reliable instrumentation you need, and HP's upgrade paths protect your capital investment in your measurement systems.

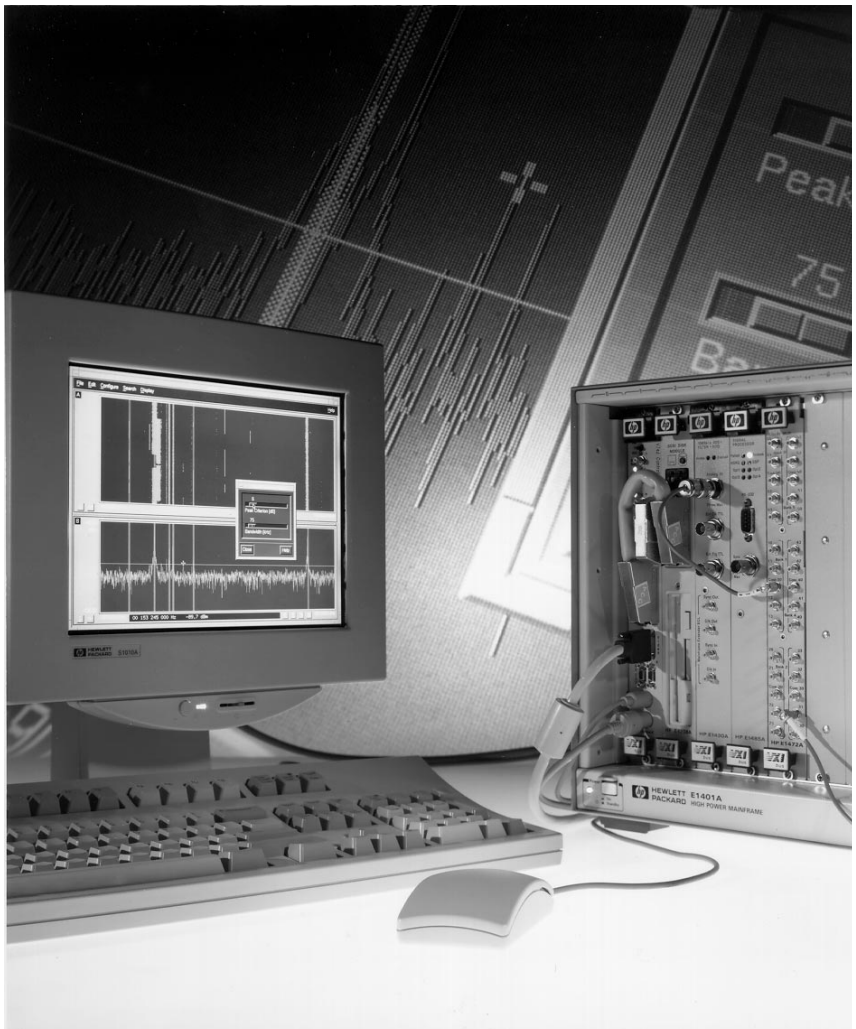
Customized Systems to Meet Your Requirements

The HP 85301B/C measurement systems are customized to fit your individual requirements. HP offers a variety of options to expand the capabilities of the standard systems and also offers customization services to meet unique measurement requirements. HP has microwave systems engineers worldwide who understand your measurement needs and who will work with you to configure a measurement system that meets your specific requirements.

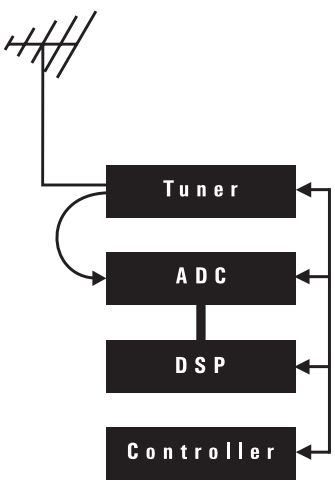
Ordering Information

HP 85301B Antenna/RCS Measurement System
HP 85301C Antenna/RCS Measurement System
HP 8530A Microwave Receiver

Please call your local HP sales representative for detailed information about these and other antenna products.



Signals development and intercept is the art of finding and analyzing signals that may not want to be found. Hewlett Packard offers a selection of products to help with this task. Each product has distinctive capabilities that make it the preferred system for a particular job.



Wide band receiver block diagram. (Antenna/ Tuner/ADC/DSP)

Use the HP E3238 signals development system for high-speed signal search, classification, and monitoring. This turn-key modular VXI system is noted for sweeping fast with excellent frequency resolution. Its block diagram is shown above. The tuner has a wide IF bandwidth, at least 4 MHz and is stepped, not continuously swept across the spectrum. The wide IF speeds search by enabling fast tuning and minimizing the number of steps needed to cross a given spectrum segment. The tuner steps so the IF can be digitized. The ADC digitizes the entire IF without degrading the signals and sends the samples to the DSP where a Fast Fourier Transform (FFT) is calculated. The FFT provides selectable frequency resolution and noise floor reduction.

The HP E3238 improves search speed by 10 or 100 times over narrow-band swept search techniques used in other systems. These systems tune a relatively narrow audio bandwidth receiver across the spectrum. Typically such a system can sweep 50 MHz in 2.5 seconds with 7.5 kHz frequency resolution. The HP E3238 can sweep the same spectrum in 50 ms.

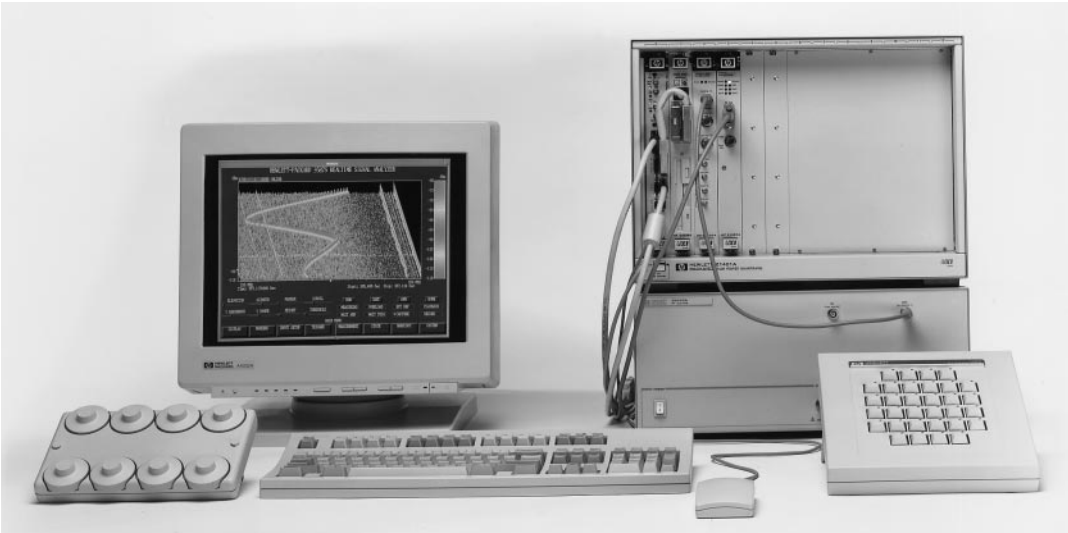
Use the HP 3587 wide-band recording and signal analysis system to evaluate and characterize signal structure. This turn-key modular VXI system is noted for its measurement performance, signal processing tools, fast flexible display types and presentation formats. The HP 3587 uses digital sampling and the FFT to form a spectrum of the signal, in real time or data it records. This technique is useful for measuring signals with a resolution of a few µHz to 100 kHz, and provides frequency, amplitude, and phase information. With its real-time signal analysis capability, and its wide-band recording features, the HP 3587 is able to capture and analyze periodic as well as random and transient signals and events.

Use the HP 6500A VXI Tuner and HP E6501A VXI receiver modules to build your own high performance receiver system. These carefully matched module sets are noted for their superior RF performance and programmability. Combine the E6500A tuner modules with HP VXI ADC and DSP modules (see VXI section in this catalog), and your software, to produce a search receiver system, wide or narrow band, which matches your needs exactly. You can also use the ADC and DSP provided standard with the tuner in the E6501A receiver modules, and your software, to search for and demodulate (AM, FM, PM, SSB, CW) signals.

Real-Time Signal Analysis System

HP 3587

- Measure DC to 3 GHz
- 8 MHz maximum frequency span
- 1 MHz real-time DSP bandwidth
- Frequency, time, and amplitude domain displays
- Spectrogram and waterfall displays
- Compatible with various downconverters



HP 3587

HP 3587 Real-Time Signal Analysis System

The HP 3587 real-time signal analysis system has the measurement power and flexibility you need to capture and analyze real world signals. Its combination of speed, dynamic range, presentation flexibility, signal capture memory, and instrument-like operation will help you analyze non-stationary and low-level signals, even those close to much higher level signals, a higher percentage of the time.

8 MHz Input Bandwidth

Analyze data with up to 8 MHz bandwidth. The HP 3587 uses a 20 MSa/s 23 bit ADC module to digitize signals. This HP A/D is fully alias-protected to assure the Nyquist valid sampling that is key for signal analysis. It also provides up to –110 dBfs of spurious-free dynamic range. A 16 dB noise figure provides excellent sensitivity to complement this dynamic range. Extend the measurement range of the HP 3587 with a selection of HF and VHF/UHF downconverters.

1 MHz Real-Time DSP Bandwidth

The digital signal processing module in the HP 3587 contains 250 MFLOPs of raw computational power. That power gives this signal analyzer 1 MHz of real-time bandwidth. That means you can monitor any 1 MHz span in the DC to 3 GHz range of the HP 3587 continuously, with < 2 kHz frequency resolution and zero revisit time.

Versatile Data Display

Monitor and analyze signals with a choice of frequency-domain, time-domain, and histogram displays. Frequency-domain displays include single-trace spectrums, multi-spectrum waterfalls, spectrograms, and rollograms. Rollograms can update at better than 800 spectrums per second. Time-domain displays include single trace, strip chart, and waterfall. Histograms, probability density function (PDF), and cumulative density functions (CDF) are standard. Other features include digital persistence, digital image enhancement filtering, and a variety of marker functions. Option AGG allows you to create your own markers and modify signal data before it is displayed, as well as modify the user interface.

Signal Capture Memory (Option ATR)

Save important wideband signals using the throughput-to-disk option (Option ATR) and as many as eight E1562 high-speed data disk modules. This capability allows you to save time data at 10 MSa/s (4 MHz bandwidth) to 64 GB of hard disk memory. That's 52 minutes of recording time.

System Advantages

The HP 3587 is a turn-key VXI system that acts like an instrument. Knob and button controls provide the look and feel of an instrument (a standard computer keyboard is also supplied). Software is loaded at the factory, so you can take the system out of the box, hook up a few cables, and start making measurements right away.

Specifications

Frequency

Range: DC to 8 MHz
Spans: 0.95 Hz to 8 MHz, octave steps
Resolution: 51 to 12,801 lines
Real-time Bandwidth: 1 MHz (801 lines, 0% overlap, spectrogram mode, rms averaging, 16-bit word width, 1024 x 768 pixel display)

Amplitude

Input Range: +30 dBm to –24 dBm
Accuracy: ± 0.03 dB, f < 100 kHz, 25° C, ± 1 V range, dc coupled alias filter on, digital filters off
Input Impedance: 50 Ω, > 40 dB return loss to 4 MHz
Harmonic Distortion: < –110 dBfs or –80 dBc, whichever is greater

Modes

Averaging Modes: Off, rms, peak, nth
Marker Modes: Single, relative (same trace, separate trace), marker to peak, marker to next peak, right/left, band power, noise power
Memory Modes: Save/recall, record/playback, signal capture
Triggering Modes: Free-run, level, magnitude, external
Printer Output: Print screen/print trace

Key Literature

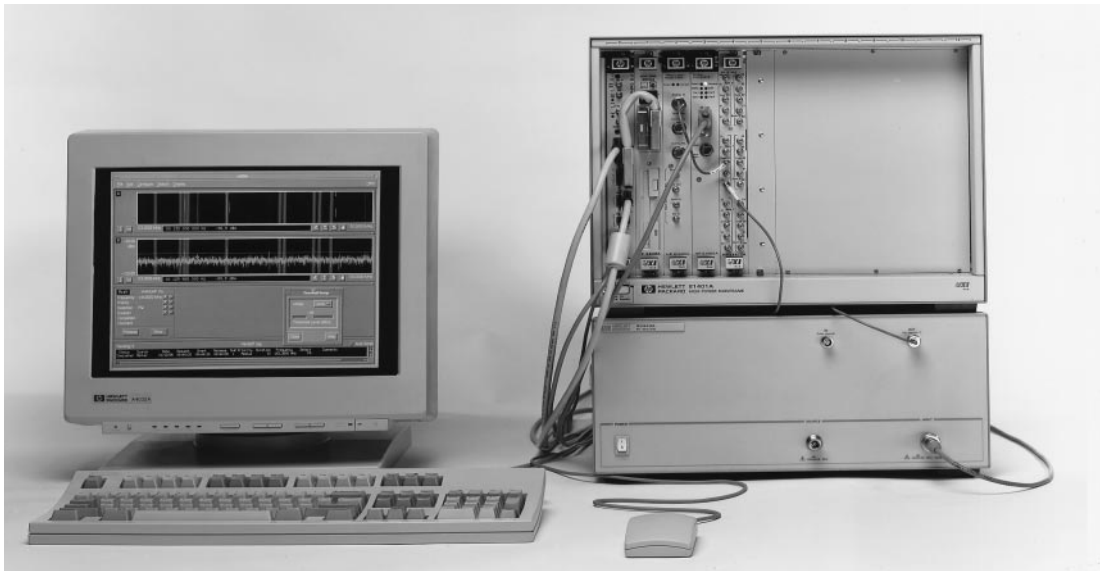
HP 3587S Signal Analysis System Brochure, p/n 5963-7089E
HP 3587S Technical Specifications, p/n 5963-6607E

For more information, visit our website:
http://www.tmo.hp.com/tmo/datasheets/English/HP3587.html

Ordering Information

HP 3587 Real-Time Signal Analysis System
System may include: HP controller, monitor, disk drive, DAT tape, VXI chassis, DSP module, ADC module, HP-UX operating system, HP 35687B measurement/control software. For a complete configuration guide contact your local Hewlett-Packard sales office.
For a pre-bundled system, order 3587B.

- 2.3 GHz/sec scanning rate with 15 kHz resolution
- Manual and automatic signal isolation tools
- Automatic energy detection tools
- Hand-off receiver control
- LAN compatible



HP E3238

HP E3238 Signals Development System

Catching intermittent or clandestine signals in dense signal environments is a challenging task. You'll be equipped to meet that challenge with the HP E3238 signals development system. This fast-scanning, high-selectivity receiver system has the manual and automatic tools you need to detect, classify, and monitor signals of interest.

General and Directed Search (Option AS7)

The HP E3238 provides a choice of signal search modes. Choose general search to monitor a large segment of spectrum as part of an environmental scan. Choose advanced directed search (Option AS7) to sequentially scan up to 100 individual spectrum segments, skipping the parts of the spectrum that aren't critical to your mission. A full selection of resolution bandwidths and averaging types are available for both modes.

Manual Signal Isolation Tools

The mouse-controlled signal isolation tools in the HP E3238 work directly where your attention is focused, on the signal trace. Zoom in the display by dragging a box around the interesting signal with the mouse; assign a hand-off receiver to a signal by pointing at the signal with the mouse and dragging the signal to the hand-off receiver control box; read the frequency and amplitude of a signal by pointing with the mouse and pressing the left mouse button to activate the marker.

Automatic Energy Detection (Option AS8, AS9)

Automatically isolate energy of interest based on its frequency, amplitude, bandwidth, duration and more with the features in option AS8. Select one of the three thresholds to automatically separate signal from noise energy. Automatically gather parameters on all energy above your threshold in the energy history database. Set the alarm function to automatically find signals of interest in the database and take action. Add frequency domain energy filters and parameter extractors, new alarms tasks and more to the HP E3238 with Option AS9 User programming.

Hand-Off Receiver Control

The HP E3238 can control any hand-off receiver with an RS-232, Ethernet, HP-IB, or VXI interface. Each receiver requires a software driver for interfacing to the HP E3238.

LAN Control

You can operate the HP E3238 via Ethernet LAN, accessing all features, displays, and menus from any X-compatible server anywhere in your network.

System Advantages

The HP E3238 is a turn-key VXI system that comes from the factory configured and ready to run. All the software is loaded on the hard disk before the system is shipped so all you have to do to get started is take the system out of the box and hook up a few cables.

Specifications

Using the HP 89431A – 2 to 2650 MHz downconverter
Frequency
Range: 2 to 2650 MHz
Spans: 1 MHz to 2650 MHz, 1 Hz resolution
Resolution: 7.3 Hz to 120 kHz, octave steps
Sweep Speed: 2.3 GHz/s (using 15 kHz RBW)
Amplitude
Input Range: –50 dBm to +25 dBm (5 dB steps)
Sensitivity: –159 dBm/Hz (–50 dBm range)
Noise Figure: 16 dB
Spur Free Dynamic Range: 70 dB

Key Literature

HP E3238S 2 to 2650 MHz Technical Specifications, p/n 5963-6609E
HP E3238S Scanning Signal Analysis System Brochure, p/n 5963-6610E

For more information, visit our website:
http://www.tmo.hp.com/tmo/datasheets/English/HPE3238S.html

Ordering Information

HP E3238 Signals Development System
Includes: HP controller, monitor, disk drive, DAT tape, DSP module, ADC module, downconverter, RF MUX module, VXI chassis, HP-UX operating system, HP 35688B measurement/control software. For a complete configuration guide contact your local Hewlett-Packard sales office.
For a pre-bundled system, order E3238B.

VXI Tuner and Receiver

HP E6500A
HP E6501A

HP E6500A VXI Tuner
- 2 MHz[1] to 1000 MHz tuning range (3000 MHz, optional)
- Excellent dynamic range (high TOI, low noise figure)
- Fully input-preselected
- Fast, synthesized tuning with 1 Hz resolution
- Software driver and register-based commands
- Compatible with HP E3238 signals development system

HP E6500A Tuner Configurations:
(left to right) HP E6500A with Option 003 (2 MHz[1] to 3 GHz) in Option 006 six-slot mainframe; HP E6500A standard system consisting of two VXI modules (2 MHz[1] to 1 GHz); HP E6500A Option 003 three-module set (2 MHz[1] to 3 GHz); HP E6500A Option 003 in Option 013 thirteen slot mainframe. (Slot zero controller ordered separately in all systems.)

HP E6500A VXI Tuner

Description

The HP E6500A VXI tuner brings high dynamic range, preselection, fast tuning, and the flexibility of a modular architecture to signal monitoring applications in the VHF/UHF frequency ranges. The HP E6500A tuner provides frequency coverage from 2 MHz[1] to 1000 MHz using two C-size VXI modules—the HP E6401A 2 MHz[1] to 1000 MHz downconverter and the HP E6402A local oscillator (LO). For applications requiring frequency coverage beyond 1000 MHz, the HP E6500A Option 003 configuration adds the HP E6403A block downconverter VXI module to extend the frequency range to 3000 MHz.

Applications

The HP E6500A tuner downconverts VHF/UHF signals to an intermediate frequency (IF) of 21.4 MHz or to a baseband output of 2.5 MHz to 9.5 MHz using the HP E6500A Option 001. The high dynamic range and fast tuning make this VXI tuner an excellent front-end for numerous system applications. For example, the standard HP E6500A tuner is combined with the HP E6404A digital IF processor to form the HP E6501A VXI receiver (shown on this page). Another alternative is to use the HP E6500A Option 001 baseband configuration with the HP E1437A or E1430A digitizer in the HP E3238 signals development system.

Many applications such as direction finding (DF) require multichannel tuners, all sharing a common local oscillator (LO). Although the standard HP E6500A is a single channel tuner, HP custom-engineered system options are available to support multiple channels.

Specifications

Frequency Range: 2 MHz[1] to 1000 MHz (3000 MHz with Option 003)
Tuning Resolution: 1 Hz
Noise Figure: 10 dB, typical (20 MHz to 1000 MHz);
14 dB, typical (1000 MHz to 3000 MHz)
Second Order Intermodulation (SOI): +67 dBm, typical
Third Order Intermodulation (TOI): +15 dBm, typical (20 MHz spacing)
Image Rejection: 95 dB
IF Rejection: 90 dB
Phase Noise @ 20 kHz offset: –100 dBc/Hz, characteristic
Internally Generated Spurious: –100 dBm, equivalent input
LO Emissions: –110 dBm (1000 MHz); –100 dBm (3000 MHz)

Key Literature

HP E6500A Product Overview, p/n 5965-5769E
HP E6501A Product Overview, p/n 5966-0165E
HP E6501A Technical Specifications, p/n 5966-3344E
HP E6501A Configuration Guide, p/n 5966-2974E

[1] Although tuning down to 2MHz is allowed, performance is not specified below 20MHz.

HP E6501A VXI Receiver
- 2 MHz[1] to 1000 MHz tuning range (3000 MHz, optional)
- Includes powerful Digital IF Processor VXI module
- Fast, > 2 GHz/sec signal search speed
- Multiple, simultaneous demodulation using digital drop receiver approach
- VXI plug-and play software driver and PC-based virtual front panel demonstration software

HP E6501A Option 003 receiver (2 MHz[1] to 3 GHz) in Option 006 six-slot mainframe. HP E6501A receiver consists of HP E6500A tuner and HP E6404A IF processor VXI module.

HP E6501A VXI Receiver

The HP E6501A VXI receiver combines the high dynamic range, fast tuning, fully preselected performance of the HP E6500A VXI tuner with the powerful digital processing capabilities of the HP E6404A digital IF processor VXI module. By providing high-value receiver subsystem hardware and accompanying software drivers, the HP E6501A enables systems integrators to more quickly and cost-effectively build signal monitoring systems that provide high-speed signal search, demodulation, and direction finding solutions for their customers.

Receiver Applications

Signal monitoring applications require receivers with fast search speed and flexible demodulation capability to detect challenging signals-of-interest. The HP E6501A is a single channel receiver configuration offering excellent RF performance, fast tuning, and DSP-based demodulation. With a software driver that supports a fast step-and-FFT approach for searches, the wide 8 MHz digital snapshot bandwidth provides search speeds faster than 2 GHz/sec with narrow channel bandwidths. Unlike traditional analog receivers which can only demodulate one signal at a time, the HP E6501A includes an optional digital drop receiver (DDR) capability which provides simultaneous demodulation of up to ten signals within an 8 MHz spectral capture range. This benefits the systems integrator by minimizing the system costs and reducing the number of VXI slots required.

Additional receiver configurations are available for applications requiring multiple channels. The HP E6502A dual receiver provides independent search and demodulation since it uses two separate tuners. It can also be configured for multiple channel demodulation requiring a capture range of at least 16 MHz. The HP E6503A dual receiver uses a single shared LO for coherent downconversion and digital I/Q outputs required in direction finding applications. Contact your HP sales representative for custom-engineered solutions supporting more than two channels.

Powerful DSP Capabilities

The HP E6501A VXI receiver includes powerful DSP capabilities to process today's challenging signals. Features and benefits include:
- DSP-based AM, FM, PM, SSB, CW demodulation
- Built-in optional digital drop receivers (DDRs) for simultaneous demodulation of multiple signals within 8 MHz capture bandwidth
- Digital IF filters from 247 Hz to 462 kHz with 1.5:1 shape factors
- Digital I and Q outputs available for post-processing
- Full-rate ADC data available (16 bits @ 28.533MSa/s)

Ordering Information

HP E6500A VXI Tuner
Opt 001 Baseband Output
Opt 003 Increases Frequency Range to 3 GHz
Opt 006 Add HP E1421B six-slot VXI Mainframe
Opt 013 Add HP E1401B thirteen-slot VXI Mainframe
HP E6501A VXI Receiver
Opt 003 Increases Frequency Range to 3 GHz
HP E6502A Dual Channel Receiver (independent LOs)
HP E6503A Dual Channel Receiver (shared LO)

- 50 kHz to 26.5 GHz with expand carrier frequencies to 110 GHz
- Quick and easy integration into your ATE system
- Ability to test a wide range of devices
- Measure AM noise directly

HP E5503A

HP E5503B

HP E5500 Series Phase Noise Measurement Solutions

The new HP E5500 A-series phase noise measurement solutions have been designed to minimize production ATE test times for one-port VCOs, DROs, crystal oscillators, and synthesizers and to maximize the capability for R&D benchtop applications. In addition, with a standard offset range capability from 0.01 Hz to 100 MHz, the HP E5500 B-series provides the capability, flexibility, and versatility to meet changing and demanding needs placed upon the R&D engineer. By building upon 30 years of Hewlett-Packard low phase noise, RF design and measurement experience, the HP E5500 series solutions continue to provide excellent measurement integrity, repeatability, and accuracy.

The E5500 phase noise measurement solutions use the power of a flexible software program to automate phase noise carrier measurements. The E5500 A-series solutions include the HP 70420A phase noise test set, which contains phase detectors and phase-lock loop circuitry, a high speed VXI digitizer with mainframe and high speed VXI-to-PC interface for base-band signal analysis, selected low-noise frequency downconverters, and measurement software. When combined with a PC running Windows NT 4.0, this series provides fast phase noise measurements of carrier frequencies from 50 kHz to 1.6 GHz, 6.0 GHz, 18 GHz, or 26.5 GHz over offset-from-carrier frequencies of 0.01 Hz to 4 MHz. The E5500 B-series includes the HP 70420A phase noise test set, a Pentium PC running Windows NT 4.0, a PC digitizer, and an RF spectrum analyzer, selected low-noise frequency downconverters, and measurement software. This series of solutions provides phase noise measurements of carrier frequencies from 50 kHz to 1.6 GHz, 6.0 GHz, 18 GHz, or 26.5 GHz over offset-from-carrier frequencies from 0.01 Hz to 100 MHz. A variety of signal generators—such as the HP 8662A, 8663A, 8643A, 8644B, 8664A/B, 8665A—can also be added to provide a low-noise reference signal.

Phase Noise Measurement Software

A graphical user interface provides measurement menus allowing the operator to specify the measurement process, including the calibration of the system. Several output formats are available to the user, including plots of the single-sideband phase noise power of the signal, integrated noise power, or the calculated Allan variance. A real-time measurement mode is available to monitor the level of phase noise and discrete spurs as changes are made to the device-under-test. The HP E5500 series phase noise measurement software requires a Pentium PC with 32 MBytes of RAM, a 1 GByte hard drive, and Windows NT 4.0.

Specifications

HP E5500 A-Series
- **HP E5501A:** 50 kHz to 1.6 GHz
- **HP E5502A:** 50 kHz to 6.0 GHz
- **HP E5503A:** 50 kHz to 18.0 GHz
- **HP E5504A:** 50 kHz to 26.5 GHz

HP E5500 B-Series
- **HP E5501B:** 50 kHz to 1.6 GHz
- **HP E5502B:** 50 kHz to 6.0 GHz
- **HP E5503B:** 50 kHz to 18.0 GHz
- **HP E5504B:** 50 kHz to 26.5 GHz

Operating Characteristics

Offset Frequency Range
A Models: 0.01 Hz to 4 MHz
B Models: 0.01 Hz to 100 MHz
System Noise Response[1]**:** –180 dBc/Hz typically (>10 kHz offsets)
System Spurious Response[1]**:** –120 dBc typically
Phase Detector Input Power: (<1.6 GHz carrier frequency)
R input = 0 to +23 dBm
L input = +15 to +23 dBm
Downconverter Input Range: 1 GHz to 6 GHz;
1 GHz to 18 GHz; 1.5 GHz to 26.5 GHz
External Noise Input Port: 0.1 Hz to 100 MHz
Measurement Accuracy: ±2 dB (<1.0 MHz offsets);
±4 dB (<100 MHz offsets)

HP E5500 A-Series Optional Capabilities
Extend offset range to 8, 10, and 100 MHz
Add RF reference source
Add high power input capability (includes μW phase and AM detectors)
Add specific ATE computer
Extend carrier frequency to 110 GHz

HP E5500 B-Series Optional Capabilities
Add RF reference source
Add high power input capability (includes μW phase and AM detectors)
Delete PC
Add remote SCPI programming client
Extend carrier frequency to 110 GHz

Key Literature

HP E5500 Series Phase Noise Measurement Solutions,
Product Overview, p/n 5965-7590E

[1]Without reference sources or downconverters

Ordering Information

HP E5501A: Phase Noise Measurement Solution, 50 kHz to 1.6 GHz
HP E5502A: Phase Noise Measurement Solution, 50 kHz to 6.0 GHz
HP E5503A: Phase Noise Measurement Solution, 50 kHz to 18.0 GHz
HP E5504A: Phase Noise Measurement Solution, 50 kHz to 26.5 GHz

HP E5500 A-Series Solution Hardware Includes:
0.01 Hz to 4 MHz VXI digitizer
VXI to PC high speed interface
6-slot, high power VXI mainframe
MMS baseband test set andframe
HP E5502/03/04A solutions add an MMS low noise downconverter.

HP E5501B: Phase Noise Measurement Solution, 50 kHz to 1.6 GHz
HP E5502B: Phase Noise Measurement Solution, 50 kHz to 6.0 GHz
HP E5503B: Phase Noise Measurement Solution, 50 kHz to 18.0 GHz
HP E5504B: Phase Noise Measurement Solution, 50 kHz to 26.5 GHz

HP E5500 B-Series Solution Hardware Includes:
1.5 GHz swept RFSA
MMS baseband test set and frame
Pentium PC with Windows NT 4.0 and digitizer
HP E5502/03/04B solutions add an MMS low noise downconverter.

Warranty Options

Opt W20 2 Year Customer Return Repair Coverage
Opt W21 2 Year On-Site Repair Coverage
Opt W22 2 Year Customer Return Calibration Coverage
Opt W30 3 Year Customer Return Repair Coverage
Opt W31 3 Year On-Site Repair Coverage
Opt W32 3 Year Customer Return Calibration Coverage
Opt W50 5 Year Customer Return Repair Coverage
Opt W51 5 Year On-Site Repair Coverage
Opt W52 5 Year Customer Return Calibration Coverage

- Downconverts 1.5 to 26.5 GHz signals
- State-of-the-art phase noise performance
- AM noise detection standard
- Coverage to 110 GHz using external mixers
- Specified spurious performance

HP 71707A

HP 71707A Microwave Downconverter

The HP 71707A microwave downconverter translates microwave signals to low-RF frequencies with minimum added phase and amplitude modulated noise. The HP 71707A can be controlled automatically by the HP E5500 series or HP 3048AR phase noise measurement system and consists of a 4-slot (MMS) HP 70427A microwave downconverter module and an HP 70004A color display/mainframe.

Specifications Summary

Downconverter
Frequency Range: 1.5 to 26.5 GHz
Input Power: –30 dBm min., +30 dBm max.
IF Output
Frequency Range: 5 MHz to 1500 MHz
Level: 0 to +5 dBm

General

Operating Temperature Range: 0° to +55° C
Power: 260 W maximum (provided by the HP 70004A)
Weight: Net, 28.75 kg (63.3 lb)
Size: 425.4 mm W x 222 mm H x 526 mm D (8.74 in x 16.75 in x 20.7 in)

Key Literature

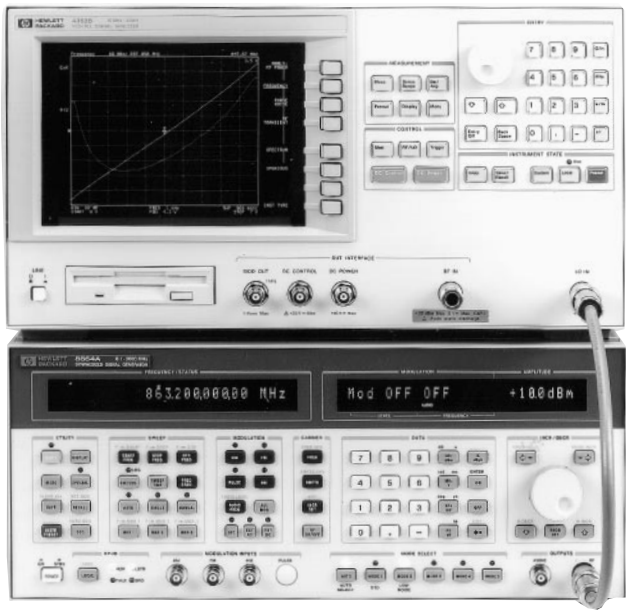
HP 71707A Microwave Downconverter Technical Data, p/n 5091-4435E

Ordering Information

HP 71707A Microwave Downconverter
(1.5 GHz to 26.5 GHz)
Opt 910 Provides a Total of Two Sets of User Guides (p/n 70427-90002) and Component Level Information Packets (p/n 70427-90004)
Opt W30 Extended Repair Service (see page 70)

Indicates QuickShip availability.

- Dedicated VCO and PLL parameters test system
- Excellent solution for LAB and production line
- Simple configuration and multifunctional system
- VCO tuning characteristics evaluation
- Outstanding phase noise measurement capability
- High resolution frequency transient measurement
- Automatic measurement capability and powerful analysis functions

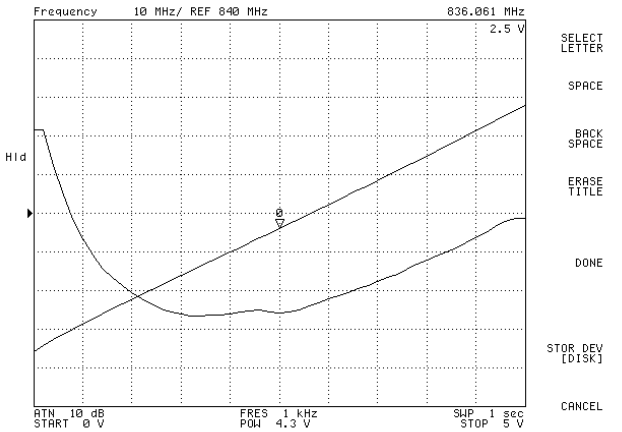


HP 4352S VCO/PLL Signal Test System

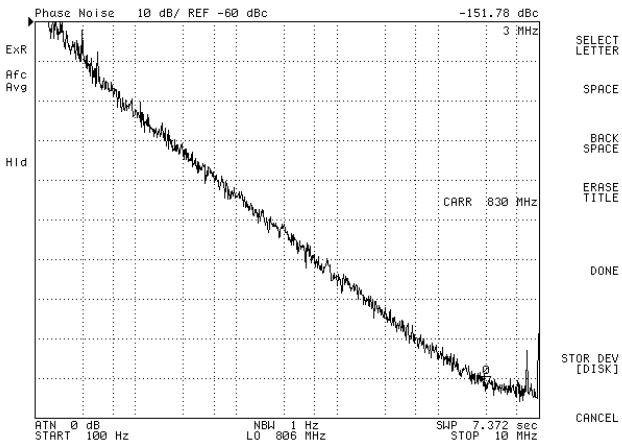
The HP 4352S test system can evaluate the characteristics of VCOs and PLLs that are essential to designing local oscillators used in RF wireless communication equipment. This system can provide both powerful analyzing capability for design evaluation in LAB and high speed measurement capability for production line test with 2 operating modes, "Signal Analyzer" and "VCO Tester" mode. The HP 4352S, which consists of the HP 4352B VCO/PLL Signal Analyzer and Hewlett-Packard low-noise signal generator controlled by the HP 4352B, covers up to 3 GHz and can measure the main VCO/PLL evaluation parameters, RF power, frequency, phase noise, spectrum, frequency transient, DC consumption current and FM deviation. In addition, the HP 4352B provides and controls the DC power supply, the low-noise DC control voltage source and the 1 kHz signal source necessary for VCO tuning characterizing.

This system can make high-speed measurements thanks to the dedicated firmware and "carrier lock multi-mode PLL" technology for phase noise measurement that enables the system lock unto the carrier of the measured signal automatically. In addition, the HP 4352B has excellent phase noise performance such as –157 dBc/Hz at 1 MHz offset typically, so that this test system can make reliable and repeatable phase noise measurement with up to 10 times reduction in measurement time. Actually it can measure 801 measurement points from 100 Hz to 10 MHz offset in 7.4 seconds/sweep. And adding the HP 71707A Microwave Downconverter expands its frequency range up to 26 GHz. Besides the powerful phase noise measurement capability, the HP 4352S can measure frequency transient with 50 Hz frequency resolution and 12.5 micro seconds time resolution. The HP 4352S improves your VCO and PLL evaluation efficiency and testing productivity dramatically.

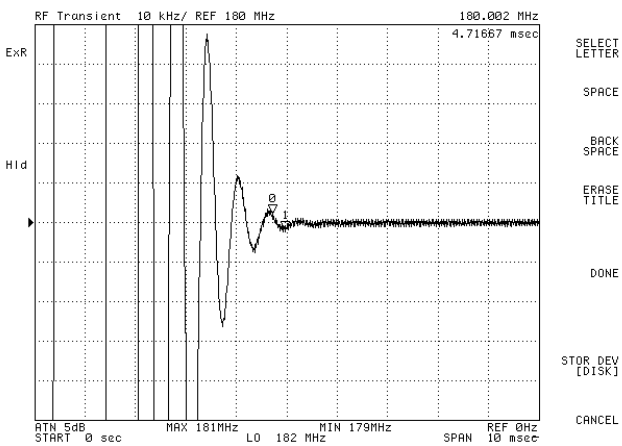
Measurement Display Examples



VCO tuning characteristics (frequency/tuning sensitivity)



VCO phase noise measurement



PLL frequency lock time measurement

Efficient Evaluation in Oscillator Circuit Design

The HP 4352S can measure the following characteristics:

For VCO evaluation

- RF power vs. tuning voltage
- Frequency vs. tuning voltage
- Tuning sensitivity
- Phase noise (Carrier-to-Noise)
- Harmonics
- FM deviation
- DC power consumption current

For PLL evaluation

- RF power
- Phase noise (Carrier-to-Noise)
- Frequency and Frequency transient
- Spurious
- Harmonics

Each parameter can be measured without changing any cable connections. So, you can easily evaluate a VCO/PLL with powerful analysis functions such as marker or limit line.

High Throughput and Easy Test Automation

Thanks to the high-speed phase noise measurement capability, it only takes about 2.5 seconds to measure five VCO parameters (RF power, frequency, phase noise, DC power consumption current and FM deviation) by using "VCO Tester" mode. The HP 4352S has the HP Instrument BASIC programming functions, built-in 3.5 inch disk drive (LIF/DOS format) and a 24-bit I/O. These capabilities allow you to interface to an automatic handler so that you can achieve automatic production-line testing without an external computer.

Specifications Summary

Source Characteristics
DC Power Voltage: 0 to +15.5 V with 1 mV step, 50 mA max.
DC Control Voltage: 0 to +20 V with 100 μV step, 20 mA max.
Option 001: –15 to +35 V
Accuracy: ± (0.1% + 2 mV)
Settling Time: < 20 ms @ 0.1% error (typical)
Noise Density: <1 nV√Hz @ 10 kHz offset
FM Signal: 1 kHz, 0 to 1 Vrms with 1 mV step @ open
Receiver Characteristics
Measurement Frequency Range: 10 MHz to 3 GHz/26 GHz
Input Power Level: –10 to +20 dBm
Input Impedance: 50 ohm
SWR: <1.2 (@ < 2 GHz); <1.3
RF Power Measurement
Accuracy @ Peak Voltage Responding
±0.2 dB (@ 1 GHz, –5 dBm, typical); ±1 dB
Resolution: 0.01 dB
Frequency Measurement
Frequency Resolution: 1 kHz
Frequency Transient Measurement
Highest Accuracy: ± 2 kHz
Highest Measurement Resolution: 50 Hz
Maximum Sweep Time: 10 sec.
Minimum Time Resolution: 12.5 usec.
Phase Noise (Carrier-to-Noise Ratio) Measurement
Offset Frequency Range: 100 Hz to 10 MHz

System Noise Level

Offset	Specification (dBc/Hz)	Typical (dBc/Hz)
100 Hz	–85	–90
1 kHz	–110	–117
10 kHz	–130	–137
100 kHz	–140	–147
1 MHz	–150	–157

Spectrum Measurement
Absolute Level Accuracy: 2 dB (–5 dBm input, @ ATT=0 dB, typical)
Relative Level Accuracy: 0.5 dB (typical)
FM Deviation Measurement
Measurement Range: 0 to 200 kHz (peak)
Accuracy: ±(2% + 0.1% of measurement range) @1 kHz FM rate; ±0.8% (typical)
Residual FM: < 3 Hzrms (@ 300 Hz – 3 kHz BW)
DC Consumption Current Measurement
Measurement Range: 0 to 50 mA
Accuracy: ±(0.2% ± 100 μA)
Storage
3.5-inch FDD: LIF/DOS format, 2DD/2HD
Internal RAM Disk: LIF/DOS format, 512 kB max.
Interfaces
HP-IB I/F, 24-bit parallel I/O I/F (HP 87510A 24-bit I/O compatible)

General Characteristics

Display: 9-inch color LCD
Operating Temperature: 0 to +40° C
Operating Humidity: 15 to 95% RH
Storage Temperature/Humidity: 0 to +40° C/15 to 95% RH
Power Requirements: 90 to 132 V or 198 to 264 V, 47 to 66 Hz, 300 VA max.
Size: 235 mm H x 425 mm W x 553 mm D
Weight (typical): 21.5 kg

Key Literature

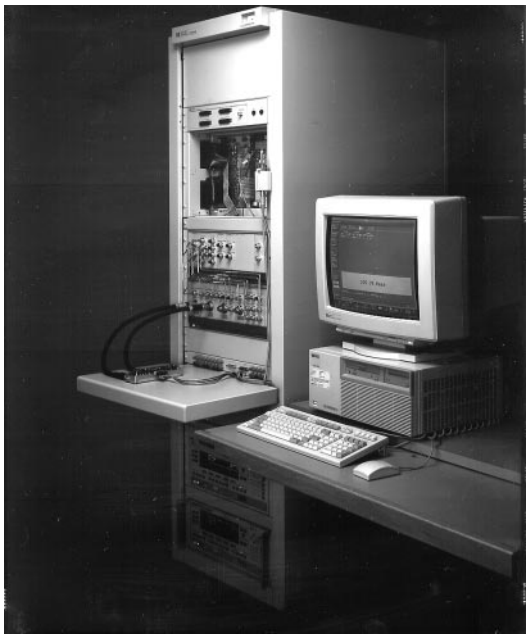
HP 4352S VCO/PLL Signal Test System Product Overview, p/n 5966-0805E
Signal Generator Selection Guide, p/n 5091E-7274E
HP 71707A Microwave Downconverter Technical Data, p/n 5091-4435E

Ordering Information

HP 4352S VCO/PLL Signal Test System
HP 4352B VCO/PLL Signal Analyzer
Opt 001 Expand DC Control Voltage
Opt 1A2 Delete Keyboard
Recommended Signal Generators
HP 8664A Synthesized Signal Generator with Option 004
HP 8644B Synthesized Signal Generator with Option 002
HP 8657B Synthesized Signal Generator
HP 71707A 26 GHz Microwave Downconverter
HP 70422A 18 GHz Downconverter Module

See Signal Sources section for more details.
When using the other signal generators, please contact the HP Call Center in your region for details.

- 50 GHz solutions for module and on-wafer test
- Device test for LMDS, satellite antenna arrays, digital radio and T/R module manufacturing



HP85120A

High-Speed Test System for the Manufacturing Floor

High Throughput Test for Microwave and Millimeter Wave Components

In a manufacturing environment, high-test throughput is a key to efficient volume production. Traditional "rack and stack" test systems, which are adequate for R&D characterization, often fall short on the production floor where a large volume and/or mix of measurements or devices require full test plan execution within a few seconds. To address this need, HP has continued development of high-speed test platforms aimed at lowering the total cost of test and reducing the time to market for device manufacturers.

HP85120A MMIC Test System

The HP 85120A series MMIC test systems are designed for complete characterization of microwave and mm wave modules and related MMIC devices. The flexible architecture incorporates a digital receiver with a single-connection, multiple-measurement (SCMM) design combined with easy to use software to optimize the entire system for fast test plan execution. The system can be configured for on-wafer, packaged device or subassembly module testing.

Software for Automated Testing

A key part of any high-throughput test system is the software. The software enables the user to quickly create or modify test plans and perform system calibrations. A scripting feature allows calling of code created by the test engineer (C++, HPVEE, RMB and other code). Measurement path transforms and de-embedding insure the most accurate test results possible, and real time data recording allows viewing of data while the test plan is running. Various data formats are available to insure a swift integration of the test solution to your production floor.

- Excellent high frequency repeatability and correlation to benchtop measurements
- Enables fast time to market and low total cost of test

Full Standard Measurement Capability

The HP 85120A MMIC test system offers broad frequency coverage from 2 GHz to 20 GHz, a variable bandwidth DSP based receiver, two test ports, 10 watt power handling capability, four- 2 amp power supplies, dual HP8360 series sources and easy test plan development.

Measurements included with standard system:
- S-Parameters, 1 or 2 port
- Power
- Gain, Compression, Flatness
- Phase Noise
- Known Spurs, Harmonics
- Voltage, Current
- Combinations of the above measurements in the form of math blocks

Optional measurement capabilities
- 10 MHz to 3 GHz and/or 1 GHz to 50 GHz frequency coverage
- Additional test ports
- Noise figure
- Pulsed-RF measurements
- Mixer/converter measurements
- Two tone IMD
- Adjacent channel power
- Digital and analog DUT control

A Modular, Reconfigurable Architecture

The 85120A uses industry-standard instrument and computer platforms to protect your investment. Systems include both VXI and MMS platforms to quickly and easily reconfigure the resources to address different manufacturing test needs. Only HP's high-speed test systems can deliver this kind of flexibility for both your present and future production test requirements.

On Wafer Solutions for the Foundry

The 85120A high throughput test solution can be combined with precision auto probers such as the Cascade Microtech PS21 .

Key Literature

HP 85120A Series MMIC Test Systems Product Overview, p/n 5965-2974E

Ordering Information

HP 85120A MMIC Test System
Please contact the HP Call Center in your region for detailed information on this product.

Communications Signal Path Design Solutions

Communications Design System Brochure
High-Frequency Structure Simulator Rel 5.0 Technical Data Sheet
5967-5846E
HP 85148A Circuit Envelope Simulator Technical Data Sheet
5964-3599E
HP 85154A Impulse Transient Simulator Brochure
5091-4268E
HP 85200A Microwave Design System Suite Brochure
5964-2309E
HP 85201A RF Design System Suite Brochure
5964-2308E
HP E4600 Series IV 6.0 Data Sheet
5962-6277E
HP E4665A HP Momentum Planar Electromagnetic Simulator Technical Data Sheet
5963-7129E
HP 85122A HP Device Modeling Systems
5964-9022E
HP 85180A HP IC-CAP Modeling Suite Release 5.0
5965-7742E
HP 85290A HP APDS Device Suite
5967-5332E
HP E8940A RF Designer
5967-6013E
HP High Frequency Structure Simulator Optimizer
5967-5594E
Picosecond Interconnect Modeling Suite Technical Data Sheet
5964-2310E
Series IV/PC Brochure
5964-4392E
Software Support from HP EEsof Technical Data Sheet
5965-7306E

(PN 1201-2) Hierarchical Modeling for Circuit Characterization
5091-1668E
(PN 1201-4) Advanced Bipolar
5091-2503EUS
(PN 1201-5) Model Parameter Monitoring 4062UX, IC-CAP & IC-MS
5091-3525EUS
(PN 1201-6) Device Characterization HP 4062UX and IC-CAP
5091-3811EUS
(PN 85150-1) Using High-Frequency Instruments with MDS
5091-1702E
(PN 85150-2) Simulating Highly Nonlinear Circuits
5091-8568E
(PN 85150-3) Using HP MDS in MMIC Applications
5091-9703E
(PN 85150-4) Simulating Noise in Nonlinear Circuits
5091-9582E
(PN 85150-5) Using the High-Yield Software Package to Create Robust Designs
5962-9271E
(PN 85150-6) Sharing Data Between the Microwave Design System and OmniSys/CDS
5965-1211E
(PN E4600) Creating Measurement-Based RFIC Models
5965-7010E
(PN E4600-9) A Flexible Waveform Generator Using OmniSys and Instrumentation
5965-8120E

EMI/EMC Test Systems

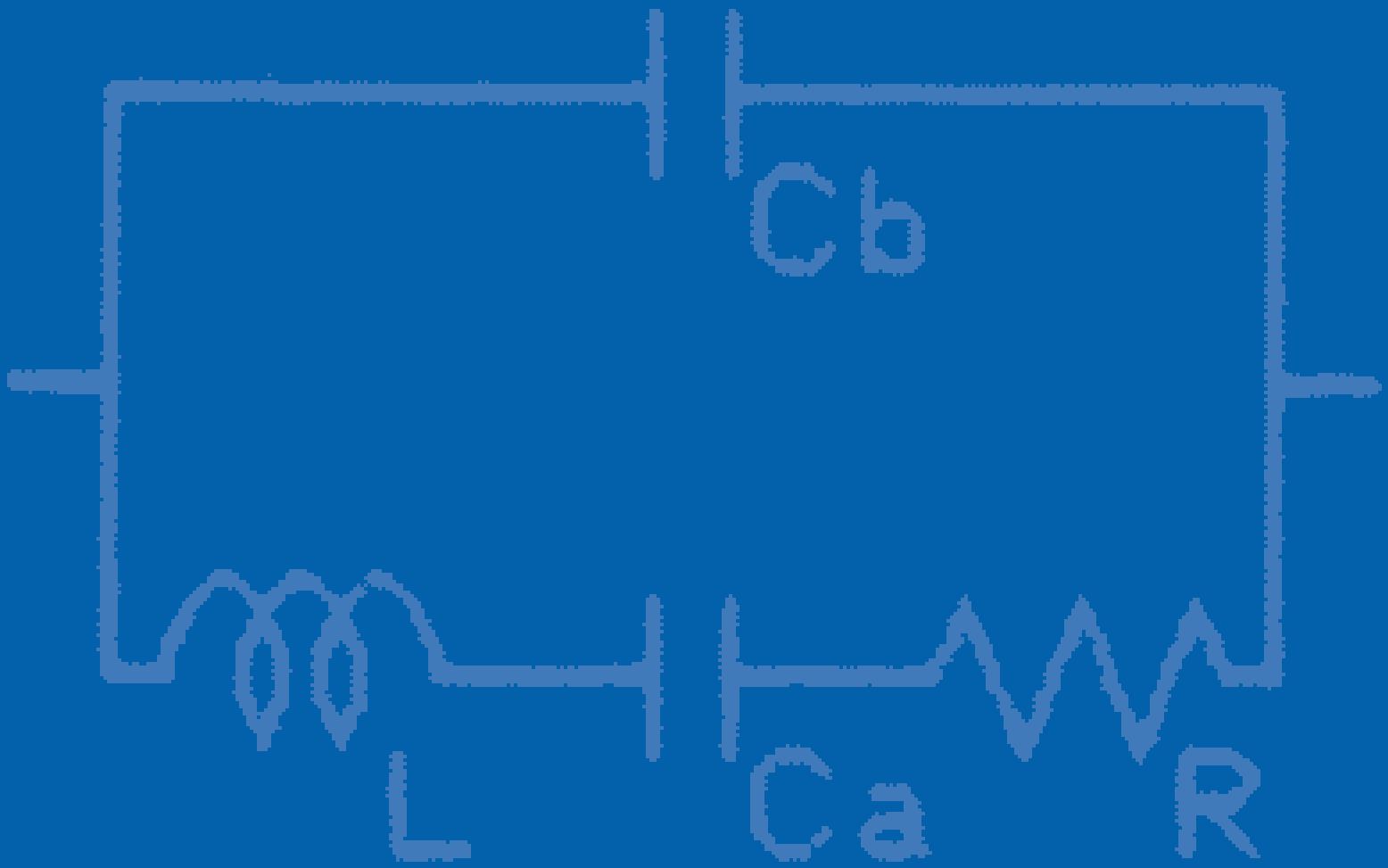
Electromagnetic Compatibility 8590EM-1
5964-2151E

(PN 8566/B) Third Order Intermodulation Distortion Measurements
5954-2701

Signals Development & Intercept Solutions

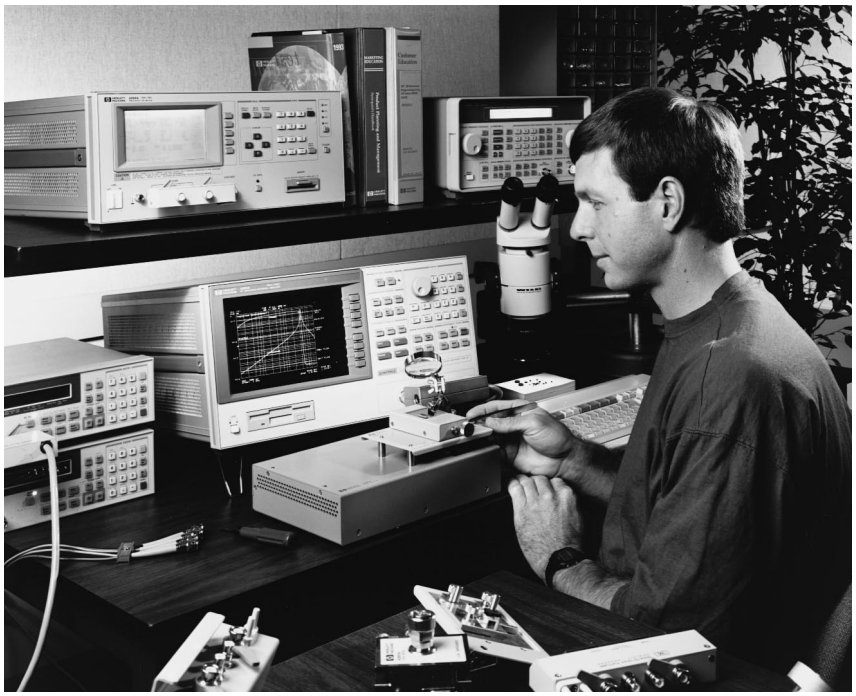
HP 3587S Signal Analysis, Opt ATR, Product Overview
5964-3631E
HP 3587S See More of What's Out There, Video
5964-9460E/PAL
HP E3238S Scanning Signal Analysis System, Opt AS8, Product Overview
5964-3632E
HP E3238S They're Running Out of Places to Hide, Video
5964-0400E/PAL
WJ9119 VXI HF Tuner, Technical Specifications
5965-5021E

Many of these literature pieces are available at:
http://www.hp.com/go/tmc99



Component Test Instruments

Overview



Impedance Measuring Instruments

Impedance measuring instruments can be divided into two general categories: LCR meters and impedance analyzers. LCR meters primarily measure inductance, capacitance, and resistance of the test device at spot frequencies. Impedance analyzers, in addition to all the functions of the LCR meter, measure impedance, phase, and sometimes transmission parameters. These analyzers have extended frequency range, a synthesized source, swept frequency capability, and excellent frequency resolution. Combination network/spectrum/impedance analyzers offer the benefits of impedance analysis as well as vector-network and spectrum analysis. See the Selection Guides that follow for general instrument capabilities. For higher frequencies (above 1.8 GHz) in a 50 ohm environment, a dedicated vector-network analyzer is the best solution for impedance measurements. See Network Analyzers.

Selecting a test fixture is as important as selecting the right instrument. HP offers a wide range of accessories for axial, radial, and SMD chip devices. See the HP LCR Meter and Impedance Analyzer Fixture Compatibility Guide on page 354 for more information.

Component Measurement

Today's electronic components are designed for higher performance, while being reduced in size, power consumption, and cost. Efficient and accurate component characterization, design evaluation, and manufacturing test are critical to the success of component users and suppliers. HP offers the industry's broadest line of component test instruments for passive as well as active components. The products in this section are designed to measure fundamental impedance-related parameters of electronic components and materials. For S-parameter analysis, see Network Analyzers.

Impedance Analyzer Selection Guide

Model	Frequency Range	Impedance Range/Other	Additional Information	Page
HP 4192A	5 Hz to 13 MHz	1 Ω to 1 MΩ gain-phase	Floating or grounded devices	360
HP 4194A	100 Hz to 40 MHz 10 kHz to 100 MHz 10 Hz to 100 MHz	10 mΩ to 100 MΩ 0.1 Ω to 1 MΩ gain-phase	Color display, equivalent circuit analysis, auto sequence program	358, 359
HP 4395A with Option 010 and HP 43961A	100 kHz to 500 MHz	2 Ω to 5 kΩ* S-parameters, gain-phase	Color display, vector-network and spectrum analysis , IBASIC	268, 269
HP 4396B with Option 010 and HP 43961A	100 kHz to 1.8 GHz	2 Ω to 5 kΩ* S-parameters, gain-phase	Color display, vector-network and spectrum analysis, IBASIC	270, 271
HP 4291B	1 MHz to 1.8 GHz	0.1 Ω to 50 kΩ*	Color display, IBASIC, SMT fixtures, equivalent circuit analysis, material	356, 357

* 10% accuracy range

LCR and Resistance Meter Selection Guide

Model	Frequency Range	Impedance Range/ Other	Additional Information	Page	
HP 4263B	100 Hz to 100 kHz (5 test frequencies)	1 mΩ to 100 MΩ	Optional transformer test	364	🚚
HP 4268A	120 Hz/1 kHz	0.0001 nF to 2000 μF	High-value ceramic capacitor test	368	
HP 4284A	20 Hz to 1 MHz (8610 freq. points)	0.01 mΩ to 100 MΩ	HP 42841A for high-current dc bias	365, 366	
HP 4285A	75 kHz to 30 MHz (100 Hz steps)	0.01 mΩ to 100 MΩ	HP 42851A Q adapter for high Q measurement	365, 366	
HP 4286A	1 MHz to 1 GHz (10 kHz steps)	200 MΩ to 3 kΩ	High-accuracy, high-speed RF LCR Meter	367	
HP 4278A	1 kHz/1 MHz	0.00001 pF to 200 μF	High-speed capacitor test	368	
HP 4279A	1 MHz	0.00001 pF to 1280 pF	C-V meter, 0 to ± 38 V		
HP 4339B	dc	1 kΩ to 1.6 x 10^{16} Ω	High-resistance meter, volume and surface resistivity, current	370	🚚
HP 4338B	1 kHz test signal	10 μΩ to 100 kΩ	Milliohmmeter	369	🚚

🚚 Indicates QuickShip availability.

Materials Measurements

Materials have two properties that determine how they interact with electromagnetic fields:

- Permittivity (ε) or dielectric constant for electric fields
- Permeability (μ) for magnetic fields

Permittivity ($\varepsilon^* = \varepsilon' - j\,\varepsilon''$) and permeability ($\mu^* = \mu' - j\,\mu''$) are complex values. The real part (ε' or μ') is a measure of how much energy is stored in a material. The imaginary part (ε'' or μ'') is a measure of how much energy is lost in a material. These properties are not constant and may change with frequency or temperature, for example. Accurate measurements of these material properties during characterization or inspection help to achieve the best performance for a given application while shortening design cycles and minimizing scrap.

A materials measurement system consists of an instrument, a fixture to hold the material, and software or firmware to calculate complex permittivity or permeability values and display the results. For material testing applications, HP currently offers three types of solutions: LCR meter-based, impedance analyzer-based, and network analyzer-based systems. LCR meters cover up to 1 GHz with discrete test frequencies. Impedance analyzers cover from 20 Hz to 1.8 GHz. Network analyzers cover the frequency range from 300 kHz to 110 GHz.

HP offers fixture accessories based on the open-ended coaxial probe, the transmission line measurement, the parallel plate capacitance, and the inductor impedance technique. These choices allow you to best match the fixture, frequency range, and measurement technique with your material's physical and electrical test requirements. Material test applications and solutions are shown in the chart below. See pages 362 to 363 for dielectric and magnetic material test solutions.

7

Material Test Applications and Solutions

	DC resistivity cell (HP 16008B) Page 370	Dielectric test fixture (HP 16451B) Page 363	Liquid dielectric test fixture (HP 16452A) Page 363	Dielectric and magnetic test fixtures (HP 16453A) (HP 16454A) Page 362	Dielectric probe system (HP 85070M) Page 361	HP material measurement software (HP 85071B) Page 361
Absorber					•	•
Ceramic	•	•		•	•	
Fermentation					•	
Film (thin)		•		•		
Food					•	
Gel, semi-solid					•	
Liquid			•		•	
Loss		•	•	•	•	
Permeability				•		•
Permitivity (dielectrics)		•	•	•	•	•
Plastic	•	•		•	•	
Powder					•	
Printed circuit board		•		•		
Resistivity	•					
Rubber	•	•		•	•	
Solid	•	•		•	•	
Substrate	•	•		•	•	

Component Test Instruments

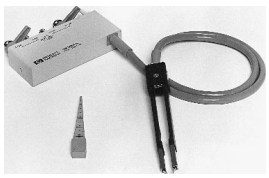
Overview

HP 16093A with HP 16099A
Note: Refer to the sections of the HP 41941A/B for more information.

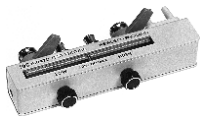
HP 16452A

HP 16314A

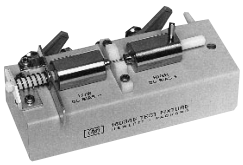
HP 16451B



HP 16334A



HP 16047C



HP 16034E

HP 16065A

HP 16089B

LCR Meter and Impedance Analyzer Fixture Compatibility Guide

	HP 16034E SMD/Chip	HP 16034H SMD/Chip, Array	HP 16034G SMD/Chip, Small	HP 16044A SMD/Chip, Four-terminal f < 10 MHzl	HP 16047A Axial and Radial, f < 13 MHz	HP 16047C HF Axial and Radial	HP 16047D Axial and Radial	HP 16048A One-Meter Test Leads, BNC	HP 16048B One-Meter Test Leads, SMC	HP 16048D Two-Meter Test Leads, BNC	HP 16048E Four-Meter Test Leads, BNC	HP 16060A Transformer Test Fixture	HP 16065A Ext. Voltage Bias w/ Safety Cover, < 200 V	HP 16065C Ext. Voltage Bias Adapter, < 40 V	HP 16085B Four-Terminal Pair to APC-7 Adapter	HP 16089A/B/C/D/E Clip Leads	HP 16092A RF Spring Clip: Axial, Radial and SMD	HP 16093A RF Two-Terminal Binding Post	HP 16093B RF Three-Terminal Binding Post	HP 16094A w/8120-4779 RF Probe Tip/Adapter	HP 16095A LF Probe Adapter	HP 16099A RF Probe to APC-7 Adapter	HP 16191A Side Electrode SMD Test Fixture	HP 16192A Parallel Electrode SMD Test Fixture	HP 16193A Small Side Electrode SMD Test Fixture	HP 16194A Wide Temperature SMD Test Fixture	HP 16314A 50 Ω/4-Term Converter 100 Hz–10 MHz	HP 16334A SMD/Chip Tweezer, < 30 MHz	HP 16451B Dielectric Test Fixture < 30 MHz	HP 16452A w/HP 16048B Liquid Test Fixture	HP 16453A RF Dielectric Test Fixture	HP 16454A RF Magnetic Test Fixture	HP 42842A/B High Bias Current 20A/40A	HP 42842C High Bias Current 10A
HP 4192A	•	•	•	•	•	•	•	•	•				•	•	•	•	1	1	1	1	•		1	1	1	1	1		•	•				
HP 4194A	•	•	•	•	•	•	•	•	•				•	•	•	•	1	1	1	1	•		1	1	1	1	1	•	•	•				
HP 4194A w/HP 41941A/B																	2	2	2	2		•	2	2	2	2								
HP 4263B	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	1	1	1	1	•		1	1	1	1								
HP 4268A	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	1	1	1	1	•		1	1	1	1		•	•	•				
HP 4278A	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	1	1	1	1	•		1	1	1	1		•	•	•				
HP 4279A	•	•	•	•	•	•	•	•	•	•			•	•	•		1	1	1	1	•		1	1	1	1		•	•	•				
HP 4284A	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	1	1	1	1	•		1	1	1	1	•	•	•	•			•	
HP 4285A	•	•	•	•	•	•	•	•	•	•	•		•	•	•		1	1	1	1	•		1	1	1	1	•	•	•	•				•
HP 4286A																	•	•	•	•			•	•	•	•								
HP 4291B																	•	•	•	•			•	•	•	•					•	•		
HP 4395A w/HP 43961A																	•	•	•	•			•	•	•	•								
HP 4396B w/HP 43961A																	•	•	•	•			•	•	•	•								

•=Compatible 1=16085B adapter required 2=16099A adapter required

HP E4915A
HP E4916A

- Adopting transmission method
- 1 MHz to 180 MHz with 1 mHz resolution
- ± 2 ppm/± 5% Fr/CI accuracy
- High-speed measurement: 125 ms
- Remove parasitics using PI-Network calibration function
- Display equivalent circuit parameters of crystal unit
- Easy operation and fast measurement of Drive Level Dependency Test (HP E4916A)
- Small size, lightweight, one-box instrument

E4915A

E4916A

HP E4915A/E4916A Crystal Impedance Meter

The HP E4915A Crystal Impedance Meter and the HP E4916A Crystal Impedance/LCR Meter provide excellent crystal impedance (CI) and resonant frequency (Fr) measurement performance from 1 MHz to 180 MHz. CI and Fr are measured using the transmission method with a PI-Network test fixture.

HP E4915A for Simple Testing of Crystal Resonators

The HP 4915A is a low-cost product having only basic measurement capabilities. The transmission PI-Network method is used, but not the oscillator method. So, the E4915A can cover a wide frequency range using only this single product.

HP E4916A for Complex Testing of Crystal Resonators

The HP 4916A is an enhanced version of the HP E4915A adds variable output power. The E4916A also has additional functions, such as drive level dependency testing, evaporation monitoring, bandpass filter testing, and LCR measurement (optional).

Major Specifications

(See the data sheet for complete specifications.)

	HP E4915A	HP E4916A
Frequency Range: **Frequency Resolution:** **Frequency Accuracy:** **Power Level:**	1 MHz–180 MHz 1 mHz ± 2 ppm –5 dBm (5 μW @ 25 ohm)	1 MHz–180 MHz 1 mHz ± 2 ppm –60 ± 18 dBm (1–100 MHz) (0.1 nW–1 mW @ 25 ohm)
Meas. Mode	Crystal, Spurious	Crystal, Spurious; Drive Level Dependency (DLD); Evaporation Monitoring (EM), Filter; LCR (Option 010)
Meas. Parameter	Fr, Fs, FL, Fa, CI, C0, C1, R1, L1, Q Spurious	Fr, Fs, FL, Fa, CI, C0, C1, R1, L1, Q; Spurious DLD: delta-Fr, delta CI, Max CI Filter: insertion loss, x dB BW; LCR: |Z|, |Y|, Θ, R, X, G, B, Ls, Lp, Cs, Cp, D, Q
Meas. Accuracy (SPC)	Fr: ± 2 ppm CI: ± 5 %	Fr: ± 2 ppm CI: ± 5 % |Z|:± 3%
Meas. Speed (SPC)	125 ms/device (Fr, CI meas.)	125 ms/device (Fr, CI meas.)

SPC: Supplemental Performance Characteristics

General Specifications

Power Requirements: 90 to 132 V or 198 to 264 V, 47 to 63 Hz, 1A max.
Operating Temperature: 0° to 55° C
Size: 320 mm W x 100 mm H x 450 mm D (12.6 in x 3.94 in x 17.72 in)
Weight: E4915A: 4.8 kg (10.6 lb) E4916A: 5.3 kg (11.7 lb)

Furnished Accessories

Operation manual, BNC cable (2ea.), power cable
Crystal Measurement s/w for HP VEE
Note: To use this software, HP E2120C or HP E2120D HP VEE for Windows is required. For more information about HP VEE, see the Sales Literature of the HP E2120C (p/n-5964-5941) or the HP E2120D, p/n-5965-6490E. (The test fixture must be ordered separately.)

Key Literature

HP E4915A/E4916A Crystal Impedance/LCR Meter
Product Overview, p/n 5965-1172E

Ordering Information

HP E4915A Crystal Impedance Meter
Manual Options
Opt 0B0 Delete Manual Set
Opt 0B1 Add Manual Set
Opt ABA U.S.-English localization
Opt ABJ Japan-Japanese localization
Opt AB2 China-Chinese localization
Service Options
Opt UK6 Commercial Cal. Certificate w/ test data
Cabinet Options
Opt 1CM Rackmount Kit
Opt 1CN Handle Kit

HP E4916A Crystal Impedance/LCR Meter
Opt 001 Add Impedance Probe Kit
Opt 010 Add LCR Measurement Function
Manual Options: (Same as HP E4915A)
Service Options
UK6 Commercial Cal. Certificate w/ test data
Cabinet Options: (Same as HP E4915A)

Test Fixtures and Accessories

HP 41900A PI-Network Test Fixture
Opt 001 CL Adapter Kit
HP 41901A SMD PI-Network Test Fixture
Opt 010 to 060 Attachment kit
Opt 011 to 061 CL Adapter kit

RF Impedance Material Analyzer, 1 MHz to 1.8 GHz

HP 4291B

- Basic accuracy ±0.8%
- Advanced calibration and error compensation
- Four component test fixtures (DUT size: 0.5 mm to 20 mm)
- Independent parameter selection in 2 channels
- Direct read-out permittivity, permeability (option)
- Two material fixtures (operating temperature: –55° to +200° C)
- Versatile analysis (temperature, cole-cole plot, relaxation time)
- Sweep parameters (frequency, ac level, dc bias, temperature)

HP 4291B

HP 4291B RF Impedance/ Material Analyzer

Excellent Performance

The HP 4291B RF impedance/material analyzer provides a total solution for high-accuracy and easy measurement of surface-mount components and dielectric/magnetic materials. The HP 4291B uses a direct current-voltage measurement technique, opposing the reflection measurement technique, for more accurate impedance measurement over wide impedance range. Basic impedance accuracy is ± 0.8%. High Q accuracy enables low-loss component analysis. An internal synthesizer sweeps frequency from 1 MHz to 1.8 GHz with 1 mHz resolution. A 1.8-m error-less cable connects the analyzer to a test station so you can extend your test point away from the analyzer without losing accuracy. Advanced calibration and error compensation function eliminate measurement error factors in fixtures and assure high accuracy and repeatability at DUT/MUT.

The HP 4291B also provides automatic level control and monitor of test signals by using IBASIC programming function; devices can be measured under a constant voltage or current. Measure bias-dependent impedance characteristics with optional dc bias (up to 40 V and 100 mA). At the push of a button, the built-in Equivalent Circuit Analysis Function automatically calculates the circuit constant values of five circuit models (similar to HP 4194A's Equivalent Circuit Analysis Function).

The HP 4291B has two measurement channels; each channel can be set to measure a single (e.g. Z) or dual (e.g. Z-theta) impedance parameter. The color TFT with split-display can show both active traces and memory traces (stored in RAM). A built-in floppy disk drive stores programs and test data in either LIF or MS-DOS format.

With built -in IBASIC, you can control external test equipment such as a temperature chamber or wafer prober directly from the HP 4291B. You do not need a separate instrument controller.

Material Evaluation

The HP 4291B enables easy and sophisticated material evaluation and improves material evaluation quality and efficiency. The HP 4291B provides the total dielectric/magnetic material measurement solutions in wide frequency range (1 MHz to 1 GHz). See page 362 for more information.

Key Features

- Direct material parameter read-out (permittivity, permeability)
- Material analysis functions (Cole-Cole plots, relaxation time analysis)
- Versatile evaluation using a variety of swept parameters (frequency, signal level, temperature, etc.)

Test Fixtures

Select from four types of component test fixtures: HP 16191A, HP 16192A, HP 16193A, and HP 16194A. These test fixtures directly connect to the test station's APC-7 connector. Each fixture is designed for a different component size range, from 0.5 mm to 20 mm, and can handle different types of termination. These adjustable fixtures simplify device connection. For temperature coefficient testing, the HP 16194A high-temperature component test fixture can be used in a temperature oven from –55° to +200° C. Together with the HP 4291B's built-in compensation software, the fixtures ensure impedance accuracy and measurement repeatability. The HP 16453A dielectric material test fixture and HP 16454A magnetic material test fixture improve the accuracy and ease of use for permittivity or permeability measurements. These material fixtures have wide operating temperature of –55° to +200° C.

For measuring thin-film devices and semiconductors, the HP 4291B easily interfaces to a wafer prober. An extension cable connects the HP 4291B's test head to a probe station. For temperature and humidity testing, the HP 4291B can control an external temperature humidity chamber via HP-IB and display the measurement result vs. temperature or humidity.

Ease of Use

With the HP 4291B, impedance testing is easy. The analyzer comes with on-line calibration and compensation routine to simplify the task. Markers and limit-line function offer quick data analysis.

Specifications

Measurement Parameters

Impedance Parameters: |Z|, |Y|, Θ, R, X, G, B, Cp, Cs, Lp, Ls, Rp, Rs, D, Q
Converted Parameters: |Γ|, U, Γx, Γy
Material Parameters: |ε|, Θ, ε′, ε″, |μ|, μ′, μ″
Operating Frequency: 1 MHz to 1.8 GHz
Frequency Resolution: 1 mHz
Frequency Reference Accuracy: < ± 10 ppm/year @ ± 5° C
Precision Frequency Reference (Option 1D5)
Accuracy: < ± 1 ppm/year @ 0° to 55°, referenced to 23°C

Basic Measurement Accuracy

Frequency (Hz)	Impedance %	Phase (radian)
1 M to 100 M	0.8	8 m
200 M	1.0	10 m
500 M	1.5	15 m
1 G	2.5	25 m
1.8 G	4.0	40 m

Source Characteristics

OSC Level: 0.2 mV to 1 V rms (1 MHz to 1 GHz)
(Output terminal open)
0.2 mV to 0.5 V rms (1 GHz to 1.8 GHz)
Basic OSC Level Accuracy: 2 dB + 6 dB X f[MHz]/1800 @ 23 ± 5°C;
(terminated with 50 Ω) @ V ≥ 250 mV
Display Level Unit: V,I, dBm
Level Monitor Function: Voltage, current
Connector: APC-7
Output Impedance (nominal value): 50 Ω

DC Bias

DC Level: 0 to ± 40 V, 0 to ± 100 mA
DC Level Accuracy:
Voltage Level: 0.1% + 4 mV + (Idc[mA] X 5 [Ω] mV @ 23 ± 5°C
Current Level: 0.5% + 30 μA + (Vdc [V]/10 [kΩ]) mA @ 23 ± 5°C
DC Level Monitor Function: DCV, DCI

Sweep Characteristics

Sweep Parameter: Frequency, ac signal level,
dc bias voltage/current (temperature by using IBASIC)

Capacitor Calibration

Open/Short/50 Ω Calibration, low loss CAL
Open/Short/Load Compensation, port extension, fixture electrical length

Key Specifications of Test Fixtures

Type of fixture	HP 16191A	HP 16192A	HP 16193A	HP 16194A
Operating freq. (typ.)	dc to 2 GHz	dc to 2 GHz	dc to 2 GHz	dc to 2 GHz
Operating temperature	–55° to +55°C	–55° to +85°C	–55° to +85°C	–55° to +200°C
DUT size (length: mm)	2.0 to 12.0	1.0 to 20.0	0.5 to 3.2	2.0 to 15.0

Display

CRT
Type: Color TFT
Size: 8 inch
Number of Display Channels: 2
Format: Single, dual, active + memory, graphic, and tabular

Storage

Type: Built-in 3½-inch floppy disk drive;
volatile RAM disk memory
Disk Format: LIF, DOS
Programming: HP Instrument BASIC (built-in)
Input and Output Characteristics
External Reference Input: 10 MHz ± 100 Hz typically
Internal Reference Output: 10 MHz nominal
Reference Oven Output (Option 1D5): 10 MHz nominal
External Trigger Input: BNC female, TTL Level

General Specifications

Operating Temperature/Humidity: 10° to 50° C/15% to 80% RH
Warm-Up Time: 30 min.
Power Requirements: 90 V to 132 V, or 198 V to 264 V, 47 to 66 Hz,
500 VA max.
Size/Weight
Mainframe: 426 mm W x 234 mm H x 537 mm D/24.2 kg
Test Station: 275 mm W x 95 mm H x 205 mm D/3.7 kg

Key Literature

HP 4291B 1.8GHz Impedance/Material Analyzer Product Overview,
p/n 5966-1501E
HP 4291B 1.8GHz Impedance/Material Analyzer Technical
Specifications, p/n 5966-1543E

Ordering Information

HP 4291B RF Impedance/Material Analyzer
Furnished Accessories: High-Impedance Test Head,
Calibration Kit, Operation Manual, Floppy Kisk, and
Power Cable. (No test fixture is supplied with the
HP 4291A.)
Options
Opt 1D5 Add High-Stability Frequency Reference
Opt 001 Add DC Bias
Opt 002 Add Material Measurement Software
Opt 011 Delete High-Impedance Test Head
Opt 012 Add Low-Impedance Test Head
Opt 013 Add High-Temperature High-Impedance
Test Head
Opt 014 Add High-Temperature Low-Impedance
Test Head

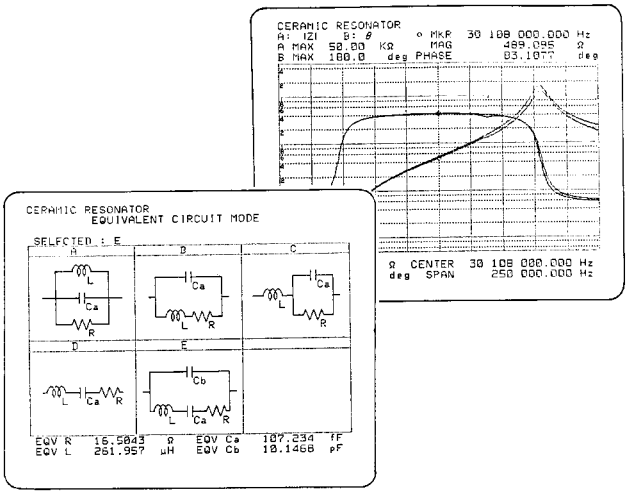
Support Options
Opt W30 Extended Repair Service
Opt W32 Calibration Service

Accessories
HP 16190A HP 4291B Performance Test Kit
HP 16191A Side Electrode Test Fixture
HP 16192A Parallel Electrode Test Fixture
HP 16193A Small Side Electrode Test Fixture
HP 16194A High-Temperature Component Test Fixture
HP 16453A Dielectric Material Test Fixture
HP 16454A Magnetic Material Test Fixture

HP 4194A

- Wide range impedance measurement:
  100 Hz to 40 MHz, 10 mΩ to 100 MΩ
  10 kHz to 100 MHz, 0.1Ω to 1 MΩ, when used with the HP 41941A/B
- Gain-phase measurement:
  10 Hz to 100 MHz, –107 dBm to +15 dBm, 0.1 dB resolution
- Flexible measurement, computation, and analysis capabilities on a color graphic display
- Fully programmable

HP 4194A with HP 41941A



HP 4194A Impedance/Gain-Phase Analyzer

The HP 4194A impedance/gain-phase analyzer is an integrated solution for efficient measurement and analysis or go/no-go testing of components and circuits. Detailed impedance and transmission characteristics, including secondary parameter derivations, can be simply and quickly evaluated or tested. The HP 4194A can contribute to improving engineering productivity and reducing test cost. The analyzer is flexible and has wide measurement capabilities in both impedance and transmission measurements. It is also fully programmable using Auto Sequence Programming (ASP). Desired measurements and computations, including graphics analysis, can be programmed simply by storing front-panel keystroke operations, allowing you to customize measurement, computation, and analysis functions. The HP 4194A also features high-accuracy and error elimination functions to ensure reliable measurements.

Wide-Range Accurate Measurement

Featuring a wide test frequency range—100 Hz to 40 MHz for impedance measurement (10 kHz to 100 MHz when using the HP 41941A/B Impedance Probe Kit) and 10 Hz to 100 MHz for gain-phase measurements—the HP 4194A satisfies a wide spectrum of needs. Realistic device characteristics can be analyzed under actual operating conditions by varying the test frequency, test signal level, and dc bias. The HP 4194A's high degree of measurement accuracy—0.17 percent for impedance measurements (1.5 percent when using the HP 41941A/B) with an amplitude ratio of 0.1 dB—ensures that you'll improve the quality of your test devices.

Quick Analysis

The HP 4194A makes high-speed measurements, (approximately 3.7 ms per point), displays results on a color CRT, and performs parameter analysis of components and circuits quickly and efficiently, substantially reducing development and evaluation time. The analysis function not only provides you with impedance and transmission characteristics, but also allows you to determine secondary parameters. Using the marker and line cursor functions, you can obtain the resonating frequency of resonators and the pass band width of band pass filters quickly.

Equivalent Circuit Analysis Function

Using the HP 4194A's equivalent circuit analysis function, you can easily and quickly obtain those equivalent circuit constants that, until now, required a number of time-consuming, complicated calculations. By using measured values, this unique function can approximate the circuit constant values of five circuit models. For example, a resonator's equivalent circuit elements or a coil's self inductance, lead resistance, and stray capacitance can be easily obtained.

The equivalent circuit analysis function also simulates the frequency characteristics of components by using derived circuit values or values you specify. By using approximation and simulation, you can compare design values to measurement values, thereby improving component design efficiency.

Auto Sequence Program (ASP)

The HP 4194A's ASP function, an internal programming feature, allows you to control all HP 4194A operations (measurement, display, and analysis) without the need for an external computer. By using ASP and actual measurement values, you can readily calculate many secondary parameters that you may need to evaluate. You can use the HP 4194A's powerful analysis functions to analyze these calculated parameters.

You can also use ASP to enhance such HP 4194A functions as alternate sweep, sweep timing control, and marker tracking. Because ASP eliminates the need for external controller, thereby eliminating data transfer time, the HP 4194A can quickly and efficiently perform production line go/no-go testing of components such as resonators and filters. All these features combine to increase your engineering and manufacturing productivity.

Increased Capabilities with the HP 41941A/B Impedance Probe Kit

When using the HP 4194A with the HP 41941A/B impedance probe kit, you can perform reliable impedance evaluations up to 100 MHz. Measurement errors due to residual impedance and stray admittance are eliminated by using the calibration standards furnished with the HP 41941A/B and the HP 4194A's automatic calibration function. This makes it possible to make highly accurate measurements (basic measurement accuracy 1.5 to 3 percent) over a wide measurement range of 100 mΩ to 1 MΩ. Calibration accuracy is guaranteed to the tips of the HP 41941A (1.5 m) and HP 41941B (3 m) impedance probes.

The HP 41941A/B can be used as a grounded probe to evaluate the impedance of in-circuit components such as printed circuit patterns, and the input/output impedance of circuits. In addition, you can connect an external dc bias source directly to the HP 41941A/B to perform dc biased measurements up to ± 150 V/0.5 A, to measure the dc characteristics of inductors, capacitors, materials, and semiconductors. To perform swept dc bias measurements, use the HP 4194A's ± 40 V internal dc bias source.

Specifications

Impedance Measurements

Measurement Parameters: |Z|, |Y|, Θ, R, X, G, B, L, C, D, Q.
Twenty parameter combinations are available.
Test Frequency: 100 Hz to 40 MHz (cable length: 0m); 100 Hz to 15 MHz (cable length: 1 m), 1 mHz resolution.
OSC Level: 10 mV –1 V rms (≤ 10 MHz), 10 mV–0.5 V rms (> 10 MHz) (UNKNOWN terminal open), 3-digit resolution
DC Bias: 0 to ± 40 V, 10 mV resolution
Measurement Terminal: 4-terminal pair configuration

Measurement Range and Maximum Resolution:

Measurement parameter	Range	Max. resolution
|Z|,R,X	10 mΩ to 100 MΩ	100 μΩ
|Y|,G,B	10 nS to 100 S	1 nS
Θ	±180°	0.01°
L	1 nH to 100 kH	10 pH
C	10 fF to 0.1 F	0.1 fF
D	0.001 to 10	0.0001
Q	0.1 to 1000	0.1

Basic Measurement Accuracy: 0.17%
Level Monitor: 1 mV to 1 V rms, 1 μA –20 mA

Gain-Phase Measurements

Measurement Parameters: Tch/Rch (dB, Linear Ratio), Tch, Rch (V, dBm, dBV), Θ (degree, rad), τ
Tch=Test Channel, Rch=Reference Channel, τ=Group Delay
Measurement Frequency: 10 Hz to 100 MHz, 1 mHz resolution
Aperture Frequency Range (Group Delay Measurements)**:** 0.5% to 100% of frequency span
OSC Level: –65 dBm to + 15 dBm, 0.1 dB resolution
Measurement Range
- **Tch/Rch:** 0 to ± 120 dB, 0.001 dB resolution
- **Tch, Rch:** –107 dBm to –5 dBm (0 dB attenuator); –87 dBm to +15 dBm (20 dB attenuator); 0.001 dB resolution
- Θ**:** ± 180° (can display phase continuously with the phase scale expansion function), 0.01° resolution
- τ**:** 0.1 ns to 1 s, 0.1 ns resolution

Basic Measurement Accuracy
- **Tch/Rch:** 0.1 dB, 0.5°
- **Tch, Rch:** 0.35 dBm

Level Monitor: Monitor the input level of the reference and test channels in units of dBm, dBV and Volts

Impedance Measurements Using the HP 41941A/B

The specifications listed are for the HP 4194A when used with the HP 41941A/B.
Frequency Range: 10 kHz to 100 MHz, 1 mHz resolution
OSC Level
- **Option 350:** 10 mV to 1.28 V rms
- **Option 375:** 10 mV to 1.54 V rms

DC Bias
- **Internal:** ± 40 V, ± 20 mA
- **External:** ± 150 V, ± 500 mA, max. 25 W

Measurement Range: 100 mΩ to 1 MΩ
Basic Measurement Accuracy: ± 1.5% to 3% (≥ 100 kHz), ± 3% to 6% (< 100 kHz)
Cable Length: HP 41941A: 1.5 m; HP 41941B: 3 m

Common Specifications

Trigger Mode: Internal, external, and manual
Sweep Capabilities
- **Sweep Parameter:** Frequency, OSC level, dc bias (impedance measurements only)
- **Entry:** START/STOP or CENTER/SPAN
- **Sweep Type:** LIN, LOG, ZERO SPAN (dc Bias: LIN or ZERO SPAN only)
- **Number of Measurement Points:** 2 to 401 points
- **Sweep Functions:** Partial sweep, expand markers sweep, program points measurement

Display

CRT: 7.5-inch color CRT
Display Mode: Rectangular (X- A & B), rectangular (A–B), table
Display Control: Autoscale, superimpose, and storage

Analysis

Marker: Single, delta, double markers
Line-Cursor: Line-cursor, delta-line cursor
Equivalent Circuit Function: Approximation, simulation
Arithmetic Operation
- **Data Register Manipulation:** Use arithmetic operations and functions to manipulate data registers
- **Go/No-Go Limits**

Programming

Auto Sequence Program (ASP)**:** Control the HP 4194A's operation with an internal program language. ASP can be entered using the front-panel keys or downloaded from HP-IB
Program Memory Size: 20 kB of nonvolatile memory
Copy: Dump, plot, print mode

General Specifications

Operating Temperature and Humidity: 0 to 40° C (HP 41941A/B: –20 to + 65° C), ≤ 95% RH at 40° C
Storage Temperature: –30° C to + 60° C (HP 41941A/B: –40 to + 65° C)
Safety: Based on IEC-348, UL-1244
Power: 100, 120, 220 V ± 10%, 240 V –10% + 5%, 48 to 66 Hz, 400 VA (max.)
Size: 425 mm W x 375 mm H x 620 mm D (16.73 in x 14.76 in x 24.41 in)
Weight: Net, approximately 37 kg (81.4 lb)

Reference Data

Typical Measurement Speed
- **Impedance:** Approximately 3.7 ms/point
- **Gain-phase:** Approximately 3.5 ms/point
- **Impedance when used with the HP 41941A/B:** Approximately 5.2 ms/point

Accessories Furnished

HP 16047D: Direct Coupled Test Fixture
HP 8120-1838: 30-cm BNC Cable (2 ea.) (Option 350)
HP 04194-61640: 30-cm BNC Cable (2 ea.) (Option 375)
HP 8120-1839: 60-cm BNC Cable (Option 350)
HP 04194-61641: 60-cm BNC Cable (Option 375)
HP 1250-0080: BNC Adapter

Key Literature

HP 4194A Impedance/Gain-Phase Analyzer Data Sheet, p/n 5952-7802

Ordering Information

HP 4194A Impedance/Gain-Phase Analyzer
- **Opt 350*** 50 Ω System
- **Opt 375*** 75 Ω System
- **Opt W30** Extended Repair Service
- **Opt 001** High-Stability Frequency Reference

HP 41941A* Impedance Probe Kit (1.5 m)
HP 41941B* Impedance Probe Kit (3 m)

*Must select either Option 350 or 375.

7

LF Impedance Analyzer, 5 Hz to 13 MHz

HP 4192A

- 5 Hz to 13 MHz variable frequency
- Gain-phase measurement: amplitude, phase, group delay
- Floating or grounded devices
- Impedance measurement: |Z|, |Y|, Θ, R, X, G, B, L, C, D, Q, Δ, Δ%
- Standard HP-IB

HP 4192A (shown with Option 907 handles)

HP 4192A LF Impedance Analyzer

HP-IB

The HP 4192A LF impedance analyzer performs both network analysis and impedance analysis on such devices such as telecommunication filters, audio/video electronic circuits, and basic electronic components. Both floating and grounded devices can be tested.

Specifications

(Refer to data sheet for complete specifications.)

Measuring Signal (23° ± 5°C)

Frequency Range: 5 Hz to 13 MHz
Frequency Step: 0.001 Hz (5 Hz to 10 kHz), 0.01 Hz (10 kHz to 100 kHz), 0.1 Hz (100 kHz to 1 MHz), 1 Hz (1 MHz to 13 MHz)
Frequency Accuracy: ± 50 ppm
OSC Level: 5 mV to 1.1 V rms variable into 50 Ω (amplitude-phase measurement) or open circuit (impedance measurement)
OSC Level Step: 1 mV (5 mV to 100 mV), 5 mV (100 mV to 1.1 V)
Level Monitor (impedance measurement)**:** Current-through or voltage-across sample can be monitored
Control: Spot and sweep via front panel or HP-IB

Measuring Mode

Spot Measurement: At specific frequency (or dc bias)
Swept Measurement: Manual or automatic sweep from START to STOP frequency (or dc bias) at selected STEP frequency (or dc bias) rate
Sweep Mode: Linear or logarithmic (frequency only)
Recorder Outputs: Output dc voltage proportional to each measured value, and frequency or dc bias
Maximum Output Voltage: ± 1 V
Key Status Memory: Five sets of measuring conditions can be stored and recalled at any time
HP-IB Data Output and Remote Control: Standard
Self-Test: Automatic introspective testing
Trigger: Internal, external, manual, or HP-IB

Amplitude-Phase Measurement

Parameter Measured: Relative amplitude B-A (dB) and phase Θ (degrees or radians), B-A and group delay, absolute amplitude A (dBm or dBV) or B (dBm or dBV), and deviation (Δ, Δ%) of all parameters
Reference Amplitude: 0 dBV = 1 V rms, 0 dBm = 1 mW (with 50 Ω termination)
OSC Output Resistance: 50 Ω
Channels A and B: Input Impedance: 1 M Ω ± 2%, shunt capacitance: 25 pF ± 5 pF
Measurement Accuracy (23 ±5° C)**:** Specified at BNC unknown terminals after 30-minute warm-up (test speed: normal or average)

B-A (relative amplitude) and Θ (phase) measurement:
± 0.01 dB, ± 0.05° (at –20 to 0.8 dB V input, freq. =100 to 10 kHz)
A, B (absolute amplitude) measurement:
± 0.4 dB (at –50 to 0.8 dB V input. freq. = 100 to 1 MHz)

Impedance Measurement

Parameter Measured: |Z|–Θ, |Y|–Θ, R–X, G–B, L–D, Q, R,G, C–D, Q, R, G and deviation (Δ, Δ%) of all parameters
Display: 4½ digits, max. display 12999 counts, 19999 for L & C
Circuit Mode: Series equivalent circuit ( ) and parallel equivalent circuit ( ). Automatic selection available.
Auto ZERO Adjustment: Automatic normalization of the readout offset due to residuals of the test fixture by pushbutton operation (at spot frequency)
Measuring Range and Accuracy (23° ± 5°C)**:** Specified at BNC unknown terminals after 30 minute warmup when OSC level is more than 0.1 V and when auto ZERO adjust is performed (test speed: normal or average). Accuracy given below is only valid when the measured value is equal to full scale of each range.

|Z|–Θ , R–X, |Y|–Θ, G–B Measurement:

Parameters	Measurement range	Basic accuracy
|Z|, R, X	1.0000 Ω to 1.000 MΩ	0.15%
|Y|, G, B	10.000 μS to 10.00 S	0.15%
Θ	–180.00° to +180.00°	0.08°

R accuracy (D ≥ 10); X accuracy (D < 1)
G accuracy (D > 1); B accuracy (D ≤ 0.1)

L–D • Q, C–D • Q Measurement:
(automatically calculated from measured Z/Y values)

Parameters	Measurement range*	Basic accuracy
L	0.01 nH to 1000 H	0.27%
C	1.0000pF to 199** mF	0.15%
D(1/Q)	0.0001 to 19.999	0.001 (C-measurement) 0.003 (L-measurement)

* Varies with measuring frequency except for D(1/Q)
** Accuracy of C ranges over 100 mF is not specified

Internal dc Bias: Standard (impedance measurement only)

Voltage Range: –35 V to +35 V, 10 mV step
Setting Accuracy (23° ± 5°C)**:** 0.5% of setting +5 mV
Bias Control: Spot and swept, using front panel controls or HP-IB

General Specifications

Measuring Time (high-speed mode)
B-A and Θ , A or B: 88 to 127 ms (≥ 400 Hz)
Impedance Parameters: 58 to 91 ms (≥ 1 kHz)
Test Level Monitor Range (impedance measurement)
Voltage: 5 mV to 1.1 V
Current: 1 μA to 11 mA
Operating Temperature: 0° to 55° C, ≤ 95% RH at 40° C
Power: 100, 120, 220 V ± 10%, 240 V +5% to –10%, 48 to 66 Hz, 150 VA max.
Size: 425.5 mm W x 235 mm H x 615 mm D (16.5 in x 9 in x 22.6 in)
Weight: Approximately 19 kg (41.9 lb)
Furnished Accessories and Parts: HP 16047A test fixture, HP 11048C 50 Ω feed thru terminations (2 ea.), power splitter, HP 11170A BNC cables (2 ea.), BNC adapter

Key Literature

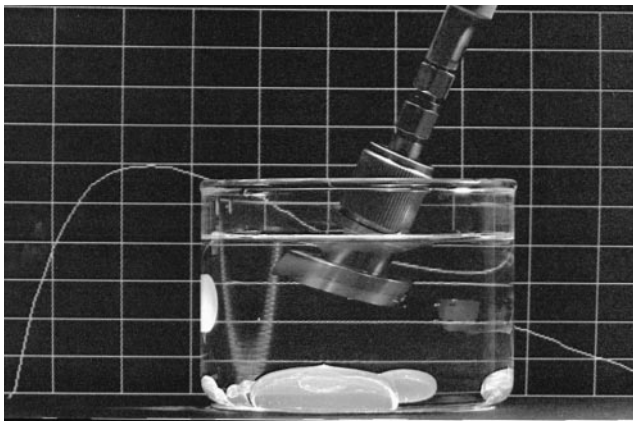
HP 4192A LF Impedance Analyzer Data Sheet, p/n 5952-8896

Ordering Information

HP 4192A LF Impedance Analyzer
Accessories
HP 16095A Probe Fixture
HP 16096A 2-Port Component Text Fixture
HP 16097A Accessory Kit
HP 16047C Test Fixture
HP 16048A Test Leads (BNC connector)

Indicates QuickShip availability.

- Accessories for characterizing the dielectric properties of materials
- Fast and convenient
- Wide frequency ranges from 30 kHz to 110 GHz



HP 85070B Dielectric Probe Kit

Measure the dielectric properties of materials quickly and conveniently with the HP 85070B dielectric probe. Measurements made with a probe-based system are nondestructive and require no sample preparation—saving you time, trouble, and material. The dielectric probe is well-suited for measurements of liquid or semisolid materials. Simply immerse the probe into the material; there is no need for special fixtures. The dielectric probe is not recommended for thin (substrates) or low-loss (resonators) materials.

Knowledge of the dielectric loss of food, rubber, plastic, and ceramic products can assist researchers in the design and optimization of materials in microwave heating processes. Dielectric properties also correlate directly with other material properties—such as moisture content, phase transitions, molecular structure, polarizability, and relaxation constants. For example, this information has been useful in the development of microwaveable prepared foods.

A measurement system based on the HP 85070B dielectric probe yields permittivity (dielectric constant), loss factor, loss tangent, or Cole-Cole diagrams—versus frequency—from 200 MHz to 20 GHz (depending on the network analyzer and material). Measurement accuracy for the dielectric probe is typically five percent.

The HP 85070B high-temperature dielectric probe kit features a hermetic glass-to-metal seal, which makes it resistant to corrosive or abrasive chemicals. It withstands a wide –40° to +200°C temperature range, which allows measurements versus frequency and temperature. This is an important variable, since the dielectric constant of a material can vary significantly as a function of temperature. A special refresh calibration simplifies measurements over temperature. The probe kit contains software and accessories including cables, port/cable adapters, switch, short circuit, mounting bracket, software, adapters, 50 ohm termination, stand, vials, and stoppers.

- Compatible with the HP 8752, 8753, 8719, 8720, 8722 and 8510 network analyzers
- Software runs on Windows 3.1 and Windows 95 or HP 9000 Series 300 (HP BASIC) controllers

HP 85071B Materials Measurement Software

Calculate the permittivity and permeability of material samples loaded into sections of coaxial airline or rectangular waveguide using the HP 85071B software. This measurement technique works well for solid materials that can be machined to fit precisely inside a transmission line.

A dielectric measurement can provide critical design parameter information for materials used in state-of-the-art RF and microwave electronic component applications. The loss of a cable or the impedance of a substrate can be related to its dielectric properties. This information is also useful for improving ferrite, radome, absorber, and packaging designs.

There are a variety of different measurement models to choose from in the HP 85071B software. A complete system requires the addition of a fixture (coaxial or waveguide transmission line), network analyzer, and controller. Measurement accuracies of one percent to two percent are typical from 100 MHz to 110 GHz (depending on the material, fixture, and network analyzer).

The standard version of the software runs on Windows 3.1 or Windows 95 systems. Option 300 provides an HP BASIC version for HP 9000 Series 300 controllers.

Other Solutions

Other measurement techniques based on RF or microwave network analyzers exist and offer their own unique advantages. For example, free-space methods are noncontacting and suitable to temperature extremes. (The HP 85071B materials measurement software is compatible with free-space measurements.) Resonator or cavity methods provide the highest accuracy and sensitivity to low-loss materials.

Below 30 MHz, the HP 16451B dielectric test fixture (coupled with an LCR meter or impedance analyzer) provides accurate low-frequency measurement of materials.

Key Literature

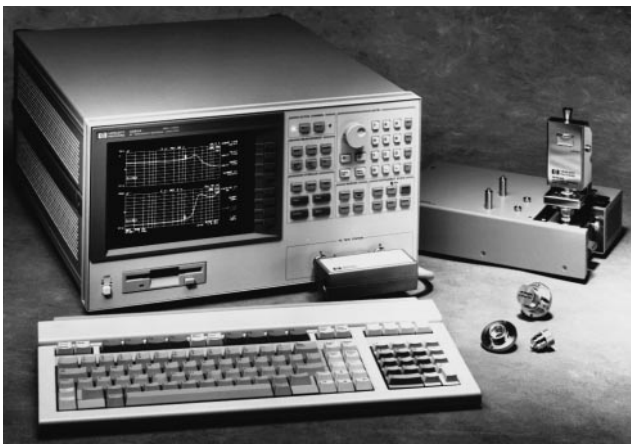
HP 85070B High-Temperature Dielectric Probe Kit Technical Data, p/n 5091-6247E
HP 85071B Materials Measurement Software Technical Data, p/n 5091-6248E
Solutions for Measuring Permittivity and Permeability, p/n 5091-9052E

Ordering Information

HP 85070B High-Temperature Dielectric Probe Kit
Opt 001 Adds Probe Stand
Opt 002 Adds High-Temperature Cable
Opt 300 Substitute HP BASIC Software
HP 85071B Materials Measurement Software
Opt 300 Substitute HP BASIC Software

HP 4291B
Option 002
HP 16453A
HP 16454A

- Integrated system for permittivity and permeability measurement from 1 MHz to 1 GHz
- Versatile fixtures for substrate materials and toroids
- Built-in firmware for direct parameter measurement and easy data analysis



HP 4291 System (HP 4291B, 16453A, and 16454A)

HP 4291B Impedance/Material Analyzer (Option 002 required)

The HP 4291B impedance/material analyzer provides an easy and versatile material test solution from 1 MHz to 1 GHz. The analyzer measures impedance accurately and automatically calculates permittivity and permeability data from impedance. Various interchangeable test fixtures, designed specifically to work with the HP 4291B, let you measure dielectric materials and magnetic materials easily.

HP 16453A Dielectric Test Fixture

The HP 16453A dielectric test fixture is best used for measuring substrate materials (solid, sheet material samples) less than 3 mm in thickness such as PC boards, substrates, and polymer materials. When used with the HP 16453A, the firmware (HP 4291B Option 002) built into the analyzer automatically calculates permittivity parameters. Typical accuracy is ±8% for real part of permittivity and ±0.005 for loss tangent. The flexible firmware also lets you display data as a Cole-Cole plot or find relaxation time.

HP 16454A Magnetic Test Fixture

For permeability analysis, the HP 16454A magnetic test fixture is designed for testing toroidal-shaped samples up to 20 mm in diameter. Examples of suitable materials-under-test are soft ferrite and magnetic cores. The HP 16454A comes with different sizes of sample holders for different toroid sizes for maximum flexibility. Built-in firmware (HP 4291B Option 002) automatically computes permeability parameters, eliminating cumbersome coil-winding or lengthy calculation. Typical accuracy is ±4% for real part of permeability and ±0.002 for loss tangent.

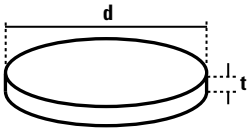
Temperature Coefficient Testing

Both HP 16453A and HP 16454A have an operating temperature range from –55° to +200° C. Two hardware options are available for interfacing the fixtures to a temperature chamber. Choose the HP 4291B Option 013 high-temperature, high-impedance test head for the HP 16453A, or the HP 4291B Option 014 high-temperature, low-impedance test head for the HP 16454A.

Specifications

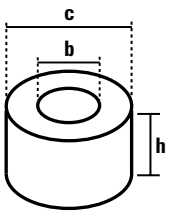
HP 4291B Option 002
Material Parameters: $|\varepsilon_r|$, ε_r', ε_r'', $|\mu_r|$, μ_r', μ_r'', tan δ
Operating Frequency: 1 MHz to 1 GHz
Basic Accuracy: Permittivity: ε_r: ±8% at ε_r < =10, tan δ: ±0.005 (typical)
Permeability: μ_r: ±4%, tan δ: ±0.002 (typical)

HP 16453A Dielectric Test Fixture



Sample Material Specifications
t: ≤3mm
d: ≥15mm
Operating Frequency Range: 1 MHz to 1 GHz
Operating Temperature Range: –55° to +200° C

HP 16454A Magnetic Test Fixture



Sample Material Specifications

Fixture Holder	Small A	B	Large C	D
c	≤8 mm	≤6 mm	≤20 mm	≤20 m
b	≤3.1 mm	≤3.1 mm	≤6 mm	≤5 mm
h	≤3 mm	≤3 mm	≤10 mm	≤10 mm

Operating Frequency Range: 1 MHz to 1 GHz
Operating Temperature Range: –55° to +200° C

Key Literature

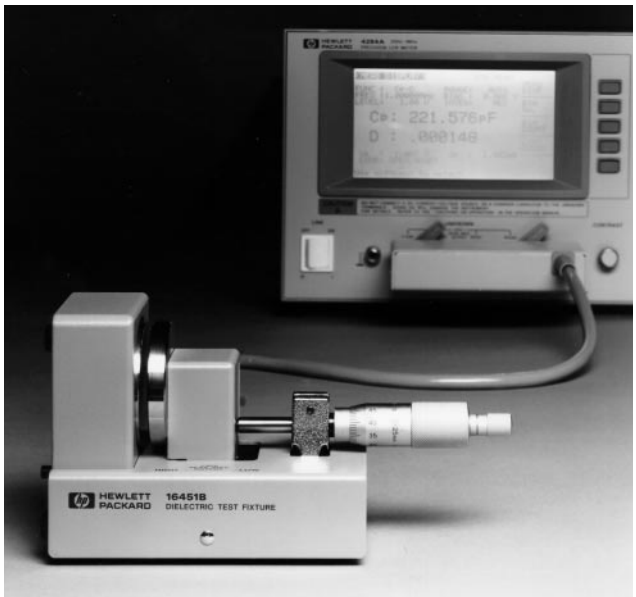
HP 4291B 1.8 GHz Impedance/Material Analyzer Product Overview, p/n 5966-1501E
Permittivity Measurements of PC Board and Substrate Materials using the HP 4291B and HP 16453A, AN Application Note 1300-3, p/n 5966-1844E
Permeability Measurements using the HP 4291B and HP 16454A, AN application Note 1300-4, p/n 5966-1844E

Ordering Information

HP 4291B RF Impedance/Material Analyzer
Opt 002 Material Measurement
Opt 013 High-Temperature, High-Impedance Test Head
Opt 014 High-Temperature, Low-Impedance Test Head
HP 16453A Dielectric Test Fixture
HP 16454A Magnetic Test Fixture

HP 16451B
HP 16452A

- For measuring capacitance or dielectric constant of solid materials
- Designed for HP four-terminal-pair LCR meters or impedance analyzers



HP 16451B Dielectric Test Fixture

HP 16451B Dielectric Test Fixture

For dielectric constant evaluation of solid materials such as polymer, electric insulator, PC board, ceramic substrate, etc., use the HP 16451B dielectric test fixture with any HP four-terminal-pair LCR meter or impedance analyzer up to 30 MHz. The HP 16451B has four types of electrodes which can be replaced according to sample size or measurement technique. Stray admittance and residual impedance of the test fixture can be eliminated by the OPEN/SHORT error correction function of the measurement instrument by using the furnished OPEN/SHORT attachments.

Specifications

Frequency Range: ≤ 30 MHz (depends on instruments)
Operating Temperature: 0 to +55° C
Sample Size: Diameter 10 to 56 mm, Thickness ≤10 mm
Parameters: Capacitance, $|\varepsilon|$, or loss tangent (depends on the LCR meter used)
Electrical Interface: Four-terminal pair

Key Literature

HP 16451B Dielectric Test Fixture Data Sheet, p/n 5950-2368

Ordering Information

HP 16451B Dielectric Test Fixture

- For measuring capacitance or dielectric constant of liquids
- Designed for HP four-terminal-pair LCR meters or impedance analyzers

HP 16452A Liquid Test Fixture

HP 16452A Liquid Test Fixture

For convenient testing of liquids, use the HP 16452A liquid test fixture with any HP four-terminal-pair LCR meter or impedance analyzer. With the HP 16452A, you will be able to measure permittivity and impedance characteristics of liquid materials like plastic resins, biological fluids, and petrochemical products. The fixture has inlet/outlet ports which allow continuous measurements of liquids flowing in a process monitoring environment. The internal cell allows accurate measurements to be performed on a small amount of liquid samples.

Specifications

Operating Frequency: ≤ 30 MHz (depends on instruments)
Operating Temperature: –20° to +125° C
Sample Size: 3.4 ml to 6.8 ml
Parameters: Capacitance, $|\varepsilon|$, or loss tangent (depends on the LCR meter used)
Electrical Interface: Four-terminal pair

Key Literature

HP 16452A Liquid Test Fixture Data Sheet, p/n 5091-9228E

Ordering Information

HP 16452A Liquid Test Fixture
Recommended measurement cables for connecting the HP 16452A to a HP four-terminal-pair LCR meter or impedance analyzer: HP 16048A Test Lead (0° to +55° C) or HP 16452-61601 (–20° to +125° C)

LCR Meter

HP 4263B

- 0.1% basic accuracy
- 100 Hz, 120 Hz, 1 kHz, 10 kHz, 100 kHz test frequencies
- 20 m to 1 Vrms in 5m Vrms steps
- Test signal level monitor function
- High-speed measurement: 25 ms
- High-speed contact check
- Wide capacitance test range
- Transformer parameter measurements (optional)

HP4263B

HP 4263B LCR Meter

The HP 4263B LCR meter is Hewlett-Packard's most cost-effective low-end LCR meter, designed for both component evaluation on the production line and fundamental impedance testing for bench-top applications. The HP 4263B has five test frequencies that allow you to simulate testing under the correct conditions: 100 Hz, 120 Hz, 1 kHz, 10 kHz, and 100 kHz. An optional 20 kHz test frequency can be added to those five frequencies (Option 002).

High-Speed Measurements

The HP 4263B can boost throughput with a measurement speed of 25 ms at any test frequency. This ability improves the throughput of electrolytic capacitor and transformer testing. The HP 4263B can check the contact condition between the test terminals and the device-under-test (DUT). This function ensures the reliability of PASS/FAIL testing with automatic handlers in production. The quick recovery system of the HP 4263B improves throughput. Normal operation is resumed the instant a faulty DUT is removed from the handler, so the handler can always be operated at its full speed.

Electrolytic Capacitor Measurements

The HP 4263B's accuracy and wide measurement range are the right tools to make precise measurements of electrolytic capacitors. Charged capacitors can discharge through the front end and destroy an instrument. The HP 4263B's front end is designed for protection and maintains test integrity.

Transformer Parameter Measurements

With the HP 4263B's ability to make turns ratio (N), mutual inductance (M), and dc resistance (DCR) measurements, data calculations and changing test setups are no longer time-consuming tasks (Option 001). The flexible signal level setting and the voltage-and-current monitor function facilitate the use of the HP 4263B for level dependent DUTs, such as core inductors.

Specifications

(Refer to Product Overview for complete specifications.)

Measurement Functions

Measurement Parameters: |Z|, |Y| , θ, R, X, G, B, L, C, Q, D, ESR

Option 001: Add DCR (dc resistance), N (turns ratio), and M (mutual inductance) measurement

Measurement Circuit Mode: Series and parallel

Mathematical Functions: Deviation and percent deviation

Test Cable Lengths: 0 m, 1 m, 2 m, 4 m (freq. = 100/120/1k Hz); 0 m,1 m, 2 m (freq. = 10k/20k Hz); 0 m, 1 m (freq. = 100 kHz)

Test Signal Information

Test Frequency: 100 Hz, 120 Hz, 1 kHz, 10 kHz, and 100 kHz

Option 002: Add 20 kHz test frequency

Frequency Accuracy: ± 0.01% (freq. = 100 Hz, 1 kHz, 10 kHz, (20 kHz, 100 kHz), ± 1% (freq. = 120 Hz)

Output Impedance: 100 Ω ± 10%, 25 Ω ± 10% (≤ 1 Ω range)

AC Test Signal Level: 20 m to 1 Vrms in 5m Vrms steps

Accuracy: ± (10% + 10 mV)

Internal dc Bias

Level: 1.5 and 2 V; **Accuracy:** ± (5% + 2 mV)

External dc Bias: 0 to +2.5 V

Measurement Range

Parameter	Measurement range
|Z| , R, X	1 mΩ to 100 MΩ
|Y| , G, B	10 nS to 1000 S
C	1 pF to 1 F
L	10 nH to 100 kH
D	0.0001 to 9.9999
Q	0.1 to 9999.9
θ	–180° to +180°
DCR	1 mΩ to 100 MΩ
N	0.9 to 200 (unspecified)
L, M	1 μH to 100 H (unspecified)
Δ%	–999.99% to +999.99%

Measurement Accuracy: ± 0.1% (basic) (for |Z|, R, X, |Y|, G, B,C, L)

Measurement Time

Mode	Time (typical)
SHORT	25 ms
MEDIUM	65 ms
LONG	500 ms

Test Signal Level Monitor: Voltage and current

Front-End Protection: Internal circuit protection when a charged capacitor is connected to the input terminals. The maximum capacitor voltage is: Vmax = √(8/C) typical @ Vmax ≤ 250 V; Vmax = √(2/C) typical @ Vmax ≤ 1000 V, C is in Farads.

Display Digits: 3, 4, or 5 (selectable)

Correction Function

Zero OPEN/SHORT: Eliminates measurement errors due to stray parasitic impedances in the test fixtures.

Load: Improves measurement accuracy by using a calibrated device as a reference.

Comparator Function: HIGH/IN/LOW for each primary measurement parameter and secondary measurement parameter.

Contact Check Function: Contact failure between the test fixture and device can be detected. Additional time for contact check: 5 ms.

Other Functions

Save/Recall: Ten instrument setups can be saved/recalled from the internal nonvolatile memory.

Continuous Memory Capability: If the instrument is turned off, or if a power failure occurs, instrument settings (except dc bias on/off) are automatically memorized (≤ 72 hours at 23° ± 5° C).

HP-IB Interface: All control settings, measured values, and comparator information.

Handler Interface: All output signals are negative-logic, optically isolated open collectors. Output signals include HIGH/IN/LOW, no contact, index, end of measurement, and alarm. Input signals include keylock and external trigger.

General Specifications

Power Requirements: 90 to 132 V or 198 to 264 V, 47 to 66 Hz, 45 VA max.
Operating Temperature: 0 to 45° C
Size: 320 mm W x 100 mm H x 300 mm D (12.6 in x 3.94 in x 11.81 in)
Weight: 4.5 kg (9.9 lb)

Key Literature

HP 4263B LCR Meter Product Overview, p/n 5964-6181E
LCR Meters, Impedance Analyzers and Test Fixtures Selection Guide, p/n 5952-1430E

Ordering Information

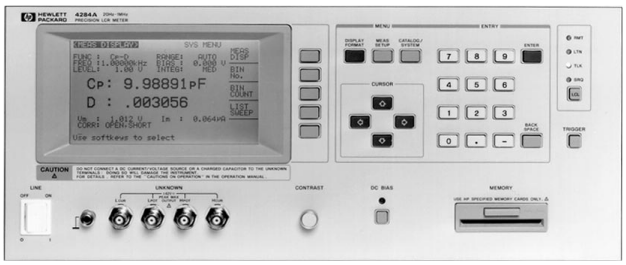
HP 4263B LCR Meter
Opt 001 Add N/M/DCR Measurement Function
Opt 002 Add 20 kHz Test Frequency
Opt ABA US-English Localization
Opt ABJ Japan-Japanese Localization
Opt OBO Delete Operation Manual
Opt W30 Extended Repair Service
HP 16060A Transformer Test Fixture (Opt 001 required)
HP 16065C External Bias Adapter (up to 40 Vdc)
HP 16089A Kelvin Clip Leads (1 m, 2 large clips)
HP 16089B Kelvin Clip Leads (1 m, 2 medium clips)
HP 16089C Kelvin Clip Leads (1 m, 2 IC clips)
HP 16089D Alligator Clip Leads (1 m, 4 medium)
HP 16089E Kelvin Clip Leads (1 m, 2 large clips)
HP 16064B LED Display/Trigger Box (pass/fail display and trigger)

Indicates QuickShip availability.

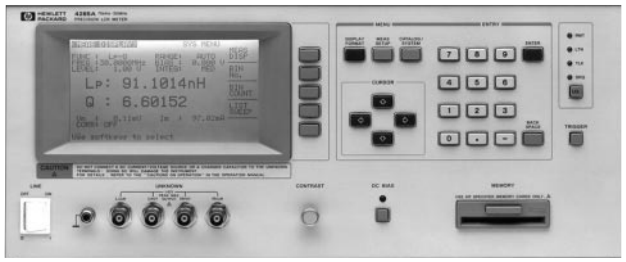
HP 4284A
HP 4285A

- 20 Hz to 1 MHz, with over 8,600 test frequencies
- 0.05% basic accuracy, 6-digit resolution
- Constant V or I test signal level
- 20 Vrms level option (Option 001)
- 40 Adc with HP 42841A
- List sweep measurement capability

- 75 kHz to 30 MHz in 100 Hz steps
- 0.1% basic accuracy
- High-speed measurements: 30 ms/meas.
- Constant V or I test signal level
- 10 Adc with HP 42841A
- Accurate Q measurement with HP 42851A
- List sweep measurement capability



HP 4284A



HP 4285A

HP 4284A, HP 4285A Precision LCR Meters

The HP 4284A and HP 4285A precision LCR meters are cost-effective solutions for component and material measurement. They can be used to improve component quality by providing an accurate, high-throughput test solution. The wide 20 Hz to 1 MHz test frequency range and superior test-signal performance allow the HP 4284A to test components to the most commonly-used test standards, such as IEC/MIL standards, and under conditions that simulate the intended application. For demanding RF component tests, the HP 4285A offers a higher test-frequency range, from 75 kHz to 30 MHz. Whether in research and development, production, quality assurance, or incoming inspection, the HP 4284A and HP 4285A will meet all of your LCR meter test and measurement requirements.

Specifications

(Refer to Data Sheet for complete specifications.)
Parameters Measured: |Z| -θ, |Y| -θ, R-X, G-B; C-D, Q, ESR, G, Rp; L-D, Q, ESR, G, Rp; Deviation and % deviation
Measurement Circuit Modes: Series and parallel
Ranging: Auto and manual
Trigger: Internal, external, manual, and bus (HP-IB)
Delay Time: 0 to 60.000s in 1 ms steps
Measurement Terminals: Four-terminal pair
Test Cable Length:
HP 4284A: Standard: 0 and 1 m; with Option 006: 0, 1, 2 and 4 m
HP 4285A: 0, 1 and 2 m
Integration Time: Short, medium, and long
Averaging: 1 to 256, programmable
Test Signal:
HP 4284A: 20 Hz to 1 MHz ± 0.01%, 8610 selectable frequencies
HP 4285A: 75 kHz to 30 MHz ± 0.01%, 100 Hz steps
Test Signal Modes:
Normal: Programs selected voltage or current at the measurement terminals open or shorted, respectively, and not at the device-under-test.
Constant: Maintains selected voltage or current at the device-under-test independent of changes in the device's impedance.

Test Signal Levels (rms)	Normal	Constant
HP 4284A	5 mV to 2 V, 50 μA to 20 mA	10 mV to 1 V, 100 μA to 10 mA
Option 001	5 mV to 20 V, 50 μA to 200 mA	10 mV to 10 V, 100 μA to 100 mA
HP 4285A	5 mV to 2 V, 200 μA to 20 mA	10 mV to 1 V, 100 μA to 20 mA

DC Bias:
HP 4284A Standard: 0 V, 1.5 V and 2 V
HP 4284A/4285A Option 001: 0 V to ± 40 V

Measurement Display Range

Parameter	Range
|Z|, R, X	0.01 mΩ to 99.9999 MΩ
|Y|, G, B	0.01 nS to 99.9999 S
C	HP 4284A: 0.01 fF to 9.9999 F HP 4285A: 0.01 fF to 999.999 μF
L	HP 4284A: 0.01 nH to 99.9999 kH HP 4285A: 0.001 nH to 99.9999 H
D	0.000001 to 9.99999
Q	0.01 to 99999.9
θ	–180.000° to 180.000°
Δ%	–999.999% to 999.999%

Basic Measurement Accuracy

	|Z|, C, L	D
HP 4284A	0.05%	0.0005
HP 4285A	0.1%	0.001

@ 23° ± 5° C, after OPEN and SHORT correction

Supplemental Characteristics

Measurement Time: Typical measurement time from the trigger command to the end of measurement (EOM) output at the handler interface connector

	HP 4284A at 1 KHz	HP 4285A 75 kHz to 30 MHz
SHORT	40 ms	30 ms
MEDIUM	190 ms	65 ms
LONG	830 ms	200 ms

Option 001 DC Bias Current Output: 100 mA max.

Display

LCD dot-matrix display: Displays measured values, control settings, comparator limits and decisions, list sweep tables, self-test messages, and annunciations.

Correction Function

Zero OPEN/SHORT: Eliminates measurement errors due to the test fixture's stray parasitic impedance.
Load: Improves measurement accuracy by using a calibrated device as reference.

List Sweep Function

A maximum of ten frequencies or test signal levels can be programmed. Single or sequential testing can be performed. When Option 001 is installed, dc voltage bias testing can also be performed.

7

Comparator

Ten-bin sorting for the primary measurement parameter. IN/OUT for the secondary measurement parameter.
Bin Count: 0 to 999999
List Sweep Comparator: HIGH/IN/LOW decision output for each measurement point in the list sweep table

Other Functions

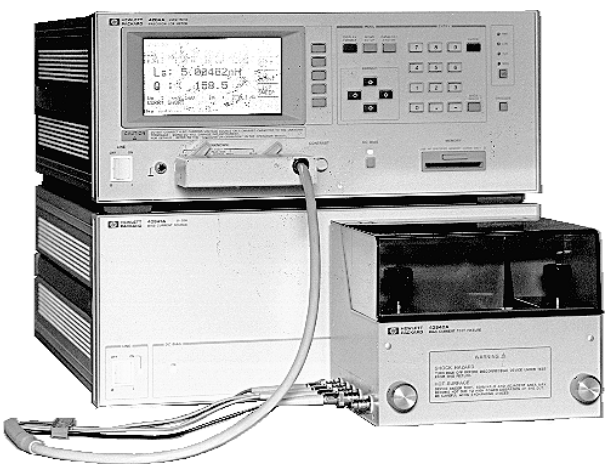
STORE/LOAD: Ten instrument setups can be stored/ loaded from the internal non-volatile memory. Ten additional setups can also be stored/loaded from a memory card.
HP-IB: All instrument control settings, measured values, comparator limits, list sweep table, and self-test results.
Memory: The memory buffer can store a maximum of 128 measurement results and output the data over HP-IB, ASCII, and 64-bit binary data formats.

General Specifications

Power Requirements: 100/120/220 V ± 10%, 240 V 5%/–10%, 47 to 66Hz
Power Consumption: 200 VA max.
Operating Temperature and Humidity: 0° to 55° C, ≤ 95% RH at 40° C
Size: 426 mm W x 177 mm H x 498 mm D (16.77 in x 6.97 in x 19.61 in)
Weight: Approximately 16 kg (35.2 lb)

Accessories

HP 42841A Bias Current Source
Bias Current Output: (23 ± 5° C); 0.01 A–20.0 A
Basic Impedance Accuracy: 1% when used with the HP 4284A/4285A (1 kHz to 1 MHz)
Interface: Custom, directly controllable by the HP 4284A/4285A with Option 002
HP 48242A/B Bias Current Test Fixture
Used with the HP 4284A and HP 42841A for high dc bias current measurements:
HP 42842A: 20 A max.
HP 42842B: 40 A max.
HP 42842C Bias Current Test Fixture
Used with the HP 4285A and HP 42841A for high dc bias current measurement. 10 A max.
HP 42843A Bias Current Cable
Used with the HP 4284A, HP 42841A (2 units), and HP 42842B for 40 A maximum applications



HP 4284A with HP 42841A and HP 42842A

HP 42851A Precision Q Adapter

Used with the HP 4285A for resonant Q measurements
Parameters Measured: Q-L, Q-C
Q Measurement Range: 5.00 to 999.99
Basic Q Accuracy: 5%
Measurement Time: 75 ms to 1.5 s
Interface: Custom, directly controllable by the HP 4285A with Option 002
Option 001: SMD Text Fixture

HP 4285A with HP 42851A

Key Literature

HP 4284A/HP 4285A/HP 4286A Precision LCR Meter Family Data Sheet, p/n 5963-5391E
HP 4284A Technical Data, p/n 5963-5390E
HP 4285A Technical Data, p/n 5963-5395E
LCR Meters, Impedance Analyzers and Test Fixtures Selection Guide, p/n 5952-1430E

Ordering Information

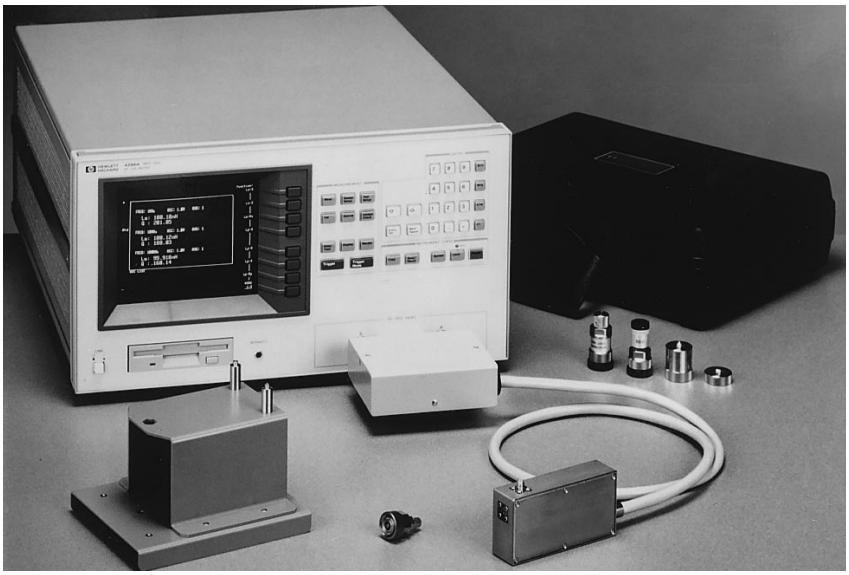
HP 4284A Precision LCR Meter
HP 4285A Precision LCR Meter
Opt 001 Power Amplifier/DC Bias (HP 4284A)
DC Bias (HP 4285A)
Opt 002 Bias Current Interface (HP 4284A)
Accessory Control Interface (HP 4285A)[1]
*__Opt 004__ Memory Card (4284A)
*__Opt 004__ Memory Card (4285A)
Opt 006 2m/4m Cable Length Operation (HP 4284A only)
*__Opt 109__ Delete HP-IB Interface (4284A)
*__Opt 109__ Delete HP-IB Interface (4285A)
*__Opt 201__ General-Purpose Handler Interface (4284A)
*__Opt 201__ General-Purpose Handler Interface (4285A)
*__Opt 202__ Handler Interface (4284A)
*__Opt 202__ Handler Interface (4285A)
*__Opt 301__ Scanner Interface (4284A)
*__Opt 301__ Scanner Interface (4285A)
HP 42841A Bias Current Source
HP 42842A Bias Current Test Fixture (20 A max.)
HP 42842B Bias Current Test Fixture (40 A max.)
HP 42842C Bias Current Test Fixture (10 A max.)
Opt 001 SMD Test Fixture (HP 42842C only)
HP 42843A Bias Current Cable
HP 42851A Precision Q Adapter
Opt 001 SMD Test Fixture

[1] Options 001 and 002 do not operate simultaneously.

* Common options

HP 4286A

- 1 MHz to 1 GHz, with 10 kHz steps
- 1% basic accuracy
- High-speed measurements: 15 ms
- 1 m/3 m errorless cable with APC-3.5 test head



HP 4286A RF LCR Meter

HP-IB

High Accuracy with Wide Impedance Range

The HP 4286A RF LCR meter offers accurate and reliable measurements in order to improve the quality and performance of your electronic components or circuit design. The HP 4286A employs direct-current voltage-measurement technique, as opposed to the reflection-measurement technique, for more accurate impedance measurement over wide impedance range. Also, Q measurement can be much improved due to advanced calibration technique (typical Q accuracy: 6% @ 100 MHz, Q=100). So you can reduce the design uncertainty by measuring your device's true impedance values at RF range.

Ease of Use

The HP 4286A can be easily operated by pressing the front panel keys. In addition, the HP 4286A with Option 1C2 HP-IBASIC allows you to customize measurement, test sequences, process control, and perform data analysis. Also, a number of APC-7 SMD test fixtures are applicable to the HP 4286A with the furnished fixture stand and APC-3.5-to-APC-7 adapter. You don't need to build your own fixture.

Simplified System Integration and High Throughput

The HP 4286A is suitable for testing the electronic components in the production line at RF range. The 1 m/3 m option-selectable errorless cable with test head can be easily connected closely to the tip of the device-under-test of the handler without accuracy decrease. The built-in comparator function, a high-speed HP-IB interface, and an optional handler interface, are available for easily combining with the handler. The HP 4286A also allows you to reduce test time and improve testing efficiency and reliability. The measurement speed is especially remarkable (approximately 15 ms).

Specifications

(Refer to Data Sheet for complete specifications.)
Measurement Parameters: |Z|, |Y|, Theta, R, X, G, B, L, C, Q, D, ESR
Measurement Circuit Mode: Series and parallel
Operating Frequency: 1 MHz to 1 GHz
Frequency Resolution: 10 kHz
Source Characteristics:
- **OSC Level:** 10 mVrms to 1 Vrms; (output terminal open); 10 mVrms to 0.5 Vrms @ 3 m test head, ≥ 500 MHz
- **Basic OSC Level Accuracy:** 2 dB @ V ≥ 0.25 V
- **Display Level Unit:** V, I, dBm
- **Level Monitor Function:** Voltage, current
- **Connector:** APC-3.5

Output Impedance (Nominal Value)**:** 50 Ω
Trigger: Internal, external, manual, and HP-IB
Delay Time: Point delay time, list-sweep delay time
Averaging: Point average, list-sweep average
Impedance Measurement Range: 200 mΩ to 3 kΩ
Basic Measurement Accuracy: |Z|: 1%, D: 0.01
Measurement Time: 15 ms
Interface: HP-IB, handler interface
Display: 7-inch B/W CRT display
Storage:
- **Type:** Built-in 3.5-inch floppy disk drive; backup SRAM disk memory

Disk Format: LIF, DOS
Programming: HP Instrument BASIC (Option 1C2)
General Specifications
- **Operating Temperature/Humidity:** 10 to 50° C/15% to 80% RH
- **Warm-Up Time:** 30 min.
- **Power Requirements:** 90 V to 132 V, or 198 V to 264 V, 47 Hz to 66 Hz, 500 VA max.
- **Size/Weight**
  - **Main Frame:** 426 mm W x 234 mm H x 537 mm D; 28 kg
  - **Test Head:** 110 mm W x 55 mm H x 28 mm D; 0.3 kg

Key Literature

HP Precision LCR Meter Family Data Sheet, p/n 5963-5391E
HP 4286A Technical Specifications, p/n 5963-5394E
LCR Meters, Impedance Analyzers and Test Fixtures Selection Guide, p/n 5952-1430E

Ordering Information

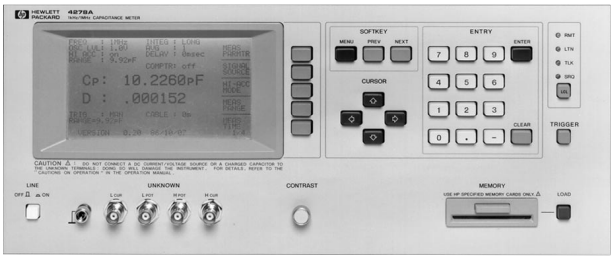
HP 4286A RF LCR Meter
Furnished Accessories: Right Angle Test Head (1m), APC-3.5-to-APC-7 Adapter, Test Fixture Stand, HP 16195A APC-7 Calibration Kit, Operation Manual, Floppy Disk, and Power Cable. (No test fixture is supplied with the HP 4286A.)
Options
- **Opt 021** Add Straight-Angle Test Head (1 m)
- **Opt 022** Add Straight-Angle Test Head (3 m)
- **Opt 031** Delete Right-Angle Test Head (1 m)
- **Opt 032** Add Right-Angle Test Head (3 m)
- **Opt 001** Delete HP 16195A Calibration Kit
- **Opt 002** Delete Test Fixture Stand
- **Opt 004** Add Working Standard Set
- **Opt 1C2** Add HP-IBASIC, Keyboard, Cable

Accessories Available
HP 16190A Performance Test Kit
HP 16191A Side Electrode SMD Fixture
HP 16192A Parallel Electrode SMD Fixture
HP 16193A Small Side Electrode SMD Fixture
HP 16194A High-Temperature Test Fixture
HP 16195A APC-7 Calibration Kit
HP 16092A Test Fixture (≤ 500 MHz)
HP 16093A Binding Post Fixture (≤ 250 MHz)
HP 16093B Binding Post Fixture (≤ 125 MHz)
HP 16094A Probe Test Fixture (≤ 125 MHz)

HP 4278A

NEW

- Measurement speed: 6.5 ms/10 ms/21 ms
- Measurement parameters: C-D,Q,ESR,G
- C-D measurement accuracy: 0.07%, 0.0005 (1 kHz, 21 ms); 0.05%, 0.0002 (1 MHz, 21 ms)
- Constant test level for high value ceramic capacitor tests
- High speed measurement: 25 ms
- Quick contact check
- 9-bin comparator



HP 4278A

HP 4268A

HP 4278A 1 kHz/1 MHz Capacitance Meter

The HP 4278A 1 kHz/1 MHz capacitance meter is a high-speed, highly reliable, precision test instrument aimed at incoming/outgoing capacitor inspection applications on the production line and in quality control. The HP 4278A will improve test efficiency by performing comparative measurements of low to medium value capacitors (up to 200 μF—a range that covers most ceramic and film capacitors).

Specifications

(Refer to Data Sheet for complete specifications.)
Measurement Parameters: C-D,Q,ESR,G
Test Signals
Frequency: 1 kHz and 1 MHz, ± 0.02%
Signal Level: 0.1 to 1 V rms, ± 10% (C≤ 20 μF), in 0.1 V rms steps
Measurement Time: 6.5 ms/10 ms/21 ms (typical)

Measurement Range

Measurement Parameter	1 KHz	1 MHz normal mode 1 MHz high accuracy
C	0.001 pF to 200.000 μF	0.00001 pF to 1280.00 pF; 0.00001 pF to 2663.00 pF
D	0.00001 to 9.99999	0.00001 to 9.99999; 0.00001 to .99999

Cable Length Compensation: 0, 1, or 2 m
Comparator: Ten-bin sorting for capacitance, and go/no-go testing for D, Q, ESR, and G
Memory Card Slot: Memory card slot for external memory for storing and recalling control settings and comparator limits (memory card is optional–see Option 004 below)

General Specifications

Operating Temperature/Humidity: 5° to 45°C, 95% RH @ 40° C
Power: 100, 120, 220 Vac ±10%, 240 Vac +5 –10%, 48 to 66 Hz, 200 VA max.
Size: Approximately 426 mm W x 177 mm H x 498 mm D (16.77 in x 6.97 in x 19.61 in)
Weight: Approximately 15 kg (33 lb, standard)

Ordering Information

HP 4278A 1 kHz/1 MHz Capacitance Meter
Opt W30 Extended Repair Service
Opt 001 1 kHz Test Frequency Only
Opt 002 1 MHz Test Frequency Only
Opt 003 +1% Frequency Shift: Prevents possible test signal interference when component test contacts are located close to those of other test units
Opt 004 Memory Card
Opt 005 –1% Frequency Shift
Opt 006 +2% Frequency Shift
Opt 101 HP-IB Compatibility
Opt 201 Handler Interface
Opt 202 Handler Interface
Opt 301 Scanner Interface
Accessories Available
HP 16270A Memory Card Set

HP 4268A 120 Hz/1 kHz Capacitance Meter

The HP 4268A capacitance meter offers ability to test high value Multi-Layer Ceramic Capacitors at a constant large test signal level and at high speed. The constant test level feature allows the MLCCs to be tested, in compliance with IEC 384-10 standard, for up to 50 μF at 1 V rms at 1 kHz. 120 Hz measurement ensures the constant 1 V test signal for up to 500 μF. The HP 4268A can provide measured values along with comparator results within 25 ms, maximizing test throughput in MLCC production lines.

Major Specifications

Measurement Parameters: Cs, Cp, D, Q, Rs, Rp, G
Test Frequency: 120 Hz and 1 kHz
Test Signal Level: 0.1 V to 1 V rms, 0.01 V rms steps
Measurement Range: 0.0001 nF to 9.9999 mF, 0.0001 to 9.9999D

Constant Test Level Range (Typical):

Test Voltage	120 Hz	1 kHz
0.5 V rms	C ≤ 1000 μF	C ≤ 100 μF
1 V rms	C ≤ 500 μF	C ≤ 50 μF

Measurement Time: 25 ms/40 ms/60 ms (typical)
Contact Check: Detects contact failure in 4T connection within 5 ms
Comparator: 9 bin output to Handler Interface
Interface: Handler, HP-IB and optional Scanner Interface

General Specifications

Power Requirements: 90 to 132 V or 198 to 264 Vac, 47 to 66 Hz, 100 VA max.
Operating Temperature: 0° to 45° C
Size: 320 mm W x 100 mm H x 450 mm D (12.6 in x 3.94 in x 17.72 in)
Weight: Approximately 7 kg

Key Literature

HP 4268A Capacitance Meter Product Overview, p/n 5967-5873E

Ordering Information

HP 4268A 120 Hz/1 kHz Capacitance Meter
Opt 001 Scanner Interface
Accessories Available
HP 16044A 4-Terminal Test Fixture for Chip Components
HP 16034E Chip Component Test Fixture
HP 16334A Tweezer-Type Test Fixture
HP 16048A Test Leads, BNC (1m)
HP 16048B Test Leads, SMC (1m)
HP 16048D Test Leads, BNC (2m)

HP 4338B

- Low and selectable test signal current: 1 μA to 10 mA
- Wide measurement range: 10 μΩ to 100 kΩ
- 10 μΩ resolution
- Contact check function
- 1 kHz ac measurement
- High-speed measurement: 34 ms
- Built-in comparator
- Auto-measurement mode

HP 4338B

HP 4338B Milliohmmeter

The HP 4338B milliohmmeter is a precise, reliable, high-speed test tool for measurements of low resistance.

Precise, Low-Resistance Measurement

Contact failure of electromechanical components in a low-current circuit is a key issue for component reliability. The HP 4338B offers selectable low ac test signals (1 μA to 10 mA). Users can now characterize low resistances of electromechanical components under low-current conditions. A high resolution of 10 μΩ allows you to determine the slightest differences in contact resistance testing of relays, switches, connectors, PC board traces and cables. The 1 kHz test signal eliminates potential errors introduced by thermoelectric effects on the device-under-test (DUT) contacts. The 1 kHz ac test signal is the best solution to evaluate the internal resistance of batteries, because it avoids dc energy consumption.

High-Speed Measurements

The high-speed (34 ms), built-in comparator and HP-IB/handler interfaces make it possible to construct a measurement system using an automatic handler and external computer to minimize production test time.

Auto-Measurement Mode

When performing gross continuity testing where the test signal level is not a significant factor in the test, the auto-measurement function allows the instrument to select an appropriate test signal and measurement range setting.

Specifications

(Refer to Product Overview for complete specifications.)
Measurement Function
Measurement Parameters: R (ac resistance), X (reactance), L (inductance), |Z| (impedance), θ (phase [°])
Combinations: R, R–X, R–L, |Z| –θ (series mode only)
Mathematical Functions: Deviation and percent deviation
Display Digits: 3, 4, or 5 (selectable)
Test Signal Characteristics
Test Frequency: 1 kHz
Frequency Accuracy: ± 0.1%
Test Signal Level: 1 μA, 10 μA, 100 μA, 1 mA, 10 mA rms
Level Accuracy: ± (10% + 0.2 μA)
Maximum Voltage Across Sample: 20 mV peak in any case

Measurement Range

Parameter	Measurement range
R	10 μΩ to 100 kΩ
X, |Z|	10 μΩ to 100 kΩ (typical)
L	10 nH to 10 H (typical)
θ	–180° to +180° (typical)

Measurement Accuracy: ± 0.4% Basic for R

Measurement Time: Time interval from a trigger command to the end of measurement (EOM) signal output at the handler interface port

Mode	Time (typical)
SHORT	34 ms
MEDIUM	70 ms
LONG	900 ms

Correction Function
Zero SHORT: Eliminates measurement errors due to parasitic impedances in the test fixture
Comparator Function
HIGH/IN/LOW for each primary measurement parameter and the secondary measurement parameter
Contact Check Function
Contact failure between the test fixture and device can be detected
Other Functions
Superimposed dc: ± 42 Vdc maximum may be present on measurement terminals.
Save/Recall: Ten instrument setups can be saved/recalled from the internal nonvolatile memory.
Continuous Memory Capability: If the instrument is turned off, or if a power failure occurs, instrument settings are automatically memorized (≤ 72 hours at 23 ± 5° C).
HP-IB Interface: All control settings, measured values, and comparator information
Handler Interface: All output signals are negative-logic, optically isolated open collectors.
Output Signals Include: HIGH/IN/LOW, index, end of measurement, and alarm. Input signals are keylock and external trigger.

General Specifications

Power Requirements: 90 to 132 V or 198 to 264 V, 47 to 66 Hz, 45 VA max.
Operating Temperature: 0° to 45° C
Size: 320 mm W x 100 mm H x 300 mm D (12.6 in x 3.94 in x 11.81 in)
Weight: 4.5 kg (9.9 lb)

Furnished Accessories

Operation manual, power cable (mating cable and test leads, or HP 16338A test lead set, must be ordered separately)

Key Literature

HP 4338B Milliohmmeter Product Overview, p/n 5964-6183E

Ordering Information

HP 16338A Test Lead Set
HP 16143B Mating Cable (0.6 m)
HP 16005B Kelvin Clip Lead (0.4 m, with large clip)
HP 16005C Kelvin IC Clip Lead (0.4 m, with IC clip)
HP 16006A Pin-Type Probe Lead (0.4 m)
HP 16007A Alligator Clip Leads (0.4 m, with 2 red clips)
HP 16007B Alligator Clip Leads (0.4 m, with 2 black clips)
HP 16064B LED Display/Trigger Box
HP 4338B Milliohmmeter
Opt ABA US-English Localization
Opt ABJ Japan-Japanese Localization
Opt OBO Delete Operation Manual
Opt W30 Extended Repair Service

Indicates QuickShip availability.

High-Resistance Meter

HP 4339B
HP 4349B

- Wide measurement range: 1 x 10^3 Ω to 1.6 x 10^{16} Ω
- Stable test fixtures: resistivity cell, component test fixture
- High-speed measurement: 10 ms
- Test sequence programming
- Resistivity calculations
- Grounded DUT measurement

HP 4339B

HP 4339B High-Resistance Meter

The HP 4339B high-resistance meter is Hewlett-Packard's most advanced tool for making precision high-resistance measurements.

Precise and Stable Measurement

The measurement range is from 1 x 10^3 Ω to 1.6 x 10^{16} Ω, with a basic accuracy of 0.6%. This wide range allows accurate, high-resistance measurement of capacitors, relays, switches, connectors, materials, cables, and PC boards. The grounded device-under-test (DUT) measurement capability of the HP 4339B gives you the ability to evaluate cables and transformers under grounded conditions. The HP 16008B resistivity cell and the HP 16339A component test fixture are designed for stable and safe measurements of materials or components.

7

Ease of Use

The test-sequence program function allows you to control a series of resistance measurements in a sequence (charge-measure-discharge). You can set the charge time, measurement interval time, and number of measurements in a sequence through the front panel. The remaining time can be displayed when executing the sequence measurements. Surface resistivity (ρs) and volume resistivity (ρv) functions can be called to act upon measurement data. Calculated results are then automatically displayed, saving you time and effort.

High-Test Throughput

The 10 ms measurement time, 2 ms high-speed contact check function, built-in comparator, and HP-IB/handler interfaces deliver high-speed test throughput for production environments.

HP 4349B 4-Channel High-Resistance Meter

The HP 4349B 4-channel high-resistance meter is HP's highest throughput high-resistance meter for production testing of capacitors. The four-channel configuration permits simultaneous testing of four capacitors with different test voltages using external voltage sources. (Refer to Product Overview for HP 4349B specifications and ordering information.)

HP 4339B Specifications

(Refer to Product Overview for complete specifications.)
Measurement Parameters: R (dc resistance), I (dc current), ρs (surface resistivity), ρv (volume resistivity)
Mathematical Functions: Deviation and percent deviation
Display Digits: 3, 4, or 5 (selectable)
Test Voltage: 0.1 to 1000 Vdc, 0.1 V steps @ 0.1 to 200 V, 1 V steps @ 200 to 1000 V
Voltage Accuracy: (0.16% + 100 mV) @ ≤ 200 V, (0.16% + 500 mV) @ > 200 V
Maximum Current: 10 mA @ ≤ 100 V, 5 mA @ ≤ 250 V, 2 mA @ ≤ 500 V, 1 mA @ ≤ 1 kV
Current Compliance Setting: 0.5 mA, 1 mA, 2 mA, 5 mA, 10 mA
Output Resistance: 1 kΩ ± 10%
Input Resistance: 1 kΩ ± 10%
Test Cable Lengths: 2 m maximum

Measurement Range/Accuracy

Parameter	Measurement range	Basic accuracy
I	60 fA to 100 μA	± 0.4%
R (Ω)	1 x 10^3 Ω to 1.6 x 10^{16}	± 0.6%

Measurement Time: Time interval from a trigger command to the end of measurement (EOM) signal output at the handler interface port (range: hold, display, off)

Mode	Time (typical)
SHORT	10 ms
MEDIUM	30 ms
LONG	390 ms

Correction Function
Zero OPEN: Eliminates measurement errors due to stray parasitic resistance in the test fixtures
Test Sequence Program: Controls a series of resistance measurements. Charge time, measurement internal time, and measurement number can be programmed.
Comparator Function: HIGH/IN/LOW for the measurement parameter
Contact Check Function
Contact failure between the test fixture and device can be detected
Available DUT Type: Capacitive DUTs only
DUT Capacitance: ≥ 1 pF + 5% of residual stray capacitance
Residual Stray Capacitance of the Fixture: ≤ 50 pF
Additional Measurement Time for Contact Check: 2 ms
Other Functions
Save/Recall: Ten instrument setups can be saved/recalled from the internal nonvolatile memory
Continuous Memory Capability: If the instrument is turned off, or if a power failure occurs, instrument settings are automatically memorized (≤ 72 hours at 23° ± 5° C)
HP-IB Interface: All control settings, measured values, and comparator information
Handler Interface: All output signals are negative-logic, optically isolated open collectors. Output signals include: HIGH/IN/LOW, no contact, index, end of measurement, and alarm. Input signals include: high voltage off, keylock, and external trigger.

General Specifications

Power Requirements: 90 to 132 V or 198 to 264 V, 47 to 66 Hz, 45 VA max.
Operating Temperature: 0° to 45° C
Size: 320 mm W x 100 mm H x 450 mm D (12.6 in x 3.94 in x 17.72 in)
Weight: 6.5 kg (14.3 lb)

Furnished Accessories

Operation manual, shunt connector, power cable (Test fixtures and/or test leads must be ordered separately.)

Key Literature

HP 4339B/HP 4349B High Resistance Meters Product Overview, p/n 5964-6182E

Ordering Information

HP 4339B High-Resistance Meter
Opt ABA US-English Localization
Opt ABJ Japan-Japanese Localization
Opt OBO Delete Operation Manual
Opt W30 Extended Repair Service
HP 16339A Component Test Fixture
HP 16008B Resistivity Cell (50 mm Diameter Electrode)
Opt 001 Add 26/76 mm Diameter Electrodes
Opt 002 Add 26 mm Diameter Electrode
Opt 003 Add 76 mm Diameter Electrode
HP 16117B Low-Noise Test Leads (1 m, 2 clips)
Opt 001 Add Pin Probes
Opt 002 Add Soldering Sockets
Opt 009 Delete Alligator Clips
HP 16117C Low-Noise Test Leads (1 m, connectors)
HP 16118A Tweezer Test Fixture
HP 16064B LED Display/Trigger Box

Indicates QuickShip availability.

Impedance Measuring Instruments

HP 4291B 1.8 GHz Impedance/Material Analyzer Product Overview
5966-1501E
HP 4291B 1.8 GHz Impedance/Material Analyzer Technical Specifications
5966-1543E
HP 4192A LF Impedance Analyzer Data Sheet
5952-8896
HP 4194A Impedance/Gain-Phase Analyzer Technical Data
5952-7802
Accessories Selection Guide for Impedance Measurements Configuration Guide
5965-4792E
HP E4915A Crystal Impedance Meter and HP E4916A Crystal Impedance/LCR Meter Product Overview
5965-1172E

(PN 16451B-1) Dielectric Constant Measurements Using the HP 16451B Test Fixture
5962-9522E
(PN 4291-1) New Technologies for Wide Impedance Range Measurements to 1.8 Ghz
5966-2046E
(PN 4291-2) Evaluating Temperature Characteristics Using a Temperature Chamber and the HP 4291B
5966-1927E
On-Chip Semiconductor Device Impedance Measurement Using the HP 4291B (AN1300-7)
5966-1845E

Materials Test Equipment

HP 4291B 1.8 GHz Impedance/Material Analyzer Product Overview
5966-1501E
HP 4291B 1.8 GHz Impedance/Material Analyzer Technical Specifications
5966-1543E
HP 85070M Dielectric Probe Measurement System and HP 85070B High-Temperature Dielectric Probe Kit
5091-6247E/EUS
HP 85071B Materials Measurement Software Technical Data
5091-6248E/EUS
HP 16200A DC Bias Adapter Product Overview
5964-6700E
HP16451B Dielectric Test Fixture Data Sheet
5962-9522E
HP16452A Liquid Test Fixture Product Overview
5091-9228E

(PN 4291B) Impedance Measurements Using the HP 4291B and the Cascade Microtech Prober
5966-1928E
(PN 4291A-5) Dielectric constant Evaluation of Rough Surface Materials
5966-1926E
Solutions for Measuring Permittivity and Permeability
5965-9430E

LCR & Resistance Meters

LCR Meter Family Brochure
5963-5391E
LCR Meters, Impedance Analyzers and Test Fixtures Selection Guide
5952-1430E
HP 16380A/HP 16380C Standard Capacitator Sets
5091-1390E
HP 4278A Capacitance Meter Data Sheet
5952-7882
HP 4286A Specification Sheet
5963-5394E
HP 4338B Milliohm Meter Data Sheet
5964-6183E
HP 4339B/HP 4349B High Resistance Meters
5964-6182E
HP 4284A Technical Data
5963-5390E
HP 4285A Technical Data
5963-5395E
HP 4263B LCR Meter Product Overview
5964-6181E

HP's Test & Measurement Web site.
The more you visit, the more you'll know.

News and information you need, 24 hours a day. Get the most complete support available for all of HP's Test & Measurement tools. Immediate access to information, 24 hours a day, means always getting the most from your instruments:

- Product Information
- Usage Tips
- Application Note Library
- Service, Support and Training
- Sales and Service Contacts
- Selection Guides
- Newsletters
- Feature Stories Showing Products in Use
- Information on Your Industry
- News Releases
- Country-Specific Sites

These features are only a snapshot of what's available at the Web site. Bookmark it—and visit it regularly—to stay completely up to date on all of HP's test and measurement solutions.

Digital Systems Debug & Verification 8

Logic Analysis & Emulation Solutions

Overview

HP provides a broad range of digital system debug tools to help you solve your hardest problems the fastest way.

Creating a Shorter Path from Problems to Insights to Answers

Your design team faces a difficult challenge to deliver quality products to the marketplace faster than your competitors. Part of that challenge is your ability to turn on early prototypes in order to characterize and debug hardware, design and test firmware and software, and perform system integration.

Design problems are getting harder to find and harder to solve. Problems stretch across domains from analog signals to source code. When the prototype does not work as expected, you need debug tools that quickly provide you with reliable insight into your toughest problems.

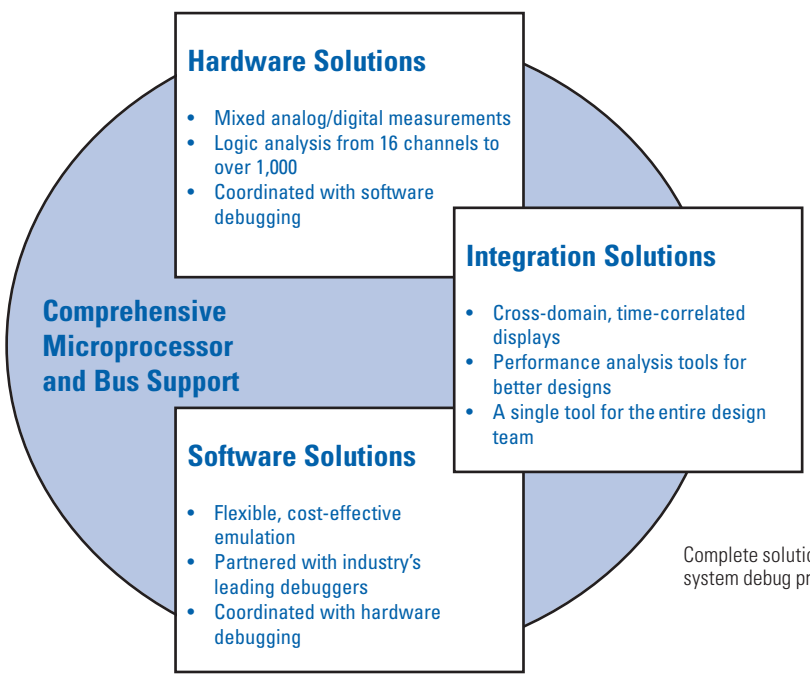
By listening to thousands of designers like you, Hewlett-Packard has developed a wide range of solutions to meet real-world debugging challenges, from 8-bit designs to 64-bit multiprocessor systems using the newest chips on the market.

Solutions from Signals to Source

If you are in need of a general purpose debugging tool, the HP 1660 and 1670 Series benchtop logic analyzers offer cost-effective 100 MHz state analysis plus timing modes at speeds up to 500 MHz. Oscilloscopes and pattern generators in the HP 1660 Series, and deep memory in the HP 1670 Series, give you the power to meet demanding troubleshooting challenges.

The new HP 16700A Series and the HP 16600A Series of scalable debug tools provide the capabilitity to do hardware debug and rapidly integrate complex digital systems. You get the digital hardware debug capabilities and low intrusion factors of a logic analyzer, combined with the software-execution visibility and processor execution control benefits of an emulator.

HP offers insight into hardware/software interaction, software performance and other system-wide behaviors that extend beyond the processor itself.



Complete solutions for all phases of your digital system debug process.

HP Benchtop Logic Analyzers

We've Made One Just Your Size

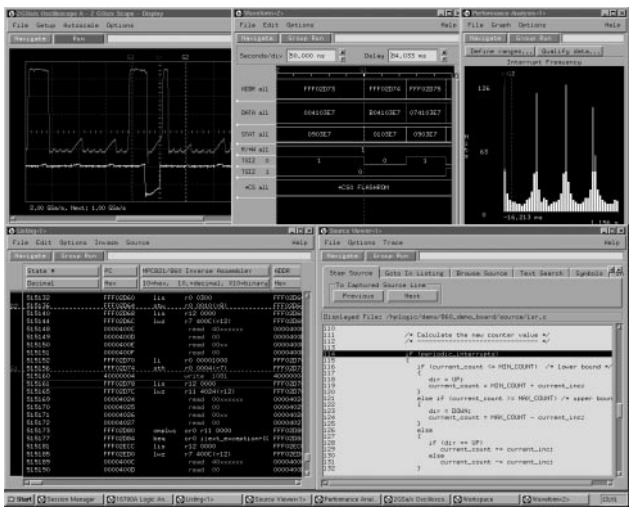
Matching the troubleshooting capabilities you need with the tool budget you have available can be a difficult task. That is why HP offers a wide variety of benchtop logic analyzers so you can choose the model that best matches your exact needs.

Selection Guide

Model Number	**HP 54620A**	**HP 54620C**			
Channels	16	16			
Application	General purpose timing analysis				
Model Number	**HP 1660E**	**HP 1661E**	**HP 1662E**	**HP 1663E**	**HP 1664A***
Channels	136	102	68	34	34
Application	General purpose logic analysis				
Model Number	**HP 1660EP**	**HP 1661EP**	**HP 1662EP**	**HP 1663EP**	
Channels	136	102	68	34	
Application	Hardware simulation and stimulus-response testing with integrated pattern generator				
Model Number	**HP 1660ES**	**HP 1661ES**	**HP 1662ES**	**HP 1663ES**	
Channels	136	102	68	34	
Application	Parametric and mixed-signal testing with integrated oscilloscope channels				
Model Number	**HP 1670E**	**HP 1671E**	**HP 1672E**	**HP 1673E**	
Channels	136	102	68	34	
Application	Complex debugging and troubleshooting with deep memory				

*50 MHz state analysis; all other models 100 MHz

Turn to page 377 for the entire story.



View system resources in multiple domains, all time-correlated.

HP 16600A and 16700A Series Logic Analysis Systems

NEW

With the power of the HP 16500 system and the familiarity of windows, the new HP Logic Analysis Systems offer a single solution for hardware, software and system debugging.

Hardware designers get the measurement power that made the HP 16500 logic analyzer the top seller for more than a decade, plus processor execution control, register access and other tools to explore software-dependent hardware problems such as interrupt handling.

Software designers get debugging and analysis tools that overcome the drawbacks of traditional emulation, while providing an easier way to solve hardware-dependent software problems that only a logic analyzer can uncover.

System designers get time-correlated views showing system activity from analog signals all the way to source code. The new HP Logic Analysis Systems' cross-domain displays minimize the mysteries of hardware-software interaction, helping the team track symptoms back to root causes quickly and confidently.

The HP 16700A and 16702A are high-performance platforms for applications that use 32- or 64-bit microprocessors in multi-processor systems; core-based ASICs; or systems on silicon. The HP 16600A is a preconfigured system with built-in analysis capabilities and is used primarily in single processor systems. See page 380 for complete details.

Special Upgrade Offer

A simple, convenient upgrade path exists from the HP 16500 and 64700B systems to these new tools, and a substantial trade-in allowance is available until March 31, 1999, to most HP 16500, 16505 or 64700B users who want to move up to the HP 16702A or 16700A. See page 376 for further details.

Processor Support

Whether it's intrusiveness that changes the behavior of the system under test, poor debugger links, shallow memory or the lack of system-wide analysis, traditional emulators are struggling to keep up with the latest microprocessors.

HP's new emulation technology keeps pace with today's most powerful 32-bit processors, as well as give you valuable insight into hardware/software interaction, and other system-wide behaviors that extend beyond the processor itself.

HP Logic Analysis Systems can be customized to support your processor by adding one or more of the following components:

- Analysis probes provide a non-instrusive mechanical and electrical connection to your processor, giving you a complete picture of bus activity.
- Source correlation tool set provides a real-time trace linked to the high-level source language, time-correlated to activity captured by the logic analyzer's acquisition modules.
- Emulation module/probe provides control of program execution including fast code download, setting breakpoints and stepping, in addition to having the ability to modify memory and registers. The emulation module or enulation probe can be controlled by a high-level debugger or by HP's emulation control interface.
  - HP's emulation control interface. If you are using the emulation module primarily for debugging hardware, control the emulation module using HP's emulation control interface. The interface gives you control over program execution including setting breakpoints and stepping, the ability to modify memory and registers, and memory disassembly.
  - Debuggers purchased from vendors (see page 391), the debugger allows you to control the emulation module. This combination gives you the tools necessary to locate elusive software-dependent hardware bugs and hardware dependent software bugs.

See page 388 for the further details.

Logic Analysis System Upgrade Program

NEW

Engineers who have used the HP 16500 during the last decade know they can always count on HP to protect their investment and provide a continuous upgrade path. That proven path continues as we introduce the successors to the HP 16500, the new HP 16700A, 16702A and 16600A Series.

If you now own an HP 16500 Series logic analysis system, you can take advantage of the benefits of an HP 16700A or 16702A logic analysis system, as follows:

Specifications

If you now own:	To upgrade to an HP 16700A system:
Logic analysis system frames - HP 16500A - HP 16500B - HP 16500C Prototype analyzer (HP 16505A with HP 16500B or 16500C frame)	Trade in your logic analysis system frame and prototype analyzer (optional) for credit toward the purchase of an HP 16700A Series frame.
Expansion frame, HP 16501A	Trade in your HP 16501A for credit toward the purchase of an HP 16701A expansion frame, which works with the HP 16700A or 16702A.
HP 1660/70 Series benchtop logic analyzers	Selected configurations can be traded in for a credit toward the purchase of an HP 16600A or 16700A Series system. This offer applies to the HP 1660C, 1661C, 1660CS, 1661CS, 1660CP, 1661CP, 1670D and 1671D models purchased with one of the following emulation probes (formerly known as processor probes): HP E3452A, E3454A, E3455A, E3456A, E3458A, E3477A, E3490A, E3491A, E3491B, E3493A, E3493B, E3494A and E3497A.
Measurement modules	Some measurement modules can be used with the HP 16700A Series logic analysis system. Those that cannot can be traded in for a 12% discount for newer modules. Refer to the next table.
Tool sets - HP B4600A System performance analysis - HP B4620A Software analyzer - HP B4601A Serial analysis	If you own a tool set for an HP 16505A prototype analyzer, and you are trading in your HP 16505A for an HP 16700A or 16702A, you will be issued a new license for the equivalent tool set installed on the HP 16700A or 16702A.
Preprocessors and inverse assemblers	All preprocessors (now referred to as analysis probes), whether made by HP or an HP channel partner, are compatible with the HP 16700A and 16600A Series systems. All inverse assemblers are compatible with the HP 16700A, 16702A and HP 16600 Series systems.
Processor probes or software probes	Any HP processor probe (now referred to as emulation probes) or software probe can be traded in for an equivalent HP emulation module for no charge. Up to two emulation modules can be installed in the HP 16700A or 16702A Series logic analysis system frames.
HP 64700B emulation	Trade in your HP 64700B emulation system for a credit toward the purchase of an HP 16700A or 16702A 16600A Series system. Some compiler and debugger companies offer special discounts for HP customers. Contact the compiler and debugger company for more information.

The logic analysis system upgrade program is valid until March 31, 1999. Please contact the HP Call Center in your region for details.

Measurement Module Compatibility

Modules NOT supported by the HP 16700A or 16702A logic analysis systems		Measurement modules SUPPORTED by the HP 16700A Series logic analysis system	
HP 16510A	HP 16532A	HP 16517A	HP 16554A*
HP 16510B	HP 16540A	HP 16518A	HP 16555A*
HP 16511B	HP 16540D	HP 16522A	HP 16555D*
HP 16515A	HP 16541A	HP 16550A	HP 16556A*
HP 16516A	HP 16541D	HP 16533A	HP 16556D*
HP 16520A	HP 16542A	HP 16534A	HP 16557D
HP 16521A	HP 16535A		
HP 16530A	HP E2474A		
HP 16531A			

*Supported but not available.

Any measurement module NOT currently supported by the HP 16700A or 16702A logic analysis systems, with the exception of the HP E2474A, can be traded in for a 12% discount on any new measurement module with the purchase of an HP 16700A or 16702A logic analysis system frame. Up to ten modules can be traded in with each HP 16500 system that is traded in.

For more information, visit our website:
www.hp.com/info/las-upgrades

Logic Analyzer Upgrade Kits

Upgrade kits include software and hardware to enhance the performance of your logic analyzer.

HP 1660 Series Upgrades

Add a built-in oscilloscope to your HP 1660E series logic analyzer with the HP E2460ES upgrade kit. The oscilloscope has two channels with simultaneous 2-GSa/s sampling, 500-MHz bandwidth and 32k deep memory.

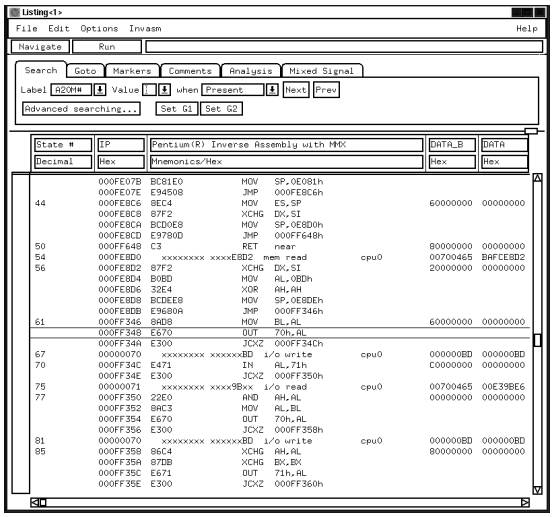
Add built-in stimulus to your HP 1660E series logic analyzer with the HP E2495A upgrade kit. The pattern generator has 32 channels of 100 M vectors/sec stimulus with a 258,048 vector memory depth. It can also be configured for 16 channels of 200 M vectors/sec.

HP 16500 Upgrades

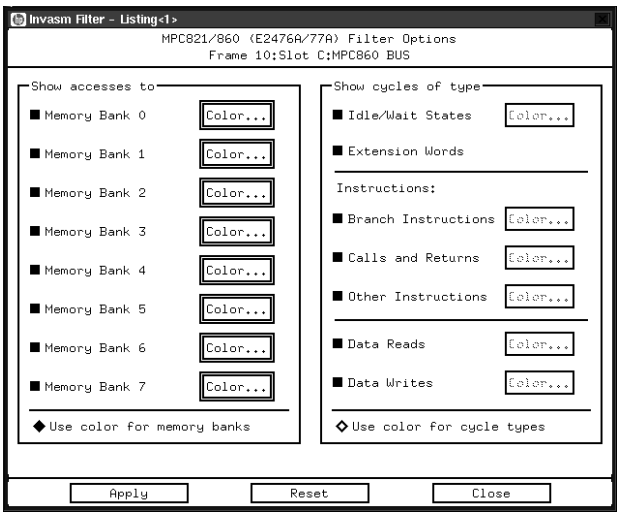
The HP E2479A includes everything necessary to upgrade your HP 16500A or 16500B to an HP 16500C frame at just over half the cost of investing in a new frame. The HP E2479A upgrade must be installed by an HP Service Center. The price includes all charges, including installation, except for shipping.

Ordering Information

E2479A 16500A/B to 16500C Upgrade Kit
E2460ES 1660ES Series Oscilloscope Upgrade Kit
E2495A 1660E Series Pattern Generator Upgrade Kit



Inverse Assembly Listing for Pentium



Inverse Assembler Filter Options for MPC 860

Isolating the root cause of elusive system turn-on and compatibility problems requires that you track the interactions between the processor(s) and critical buses in the system. When tailored to your system requirements with processor and bus specific analysis probes and emulation modules, the HP 16600A or 16700A Series logic analysis system gives you invaluable insight into system operation. Here are a few examples of HP's extensive analysis probe support.

Intel Pentium II or Pentium System Debug

To capture the complete picture of your computer system's operation, it is necessary to track activity on multiple buses at once. The HP 16600/16700 Series logic analysis systems allow you to time-correlate your display of data captured on multiple buses in your system. With the HP 16600/16700 Series logic analysis systems, it is simple to display Pentium II or Pentium processor bus traffic in the same listing as PCI, ISA and APIC bus traffic. In addition, bus cycles on the Intel i960RP peripheral processor bus can be captured and viewed using an HP analysis probe. Since data captured on each bus in the system is time-correlated, it is easy to measure time delays across bus bridges in your system.

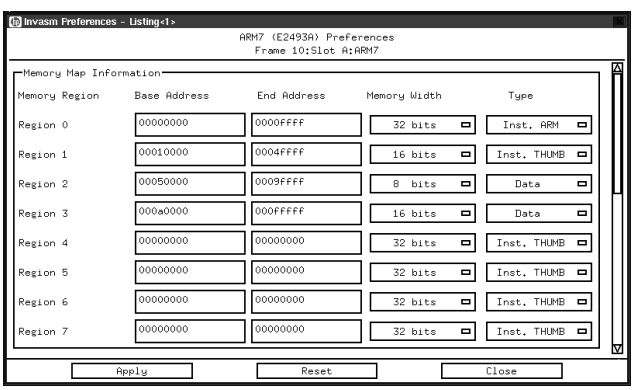
The HP inverse assembler displays code execution in familiar code mnemonics. The inverse assembler takes advantage of the Pentium II or Pentium processor's branch trace message (BTM) bus cycles. Branch trace messages are special bus cycles issued by the CPU (when enabled) that indicate the "from" and "to" addresses of a branch. By using BTMs, the inverse assembler can track code flow when cache is enabled.

Motorola MPC 800 Series System Debug

HP's solutions for Motorola MPC 800 microprocessors can combine the powerful tools of emulation, code download, debugger connections, and logic analysis for a complete, scalable system debug environment.

Using an HP analysis probe in conjunction with an HP emulation probe or module, quickly configure the logic analyzer by labeling address, data and status signals for the MPC 860/821, as well as control program execution through single stepping, start/stop, run/break and set/modify breakpoints. You can also run code at full speed in the target.

Once the logic analyzer acquires the real-time trace, using the source correlation tool set, step through the trace at assembly-code level or source-code level. Locate the cause of a problem by time correlating this measurement to other system activity.



Inverse Assembler Configuration Screen for ARM7

ARM7 System Debug

Because ARM-based systems are designed with a variety of external signals available, HP's inverse assembler's operation has been designed to be highly adaptable to your situation.

The software provided for analysis provides you with the capability to quickly configure the logic analyzer by labeling address, data and status signals for the ARM7 microprocessor. The software includes an inverse assembler, which gives you ARM or Thumb mnemonics in the trace listing for easy correlation between captured data and target code.

The inverse assembler provides filters and color coding to show and/or suppress different types of instructions such as data reads, data writes, unexecuted instructions, "cc Failed" instructions, etc.

The inverse assembler can be used with the HP B4620B source correlation tool set. This allows time correlation of an acquired trace to source code. The source correlation tool set uses the symbolic information provided in your object file to a build a database of source files, line numbers and symbol information.

378 HP 1660/1670 Series Benchtop Logic Analyzers

HP 1660E
HP 1661E
HP 1662E
HP 1663E
HP 1664A
HP 1660ES
HP 1661ES
HP 1662ES
HP 1663ES
HP 1660EP
HP 1661EP
HP 1662EP
HP 1663EP
HP 1670E
HP 1671E
HP 1672E

NEW

- Cost-effective solutions that match your specific application
- View analog and digital signals simultaneously with two 500 MHz scope channels on the HP 1660ES
- Stimulate circuits and simulate missing components with the pattern generator capability in the HP 1660EP
- Simplify capture and analysis of complex events with up to 1M deep memory in the HP 1670E
- Find information quickly on the color flat-panel display.

Cost-Effective Solutions that Match Your Specific Application Needs

The HP 1660 and 1670 Series benchtop logic analyzers offer cost-effective 100 MHz state analysis and 500 MHz timing analysis with a built-in VGA resolution, color, flat-panel display. Oscilloscope and pattern generator features in the HP 1660 Series and deep memory in the HP 1670 Series give you the capability to configure a solution that meets your demanding troubleshooting challenges.

Navigating through the user interface is made simple via the user's choice of either mouse or front-panel operation. An optional keyboard is also available.

Graphical trigger macros assist in making powerful measurements. Trigger set-ups can be selected from a categorized list of trigger macros. Each macro is shown in a graphical form and has a written description. Macros can be chained together to create a custom trigger sequence.

HP 1660 Series Benchtop Logic Analyzer NEW

An Excellent Toolset for Hardware Development

Some of the tougher hardware problems can be found only with digital triggering capabilities of a logic analyzer and solved only with the analog resolution of an oscilloscope. That's why the ES models come with a built-in, 500-MHz, 2-GSa/s oscilloscope that can be triggered by the logic analyzer. Now, you can see what bus lines really look like at critical moments.

The pattern generator capability in the EP models allows you to functionally test your digital design. You can stimulate the device under test and see how it responds to specific signals or clock speeds. You can also use the pattern generator to substitute for missing sub-systems. The data captured with the state or timing analyzer can then be used to verify correct operation.

Key Specifications and Characteristics for HP 1660 Series Benchtop Logic Analyzers

State and Timing Channels
- **HP 1660E, HP 1660EP, HP 1660ES:** 136
- **HP 1661E, HP 1661EP, HP 1661ES:** 102
- **HP 1662E, HP 1662EP, HP 1662ES:** 68
- **HP 1663E, HP 1663EP, HP 1663ES, HP 1664A:** 34

State Analysis Speed: 100 MHz (HP 1664A: 50 MHz)
State/Timing Memory Depth: 4K samples on all channels, 8K samples on half channels (state analysis depth is halved with time tags on)
Setup/Hold Time: 3.5/0 ns to 0/3.5 ns adjustable in 500-ps increments
Timing Analysis
- **Conventional:** 250 MHz on all channels, 500 MHz on half channels
- **Transitional:** 125 MHz on all channels, 250 MHz on half channels
- **Glitch:** 125 MHz on half channels

Probe Input R & C: 100 k Ω, 8pF
Trigger Resources
- **Patterns:** 10
- **Edge and Glitch Terms:** 2
- **Ranges:** 2
- **Timers:** 2

Trigger Sequence Levels : 12 with state analysis and 10 with timing analysis
Trigger Macros: 23 predefined trigger sequences with graphical representations and plain language descriptions
Mass Storage: Hard disk drive and 1.44-MB flexible disk drive
Ethernet LAN Interface: Standard (HP1664A: Not Available)

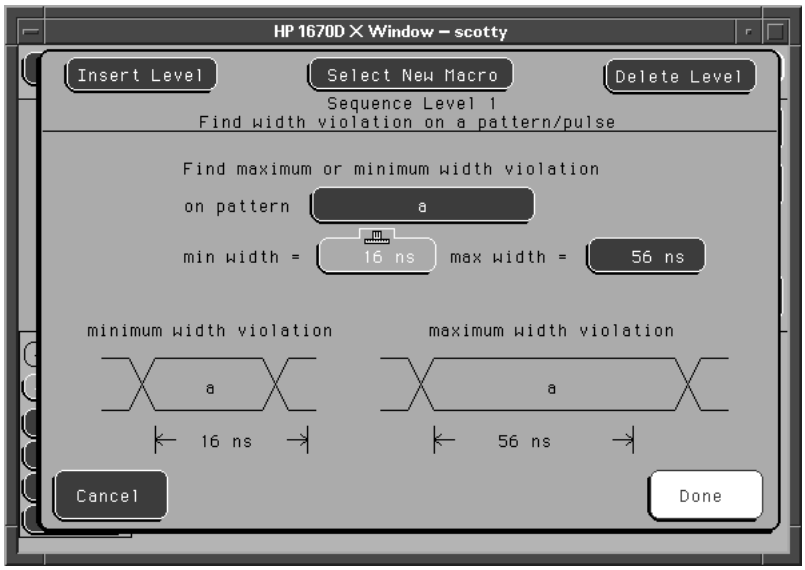
Additional Information for 1660ES, 1661ES, 1662ES and 1663ES

Scope Channels: 2
Scope Sample Rate, Bandwidth: 2 GSa/s, 500 MHz
Scope Vertical Resolution: 8 bits
Scope Memory Depth: 32K samples per channel

Additional Information for 1660EP, 1661EP, 1662EP and 1663EP

Maximum Clock Speed: 100 MHz (32 channels), 200 MHz (16channels)
Maximum Memory Depth: 258,048 vectors

NEW



Pre-defined graphical trigger macros make powerful measurements easy to set up.

HP 1670E Series Benchtop Logic Analyzers NEW

Get the Whole Picture with Deep Memory

Deep memory can be a valuable logic analyzer feature for solving difficult or poorly understood problems in embedded microprocessor systems. It saves time you might otherwise spend taking multiple traces to piece together a complete picture of prototype behavior. Deep memory can also reduce the need to set up multilevel triggers because you don't have to be as precise about the data you capture. The HP 1670E Series logic analyzers have 1M samples of memory depth.

Specifications

State and Timing Channels
- **HP 1670E:** 136
- **HP 1671E:** 102
- **HP 1672E:** 68

State Analysis Speed: 100 MHz
State/Timing Memory Depth: (state analysis depth is halved with time tags on); 1M samples on all channels; 2M samples on half channels (timing mode only)
Setup/Hold Time: 3.5/0 ns to 0/3.5 ns adjustable in 500-ps increments
Timing Analysis
- **Conventional:** 125 MHz on all channels; 250 MHz on half channels

Probe Input R & C: 100 k Ω, 8 pF
Trigger Resources
- **Patterns:** 10
- **Edge and Glitch Terms:** 2
- **Ranges:** 2
- **Timers:** 2

Trigger Sequence Levels: 12 with state analysis and 10 with timing analysis
Trigger Macros: 23 predefined trigger sequences with graphical representations and plain language descriptions
Mass Storage: Hard disk drive and 1.44-MB flexible disk drive
Ethernet LAN Interface: Standard

Key Literature

HP 1660 and 1670 Series Benchtop Logic Analyzers,Product Overview, p/n 5968-0529E
HP 1660E/1670E Series Technical Specification, p/n 5968-0327E
HP 1660 and 1670 Series Benchtop Logic Analyzers Demonstration Video Tape (10 min.), p/n 5968-0530EUS (NTSC), or 5968-0530E (PAL)

Ordering Information

1660 Series Benchtop Logic Analyzers
1660E 136-Channel 100 MHz State/500 MHz Timing
1660ES 136-Channel 100 MHz State/500 MHz Timing with Integrated 2 Channel, 500 MHz, 2 GSa/s Oscilloscope
1660EP 136-Channel 100 MHz State/500 MHz Timing with Integrated 32-Channel Pattern Generator
1661E 102-Channel 100 MHz State/500 MHz Timing
1661ES 102-Channel 100 MHz State/500 MHz Timing with Integrated 2 Channel, 500 MHz, 2 GSa/s Oscilloscope
1661EP 102-Channel 100 MHz State/500 MHz Timing with Integrated 32-Channel Pattern Generator
1662E 68-Channel 100 MHz State/500 MHz Timing
1662ES 68-Channel 100 MHz State/500 MHz Timing with Integrated 2 Channel, 500 MHz, 2 GSa/s Oscilloscope
1662EP 68-Channel 100 MHz State/500 MHz Timing with Integrated 32-Channel Pattern Generator
1663E 34-Channel 100 MHz State/500 MHz Timing
1663ES 34-Channel 100 MHz State/500 MHz Timing with Integrated 2 Channel, 500 MHz, 2 GSa/s Oscilloscope
1663EP 34-Channel 100 MHz State/500 MHz Timing with Integrated 32-Channel Pattern Generator
1664A 34-Channel 50 MHz State/500 MHz Timing with monochrome CRT display

1670 Series Benchtop Logic Analyzers
1670E 136-Channel 100 MHz State/250 MHz Timing with 1M Memory Depth
1671E 102-Channel 100 MHz State/250 MHz Timing with 1M Memory Depth
1672E 68-Channel 100 MHz State/250 MHz Timing with 1M Memory Depth

380 HP 16600A/16700A Series Logic Analysis Systems

HP 16600A
HP 16601A
HP 16602A
HP 16603A
HP 16700A
HP 16701A
HP 16702A

NEW

- Precisely correlated displays from analog signals to source code
- Simultaneous measurements on up to 1,020 channels
- Integrated emulation that takes advantage of on-chip debugging
- Tight coupling of logic analysis and emulation enables hardware and software designers to coordinate their debugging effort

The new HP 16702A, 16700A and 16600A Series logic analysis systems allow for rapid hardware debug and integration of complex systems.

Take Advantage of Integrated Insight During Hardware/Software Integration

Debugging today's digital systems is tougher than ever. Increased product requirements, complex software, and innovative hardware technologies all need to come together in a shorter amount of time to meet your market window.

When the prototype does not work as expected or needs tuning to meet performance requirements, you need test equipment that quickly provides reliable insight into your toughest problems. You want the answer to the problem, and you want it right away.

This is why HP has introduced a suite of logic analysis, emulation and software tools to give you the insight you need. Whether you are a hardware or software designer, HP has tools that address your debugging and verification needs.

Debugging Tools That Will Help You Redefine Teamwork

The new HP 16700A, 16702A and 16600A Series logic analysis systems offer a single solution for hardware, software and systems debugging.

Hardware designers get the measurement power that made the HP 16500 logic analyzer the top seller for more than a decade, plus processor execution control, register access and other tools to explore software-dependent hardware problems such as interrupt handling.

Software designers get debugging and analysis tools that overcome the drawbacks of traditional emulation, while providing an easier way to solve hardware-dependent software problems that only a logic analyzer can uncover.

System designers get time-correlated views showing system activity from analog signals all the way to source code. The HP Logic Analysis System's cross-domain displays minimize the mysteries of hardware-software interaction, helping the team track problems back to root causes quickly and confidently.

More Windows on the Problem

The HP 16600A and 16700A Series logic analysis systems allow you to examine system behavior from multiple angles—code execution, bus activity, timing and signal integrity—simultaneously. With integrated emulation capabilities, you gain insight into tough hardware/software integration problems even faster.

On-Chip Emulation Tools Make Fixing Bugs Easier

Combining processor execution control with logic analysis lets you untangle the toughest hardware/software integration problems.

For specific microprocessor families that feature on-chip emulation, you can add an emulation module to connect the on-board debugging resources of the microprocessor to the logic analyzer and to a high-level debugger.

Integrated Debugger Support

The HP 16600A and 16700A Series logic analysis systems offer you unprecedented visibility into software execution. Gain the ability to control your processor (break, step, run, stop) and modify/read registers with the addition of an emulation module. The emulation module comes standard with an integrated connection to the industry's leading debuggers. This gives you complete hardware-assisted software debug.

Set-up Assistant Allows for Fast Analyzer Setup

Usability testing revealed that one of the hardest parts of using a logic analyzer is connecting it to the target and setting it up to make measurements. The set-up assistant in the new HP 16600A and 16700A Series logic analysis systems guides you through all the necessary steps to get you to your first measurement quickly.

The Solution With a Built-In Future

HP keeps pace with your digital debug needs while protecting your investment. You may receive a trade-in allowance for your existing HP logic analyzer or emulator when purchasing the new HP 16600A and 16700A Series logic analysis systems. See page 376 for details.

HP 16702A
HP 16500C

NEW

- Built-in 10.3 inch 800X600 display and front panel keyboard.
- 4 GHz timing and 2 GHz scope options
- Scalable solution with simultaneous measurements on up to 1,020 channels
- Small footprint allows for use in limited space environments, or where transportability is required
- Measurement and analysis power of the HP 16500C with the addition of integrated emulation capabilities and a new windowed interface

The new HP 16702A provides advanced logic analysis and emulation features in a standalone mainframe.

HP 16702A Logic Analysis System Mainframe NEW

For more than a decade, the HP 16500 logic analyzer helped engineers troubleshoot the toughest design challenges around. Now, the new HP 16702A is ready to take over that leadership position, with all the 16500's power and then some.

The improved, flexible and intuitive user interface of the HP 16702A provides you with the familiarity of windows and the ability to control the analyzer directly from the tab menus without searching through several pop-up menus. Debugging is simplified by providing:

- Easy connection to your target and measurement setup using the setup assistant
- Insight into signal integrity problems with the improved full-function oscilloscope interface
- Quick access to the most commonly used features with menu tabs
- Ability to size and position windows on the built-in flat screen monitor to suit your troubleshooting process

Specifications

Mainframe: 5 measurement modules, 2 emulation modules
Expansion Mainframe: 5 measurement modules, 2 emulation modules
Maximum Channel Count: 510 with HP 16702A only; 1,020 by adding HP 16701A
Maximum State Clock: 100 MHz to 1 GHz/s (depending on module selection)
Maximum Timing Sample Rate: 500 MHz to 4 GHz/s (depending on module selection)
Memory Depth: 4 K to 4 M (depending on module selection)
Built-in Display: Yes

Key Literature

HP 16600A and 16700A Series Logic Analysis System Mainframes, p/n 5966-3107E
HP Logic Analysis Systems Upgrade, p/n 5966-3059E

Ordering Information

HP 16702A Logic Analysis System Mainframe
Opt 001 17" Color Monitor
Opt 003 Performance Upgrade/160MB RAM and 2M video RAM
Opt 004 External CD-ROM drive

HP 16500C Logic Analyzer Mainframe

The HP 16500C has proven its value with more than a decade of dependable service and will continue to be available if you need a replacement.

Key Literature

HP 16500C Logic Analysis System,Product Overview, p/n 5965-3187E
HP 16500C Logic Analysis System, Technical Specifications, p/n 5965-3184E

Ordering Information

HP 16500C Logic Analyzer Mainframe

8

HP 16600A
HP 16601A
HP 16602A
HP 16603A
HP 16700A
HP 16701A

NEW

HP 16700A Logic Analysis System Mainframe NEW

The HP 16700A logic analysis system offers comprehensive cross-domain debugging optimized for multiprocessor designs. Hardware designers get high-speed logic analysis on up to 1,020 channels, while software designers get a full suite of emulation tools. And with multiple time-correlated views on screen simultaneously, and access to test data through a shared physical connection, the whole team can work together more effectively and efficiently.

Specifications

Mainframe: 5 measurement modules, 2 emulation modules
Expansion Mainframe: 5 measurement modules, 2 emulation modules
Maximum Channel Count: 510 with HP 16700A only; 1,020 by adding HP 16701A
Maximum State Clock: 100 MHz to 2 GHz/s (depending on module selection)
Maximum Timing Sample Rate: 500 MHz to 4 GHz/s (depending on module selection)
Memory Depth: 4 K to 4 M (depending on module selection)

Key Literature

HP 16600A and 16700A Series Logic Analysis System Mainframes, p/n 5966-3107E
HP Logic Analysis Systems Upgrade, p/n 5966-3059E

Ordering Information

HP 16700A Modular Mainframe
HP 16701A Expansion Mainframe
- **Opt 001** 17" Color Monitor
- **Opt 003** Performance Upgrade/160MB RAM and 2M video RAM
- **Opt 004** External CD-ROM drive

HP 16600A Series Logic Analysis Systems NEW

The HP 16600A Series logic analysis systems offer the power of combined logic analysis and emulation in a simple, cost-effective package.

HP 16600A systems are preconfigured with 68, 102, 136 or 204 measurement channels. In addition, the HP 16600A provides one open slot for an emulation module and one open slot for a measurement module.

Specifications

State and Timing Channels
- **HP 16600A:** 204
- **HP 16601A:** 136
- **HP 16602A:** 102
- **HP 16603A:** 68

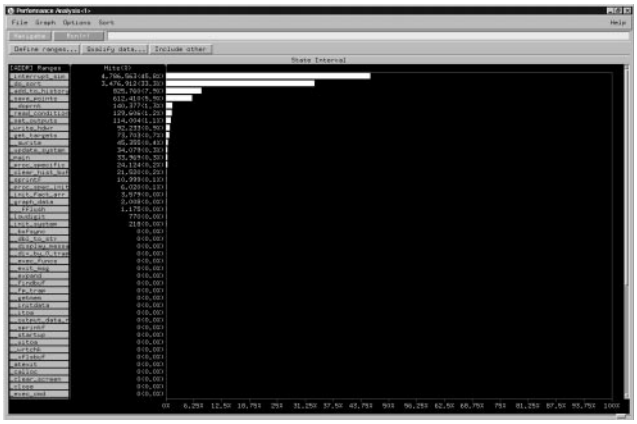
State Analysis Speed: 100 MHz
State/Timing Memory Depth: 64/128 K per channel (full/half channels)
Setup/Hold Time: 0/4.5 ns to 4.5/0 ns adjustable in 500 ps increments
Maximum Timing: 125/250 MHz (full/half channels) sample rate
Context Store: 16/32/64 state stored around trigger point
Open Slots: 1 measurement module; 1 emulation module

Ordering Information

HP 16600A 204-Channel Logic Analysis System
HP 16601A 136-Channel Logic Analysis System
HP 16602A 102-Channel Logic Analysis System
HP 16603A 68-Channel Logic Analysis System
- **Opt 001** 17" Color Monitor
- **Opt 003** Performance Upgrade/160MB RAM and 2M video RAM
- **Opt 004** External CD-ROM drive
- **Opt 010** 17-Channel Probe Leads (2 sets)

HP B4600B
HP B4601B
HP B4620B

- Uncover hidden timing and code flow problems
- Link causes and events across domains, from analog signals to digital circuits to source code
- Move from high-level performance analysis to detailed troubleshooting in seconds
- View serial data in a parallel format



The optional HP B4600B system performance analysis tool set highlights the most critical areas you need to work on to improve your design's performance.

Get an Accurate Picture of In-Target Software Performance

The success of your digital system depends upon three factors—functionality, time-to-market and the price/performance ratio. The optional software tool sets available for the HP 16702A, 16700A and 16600A Series logic analysis systems provide you with the extended capabilities to observe software execution by a microprocessor without halting the system or adding instructions to the code, optimize system performance and view serial data streams in the context of system activity.

The source correlation, system performance analysis and serial analysis tool sets provide you with the insight needed to solve the tough hardware/integration problems, thus allowing you to get products to market on time.

HP B4620B Source Correlation Tool Set

The HP B4620B source correlation tool set combines the versatility of an HP Logic Analysis System with an interface that is tailored for correlating software measurements with other system activity.

The HP source correlation tool set provides a link between your trace listing and high level source code language. Once a trace is complete, it is displayed in the source viewer as high-level source code. Concurrently, the trace is displayed in the listing window in microprocessor mnemonics.

Symbol names from your source code, such as function and variable names, can be used to specify trigger conditions, or can be viewed in trace listings. Examples of supported symbols include: variable names, function and procedure names, and module names. Many file formats are supported.

HP B4600B System Performance Analysis Tool Set

The HP B4600B system performance analysis (SPA) tool set for the HP 16702A, 16700A and 16600A Series logic analysis systems provides statistical representations of data captured by the measurement modules. The SPA tool set helps to find the routines that are called most often in your system, identify inefficient peripheral use, and pinpoint processes that use too much CPU time.

The SPA tool set helps to provide answers to the following hardware and software performance questions:

Performance
- What functions are most often executed by the processor?
- What functions are never executed?
- What is the relative workload of each processor in a multiple-processor system?

Responsiveness
- What is the minimum, maximum and average execution time of a function (including calls)?
- How many interrupts does the system receive per consecutive time slice?
- What is the response time of my system to an external event?

Coverage
- Do my test suites provide thorough coverage of my application?
- Is this function or variable accessed by the application?

Debug
- Does this pointer address the right memory buffer?
- How does the system react when it receives too many simultaneous interrupts?

System Parameters
- Is the stack size adequate?
- Is the cache size adequate?

HP B4601B Serial Analysis Tool Set

The HP B4601B Serial Analysis tool set for the HP HP 16702A, 16700A and 16600A Series logic analysis systems quickly converts acquired serial bit streams to parallel format for easy viewing and analysis. The serial tool also allows you to process frame information to isolate the data you want to analyze.

Key Literature

Postprocessing Tool Sets for the HP 16600A and 16700A Series Logic Analysis Systems, p/n 5966-3147E

Ordering Information

HP B4600B System Performance Analysis Tool Set

General Purpose and High Speed State and Timing Analysis Modules

HP 16550A
HP 16557D

- State analysis up to 135 MHz
- Timing analysis up to 500 MHz
- Deep memory (up to 2 M samples per channel)
- Five timing modes with resolution down to 2 ns and glitch capture down to 3.5 ns

Build a System to Fit Your Exact Application Needs

Modularity is the key to the HP 16702A, 16700A and 16600A Series logic analysis systems' long term value. You can buy only the capability you need now, then expand as your needs evolve. Module choices include a pattern generator, scopes and both general-purpose and high-speed state/timing modules. All modules are tightly integrated to provide time-correlated cross-domain measurements.

HP 16550 Series State and Timing Modules

General Purpose State and Timing Analysis with a Choice of Depth

The HP 16550 Series of state and timing analyzers offer general purpose state analysis up to 135 MHz and timing analysis up to 500 MHz, with as many as 1,020 channels in a system. The HP 16557D analyzer provides you the same acquisition and triggering capabilities as the HP 16550A, but with deeper memory needed to capture elusive system crashes.

Analyze Widely Separated Events with Transitional Timing

Capture events that are seconds apart while maintaining 4-ns resolution with the HP 16550A. Transitional timing samples at full speed but only stores data when a transition occurs. This technique effectively extends the total time captured by the acquisition memory while maintaining high time resolution.

Set Up Your Measurement Using Advanced Trigger Macros

The basic and complex state and timing macros, available in the trigger macro library, allow you to create set-ups in terms of the measurement you want to make, rather than in terms of the trigger functions of the logic analyzer.

Capture Elusive System Problems Using a Large Variety of Trigger Resources

- Sequence levels allow you to focus in on a specific trigger point or to qualify the data and store only the information that interests you.
- Pattern terms and their logical combinations let you identify which states to store, when to branch, and when to trigger. Trigger on groups of channels up to the full width of the analyzer.
- Range terms provide a way to monitor program and data accesses within a specified area of memory.
- Timers can be set up to trigger when one event happens too late or too soon with respect to another event.
- In timing mode, the edge terms let you trigger on a rising or falling edge, either edge or a glitch.

Specifications

	HP 16550A	HP 16557D[1] NEW
Timing-analysis Rate	Conventional: 250/500 MHz [2] Transitional: 125/250 MHz [2] Glitch: 125 MHz	Conventional: 250/500 MHz [2]
State-analysis Rate	100 MHz	135 MHz (1-3 modules) 100 MHz (4-5 modules)
Channels/Card **Channels/Timebase**	102 204	68 340
Memory Depth/ Channel (full/half channels)	4 K/8 K	2M/4M [3]
Setup/Hold Time	3.5/0 ns to 0/3.5 ns adj. in 500 ps steps	3.0/0 ns to-0. 5/3.5 ns adj. in 500 ps steps
Minimum Detectable Glitch	3.5 ns	3.5 ns
Probe Input R and C	100k Ω + ~ 8pF	100k Ω + ~ 8pF
Triggering Terms	Patterns: 10; Ranges: 2; Edge and glitch: 2; Timers: 2	Patterns: 10; Ranges: 2; Edge and glitch: 2; Timers: 2
Trigger Sequence Levels	12 in state 10 in timing	12 in state 10 in timing
Symbols	Unlimited	Unlimited

1 HP 16557D can only be used with the HP HP 16702A, 16700A and 16600A Series logic analysis system mainframes.
2 Half-channel mode doubles memory depth, doubles maximum conventional timing speed and doubles maximum transitional timing speed.
3 Memory depth doubles in half-channel timing mode.

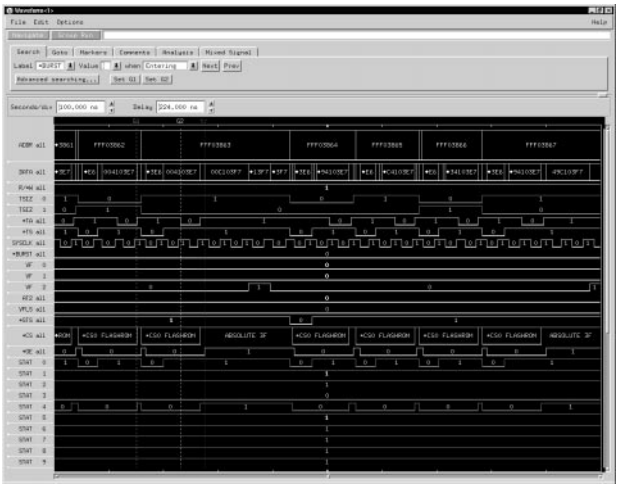
Key Literature

State and Timing Modules for HP Logic Analysis Systems, Product Overview, p/n 5966-3367E

Ordering Information

HP 16550A 102-Channel, 100 MHz State/500 MHz Timing Card with 4 K Acquisition Memory/Channel
HP 16557D 68-Channel, 135 MHz State/500 MHz Timing Card with 2 M Acquisition Memory/Channel

- Trigger directly on setup and hold violations down to 2 ns
- Make timing measurements across as many as 80 channels with the resolution and precision of an oscilloscope
- Characterize the performance of a high-speed ASIC or target system
- Capture the most complex problems with an easy-to-use trigger macro library



View circuit operation with better precision than ever before in a logic analyzer.

HP 16517A/16518A High-Speed Timing Modules

Find the Cause of Elusive Problems

The 64 K deep memory lets you capture data over many clock cycles while retaining the highest multichannel accuracy ever in a logic analyzer. Verify the timing of critical edges with 250 ps resolution across up to 40 channels, or 500 ps resolution across up to 80 channels. You can use the 1 GSa/s synchronous state analysis to view high-speed data streams across up to 80 channels.

Precisely Characterize Setup or Hold Times

The 250 ps precision (channel-to-channel skew) allows your logic analyzer to be used in place of an oscilloscope for characterization. The high-channel count of a logic analyzer improves the efficiency of the characterization process.

The HP 16517A and 16518A are capable of triggering on violations of timing specifications. This is particularly powerful since it allows the wide channel count of the analyzer to look for setup and hold violations. Advanced setup/hold trigger macros are available to help you set up your timing violation triggering easily.

Specifications

HP 16517A/16518A
Maximum Timing Speed: 2 GSa/s or 4 GSa/s[1]
Maximum State Speed: 1 GSa/s or 2 GSa/s[2]
Memory Depth: 64 K or 128 K[1]
Channels per Card: 16/16[3]
Probe Input R&C: 0.2 pF, then through 500 Ω, 3 pF and 100 kΩ
Trigger Macro Library: Yes, with 4 sequence levels
Channel-to-channel Skew: 250 ps, typical

[1] Half-channel mode doubles memory depth and doubles timing speed.
[2] Maximum state speed with oversampling.
[3] HP 16518A expansion card requires HP 16517A master card. Up to four HP 16518As are supported by each HP 16517A.

8

Key Literature

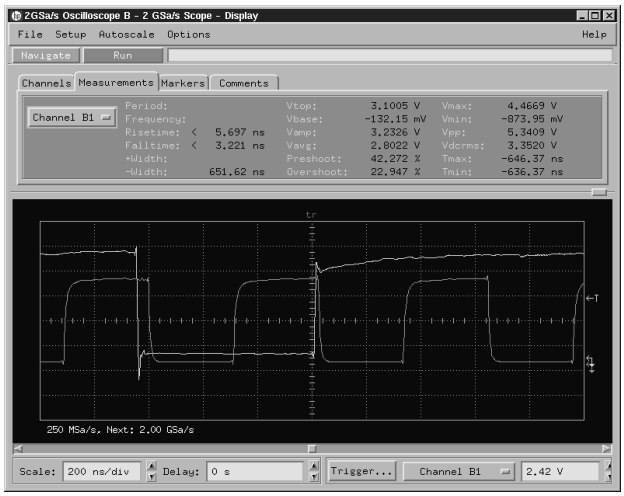
State and Timing Modules for HP Logic Analysis Systems, Product Overview, p/n 5966-3367E

Ordering Information

HP 16517A 16-Channel, 4 GHz Timing/1 GHz State Master Card
HP 16518A 16-Channel, 4 GHz Timing/1 GHz State Expander

HP 16533A
HP 16534A

- Use automatic measurements to easily analyze a signal's behavior
- Cross-module triggering with parametric and logical trigger conditions
- Combine scope and logic measurements in any configuration
- Window interface allows for quick access to information with mouse re-sizing and drag-n-drop features



Explore analog signals and signal parameters using the digitizing oscilloscope modules

HP 16534A and 16533A Digitizing Oscilloscopes

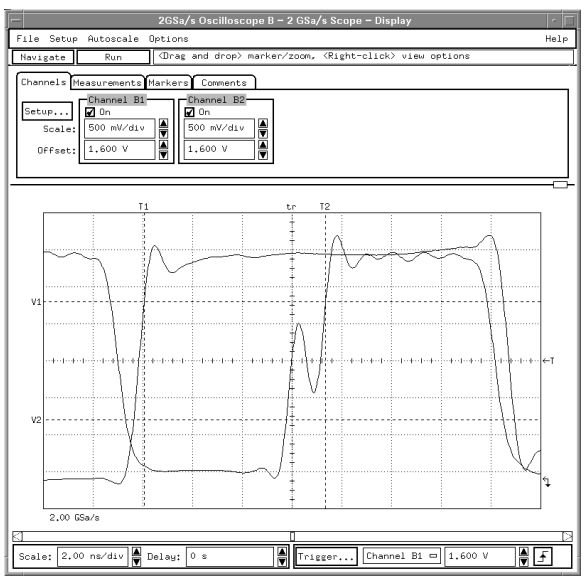
Built-In, Full-Featured Digitizing Oscilloscopes

The HP 16534A and 16533A offer the features of a color digitizing oscilloscope integrated into your logic analysis system. These modules provide digitizing advantages such as autoscale, automatic measurements, powerful triggering, negative-time (pre-trigger) viewing, voltage markers, and time markers.

8

Use as a Standalone Scope with Many Channels

You can capture up to eight analog channels simultaneously (single time base). You can measure slow and fast events by adding additional oscilloscope modules to create a multiple time base digitizing oscilloscope. For large channel count measurements, you can configure as many as 20 scope channels in a single system.



All primary oscilloscope control settings, including scale factors and trigger settings, are visible simultaneously.

Get to the Answer Faster with an Intuitive User Interface

When installed in the HP 16702A, 16700A or 16600A Series logic analysis system mainframes, these oscilloscope modules make powerful measurement and analysis accessible and uncomplicated, so you can find the answer to tough debugging problems in less time. Oscilloscope controls are easy to find, recognize, and use.

Gain Insight Faster with Automatic Measurements and Time and Voltage Markers

The HP 16533A and 16534A oscilloscope modules allow you to characterize signals quickly with automatic measurements of rise time, voltage, pulse width and frequency. You can also measure timing and voltage margins using convenient time and voltage markers. Four independent voltage markers are available.

The global time markers of the HP logic analysis systems let you make time-correlated measurements across state, timing and oscilloscope measurements. Two local time markers are available in addition to two global time markers.

Specifications

	HP 16534A	HP 16533A
Sample Rate	2 GSa/s	1 GSa/s
Bandwidth[1]	500 MHz	250 MHz
Rise Time[2]	700 ps	1.4 ns
Time-interval Accuracy	± 100 ps	± 100 ps
ADC Resolution	8 bits	8 bits
Waveform Record Length	32K	32K
Channels per Card	2	2
Max. Single Time Base Channels	8	8
Max. Channels per System	20	20

[1] Specifications
[2] Rise time is calculated from: Rise time = 0.35/bandwidth

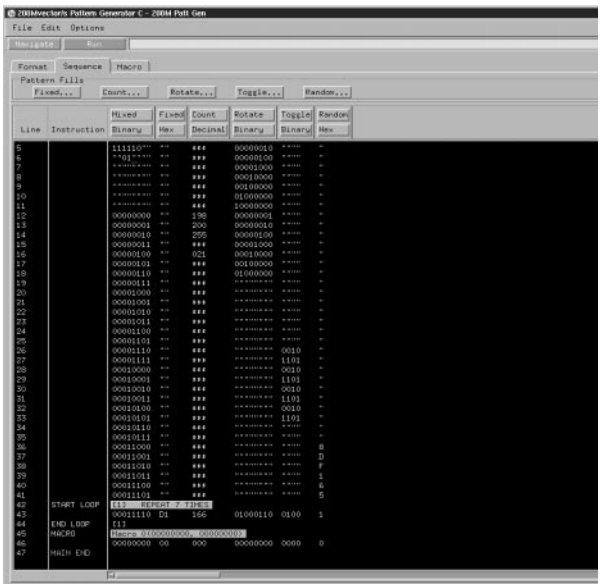
Key Literature

Oscilloscope Modules for HP Logic Analysis Systems, p/n 5966-3150E

Ordering Information

HP 16533A 2-Channel 1, GSa/s Oscilloscope Module
HP 16534A 2-Channel 2, GSa/s Oscilloscope Module

- Test systems under a variety of operating scenarios
- Simulate hardware still under development to speed up software development
- Easily develop complex tests with macros, repeat loops, pattern fills, and state-to-pattern conversion



Use the HP 16522A pattern generator module to create virtually any digital stimulus you need.

HP 16522A Digital Pattern Generator Module

Functionally Test Your Designs

The HP 16522A digital pattern generator module is the perfect tool for testing of your digital design. The pattern generator allows you to check the characteristics of your system. See how your system responds to specific signals or clock speeds. Correlate data captured with other HP 16500, 16702A, 16700A and 16600A Series modules to verify correct operation.

Digital Stimulus for Prototype Turn-on and Evaluation

The HP 16522A pattern generator provides a number of features to help you turn on and evaluate prototypes quickly:

- Vectors up to 200 bits wide
- Speeds up to 200 Mvectors/sec
- Synchronized clock output
- Wait for input pattern
- Initialize block is run once in a repetitive run
- Conditional branch at 50 MHz
- Macros and repeat loops simplify creation of stimulus programs
- Pattern fills and state to pattern provide quick development of complex stimulus programs
- ASCII input file format

The pattern generator is designed for operation with the external clock and data pods and lead sets. Both the data pods and data cables use standard connectors that you can design in your system.

Lead Set Characteristics

HP 10474A 8-Channel Probe Lead Set: Provides most cost-effective lead set for the HP 16522A clock and data pods. IC clips are not included.
HP 10347A 8-Channel Probe Lead Set: Provides 50 Ω coaxial lead set for unterminated signals, required for HP 10465A ECL Data Pod (unterminated). IC clips are not included.

Data Pod Characteristics

HP 10461A TTL Data Pod
Output Type: 10H125 with 100 Ω series
Maximum Clock: 200 MHz
Skew: Typical < 2 ns; worst case = 4 ns

HP 10462A 3-State TTL/CMOS Data Pod
Output Type: 74ACT11244 with 100 Ω series
3-State Enable Pin: High input disables output; low input or no connect enables
Maximum Clock: 100 MHz
Skew: Typical < 4 ns : worst case = 12 ns

HP 10464A ECL Data Pod (terminated)
Output Type: 10H115 with 330 Ω pulldown, 47 Ω series
Maximum Clock: 200 MHz
Skew: Typical < 1 ns; worst case = 2 ns

HP 10465A ECL Data Pod (unterminated)
Output Type: 10H115 (no termination)
Maximum Clock: 200 MHz
Skew: Typical < 1 ns; worst case = 2 ns

HP 10466A 3-State TTL/3.3 Volt Data Pod
Output Type: 74LVT244 with 100 Ω series
3-State Enable Pin: High input disables output; low input or no connect enables
Maximum Clock: 200 MHz
Skew: Typical < 3 ns ; worst case = 7 ns

Clock Pod Characteristics

HP 10460A TTL Clock Pod
Clock Output Type: 10H125 with 47Ω series; true and inverted
Clock Output Rate: 100 MHz maximum
Clock Out Delay: 11 ns maximum in 9 steps
Clock Input Type: TTL – 10H124
Clock Input Rate: DC to 100 MHz
Pattern Input Type: TTL – 10H124 (no connect is logic 1)
Clock-in to Clock-out: Approximately 30 ns
Pattern-in to Recognition: Approximately 15 ns + 1 clk period

HP 10463A ECL Clock Pod
Clock Output Type: 10H116 differential unterminated; and differential with 330 Ω to – 5.2 V and 47 Ω series
Clock Output Rate: 200 MHz maximum
Clock Out Delay: 11 ns maximum in 9 steps
Clock Input Type: ECL – 10H116 with 50 k Ω to –5.2 V
Clock Input Rate: DC to 200 MHz
Pattern Input Type: ECL – 10H116 with 50 k Ω (no connect is logic 0)
Clock-in to Clock-out: Approximately 30 ns
Pattern-in to Recognition: Approximately 15 ns + 1 clk period

Key Literature

HP 16522A 200 M Vector/sec Pattern Generator Module for the HP Logic Analysis Systems, p/n 5964-2250E
Digital Verification with the HP 16522A Pattern Generator, p/n 5964-6347E

Ordering Information

HP 16522A 40-Channel 200-MVector/s Pattern Generator Card
Lead Sets
HP 10474A 8-Channel Probe Lead Set
HP 10347A 8-Channel Probe Lead Set
Data and Clock Pods
HP 10461A TTL Data Pod
HP 10462A 3-State TTL/CMOS Data Pod
HP 10464A ECL Data Pod (terminated)
HP 10465A ECL Data Pod (unterminated)
HP 10466A 3-State TTL/3.3 Volt Data Pod
HP 10460A TTL Clock Pod
HP 10463A ECL Clock Pod

The HP E9484A #002 analysis probe provides an easy way to probe the pinless Motorola PowerPC 821/860 BGA package.

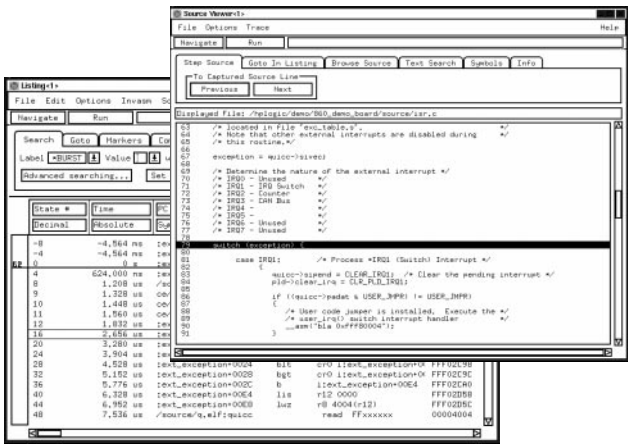
Emulation probes provide an easy, nonintrusive connection to your chip's debug port.

Configure a Logic Analysis or Emulation System

For a complete processor or bus solution you need tools that probe, acquire, and analyze your system's data. HP and its complementary vendors provide an extensive range of quality tools that offer non-intrusive, full-speed, real-time analysis and processor execution control to accelerate your debugging process.

Real-Time Analysis

Component	HP Model #	Description	Feature	Capability
Frame	HP 16700A HP 16701A HP 16702A	5 slot mainframe 5 slot expansion mainframe 5 slot mainframe w/flat panel display		Support up to 1,020 channels of state/timing, oscilloscope, pattern generation and emulation modules.
	HP 16600 Series	Built-in acquisition with one extra measurement module slot.	Context Store	Identify what routine corrupted a variable or called a particular function.
Logic Analyzer Measurement Module(s)	See page 384	Provides state and timing acquisition.	Real-Time Trace	Capture and analyze code flow and data flow without halting the target system. Monitor processor activity in relation to system buses, other processors, or I/O devices.
			Time-Tagged Trace Execution	Time-correlate analog, timing and state events across your entire system. Identify real-time performance problems. Check the execution time of specific functions.
			Advanced Triggering	Capture and focus on problems that occur infrequently or only after a specific series of events.
			Non-intrusive	Run target system at full speed.
Analysis Probe	See page 390		Probing	Access all processor signals through reliable, quick, easy target connection.
			Configuration Files	Quick, easy analyzer setup correlated to hardware connection.
			Inverse Assembler	Disassemble trace into processor mnemonics.
Source Correlation Tool Set	HP B4620B	Provides correlation of acquired trace to high-level source code by using information from your object file to build a database of source files, line numbers, and symbol information.		Time-correlate acquired trace to high-level source code. Step through trace in assembly level or source code level. Easily locate a problem's cause by stepping backward from the symptom occurrance.



Inverse assembled trace time-correlated to source code using the HP source correlation tool set.

Emulation modules provide an integrated solution for the HP 16702A, 16700A and 16600A Series logic analysis systems that combines logic analysis with non-intrusive connection to your processor's on-chip debug port.

Processor Control

Component	HP Model #	Description	Feature	Capability
Emulation Module	See page 390	Processor control integrated in HP 16702A, 16700A and 16600A Series frames.	Easy, non-intrusive connection	Access the debug pins of the target microprocessor without affecting any other signals.
			Program Execution Control	Reset, run/break, start/stop, single step.
			High-Speed Code Download	Download code to target RAM or FLASHPROM.
Emulation Probe	See page 390	Standalone processor control. Controlled over local area network (LAN).	Easy, non-intrusive connection	Access the debug pins of the target microprocessor without affecting any other signals.
			Program Execution Control	Reset, run/break, start/stop, single step.
			High-Speed Code Download	Download code to target RAM or FLASHPROM.
Emulation Control Interface	Standard on HP 16600 and 16700 Series mainframes.	Multiple windowed interface for emulation modules and probes.	Control of emulation module/probe	Setup breakpoints, read and modify memory and I/O in the target system.
High-level Debugger	Complementary Vendor	Source-level software debug Control of emulation module/probe.	Hardware-assisted software debug	Debug of C or C++ plus the ability to access on-chip debug features via HP emulation module/probe.
Emulation Solution	See page 390	A bundle of products for ordering convenience. Includes an analysis probe, source correlation tool set and emulation module/probe.	Provides real-time trace, emulation and source correlation.	See pages 388 and 389 for specific details.

HP Support for New Microprocessor and Bus Interfaces

Hewlett-Packard is committed to providing support for the latest microprocessors and bus interfaces. HP works with semiconductor vendors and premier channel partners to ensure early development solutions for new processors and bus interfaces. Please see page 389 for a complete listing of supported devices. If you do not see your processor listed, please contact your local sales office for the latest processor support update.

Custom Inverse Assemblers

If your target system microprocessor is not supported by HP or an independent third-party vendor, you can write your own disassembler with the HP 10391B. This software packages allows you to create software that displays your processor operation in familiar mnemonics.

Key Literature

Processor and Bus Support for HP Logic Analysis Systems, p/n 5966-4365E

Ordering Information

HP 10391B Inverse Assembler Development

For individual component pricing, please see page 389.

Selection Guide Key[1]

AP = Analysis Probe
EM = Emulation Module
IA = Inverse Assembler
EP = Emulation Probe
EMG = Emulation Migration
ES = Emulation Solution
AD = Adapter

Device Manufacturer and Name	Package Type	Prod Type	State	Timing	Emulation	Min#/ Max# Pods	HP Product or Channel Partner
Actel FPGA							
ACT1280	176-PGA	AP		•		-/9	Corelis
Altera EPLD							
EPM5192-P	84-PGA	AP		•		-/5	Corelis
AMD							
29000/50	PGA	AP	•	•		5/9	Corelis
29030	PGA	AP	•	•		5/7	Corelis
29040	PGA	AP	•	•		5/9	Corelis
29200	PQFP	AP	•	•		5/10	Corelis
29202	PQFP	AP	•	•		5/8	Corelis
29205	PQFP	AP	•	•		5/6	Corelis
29240/43/45	PQFP	AP	•	•		5/11	Corelis
186EM/ES	PQFP	AP	•	•		4/8	Corelis
	TQFP	AP	•	•		4/8	Corelis
188EM/ES	PQFP	AP	•	•		4/8	Corelis
	TQFP	AP	•	•		4/8	Corelis
Analog Devices							
ADSP2111	PQFP	AP	•	•		3/6	ET[6]
Aptix							
AX1024D FPIC	PGA	AP		•		-/4	Aptix
ARM							
ARM7[1]	IA Only	AP	•	•		4/4	E9595A #001
ARM7TDMI, ARM7DI	IA Only	ES[5]	•	•	•	4/4	E9495A #001
		EP[5]			•		E5900A #300
		EM[5]			•		E5901A #300
AT&T							
92010 (Hobbit)	PQFP	AP	•	•		6/6	Corelis
Cyrix							
486SLC	PQFP	AP	•	•		4/5	ET[6]
Dallas							
80C320	DIP	AP	•	•		2/3	ET
	PLCC	AP	•	•		2/3	ET
	PQFP	AP	•	•		2/3	ET[6]
DEC							
SA-110	TQFP	AP	•	•		5/6	Corelis
Fujitsu							
MB86930/932	208-PQFP	AP	•	•		6/8	ALD
MB86933H	160-PQFP	AP	•	•		6/8	ALD
MB86934	256-PQFP	AP	•	•		8/10	ALD
MB86935/36	208-PQFP	AP	•	•		6/8	ALD
Hitachi							
SH7042R/43R/14	112-QFP	EP/AP	•		•	6/6	E3472A
SH7040/41/42A / 43A/44/45	144-QFP	EP/AP	•		•	6/6	E3472D
SH7050/51	168-QFP	EP/AP	•		•	6/6	E3473A
SH3-7708	144-LQFP	AP	•	•		6/10	E8018A
SH3-7709	208-LQFP	AP	•	•		6/10	E8019A
IBM PowerPC 4XX Family							
PPC 403 GA/B/C/CX	IA Only	AP	•	•		5/8	E2449B
PPC 403 GA/C/CX	160-PQFP	AP	•	•		5/8	E2468A
PPC 401/403	All	EP[5]			•		E5900A #060
		EM[5]			•		E5901A #060
IBM PowerPC 6XX Family							
PPC 601	IA Only	IA	•	•		8/10	E2449B
PPC 603, 603e, 603ev	IA Only	AP	•	•		8/10	E9587A #001
		ES[5]	•	•	•	8/10	E9487A #001
	240-PQFP	AP	•	•		8/10	E9587A #002
		ES[5]	•	•	•	8/10	E9487A #002
PPC 604	289-PGA	AP	•	•		8/11	E9588A #002
		ES[5]	•	•	•	8/11	E9488A #002
PPC 603/e/ev, 604/e/ev	All	EP[5]			•		E5900A #060
		EM[5]			•		E5901A #060
IBM PowerPC 7XX Family							
PPC 740/750	IA Only	AP	•	•		8/10	E9586A #001
		ES[5]	•	•	•	8/10	E9486A #001
PPC 740,750	All	EP[5]			•		E5900A #070
		EM[5]			•		E5901A #070
		EMG[5]			•		E5902A #070
IDT							
R3041	PLCC	AP	•	•		5/6	Corelis
R3051/52/81/82	PLCC	AP	•	•		5/6	Corelis
R3640	TQFP	AP	•	•		5/7	Corelis
R36100	MQUAD	AP	•	•		6/12	Corelis
R4000/4400PC	PGA	AP	•	•		8/9	Corelis
R4600/4700	PGA	AP	•	•		6/7	Corelis
	MQUAD	AP	•	•		6/7	Corelis
R4640	PQFP	AP	•	•		4/4	Corelis
R4650	MQUAD	AP	•	•		6/7	Corelis
R5000	PGA	AP	•	•		6/9	Corelis
Intel Pentium							
Pentium 567\66	PGA	AP		•		-/12	ET
Pentium and Pentium w/MMX	296-SPGA	AP	•	•		8/10	E9592A #002
		ES[5]	•	•	•	8/10	E9492A #002
		EP[5]			•		E5900A #500
		EM[5]			•		E5901A #500
Pentium Pro	387-SPGA	AP	•	•		10/10	E2466B
Pentium II	Slot 1	AP	•	•		10/10	E2466C
Pentium II	Slot 1,2	AP	•			12/12	E2492S
Pentium II	Mobile	AP	•			12/12	E2494S
Pentium Pro, Pentium II		EP[5]			•		E5900A #510
		EM[5]			•		E5901A #510
Intel 80X86							
8086/8088	DIP	AP	•			3/3	ET
80186/88/XL	PGA	AP	•	•		3/6	ET[6]
	PLCC	AP	•	•		3/6	ET
80C186EB	PLCC	AP	•	•		3/6	ET[6]
	PQFP	AP	•	•		3/6	ET
80286	PGA	AP	•	•		3/4	E2409C
	68-PLCC	AD[1,2]					#1CB
80386CX	PQFP	AP	•			4/6	ET[6]
80386EX	132-PQFP 144-TQFP[1,2]	AP	•	•		4/6	E2454A
80386SX	PQFP	AP	•	•		4/4	ET[6]
80486SX,DX2,OD	PGA	AP	•	•		5/7	E2411C
	(For 208, 196, 176-PQFP see footnotes)[1,2]						
Intel 80960X							
80960CA	PGA	AP		•		-/5	Corelis
80960H-Series	PGA	AP	•	•		6/7	E2473A
80960J-Series	PGA	AP	•	•		5/6	E2464A
	PQFP	AD[1,2]					E5337A
80960KA/KB/MC	PGA	AP	•	•		5/6	Corelis[1,3]
80960RD,RP	BGA	AP	•	•		5/6	E2484A
80960SA,SB	PLCC	AP	•	•		4/4	ET
Intel Other							
8085	DIP	AP	•			2/3	ET
8031/51	DIP	AP	•	•		3/3	E2415B
	44-PLCC	AD[1,2]					ET
8X51GB	PLCC	AP	•	•		2/5	ET[6]
80C196KA/KB	PLCC	AP	•	•		3/5	E2416B
80860XR	PGA	AP		•		-/5	Corelis
LSI Logic							
LR33000/33050	PGA	AP	•	•		5/8	Corelis
LR33020	PGA	AP	•	•		7/11	Corelis
LR333X0	PQFP	AP	•	•		5/8	Corelis
Motorola PowerPC 5XX Family							
MPC505/509	160-PQFP	AP	•	•		6/10	E9585A #002
		ES[5]	•	•	•	6/10	E9485A #002
MPC 505/509	All	EP[5]			•		E5900A #050
		EM[5]			•		E5901A #050
Motorola PowerPC 6XX Family							
PPC 601	IA Only	IA	•	•		8/10	E2449B
PPC 603/e/ev	IA Only	AP	•	•		8/10	E9587A #001
		ES[5]	•	•	•	8/10	E9487A #001
	240-PQFP	AP	•	•		8/10	E9587A #002
		ES[5]	•	•	•	8/10	E9487A #002
PPC 604	289-PGA	AP	•	•		8/11	E9588A #002
		ES[5]	•	•	•	8/11	E9488A #002
PPC 603/e/ev 604/e/ev	All	EP[5]			•		E5900A #060
		EM[5]			•		E5901A #060
Motorola PowerPC 7XX Family							
PPC 740/750	IA Only	AP	•	•		8/10	E9586A #001
		ES[5]	•	•	•	8/10	E9486A #001
PPC 740/750	All	EP[5]			•		E5900A #070
		EM[5]			•		E5901A #070
		EMG[5]			•		E5902A #70

8

Device Manufacturer and Name	Package Type	Prod Type	State	Timing	Emulation	Min#/ Max# pods	HP product or Channel Partner
Motorola PowerPC 8XX Family							
MPC860, 821	IA Only	AP	•	•		6/12	E9584A #001
		ES[5]	•	•	•	6/12	E9484A #001
	357-BGA	AP	•	•		6/12	E9584A #002
		ES[5]	•	•	•	6/12	E9484A #002
MPC860, 821, 850,860	All	EP[5]			•		E5900A #080
		EM[5]			•		E5901A #080
		EMG[5]			•		E5902A #080
Motorola 68K							
68000/10	DIP	AP	•	•		3/4	ET
	SDIP	AP	•	•		3/4	ET
	PLCC	AP	•	•		3/4	ET
	PGA	AP	•	•		3/4	ET
68000/HC000	PGA	AP	•	•		3/7	E2447AA
68HC000/001	PGA	AP	•	•		3/4	ET[6]
	PLCC	AP	•	•		3/4	ET
68EC000	PLCC	AP	•	•		3/7	E2447AB
68008	DIP	AP	•	•		3/4	ET
68020	PGA	AP	•	•		5/6	E2426A
	PQFP	AD[1,2]					#1CC
68030	PGA	AP	•			5/5	E2406A
	PQFP	AD[1,2]					#1CC
68EC030	PGA	AP	•			5/5	E2406A
68060/68040	PGA	AP	•	•		6/8	E2459A
	184-PQFP	AD[1,2]					E5345A
Motorola CPU32 Family							
68331/32/34/35	132-PQFP	AP	•	•		4/12	E9589A #002
		ES[5]	•	•	•	4/12	E9489A #002
68331/32	144-TQFP	AP	•	•		4/12	E9589A #003
		ES[5]	•	•	•	4/12	E9489A #003
68336/76	160-PQFP	AP	•	•		4/12	E9596A #002
		ES[5]	•	•	•	4/12	E9496A #002
68360, 68EN360, 68MH360	241-PGA	AP	•	•		6/12	E9590A #002
		ES[5]	•	•	•	6/12	E9490A #002
	240-PQFP	AP	•	•		6/12	E9590A #003
		ES[5]	•	•	•	6/12	E9490A #003
68330/1/2/4/5/6, 68340/1/9, 68360/EN/MH, 68376, 68F333, 68CK338		EP[5]			•		E5900A #030
		EM[5]			•		E5901A #030
68332	PGA	AP	•	•		4/7	ET[6]
	PQFP	AP	•	•		4/7	ET[6]
68339	QFP	AP	•	•		4/4	ET[6]
68340	PGA	AP	•	•		3/7	Corelis
68340	PQFP	AP	•	•		4/7	ET
Motorola 6830X							
68302	PGA	AP	•	•		3/6	Corelis
	PQFP	AP	•	•		3/6	Corelis
68302	PGA	AP	•	•		3/7	ET
	PQFP	AP	•	•		3/7	ET
68EN302	TQFP	AP	•	•		3/7	Corelis
68LC302	PGA	AP	•	•		3/6	Corelis
68LC302	TQFP	AP	•	•		3/6	Corelis
Motorola M-Core Family							
M-Core	All	EP[5]			•		E5900A #090
Motorola DSPs							
56116/156/166	—	IA	•			5/5	Corelis
56303	TQFP	AP	•	•		4/7	Corelis
56L811	TQFP	AP	•	•		4/5	Corelis
Motorola 68HCXX							
68HC11F1	PLCC	AP	•	•		3/4	ET
68HC11KA2	PLCC	AP	•	•		3/4	ET
68HC11K4	PQFP	AP	•	•		2/5	ET
68HC12A4	TQFP	AP	•	•		3/6	ET
68HC12B32	PQFP	AP	•	•		3/4	ET
68HC12D60	QFP	AP	•	•		3/6	ET[6]
NEC							
V25	PLCC	AP	•	•		3/5	ET
V830	LQFP	AP				5/6	Corelis
Vr4100	TQFP	AP	•	•		6/6	Corelis
Vr4200	PQFP	AP	•	•		6/7	Corelis
Vr4300	PQFP	AP	•	•		4/4	Corelis
R5000	PGA	AP	•	•		6/9	Corelis
NKK							
NR4645MQF	PQFP	AP	•	•		4/4	Corelis
NR4650GQF	PQFP	AP	•	•		6/7	Corelis
NR4650LQF	PQFP	AP	•	•		6/7	Corelis
NR4700LMQ	PQFP	AP	•	•		6/7	Corelis

Device Manufacturer and Name	Package Type	Prod Type	State	Timing	Emulation	Min#/ Max# pods	HP product or Channel Partner
PACE							
1750	PGA	AP	•			3/3	Lital
QED							
5230	PQFP	AP	•	•		6/7	Corelis
5260	PQFP	AP	•	•		6/11	Corelis
Siemens							
80C165	PQFP	AP	•	•		3/7	ET
80C166	PQFP	AP	•	•		3/8	ET[6]
80C167	PQFP	AP	•	•		4/9	ET
80C515	PLCC	AP	•	•		2/4	ET[6]
80C517/537	PLCC	AP	•	•		2/4	ET
Texas Instruments							
320C20/25	PGA	AP	•	•		3/3	Corelis
320C30	PGA	AP	•			4/7	Corelis
320C31	PQFP	AP	•			4/7	Corelis
320C32	PQFP	AP	•	•		6/6	Corelis
320C32	TQFP	AP	•	•		6/6	Corelis
320C40	PGA	AP	•	•		5/16	Corelis
320C50/51/53	PQFP	AP	•	•		3/6	Corelis
320C52	PQFP	AP	•	•		4/4	Corelis
320C80	PGA	AP		•		-/8	Corelis
320C542/48/49	TQFP	AP	•	•		4/7	Corelis
370C16	—	IA	•			6/6	Corelis
470R1X	TQFP	AP	•	•		4/4	Corelis
Toshiba							
R3900	PQFP	AP	•	•		6/7	Corelis
R3901/03/04	All	EP			•		E3492B
TX19/39	All	EP[5]			•		E5900 #800[4]
	All	EM[5]			•		E5900 #800[4]
Xilinx LCA							
XC4005/4006	156-PGA	AP		•		-/8	Corelis
XC4008/4010	191-PGA	AP		•		-/8	Corelis
Zilog							
Z80	DIP	AP	•	•		2/3	ET
Z80	PLCC	AP	•	•		2/3	ET
Z180	PLCC	AP	•	•		2/4	ET
Standard Buses							
AGP	N/A	AP	•	•		4/4	FuturePlus
APIC	N/A	AP	•	•		2-4	E2467A
Compact PCI/Ext	N/A	AP	•	•		4-7	FuturePlus
EISA	N/A	AP	•	•		5/10	ALD
Fibre Channel	N/A	AP	•	•		4/8	FuturePlus[4]
I2C	N/A	AP	•	•		2/2	ALD[1,2]
IBM ISA (AT)	N/A	AP	•	•		6/6	Corelis
ISA/Extender	N/A	AP	•	•		5-6	FuturePlus
IBM ISA (AT)	N/A	AP	•	•		5/5	Lital
IEEE 488 (HPIB)	N/A	AP	•	•		1/2	ALD
IEEE 1284	N/A	AP	•	•		2/2	ALD
IEEE 1394	N/A	AP	•	•		4	FuturePlus[4]
JTAG 1149.1	N/A	AP	•	•		1/1	Corelis
JTAG 1149.5	N/A	AP	•	•		1/1	Corelis
PCI-64	N/A	AP	•	•		4-6	FuturePlus[1,3]
PCI/EXT-32	N/A	AP	•	•		4/4	FuturePlus
PCI/EXT-64	N/A	AP	•	•		4-6	FuturePlus[1,3]
PCI-32/Extender	N/A	AP	•	•		4/4	Corelis
PCI-32/E	N/A	AP	•	•		6/6	Corelis
PCI-64/Extender	N/A	AP	•	•		6/6	Corelis
PCI Mezzanine (PMC)		AP	•	•		4/4	FuturePlus
PCI EIO	N/A	AP	•	•		4/4	FuturePlus
PCI Cardbus	N/A	AP	•	•		4/4	FuturePlus
PCI Logic Scope	N/A	AP	•	•		4-6	FuturePlus
PCI Scope	N/A			•			FuturePlus
PCMCIA	N/A	AP		•		-/4	Mobile
RS232c,RS449	N/A	AP	•	•		2/2	ALD
SCSI 1,2,3	N/A	AP	•	•		2/4	FuturePlus
LVD SCSI (Ultra)	N/A	AP	•	•		2/4	FuturePlus
Univ Serial Bus	N/A	AP	•	•		2-3	FuturePlus
VME64/VXI	N/A	AP	•	•		5-9	FuturePlus
168-pin DIMM	N/A	AP		•		-/6	FuturePlus
72-pin SIMM	N/A	AP		•		-/4	FuturePlus
User Defined							
User Defined Interface						1/-	E2445A

[1] Refer to publication #5966-4365E for additional information.
[2] Requires purchasing multiple products.
[3] Multiple products are available with varying prices.
[4] Prices not available at publication.
[5] Debuggers are available from third party vendor(s). See page 391
[6] Contact vendor for pricing information.

Third Party Debugger Support

Debuggers from several companies can be used to control HP emulation probes and emulation modules. Connections to HP tools through familiar debugger interfaces provide access to emulation features so that in-circuit debugging becomes an extension of the software debugging process under way.

The following debuggers connect to HP emulation probes and emulation modules, providing support for a variety of processor architectures and real-time operating systems. Contact the HP Call Center in your region for detailed connection information.

Processor Family	Debugger Vendors
ARM	ARM
IBM PPC4xx	GHS, Microtec, SDS
IBM PPC 6xx	GHS, Microtec, SDS
IBM PPC 7xx	GHS, SDS
Pentium and Pentium w/MMX processors	CAD-UL
Pentium II, Pentium Pro and Pentium II mobile processors	American Arium
Motorola MPC 5xx	GHS, SDS
Motorola PPC 6xx	GHS, Microtec, SDS
Motorola PPC 7xx	GHS, SDS
Motorola MPC 8xx	GHS, Microtec, SDS
CPU32	GHS, Microtec, SDS
M-Core	SDS

Complementary Vendors

The following companies provide products that complement HP logic analyzers and emulation probes/modules. Hewlett-Packard works closely with these companies to ensure quality products, but the vendor is responsible for functionality, pre-sales and post-sales support, and warranty. For companies listed below with a "Resell Code", their products are also available from Hewlett-Packard's Corporate Price List. For resale products, the Channel Partner is still responsible for functionality, pre-sales, post-sales, and warranty.

ALD
Premiere Channel Partner
Advanced Logical Design (Re-sell Code ALO)
Ph 408-446-1004
Fax 408-446-1079
http://www.ald.com

APTIX
Aptix Corporation
Ph 408-428-6200
Fax 408-944-0646
http://www.aptix.com

AMERICAN ARIUM
American Arium
Ph 714-731-1661
Fax 714-731-6344
http://www.arium.com

ARM
ARM Inc.
Ph 408-399-5199
http://www.arm.com

CAD-UL
CAD-UL, Inc.
Ph 602-945-8188
Fax 602-945-8177
http://www.cadul.com

CAPITAL
Capital Equipment Corp.
Ph 800-234-4232
Fax 508-663-2626
http://www.cec488.com

CORELIS
Premiere Channel Partner
Corelis, Inc. (Re-sell Code CRL)
Ph 562-926-6727
Fax 562-404-6196
http://www.corelis.com

DIAGONAL
DS Diagonal Systems AG
Ph 41 1 905 60 60
Fax 41 1 905 60 69
http://www.diagonal.com

ET
Premiere Channel Partner
Emulation Technology Inc. (Re-sell Code ETN)
Ph 408-982-0660
Fax 408-982-0664
http://www.emulation.com

EUROPE TECH–NOLOGIES
Europe Technologies
Ph 33 493 004 300
Fax 33 493 004 301

Future Plus
Premiere Channel Partner
Future Plus Systems Corporation (Re-sell Code FSI)
Ph 719-380-7321
Fax 719-380-7362
http://www.futureplus.com

GHS
Green Hills Software, Inc.
Ph 805-965-6044
Fax 805-965-6343
http://www.ghs.com

JME
J M Engineering
Ph 800-982-6355
Fax 719-637-1777
http://www.jmecorp.com

LITAL
Lital Electronics, Inc.
Ph 714-731-8123
Fax 714-731-8170

MOBILE
Mobile Media Research
Ph 510-657-4891
Fax 510-657-4862
http://www.mobmedres.com

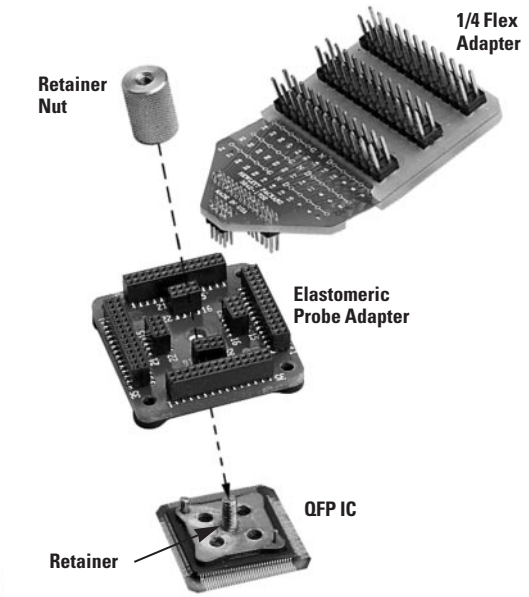
MRI
Microtec
Ph 800-950-5554
Fax 408-487-7001
http://www.mentorg.com/microtec

POMONA
ITT Pomona
Ph 909-469-2900
Fax 909-629-3317

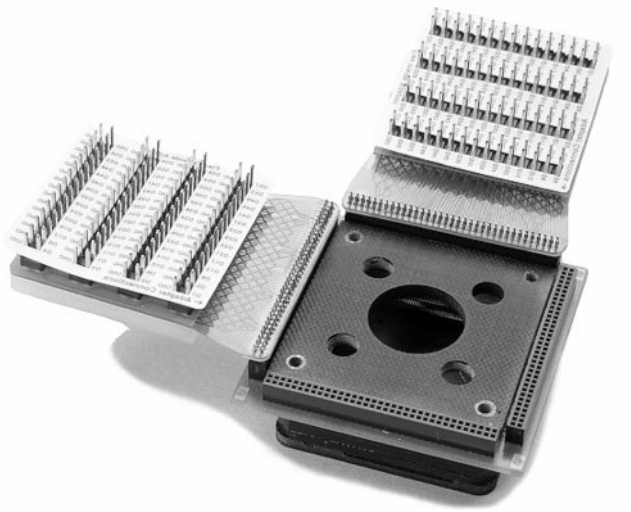
SDS
Software Development Systems, Inc.
Ph 800-448-7733
Fax 630-990-4641
http://www.sdsi.com

TSSI
TSSI
Ph 503-672-8774
Fax 503-672-8700
http://www.tessi.com

ZILOG
Zilog, Inc.
Ph 408-370-8000
Fax 408-370-8056
http://www.zilog.com



HP's elastomeric probe adapters offer a simple means of connecting to PQFP and TQFP packages with minimal "keep out" area.



Locator base probing system with 1/4 flex adapters.

Reliable Measurements Start with Good Probing

Accurate measurements require reliable probing. HP's innovations in probing and accessories assure you of reliable measurements, while making it easy to connect the logic analyzer to your system.

HP's advances in probing minimize your concerns in the following areas:

- Keep out area
- Loading, both resistive and capacitive
- Ease of installation
- Reliability - mechanical and electrical

We Make it Easy to Select and Order the Probes You Need

HP makes it easy for you to select the right probe for your needs. Most HP analysis probes come complete with all the accessories needed to complete the connection to your processor or bus.

Visit the HP website at **http://www.hp.com/go/logicanalyzer** for the latest information on all HP probes and accessories.

Probing Alternatives

Probing Solution	Purpose
HP MicroWedge, Grabbers, Micrograbbers	Use this option if you are probing a few pins, or need to connect to PC boards/packages in hard-to-reach or already installed systems.
High-Density Termination Adapter	Provides a direct connection to 34 signals on an industry-standard connector. Use this approach if you are beginning to layout a board and need to access custom parts or buses in your system, or are using BGA packages.
Elastomeric Probing	HP's patented Elastomeric Probing technology is ideal for low intrusion, easy and reliable connection to today's PQFP and TQFP packages.
Locator-base Probing	Ideal for solid, robust connection.

Elastomeric Probing Solutions

An elastomeric probing solution from HP offers you an inexpensive, rugged, and easy-to-use probing solution for both TQFP and PQFP packages. These probes require a minimal "keep out" area around the device.

The elastomeric probe makes contact to the pins of a device with an elastomer material. There are redundant connections for each pin, ensuring a reliable and rugged connection. A retainer is glued to the top of the device to ensure a solid connection to each pin of the device.

Locator-Base Probing Solutions

There are several solutions available for high-density packages using a locator base. This solution allows connection to 0.5 mm or 0.65 mm pitch CQFP and PQFP devices.

A locator base must be placed on the PC board around the device to be tested. The base can be glued to the board or connected directly to the board with mounting screws. The probe adapter then slides over the chip and attaches to the locator base. Connection is made to each pin on the device.

High-Density Adapters

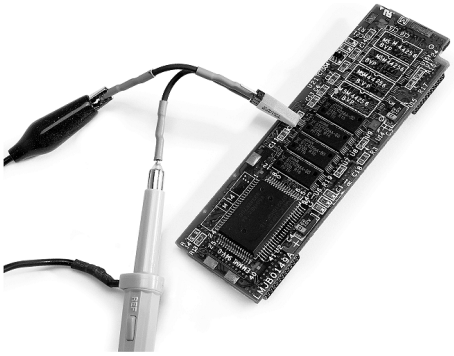
The HP E5346A and HP E5351A high-density adapters provide a convenient and easy way to connect an HP logic analysis system to the signals on your target system. With difficult packages to probe, such as BGA, or with other probing restrictions, the adapters provide a high-density logic analysis connection that gives you access to multiple signals without taking up board space.

Termination Adapter

The HP 01650-63203 termination adapter allows you to use 3M 2x10 connectors in your system for connection to an HP logic analysis system. The termination is located at the probe tip of the adapter for easy application. Each connector is used for 16 data channels and one clock.

Wedge Probe Adapter

The HP Wedge provides an accurate, mechanically non-invasive way to make contact with IC pins, with spacing of 0.65 or 0.5 mm. You can connect logic analyzer flying leads directly to the adapter or connect scope probes through a dual-head adapter.



The HP MicroWedge probe adapter provides mechanically sound, noninvasive connection to three adjacent pins on TQFP and PQFP packages.

The HP E5346A high-density termination adapter provides access to 34 signals per connector; the standard termination adapter (01650-63203) provides 17.

Probing Solutions

Package Type	Pin Pitch	Elastomeric Solutions	Locator Base Solutions
304-Pin PQFP/CQFP	0.5 mm		HP E5331A Probe Adapter HP E5333A Flexible Adapter
240-Pin PQFP/CQFP	0.5 mm	HP E5363A Probe Adapter HP E5371A 1/4 Flexible Adapter	HP E5315A Probe Adapter HP E5316A Flexible Adapter HP E5330A Rigid Adapter
208-Pin PQFP/CQFP	0.5 mm	HP E5374A Probe Adapter HP E5371A 1/4 Flexible Adapter	HP E5318A Probe Adapter HP E5316A Flexible Adapter HP E5330A Rigid Adapter
184-Pin PQFP/CQFP	0.5 mm		HP E5343A Probe Adapter HP E5316A Flexible Adapter HP E5330A Rigid Adapter
176-Pin PQFP	0.5 mm	HP E5348A Probe Adapter HP E5349A 1/4 Flexible Adapter	
160-Pin QFP	0.5 mm	HP E5377A Probe Adapter HP E5349A 1/4 Flexible Adapter	
160-Pin PQFP/CQFP	0.65 mm	HP E5373A Probe Adapter HP E5349A 1/4 Flexible Adapter	HP E5319A Probe Adapter HP E5316A Flexible Adapter HP E5330A Rigid Adapter
144-Pin PQFP/CQFP	0.65 mm	HP E5361A Probe Adapter HP E5340A 1/4 Flexible Adapter	
144-Pin TQFP	0.5 mm	HP E5336A Probe Adapter HP E5340A 1/4 Flexible Adapter	

Key Literature

Probing Solutions for TQFP/CQFP/PQFP Packages,
Product Overview, p/n 5965-2790E
Minimizing Intrusion Effects When Probing With a Logic Analyzer,
p/n 5962-8620E
HP E5346A and HP E5351A High-Density Adapters, p/n 5965-5475E
Processor and Bus Support for HP Logic Analysis Systems,
p/n 5966-4365E

Ordering Information

High-Density Adapters

HP E5346A High-Density Termination Adapter
HP E5351A High-Density Adapter
HP E5346-44701 Recommended Support Shroud
HP E5346-60002 High-Speed Mictor Break-Out Adapter
HP E5346-68701 Five Mictor Connectors and 5 Support Shrouds

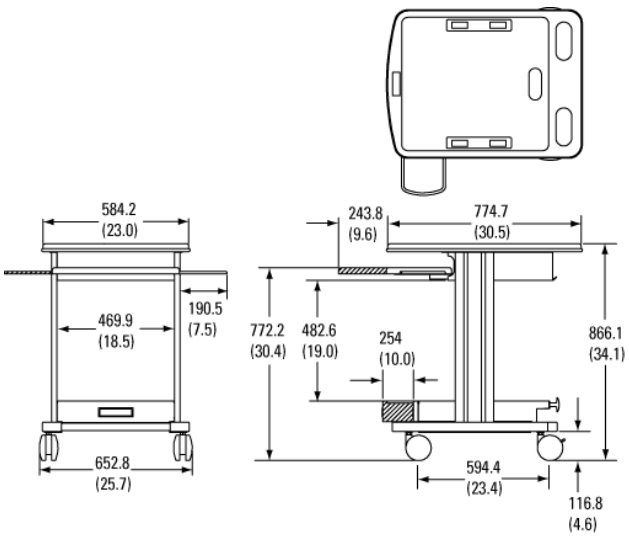
Termination Adapters

HP 01650-63203 Standard Termination Adapter

Wedge Probe Adapters

HP E2613B HP Wedge 0.5 mm Probe Adapter-3 Signal
HP E2614B HP Wedge 0.5 mm Probe Adapter – 8 Signal
HP E2615B HP Wedge 0.65 mm Probe Adapter – 3 Signal
HP E2613A HP Wedge 0.5 mm Probe Adapter – 3 Signal
HP E2615A HP Wedge 0.65 mm Probe Adapter – 3 Signal

- Keyboard tray with adjustable tilt and height
- Mouse extension on keyboard tray accommodates either right or left hand operation
- HP 16700A frame and HP 16701A expansion frame can be located in the bottom of the cart, leaving the top free to accommodate a monitor
- Locking casters for safety on uneven surfaces
- Strap provided to stabilize the monitor



HP 1184A testmobile cart dimensions. Dimensions: mm (inches).

Sturdy testmobile design gives your logic analyzer mobility and frees up bench space.

Testmobiles

NEW

Make your logic analysis system a portable one with the HP testmobile. Each testmobile is designed to withstand rugged use.

Ordering Information

HP1184A Testmobile

Soft Carrying Case

The HP 1540-1066 soft carrying case allows you to easily carry your HP 1660 and 1670 series benchtop logic analyzer and its accessories to remote sites.

Ordering Information

HP1540-1066 Logic Analyzer Soft Carrying Case

The HP 81200 Data Generator/Analyzer for characterizing complex multi-channel digital designs, shown here with the larger mainframe.

Verification solutions help engineers in the design and test of digital devices, computers, peripherals, and communication systems. By emulating real-world conditions, hardware problems can be identified early in the product cycle.

Products range from general-purpose instruments like pulse and data generators, through to generic stimulus/response platforms and application-specific solutions such as PCI bus exercisers and, for testing routers, the parallel traffic generator/analyzer.

ATM/Parallel Test Solutions

The HP E4829B Parallel Cell/Traffic Generator/Analyzer is designed to speed-up the verification process of parallel interfaces implemented with ICs, modules and sub-systems. Please see page 454 for further details.

PCI Bus Exerciser & Analyzer

The HP E2920 PCI Series is the only family of PCI-based test tools suitable for developing chips, boards and systems that employ the PCI bus. This means a common test standard for all out-sources, key companies and end-users. For more detailed information, please consult 398.

Data Generators/Analyzers

Data generators focus on functional and worst-case testing of digital devices with many inputs and requiring many test vectors. Two models are offered: the HP 80000 1 GHz Data Generator and the HP 81200 Data Generator/Analyzer Platform (see table below).

The HP 81200 is an expandable system that can be configured with analyzer channels for data capture, real-time compare and BER measurements so that at-speed, functional and performance tests can be performed by a single instrument. Initial investment is protected not only through the modular, upgradeable structure but also through the platform architecture that allows new features to be added.

Digital Transmission Test

The HP E4859A Serial Cell Generator/Analyzer System characterizes the transmission performance of time division multiple access (TDMA) and other burst-mode transmitters and receivers. For more details, see page 397.

Pulse/Pattern Generators

For more information, please see page 407.

Synthesized Function/Sweep Generators

Synthesized Function/Sweep Generators provide a variety of stable analog signals. In digital applications synthesized function/sweep generators are useful as an accurate clock source or reference. For further information consult page 168 (HP 3324A).

	HP 80000 Data Generator	HP 81200 Data Generator/Analyzer Platform
Key features	$2^{23}-1$ hardware prbs 1 GHz clock rate	1 Mbit memory/channel[1] Stimulus/response Sequencing
Max. clock rate	1 GHz	660 MHz
Max. data rate using channel add.	2 Gbit/s NRZ	1.32 Gbit/s NRZ
Clock jitter	<10 ps rms typical	<5 ps rms typical
Timing resolution	2 ps	2 ps
Outputs	Single-ended	Differential or single-ended[2]
Transitions, 20% to 80% amplitude	100 ps fixed	200 or 400 ps fixed[2]
Levels, 50 Ω into 50 Ω	2.5 Vpp max	2.5 or 3.3 Vpp max[2]
Format	RZ/NRZ	RZ/NRZ or NRZ only
RZ width	50%	Variable
Memory	16 or 128 kbit/channel[2]	1 Mbit/channel[1]
Memory resident prbs/prws	Up to $2^{11}-1$	Up to $2^{15}-1$
Hardware prbs/prws	$2^{23}-1$	No
(prws is a sequence for bit-error rate testing of multiplexers)		
Channel addition	External, analog (Option H06)	Internal EXOR
Max. Channels:		
Single frame	20	Small frame 10 (20 NRZ) Large frame 38 (76 NRZ)
Multi-frame	80	120 (224 NRZ)
Further details on page	410	400

[1] Depends on module type and measurement mode.
[2] Depends on module type.

HP E4859A
HP E4853A
HP E4854A

- Error performance analysis of burst-mode data
- Up to 16 serial cell generators
- Cells with mixed PRBS/user-defined pattern
- Variable cell lengths and cell timing
- Bit rate 170 kb/s to 250 Mb/s (optional 660 Mb/s)
- Auto-adjust cell transfer delay and threshold
- Detect mode with clock and data input

HP E4859A, with HP E4854A and peripherals

HP E4859A Serial Cell Generator and Analyzer Entry System

The HP E4859A Serial Cell Generator and Analyzer Entry System provides one bursted serial cell generator, a companion cell error analyzer, and a central synthesized clock source. For configurations requiring multiple generators or analyzers, modules can be added to the entry systems.

The HP E4859A is used in research and development to characterize the transmission performance of Time Division Multiple Access (TDMA) and other burst-mode transmitters/receivers used in communication systems.

Generation of All Types of Burst-Mode Data

Multiple HP E4854A dual serial cell generators can be set up to emulate burst-mode data in a network. Cell length, cell content and cell timing can be varied for each generator to allow characterization of the transmission performance under real network conditions, even for designs using proprietary cell formats.

Error Performance Analysis of Burst-Mode Data

The HP E4853A serial cell analyzer measures the bit error performance of burst-mode cells transmitted from one of the generators. The generator and analyzer are synchronized by auto-adjust.

Applications

Applications include characterization of burst-mode transmitter/receiver, components, modules, and sub-systems during research and development:

- Time Division Multiple Access (TDMA). TDMA technology is typically used in point-to-multipoint networks, especially for upstream transmission in local access networks for interactive B-ISDN. Such networks are Passive Optical Network (PON), Passive Double Star (PDS), Fiber To The Curb (FTTC), and ground stations for Personal Handy Phone System (PHS).
- Time Compression Multiplex (TCM or pingpong)
- Wavelength Division Multiplex (WDM)
- Point-to-point burst-mode transmission
- Optical bus, optical computer interconnects, LAN
- Digital/optical CATV transmission
- Military communication system

Specifications (typical)

HP E4854A provides two serial cell generators.
HP E4853A provides one serial cell analyzer and one generator.
Bit Rate: 170 kb/s to 250 Mb/s, optional 660 Mb/s
Cell Content: Up to 28 segments of user-defined pattern and/or PRBS
User-Defined Pattern: 64 Kb per channel
PRBS: 2^7-1 to $2^{31}-1$
Segment Length: 1 bit to 64 Kb
Guardtime Between Cells in Burst-Mode: 0 to 24 ms, resolution 10 ps
Output Amplitude: 0.3 V to 2.5 V, TTL, ECL, PECL
Auxiliary Output (opt.)**:** Cell envelope, bursted clock, continuous clock
Auto-Adjust: Synchronization of analyzer and generator
Clock Input (opt.)**:** Detect mode with clock and data input for the analyzer
Measurements: Bit error count, bit error ratio; individual cell segments can be selected
Decision Threshold Voltage: –2.1 V to +5.1 V
Module Size: VXI C-size, one slot

Key Literature

Product Overview, p/n 5963-9985E
Technical Data, p/n 5963-9924E
Configuration Guide, p/n 5964-0004E

For more information, visit our website: **http://www.hp.com/go/dvt**

Ordering Information

The entry system is needed. Optionally, the free slots can be used for additional HP E4853A and HP E4854A modules. For assistance in defining your configuration, please contact the HP Call Center in your region.

HP E4859A Entry System* (seven free slots)
  Opt 001 Auxiliary Output
  Opt 002 Clock Input for Analyzer
  Opt 660 Bit Rate 660 Mb/s max.
HP E4853A Generator/Analyzer Module (one slot)
  Opt 001 Auxiliary Output
  Opt 002 Clock Input for Analyzer
  Opt 660 Bit Rate 660 Mb/s max.
HP E4854A Dual Generator Module (one slot)
  Opt 001 Auxiliary Output
  Opt 660 Bit Rate 660 Mb/s max.

*The entry system comes pre-installed and includes mainframe, clock source and sequencer, one HP E4853A (one generator/one analyzer) module, controller with operating system, application software, licenses, and documentation. Monitor, keyboard, and mouse have to be ordered separately.

8

HP E2920 PCI Series

HP E2925B
HP E2926A
HP E2927A
HP E2935A
HP E2936A
HP E2970A
HP E2971A
HP E2972A
HP E2974A
HP E2975A
HP E2979A

- Complete family of professional PCI bus test equipment
- PCI Exerciser and Analyzer hardware for every PCI technology level
- Tailored software packages for successful PCI testing
- PCI test bundles for managing standard tasks in PCI testing
- Fully programmable PCI master and target
- Low and high level control of protocol and traffic behavior

HP E2920 Computer Verification Tools

The HP E2920 PCI Series of Computer Verification Tools is a family of test tools designed to provide early and extensive insight into PCI-based designs, revealing and solving design problems sooner throughout the entire development process, from initial bring-up of devices and systems through to system validation.

The tools supplied with the HP E2920 PCI Series not only help you keep new designs on schedule, but also give you the confidence of knowing your product will perform in any conceivable situation.

Bring-up & Debug

To bring-up and debug PCI chips cards and systems you need interactive tools to analyze, stimulate and control the device-under-test and its environment. The PCI exerciser and analyzer contains an independent, controllable PCI agent combined with a PCI state logic analyzer and protocol checker on a single PCI card.

With the HP E2970A PCI Analyzer GUI the analyzer hardware can be set up and controlled from a PC. Bus traffic from state waveform level up to data transfer level can be captured and analyzed, allowing the observation of traffic at a level meaningful to the problem. The identification and triggering of protocol violations is possible at any time. The HP E2971A PCI Exerciser GUI sets up and controls the exerciser hardware, which contains programmable PCI master and target. Missing PCI traffic can be generated easily with a wide choice of protocol and traffic variations.

System Validation

The PCI exerciser and analyzer use the PCI bus as the "standard" interface to validate a system. Variable levels of background traffic can be generated and typical peripheral traffic patterns emulated to stress arbitration, memory controller, bridges and system interrupt. The HP E2974A Sub-System Stress Tests provide a set of tests for testing particular subsystems. The C-Application Programming Interface (C-API) available with the HP E2975A Protocol Permutator and Randomizer enables full range testing. Automatic PCI protocol permutations within user-defined constraints enable the testing of the PCI behavior of a device or system exhaustively.

Performance Optimization

Used in conjunction with the PCI exerciser and analyzer, the HP E2972A PCI Performance Analyzer is a powerful tool to analyze critical bus performance. The easy-to-use GUI provides hierarchical data representation, real-time and in-depth post processing. Identifying bottlenecks and true potential performance helps the engineer optimize his design.

System Description

The PCI exerciser and analyzer is delivered as a single, short PCI card, which requires plugging into the system that needs to be tested. Plugging other PCI devices into the system-under-test enables these devices to also be tested.

The PCI exerciser and analyzer hardware consists of a fully programmable PCI master and target, analyzer unit, exerciser unit and data interfaces. With the included Command Line Interface and the C-API all functions can be controlled by a user test program.

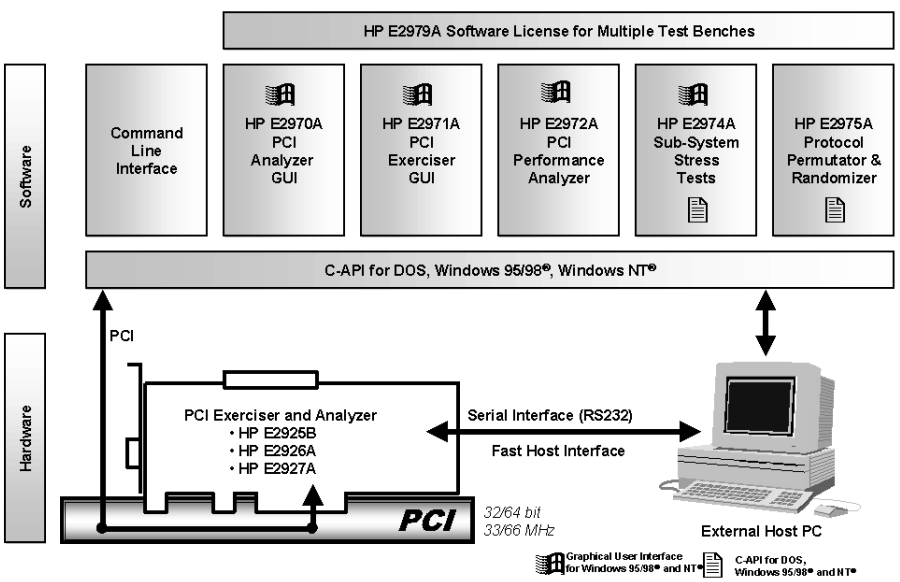
The additional software packages of the HP E2920 PCI Series are designed for easy usage and help engineers to successfully manage PCI testing tasks. The software packages also control the hardware functions through the C-API.

The PCI exerciser and analyzer can be used to:

Test applications on the system-under-test.
The software runs on a functioning, Windows 95/NT system-under-test. Data and test code are transferred directly through the in-system PCI bus.

Test applications on an external host PC.
The software runs on an external host PC (DOS, Window 95/NT). A minimum of one free RS232 port is required. The PCI exerciser and analyzer cards have on-board RS232 and fast host interfaces. A serial RS232 or an optional fast host interface connection between the test system (with the PCI exerciser and analyzer card) and the external host PC transfers the data and test code.

HP E2920 System Architecture



HP E2925B 32 Bit, 33 MHz PCI Exerciser and Analyzer, HP E2926A 32/64 Bit, 33 MHz PCI Exerciser and Analyzer, HP E2927A 32/64 Bit, PCI Exerciser and 66 MHz Analyzer

Specifications

State PCI Logic Analyzer Trace Memory: 64 KB on-board/4 MB (Opt 100)
Real-time Measures: 8
PCI Signal Levels: 3.3/5 V
Trigger Sequencer: 256 branches/up to 64 states
Data Memory: 512 KB (64 K*64 bit)
Burst Length: 1 –2,000,000,000 dwords
Data Compare: In real-time with hardware
Real-time Checked Protocol Rules: 53
Decode Speed: Fast/medium/slow
Data Interfaces: PCI (on system-under-test), RS232 serial port (via external host PC), fast host interface (via external host PC – Opt 002 required)
Fast Host Interface Speed: 4 MB/s
Standard Software Package: Command Line Interface, C-API programmable library
Supported PCI Command Types: All
Built-in Test Functions: Write/read/compare, make traffic, block move, protocol error detect, dump result
Additional Interfaces: CPU port interface, eight static I/O pins, 12 external trigger I/O signals, two 32 bit mailbox registers
Additional Features: Programmable PCI configuration space, expansion EEPROM, programmable interrupt generator, ports into the system-under-test's memory, I/O and configuration spaces

For the HP E2925B, HP E2926A and HP E2927A the following options are available:

Option 001 External Power Supply
This device is available for applications where the PCI exerciser and analyzer should be transparent to the system. It prevents the card from drawing power from its slot.

Option 002 Fast Host Interface Kit
The kit enables a high-speed connection between the PCI exerciser and analyzer card and the external controlling host PC. It increases the transfer rate from the standard RS232 speed to 4 MB/s.

Option 003 HP Logic Analyzer Adapter
An add-on daughter card with terminated connectors lets you connect an external HP logic analyzer for system-wide analysis.

Option 004 Universal Logic Analyzer Adapter
This adapter provides all of the on-board PCI analyzer signals to connect to an external logic analyzer. Appropriate terminators, depending on the selected logic analyzer, have to be added.

Option 100 4 M Memory Board
This piggyback board provides a deeper trace memory for up to 4 M PCI trace samples. It is strongly recommended for PCI performance measurement applications.

HP E2970A PCI Analyzer Graphical User Interface

The HP E2970A is a comprehensive Windows 95/NT Graphical User Interface for the PCI exerciser and analyzer's on-board logic analyzer. The HP E2970A allows the analysis of PCI bus traffic quickly and easily:
- Easy setup of trigger sequences and storage qualification for the on-board PCI state logic analyzer
- Real-time PCI protocol checker
- State Waveform Lister displays waveform trace of all PCI signals, sideband I/O and internal bus state signals
- Bus Cycle Lister disassembles bus traffic at state level, with comprehensive error reporting including cross references to PCI specification
- Bus Transaction Lister summarizes bus transfer at address and data level

HP E2971A PCI Exerciser Graphical User Interface

The HP E2971A is a comprehensive Windows 95/NT Graphical User Interface, which controls the PCI exerciser and analyzer's programmable PCI master and target:
- Configuration Space Editor to set up the PCI configuration space
- Master Transaction Editor to set up master transactions and protocol behavior
- Target Attribute Editor to set up protocol behavior for the target
- Data Memory Editor to view/modify the on-board memory content

HP E2972A PCI Performance Analyzer

The HP E2972A is a comprehensive Windows 95/NT Graphical User Interface using the PCI exerciser and analyzer capabilities to help engineers optimize performance. It features:
- Performance analysis with real-time counters and in-depth post-processing
- Hierarchical data representation for fast problem detection and in-depth root cause analysis with report generation
- Numerable ready-to-go tests: data transfer rate, data efficiency, bus usage, retry rate
- HP E292x PCI Exerciser and Analyzer Opt 100 4 M Memory Board strongly recommended.

HP E2974A Sub-System Stress Tests

The HP E2974A software package provides a C library of ready-to-run tests and a comprehensive Windows 95/NT Graphical User Interface to set up test parameters. The package features:
- A full function set to stress the system memory, PCI bus and interrupt system to the limit
- Ongoing detailed test reporting, including protocol errors and bus hang-ups
- Configuration space and bus trace dump in error cases

HP E2975A PCI Protocol Permutator & Randomizer

The HP E2975A C library provides automatic PCI protocol permutations within user-programmed constraints. It features:
- Reduced and predictable test time, as use of the system CPU is not required
- PCI master and target support
- Comprehensive reports of performed protocol variations

HP E2979A Software License for Multiple Test Benches

The HP E2979A is a cost efficient and convenient way to equip laboratories with any HP E2920 PCI Series software.

HP E2935A/E2936A PCI Debug & Test Bundles

- Ready-to-use PCI test solutions
- Basic configuration upgradable for every computer verification task
- Usable for bring-up and debug, root cause analysis, performance optimization (Opt 200) and system validation (Opt 300)

Key Literature

HP E2920 PCI Series, technical specifications, p/n 5967-6176E
HP E2920 PCI Series, Color Brochure, p/n 5965-4723E
HP E2920 PCI Performance Multimedia CD, p/n 5965-5882E

For more information, visit our website: **http://www.hp.com/go/dvt**

Ordering Information

HP E2925B 32 Bit, 33 MHz PCI Exerciser and Analyzer
Opt 001 External Power Supply
Opt 002 Fast Host Interface Kit
Opt 003 External HP Logic Analyzer Adapter, terminated
Opt 004 Universal Logic Analyzer Adapter, non-terminated
Opt 100 4M Memory Board
HP E2926A 32/64 Bit, 33 MHz PCI Exerciser and Analyzer
Opt 001 – Opt 100 as HP E2925B
HP E2927A 32/64 Bit, PCI 50 MHz Exerciser and 66 MHz Analyzer
Opt 001 – Opt 100 as HP E2925B
HP E2970A PCI Analyzer GUI
HP E2971A PCI Exerciser GUI
HP E2972A PCI Performance Analyzer
HP E2974A Sub-System Stress Tests
HP E2975A Protocol Permutator & Randomizer
HP E2979A Software License for Multiple Test Benches
HP E2935A 32 Bit, 33 MHz PCI Debug & Test Bundle
Opt 200 Performance Analysis Package
Opt 300 PCI traffic Software Generation Package
HP E2936A 32/64 Bit, 33 MHz PCI Debug & Test Bundle
Opt 200 – Opt 300 as HP E2935A

Data Generator/Analyzer Platform

HP 81200

- Characterizes digital hardware from ICs to systems
- Function and margin tests, error analysis
- Stimulus and response in one ready-to-use instrument
- Stimulus up to 660 Mb/s (RZ)
- Response sampling rate up to 660 MSa/s
- 2 to 120 channels (2 to 240 NRZ/330 MSa/S channels)
- 100 ps resolution, 50 ps accuracy
- Semi-automatic deskew

Confirm Digital Hardware Early in the Product Cycle

The HP 81200 Data Generator/Analyzer Platform helps engineers in design and engineering environments to characterize digital hardware such as ICs, boards, modules, frames and systems. The HP 81200 configurations are compact and accessible so that characterization under near-to-real conditions can be performed at an early stage in the design or manufacturing cycle, thus reducing risks, costs and time-to-market.

Application Examples

- CMOS, ECL logic characterization
- Emulate clock, data and control signals
- Functional test, margin test, error analysis
- Computer clock, multi-phase clocks
- High speed DACs
- High speed digital transmission devices

Emulate the Device's Environment

Communication and computing devices can require very complex stimuli. To meet this need, the HP 81200 provides sequencing and looping so that its 1 Mb/channel memory can generate very deep patterns. The internal editor includes memory-based prbs/prws (pseudo-random binary/word sequences) to simulate traffic and allow multiplexer testing.

Programmable output levels, pulsewidth, delay and transitions are independent for each channel so that performance at and beyond working conditions can be measured. RZ/NRZ (return to zero/non-return to zero) and R1 (return to one) formats are available, and RC (return to complement) can be arranged by the logical addition of two channels using the EX-OR output addition feature.

For high-speed devices, fast, stable edges with rates up to 660 Mb/s, RZ/NRZ are available. For higher data rates, the EX-OR feature allows 2:1 multiplexing for data rates up to 1.32 Mb/s NRZ, without halving the voltage because an external adder is not required. This feature can be of use in communications applications where prbs (pseudo-random binary sequences) up to $2^{15}-1$ are adequate. (If the device requires a clock for the multiplexed signal, an external source such as the HP 8133A, is needed to clock the HP 81200 at up to 660 MHz, and at the same time, clock the device at twice that frequency.)

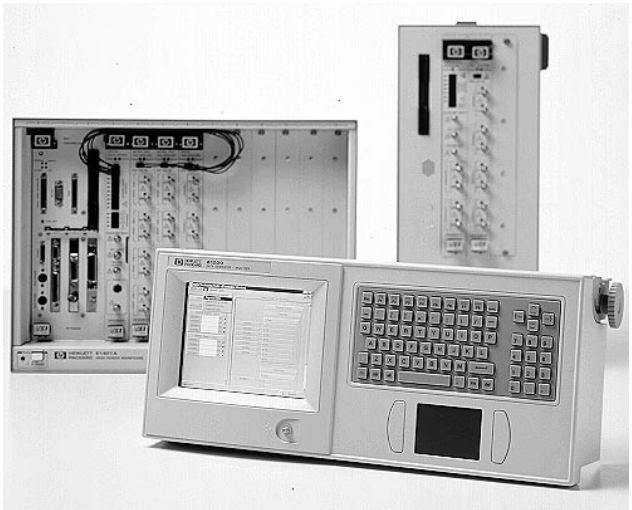
For less demanding applications (control signals, slower logic), dual output/input module front-ends are available which can reduce investment.

Easy Performance Measurement

Performance measurements are easy because they are implemented under the same user interface as the stimulus. The HP 81200 captures, and displays data in a state list. Data can also be compared in real-time, with the results displayed as an error map, a state list or as an error count or rate. Skews introduced by the user's cabling and fixturing can be compensated by a software-guided procedure (HP E4805A and Option 003 required).

Bench and System Operation

Manual operation is via a Windows NT-based user interface. Channel allocation, pattern and parameters are among the items that can be set up. Patterns can be imported and exported in ASCII via HP-IB (SCPI), LAN or 3.5" disk. For system operation, the HP-IB can be used in one of two ways: to control other HP-IB instruments (for this, a suitable controller language such as C, HP Basic or HP VEE must be installed by the user in the built-in PC), or another computer can control the HP 81200.



The HP 81200 Data Generator/Analyzer shown in the 10- and 3-slot mainframes. In front, the optional Display and Entry Panel.

Convenient and Upgradeable

Bench users, in particular, will appreciate the HP 81200's "switch on and go" philosophy and will adapt rapidly to the Windows-type instrument control.

The HP 81200 is supplied ready-to-use[1] with the desired number and types of channels. The software supports any channels that the user may choose to add at a later date.

The modular structure (mainframes, modules, module front-ends and user interfaces) allow required channel counts to be implemented economically. The following table gives some examples using the small frame:

Requirement	Minimum	Optional
Generator-only, max. 10 channels, up to 660 Mb/s	Small frame, Clock/data module, 1 or 2 HP E4843A front-ends	2 HP E4841A modules 8 HP E4843A front-ends
Generator-only, max. 20 channels, up to 200 Mb/s	Small frame, Clock/data module, 1 or 2 HP E4846A front-ends	2 HP E4841A modules 8 HP E4846A front-ends
Generator/analyzer, max. 8 channels, up to 600 Mb/s and 660 MSa/s	Small frame Clock module HP E4841A module Up to 4 HP E4843A/44A front-ends, any mix	HP E4841A Up to 4 HP E4843A/44A front-ends, any mix
Generator/analyzer, max. 16 channels, up to 200 Mbit/s and 200 M/Sa	Small frame Clock module HP E4841A module Up to 4 HP E4845A/46A front-ends, any mix	HP E4841A module Up to 4 HP E4845A/46A front-ends, any mix

HP 81200 Brief Specifications (50 Ω load, 10°C to 40°C)

HP E4805A Clock and HP E4831A Clock/Data Modules

Frequency: 1 kHz to 660 MHz
Resolution: 1 Hz (HP E4831A: 4 digits)
Accuracy: 50 ppm (HP E4831A: 100 ppm)
Jitter: 5 ps rms, typ.
Ext. Clock: 170 kHz to 666.66 MHz
Front-End Slots: None (HP E4831A: 2 generator)
Ck Fan-Out: 11 x HP E4841A + 2 x HP E4805A (HP E4831A: 6 x HP E4841A)

[1]All software and hardware is in place and connected. However, expander modules and monitors are packaged separately, and these items must be connected for initial use. In the case of expander modules, the mainframe clock generator must be removed and opened in order to connect a ribbon cable to the expander clock module(s).

Data Generator Configurations (HP E4831A, E4841A)

Front-End Slots per Module: 4 (HP E4831A: 2)
Memory Depth: 1 Mb per HP E4831A/41A front-end slot
Pattern Up/Download: ASCII file via LAN, 3.5" disk or HP-IB to/from the internal database. Transfer between database and hardware is executed by the supplied HP 81200 user interface
Segments: The memory can be divided into segments. The segments, which are loopable, can contain user-defined patterns or a prbs, or represent a pause
Prbs/Prws: 2^n–1 (n = 7, 9, 10, 11, or 15).
Loops: The maximum number of loops is 60 minus the number of segments
Delay: Zero to 3 μs (2 ps resolution). Each channel is independent
Pulsewidth: Variable in RZ mode with 2 ps resolution. For limits, see table "Generator Front-Ends", below
Edge-Placement Accuracy: ± 50 ps ± 50 ppm
Output Skew: < 50 ps typ. after deskew. Constant levels and frequency
Output Levels: See Table "Generator Front-Ends", below
Output Impedance: 50 Ω typ; output connector: SMA

Generator Output Front-Ends

	HP E4843A	HP E4842A	HP E4846A
Target Logic	ECL, PECL, CMOS	CMOS, TTL	CMOS, TTL
Frequency	660 MHz	330 MHz	200 Mbit/s
Outputs	1, differential	1, single-ended	2, single-ended
Format	RZ, R1, NRZ	RZ, R1, NRZ	NRZ
Amplitude 50 Ω into 1 kΩ	0.3 to 2.50 Vpp	0.25 to 3.50 Vpp	0.25 to 3.50 Vpp
Window 50 Ω into 50 Ω 50 Ω into 1 kΩ	–2.0 to +3.0 V –4.0 to 6.0 V	–2.0 to +3.50 V N/A	–1.75 to +3.50 V –3.50 to + 7.0 V
Transition Time	350 ps fixed[1]	0.7-6 ns[2]	1.2 ns fixed[2]

[1] At ECL levels, 20–80% of amplitude
[2] 10–90% of amplitude

Data Analyzer Configurations (HP E4841A)

Front-End Slots per Module: 4, generator or analyzer, any mix
Memory Depth: 1 Mb per HP E4841A front-end slot. In compare mode, memory is shared between expected data and captured data
Sampling Point Delay: Zero to > 1 period, worst case 3 μs (2 ps resolution). Each channel is independent
Capture Mode: State list, max. sample rate is 660 MSa/s
Compare Mode: State list (with highlighted errors), error map, error count or bit error rate. Max. sample rate is 333.33 MSa/s
Other Characteristics: See following table "Analyzer Front-Ends"

Analyzer Input Front-Ends

	HP E4844A	HP E4845A	HP E4847A
Sampling Rate	660 MSa/s	330 MSa/s	330 MSa/s
Inputs	1	2	2
Input Sensitivity	100 mV typ.	100 mV typ.	200 mV
Impedance	50 Ω	50 Ω	50 Ω/high -z
Input Threshold	–2.1 v to +5.1 V, 5 mV resolution	–2.1 v to +5.1 V, 5 mV resolution	–2.1 v to +5.1 V, 5 mV resolution

General

Programming Interface: From an external controller over HP-IB, SCPI (1992) commands. Alternatively, use the embedded PC to control other test equipment via HP-IB
Graphical User Interface: Windows NT-based, color, on-line help, graphical sequencing and channel connection windows
Display and Entry Panel: TFT display and alpha-numerical entry pad. Alternatively, monitor, keyboard and mouse
Save/Recall: Multiple settings and test patterns can be stored in an internal database
Built-in Diagnostics: Module and system self-tests can be implemented
Mainframe Dimensions:
HP E4840A: 177 mm H x 426 mm W x 498 mm D (Option 001: add 10 mm)
HP E4849A: 310 mm H x 426 mm W x 602 mm D (Option 001: add 10 mm)
Operating Temperature: 10° C to 40° C
Interfaces: LAN 10baseT (AUI, BNC), RS232, SVGA port, SCSI, Centronics parallel port, mini-DIN connectors for keyboard and mouse, HP-IB, 3.5" floppy drive
Warranty: 3 years
Standards: CE-mark, designed and produced according to ISO 9001, IEC1010-1, CSA 1010.1, En 55011/CISPR 11, Group 1, Class A +10 dB

Key Literature

HP 81200 Data Generator/Analyzer Platform, Color Brochure, p/n 5965-3416E
HP 81200 Data Generator/Analyzer Platform, Technical Specifications, p/n 5965-3415E
HP 81200 Data Generator/Analyzer Platform, Configuration Guide, p/n 5965-3417E

For more information, visit our website: **http://www.hp.com/go/dvt**

Ordering Information

Mainframes
HP E4840A Small mainframe with 3 slots
Includes embedded PC and installed software (Windows NT operating system and HP E4873A user software)
- **Opt 001** Display and entry panel HP E4807A
- **Opt 002** 8-line trigger pod
- **Opt 003** 15" VGA monitor
- **Opt 004** 17" VGA monitor
- **Opt 005** 21" VGA monitor
- **Opt 006** Keyboard, USA/English, Windows 95/NT, mini-DIN
- **Opt 007** Mouse, 2-key, mini-DIN connector (Options 003 – 007 are not required if Option 001 is ordered)
- **Opt 008** External CD-ROM drive, SCSI, required for HPE4873A user software updates

HP E4849A Mainframe with 10 free slots (9 with Option 002)
Includes HP E4806A PC module and installed software (Windows NT operating system and HP E4873A user software)
- **Opt 002** VXI extender module HP E1482B required for 1 or 2 expander frames (Other options as HP E4840A)

HP E4848A Expander frame, includes HP E1482B VXI extender module and all cables for connecting to the mainframe. HP E4805A clock module required

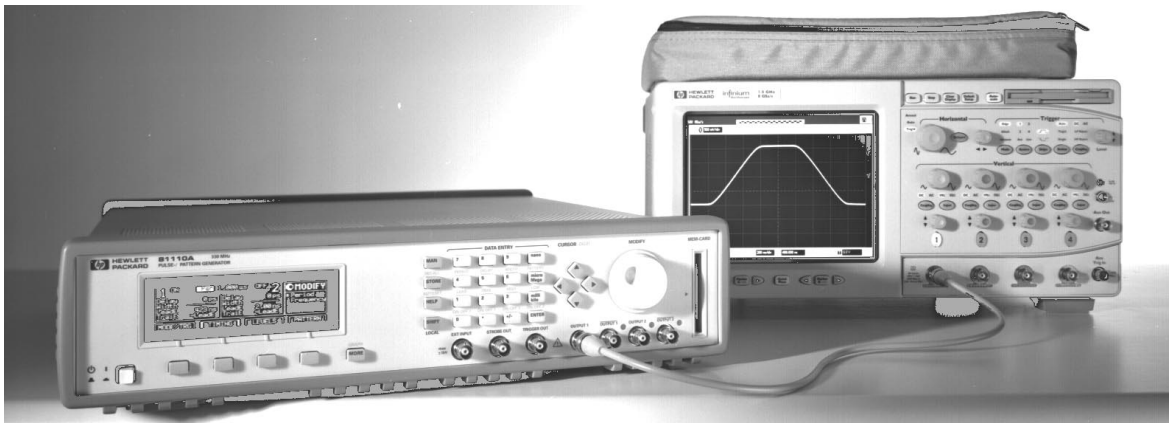
Modules
HP E4805A 660 MHz clock module
- **Opt 003** Deskew probe HP 1144A

HP E4831A 660 MHz clock and data module
HP E4841A 660 MHz data generator/analyzer module

Generator Front-Ends
HP E4843A 660 Mbit/s RZ/NRZ
HP E4846A 200 Mbit/s NRZ, dual channel
HP E4842A 330 Mbit/s RZ/NRZ, variable transitions

Analyzer Front-Ends
HP E4844A Dual threshold, 50 Ω
HP E4845A Dual input, 50 Ω
HP E4847A Dual input, 50 Ω/hi-z

Accessories
SMA components see pages 403 and 410



An HP 81100 setup for characterizing designs with low channel counts. For lasers and diodes needing more power, use the HP 8114A. For fast technologies requiring low jitter and high timing resolution, use the HP 8133A. If more than two channels are needed, refer to page 400

Pulse generators provide variable parameters for characterizing a wide range of digital devices such as memory cells, PLLs and transponders. Good repeatability and a viable feature set help you make fast, credible measurements easily.

Pattern capability combined with pulse generator features adds a new dimension because you can now carry out function test under worse case conditions. Thanks to the channel-add feature, you can also simulate distortion (such as unequal timing, glitches, and cross talk) and, with analog channel addition, 3-level signals so that measurements can be performed under true-life conditions. These capabilities let you test your device thoroughly much earlier in the product cycle.

Matching your needs better

The Hewlett-Packard range of pulse generators extends from the HP 8114A 100 V, 2A Pulse Generator to the HP 8133A 3 GHz Timing Generator. The new HP 81100 Family of Pulse/Data Generators bridges the extreme and in addition to replacing the HP 8110A Pulse Generator with a compatible instrument with new standards of reliability and performance, also provides a spectrum of instruments with the same look and feel. Cost-effective solutions are now available for simpler low frequency applications right up to precision high-speed requirements.

8

Selection Table

	HP 81100 Family of Pulse/Data Generators								
Mainframe	**HP 8114A**	**HP 81101A**	**HP 81104A**	**HP 8110A**[1]	**HP 81110A**[1]		**HP 81130A**		**HP 8133A**
Channel module	N/A	N/A	HP 81105A	HP 81103A[1]	HP 81111A[1]	HP 81112A	HP 81131A	HP 81132A	N/A
Max clock rate	15 MHz	50 MHz	80 MHz	150 MHz	165 MHz	330 MHz	400 MHz	660 MHz	3 GHz
Accuracy									
Triggerable	± 5%+100 ps	± 5%	± 5%	± 5%+100 ps	± 3%[2]	± 3%[2]	N/A	N/A	N/A
With PLL	N/A	0.01%	± 0.01%	± 0.1%	± 0.01%	± 0.01%	± 0.01%	± 0.01%	± 0.5% (YIG)
Jitter, rms									
Triggerable	± 0.03% +25 ps	± 0.01% +15 ps	± 0.01% +15 ps	± 0.03% +25 ps	± 0.01% +15 ps	± 0.01% +15 ps	N/A	N/A	N/A
With PLL	N/A	0.001% + 15 ps	± 0.001% +15 ps	± 0.003% +20 ps	± 0.001% +15 ps	± 0.001% +15 ps	± 0.001% +10 ps	± 0.001% +10 ps	± 5 ps (YIG)
Width/delay									
Resolution	3 digits	3 ½ digits	3 ½ digits	3 digits	3 ½ digits	3 ½ digits	4 digits	4 digits	4 ½ digits
Best case	10 ps	5 ps	5 ps	10 ps	5 ps	5 ps	2 ps	2 ps	1 ps
Accuracy	± 5% ± 250 ps/ ± 1 µs	± 5% ± 500ps/ ± 1 µs	± 5% ± 250/ 500 ps	± 5% ± 250 ps/ ± 1 µs	± 3%[2] +250/ 500 ps	± 3%[2] +250/ 500 ps	0.01% +200/ 100 ps[3]	0.01% +200/ 100 ps[3]	150 ps
Jitter, rms	± 0.03% +25 ps	± 0.01% +15 ps	± 0.01% +15 ps	± 0.03% +25 ps	± 0.01% +15 ps	± 0.01% +15 ps	± 0.001% +200 ps	± 0.001% +200 ps	± 5 ps
Transition time Fixed/variable	7 ns Fixed	5 ns Variable	3 ns Variable	2 ns Variable	2 ns Variable	0.8/1.6 ns Selectable	0.8/1.6 ns Selectable	0.5 ns Fixed	100 ps Fixed
Output into 50 Ω									
50 Ω source	50 Vpp	10 Vpp	10 Vpp	10 Vpp	10 Vpp	3.8 Vpp	3.8 Vpp	2.4 Vpp	3 Vpp
Hi-Z source	100 Vpp	20 Vpp	20 Vpp	20 Vpp	20 Vpp	N/A	N/A	N/A	N/A
Bits/channel	N/A	N/A	16 kbit	4 kbit	16 kbit	16 kbit	64 kbit sequencing	64 kbit sequencing	Opt 002: 32 bit or 2^{23} -1 prbs
Channels	Single	Single	1 or 2	1 or 2	1 or 2	1 or 2	1 or 2	1 or 2	1 or 2
Internal channel add	N/A	N/A	Analog	Analog	Analog	N/A	EXOR	EXOR	N/A
Catalog page	408	404	404	407	404	404	404	404	409

[1] The HP 81110A is a form/function replacement for the HP 8110A. Great care has been taken to ensure compatibility so that the user may take immediate advantage of the HP 81110A's glitch-free range-changing and improved price and performance. However, for those customers who prefer to continue using the HP 8110A in existing test systems or products, the HP 8110A will remain available for an interim period. The HP 81110A (with one or two HP 81111A output modules) is equivalent to the HP 8110A with the HP 81106A PLL module (plus one or two HP 81103A output modules).

[2] ±0.5% with self-calibration.

[3] Frequency > 170 kHz

Accessories

1. With BNC connectors
HP 15104A Pulse Adder/Splitter: 50 ohm delta network, rise time 150 ps, 6 dB insertion loss, 2 W
HP 15116A Pulse Inverter: 50 ohm pulse transformer, 5% droop (500 ns pulse), 0.3 dB insertion loss, 0.75 W
HP 15115A Splitter-Inverter: 50 ohm delta network with pulse transformer in one output. Output skew: 1 ns, other specs as HP 15104A/15116A.
2. With SMA connectors
HP 11667B Pulse Adder/Splitter: 50 ohm series network, 26.5 GHz bandwidth, 6 dB insertion loss, 0.5 Ω

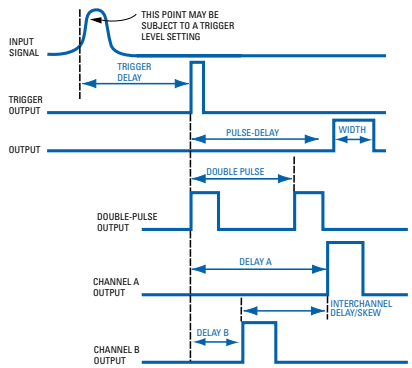
Transition Time Converters:

These components are for use when a very smooth pulse is needed, or when the stimulus is too fast for the DUT (as evidenced by excessive cross-talk, ringing, etc). The converters use a patented absorption technique for minimum reflection and to allow cascading.

Model	Output Transition
HP 15435A	150 ps
HP 15432B	250 ps
HP 15433B	500 ps
HP 15434B	1 ns
HP 15438A	2 ns

Pulse Parameter Definitions of Terms Used in Instrument Specifications

Time Reference Point: Median (50% amplitude point on pulse edge).
Pulse Period: The time interval between the leading edge medians of consecutive trigger output pulses.
Trigger Delay: Interval between trigger point of input signal and the trigger output pulse's leading-edge median. Applies in trigger, external width, gate and burst modes.

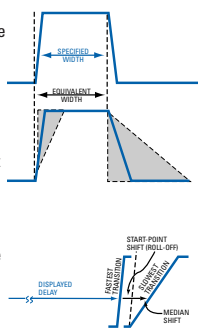


Pulse Delay: Interval between leading-edge medians of trigger-output pulse and output pulse.
Double-Pulse: Interval between leading-edge medians of the double-pulse.
Interchannel Delay/Skew: Interval between corresponding leading-edge medians.
Pulsewidth: Interval between leading and trailing-edge medians.

Additional Information for Pulse Generators with Variable Transition Times

Pulsewidth: The specified and displayed value are those which are obtained with the fastest edges, essentially equal to the interval from the start of the leading edge to the start of the trailing edge.

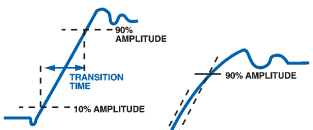
By designing the pulse edges so that they turn about their start points, the interval from leading-edge start to the trailing-edge start stays unchanged* when transition times are varied. This is more convenient for programming, and the width display is easy to interpret.



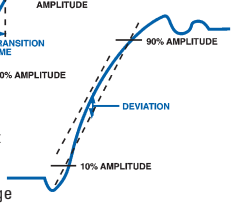
* In practice, start points may shift with changes in transition time.

Delay: The specified and displayed values are those obtained with the fastest leading edge. For a slower edge, the actual delay exceeds the displayed delay by the combined shift of the start point and the median.

Transition Time: Interval between the 10% and 90% amplitude points on the leading/trailing edge.



Linearity: Peak deviation of an edge from a straight line through the 10% and 90% amplitude points, expressed as a percentage of pulse amplitude.

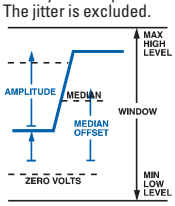


Jitter: Short-term instability of one edge relative to a reference edge. Usually specified as an rms value, which is one standard deviation or "sigma". If the distribution is assumed to be Gaussian, six sigma represents 99.74% of the peak-to-peak jitter.

The reference edge for the period jitter is the previous leading edge, whereas the reference edge for the delay jitter is the leading edge of the trigger output. Width jitter is the stability of the trailing edge with regard to the leading edge.

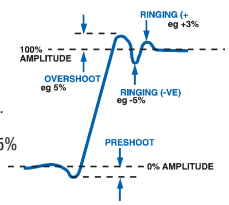
Stability: Long-term average instability over a specific time, for example, an hour, or a year. The jitter is excluded.

Pulse Amplitude: Pulse output is specified as pulse top and pulse base (usually referred to as high level and low level), or as peak-to-peak amplitude and median offset. A "window" specification shows the limits within which the pulse can be positioned.

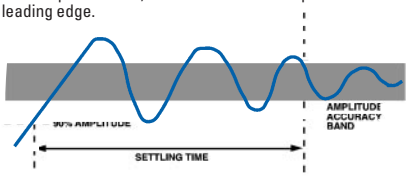


Preshoot, Overshoot, Ringing: Preshoot and overshoot are peak distortions preceding/following an edge. Ringing is the positive-peak and negative-peak distortion, excluding overshoot, on pulse top or base. A combined preshoot overshoot, ringing specification of e.g. ±5% implies:

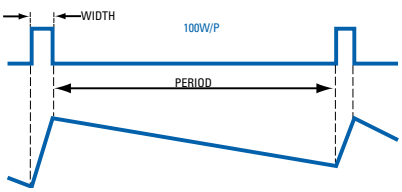
- Overshoot/undershoot <5%
- Largest pulse top oscillation < ±5% of pulse amplitude



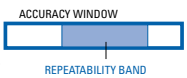
Settling Time: Time taken for pulse levels to settle within a level specification, measured from a 90% point on the leading edge.



Duty Cycle: Percentage ratio of pulsewidth to period. In pulse/function generators, this term is also used to define sine and triangle symmetry. Note that in pulse generators, this is a secondary parameter derived from the period and width settings. The duty cycle achieved is therefore subject to width and period accuracies.



Output Impedance/Resistance: Effective pulse source impedance/dc resistance.
Reflection Coefficient: Reflection at the pulse generator output expressed as a percentage of the incident pulse amplitude. (Test pulse edges correspond to the generator's fastest transitions.)
Repeatability: When an instrument operates under the same environmental conditions and with the same settings, the value of a parameter will lie within a band inside the accuracy window. Repeatability defines the width of this band.



HP-IB Programming Times

Listen Time: The time an instrument occupies the bus to receive and verify a message. The NRFD signal is active during this period.

Settling Time: The time taken by the instrument to execute an HP-IB message and for the output to settle within the accuracy specification. NRFD inactive.

Execution Time: The sum of Listen Time and Settling Time.

Talk Time: The time an instrument occupies the bus to output a specified string. Output data is typically instrument error status, or current or stored parameters.

For more information, visit our website:
http://www.hp.com/go/dvt

8

HP 81101A
HP 81104A
HP 81110A
HP 81130A

NEW

- VFO and PLL timing
- 2 ns variable transitions up to 10 Vpp (20 Vpp) into 50 Ω
- Fast transitions up to 400 ps (ECL)
- 2 ps timing resolution
- 0.01% frequency accuracy
- Dropout- and glitch-free change of any timing parameters
- Pulse, burst, pattern (data) modes
- Analog or digital channel addition
- Modular, user exchangeable

The HP 81100 Family of Pulse/Data Generators uses the same operating principle throughout (front-panel and programming), and is compatible with the well-established HP 8110A to protect current and future investments. Growing with future needs is easy as the HP 81110A is a true superset of the HP 81104A and HP 81101A.

Signals for Testing Digital Designs and Components

The HP 81100 Family generates all standard pulses, multi-level waveforms, digital patterns and data needed to test the current logic technologies (CMOS, TTL, LVDS, ECL, etc.) up to 660 MHz. Continuous operation is enabled through the dropout- and glitch-free change of any timing parameters (e.g. to measure a PLL's pull-in/ hold range) for all models except the HP 81130A.

8

Smooth Integration Into Automated Test Systems

Accessories and the HP 81101A's and HP 81104A's 100% upward compatibility to the HP 81110A permit growth based on future needs through the physical exchange of instruments.

Specifications

50 Ω load, 0°C and 55°C
Please refer to the tables overleaf.

Channel Addition (with two HP 81105A and HP 81111A output channels): Simulates digital signals with interference pulses, or 3 or 4 level communication signals. When channel 2 is added internally to channel 1, channel 2 is disabled. 48/500 Ω source selectable.
Logic Channel Addition: Both the HP 81131A and HP 81132A output channels add channels logically (EXOR) to the HP 81130A on channel 2. All specifications remain the same as for one channel.

User Interface/Remote Control

Non-volatile Memory: Current setting is saved on power-down. Up to nine user settings and one fixed default setting can be stored in the instrument memory
Memory Card: 99 settings can be stored on a 1MB PCMCIA card (MS-DOS)
Remote Control: Operates according to IEEE standard 488.2, 1987 and SCPI 1992.0 with the function codes SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0.

General

Operating Temperature: 0°C to +55°C
Storage Temperature: –40°C to +70°C
Humidity: 95% r.h. up to 40°C ambient temperature
EMC: conforms to EN50082-1, EN 55011, Class A
Noise Emission: 5.7 bel typical
Battery: Lithium CR2477-N
Safety: IEC1010, CSA1010
Power Requirements: 100-240 Vac ±10%, 50-60 Hz, 100-120 Vac ±10%, 400 Hz
Power Consumption: 300 VA max.
Max. Dimensions (H * W * D): 89 mm * 426 mm * 521 mm
Weight Net: 9.2 kg
Weight Shipping: 13.8 kg
Recalibration Period: 1 year recommended
Warranty: 3 years standard

Key Literature

HP 81100 Family of Pulse/Pattern Generators, Color Brochure, p/n 5967-6236E
HP 81101A Pulse Generator, Technical Specifications, p/n 5967-6274E
HP 81110A/HP 81104A Pulse/Pattern Generators, Technical Specifications, p/n 5967-5984E
HP 81130A Pulse/Data Generator, Technical Specifications, p/n 5967-6237E

Ordering Information[1]

The minimum configuration for a working instrument consists of a mainframe and one output module (except for the HP 81101A which is supplied with one module). A second output module may be added later, but must be of the same model number as the first. Output modules can be exchanged and retrofitted by the user.

The English Quick Start Guide (811xx-91010) and Reference Guide (811xx-91011) is supplied with each mainframe for all configurations. A memory card is not included.

HP 81101A 50 MHz 1 channel Pulse Generator

HP 81104A 80 MHz Pulse/Pattern Generator Mainframe
HP 81105A 80 MHz, 10 V Output Module

HP 81110A 330/165 MHz Pulse/Pattern Generator Mainframe
HP 81111A 165 MHz, 10 V Output Module
HP 81112A 330 MHz, 3.8 V Output Module

HP 81130A 400/660 MHz Pulse/Data Generator Mainframe
HP 81131A 400 MHz, 3.8 V Output Module
HP 81132A 660 MHz, 2.5 V Output Module

The following accessories are available for each mainframe.
- **Opt 1CP** Rack Mount and Handle Kit (5063-9219)
- **Opt 1CM** Rack Mount Kit (5063-9212)
- **Opt 1CN** Handle Kit (5063-9226)
- **Opt 1CR** Rack Slide Kit (1494-0059)
- **Opt UFH** 1MB SRAM Memory Card (0950-3380)
- **Opt UN2** Rear (instead of front) Panel Connectors
- **HP 15104A** Pulse Adder/Splitter

Quick Start Guide Language Options
- **Opt ABF** French Guide (811xx-91210)
- **Opt ABJ** Japanese Guide (811xx-91510)
- **Opt AB0** Taiwan Chinese Guide (811xx-91610)
- **Opt AB1** Korean Guide (811xx-91710)
- **Opt AB2** Chinese Guide (811xx-91810)

Additional Documentation Options
- **Opt 0BW** Service Manual (811xx-91021)
- **811xx-91031** Service Documentation (Component Level)

[1] xx is used to denote that the product is available to order for each mainframe. Please substitute xx for 01, 04, 10, 30 (the last two digits of the relevant mainframe) when ordering.

Mainframe Output Channel	HP 81101A Included	HP 81104A HP 81105A	HP 81110A HP 81111A	HP 81110A HP 81112A	HP 81130A HP 81131A	HP 81130A HP 81132A
Timing[1]						
Frequency Range 50 Ω **Source**[2]	1 mHz to 50 MHz Up to 50 MHz typ.	1 mHz to 80 MHz Up to 50 MHz typ.	1 mHz to 165 MHz Up to 60 MHz typ.	1 mHz to 330 MHz N/A	1 Hz to 400 Mhz N/A	1 Hz to 660 MHz N/A
Timing Resolution	3.5 digits, 5 ps best case	3.5 digits, 5 ps best case	3.5 digits, 5 ps best case	3.5 digits, 5 ps best case	4 digits, 2 ps best case	4 digits, 2 ps best case
Accuracy with PLL (without PLL)	0.01% (5%)[3]	0.01% (5%)[3]	0.01% (0.5% typ. after self-cal., 3% without self-cal.)[3]	0.01% (0.5% typ. after self-cal., 3% without self-cal.)[3]	0.01% (± 100 ppm)	0.01% (± 100 ppm)
RMS Jitter with PLL (without PLL)	0.001% + 15 ps (0.01% + 15 ps)[3]	0.001% + 15 ps (0.01% + 15 ps)[3]	0.001% + 15 ps (0.01% + 15 ps)[3]	0.001% + 15 ps (0.01% + 15 ps)[3]	0.001% + 10 ps	0.001% + 10 ps
Width Range	10 ns to (period - 10 ns)	6.25 ns to (period - 6.25 ns)	3.03 ns to (period - 3.03 ns)	1.515 ns to (period - 1.515 ns)	1.25 ns to (period - 1.25 ns)	750 ps to (period - 750 ps)
Accuracy	± 5% ± 500 ps	± 5% ± 250 ps	After self-cal. ± 0.5% typ. ± 250 ps Without self-cal. ± 3% ± 250 ps	After self-cal. ± 0.5% typ. ± 250 ps Without self-cal. ± 3% ± 250 ps	> 170 KHz ± 0.01% ± 200 ps < 170 KHz ± 0.06%	> 170 KHz ± 0.01% ± 200 ps < 170 KHz ± 0.06%
Deskew	N/A	N/A	N/A	N/A	± 25 ns	± 25 ns
Delay (ext. in to out) (ext. in to trig. out)	28.5 ns fixed typ. 12 ns fixed typ.	27 ns fixed typ. 12 ns fixed typ.	26 ns fixed typ. 12 ns fixed typ.	22 ns fixed typ. 12 ns fixed typ.	47 ns typ. ± 1 period 15 ns ± 1 period	47 ns typ. ± 1 period 15 ns ± 1 period
Additional Variable Delay Range	0 ns to (period - 20 ns)	0 ns to (period - 12.5 ns)	0 ns to (period - 3.03 ns)	0 ns to (period - 3.03 ns)	0 ns to 3.00 µs	0 ns to 3.00 µs
Accuracy[4]	± 5 % ± 1 ns	± 5 % ± 0.5 ns	After self-cal. ± 0.5% typ. ± 0.5ns Without self-cal. ± 3% ± 0.5 ns	After self-cal. ± 0.5% typ. ± 0.5ns Without self-cal. ± 3% ± 0.5 ns	< 170 KHz ± 0.01% ± 100 ps > 170 KHz ± 0.035% of period	> 170 KHz ± 0.01% ± 100 ps < 170 KHz ± 0.035% of period
Double Pulse Delay Range	(Width + 10 ns) to (period - width – 10 ns)	(Width + 6.25 ns) to (period - width – 6.25 ns)	(Width + 3.03 ns) to (period - width – 3.03ns)	(Width + 1.5 ns) to (period - width – 1.5 ns)	N/A	N/A
Transition Time Range (10/90)	5 ns to 200 ms variable	3 ns to 200 ms variable	2 ns to 200 ms variable	0.8 ns or 1.6 ns selectable	0.8 ns or 1.6 ns selectable	500 ps typ. at 2.2V 250 ps typ. at ECL fixed
At 1 KΩ Source Imped.	6 ns typ.	5 ns typ.	5 ns typ.	N/A	N/A	N/A
Level/Pulse Performance[5]						
Amplitude **50 Ω into 50 Ω** **1 KΩ into 50 Ω**	100 mVpp to 10.0 Vpp 200 mVpp to 20.0 Vpp	100 mVpp to 10.0 Vpp 200 mVpp to 20.0 Vpp	100 mVpp to 10.0 Vpp 200 mVpp to 20.0 Vpp	100 mVpp to 3.8 Vpp N/A	100 mVpp to 3.8 Vpp N/A	100 mVpp to 2.4 Vpp N/A
Level Window **1 KΩ into 50 Ω**	–10.0 V to +10.0 V –20.0 V to +20.0 V	–10.0 V to +10.0 V –20.0 V to +20.0 V	–10.0 V to +10.0 V –20.0 V to +20.0 V	–2.0V to +3.8 V N/A	–2.0V to +3.8 V N/A	–2.0 V to 3.0 V N/A
Accuracy **50 Ω into 50 Ω** **1 KΩ into 50 Ω**	± (3% + 75 mV) ± (5% + 150 mV)[6]	± (3% + 75 mV) ± (5% + 150 mV)[6]	± (1% + 50 mV) ± (1% + 100 mV)[6]	± (2% + 50 mV) N/A	± (2% + 50 mV) N/A	± (5% + 50 mV) N/A
Output Connectors	BNC single-ended	BNC single-ended	BNC single-ended	BNC differential	SMA (f) 3.5 mm differential	SMA (f) 3.5 mm differential
Source Impedance	Selectable 50 Ω or 1 KΩ	Selectable 50 Ω or 1 KΩ	Selectable 50 Ω or 1 KΩ	50 Ω	50 Ω	50 Ω
Accuracy	Typ. ± 1 %	Typ. ± 1 %	Typ. ± 1 %	Typ. ± 1 %	Typ. ± 1 %	Typ. < ± 5 %
Max. External Voltage	± 24 V	± 24 V	± 24 V	–2.2 V to +5.5 V	–2.2 V to +5.5 V	–2 V to 4 V
Short Circuit Current	± 400 mA max. (doubles for channel addition)	± 400 mA max. (doubles for channel addition)	± 400 mA max. (doubles for channel addition)	–84 mA to + 152 mA	84 mA to + 152 mA	–80 mA to 120 mA

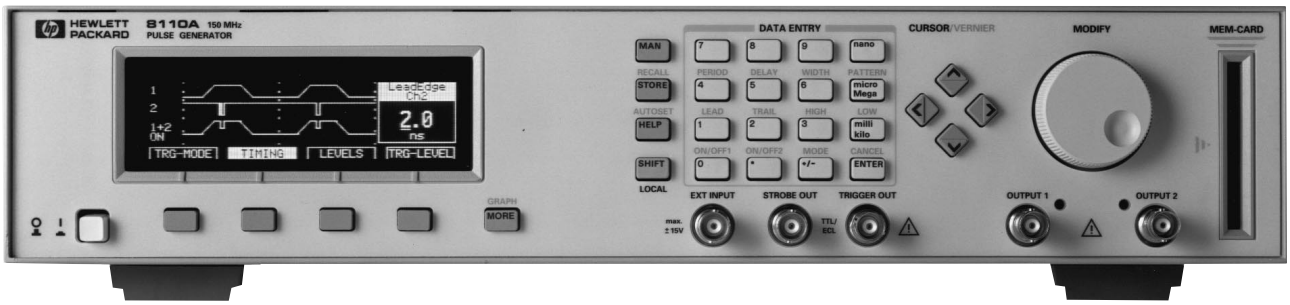
[1] Measured at 50% amplitude at fastest transitions in continuous mode and with 50 Ω source impedance
[2] Source impedance is selectable from 50 Ω or 1KΩ for the HP 81105A and HP 81111A
[3] If the startable oscillator is used (PLL not active)
[4] Constant amplitude
[5] Level specifications are valid after a 5 ns (HP 81112A, HP 81131A) or 30 ns (HP 81111A, HP 81105A, HP 81132A) typical settling time
[6] Applies to pulses within a ± 19 V window

HP 81100 Family of Pulse/Pattern Generators (50 MHz – 660MHz) (cont'd)

Mainframe Output Channel	HP 81101A	HP 81104A	HP 81110A HP 81111A	HP 81110A HP 81112A	HP 81130A HP 81131A	HP 81130A HP 81132A
Dynamic Crosstalk **Baseline Noise** **Overshoot/ Preshoot/Ringing**	< 0.1% typ. 10 mV RMS typ. ± 5% of amplitude ± 20 mV	< 0.1% typ. 10 mV RMS typ. ± 5% of amplitude ± 20 mV	< 0.1% typ. 10 mV RMS typ. ± 5% of amplitude ± 20 mV	< 0.1% typ. 4 mV RMS typ. ± 5% of amplitude ± 50 mV	< 0.1% typ. 4 mV RMS typ. ± 5% of amplitude ± 50 mV	< 0.1% typ. 2 mV RMS typ. ± 5% of amplitude ± 50 mV typ.
Pattern/ Data Capabilities	N/A	16 Kbit/channel and strobe output	16 Kbit/channel and strobe output	16 Kbit/channel and strobe output	64 Kbit/channel	64 Kbit/channel
Sequencing	N/A	N/A	N/A	N/A	Up to four segments, one loop (loop count 1 to 2^{20} times), one jump	Up to four segments, one loop (loop count 1 to 2^{20} times), one jump
Format	N/A	RZ, MRZ, DNRZ	RZ, NRZ, DNRZ	RZ, NRZ, DNRZ	R1, RZ, NRZ, DNRZ	R1, RZ, NRZ, DNRZ
Burst	Single or double pulses Burst count from 2 to 65536	Single or double pulses Burst count from 2 to 65536	Single or double pulses Burst count from 2 to 65536	Single or double pulses Burst count from 2 to 65536	Single pulses Burst count from 2 to 65536	Single pulses Burst count from 2 to 65536
Trigger Modes	Continuous Triggered (ext., int., man.) Gated (ext., int., man.) External width	Continuous Triggered (ext., int., man.) Gated (ext., int., man.) External width	Continuous Triggered (ext., int., man.) Gated (ext., int., man.) External width	Continuous Triggered (ext., int., man.) Gated (ext., int., man.) External width	Continuous Gated (ext. or man.), Start(ext. or man.)	Continuous, Gated (ext. or man.), Start(ext. or man.)
Inputs	PLL Ref. In, Clock In, Ext.In	PLL Ref. In, Clock In, Ext.In	PLL Ref. In, Clock In, Ext.In	PLL Ref. In, Clock In, Ext.In	PLL Ref. In, Clock In, Ext.In	PLL Ref. In, Clock In, Ext.In
Load Compensation	Actual load value can be entered to display actual outputs	Actual load value can be entered to display actual outputs	Actual load value can be entered to display actual outputs	N/A	N/A	N/A
Additional Outputs	Trigger out, strobe out	Trigger out, strobe out (16 Kbit user-defined pattern)	Trigger out, strobe out (16 Kbit user-defined pattern)	Trigger out, strobe out (16 Kbit user-defined pattern)	Trigger out	Trigger out
Limits	Programmable high and low levels to protect the device-under-test	Programmable high and low levels to protect the device-under-test	Programmable high and low levels to protect the device-under-test	Programmable high and low levels to protect the device-under-test	Programmable high and low levels to protect the device-under-test	Programmable high and low levels to protect the device-under-test
Channel Addition	N/A	Analog	Analog	N/A	EXOR	EXOR

Analog Channel Addition	HP 81104A with Two Output Modules (HP 81105A)	HP 81110A with Two Output Modules (HP 81111A)
Amplitude 50 Ω into 1 KΩ **1 KΩ into 50 Ω**	100 mVpp to 20.0 Vpp 200 mVpp to 20.0 Vpp	100 mVpp to 20.0 Vpp 200 mVpp to 20.0 Vpp
Source Impedance	Selectable from 50 Ω or 1 KΩ	Selectable from 50 Ω or 1 KΩ
Level Window 50 Ω into 1 KΩ **1 KΩ into 50 Ω**	–20.0 V to +20.0 V –20.0 V to +20.0 V	–20.0 V to +20.0 V –20.0 V to +20.0 V
Max. Frequency 50 Ω Channel **1 KΩ Channel**	60 MHz typ. 15 MHz typ.	60 MHz typ. 15 MHz typ.
Min.Transitions 50 Ω Channel **1 KΩ Channel**	2.5 ns typ. (channel one), 5 ns typ. (channel two) 20 ns typ. on both channels	2 ns typ. (channel one), 5 ns typ. (channel two) 20 ns typ. on both channels

- VFO and PLL timing
- 10 ps resolution
- 2 ns variable transitions
- 20 V into 50 Ω
- Pulse, burst and data modes
- 3 and 4 level signals
- Configurable
- Master/slave capability



HP 8110A and two HP 81103As

HP 8110A Brief Specifications
50 Ω load, 0° C to 55° C

HP 8110A Mainframe

Frequency: 1.00 Hz to 150 MHz (**Period:** 6.65 ns to 999 ms)
Modes: Continuous/externally-triggered/externally-gated sequences of pulses, double-pulses, bursts, and patterns. Also external width
Burst Length: 2 to 65536 pulses or double-pulses
Strobe Channel: 2 to 4096 bits, freely programmable, NRZ, TTL/ECL, 50 Ω typical

HP 81106A PLL/Ext. Clock Module

Frequency: 1.000 mHz to 150.0 MHz (**Period:** 6.65 ns to 999.0 seconds)
Clock Modes:
Int. Clock: With int. or ext. references (as period source or trigger for bursts and patterns)
Ext. Clock: For synchronization to a system clock or for master/slave operation

HP 81103A Channel Module

Timing
Delay: 0.00 ns to 998 ms or **Double-Pulse:** 6.65 ns to 998 ms
Width: 3.30 ns to 998 ms
Transitions (10 to 90% amplitude)**:** 2.00 ns to 200 ms
Accuracy: 10% + 200 ps
Overshoot, Ringing: 5% + 20 mV

Output Parameters (into 50 Ω load)

	50 Ω source	1 kΩ source
Amplitude, p-p	100 mv to 10.0 V	200 mV to 20.0 V
High level	–9.90 to + 10.0 V	–18.8 to + 19.0 V
Low level	–10.0 to + 9.90 V	–19.0 to + 18.8 V

Also programmable as current ±4.00 to ±400 mA.
Limits: programmable to suit and protect device.

Source Resistance: 50 Ω/1 kΩ, selectable
Load Resistance: Values 0.1 Ω to 999 kΩ can be entered for direct reading display of output level
Modes: Normal/complement, on/off
Channel Addition (with two HP 81103A output channels)**:** Simulates digital signals with interference pulses, or 3 or 4 level communications signals. 48/500 Ω source selectable
Pattern Capabilities: 2 to 4096 bits. Edit capabilities include prbs 2^n–1, where n is selectable from 7 to 12. Value 12 is CCITT O.151-compatible
Format: RZ (width and delay programmable), DNRZ (delay programmable)

HP 81107A Two Channel Deskew Module

Compensates for unequal propagation times in the test setup, or for slave propagation delay in master/slave setups.
Delay (each channel)**:** 0.00 to 28.00 ns + typ. 6.5 ns. Independent of period

General

HP-IB Capability
Conformity: IEEE-488.2, 1987, SCPI 1992.0
Function Code: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, CO
Storage of Instrument Settings: One power-down, one default setting and nine user locations. Additionally, 40 settings can be stored on the HP 8110A Option UFH memory card
Environmental
Temperature: 0° to 55° C operating, –40° to 70° C storage
Humidity: 95% RH at 0° to 40° C
Power: 100 to 240 V ac ± 10%, 50 to 60 Hz; 100 to 120 V ac ± 10%, 50 to 60/400 to 440 Hz
Consumption: 300 VA (max. configuration)
EMC Conformity: CISPR 11, A; EN55011, A; EN50082-1
Size: 426 mm W x 89 mm H x 445 mm D (17 in x 3.3 in x 17.5 in)
Weight: Net, 9.2 kg; shipping, 20.2 kg
Recal. Period: 1 year recommended
Warranty: 3 years

Key Literature

Color Brochure, p/n 5964-6335E

For more information, visit our website: **http://www.hp.com/go/dvt**

Ordering Information

HP 8110A Mainframe (includes English operating and programming manual 08110-91012).
Always order at least one HP 81103A with each HP 8110A.
A second HP 81103A or an HP 81106A or HP 81107A–in any combination–can be ordered at the same time or fitted retrospectively.
HP 81103A Output Module
HP 81106A PLL/Ext. Clock Module
HP 81107A Deskew Module
HP 8110A Options
Opt 0B2 Additional Manual 08110-91012
Opt UFH 128 kB Memory Card
Opt UK6 Commercial Cal. Certificate
Opt UN2 Rear (instead of front) Panel Connectors
Opt 1CN Front Handle Kit (5062-3988)
Opt 1CP Rack Mount/Handle Kit (5062-3975)
Opt 1CM Rack Mount Kit (5062-3974)
Opt 1CR Rack Slide Kit (1494-0060)
Opt 1BP MIL-45662A Cal with Test Data
Opt OBV Service Manual, Component Level
Opt OBW Service Manual, Assembly Level
Opt 503 Front and Rear Panel Connectors

100 V, 2 A High Power Pulse Generator

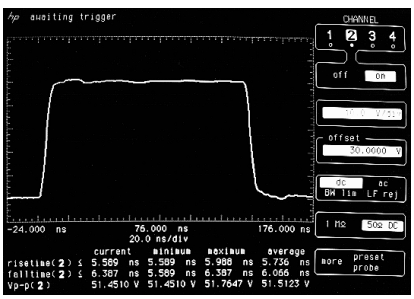
HP 8114A

- 100 V, 2 A pulses into 50 Ω
- 7 ns transitions (50 Ω into 50 Ω)
- Counted burst and external width
- SCPI programming commands
- Variable baseline ± 25 V (Option)
- Inhibit Input

HP 8114A 100 V, 2 A Pulse Generator

Tests High Power Devices Reliably

The HP 8114A programmable pulse generator delivers fast-transition 100 V pulses into 50 Ω loads at rates of up to 15 MHz. In addition to simulating transients and glitches, it is well-equipped to characterize and test devices requiring high voltage or current pulses, such as flash memories, power MOS devices, IR/laser diodes and radar devices.



Typical 2 A pulse into 50 Ω for IR-diode test

Protects Your Device

The HP 8114A gives you fast, clean, and reliable pulses without risking damage to the device-under-test. You can also set voltage, current, and duty cycle limits to prevent accidental damage, and use an external TTL control signal at the Inhibit Input to inhibit/enable the pulse output.

Integrates Easily into Test Systems

SCPI programming commands for HP-IB control and optional rear-panel connectors make the HP 8114A ideal for automated test systems. In addition, the Variable Baseline option allows a dc voltage of up to ± 25 V to be added to the pulse baseline, making an additional dc power supply unnecessary. The HP 8114A output is protected against excessive power dissipation.

Specifications

Output: 50 Ω into 50 Ω
Amplitude: 1.00 Vp-p to 50.0 Vp-p, 20.0 mAp-p to 1.00 Ap-p (doubles when Hi-Z source selected)
Resolution: 3 digits, best case 10 mV
Accuracy: ± 1% of amplitude ± 0.5% baseline ± 100 mV
Baseline: 0 V ± 100 mV ± 0.5% of amplitude
Variable Baseline Option 001: –25 V to + 25 V, 50 Ω source impedance only
Accuracy: ± 1/± 100 mV ± 0.5% of amplitude
Polarity: Positive or negative baseline selectable
Source Impedance: High impedance or 50 Ω selectable
Max. Short Circuit Current: 2 A

Pulse Performance

Overshoot/Preshoot/Ringing: < 5% of amplitude ±100 mV
Setting Time: < 100 ns typical
Transition Times (10/90% amplitude):
50 Ω into 50 Ω: < 7 ns (amplitude > 5 V); High-Z into 50 Ω: < 12 ns

Timing Parameters

Measured at 50% of amplitude with 50 Ω source impedance into 50 Ω load

Period: 66.7 ns to 999 ms (**Frequency:** 1.00 Hz to 15 MHz)
Accuracy: ± 5% ± 100 ps
Resolution: 3 digits best case 100 ps
Width: 10.0 ns to 150 ms
Duty Cycle: 0.1 % to 100% (maximum duty cycle limited for amplitude > 20 V, worst case 15%)
Accuracy: ± 5% ± 500 ps
Resolution: 3 digits best case 100 ps
Delay: 0.00 ns to 999 ms (maximum value = period – 4 ns)
Accuracy: ± 5% ± 1 ns
Resolution: 3 digits best case 100 ps
Fixed Delay: 42 ns (trigger output to output) typical
Double Pulse: (Delay and Double-Pulse are mutually exclusive) 20.0 ns to 999 ms, minimum period 133 ns
Resolution: 3 digits best case 100 ps

Inhibit Input

External TTL signal inhibits the pulse output, holding the output signal at its baseline level.
Edge Mode: An active edge inhibits the pulse signal, reset from front panel or HP-IB.
Level Mode: An active level inhibits the pulse signal, an inactive level enables the signal level.

Trigger Modes

Continuous: Continuous pulse train
Triggered: External Input transition or manual trigger key generates pulse, double-pulse or burst of pulses
Gated: Active level at External Input or manual trigger key enables pulses, double-pulses or burst of pulses
External Width: Width of signal at External Input determines pulsewidth (maximum amplitude 20 V, 50 Ω into 50 Ω)
Burst: Bursts of 2 to 65536 pulse periods can be programmed

General

Operating Temperature: 0° to +55° C
Power: 100 to 240 Vac ± 10%, 50 to 60 Hz; 500 VA max.
Size: 426 mm W x 133 mm H x 422 mm D (16.8 in x 5.2 in x 16.6 in)
Weight: Net, 14 kg; shipping, 17 kg

Key Literature

Color Brochure, p/n 5965-1111E

For more information, visit our website: **http//www.hp.com/go/dvt**

Ordering Information

HP 8114A 100 V, 2 A Pulse Generator*
Opt 001 Variable Baseline ±25 V
Opt OB2 Additional Users' Guide
Opt OBV Service Guide, Component Level
Opt OBW Service Guide
Opt UFH 128 kB Memory Card
Opt UK6 Commercial Cal. Certificate
Opt UN2 Rear (instead of front) Panel Connectors
Opt 1BP MIL-45662A Cal. with Test Data
Opt 1CM Rack Mount Kit
Opt 1CN Front Handle Kit
Opt 1CP Rack Mount/Handle Kit
Opt 1CR Rack Slide Kit
Opt 503 Front and Rear Panel Connectors

* Memory card not included.

HP 8133A

- Transitions typically < 60 ps
- 1 ps resolution, 350 fs with HP-IB
- Optional data and PRBS capabilities
- Jitter typically < 1 ps
- Optional second pulse channel
- Synchronization of up to three instruments

HP 8133A Timing Generator with Option 002

HP 8133A Timing Generator

When timing is critical, the ability to characterize a digital product begins and ends with accurate edge-placement of the test signal. The HP 8133A makes an outstanding contribution through high resolution, very low jitter and very fast, linear transitions.

These attributes are required in digital designs with clock rates from a few hundred MHz and upwards. Some examples are:

- Circuits for distributing clock signals of several hundred MHz. At these frequencies, parametric effects cause asymmetry so that designers need to test performance under conditions where the duty cycle is not 50%.
- Microprocessor boards—the faster the processor, the more acute the HF problems. At high frequencies, the effects cannot be fully emulated, and therefore measurements on hardware are essential.
- The same applies to fast chip-to-chip communication, especially in integrated designs where discovery of timing problems late in the design cycle can be disastrous.
- Datacom/Telecom chips where clock rates go from several hundred MHz to a few GHz.

The HP 8133A means more efficiency in manufacture as well as design because the tightly-toleranced test signal reduces the reject rate and avoids overspecification.

As mentioned, a fast edge contributes to placement accuracy. On the other hand, if the edge is too fast, measurements can be impaired through unnecessary ringing or reflections. For this reason, a range of transition time converters are available which match the requirements of today's faster technologies and provide signals with very level pulse top, and little or no overshoot.

When several channels must be stimulated at the same time in order to perform a measurement, multi-channel accessory kits allow two or three HP 8133As to be master/slaved for up to six channel operation.

To investigate pattern effects or to make rapid performance checks using the eye-pattern technique with the HP 54120 series oscilloscope, the HP 8133A can be fitted with a pulse/data channel in place of the second pulse channel. This supports 32 bit patterns and the CCITT 0.151 2^{23}–1 prbs.

HP 8133A Configuration Overview

Channel	Standard	Option 001[1]	Option 002[1]	Option 003[1]
1	Pulse channel width or delay	Pulse channel width and delay	Pulse channel width and delay	Pulse channel width and delay
2	None	None	Data channel 32 bit or PRBS	Pulse channel width or delay

[1]Options are mutually exclusive.

Brief Specifications

Timing
Frequency: 33.0 MHz to 3.0000 GHz, 100 KHz resolution
Period: 300 ps to 30.000 ns, 1 ps resolution
Accuracy: ± 0.5%, ± 0.1% nominal
Pulse Channel(s)
Square Mode (50% duty cycle):
Delay: 0.000 to 10.000 ns (–5.000 to +15.000 ns in Channel 1 if Option 001, 002, or 003 used)
Pulse Mode:
Delay: No variation (–5.000 to +5.000 ns in Channel 1 if Option 001, 002, or 003 used)
Width: 150 ps to 10.000 ns (max.: period –150 ps)
Duty Cycle: 0.0 to 100.0%, 0 and 100% mean dc at outputs
Accuracy: Typically 30 ps
Delay Drift Against Delay: 50 ps
Phase: –360.0 to +360.0°, subject to delay limits
Outputs, Channels 1 and 2 and (Trigger Output)
Amplitude: 0.30 to 3.00 Vp-p (0.5 to 1.80 Vp-p)
Level Window: –2.00 to +4.00 V (–4.00 to +4.00 V)
Outputs: Differential outputs, invertible (single)
Transition Times: 10% to 90% of amplitude: < 100 ps, 60 ps nominal; 20% to 80% of amplitude: < 60 ps, 40 ps nominal (< 100 ps)
EMC Conformity: CISPR II, EN5501, EN50082-1

Key Literature

Brochure, p/n 5091-7678E

For more information, visit our website: **http://www.hp.com/go/dvt**

Ordering Information

HP 8133A Pulse Generator
Opt 001 Delay Channel 1
Opt 002 Pulse/Data Channel 2
Opt 003 Pulse Channel 2
Note: Option 002 and Option 003 contain Option 001.
These options are mutually exclusive. Extended warranty options (see page 70) available on request.
Opt OB2 Additional Users' Guide
Opt OBV Service Manual, Component Level
Opt OBW Service Manual, Assembly Level
Opt UK6 Commercial Cal. Certificate
Opt 1BP MIL-45662A Cal. with Test Data
Opt 1CM Rackmount Kit
Opt 1CN Handle Kit
Opt 1CP Rackmount/Handle Kit
Opt 1CR Rack Slide Kit (requires Opt H01)
Opt H01 Peparation for Rack Slides
Accessories
HP 1250-1462 Adapter SMA (m) to SMA (f)
HP 8120-4948 50 Ω Cable, SMA (m-m)
HP 8710-1582 Torque Wrench, 5 in/lb
HP 8493A Series Attenuator
Opt 003 3 dB
Opt 006 6 dB
Opt 010 10 dB
Opt 020 20 dB
Opt 030 30 dB
HP 11667B Power Splitter
HP 15436A Multi-channel Accessory Kit for three HP 8133As (additional HP 11667B Power Splitter is needed)
HP 15439A Multi-channel Accessory Kit for two HP 8133As
HP 15435A 150 ps Transition Time Converter
See page 391 for other transition time converters.

Indicates QuickShip availability.

410 Data Generator System

HP 80000

- Clock or data rate up to 1 GHz
- 16 or 128 Kb memory per channel
- Delay range ± 2 ns, 2 ps resolution
- Amplitude up to 2.5 V or 3.0 V in –2 V to 3 V level window
- Color touchscreen
- 4 to 80 channels

HP 80000 Data Generator System with two strobe and 16 data channels. With the expansion frames, up to 80 channels can be configured.

8 HP 80000 Data Generator System

When you need multiple lines of real data to characterize your device, the HP 80000 system delivers everything needed to make the test complete, accurate and reliable. This is because it offers the kind of edge-placement precision that is usually only found in high performance pulse generators —but at up to 1 GHz and over 80 channels.

These features—plus affordability, PRBS and conformance to national and international electromagnetic regulations—have made the HP 80000 system a preferred choice when characterizing fast ICs, modules, or components such as:

- MUX, DAC, memories
- ATM, SONET/SDH, switches

as well as passive devices like HF connectors and computer backplanes.

Rapid performance verification can be carried out with the HP 80000's PRBS and the help of the HP 54750A series oscilloscope—using the eye-pattern technique—or the HP 71600 series BERT, where the HP 80000's unique 2^{23}–1 pseudo-random word sequence allows even MUXs to be BER-tested. The memory is segmentable, so that preamble/data or initialize/data sequences can be set up.

The HP 80000 system consists of a mainframe, an expansion frame, and a choice of modules so that systems with up to 80 channels can be factory-configured or retrofitted. The mainframe includes an internal clock plus synchronous start/stop logic. It has a friendly HP 16500-type user interface and supports two internal disk drives, an HP DeskJet RS232 printer and HP-IB. The mainframe, like the extender, has room for five modules.

The four channel, 1 GHz data modules provide RZ (50% duty cycle) and NRZ formats. Edges can be positioned with 2 ps resolution in a ± 2 ns window, independent of clock rate. There is a choice of 16 or 128 Kb per channel.

The clock/strobe modules process the mainframe clock to provide normal and complement clock outputs. They also have two channels which can be used as strobes, as clock dividers for multi-phase signals, or for data patterns. 16/128 Kb modules are available.

Key Literature

For more information, please consult the *HP 80000 Data Generator System* Brochure, p/n 5091-9396E and the *HP 80000 Data Generator System* Technical Data Sheet, p/n 5091-9397E

For more information, visit our website: **http://www.hp.com/go/dvt**

Ordering Information

HP 80000 Data Generator System Components
HP E2900A 5-slot Mainframe with internal clock
HP E2901A 5-slot Expansion Frame
HP E2902A 1 GHz Clock/Strobe Module
HP E2903A 1 GHz Data Module
HP E2905A 128 Kb 1 GHz Clock/Strobe Module
HP E2906A 128 Kb 1 GHz Data Module
Accessories
HP 15432B 250 ps Transition Time Converter
See page 402 for other transition time converters.
HP 1250-1462 Adapter SMA (m) to SMA (f)
HP 8120-4948 50 Ω Cable, SMA (m-m)
HP 8710-1582 Torque Wrench, 5 in/lb
HP 1182A/1181A Testmobile Carts for Instruments
HP 13242G RS-232C Cable for HP DeskJet
Opt OB2 Additional User's Guide
Opt OBV Service Manual, Component Level
Opt OBW Service Manual, Assembly Level
Opt 1BP MIL-45662A Cal. with Test Data
Opt UK6 Commercial Cal. Certificate

Logic Analyzers

Timing Characterization Using the HP 16571/18A with Intel Pentium Processor Measurement Examples, Note #1261
5091-8798E
Accessories for HP Logic Analyzers
5963-3376E
Designing a Custom Interface for a Logic Analyzer using HP User Definable Design Tools, Application Note 1244-1
5091-8839E

Digital Verification Tools

HP E2910A Brochure
5964-1621E
HP 2910A Technical Data
5965-1438E
Digital Testing Under Real-World Conditions? HP 8110A Application Brief
5091-7601E
HP 80000 and HP 16500A Digital Stimulus and Response Application Lab #6
5091-5481E
HP 8114A Pulse Testing 980-nm Pump Laser-Diodes in Optical Fiber Amplifiers
5963-6988E
HP 81100 Family of Pulse/Pattern Generators Flyer
5968-0212E
(PN) E6280A PNNI Signalling Test Software for the Broadband Series Test System
5965-9079E
(PN 16522A) Digital Verification with the HP 16522A Pattern Generator
5964-6347E

HP's Test & Measurement Web site.
The more you visit, the more you'll know.

News and information you need, 24 hours a day. Get the most complete support available for all of HP's Test & Measurement tools. Immediate access to information, 24 hours a day, means always getting the most from your instruments:

- Product Information
- Usage Tips
- Application Note Library
- Service, Support and Training
- Sales and Service Contacts
- Selection Guides
- Newsletters
- Feature Stories Showing Products in Use
- Information on Your Industry
- News Releases
- Country-Specific Sites

These features are only a snapshot of what's available at the Web site. Bookmark it—and visit it regularly—to stay completely up to date on all of HP's test and measurement solutions.

HP 8168D
HP 8168E
HP 8168F

- Output power up to +8 dBm
- Tuning linearity ±1 pm possible
- 2 year re-calibration period
- Auto-realignment of laser cavity for even better reliability

HP 8168D/E/F Tunable Laser Sources

Tunable laser sources are basic tools for characterizing and testing optical amplifiers and components. The HP 8168D/E/F Tunable Laser Sources operate in the 1550 nm transmission window and cover the wavelength range needed to test dense WDM component designs. All three products are equipped with a built-in sidemode filter to ensure true single-mode operation over the full wavelength range. Output power and wavelength are selectable independent from each other. Wavelength scans, which require an output power that is stable over time and flat across all wavelengths, can be performed reliably, accurately and quickly. Built-in software allows single or dual channel loss, return loss and coupling ratio measurements together with an HP 8153A Lightwave Multimeter. The instruments' dependability and reliability make them perfect for integration into a fully-automated production test environment.

Specifications

9

	HP 8168D	HP 8168E	HP 8168F
Wavelength range	1490 nm to 1565 nm	1475 nm to 1575 nm	1450 nm to 1590 nm
Absolute wavelength accuracy, typical	± 0.2 nm	± 0.1 nm	± 0.1 nm
Relative wavelength accuracy	± 0.1 nm	± 0.035 nm, typ. ± 0.001 nm*	± 0.035 nm, typ. ± 0.001 nm*
Wavelength resolution	0.001 nm	0.001 nm	0.001 nm
Wavelength stability	< ± 1 GHz	< ± 100 MHz	< ± 100 MHz
Wavelenght repeatability	± 0.1 nm	± 0.035 nm, typ. ± 0.001 nm*	± 0.035 nm, typ. ± 0.001 nm*
Linewidth (typical)	100 kHz	100 kHz	100 kHz
broadened (effective, typical)	30 - 500 MHz	50 - 500 MHz	50-500 MHz
Signal to source spontaneous emission ratio	> 30 dB/1 nm	> 35 dB/1 nm	> 45 dB/1 nm
Signal suppression ratio	—	> 40 dB	> 50 dB
Maximum output power (peak, typical)	**–3 dBm**	**–7 dBm**	**+8 dBm**

* Peformance when controlled with appropriate wavelength meter

Dimensions: 145 mm H, 426 mm W, 545 mm D (5.8" x 16.9" x 21.6")
Weight: Net, 18 kg (40 lb.); shipping, 21 kg (46 lb.)
Power: 100 to 240 Vrms ±10%, 260 VA max.

Key Literature

Technical Specification, 5964-9000E
Configuration Guide, 5964-9001E

Ordering Information

HP 8168D Tunable Laser Source
HP 8168E Tunable Laser Source
HP 8168F Tunable Laser Source
Options (not available for all instruments and in all combinations)
Opt 021 Straight Contact Output Connector
Opt 022 Angled Contact Output Connector
Opt 023 Angled Non-Contact Output Connector (Diamond HMS-10/HP/HRL)
Opt 003 Built-in Variable Attenuator
Opt 007 Polarization Maintaining Fiber
HP 81000AI/FI/GI/KI/NI/PI/SI/VI/WI Connector Interface

HP 8167B
HP 11896A
HP 8169A

- Output power up to +4 dBm
- Tuning linearity ± 1 pm possible
- 2 year re-calibration period
- Auto-realignment of laser cavity for even better reliability
- ±0.002 dB insertion loss variation with adjustment (HP 11896A)
- 1250 nm to 1600 nm coverage (HP 11896A)
- Synthesis of states of polarization (HP 8169A)

HP 8167B

HP 11896A and 8169A

HP 8167B Tunable Laser Source

Within Hewlett-Packard's family of tunable lasers, the HP 8167B addresses the 1300 nm transmission window. A built-in sidemode filter ensures that a true single-mode laser line is generated for every wavelength point, eliminating any possible multimoding. Independent control of the instrument parameters ensures that the output power is kept stable over time and wavelength. In manufacturing applications, the instrument can be integrated into a fully-automated production test environment for precise, fast and repeatable testing. In a manual setup, single or dual channel loss, return loss and coupling ratio measurements can be performed using the built-in application software.

Specifications

Wavelength range: 1255 nm to 1365 nm
Absolute wavelength accuracy: ± 0.1 nm, typical
Relative wavelength accuracy: ± 0.035 nm, typical [1]
Wavelength resolution: 0.001 nm
Wavelength stability: < ± 100 MHz
Wavelength repeatability: ± 0.035 nm, typical [1]
Linewidth: 100 kHz, typical
Effective linewidth when broadened: 10 to 500 MHz, typical
Signal to source spontaneous emission ratio: > 35 dB/1 nm
Sidemode suppression ratio: > 40 dB, typical
Maximum output power: 3 dBm
Minimum output power: - 7 dBm (–47 dBm with option 003)
Dimensions: 145 mm H, 426 mm W, 545 mm D (5.8" x 16.9" x 21.6")
Weight: Net, 18 kg (40 lb.); shipping, 21 kg (46 lb.)
Power: 100 to 240 Vrms ± 10%, 260 VA max.

[1] ± 0.001 nm when controlled with appropriate wavelength meter.

Key Literature

HP 8167B Technical Specifications, p/n 5964-9000E
HP 8167B Configuration Guide, p/n 5964-9001E

Ordering Information

HP 8167B Tunable Laser Source
Opt 021 Straight Contact Output Connector
Opt 022 Angled Contact Output Connector
Opt 023 Angled Non-Contact Output Connector (Diamond HMS-10/HP/HRL)
Opt 003 Built-in Variable Attenuator
Opt 007 Polarization Maintaining Fiber
HP 81000AI/FI/GI/KI/NI/PI/SI/VI/WI Connector Interface

HP 11896A Polarization Controller

The HP 11896A adjusts polarization and not power. Its optical fiber loop design provides all states of polarization with extremely small optical insertion-loss variations (±0.002 dB) over a wide spectral range (1250 to 1600 nm). This performance combination maximizes measurement accuracy for power-sensitive applications like polarization-dependent loss and gain. This is because the measurement uncertainty contributed by the polarization controller is minimized.

HP 8169A Polarization Controller

The HP 8169A provides polarization synthesis relative to a built-in linear polarizer. The internal quarter-wave plate and half-wave plate are individually adjusted to create all possible states of polarization. Predeterministic algorithms within the HP 8169A enable the transition path from one state of polarization on the Poincare sphere to another to be specified along orthogonal great circles. These features are important because device response data can be correlated to specific states of polarization input to the test device.

Specifications

Note: Fiber pigtail interface assumed in all cases.

	HP 11896A	HP 8169A
Operating Wavelength Range (nm):	1250 to 1600	1470 to 1570
Insertion Loss:	<1.5 dB	<1.5 dB
Variation with Adjustment:	<±0.002 dB	<±0.03 dB
Variation with Wavelength:	<±0.1 dB	<±0.1 dB

Key Literature

HP 11896A and HP 8169A Technical Specifications, p/n 5962-0017E

Ordering Information

HP 11896A Lightwave Polarization Controller
Standard instrument includes FC/PC connector interfaces
Opt 025 One Meter Pigtail Fiber w/ FC/PC Connector Interfaces
HP 8169A Lightwave Polarization Controller
(Polarization controller must be ordered with connector option)
Opt 020 Pigtailed Fiber Ports
Opt 021 Straight Contact Connector Output
Opt 022 Angled Contact Connector Output
HP 81000AI/FI/GI/KI/NI/PI/SI/VI/WI Connector Interfaces

HP 81600 Series EDFA Test System

- Fast, easy device characterization
- Single-channel and WDM testing
- Multi-unit testing
- Menu-driven software.
- Automatic calibration
- Measurement methods in compliance with IEC
- Fully specified with traceable accuracy
- ISO 9000 certified
- Reliable performance, proven by large installed base
- World-wide support

Hewlett-Packard offers a diverse selection of erbium doped fiber optical amplifier test solutions, each focused entirely on the requirements of the customer. Basic offerings include EDFA test systems for amplifier development and evaluation, incoming inspection, and high-volume manufacturing.

The HP 81600 series 200/210 is a fully automatic, turnkey EDFA test system for automatic, fast and accurate characterization of EDFAs. The system includes all the necessary test equipment, a controller, a system rack and the software. A software development kit (and the training) allows customized measurements, for example, the control of a temperature chamber or a current source.

The HP 81600 test system meets a broad range of amplifier test requirements such as the measurement of gain, noise figure and output power as a function of wavelength and input power. Various test methods and test capabilities are available including:

- Single-channel gain and noise figure, using the polarization-extinction method
- Single-channel gain and noise figure measurements, using ASE interpolation method
- Polarization mode dispersion (PMD) and polarization-dependent gain (PDG)
- WDM gain and noise figure with signal substitution technique (patent pending)
- Dynamic gain and noise figure measurement using a tunable laser as probe signal
- Multi-unit testing

For most of these options, the system consists of an HP 8168F Tunable Laser Source, an HP 8153A Lightwave Multimeter and an HP 71452B Optical Spectrum Analyzer. Other parts are added as necessary. Three noise figure test methods are available, all based on accurate measurement of the amplified spontaneous emission (ASE): ASE interpolation with source subtraction, polarization extinction and signal substitution (patent pending).

Available Systems

HP E4340A, Series 200 - Single-Channel Gain & NF

This system measures the gain, output power and noise figure. It uses the polarization extinction method to determine the noise figure. This technique is preferable at high input power levels. Maximum input power is +3 dBm, with gain accuracy of ± 0.2 dB and noise figure accuracy of ± 0.25 dB.

HP E4341A, Series 210 - Single-Channel Gain & NF

The measurement capabilities are the same as those of the series 200, except that the ASE interpolation/subtraction method is used in the noise figure measurement. Maximum input power is +3 dBm, gain accuracy is ± 0.2 dB and noise figure accuracy is ± 0.4 dB.

HP E4340A Series 200, Option 003 - Single-channel Gain & NF with Booster Amplifier

In the booster option, an HP 8156A Optical Attenuator and an HP 8169A Polarization Controller is added, so that a booster amplifier can provide up to +13 dBm input power. The noise figure is measured with the signal displacement technique . Gain/output power uncertainty is ± 0.4 dB and noise figure uncertainty is ±0.5 dB.

HP E4340A Series 200, Option 110 - PMD and PDG Measurement

In the PMD/PDG option, a polarization controller is added to the series 200 system, so that the PMD and the PDG of the EDFA can be measured by Mueller/Stokes analysis. The PMD uncertainty is ± 0.1 ps for small PMD values. The PDG uncertainty is ± 0.05 dB.

HP E4340A Series 210 Option WDM - Dense WDM Gain & NF Measurement

This system measures the gain and noise figure of an EDFA when driven with a multi-wavelength WDM source. Available channel spacing is 0.8 nm minimum. The signal substitution technique (patent pending) is used. Channel gain/noise figure uncertainty is ±0.3 dB.

HP E4340A, Series 210, Option DG - Dynamic Gain & NF Measurement

This system measures the gain and noise figure using a reduced number of saturating lasers, to predict the gain and noise figure of the full multi-wavelength WDM signal. The system is based on a selectable number of saturating lasers and a single tunable probe laser. Gain/noise figure uncertainty is ± 0.3 dB.

HP E4340A, Option MU - Multi-Unit Gain and NF Measurement

Multiple unit testing is advisable when unattended measurements are needed, e.g. in volume production and environmental testing. In this option of the HP 81600 test system, two switch matrices are added to connect up to 24 EDFAs in parallel. The gain/signal output power uncertainty is ± 0.3 dB, the noise figure uncertainty is ± 0.3 dB when the polarization extinction method is used (series 200).

Additional measurement capabilities, customizations and other services are available upon request.

Key Literature

Automatic Test System for Erbium Doped Fiber Amplifiers, p/n 5967-5983E

Dynamic Gain and Noise Figure Measurement of Erbium Doped Fiber Amplifiers, p/n 5968-1143E

Testing Polarization Mode Dispersion and Polarization Dependent Gain of Erbium Doped Fiber Amplifiers, p/n 5963-3716E

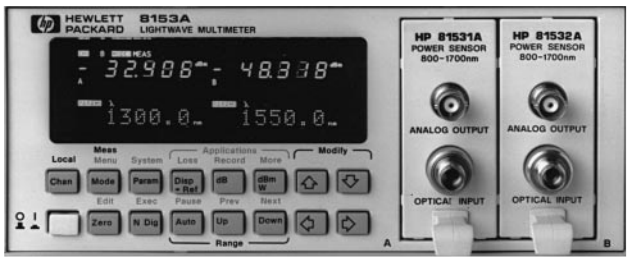
Testing Gain and Noise Figure of Erbium Doped Fiber Amplifiers for DWDM Applications, p/n 5967-5965E

Testing EDFAs for High Power Applications, p/n 5968-1142E

- 0.05 dB attenuation accuracy, 0.001 dB resolution
- 0.02 dBp-p polarization sensitivity
- Optional monitor output
- Back reflector mode
- User-exchangeable plug-in modules for tailor-made measurements

HP 8153A
HP 8156A

HP 8156A



HP 8153A

HP 8156A Attenuator

The HP 8156A is a high performance attenuator for single-mode and multimode applications.

Options are available to select the desired return loss performance (up to 60 dB.) An optional 13 dB monitor output allows you to measure the signal power at the output of the attenuator. Using the built-in back reflector mode and an external reference reflector (HP 81000BR), the HP 8156A can be used as a programmable back reflector to measure component and system sensitivity against reflections.

The attenuation range is 60 dB with 0.001 dB resolution between 1200 nm and 1650 nm. Due to a novel single filter design, no ranging occurs. This completely eliminates dark spots or potential attenuation overshoots or undershoots. Attenuation accuracy is typically better than ±0.05 dB with a polarization sensitivity of less than 0.02 dB peak-to-peak.

For more detailed information, see the *Lightwave Test and Measurement Catalog*.

Specifications

	HP 8156A Opt 100	HP 8156A Opt 101/201	HP 8156A Opt 121/221	HP 8156A Opt 350
Wavelength range	1200 to 1650 nm			
Fiber type	single-mode			50 μm multimode
Attenuation range	60 dB			
Resolution	0.001 dB			
Return loss **Insertion loss** (typical)*	>35 dB 4.5 dB	>45 dB/>60 dB 2.5 dB	>45 dB/>60 dB 3.3 dB	>22 dB 3.0 dB
Attenuation accuracy (typical)	±0.1 dB	±0.05 dB	±0.05 dB	±0.08 dB
Polarization sensitivity (typical)	<0.075 dBp-p	<0.02 dBp-p	<0.03 dBp-p	—
Repeatability (typical)	±0.005 dB			
Switching time	20–400 ms			
Maximum input power	+23 dBm			

*Includes insertion loss of two HMS-10 connectors.

Size: 212.3 mm W x 89 mm H x 345 mm D (8.36 in x 3.5 in x 13.6 in)
Weight: Net, 5.3 kg (11.7 lb); shipping, 9.6 kg (21.2 lb)

Ordering Information

Two connector interfaces (three for Option 121/221) are required for each HP 8156A

HP 8156A Optical Attenuator Mainframe
- **Opt 100** Standard Performance Version
- **Opt 101** High Performance Version
- **Opt 121** Monitor Output, 45 dB Return Loss
- **Opt 201** High Performance, High Return Loss Version
- **Opt 203** Back Reflector Kit for Option 201*
- **Opt 221** Monitor Output, 60 dB Return Loss
- **Opt 350** 50/125 μm Multimode

HP 81000AI/FI/GI/KI/NI/PI/SI/VI/WI Connector Interfaces

* Kit consists of one each: 81000SI, 81000FI, 81113PC, 81000UM, and 81000BR.

HP 8153A Lightwave Multimeter

The HP 8153A Lightwave Multimeter mainframe offers two slots for plug-in modules. Since modules can be combined in any configuration, the instrument can be used as a 1/2 channel power meter, a 1/2 channel light source, a loss test set, or even as a return loss test set.

Four different power sensor modules, with different sensitivities from –70 dBm down to –110 dBm, cover the 450 nm to 1700 nm wavelength range. Each is individually calibrated over its entire wavelength range and is traceable to NIST and PTB for precise optical power measurements. The excellent linearity and high stability of the source modules provides the basis for precise determination of optical insertion loss for both single-mode and multimode components.

The external power sensors (optical heads) cover the power range from +27 to –90 dBm. They are especially suitable for obtaining the highest requirements in absolute accuracy, e.g. for calibration services, and also for open beam measurements.

The source modules offer very good short-term and long-term stability. The high output power can be internally attenuated by up to 6 dB. All sources are able to output CW or pulse-modulated light (internal modulation at 270 Hz, 1 kHz, or 2 kHz).

Key Literature

Modular Systems for Optical Power, Loss and Return, Color Brochure, p/n 5962-9321E
HP 8153A Lightwave Multimeter, Configuration Guide, p/n 5963-3366E

Ordering Information

HP 8153A Lightwave Multimeter Mainframe
HP 81530A Si, +3 to –100 dBm, 450 to 1020 nm
HP 81531A InGaAs, +3 to –90 dBm, 800 to 1700 nm
HP 81532A InGaAs, +3 to –110 dBm, 800 to 1700 nm
HP 81536A InGaAs, +3 to –70 dBm, 800 to 1700 nm
HP 81534A Return Loss Module, InGaAs, 60 dB/65 dB return loss range, 1250–1600 nm
HP 81533B Optical Head Interface Module
HP 81520A Optical Head, Si, +10 to –100 dBm, 450 to 1020 nm
HP 81521B Optical Head, Ge, +3 to –80 dBm, 900 to 1700 nm
- **Opt 001** 0.003 dBp-p polarization sensitivity, +3 to –64 dBm

HP 81524A Optical Head, InGaAs, +3 to –90 dBm, 800 to 1650 nm
HP 81525A Optical Head, InGaAs, +27 to –70 dBm, 800 to 1650 nm
HP 81551MM 850 nm, LD, Multimode
HP 81552SM 1310 nm, LD, Single-Mode
HP 81553SM 1550 nm, LD, Single-Mode
HP 81554SM 1310/1550 nm, LD, Single-Mode
HP 81542MM 1300 nm, LED, 50 μm Multimode Fiber Output
HP 81002FF Integrating Sphere

9

Protect Your Networks

Installers and operators of fiber optic communications networks are faced with the continuing challenge of managing and maintaining their systems with near-perfect uptime and quality while employing the most cost-effective procedures and equipment available. Through the technology and value leadership of our products and services, Hewlett-Packard can serve as your working partner in this endeavor. We offer a full range of scalable solutions for fault isolation, characterization, and reporting—on site, at the bench, or remotely across an entire network.

The HP E6000A mini-Optical Time Domain Reflectometer (mini-OTDR) equips the on-site installer or maintenance technician with a complete, highly portable optical fiber test set. This small, lightweight, modular instrument combines high resolution and long-distance, high speed and high dynamic range with one-button operation and an award-winning user interface that extends your technicians' efficiency and effectiveness. Several additional modules and sub-modules can enhance their capabilities without the penalty of added weight.

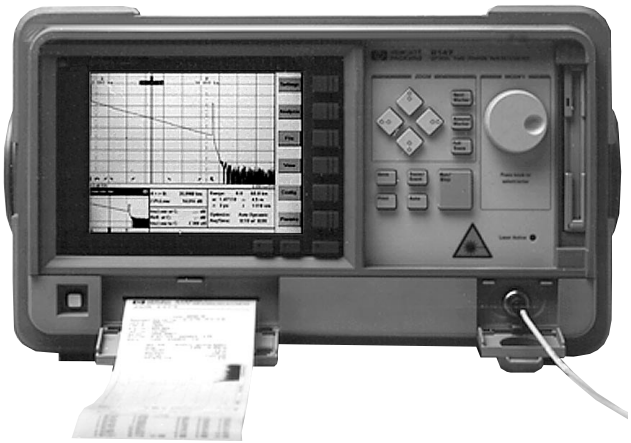
At the next level of test and measurement capability, the HP 8147 Optical Time Domain Reflectometer (OTDR) combines automatic measurement and analysis capability with preprogrammable procedures that speed up operation. Functionality spans on-site problem-solving, bench-top characterization and remote controlling, while modular architecture allows you to expand its capabilities in keeping with both your needs and your budget.

The HP E6053A, HP E6058A and the HP E6060A rack OTDRs are the newest arrivals in the Hewlett-Packard OTDR family. Primarily suited for use in fiber test systems, the rack OTDRs feature the high durability of the HP E6000A mini-OTDR and easy integration into manufacturing, monitoring or test systems.

To manage and maintain your entire fiber optic network at maximum uptime and quality with minimum cost, implement AccessFiber. Based on a detailed and comprehensive fiber network model, AccessFiber delivers all the information required for effective and efficient network planning, as well as installation and maintenance processes. Interfaces for standard tools, such as workflow and workforce management systems and GIS (geographic information systems) are provided. The availability of such interfaces means that you can protect your investment and revenues while you add significant value to the quality of service received by your customers.

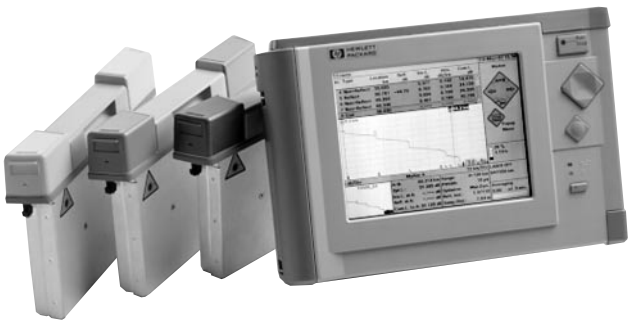
HP 8147
HP E6000A

- High resolution and dynamic range in each module
- Pre-programmable procedures
- Full on-line analysis and remote operation
- Exceptionally flexible



HP 8147

- Fast and accurate fault characterization
- One button automatic measurement and analysis
- Small, rugged and lightweight
- Excellent resolution
- Ultra high dynamic range



HP E6000A

HP 8147 Optical Time Domain Reflectometer

The HP 8147 is a high performance optical time domain reflectometer for installation, commissioning and bench applications. It is designed for fast and accurate measurement and analysis of a fiber link, all at the touch of a single button.

"Easy Mode" lets you pre-program complete procedures. So, with a couple of keystrokes, you get standardized measurements. That way, regardless of the operator's experience level, you get accurate and repeatable results every time.

Extended in-depth analysis including two-way measurements, delta measurements and comparison of up to four traces, is now available online. A return loss graph allows you to see the reflectance of individual events at a glance, as well as the total return loss of the link.

The HP 8147 remote capability provides for the centralized operation, collection and analysis of results from remotely-stationed OTDRs. As a result, you can maximize the use of scarce test expertise throughout your network.

At only 9 kg (20 lbs), the HP 8147 can be easily carried into those awkward places.

A variety of performance classes can now be selected to ensure you have just the right performance for your application. Many standard interfaces and options are available to ensure that the OTDR can be configured to your exact needs.

Specifications

HP 8147 OTDR	Wavelength	Fiber Type	Dynamic Range	Attenuation Deadzone
HP E4311A	1310 ± 15 nm	Single-mode	29 dB	20 m
HP E4312A	1550 ± 15 nm	Single-mode	28 dB	30 m
HP E4313A	1310/1550 ± 15 nm	Single-mode	29/28 dB	20/30 m
HP E4314A	1310 ± 15 nm	Single-mode	35 dB	20 m
HP E4315A	1550 ± 15 nm	Single-mode	34 dB	30 m
HP E4316A	1310/1550 ± 15 nm	Single-mode	35/34 dB	20/30 m
HP E4317A	1310 ± 15 nm	Single-mode	40 dB	30 m
HP E4318A	1550 ± 15 nm	Single-mode	39 dB	40 m
HP E4319A	1310/1550 ± 15 nm	Single-mode	40/39 dB	30/40 m
HP E4321A	1625 ± 15 nm	Single-mode	40 dB	30 m
HP E4324A	1310/1550 ± 15 nm	Single-mode	42/41 dB	20/30 m

Key Literature

HP 8147 Optical Time Domain Reflectometer, Technical Specifications
p/n 5964-1986E
HP 8147 Optical Time Domain Reflectometer, Configuration Guide
p/n 5964-1987E

Ordering Information

At least one user-exchangeable connector interface (HP 81000xI) is required for the module.

HP E4310A Optical time domain reflectometer mainframe
- **Opt 001** DC input: 11–30 V
- **Opt 002** Thermal printer
- **Opt 003** Color screen, VGA-LCD
- **Opt 004** HP-IB interface
- **Opt 005** LAN interface
- **Opt AB2** Chinese user interface

HP E4311A 1310 nm single-mode module (29 dB)
HP E4312A 1550 nm single-mode module (28 dB)
HP E4313A 1310/1550 nm single-mode module (29/28 dB)
HP E4314A 1310 nm single-mode module (35 dB)
HP E4315A 1550 nm single-mode module (34 dB)
HP E4316A 1310/1550 nm single-mode module(35/34 dB)
HP E4317A 1310 nm single-mode module (40 dB)
HP E4318A 1550 nm single-mode module (39 dB)
HP E4319A 1310/1550 nm single-mode module (40/39 dB)
HP E4321A 1625 nm single-mode module (40 dB)
HP E4324A 1310/1550 nm single-mode module (42/41 dB)
HP E6090A ODTR Toolkit Software

HP E6000A Mini-Optical Time Domain Reflectometer

The HP E6000A mini-OTDR maximizes your network uptime by locating and characterizing faults quickly and accurately. The unrivalled combination of 16,000 data points and a minimum sample spacing of 8 cm allows the powerful analysis algorithm to determine the exact location and characteristic of an event. Add to this the 20 m attenuation deadzone, and you really can measure and resolve closely-spaced events along the whole fiber link.

Its one button operation, combined with its intuitive user interface, makes it easy even for those with minimal training to quickly make advanced, reliable OTDR measurements.

Its high dynamic range of more than 40 dB not only gives you the possibility to look at long stretches of fiber, but also helps you increase the speed at which you can accurately determine a certain event.

The HP E6000A, however, goes beyond a mini-OTDR. Its fiber break locator mode looks exclusively for breaks, and these are then quickly displayed. The real-time mode gives you instant feedback on parameter changes you make, so that the optimal setup can be found quickly.

HP 8147
HP E6000A

Specifications

HP E6000A Mini-OTDR	Wavelength	Fiber Type	Dynamic Range	Attenuation Deadzone
HP E6001A	1310 ± 25 nm	Single-mode	28 dB	25 m
HP E6002A	1310 ± 25 nm	Single-mode	35 dB	20 m
HP E6003A	1310/1550 ± 25 nm	Single-mode	35/34 dB	20/25 m
HP E6004A	1310/1550 ± 25 nm	Single-mode	28/28 dB	20/25 m
HP E6008A	1310/1550 ± 25 nm	Single-mode	40/39 dB	20/25 m
HP E6010A	1625 ± 20 nm	Single-mode	37 dB	28m
HP E6005A	850/1300 ± 30 nm	Multimode	26/34 dB	10/10 m
HP E6009A	850/1300 ± 30 nm	Multimode	18/23 dB	10/10 m

Additional Modules

The HP E6000A mini-OTDR is not just a high performance OTDR for single-mode fiber networks. Additional modules and sub-modules enhance its capabilities, without adding any significant weight. The modules simply plug into the existing instrument, making the mini-OTDR the right tool for versatile, optical fiber test measurements.

Multimode Modules

These modules are designed to test all popular multimode fibers at both 850 nm and 1300 nm wavelengths. With an event deadzone of less than three meters, the HP E6005A multimode module offers a dynamic range of up to 34 dB.

Ultra High Performance 1625 nm Modules

The HP E6010A, HP E4321A and HP E6060A OTDR modules enable testing of Optical Supervisory Channel capability of WDM links and fast and accurate fiber testing at 1625 nm. Out of band testing also allows users to perform a fiber test while transmitting data at 1310 nm or 1550 nm.

Optical Power Meter Sub-Module

This high performance, miniature and extremely light (130 g) sub-module provides a measurement range of +10 dBm to –70 dBm with 5% accuracy, 0.01 dB resolution and automatic zeroing. The power meter can be used to perform end-to-end loss testing, characterize optical passive components and test transmitter power levels.

A simple user interface and a hold data function make this power meter easy-to-use. A reference power level can be stored at each wavelength for loss measurements when the source is not available. It can even detect various modulation frequencies used to identify the wavelength being sent by the source. Now it's possible to perform end-to-end loss testing without communicating with the other end of your link.

The power meter has high return loss and low polarization-dependent loss. This ensures accurate measurements, especially for high coherent laser sources, such as in Dense Wavelength Division Multiplexing (D-WDM) and CATV applications. It is fast, providing more than three updates each second. Its non-contact ferrule enhances reliability and facilitates cleaning in the field.

Visual Fault Finder Sub-Module

This visible light source helps you to identify bends, breaks and stress points along individual fibers at the patch panel. The bright red light allows you to locate these faults within the deadzone of an OTDR, and at distances of up to 5 km. The Visual Fault Finder can be used to identify fibers within a cable and also to check the quality of your patchcords and connections. The 1 Hz modulation causes the light to flash, making it easier to identify fibers and locate faults.

Optical Fiber Test Set–Everything in Your Hands

The mini-OTDR from Hewlett-Packard provides much more than just the fastest OTDR measurements; all the HP OTDR modules also act as powerful stabilized continuous wave (CW) light sources, and with the Optical Power Meter Sub-Module in place, you're able to perform loss and power measurements. Within half a minute, you can switch from locating a break with the Visual Fault Finder to checking the multimode LAN.

All the OTDR modules use HP connector interfaces, which are easy to clean, interchangeable and provide flexibility.

At less than 2.8 kg (6.2 lbs), the HP E6000A, with its rugged design, is ideal to be carried even into those inaccessible places. Containing the most advanced smart battery technology, you never need be caught without power. The battery delivers exact information on the charge status—with an accurate on-screen "fuel gauge". A full recharge takes less than 3 hours.

There's no need to switch instruments, for multimode or single-mode measurements; with the HP mini-OTDR, you have a complete optical fiber test set in one instrument.

Key Literature

Fiber Optic Test Solutions for Network Installation and Maintenance, Color Brochure, p/n 5965-1256E
HP E6000A Mini-Optical Time Domain Reflectometr, Technical Specifications, p/n 5965-1298E

For more information, visit our website:
http://www.hp.com/go/lightwave

Ordering Information

At least one user-exchangeable connector interface (HP 81000xI) is required for the module.

HP E6000A Mini-OTDR Mainframe
- **Opt 002** Hardcase
- **Opt 003** Color Display
- **Opt 004** Software Upgrade Kit
- **Opt 005** 20 MB Flashdisk Card
- **Opt AB1** Korean user interface
- **Opt AB0** Traditional Chinese user interface
- **Opt AB2** Simplified Chinese user interface
- **Opt AB8** Turkish user interface
- **Opt AB9** Portuguese user interface
- **Opt ABD** German user interface
- **Opt ABE** Spanish user interface
- **Opt ABF** French user interface
- **Opt ABJ** Japanese user interface
- **Opt ABZ** Italian user interface
- **Opt ABZ** Italian user interface
- **Opt ACB** Russian-Cyrillic user interface

HP E6001A 1310 nm single-mode module (economy) (28 dB)
- **Opt UK6** Calibration Report

HP E6002A 1310 nm single-mode module (high performance) (35 dB)
- **Opt UK6** Calibration Report

HP E6003A 1310/1550 nm single-mode module (high performance) (35/34 dB)
- **Opt UK6** Calibration Report
- **Opt 022** Angled Connector

HP E6004A 1310/1550 nm single-mode module (economy) (28/28 dB)
- **Opt UK6** Calibration Report
- **Opt 022** Angled Connector

HP E6005A 850/1300 nm multimode module (high performance) (26/34 dB)
- **Opt UK6** Calibration Report

HP E6006A Optical Power Meter Sub-Module
- **Opt UK6** Calibration Report

HP E6007A Visual Fault Finder Sub-Module

HP E6008A 1310/1550 nm ultra high performance single-mode module (40/39 dB)
- **Opt UK6** Calibration Report
- **Opt 022** Angled Connector

HP E6009A 850/1300 nm multimode module (economy) (18/23 dB)
- **Opt UK6** Calibration Report

HP E6010A 1625 nm ultra high performance single- mode module (37 dB)

HP E6090A OTDR Toolkit Software

HP 81000AI/FI/GI/HI/KI/SI/VI/WI Connector Interfaces

HP E597xA Handheld Fiber Optic Test Equipment
Please refer to Product Overview 5963-6656E.

HP E6053A
HP E6058A
HP E6060A
HP E6090A

- Low cost
- Easy integration into manufacturing, monitoring or test systems
- Software tools included for seamless use with existing systems
- Remote control via PC
- Automatically commission and monitor fiber links
- Software toolkit post-processes and analyzes Bellcore GR-196 files

HP E6053A, HP E6058A, HP E6060A Rack Optical Time Domain Reflectometer

Hewlett-Packard's new series of rack OTDRs cost about one-third the price of the large OTDRs used in most rack systems. They feature the high durability you would expect from an instrument based on the design of the HP E6000A mini-OTDR and are ideal for use in the fiber test procedures normally conducted by cable- or network-equipment manufacturers and telecommunications companies.

These rack OTDRs can be built into a system and controlled remotely with a PC for non-stop use. A range of included software tools is available for integration into existing environments. When used in conjunction with an optical switch and a PC, the HP rack OTDR can be used for commissioning and monitoring a fiber optic link automatically. The HP rack OTDR can also be used with a keyboard and VGA monitor as a standalone mini-OTDR.

Specifications

Rack OTDR	Wavelength	Fiber Type	Dynamic Range	Attenuation Deadzone
HP E6053A	1310/1550 ± 25 nm	Single-mode	35/34 dB	20/25 m
HP E6058A	1310/1550 ± 25 nm	Single-mode	40/39 dB	20/25 m
HP E6060A	1625 ± 20 nm	Single-mode	37 dB	28 m

Key Literature

Fiber Optic Test Solutions for Network Installation and Maintenance, Color Brochure, p/n 5965-1256E
HP E6053A, HP E6058A, HP E6060A Rack Optical Time Domain Reflectometer, Technical Specifications, p/n 5966-3115E

For more information, visit our web site:
http://www.hp.com/go/lightwave

Ordering Information

HP E6053A 1310/1550 nm single-mode module
Opt 002 HP connector interface for straight connectors
Opt 006 RS485 serial interface
Opt UK6 Commercial calibration certificate
HP E6058A 1310/1550 nm single-mode module
Opt 002 HP connector interface for straight connectors
Opt 006 RS485 serial interface
Opt UK6 Commercial calibration certificate
HP E6060A 1625 nm single-mode module
Opt 002 HP connector interface for straight connectors
Opt 006 RS485 serial interface
Opt UK6 Commercial calibration certificate
HP 81000AI/FI/GI/HI/KI/SI/VI/WI Connector Interfaces

HP E6090A OTDR Toolkit

The HP E6090A OTDR Toolkit is ideal for post-processing, analyzing and batch processing Bellcore GR-196 based OTDR files. Systems employing the HP E6090A software can transfer data serially to a PC running Windows 3.1, Windows 95 or Windows NT. The data can then be analyzed easily and saved for use in a spreadsheet or database. All HP OTDR and mini-OTDR test instruments can be remote-controlled from a PC running the HP E6090A software.

Other HP E6090A OTDR Toolkit features include:

- Analysis of splices, connectors and attenuations
- Comparison of up to four traces simultaneously
- Trace Manager, to enable high-speed multiple trace transfer between the OTDR and PC
- "Print Multiple Traces" capability to facilitate fast paper documentation
- "Process Multiple Traces" capability to allow templating of traces after measurement
- Two-way averaging for accurate loss calculations
- Subtract traces for easy trace comparison
- Comprehensive context-sensitive on-line help
- ASCII export for further spreadsheet processing
- "Copy to Clipboard" capability to enable quick and easy report generation

The OTDR Trace Viewer, the viewing companion based on the HP E6090A which displays Bellcore GR-196 trace data, can be downloaded free from our website: **http://www.hp.com/go/lightwave** (search "HP OTDR Trace Viewer")

Key Literature

OTDR Toolkit HP E6090A Photocard, p/n 5966-4760E

For more information, visit our web site:
http://www.hp.com/go/lightwave

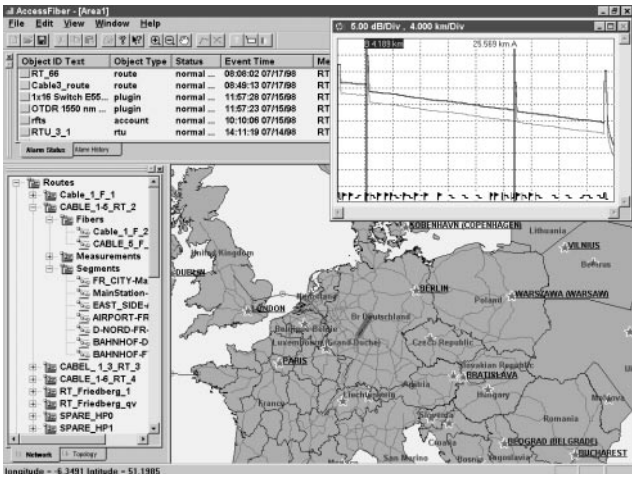
Ordering information

HP E6090A OTDR Toolkit

9

NEW

- Integrated Fault Management workflow
- GPS Coordinates-based Fiber Network Documentation
- Standards-complient (SNMP and TMN)
- Both dark and active fiber monitoring and testing.
- Easy access to centralized informaton from anywhere



AccessFiber

AccessFiber is a modular, distributed system that manages the planning, installation and maintenance of a fiber optic network through a single application using the network central database information. GPS coordinates are used to accurately model the fiber optic network and locate the outside plant equipment (OSP). Using the location information plus the comprehensive fiber optic network model, the system always presents the appropriate information about the network to the end user, whether the information is for planning, installation, maintenance or emergency purposes.

The system consists of processor, measurement and communication hardware, as well as operating and application software. The system can be tailored to suit all requirements and is designed to follow the growth of your network. Configuration options range from a single site standalone system up to a multiple remote site system.

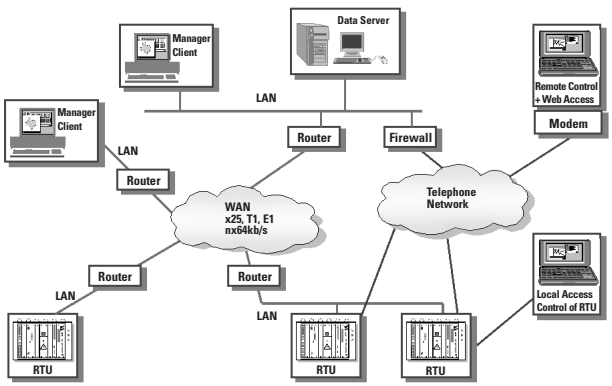
Effective alarm handling is granted by an intuitive graphical user interface that provides design and modeling of the alarm workflow exactly according to the end users needs. As an alternative, standard interfaces to tools that might already be in place are provided, thus the investment made is protected.

The system uses remote test units (RTUs) to perform and analyze OTDR measurements of optical fibers. An RTU consists of a cardcage that fits a central office rack and can be accessed via various networking options. OTDR modules are available for 1310 nm, 1550 nm and 1625 nm wavelengths with a choice of a 34 dB to 42 dB dynamic range, so the most appropriate price/performance option for a particular application can be selected. Switch modules from 1 x 4 to 1 x 96 can be integrated into the same cardcage. The OTDR modules support both dark and active fiber testing.

The signatures taken by the OTDR are compared with stored reference measurements to determine if any changes can be detected. This ongoing process of measurement and comparison produces a comprehensive view of the status of the optical fiber network. Significant changes or failures, as well as the exact geographic location of the problems are reported to the central manager. User-definable alarm thresholds ensure that any gradual deterioration of fiber performance is reported before a breakdown of service occurs. The system handles the alarm management workflow.

AccessFiber improves network quality as it checks fiber links automatically on a regular basis and supports the fiber network documentation process by providing access to all fiber-related information via one centralized repository. The system also takes advantage of open communication protocols and can be fully integrated into an SNMP Network Management, as well as a standardized Telecommunications Management Network (TMN) environment. AccessFiber is an element manager for the network element fiber and meets the requirements of standard ITU-T M.3010, based on the OSI model.

System Components and Interconnections



Specifications

Central wavelengths: 1310 nm, 1550 nm, 1625nm
Attenuation deadzone: 20 m to 30 m
Dynamic range: 28 dB to 42 dB
OTDR modules:

1310 nm/1550 nm	35/34 dB and 42/41 dB
1550 nm	34 dB and 41 dB
1625nm	40 dB

Switch modules: 4, 8, 16, 24, 32, 48, 72, 96 channels
Insertion loss: Typically 1 dB
Return loss: 40 dB
Cardcage: 9 slots
Controller: Pentium 166 or better
Power supply: -36 V to –60 V DC
Dimensions: 418 mm H x 426 mm W x 218 mm D
(16.5 in H x 16.8 in W x 8.6 in D)

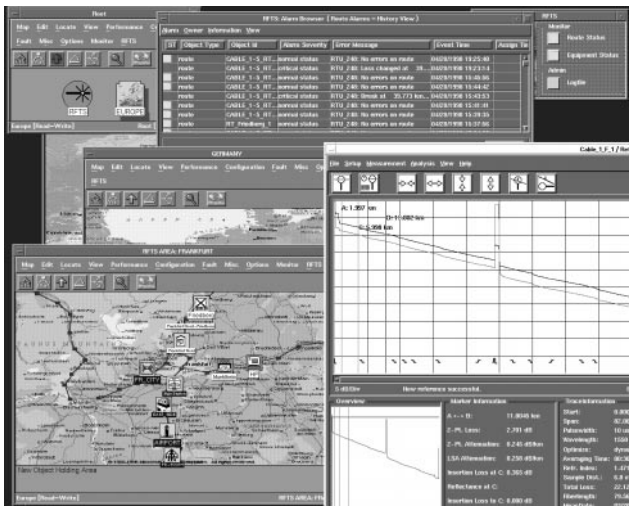
Key Literature

Color Brochure, p/n 5968-0065E
Technical Specifications, 5968-0067E

Ordering Information

Please contact the HP Call Center in your region for ordering information and prices.

- Automatic testing of fiber optic links
- Both dark and active fiber testing
- Centralized storing and evaluating of fiber information
- TMN-compliant OpenView-based system



HP 81700 Series 200 Remote Fiber Test and Management System

The HP 81700 Series 200 is a modular, distributed system that takes advantage of open communication protocols to integrate easily into telecom networks. The system consists of processor, measurement and communications hardware, along with the operating and application software. It can be tailored to suit all requirements, from a single site standalone system to a multiple remote site system which is fully integrated into a telecom network management strategy.

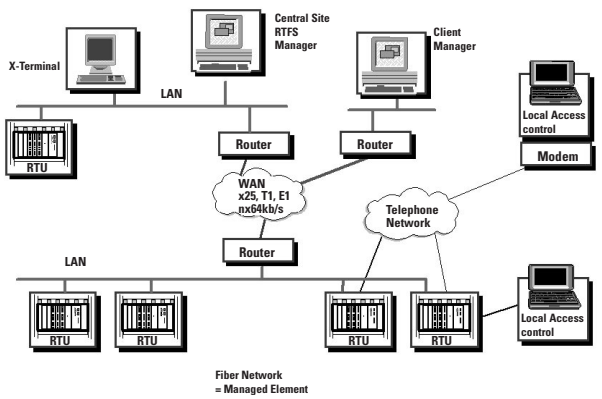
The system uses remote units to collect and analyze OTDR measurements of optical fibers. These signatures are then compared with stored reference measurements to determine if any changes can be detected. This ongoing process of measurement and comparison produces a comprehensive view of the status of the optical fiber network. Significant changes or failures are reported to the central manager. User-definable alarm thresholds ensure that any gradual deterioration of fiber performance is reported before a breakdown of service occurs.

The system RTU/OTAU hardware consists of a cardcage that fits a central office rack and provides various networking capabilities to access the remote measurement units. The measurement unit contains OTDR modules which are available for 1310 nm, 1550 nm and 1625 nm wavelengths. With a choice of a 34 dB to 42 dB dynamic range, the most appropriate price/performance option for a particular application can be selected. Switch modules from 1 x 4 to 1 x 96 can be integrated into the same cardcage. The OTDR modules support both “dark” and “active” fiber testing.

A “manager” takes command of the entire remote testing configuration and can interface with the operations support system of the network. The manager performs functions including trouble ticketing, fast alarming, geographic reference to events on the cable route, auto-configuring measurement hardware and storing network maps. The HP 81700 Series 200 RFTS clearly presents information for fiber management documentation. Customer-specific topology is stored for both monitored and non-monitored fibers throughout the whole cable network. The multi-user concept for the GUI provides access to fiber information and reference measurement setups from central sites to many different groups of users. The HP 81700 Series 200 can be fully integrated into a standardized Telecommunications Management Network environment and is an element manager for the network element “fiber”, which meets the requirements of standard ITU-T M.3010, based on the OSI model.

Remote fiber test systems improve network quality as they check fiber links automatically on a regular basis. Information is stored centrally, allowing link degradations to be identified and located quickly to minimize downtime.

System Components and Interconnections



Specifications

Central wavelengths: 1310 nm, 1550 nm, 1625 nm
Attenuation deadzone: 20 to 40 m
Dynamic range: 34 dB to 42 dB
OTDR modules:

1310/1550 nm	35/34 dB and 42/41 dB
1550 nm	34 dB and 41 dB
1625 nm	40 dB

Switch modules: 4, 8, 16, 24, 32, 48, 72, 96 channels
Insertion loss: Typically 1 dB
Return loss: 40 dB
Cardcage: 9 slots
Controller: Pentium 166 or better
Power supply: –36 V to –60 V dc
Dimensions: 418 mm H x 426 mm W x 218 mm D
(16.5 in H x 16.8 in W x 8.6 in D)

Key Literature

Brochure, p/n 5964-1822E
Technical Specifications, p/n 5965-1479E

Ordering Information

Please contact the HP Call Center in your region for ordering information and prices.

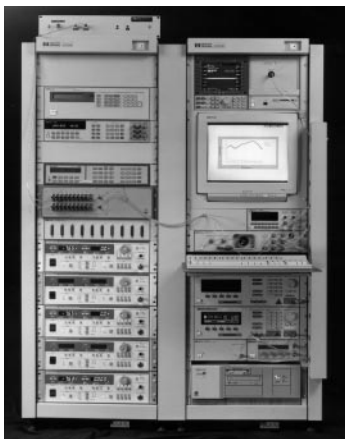
Lightwave Test System Solutions

Manufacturing Test Solutions

HP 83464A
HP 83465A
HP 86060 Series
HP 86037A

- Flexible solution platforms
- High accuracy
- Fast throughput
- Custom capabilities

Passive Component Test System



EDFA Test System

Chromatic Dispersion Measurement System

Hewlett-Packard leverages its expertise in lightwave instrumentation, and insight into relevant measurement issues, to provide measurement solutions that extend beyond the capabilities of individual instruments. These solutions are used to quickly and accurately characterize the components and subsystems needed for lightwave transmission systems.

Available systems include:

- Passive optical component test (including DWDMs)
- Erbium-doped fiber amplifier test
- Chromatic dispersion test

HP 83464A DWDM and Passive Optical Component Test System

The HP 83464A dense wavelength division multiplexer (DWDM) measurement system is specifically designed for use in the manufacturing and development of these devices, providing accurate characterizations of key parameters such as center wavelength, bandwidth, insertion loss and crosstalk, as well as polarization dependence of several parameters.

The system features up to 8 input and 64 output device ports per measurement setup and automatic wavelength calibration. Multiple DUT Setup allows for hours of unattended testing. High acccuracy (wavelength to ± 10 picometers) is combined with uncompromised measurement throughput (1 to 6 minutes per channel, dependent upon test parameter choices). Dual modes (operator and supervisor) of operation ensure the right level of software access for the user. There are 2 standard configurations: E10 includes an HP 8168F tunable laser; E11 deletes the laser (System specifications require the presence of an HP 8168E or 8168F tunable laser).

HP 83465A Erbium-Doped Fiber Amplifier (EDFA) Test System

HP's EDFA test systems utilize different measurement techniques, including time-domain extinction ratio and polarization nulling, to meet the varied needs and customer-specific requirements of EDFA testing.

An in-depth knowledge of EDFA testing is leveraged and provided through an array of EDFA test solutions and capabilities. HP's EDFA platforms can be expanded into highly-efficient production systems that meet your manufacturing needs.

HP 86037A Chromatic Dispersion (CD) Test System

HP's chromatic dispersion test systems are based upon the modulation phase-shift/delay measurement technique that has been demonstrated to be the preferred solution in system, sub-system, and component test applications. The CD systems provide the utmost in accuracy and flexibility for testing fiber, gratings, and dispersion compensating devices. Use the HP 86037A to measure chromatic dispersion, group delay, length, and gain versus wavelength at 1300 or 1550 nm. New features on the system include a migration to Windows NT, a remote file interface and a gratings specific menu.

Custom System Capabilities

Hewlett-Packard is committed to meeting customer needs by providing measurement solutions suited for specific requirements. These systems can range from the simple to the very complex. In addition, Hewlett-Packard offers a wide variety of services including consultation, design, manufacturing, installation, and support. Please contact your local HP Call Center to discuss how HP might best be able to address your needs. See page 74 for an overview of HP's Custom System Capabilities.

HP 86060 Series of Lightwave Switches

The HP 86060 series of programmable lightwave switches cover a broad range of switching capacity and provide easy signal routing for accurate and repeatable measurement automation. These switches provide an important building block for implementing automated test systems.

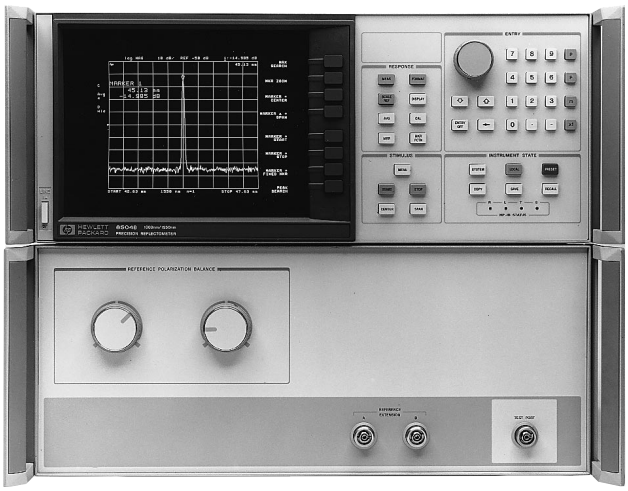
HP's switch family features an easy-to-use manual interface and a visual signal routing display. These switches can be easily integrated into automated test systems using SCPI-compatible commands via HP-IB or RS-232 interfaces.

For more complete information order the Lightwave Test and Measurement catalog. See detailed description on page 621.

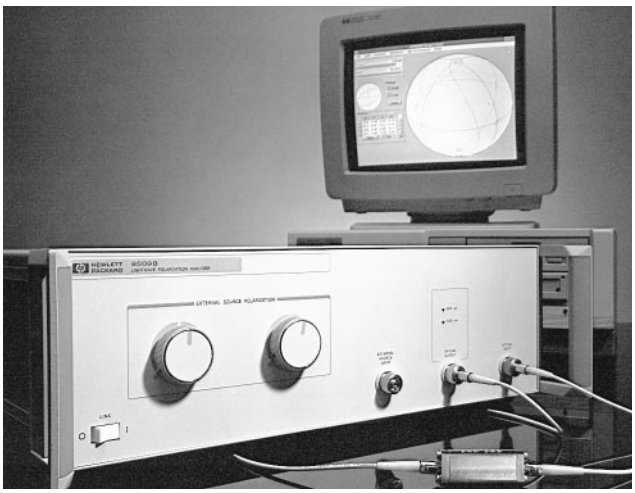
HP 8504B
HP 8509B

- Return loss measurement range beyond 80 dB
- 25 μm two-event resolution (in air, 16 μm in glass)
- 1300 and 1550 nm wavelengths
- 1 mm to 400 mm scan widths

- Two automated polarization-mode dispersion (PMD) measurements; Jones matrix eigenanalysis and swept wavelength
- Calibrated, real-time measurements of state and degree of polarization
- Fast, automatic measurements of polarization-dependent loss in optical components



HP 8504B



HP 8509B

HP 8504B Precision Reflectometer

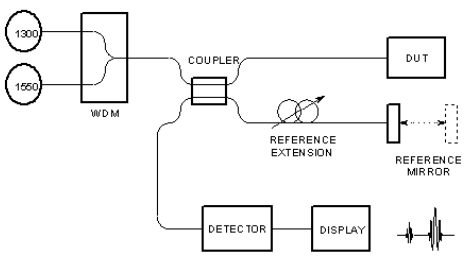
The HP 8504B precision reflectometer provides state-of-the-art lightwave reflection measurements. Individual reflections are measured and displayed as a function of distance or position. Return loss measurements beyond 80 dB are achievable, even when larger reflections are present in the measurement path. Two reflections can be closer than 25 μm (equivalent distance in air) and still be individually identified. Engineers and scientists now have a tool to precisely locate, identify, and quantify individual reflections within lightwave components and assemblies. Designs are optimized easily in the development phase. In product manufacturing, problems are solved quickly as even very small faults and discontinuities are found easily. Calibrated measurements are performed in seconds using a simple user interface and a rapid scan rate.

The HP 8504B precision reflectometer measures connectorized components in single-mode fiber. (Performance is good, but not optimum in multimode fiber.) The measurement span can be varied from 1 mm to 40 cm. The location of the 40 cm measurement window can be offset by adding the appropriate length of extension cable. Measurements are made using internal 1300 nm and 1550 nm light sources.

The HP 8504B can also be an important tool in preventing and solving component failure modes. Determining the precise location of a crack or break in a small optical assembly is easily achieved.

In addition to measuring reflections, there are also a variety of other applications including source coherence functions, precision length measurements, and characterization of the effects of birefringence (including polarization mode dispersion and fiber beat length).

Block diagram of HP 8504B



For more complete information, order the Lightwave Test and Measurement Catalog. See detailed description on page 622.

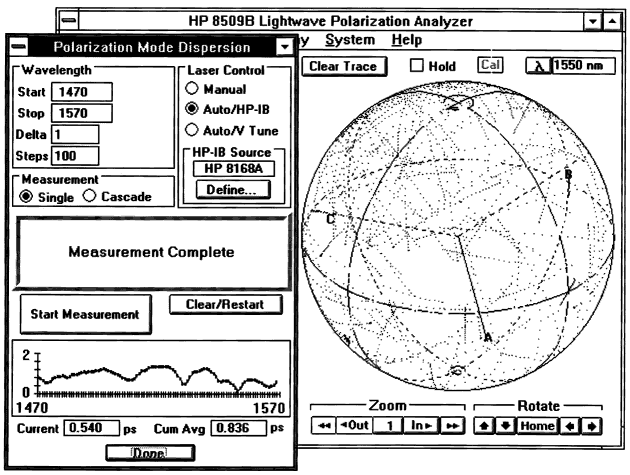
HP 8509B Lightwave Polarization Analyzer

The HP 8509B lightwave polarization analyzer system offers calibrated polarization measurements of optical signals and components. These capabilities are provided by innovations in hardware, software, and mathematics.

Hardware contributions include a four-diode detection scheme covering 1200 nm to 1600 nm. Single-wavelength, 1300 and 1550 nm Fabry-Perot lasers, and an automatic three-state polarization generator are provided within the HP 8509B. External single-wavelength or swept-wavelength sources can also be used.

System software delivers an easy-to-understand data display of simultaneous, numeric and graphic formats featuring average power, degree of polarization, Poincare sphere, polarization ellipse, Jones matrix, Stokes parameters, and polarization-maintaining fiber launch conditions.

Mathematical innovation in Jones matrix analysis automate and simplify the measurements of polarization mode dispersion, polarization dependent loss, and polarization reference frames.

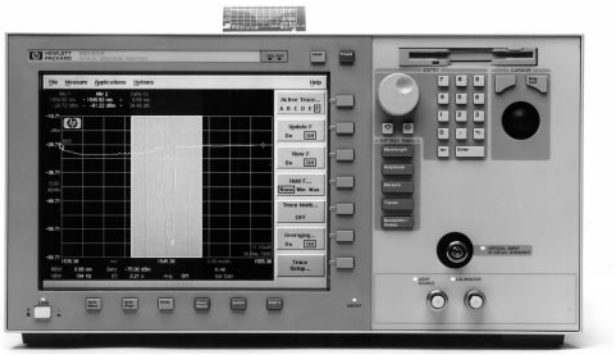


A polarization-mode dispersion graph is generated automatically as the system computer conducts the measurement.

HP 86140A
HP 86142A
HP 86143A
HP 86145A
HP 83437A
HP 83438A

NEW

- Benchtop and portable platforms
- Intuitive graphic user interface
- Excellent wavelength accuracy and low polarization dependency
- 90 dBm sensitivity and 70 dB dynamic range
- Integral floppy disk and printer
- Real time sweep rates and high-speed data transfer
- Built-in applications
- Two-year calibration cycle
- Optional internal EELED and wavelength calibrator
- VGA and parallel (Centronics) interface



HP 86140A

HP 86140A, 86142A, 86143A, 86145A Optical Spectrum Analyzers

NEW HP-IB

The HP 86140A, 86142A, 86143A and 86145A are a family of grating-based optical spectrum analyzers that display the amplitude of light versus wavelength over a 600 to 1700 nm wavelength range. The OSA uses a double-pass monochromator design to simultaneously achieve high sensitivity and dynamic range with a fast sweep time. This is key for characterizing DWDM components and multiple channel systems, especially in a manufacturing environment where speed, accuracy and throughput are critical.

The family consists of both benchtop HP 86140/42 and portable HP 86143/45 units that have integral printers and floppy disk drives to allow instant documentation of results and transfer electronic copies to a PC. A VGA port allows a PC monitor to be hooked up directly to the OSA screen, and a parallel (Centronics) interface enables clear color copies of measurement results to be generated. The HP-IB interface provides exceptional transfer speeds across the bus which are critical in a high throughput environment. The uncluttered front panel has been designed to compliment the intuitive graphical user interface (GUI) that has been significantly enhanced over the previous generation HP 71450B series optical spectrum analyzers. The interface can be driven either from the front panel or using an external pointing device.

High Performance

The benchtop HP 86142A and portable HP 86145A analyzers are top of the range high performance units ideally suited to applications where power and wavelength accuracy, dynamic range and low polarization dependency are critical. In these units, many of the OSA high performance parameters have been optimized to cover the EDFA extended wavelength bands (1520 nm to 1620 nm). This extended WDM wavelength range also makes these OSAs ideal for testing WDM passive components (filters, multiplexers and Bragg Gratings), characterizing DWDM transmitter lasers and analyzing DWDM multi-channel system performance.

High Flexibility

The HP 86140A benchtop and HP 86143A portable optical spectrum analyzers maintain much of the high performance of the HP 71450 series, at the same time being ideal for budget sensitive applications.

Built-in Applications

HP has introduced a new user-specific approach for the internal suite of OSA applications. These allow the user to drive the OSA from a device rather than an optical spectrum analyzer perspective. In particular, the passive component test (PCT) application allows the user to enter a specification table using a spreadsheet template. This uses device specific parameters such as bandwidth, ripple and mean wavelength to create a test sequence with pass/fail limits that can be loaded into the OSA.

HP 86143A

The manufacturing mode enables simple key step guided measurement of the device. When the testing is complete, a summary report is generated either from the internal printer or in color using a printer attached to the parallel interface.

New Features

The new OSA family has many new features and enhanced capabilities including wavelength limit lines for localized trace searches, sweeps and power integration. A compliment of four independent markers allow easy measurement of wavelength separation (GHz or nm), power density and optical signal-to-noise ratio.

Benchtop Platform

The benchtop OSA has a large, bright 10.4" active matrix color LCD display and a reduced 42 cm x43 cm (16.7"x 16.8") footprint. This OSA is ideal for R&D and manufacturing environments, where display clarity and ease of use are important.

Portable Platform

The high performance portable platform has a small 32.5 cm x43cm (12.8"x16.8") footprint and weighs in at 32 lb. This is designed for applications where space is at a premium and yet full optical spectrum analyzer capability (not offered by today's mini OSAs) is required. This makes the OSA ideal for both field and factory use, particularly in high level system installations or situations where bench space is limited. The portable unit has a high clarity 6.4" active matrix LCD display.

	Benchtop OSA	Portable OSA
High Performance	HP 86142A	HP 86145A
General Purpose	HP 86140A	HP 86143A
Options		
004	1300 nm/1550 nm EELED	
005	1550 nm EELED	
006	Wavelength Calibrator	Wavelength Calibrator

HP 83437A Broadband Light Source
HP 83438A Erbium ASE Source

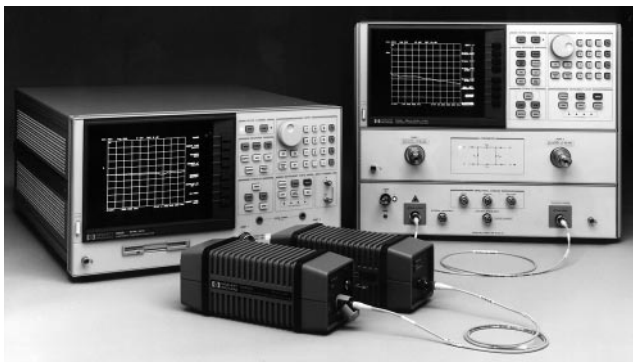
In conjunction with an OSA, the incoherent light sources HP 83437A and 83438A allow you to measure insertion loss, crosstalk, bandwidth, polarization dependencies, and other parameters of passive optical components versus wavelength.

Built to order, the HP 83437A can incorporate up to four edge-emitting LEDs (EELEDs), with five available wavelengths (1200 nm/–17 dBm, 1310 nm/–13 dBm, 1430 nm/–13 dBm, 1550 nm/–13 dBm, 1650 nm/–17 dBm). The peak power density of each EELED in a single-mode fiber is more than 25 dB stronger than that of a white light source. It is also the ideal noise source for the NGP technique mentioned above.

The HP 83438A provides more than +6 dBm in the 1550 nm window, allowing you to characterize advanced components such as isolators, circulators, add/drop multiplexers, gratings, or demultiplexers for dense wavelength-division multiplexing (DWDM) systems.

For more complete information, order the Lightwave Test and Measurement Catalog. See detailed description on page 622.

- 300 kHz to 20 GHz modulation frequency
- 850, 1300 or 1550 nm operation
- Calibrated frequency response measurements of high-speed optical, electro-optical, and electrical components
- RIN measurements to –165 dB/Hz
- Interferometer for laser linewidth and chirp measurements



HP 8702D and 8703A

Lightwave Component Analyzers

The HP 8702D and 8703A precisely characterize the swept modulation frequency response of wide bandwidth fiber optic system elements such as lasers, LEDs, photodiodes, and electro-optical modulators. Both the HP 8702D and 8703A operate at a fixed wavelength and sweep the frequency of the intensity modulation signal over the bandwidth you select.

The HP 8702D has 1300 and 1550 nm lightwave sources and receivers as well as an 850 nm receiver. The 8703A can operate at 1300 and 1550 nm. These sources and receivers are characterized to allow calibrated measurements of electro-optical test devices.

When used to measure linear electrical components, such as filters, amplifiers, and transmission lines, the lightwave component analyzers have the full measurement capability of a microwave network analyzer. Typical measurements are bandwidth, insertion loss/gain, phase, impedance, match, and group delay.

HP 8702D Lightwave Component Analyzer

HP-IB

300 kHz–3 GHz (850 nm) 300 kHz–6 GHz (1300, 1550 nm)

The HP 8702D offers several significant improvements in versatility, performance and productivity. A few of these are:

- improved optical calibration accuracy
- built-in 3.5-inch floppy disk drive with LIF/DOS formats
- integrated S-parameter test set
- serial and parallel printer interfaces
- test sequencing for automated measurements
- faster CPU and increased non-volatile memory

HP 8703A Lightwave Component Analyzer

HP-IB

130 MHz–20 GHz (1300 and 1550 nm)

The standard configuration includes one 1300/1550 nm receiver and one lightwave directional coupler. An optional 1300 or 1550 nm DFB internal laser source must be specified. The external lightwave source input (Option 100) can be used for additional wavelength flexibility. Lasers with center wavelength between 1530 and 1570 nm can be used with HP 8703A Option 210 (1550 nm). Lasers with center wavelength between 1290 and 1330 nm can be used with HP 8703A Option 220 (1300 nm).

HP 71400C with HP 70810B

HP 71400C and 71401C Lightwave Signal Analyzers

HP-IB

Calibrated Measurement of Intensity Modulation to 22 GHz

The HP 71400C combines a high-performance microwave spectrum analyzer with a wideband, sensitive optical receiver. This system measures modulated light on single-mode optical fibers from 100 kHz to 22 GHz. Optical modulation, noise, and average power are presented on a fully-calibrated display.

With the HP 11980A fiber-optic interferometer, the analyzer can also measure linewidth. With an interferometer and a gated source, the analyzer can measure chirp and FM characteristics of distributed-feedback (DFB) and other single-line lasers.

This system is also a fully-functional microwave spectrum analyzer with all the capability of the HP 71210C. Because the lightwave signal analyzer is part of the HP 70000 modular measurement system, its measurement capabilities can be expanded easily. For example, you can add a tracking generator module for modulation response measurements to 18 GHz, or an optical spectrum analyzer for wavelength analysis.

The HP 71400C measures intensity modulation up to 22 GHz and operates over wavelengths from 1200 to 1600 nm or, with Option 850, from 750 to 870 nm. It can achieve an optical sensitivity of better than –60 dBm. The analyzer also offers average-power measurement, displayed both as a real-time vertical power bar and as a digital readout. Full calibration of both average power and modulation power makes this system a reference receiver for measuring and characterizing optical detectors and receivers.

A program for relative intensity noise (RIN) measurement is included. This program subtracts thermal noise and shot noise components of the measurement and calculates to –165 dB/Hz.

The HP 71401C has an upper frequency limit of 2.9 GHz but the same functions and features as the HP 71400C. Both models provide lightwave optical or electrical units in watts or decibels, and microwave units for electrical spectrum analysis.

HP 70810B Lightwave Receiver Module

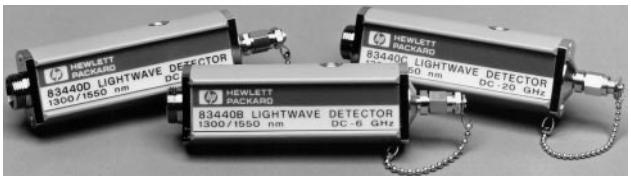
The HP 70810B lightwave section is a one-slot lightwave receiver module for the HP 70000 modular measurement system. The module has a built-in average power meter and attenuator, a wavelength range of 1200 to 1600 nm (750 to 870 with Option 850), a detected modulation bandwidth of 100 kHz to 22 GHz, and a built-in, 32 dB RF amplifier that gives an optical sensitivity of –60 dBm in a 10 Hz bandwidth. It can be used in standalone applications as a lightwave receiver housed in an HP 70000 mainframe. In this configuration, the electrical output is the detected intensity modulation in its amplified and uncorrected state.

For more complete information, order the Lightwave Test and Measurement Catalog. See detailed description on page 621.

High-Speed DC-Coupled Lightwave Converters and Lightwave Clock/Data Receivers

HP 11982A
HP 83440B
HP 83440C
HP 83440D
HP 83446A
HP 83446B

- DC-coupled optical-to-electrical converters
- Bandwidths from dc to 30 GHz
- Fast-pulse response
- Optical receiver for BERT or oscilloscope
- Clock and data recovery at 2488 or 622 Mb/s
- High sensitivity



HP 83440 Series

HP 11982A

HP 83446B

DC-Coupled Optical Converters

Optical communication systems that incorporate time-domain instruments often require optical-to-electrical (O/E) converters in order to make optical pulse and eye-diagram measurements. Whether to use an unamplified or an amplified O/E converter depends on the measurement application. If signal power levels are high enough, a simple photodiode-only converter such as the HP 83440 offers well-behaved pulse response performance. To measure low power signals, an RF-amplified O/E converter such as the HP 11982A may be required.

In frequency-domain applications, O/E converters allow frequency-domain instruments such as network and spectrum analyzers to accept optical signals for basic lightwave measurements. Users can measure, quantify, and model modulation characteristics such as spectral purity, harmonic content, and noise spectral density.

HP 83440 Series Unamplified Lightwave Converters

The HP 83440 series offers a variety of bandwidth options for converting incoming modulated optical power or optical pulses into electrical current. Ideal for optical pulse parameter measurements, these fully-integrated hermetic InGaAs photodetectors feature very low noise and pulse aberrations, fast, accurate O/E conversion, and a standard user-interface compatible with most electrical instruments. The converters mount directly on test-instrument front panels. Simple internal structure ensures low-signal distortion for improved output-signal fidelity, a novel optical launch ensures low optical reflection, and integral dc-bias regulation ensures stable frequency response performance.

The HP 83440 series can be used with high-speed digitizing oscilloscopes to accurately measure rise and fall time, overshoot, undershoot, ringing, peak power (pulse amplitude), pulse width, amplitude noise, and extinction ratio. The HP 83440 series also makes excellent mask measurements when sufficient optical power is available.

The HP 83440B Option 050 provides 50 Ω output required for use with external SDH Bessel-Thomson filters such as the HP 87441 family.

When using the HP 83440 with an ac-coupled instrument (except Option 050), a bias tee such as the HP 11612A or, alternatively, a 3 dB fixed attenuator on the output is required to provide a dc-bias return path.

HP 11982A Amplified Wide Bandwidth Lightwave Converter

A wide-bandwidth, sensitive O/E converter for characterizing lightwave systems and components, the HP 11982A combines a PIN photodetector with a low-noise dc-coupled preamplifier to create a general-purpose front end. It covers wavelengths from 1200 to 1600 nm and bandwidths from dc to 15 GHz. With 300 V/W conversion gain and 0.05 percent input optical reflections, it significantly improves the sensitivity of the measurement system. The converter comes with a calibration chart of instrument-specific data for making corrected frequency-response measurements.

Combine the HP 11982A with an HP 83480 series digital communications analyzer to make optical eye-pattern and impulse-response measurements. Use the results to verify optical and optoelectronic components and optical system level performance.

The HP 11982A can be used with an electrical spectrum analyzer to display optical modulation power as a function of frequency. Intensity modulation, distortion, and laser intensity noise are also measured. The Option 001 memory card programs an HP 8590 E series spectrum analyzer with frequency-response corrections, and menus for easy, accurate lightwave measurements to 22 GHz. Using this converter with the HP 11980A interferometer, you can measure linewidth (with a gateable modulation source), chirp, and frequency modulation of single-line lasers.

HP 83446A/B Lightwave Clock/Data Receivers

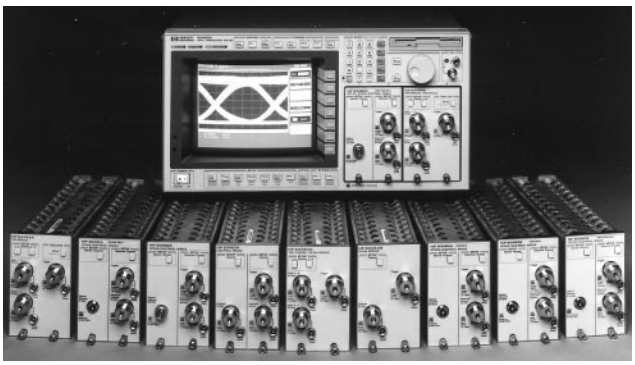
The HP 83446A/B lightwave clock/data receivers are used to extract clock and data signals from SDH/SONET optical signals operating at 2488 Mb/s (STM-16/OC-48) or 622 Mb/s (STM-4/OC-12) rates, respectively. The HP 83446A/B operate over the full range of power levels specified in SDH/SONET standards (–27 dBm sensitivity) at both 1300 nm and 1550 nm wavelengths, using multimode or single-mode fiber. Designed for use with high-speed BERTs such as the HP 71603B bit-error rate tester, BER testing can now be performed directly on optical signals. A third port routes the high-gain avalanche photodiode output to the front panel, previous to clock/data regeneration for analysis of the optical waveform. An electrical input allows clock and data recovery from a 2488 Mb/s (83446A) or 622 Mb/s (83446B) electrical signal.

For more complete information, order the Lightwave Test and Measurement Catalog. See detailed description on page 622.

HP 11898A
HP 83480A
HP 83481A
HP 83482A
HP 83483A
HP 83484A
HP 83485A
HP 83485B
HP 83486A
HP 83487A

- Automated mask and template measurements
- Integrated optical channels for accuracy and ease of use
- High-measurement throughput
- Filtered measurements for compliance test or full bandwidth for waveform analysis
- Fast statistical waveform analysis
- Wide range of standard telecom and datacom masks and templates

HP 83480A



HP 83480A with plug-in modules

HP 83480A Digital Communications Analyzer

The HP 83480A represents a significant advancement in the instrumentation used to view waveforms in high-speed digital communications. Industry-standard tests including mask and template tests as well as eye-diagram analysis including extinction ratio are made using easy-to-use, built-in measurements. For measuring optical signals, lightwave receivers are integrated into the instruments to provide highest accuracy and waveform fidelity.

With up to 50 GHz of bandwidth, the HP 83480A can be used on low-rate tributary signals through 10 Gb/s optical waveforms.

Industry Standard Masks and Templates

Achieve high-throughput waveform testing with both optical and electrical masks and templates including SDH, SONET, Gigabit Ethernet, and Fibre Channel standards. For guardband testing, use mask margins. Custom/user-defined masks can also be generated. Masks are automatically aligned and scaled.

Integrated Optical Receivers

The HP 83480A is a modular platform with a family of optical receivers with very high-speed internal photodiodes (2.5 GHz, 20 GHz, or 30 GHz bandwidths). For filtered measurements, filters are switched in with a simple keystroke to produce a calibrated reference receiver, or switched out for full bandwidth waveform analysis.

The HP 83480A can accept one or two plug-in modules for up to four measurement channels. Modules have two electrical channels or one optical channel and one electrical channel. The following optical/electrical plug-ins have 9/125 μm single-mode optical interfaces for 1310 and 1550 nm applications. The HP 83481A has a 20 GHz electrical channel and a 2.5 GHz optical channel with 155 and 622 Mb/s switchable filters. The HP 83482A provides a 40 GHz electrical channel and a 30 GHz optical channel. The HP 83485A provides a 20 GHz electrical channel and a 20 GHz optical channel with a 622 or 2488 Mb/s switchable filter. The HP 83485B provides a 40 GHz electrical channel and a 10 Gb/s filtered channel.

Two optical/electrical plug-ins have 62.5/125 μm optical interfaces for both single-mode and multimode measurement applications. For 1310 and 1550 nm applications, the HP 83486A has a 2.5 GHz optical channel with 155 and 622 Mb/s switchable filters for SDH/SONET/ATM applications or 1063 and 1250 Mb/s switchable filters for Fibre Channel and Gigabit Ethernet. For 850 nm applications, the HP 83487A has a 2.5 GHz optical channel with 1063 and 1250 Mb/s switchable filters (Fibre Channel and Gigabet Ethernet). Both modules also have a 20 GHz electrical channel.

Accurate Eye-Diagram Analysis

Integrated optical receivers are the key to accurate eye-diagram analysis of lightwave signals. Internal photodiodes have well-behaved frequency responses which are not degraded by external cabling and adapters. This yields the highest in waveform fidelity and measurement accuracy. Extinction-ratio measurements are accurate and repeatable.

General-Purpose Oscilloscopes

In addition to digital communications analysis, the HP 83480A can be used as a general-purpose, high-speed, sampling oscilloscope. The HP 83483A electrical plug-in provides two 20 GHz electrical channels, the HP 83484A has two 50 GHz electrical channels. Add TDR capability to the HP 83480A with the HP 54755A software and TDR module HP 54753A or HP 54754A (see page 127). The HP 11898A module extender provides a 1.5 meter extension cable for placing the electrical module adjacent to the high-speed circuit-under-test.

For more complete information, order the Lightwave Test and Measurement catalog. See detailed description on page 622.

9

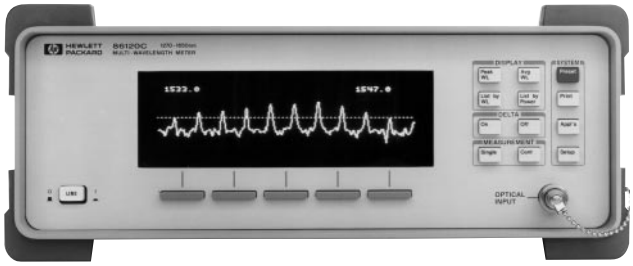
Optical Wavelength Meter

Multi-Wavelength Meter and Lightwave Catalog

HP 86120C

NEW

- Characterize WDM spectra during installation and maintenance
- Simultaneously measure up to 100 wavelengths and powers
- Characterize Fabry-Perot lasers using the built-in automated measurement routine
- ±2 ppm wavelength accuracy
- 10 GHz wavelength resolution
- Signal-to-noise ratio measurements



HP 86120C

HP 86120C Multi-Wavelength Meter NEW

The HP 86120C multi-wavelength meter, like other Michelson interferometer-based wavelength meters, allows you to measure the average wavelength of the input signal. In addition, the HP multi-wavelength meter—with advanced digital signal processing—accurately and easily differentiates and measures up to 100 discrete wavelengths. Unlike other optical wavelength meters, the HP 86120C can simultaneously measure the individual powers of the discrete wavelengths, offering the following measurement capabilities:

- 1 to 100 wavelengths and powers
- Average wavelength and total power
- 2 ppm wavelength accuracy (0.003 nm at 1550 nm)
- 10 GHz wavelength resolution
- Calibrated for elevation in air or vacuum
- Wavelength units in nm, Thz, or wave number (cm-1)
- Amplitude units in dBm, mW, or μW
- SNR and averaged SNR for WDM SONET/SDH systems
- Rugged design to withstand even strong shocks and vibration

Laser Manufacture and Test

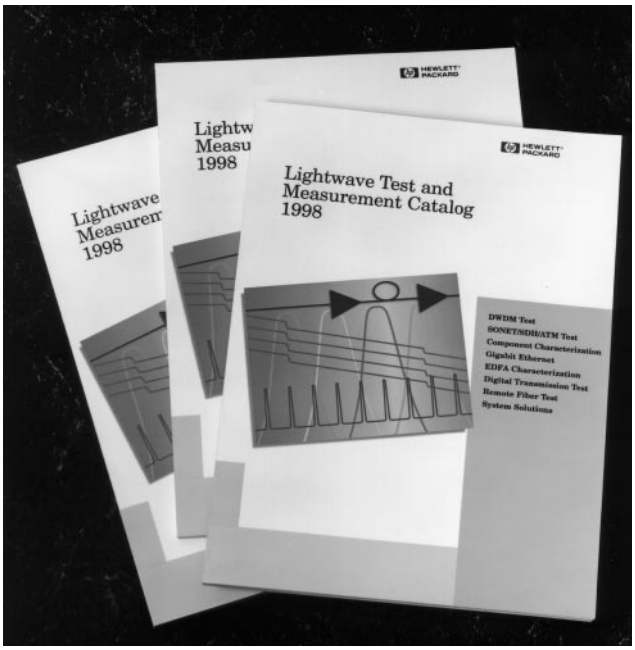
The superior wavelength and amplitude measurement capabilities of the HP 86120C multi-wavelength meter enable you to maximize the performance of your components in the factory. You can measure DFB, FP, and multiple DFB-laser wavelengths and amplitudes during burn-in, environmental evaluation, final test, and incoming inspection.

Transmission Systems

Combining measurement performance with a rugged and portable package, the multi-wavelength meter lets you easily and accurately verify the optical carrier performance of transmission systems by measuring wavelength, power, and signal-to-noise ratios during design, installation, monitoring, and maintenance.

WDM Systems and Components

With the HP 86120C, you can simultaneously resolve the individual optical carriers and accurately confirm wavelengths, powers, channel spacing, drift, and signal-to-noise ratios in WDM components and systems both in the lab and in the field.



Lightwave Test and Measurement Catalog

The *Lightwave Test and Measurement Catalog* has information and specifications on HP's full line of lightwave test equipment and accessories. Measurement tutorials in the catalog cover:

- Standards, Calibration, and Traceability
- Fiber-Optic Connectors–The Right Choice and Care
- Power Measurements
- Wavelength Measurements
- Spectral Measurements
- Optical Amplifier Testing
- Testing DWDM Components
- Polarization Measurements
- Return Loss Measurements
- Frequency-Domain Measurements
- Communications Waveform Measurements
- Error Performance and SONET/SDH Analysis
- Field Service and Installation
- Common Opto-Electronic Signal Relationships

A product matrix, at the front of the catalog, helps you find the Hewlett-Packard instrument to meet your lightwave measurement needs.

To receive your free copy, complete and return the business reply card at the end of this catalog or call your local HP sales office and ask for literature number 5966-0366. Visit HP on the World Wide Web: **http://www.hp.com/go/tmcatalogs**, and order a copy.

Overview

Lightwave Test & Measurement Catalog
5966-0366E/EUS

Optical Component Test

EDFA HP 81600 Series 200 Are You Certain of Your Measurements?
5091-7728E
EDFA Testing—Problems and Solutions
5963-2273E
HP E5574A Optical Loss Analyzer Sources Configuration Guide
5963-6886E
Brochure
5963-6889E
Technical Specifications
5964-1524E
PDL Measurements Using the HP 8169A Polarization Controller.
5964-9937E
HP 8153A Modular System for Optical Power Loss and Return-Loss Measurements Brochure
5963-7132E
HP 8153A Technical Data Sheet
5962-9321E
HP 8156A Optical Attenuator Brochure
5091-7758E
HP 8156A Optical Attenuator Configuration Guide
5963-3367E
HP 8156A Optical Attenuator Technical Data Sheet
5962-8631E
Lightwave Test & Measurement Catalog
5966-0366E/EUS

(PN 8167B) Tunable Laser Source HP 8167B, HP 8168D, HP 8168E, HP 8168F
5964-9542E
(PN 8168E/F) HP 8168E and HP 8168F Tunable Laser Sources
5965-5877E
(PN 11896-2) Polarization-dependent Loss Measurements Using Modular Test System Configurations
5965-5720E
(PN 81534A) Measuring the Return Loss of Fiber Optic Components–HP 81534A Return Loss Module
5091-2639E

Field Installation & Maintenance

Power Meter Sub-module HP E6007A and Visual Fault Finder Sub-module HP E6007A, Photo Card
5966-0022E
Multimode OTDR Modules HP E6005A, HP E6009A, Photo Card
5966-0023E
HP E4324A Ultra High Performance OTDR Module
Photocard
5966-1453E
HP E6008A Ultra High Performance OTDR Module
Photocard
5966-0021E
HP E6053A, HP E6058A, HP E6060A Rack OTDR
Photocard
5966-4227E
HP ODTR Family Accessories
Photocard
E5966-4878E
HP E6090A OTDR Toolkit
Photocard
5966-4760E
HP E6010A, HP E4321A Ultra High Performance 1625 nm OTDR Modules
Photocard
5966-4877E

Lightwave Test System Solutions

HP 86060 Series of Lightwave Switches Product Overview
5967-59002E
HP 83464A DWDM Measurement System Product Overview
5966-3758E
HP 86037A Chromatic Dispersion Test System Product Overview
5967-6202E
Lightwave Test & Measurement Catalog
5966-0366E/EUS

Precision Reflectometers & Polarization Analyzers

Lightwave Test & Measurement Catalog
5966-0366E/EUS
HP 8504B Lightwave Component Return Loss Measurements Brochure
5963-6730E
HP 8509B Lightwave Polarization Analyzer Product Overview
5966-1557E

(PN 8504-1) Measurements of Lightwave Component Reflections with the HP 8504B Precision Reflectometer
5963-7191E
(PN 8509-1) Polarization Measurements of Signals and Components
5091-2879E

Spectrum, Component & Signal Analyzers

Lightwave Test & Measurement Catalog
5966-0366E/EUS
HP 11982A Amplified Lightwave Converter Product Overview
5966-1583E
HP 70880A, 71400C, 71401C LW Personality Data Sheet
5091-5541E
HP 71400C, 71401C, 70810B LW Signal Analyzers Data Sheet
5091-7030E
HP 8702D LW Component Analyzer Brochure
5965-5624E
HP 8702D LW Component Analyzer Configuration Guide
5965-6403E
HP 8702D LW Component Analyzer System Technical Specifications
5965-6404E
HP 8703A LW Component Analyzer Technical Specifications
5952-1754E

HP 8614XA Optical Spectrum Analyzer Family Technical Specifications
5968-1124E
HP 8614XA OSA Family for Factory & Field Applications Brochure
5968-1123E
HP 83737A Broadband Light Source
HP 83738A Erbium ASE Source Product Overview
5965-3252E

(PN 71452-2) HP 71452B Optical Spectrum Analyzer—EDFA Testing with the Time Domain Technique
5963-7147E
(PN 71400-1) Lightwave Signal Analyzers Measure Relative Intensity Noise
5091-2196E
(PN 71400C-2) Lightwave Signal Analyzers with the HP 70810B LW Section
5091-2324E
(PN 86120-1)WDM System Test with the HP 86120
5964-6896E
(PN 71450) HP 71452 Optical Spectrum Analyzer—EDFA Testing with the Interpolation Technique
5963-7146E
(PN 71452-4) HP 71452B Optical Spectrum Analyzer—Synchronizes Its Internal Activities With External Signals
5964-6416E
(PN 71452-3) HP 71452B OSA-EDFA Noise Gain Profile
5963-7148E

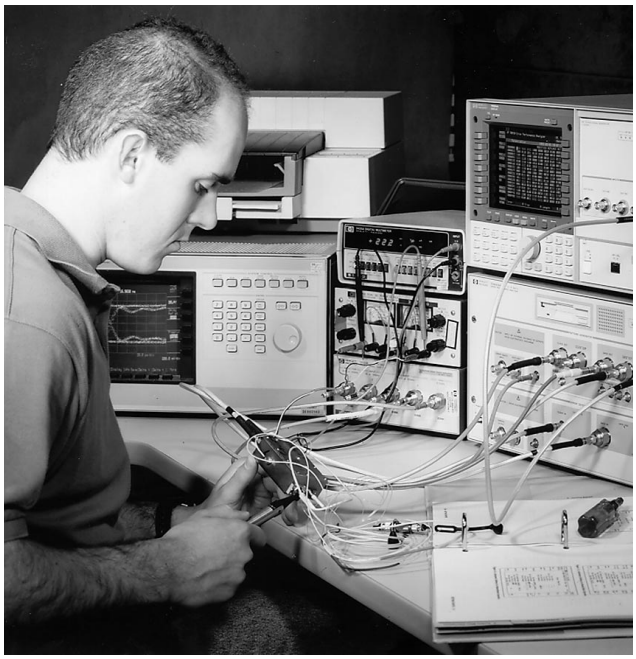
Digital Communications Analyzers

Lightwave Test & Measurement Catalog
5966-0366E/EUS
HP 11982A Amplified LW Converter Product Overview
5966-1583E
HP 83446A/B LW Clock/Data Receiver Product Overview
5964-1682E
HP 83440B/C/D High-Speed Lightwave Converters Product Overview
5091-5536E
HP 83480A 10 Methods for Faster High-Speed Digital Communication Design Brochure
5966-4258E
HP 83480A Series Digital Communication Analyzer Product Overview
5964-2238E

Optical Wavelength Meter

HP 86120c Multi-Wavelength Meter Brochure
5968-1044E
HP 86120C Multi-Wavelength Meter Technical Specifications
5968-1045E

Many of these literature pieces are available at:
http://www.hp.com/go/tmc99



HP71612A

Portable protocol analyzer isolates operational problems on data communications networks.

Test Solutions for Communications Networks

With the most comprehensive technology resources available anywhere, Hewlett-Packard can provide complete and integrated solutions to meet your test needs at every phase of the network life cycle. HP offers telecommunication and data communication test equipment to help you design state of the art, high quality communication products. We also offer the tools you need to test, monitor, troubleshoot and eliminate operational problems on your network, no matter what its size or type.

From handheld testers to network monitoring systems, HP equipment is easy to use and rugged enough to stand up to years of use in the field, factory, or lab. Backed by HP's unparalleled worldwide support, this total capability enables you to increase your network's quality of service and uptime—and to enjoy a low overall cost of ownership.

You can maximize the value of your investment in HP solutions through comprehensive education and training courses that give your workforce the skills necessary to solve the problems they encounter accurately and quickly. Both traditional classroom and customized on-site training is available in a wide variety of areas. Example topics include:

- Developing IP Networks in an ATM environment
- Design of SONET Networks
- Frame Relay technology and troubleshooting techniques
- Migrating to fast and switched ethernet

For a complete list of courses and times please see the HP web site:
www.hp.com/go/tmeducation

Protocol Analyzers

Protocol Analyzers are instruments that monitor the traffic on a network to determine that it conforms to the specific set of rules, helps to identify specific error conditions and manage network performance and quality. HP provides a broad set of solutions specifically designed for R&D engineers, Network Managers and Field Service Technicians. A full range of technologies is supported, including: Ethernet, fast Ethernet, gigabit Ethernet, token-ring, FDDI, ISDN, frame relay, X.25 and ATM. HP also supports the industries broadest coverage of network types with solutions for low speed dial-up connection all the way to OC12 core transmission circuits.

HP Internet Advisors-LAN/WAN/ATM

The HP Internet advisor gives you the capabilities you need to identify and solve problems correctly the first time you connect, anywhere in the internetwork. To maximize network uptime, the HP Internet Advisor helps you isolate network problems before they occur. With the capability to base line network behavior, the Internet Advisor provides critical information for intelligently optimizing, reconfiguring, fine-tuning and expanding data communications networks.

Signaling Test Sets

THE HP 37900E signaling test set is a rugged, portable PC-based instrument, providing monitor and emulation of SS7, ISDN, X.25 and V.5 protocols. It can handle up to 40 duplex protocol streams carried on one to 24 links. The HP 37900E is targeted at the telecommunications protocol test market, particularly SS7-based protocols in both wireless and fixed/wireline networks. The test set can be used for emulating protocols as well as monitoring live traffic and deriving measurement statistics.

The HP 37907A Signaling Advisor (new in this catalog) is designed for signaling engineers and technicians who maintain, install and develop multilink, multiprotocol wireline or wireless signaling networks. This practical, intuitive-to-use test tool enables technicians to deal with routine signaling problems easily, and frees engineers to focus on major or complex signaling issues.

Transmission Impairment Measuring Sets (TIMS)

It is necessary to make analog measurements on a network in order to analyze its ability to transmit signals on the Physical Layer. The HP 4934A (TIMS) measures frequency response, noise and cross talk, with the results displayed indicating the health, or acceptability, of the network.

The deployment of DSL technologies such as HDSL and ADSL requires a new generation of wideband TIMS. New in this catalog are the N1625A (ANSI) and N1626A (ITU) xDSL TIMS modules. These modules plug into the N1610A HP Service Advisor tablet, new in this catalog. The Service Advisor provides a three tier Asymmetric Digital Subscriber Line (ADSL) HP test solution to support local-loop service deployment, and addresses testing required for high speed ADSL services for consumers and businesses over existing copper lines.

The HP 37718A and 37719A communications performance analyzers offer a multi-rate test solution for both network operators and network equipment manufacturers.

Hewlett-Packard provides a wide range of portable testers to help you monitor and maintain your digital and analog networks.

Digital Transmission Testers

The fundamental measure of performance, or quality, in digital systems is the probability of any transmitted bit being received in error. This is the purpose of digital pattern generators and error detectors, often referred to as "Bit Error Rate Testers" or BERTs. HP offers the highest performance family of these instruments for synchronous (SONET/SDH) and plesiochronous (PDH) networks.

PDH

HP manufactures a full line of products for use in the installation, maintenance, and troubleshooting of telecommunications networks worldwide. These include handheld test sets and portable analyzers. Configurations address your needs for network use and speed, including ATM.

The HP E7580A ProBER (new in this catalog) is a powerful handheld solution for testing 2Mb/s and 64 kb/s digital circuits. It offers extensive BER test functions plus a unique range of signal quality measurements (pulse mask, jitter, level and frequency). For other PDH test solutions see the HP 71603B Gigabit Error Performance Analyzer, the HP 4594A T1 Test Advisor and the HP E8595A HDSL Installer Assistant.

SONET/SDH

HP's SONET and SDH analyzers perform accurate, reliable tests on network equipment and transmission services. Low-cost and portable units troubleshoot SONET equipment at rates up to 155 Mb/s or, optionally, to 622 Mb/s. Modular, VXI-based instrumentation can be easily integrated into R&D, production-line, or ATE systems that tests in both SONET and SDH transmission standards, up to 2.488 Gb/s.

The HP 37718A and 37719A Communications Performance Analyzers (new in this catalog) offer a multi-rate test solution for both network operators and network equipment manufacturers. The HP 37717C Communications Performance Analyzer offers an upgradeable one box solution for installation, field maintenance, commissioning and manufacturing, which is rugged and portable and allows full functioning testing of SDH, PDH and ATM equipment, including jitter generation and measurement. The HP E4480A (CERJAC 156 MTS) is a complete DS3 test set that offers a wide range of optional features including DS0, DS1, FT1, E1 and SONET, ATM and T-carrier in-service or out-of-service testing, for both electrical and optical networks.

Network Monitoring Systems

HP offers distributed systems that monitor network performance and report results at a central location. This creates the ability to achieve accurate fault diagnosis and location quickly, improve network and service reliability and decrease overall maintenance costs. HP offers monitoring systems for network technologies such as:

- Common Channel Signaling (AcceSS7)
- Interoffice Fiber Trunks
- Enterprise datacomm networks for LAN, WAN and ATM
- ISP services management
- Network Timing and synchronization

For more information on these options, contact the HP Call Center in your region, or call the number at the bottom of the page.

Communications Products Covered in Other Sections of this Catalog

HP offers a comprehensive line of network test, measurement and timing products to satisfy your needs in all types of networks, and all phases of their life cycle. Please also see the following for more information:

- Cellular Testers (See pages 462-493)
- Microwave Radio Testers (See page 461)
- Lightwave Transmission Testers (See page 424)
- Network Synchronization Units (See pages 514-519)

For the latest product information, please visit the HP communications test web site**: www.hp.com/go/comms**

HP J23446C
HP J2901A
HP J2932A
HP J2300C
HP J3506A
HP J3307A
HP J3710A
HP J2899A

HP J2300C

HP Internet Advisor

The HP Internet Advisor is designed to be a strategic tool for today's network managers, network engineers, and field service personnel for the deployment, troubleshooting, and optimization of today's mission-critical networks. The HP Internet Advisor gives you the capabilities you need to identify and solve problems correctly the first time you connect, anywhere in the internetwork. With the capability to baseline network behavior, the HP Internet Advisor provides critical information for optimizing, reconfiguring, fine-tuning and expanding diverse and increasingly complex networks. The HP Internet Advisor's modular design enables the user to start with any combination of LAN, WAN, or ATM test capability, with the option to add further functionality as the network evolves.

Dedicated acquisition hardware ensures the user of 100% data capture and analysis. With its PC Pentium-based Windows architecture, the HP Internet Advisor offers a familiar environment which allows users to become more effective in troubleshooting and solving network problems.

Three mainframe configurations are available for different measurement requirements. The HP J2300C offers WAN and ATM analysis while the HP J3446C offers Ethernet and Fast Ethernet (10/100) analysis. The HP J3754C is a streamlined mainframe which, when coupled with one of the undercradles, provides a single technology test solution. Each of these mainframes can also be enhanced with any of the following undercradles or modules:

LAN	WAN	ATM
Ethernet	T1/E1	T1/E1
Fast Ethernet	ISDN	DS3/E3
Gigabit Ethernet	HSSI	OC3/STM1
Token Ring	DS3/E3 (frame	155 Mbps UTP
FDDI	and cell-based)	
	DDS 4-wire	

Solve Network Problems the First Time

- Expert analysis and network health reporting
- Vitals which anticipate and solve problems
- Commentators point you to the source of the problem
- LAN over WAN analysis
- LAN over ATM analysis
- Customizable statistical analysis
- Extensive on-line help

Built-in Fully Integrated Personal Computer

- Pentium-based, Windows platform
- 32M RAM
- Dual PCMCIA slots
- 3G hard drive
- Active SVGA display (optional)
- Up to 64M capture buffer

HP Internet Advisor LAN

The HP Internet Advisor LAN offers extensive measurement capabilities on Ethernet, Fast Ethernet, Gigabit Ethernet, Token Ring and FDDI networks. The analyzer has seven–layer protocol decodes, comprehensive statistical measurements, active stimulus / response tests and traffic generation. In addition the Expert Analyzer provides continuous feedback on key network issues such as router misconfigurations, connection resets and many other problems. The drill down capability of the Expert Analyzer enables the user to focus on the data to find the source of the problem. On-line help enables the user to quickly understand the problem and offers suggestions for solutions or optimizations.

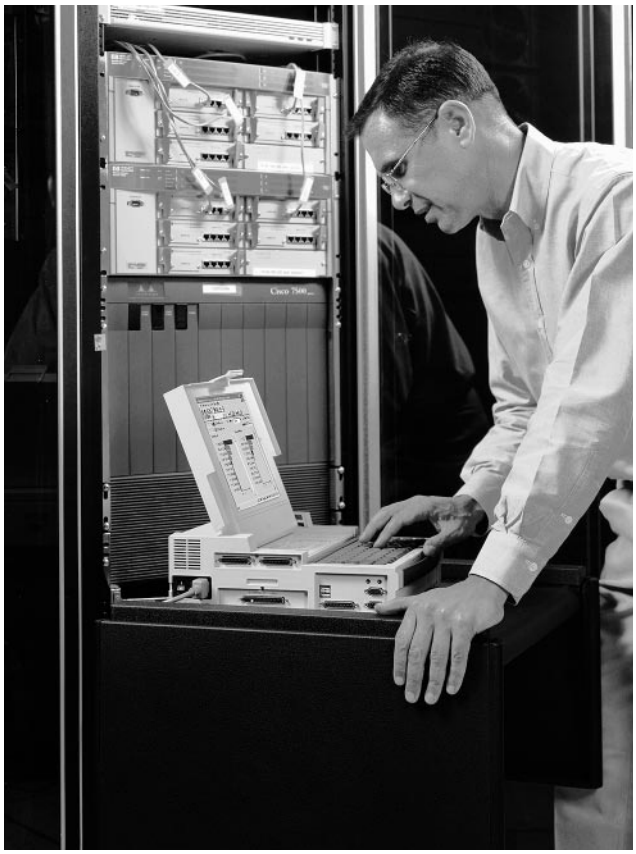
HP Internet Advisor WAN

To install, maintain, or troubleshoot a wide area network, you need to test many things: physical errors, equipment interoperability, and network inter-connectivity. The HP Internet Advisor WAN offers integrated WAN and LAN over WAN protocol analysis capabilities, along with bit error rate testing, stimulus and response measurements, and statistical analysis capability to help you solve your networking problems.

- Frame Relay –56kbps –45Mbps
- Multilink PPP
- Encapsulated LAN over WAN
- ISDN BRI and PR
- ATM DXI
- X.25
- SNA/SDLC
- SMDS
- Async and bisync
- PPP (sync and async)

HP Internet Advisor ATM

No matter where you are in the process of bringing up your ATM network, the HP Internet Advisor ATM gives you the tools to identify and resolve network problems quickly the first time. To install or troubleshoot an ATM link, you need to test for many things: Physical congestion, equipment interoperability, ATM cell congestion, and even LAN traffic problems. The HP Internet Advisor ATM offers integrated ATM, WAN, and LAN protocol analysis capabilities you require to get a good look at the physical layer, the data link layer, and the upper layer protocols.



HP Internet Reporter

The HP Internet Reporter automatically generates presentation-quality tables, charts and reports on statistics collected on almost any network. Useful for a wide variety of baselining and benchmarking tasks, the HP Internet Reporter will help you evaluate network operation, isolate traffic-related problems, evaluate the impact of hardware or software changes and plan for future growth.

- Build historical trends to anticipate problems and bottlenecks before they occur
- Benchmark applications and network devices
- Cost-justify network upgrades (gateways, controllers, bridges, routers, switches, lines, etc.)
- AutoReport feature makes report generation as easy as selecting a data file, choosing a report type, and pressing the GO! Button; AutoReport does the rest
- HP Internet Reporter's tables are stored in a Microsoft Excel format so that you can perform custom analysis of your network data when you desire
- Available with the LAN, WAN, and ATM platforms, statistics are broken out into individual tables, charts, and reports, giving you a view into your network you never thought possible

Oracle Commentator

HP Internet Advisor LAN Oracle Commentator software gives you the expert analysis capabilities you need to successfully manage Oracle distributed relational databases running in a client/server environment on Ethernet, Fast Ethernet, Token Ring and FDDI networks. With the Oracle Commentator, you can view summary information of significant network events and then drill down to get an easy-to-understand description of events, including an explanation of probable causes and suggestions for correcting the problem.

Ordering Information

LAN
HP J3446C Internet Advisor LAN - Fast Ethernet
HP J3447A Internet Advisor LAN - Fiber Interface for J3446A
HP J3754C Internet Advisor
HP J2306B Internet Advisor LAN - Ethernet Undercradle
HP J2307A Internet Advisor LAN - Token Ring Undercradle
HP J2309B Internet Advisor LAN - Ethernet/TR Undercradle
HP J2524A Internet Advisor LAN - FDDI Undercradle
HP J2901A Internet Advisor LAN - Gigabit Ethernet Undercradle
HP J3444A Internet Advisor LAN - Fast Ethernet Undercradle
HP J3445A Internet Advisor LAN - Fiber Interface for J3444A

WAN
HP J2300C Internet Advisor WAN
HP J2905B Internet Advisor WAN - ISDN BRI S/T/U
HP J3759A Internet Advisor WAN - DS3/E3 Cells and Frames Module
HP J3762A HSSI Module

ATM
HP J2912B Internet Advisor ATM OC-3c/STM-1 Module and Software
HP J2913B Internet Advisor ATM - 155 UTP Module and Software

HP Internet Reporter
HP J3307A Internet Reporter - LAN/WAN/ATM

Software
HP J3506A IP Switching Software
HP J3710A Oracle Commentator Software

Services
HP J2899A UAF Internet Advisor Software Subscription

Key Literature

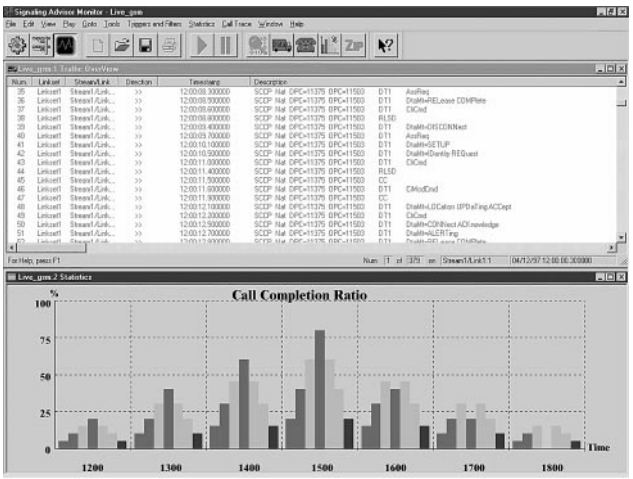
HP Internet Advisor LAN, Technical Specifications, p/n 5966-0829E
HP Internet Advisor LAN, Product Overview, p/n 5966-0828E
HP Internet Advisor ATM, Technical Specifications, p/n 5967-5557E
HP Internet Advisor ATM, Product Overview, p/n 5967-5558E
HP Internet Advisor WAN, Technical Specifications, p/n 5967-5567E
HP Internet Advisor WAN, Product Overview, p/n 5967-5566E
HP Internet Advisor, Brochure, p/n 5965-8049E
HP Internet Reporter, Technical Specifications, p/n 5967-5555E
HP Internet Reporter, Application Note, p/n 5967-5556E

HP 37907A

NEW

- Intuitive GUI simplifies monitor-and emulate-testing
- Flexible architecture extends to all telecom protocols
- Auto-configure hardware and software
- Up to 16 links and 40 duplex timeslots monitor and emulate
- Replacement for HP 37900D signaling test set

HP 37907A



Graphics-based user interface lets you analyze problems and status of signaling simultaneously.

HP 37907A Signaling Advisor NEW

The new HP 37907A test solution is specially designed for engineers who maintain, install or develop multiprotocol signaling networks. The HP Signaling Advisor makes measurements and results analysis easy for signaling engineers, enabling them to check performance and troubleshoot signaling systems easily and accurately.

The HP Signaling Advisor is rugged and portable, weighing less than 10 kg for 16 links, and provides powerful, modular, scaleable test capability. It covers SS7, ISDN, X.25 and V5 signaling for wireline and wireless signaling networks; checks signaling interactions in fixed, access, PCS and GSM networks; and verifies services such as AIN, CLASS and LNP.

Monitor

The HP Signaling Advisor enables customers to monitor signaling interactions across link sets or complete network elements easily, without having to reconfigure network equipment for tests artificially. Users can perform measurements on up to 40 duplex time slots from eight duplex signaling links (expandable to 16), working at sub and fractional rates, or full rate T1/E1.

The HP Signaling Advisor's time-saving features and user-friendly operation are designed to improve service quality and availability, allowing signaling engineers to predict problems early and resolve faults quickly and effectively. Its intuitive graphical interface helps users configure even the most complex triggers, filters or traces for tests across multiple links involving multiple signaling protocols and standards.

Test analysis also is simplified with automatic sequence- and protocol-deviation detection, decoding of signaling to text and graphical statistics. Understanding complex signaling interactions and messages, even those involving multiple protocols, becomes simple. The HP Signaling Advisor lets users work with up to 40 SS7, ISDN, X.25 and V5 protocols simultaneously.

Emulation

The optional emulation application turns the HP Signaling Advisor into an equally impressive tool for installation, verification, development and acceptance tests. Built-in programming capabilities reflect the user-friendly emphasis shown in the monitor application and ensure that emulation testing—simple or in-depth—can be done easily.

Key Literature

5966-3923E Technical Specifications
5966-3924E Configuration Guide
5966-4022E Brochure

Ordering Information

HP 37907A Signaling Advisor

HP E7580A
HP 37722A

NEW

- Combined transmitter and receiver
- 2 Mb/s, n x 64 kb/s, 64 kb/s co-directional
- Complete set of Signal Quality measurements (pulse mask, jitter, frequency, level)
- Large graphical display (1/4 VGA)
- >8 hours measurement operation from single battery charge

HP E7580A

- Complete range of in- and out-of-service telecom installation and maintenance measurements in one tester
- Low-cost, rugged, easy to use
- Adaptable to future requirements—no need to buy new test sets
- Powerful results storage and analysis: including distributed network monitoring capability

HP 37722A

HP E7580A ProBER 2 NEW

Combining error and alarm transmit/receive testing with a full range of Signal Quality measurements, the HP ProBER 2 delivers unrivalled 2 Mb/s test capability in a handheld package. This measurement power coupled with the test set's quick-to-learn, fast-to-use graphical user interface makes ProBER 2 the ideal choice for all your 2 Mb/s network test applications.

Applications

2 Mb/s and 64 kb/s co-directional testing for:
- Network maintenance
- Path commissioning
- Equipment installation
- Troubleshooting

Measurement Summary

Errors: Bit, Code, Frame (FAS), CRC, E-bit
Analysis: G.821, G.826
Alarms Seconds: LOS, LOF, AIS, RDI, RDI (MF), LOMF (CAS), LOMF (CRC), Pattern Loss
Signal Quality (2 Mb/s)**:** Line frequency (Hz), Offset (Hz and ppm), Pulse Mask (+pulses, -pulses, pulse width ratio, pulse level ratio), Jitter (+pk, -pk, pk-pk, hit count, hit seconds, hit free seconds), Level (+pk, -pk, pk-pk; volts and dB)
VF Tone (2 Mb/s timeslot)**:** Frequency (Hz), Level (dBm)
Delay: Supports measurement of both network round-trip delay and network element transit delay
Frame Data: Monitoring of FAS, NFAS, MFAS, CRC MFAS, E-bits, Sa4-Sa8 spare bits, ABCD signaling, timeslot data

Ordering Information

HP E7580A 2 Mb/s Test Set (includes soft carrying case, ac adaptor, operating manual)
Option 001 Advanced Signal Quality Measurements (adds 2 Mb/s pulse mask, jitter and level measurements)
Option 002 64 kb/s Co-directional Interface

HP 37722A Telecom Analyzer

The HP 37722A telecom analyzer offers installation and maintenance (in-service and out-of-service), bit error, and signal measurements on CEPT digital circuits in a portable, rugged package. M2100 measurements are standard, M2110/M2120 optional. The HP 37722A provides framed pattern generation and measurements at 704 kb/s, 8 Mb/s, and 2 Mb/s, and n x 64 kb/s testing. It offers many other features to help increase productivity and network uptime: event storage in text and graphic form, n x 64 kb/s testing, timeslot monitor including all signaling bits display, and framing/frame word. Options add framed/unframed 704 kb/s and 8 Mb/s, n x 64 kb/s timeslot access, sub-64 kb/s testing, slips and wander, and tone generation and measurement.

The HP 37722A is easily upgraded to the HP 37732A telecom/datacom analyzer (see page 440). The HP 37722A can be used as part of a distributed network analysis system, by combining it with the HP E4540A distributed network analysis software (see page 440).

Specifications

Full Transmit and Receive Capability
Interfaces: 64 kb/s codirectional, 704 kb/s, 2.048 Mb/s, 8.44 Mb/s
Measurements: Bit errors, code errors, frame errors, CRC errors, REBEs (E bits), slips, round trip delay
Error Analysis: G.821 standard, user-defined and Annex D, M.2100
Timeslot Access: External drop/insert of 64 kb/s timeslot to VF ports or n x 64 kb/s (n = 1 to 6) to X.21 datacom port: internal tone generation/measurement and talk/listen
RS-232 Remote Control and Printer Interface
Universal ac Power Supply
Size: 340 mm W x 190 mm H x 208 mm D (13.4 in x 7.7 in x 8.2 in)
Weight: 4.5 kg (10 lb)

Ordering Information

HP 37722A Telecom Analyzer
Opt 002 8 Mb/s (framed and unframed)
Opt 003 704 kb/s (framed and unframed)
Opt 004 Small Siemens Connectors
Opt 005 Sub-Rate Testing, Timeslot Access and Tones
Opt 006 Timeslot Access and Tones
Opt USS HP E4540A DNA Firmware

Accessories
HP 15901A Opt 001 Datacom Module With V.24, V.11/X.21-Leased, V.35 Interfaces

10

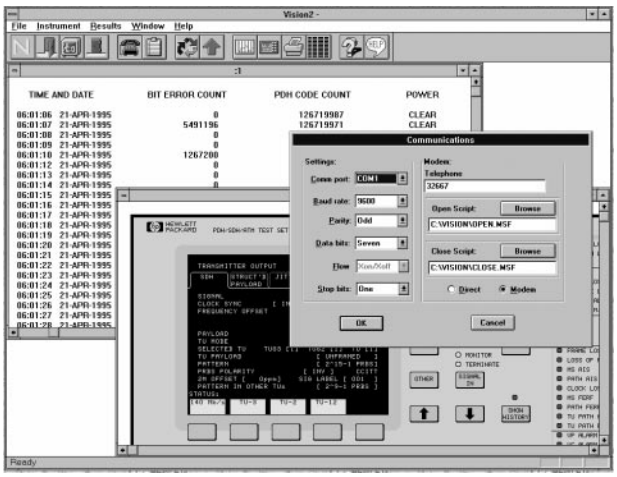
Telecom/Datacom Analyzer and Remote Test Software

HP 37732A
HP E4540A

- Combined telecom and datacom testing in one analyzer; no need for separate test sets or plug-ins
- Eight interfaces in one analyzer
- Powerful results storage without using printer
- Rugged, portable, easy to use

HP 37732A

- Low-cost distributed network analysis software
- Controls the HP 37XXX range of portable test sets
- Creates a multisite remote monitoring and results retrieval system



HP E4540A

HP 37732A Telecom/Datacom Analyzer

The HP 37732A is a lightweight, field-portable, and rugged test set that combines the full telecom testing capability of the HP 37722A telecom analyzer (see page 442) with datacom testing. The HP 37732A telecom/datacom analyzer consists of the HP 37722A and the HP 15901A Option 001 datacom module.

The HP 37732A provides testing at V.24, V.35, V.11/X.21-leased interfaces at rates up to 2 Mb/s. It also provides a full range of BER/BLER measurements, control-circuit timing analysis with transitions diagrams on the screen, a built-in V.24 breakout box, and an internal synthesizer. It offers event storage in text and graphic form. The HP 37732A reduces test time and speeds problem resolution by simplifying test setup. It presents results in easy-to-read and easy-to-record ways that make it easy to pinpoint the cause of a problem.

There is also the HP E4540 distributed network analysis software for results management and remote instrument control.

Applications

- Installation of digital telecom circuits and services
- Long-term network monitoring
- Maintenance and troubleshooting

Specifications

Telecom testing, remote control, power supply, and size specifications as HP 37722A (see page 442).
Datacom Interfaces: V.24, V.35, V.11/X.21-leased
Data Rates: 50 b/s to 2.048 Mb/s (synchronous: built-in synthesizer); 50 b/s to 19.2 kb/s (asynchronous)
V.24 Breakout: Patch points, monitors, voltage sources, and switches
V.11/V.35: Activity indicators on data, clock, and control circuits
Test Patterns: 63-bit, 511-bit, 2047-bit, 2^{15}–1, 2^{20}–1, all 1s, all 0s, 8 to 1024-bit user-definable word, FOX word
Measurements: Errors, BER, block, block-errors, BLER, error seconds, % EFS, Tx and Rx frequency, alarm seconds, clock slips, alarms, G.821 analysis
Control-Circuit Timing: Measures times between selectable start/stop events; timing range 100 ms, 1s, 10s
Transition Diagrams: For RTS, CTS, DTR, DSR, and DCD
Weight: 5.9 kg (12.5 lb)

Ordering Information

HP 37732A Telecom/Datacom Analyzer

HP E4540A Distributed Network Analyzer Software

The HP E4540A allows the creation of a low-cost distributed network analysis system to reliably gather information about network performance from remote test sets. It avoids the large commitment of time and resources needed to implement a dedicated network management system—an important benefit with network technologies changing so rapidly. The HP E4540A distributed network analyzer software controls HP's range of HP 377XXX PDH/SDH/ATM and jitter test sets, and allows the creation of an extensive measurement and data analysis system. With this PC software it is possible to control one instrument (at a local or remote site) or a number of instruments in a multi-site system.

With network technologies evolving rapidly, it is difficult to keep up to date with ever-changing test procedures. The HP E4540A interactive diagnostics allow the maximum use of scarce test engineering expertise. The expert at the central control site, using virtual instrument displays, can interactively work with technicians at the remote site. Test sequences simplify complex testing of new technologies. Key HP E4540A features include:

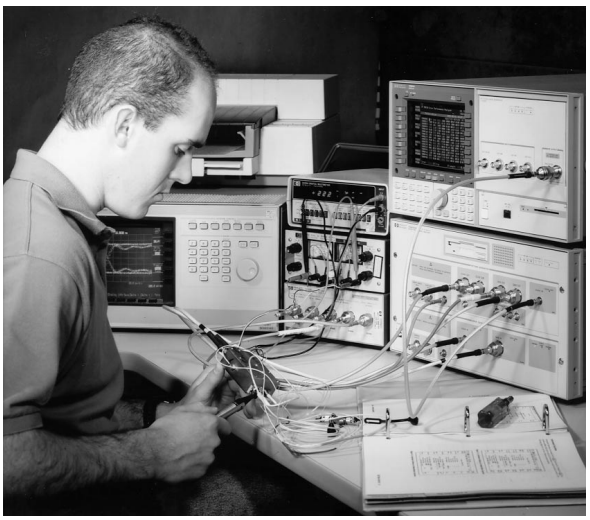
- No software expertise required to use the HP E4540A
- Robust automatic results retrieval for monitoring network performance
- Transfer of results into MS Windows applications for analysis, or to produce graphs and reports
- Simplified installation and maintenance testing using stored test sequences and configurations
- Real-time update of keystrokes at remote site and central site

The HP E4540A analyzer software is Windows-based, operating on a PC or laptop, and connects to the remote site via Hayes compatible modems, or using the LAN remote control port available on the test set.

Ordering Information

HP E4540A Distributed Network Analyzer
Opt 0A9 10 User License
Opt UAT Unlimited User License
Note:
Opt USS Distributed network analyzer firmware required in HP 377XXX test set (not required for HP 37718A and HP 37719A)

- User-programmable patterns with screen-based editor
- Hitless switching between two programmed patterns
- Trigger anywhere in pattern
- Automatic setting of clock/data phase and data decision threshold
- Advanced eye-diagram analysis



HP 71612A

HP 71603B 3 Gb/s Error Performance Analyzer

Comprises Pattern Generator, Synthesized Clock Source and Error Detector

The HP 71603B covers the range 100 Mb/s to 3 Gb/s and features automatic clock/data alignment for rapid setup of the error detector. The HP 71603B makes measurements on waveforms badly distorted by noise, jitter, inter-symbol interference through the high-resolution setting of decision threshold, and phase adjustment.

HP 71604B 3 Gb/s Pattern Generator

Comprises Pattern Generator and Synthesized Clock Source

The HP 71604B covers the range 100 Mb/s to 3 Gb/s and features pseudo-random test patterns up to 2^{31}–1 bits long. Users can program and run variable length test patterns from 1 bit to 4 Mb long on MS-DOS-compatible disks.

Applications

Component test
GaAs and high-speed silicon; electrical and optical components

Module/system test
SONET and SDH; broadband video and ATM; submarine cable; high-speed datacom, LAN and computer peripheral communication

Specifications (typical)

Bit Rate: 100 Mb/s to 3 Gb/s (optional 50 Mb/s to 3 Gb/s)
Rise Time: (20% to 80%): < 90 ps
Patterns: 2^7–1 to 2^{31}–1, user patterns to 4 Mb
Data and Data Outputs: 0.25 V to 2 V p-p amplitude; +1 V to –3.75 V range
Data Input Sensitivity: < 50 mV @ 2.5 Gb/s
Decision Threshold Voltage: +1 V to –3 V, resolution 1 mV
Clock/Data Delay: ± 1 ns; resolution 1 ps
Measurements: Error count, ratio, errored-intervals, G.821 analysis, eye width and height

Ordering Information

HP 71603B Error Performance Analyzer
HP 71604B Pattern Generator

Individual modules can be ordered separately.

- Full jitter analysis capabilities
- Fast transition times, low jitter
- Burst-mode capability for fiber-loop testing (HP 71612A)
- 4 sub-rate outputs for WDM testing (HP 71612A)
- Location of specific errored bits (HP 71612A)

HP 71612A Series 12 Gb/s Testers

The HP 71612A series of 12 Gb/s products includes an error performance analyzer, pattern generator, and error detector, with similar functionality to the 3 Gb/s series. User pattern length has been increased to 8 Mb, and this series offers Error Location Analysis. The HP 71612A Option UHF error performance analyzer and Option UHG pattern generator have four sub-rate pattern outputs at one quarter of the output rate.

Applications

The increased speed and pattern size allow the simulation of SONET and SDH frames at the STM-64/STS-192 transmission rate and margin testing up to 12 Gb/s. The burst mode feature allows fiber-optic loop tests, while Error Location Analysis allows the identification of pattern dependent errors for user defined patterns.

Specifications (typical)

Bit Rate: 1 to 12 Gb/s (optional 100 Mb/s to 12 Gb/s)
Patterns: Same as the HP 71603B with user patterns extended to 8 Mb
Transition Times: (10% to 90%) <30 ps
Jitter: <15 ps p-p @ 10 Gb/s
Data and Data Outputs: 0.5 V to 2 V p-p amplitude; +1.5 V to –3.0 V range
Data Input Sensitivity: <50 mV @10 Gb/s (typical)
Decision Threshold Voltage: +1 V to –3 V: resolution 1 mV
Clock/Data Delay: ±1 ns up to 500 MHz; 1 clock period 500 MHz to 12 GHz
Measurements: Same as HP 71603B with the addition of optional Error Location Analysis

Add Jitter Analysis Capability to the HP 71603B or 71612A

Full jitter analysis capability can be achieved with either the HP 71603C or 71612B with the addition of the HP 71501C. Measurements include jitter transfer, jitter tolerance and jitter generation over the full data rate range of the error performance analyzer.

HP E4543A Q-Factor and Eye-Contour Software

This PC-based software automates measurements made by the HP 71612A/71603B, providing rapid analysis of eye-diagrams in optical line systems. The HP E4543A software controls the acquisition of measurement data and interprets and displays the eye contour and Q-factor which can be used to estimate very low BER.

HP E4544A SONET/SDH Functional Test Software

This PC-based software allows the user to construct SONET/SDH frames up to OC-192/STM-64 and load them into the pattern memory of the HP 71612A/71603B. Frames can be edited to inject specific parity errors and alarm conditions.

Ordering Information

HP 71612A Opt UHF Error Performance Analyzer
HP 71612A Opt UHG Pattern Generator
HP 71612A Opt UHH Error Detector
HP E4543A Analysis Software
HP E4544A Functional Test Software

HP E448XA
HP E449XA

- R&D, manufacturing test or network "keep-alive" application platform

HP E448XA, E449XA

Communications Products

This family of modular communications products is designed to provide telephone companies and network providers with a cost-effective way to maintain service while installing new T-Carrier and SONET-based network equipment. It consists of a compact, standardized, multi-purpose equipment shelf and plug-in product modules, which are each packaged separately. Communications modules, which are shipped ready-to-use, include:

- DS1 Bridge Amplifier
- E1 Bridge Amplifier
- DS3 Bridge Amplifier
- STS-1 Bridge Amplifier
- DS3 Bridge Repeater
- DS3 Signal Source
- STS-1/DS3 Signal Source

Applications and Features

These communications products can be used to support applications including:

- Standard cut-over, reconfiguration and emergency restoral
- Re-routing of service around construction sites
- Extension of cross-connect distance
- Generation of "keep-alive" signals for spare fiber and radio routes

Intuitive controls and output connectors are conveniently located on each module's front panel, so the communications product family requires a minimum of operator training and is easy to use. And because any combination of plug-in modules can be mixed within a single shelf, users can configure a general-purpose portable tool, or support specific applications, as required.

Ordering Information

E4488A
Opt 001 12-slot, 33 cm (13 in) rackmount
Opt 002 12-slot portable
Opt 003 16-slot 48 cm (19 in) and 58 cm (23 in) rackmount
E4489A STS-1/DS3 signal source for use in E4488A
Opt 001 Add single channel error burst
Opt 002 Add Stratum-3 on-board STS-1 clock
E4490A DS3 bridge amplifier
E4491A DS3 bridge amplifier with monitor
E4492A DS3 bridge repeater
E4493A DS3 signal source
Opt 001 Add single channel error burst
E4494A DS1 bridge amplifier
E4495A DS1 bridge amplifier with monitor

- Remote testing and maintenance device for DS3 services
- Quickly isolates network or customer equipment problems
- Cuts costs by reducing the need to dispatch technicians

NIU 1-slot, 3-slot, 12-slot

DS3 Network Interface Unit

The DS3 Network Interface Unit (NIU) serves as a demarcation point between the network and customer premises equipment (CPE). The NIU features loopback capabilities that can be used for remote test and maintenance, verification at customer service turn-up, and quick isolation of network or customer equipment problems.

Applications

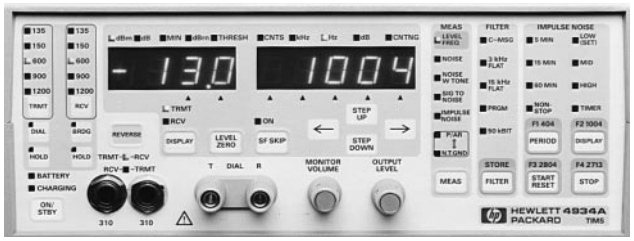
- Resides at the demarcation point between the customer premises and carrier network.
- Provides the ability to run a BERT between the Central Office and the NIU residing on the customer premises to isolate network/customer equipment problems.

Measurement Summary

Responds to ANSI T1.404, Network-to-Customer Installation "reserved for network use" loopback Far-End Alarm and Control (FEAC) codewords. Monitor ports available for on-site monitoring of network and customer equipment signals.

Ordering Information

HP E4586B DS3 NIU Interface Card Plug-in
HP E4587A 1-slot NIU Housing
Opt 001 248 Vdc Power Supply (115 Vac)
HP E4588A 3-slot NIU Housing for 23-inch Rack
HP E4589A 12-slot NIU Housing for 19-inch or 23-inch Rack



HP 4934A

HP 4934A TIMS

The HP 4934A transmission impairment measuring set (TIMS) increases installation and maintenance productivity for telephone companies and service providers through its ease of use, portability, and ruggedness. Measurements include:

- Level/frequency up to 110 kHz (200 kHz option)
- Noise and noise-to-ground
- Noise-with-tone and signal-to-noise ratio
- Three-level impulse noise
- P/AR
- RS-232 remote control (not available with J01/J02)

The HP 4934A TIMS Option J01 and J02 are versions of the instrument with measurements for installation and maintenance of voice frequency or wideband leased lines to CCITT specifications. Option J01 is for countries with 820 Hz holding tone and Option J02 is for countries with 1020 Hz holding tone. Measurements are to CCITT specifications:

- Level/frequency to 110 kHz
- Circuit noise
- Noise-with-tone and signal-to-noise ratio

(Optional battery with typical 6 hours of operation.)

Ordering Information

HP 4934A 110 kHz TIMS
Opt 001 Internal Battery and Charger
Opt 021 200kHz Wideband (ANSI VER only)
Opt J01 CCITT (820 Hz tone)
Opt J02 CCITT (1070 Hz tone)

HP 37741A

HP 37741A DS1 Tester

The HP 37741A is a handheld T1 test set with full T1 and fractional T1 transmit and receive capabilities for testing unframed, SF, ESF and SLC-96 circuits. For simplified operation, the HP 37741A has an auto key that automatically sets test mode, framing, line coding, and performs pattern detection and synchronization. Test results are easily read using the combination of the LCD display and bi-colored LEDs. Test results are stored for later printing or uploading to a PC. The rugged design of the unit ensures that the HP 37741A will tolerate a rough environment.

Measurement Summary

T1: BER testing, alarm detection and injection, error injection, detection of framing, pattern, code, CRC or BPV errors, control of Teltrend and Westell addressable line and office repeaters, loopback control codes, auto-detection of FT1 facilities (n x 56 and n x 64 kb/s) and T1 line level and frequency

Ordering Information

HP 37741A T1 Tester

HP 37701B or HP 37702A

HP 37701B and HP 37702A T1/Datacom Tester

The HP 37701B T1/datacom tester offers complete T1 and fractional T1 bit-error and signal measurements. It also generates tones in a channel and allows VF signals in any timeslot to be monitored. Test results are presented using easy-to-read bar charts allowing quick analysis of the circuit trouble. Tests can be performed using auto-configure or user-prestored setups for fast and easy testing. Optional pulse shape and clock slip analysis allow quick, graphic interpretation of distortion and timing problems. DTE/DCE interface and measurements can be added for datacom testing.

The HP 37702A digital data tester has all the functions of the HP 37701B plus DDS capabilities in one unit. It performs the full range of DDS testing from simple in-service tests to complete installation and acceptance tests. Built-in T1 channel access allows access to a signal in any timeslot.

Measurement Summary

T1: Auto code, frame, and pattern detection, error monitoring, BER testing, alarm, and event generation, ESF decode and encode, DS1 signal level and frequency, fractional T1 n x 56 or n x 64 kb/s contiguous or non-contiguous
DDS: (DS0A, DS0B) BER testing, error correction, error monitoring, loop back operation and MJU control

Ordering Information

HP 37701B T1 Tester
HP 37702A T1/DDS Tester
Opt 001 Pulse Shape
Opt 002 Data Comm
Opt 004 DS0B Testing (OZA only)

Digital Transmission Testers

T1/E1 Testers

HP E4594A
HP E6325A
HP E6323A
HP E6349A

- Windows graphical user interface
- T1 or E1 testing
- Full and fractional testing
- Full drop-and-insert voice frequency testing
- Datacom testing

E1 Test Advisor Family

The 2 Mb/s test products are designed to work with the T1 products. Together, they provide flexible, modular solutions for expanding business needs. Like the T1 test products, the 2 Mb/s products are extremely easy to use, even for the occasional user, with intuitive Windows-based interfaces, context-sensitive help functions and on-line manuals.

The 2 Mb/s Test Advisor product family includes a range of product options so users can select the configuration that best fits their needs. Versions include a “brick” for use with a PC and an “undercradle” for use with the Internet Advisor (J230XX).

All HP 2 Mb/s test solutions include G.821 Error Analysis as well as M2100, M2110, and M2120 Error Analysis. The products are dual-port testers that enable technicians to simultaneously control two full-duplex drop-and-insert transmitters and receivers. All include a built-in log that captures up to 3300 separate, user-selected error events.

Applications

The 2 Mb/s Test Advisor’s main screen provides vital at-a-glance information for quick circuit “check-ups,” including alarms, alarm history and results summary. Other tab displays provide information on level and frequency of the 2 Mb/s signal, comprehensive BERT results, and allow drop-and-insert of tones and data. Optional data modules allow BER testing at V.35, RS-232, RS-449 and EIA-530A interfaces.

HP E6323A Test Advisor Undercradle for the Internet Advisor (J230XX)

Provides E1 testing for J230xx LAN or WAN Internet Advisor. Can be used with J3754C for complete stand-alone E1 testing.

HP E6349A E1 Test Advisor Brick

An existing notebook PC can be used with the E6349A configuration of the E1 Test Advisor. It is ideal for “drop-box” applications at customer sites that require long-term monitoring via modem or LAN.

HP E6351A Dual 600-ohm Audio Access Plug-in

Provides dual 600-ohm DSØ access for audio delay and echo cancellor applications

T1 Test Advisor Family

All versions of the T1 Test Advisor provide users with capabilities for simultaneous control of two full-duplex drop-and-insert transmitters and receivers. The product’s intuitive Windows graphical user interface, combined with context-sensitive help and on-line manuals, makes the T1 Test Advisor extremely easy to use, even for occasional users. Optional plug-in modules provide support for datacom testing capability while also providing an easy method of extension. Upgradeability is accomplished either by a disk containing new software and firmware, or over a dial-up telephone line. Results and set-ups can be stored to disk for later analysis. SLC96 testing includes TR-TSY-000008 SLC modes and makes full use of graphics to ensure easy hook-up and testing. The T1 Test Advisor supports full and fractional T1 testing and comes standard with two transmitters and two receivers. T1-based DDS capability is included. Versions include a "brick" for use with a PC or an "undercradle” for use with the Internet Advisor (J230xx).

Applications

The T1 Test Advisor’s main screen provides vital at-a-glance information for quick circuit “check-ups,” including alarms, alarm history and results summary. Other tab displays provide information on level and frequency of the T1 signal, comprehensive BERT results, and allow drop-and-insert of tones and data. Optional data modules allow BER testing at DDS/DSØ V.35, RS-232, RS-449 and EIA-530A.

HP E4594A T1 Test Advisor Undercradle for the Internet Advisor (J230XX)

Provides T1 testing for J230xx LAN or WAN Internet Advisors. Can be used with J3754C for complete stand-alone T1 testing.

HP E6325A T1 Test Advisor Brick

An existing notebook PC can be used with the E6325A configuration of the T1 Test Advisor. It’s ideal for “drop-box” applications at customer sites that require long-term monitoring via modem or LAN.

E8529A DDS plug-in module for T1 Test Advisors.

Test DS0 DDS circuits from bi-polar, logic near and logic far access points using bit/byte or composite clocks.

J3754C HP pcAdvisor

Pentium-based mainframe to be combined with E4594A or E6323A for complete stand-alone T1 or E1 testing package.

Ordering Information

E4594A T1 Test Advisor Undercradle
E6325A T1 Test Advisor Brick
E6323A T1 Test Advisor Undercradle
E6349A T1 Test Advisor Brick
E4592A V/F Plug-in Module (for E4594A, E6325A)
E4593A RS-232 Plug-in Module
(for E4594A, E6325A, E6323A, E6349A)
E4597A V.35 Plug-in Module
(for E4594A, E6325A, E6323A, E6349A)
E4598A RS-449 Plug-in Module
(for E4594A, E6325A, E6323A, E6349A)
E4599A EIA-530A Plug-in Module
(for E4594A, E6325A, E6323A, E6349A)
E6328A NI-CAD rechargeable battery (for E6325A, E6349A)
J2305A Softside Carrying Case (for E4594A, E6349A)
E6326A Custom Softside Carrying Case (for E6325A, E6349A)
E6351A Dual 600-ohm audio access for E6323A and E6349A
E8529A DDS plug-in for E6325A and E4594A
E8530A LAN interface for E6325A and E6349A
J3754A HP pcAdvisor for E4594A or E6323A

HP E8505A
HP E8509A
HP E8510A
HP E8511A

HP E8505A

HDSL Installer's Assistant

The HDSL Installer's Assistant offers a wide range of capabilities for HDSL circuit installation and maintenance including:

- HDSL plug-in card powering and verification
- Load coil detection
- Cable loss measurement
- T1 BERT

The HDSL Installer's Assistant is a field-portable, rugged unit which accepts Central Office, Doubler, and remote unit HDSL plug-in cards. The plug-in cards are powered from the built in AC power supply, or they may be line powered. The unit can verify proper operation of the HDSL cards with each other. Easily accessible front panel break jacks allow connection to the circuit. If the circuit does not come up properly with the plug-ins, the technician can access the cable pairs at any point in the span to sectionalize the problem to an individual part of the cable span.

After the pre-turn-up tests are completed and the HDSL plug-ins are installed, the technician can use the built-in T1 BERT tester for final turn up and trouble shooting. Using a pair of HDSL Installer's Assistants, it's a simple matter to generate an end-to-end HDSL signal on the cable span.

Ordering Information

E8505A HDSL Installer's Assistant
E8506A Cable Kit for E8505A
E8507A Softside Carrying Case for E8505A

New HDSL Modules Support Specialized Needs

The HDSL Assistant family offers a wide range of capabilities for HDSL circuit installation and maintenance including:

- HDSL plug-in card powering and verification
- Transmitting and receiving HDSL signals over a circuit
- Temporary jumpering of a doubler into a circuit

The HDSL Assistants are a trio of field-portable, rugged units, which accept central office, doubler, and remote unit HDSL plug-in cards. The plug-in cards are powered from the built-in AC power supply; or they may be line powered. Used together, the units can verify a wide range of HDSL installation and maintenance problems. In addition, all can be used in conjunction with the E8505A HDSL Installer's Assistant.

After the pre-turnup tests are completed, and the HDSL plug-ins are installed, the technician can use a DS1 BERT tester for final turn up and trouble shooting via the front panel DS1 transmit and receive jacks. Using a set of HDSL Assistants, it's a simple matter to generate an end-to-end HDSL signal on the cable span.

An excellent complement to the E8505A HDSL Installer's Assistant, this trio of plug-in verification tools replaces cumbersome, jury-rigged equipment shelves currently in use and help technicians to install, test, and sectionalize HDSL circuits.

Separate cable kits and soft side carrying cases are available for each unit .

HDSL Central Office

Assistant (E8509A)

This unit accepts standard HDSL central office plug-in cards. It can be connected to the distribution frame at the serving office, providing a powered HDSL signal toward the customer. It includes a built in AC power supply.

HDSL Doubler/Remote

Assistant (E8510A)

This unit accepts standard doubler, mini-doubler, and remote HDSL plug-in cards. It can be connected to the circuit at either a midspan point or at a remote end pedestal for maintenance applications. A doubler or remote line unit can be switched in to verify performance level. Because the plug-in cards are powered by the HDSL line, no further field power is required.

The HDSL Remote Assistant

(E8511A)

This unit can be easily patched in at any point in the circuit to verify HDSL transmission from the central office to the patch in point. Because the plug-in cards are powered by the HDSL line, no further field power is required.

Ordering Information

HDSL Modules
E8509A HDSL Central Office Assistant
E8510A HDSL Doubler/Remote Assistant
E8511A HDSL Remote Assistant

HDSL Module Accessories
Cable Kits
E8513A Cable kit for the HDSL CO Assistant (E8509A) & HDSL Remote Assistant (E8511A)
E8514A Cable kit for the Doubler/Remote Assistant (E8510A)

Carry Cases
E8512A Padded carry case for the CO Assistant (E8509A)
E8515A Padded carry case for the Doubler/Remote Assistant (E8510A)
E8516A Padded carry case for the Remote Assistant (E8511A)

Shelf Adapters for Line Units
E8508A Mini-Doubler Adapter for the E8505A and E8509A
E8517A HLU-319 Shelf Adapter for the E8505A and E8509A
E8518A HLU-388 Shelf Adapter for the E8505A and E8509A
E8519A Shelf Adapter set for the E8505A and E8509A (includes E8508A, E8517A, and E8518A)

Rugged handheld power for ADSL installation and maintenance

The ADSL Service Installer (E8550A) provides field personnel with all of the tools needed for ADSL cirucit turn-up and maintenance. This Installer's Assistant provides the following features:

- Emulates the CPE ADSL Modem (ATU-R)
- Modules for CAP and DMT transmission protocols
- Built-in load coil detector
- Integrated POTS splitter for butt set connection
- Measures cable loss with tone transceiver
- Generates and measures standard VF test tones, 404, 1004 and 2804 Hz
- Field

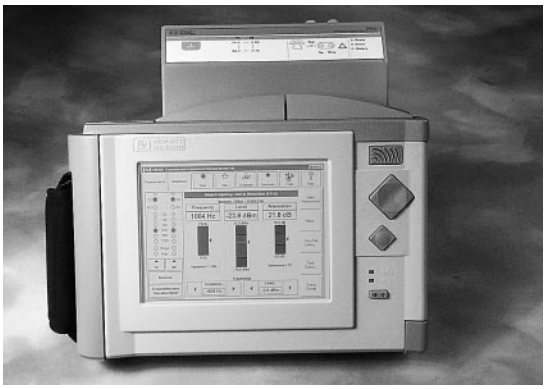
It also has the following test applications:

- ADSL Golden Modem
- Performs DC current and voltage measurement
- Load coil detection
- Cable loss measurement
- VF Tone transmit and receive

IP LAN and IP ADSL service qualification

The IP Service Installer Software (N1604A) operates with the Service Advisor Portable Test Tablet or with the HP 620LX Handheld PC providing the user with the ability to:

- Validate connectivity/configuration of IP services
- Qualify IP service to the Service Provider
- Measure data throughout on ADSL local loop
- Ping and trace Internet and Intranet hosts
- Lookup hosts on domain name server database



The HP Service Advisor offers unmatched flexibility and value for field testing

HP N1610A Service Advisor Portable Test Tablet is HP's newest modular state-of-the-art test platform. The versatile platform provides enormous test flexibility with its modular design for Telco, residential access and line qualification applications.

Interchangeable Test Modules

For maximum flexibility, the Service Advisor Portable Test Tablet can accept either 2 single width plug-in modules or 1 dual width plug-in module. With the application software contained with the plug-in modules, the Service Advisor Portable Test Tablet expands to meet new requirements. Hot swap capability enables the user to rapidly switch interfaces or applications.

Operating System

With the advanced Windows CE Operating System (OS), the Service Advisor Portable Test Tablet provides state-of-the-art control and flexibility. The wide range of software currently available today for CE greatly expands the applications for the Service Advisor. The consistent user interface shortens learning time between applications.

Touch Sensitive Color VGA Display

With the touch sensitive color VGA Graphical User Interface application, users can quickly and easily complete testing. The large target areas of the 7.2" 640x480 VGA color display allows the user to operate the test set with "the touch of a finger" for most test applications. For standard "off-the-shelf applications" with smaller target areas, a stylus is provided.

Battery Powered

The Service Advisor Portable Test Tablet is powered by an easily replaceable and rechargeable NiMH (Nickel Metal Hydride) smart battery. The state-of-the-art battery technology ensures long battery duration and charge status during the use cycle. Advanced power saving features conserve power for extended operation.

Remote Control

The companion remote control software package enable the Service Advisor Portable Test Tablet to work in concert with Windows-based PC. The file transfer capability enables users to transfer results and configurations with a companion PC. The SCPI command line interface enables users to control the Service Advisor with other computers.

PC-Cards

Using the TYPE II PC-CARD slot, users can remotely control the Service Advisor Portable Test Tablet with either a modem or a LAN. PC-CARD FLASH-ROM cards enable the users to load and store programs and data.

Flexible I/O

The Service Advisor Portable Test Tablet features a full suite of I/O ports for every test application. Using the serial port, users can operate the Service Advisor with a companion PC or an external modem. A parallel port is provided for printing on standard printers. A PS/2 port enables the use of an external keyboard. An internal speaker provides on-board audio monitoring and software feedback. A headphone and microphone jack enable the Service Advisor Portable Test Tablet to be used with standard headphones and microphones in noisy environments.

Field Portable

The Service Advisor Portable Test Tablet is rugged, water-resistant and lightweight, and is designed for many years of field use. With the ergonomically designed packaging, the Service Advisor Portable Test Tablet is easy to carry, use and store.

N1645A SONET/SDH ATM Interface Module 1310nm IR

The N1645A SONET/SDH ATM Interface Module 1310 nm IR SM for the Service Advisor Portable Test Tablet provides:

- 155Mbps (OC-3c/STM-1o) and 51Mbps (OC-1/STM-0o) optical interfacing
- 1310nm Intermediate Reach (IR) Single Mode laser
- FC/PC, ST and SC connectors
- Clear channel BERT
- LEDs for quick and easy error, alarm and status reporting
- Pointer, APS and overhead control and monitoring
- Error, alarm and status file logging
- Inter-operates with ATM cell processor module

N1640A ATM Cell Processor Test Module

The N1640A ATM Cell Processor Test Module for the Service Advisor Portable Test Tablet provides:

- ATM testing up to 155Mbps
- Quality of Service (QoS) testing
- VPI/VCI scan
- AAL0 and AAL 1 Cross Cell BERT
- ATM cell capture
- HEC error testing
- OAM support
- LEDs for quick and easy error, alarm and status reporting
- Error, alarm and status file logging
- Inter-operates with SONET/SDH interface module

Service Monitor Configuration

The ATM Remote Service Monitor (N1690A) combines the functionality of the Service Advisor (N1610A) with the combined processing capability of the SONET/SDH Interface Module (E1645A) and the ATM Cell Processor Module (N1640A).

N1625A North American (ANSI) TIMS Test Module and N1626A ITU-T TIMS Test Module

The N1625A North American (ANSI) TIMS Test Module and N1626A ITU-T TIMS Test Module for the Service Advisor Portable Test Tablet is configurable for VF/ISDN, HDSL and ADSL testing and provides:

- Line Qualification Test Sequences for xDSL installations including ADSL, HDSL, SDSL, IDSL
- Line Qualification Test Sequences for analog services including VF-POTS and Modem
- 36 Individual Tests
- ANSI and ITU-T Versions
- Complies with IEEE-743, T1.413
- User Defined Test Sequences
- Standard/Custom Line Qualification

Service Monitor Configuration

The TIMS Remote Service Monitor (N1675A) combines the functionality of the Service Advisor (N1610A) with the TIMS Test Module (N1625A or N1626A).

Ordering Informtion

N1610A Service Advisor Portable Test Tablet
N1640A ATM Cell Processor Test Module
N1645A SONET/SDH Interface module 1310 nm IR SM
N1625A North American (ANSI) TIMS Test Module
  Opt 002 Testing to 400Khz
  Opt 003 Testing to 2Mhz
N1626A ITU TIMS Test Module
  Opt 002 Testing to 400khz
  Opt 003 Testing to 2Mhz

HP 37718A
HP 37719A

NEW

- Multi-rate testing to OC-48/STM-16, including jitter
- Supports concatenated payloads to OC-48c/STM-16c
- Comprehensive measurement capability includes protection switching tests, mixed payload generation and analysis, and pointer processing
- HP Smart Test offers fast access to key measurement tasks
- Works with HP E4540A distributed network analysis software

HP 37718A Communications Performance Analyzer NEW

The HP 37718A offers SDH or dual SONET/SDH testing to STM-16/OC-48 including STM-16c/OC-48c payloads. Rugged and portable, this single-unit solution is ideal for installation, maintenance and manufacturing of SDH and SONET networks and network elements. It provides full PDH/T-carrier capability and SDH/SONET capability. Plus, it has a large, multi-window color display, optional graphics printer, and integral 3.5 inch disk drive for results storage/retrieval and firmware upgrades.

SDH/SONET

The HP 37718A provides a single set of multi-rate optical interfaces covering SONET/SDH BER and jitter testing at 52 Mb/s, 155 Mb/s, 622 Mb/s and 2.5 Gb/s. In addition, it provides full ITU-T G.707/GR.253 mapping support including concatenated payloads at STM-1/OC-3c, STM-4c/OC-12c and STM-16c/OC-48c. Optical 1310 nm and 1550 nm interfaces are supported as well as electrical interfaces at 52 Mb/s and 155 Mb/s. Key measurements supported are SONET/SDH error/alarm generation, APS times, mixed payloads generation/detection, pointer sequence generation, overhead sequence generation and detection. The instrument supports full mux/demux from 2.5 Gb/s to n x 64 or n x 56 kb/s. The user interface provides error and alarm stored measurement graphics, pointer graphs, in-service alarm/BIP scan and out-of-service tributary scan.

HP Smart Test capability provides fast access to key measurement tasks. HP Smart Setup provides an easy-to-use graphical means of detecting unknown payload structures and aids the user to quickly setup the instrument. This mode also provides fast detection of payload test patterns.

Full thru-mode capability at all synchronous rates (optical and electrical) is provided with internal TU-n/VTn drop/insert for SDH/SONET ring testing.

PDH/T-carrier

PDH interfaces are supported at ITU-T rates of 2, 8, 34 and 140 Mb/s plus T-carrier rates of DS1 and DS3. Full mux/demux is available, as is PDH/DSn error/alarm generation and detection.

Jitter and Wander

Jitter generation/measurement is available from 2.5 Gb/s through 622/155/52 Mb/s to PDH rates from 140 Mb/s to 2 Mb/s/DS1. Automatic jitter tolerance and automatic narrowband jitter transfer testing is available to ITU-T G.958 for SDH network elements, GR-253 for SONET, and ITU-T G.823 for PDH network elements. Full jitter and wander generation to ITU-T G.825 is available, plus transient pointer jitter measurements to ITU-T G.783/GR.253 and SDH/SONET line rate jitter to ITU-T G.958/GR.253 with RMS and peak-to-peak jitter measurements. Wander generation plus wander measurements at all rates are supported.

ATM

ATM cell capability is provided up to 622 Mb/s (STM-4c/OC-12c) with mux/demux up to 2.5 Gb/s. Full access to ATM cell header, payload test patterns and alarm/error generation is provided.

HP 37719A Communications Performance Analyzer NEW

The HP 37719A offers SONET testing to OC-48 including OC-48c payloads. Rugged and portable, this single-unit solution is ideal for installation, maintenance and manufacturing of SONET networks and network elements. It provides full T-carrier capability and SONET capability. Plus it has a large color display, optional graphics printer, and integral 3.5 inch disk drive for results storage/retrieval and firmware upgrades.

SONET

The HP 37719A provides a single set of multi-rate optical interfaces covering SONET BER and jitter testing at 52 Mb/s, 155 Mb/s, 622 Mb/s and 2.5 Gb/s (OC-1 through to OC-48). In addition, it provides full GR.253 mapping support including concatenated payloads at OC-3c, OC-12c and OC-48c. Optical 1310 nm and 1550 nm interfaces are supported as well as electrical interfaces at 52 Mb/s and 155 Mb/s. Key measurements supported are SONET error/alarm generation, APS times, mixed payloads generation/detection, pointer sequence generation, overhead sequence generation and detection. The instrument supports full mux/demux from 2.5 Gb/s to n x 64 or n x 56 kb/s. The user interface provides error and alarm stored measurement graphics, pointer graphs, in-service alarm/BIP scan and out-of-service tributary scan.

HP Smart Test capability provides fast access to key measurement tasks. HP Smart Setup provides an easy to use graphical means of detecting unknown payload structures and aids the user to set up the instrument quickly. This mode also provides fast detection of payload test patterns.

Full thru-mode capability at all synchronous rates (optical and electrical) is provided with internal VTn drop/insert for SONET ring testing.

T-carrier

T-carrier interfaces are supported at rates of DS1, DS3, E1 and E3. Full mux/demux is available, as is DSn error/alarm generation and detection.

Jitter and Wander

Jitter generation/measurement is available from 2.5 Gb/s through 622/155/52 Mb/s to T-carrier rates from DS3/E3 to DS1/E1. Automatic jitter tolerance and automatic narrowband jitter transfer testing is available to GR.253 for SONET network elements. Transient pointer jitter measurements and SONET line rate jitter to GR.253 with RMS and peak-to-peak jitter measurements are supported, as are wander measurements at all rates.

ATM

ATM cell capability is provided up to 622 Mb/s (OC-12c) with mux/demux up to 2.5 Gb/s. Full access to ATM cell header, payload test patterns and alarm/error generation is provided.

Ordering Information

HP 37718A Communications Performance Analyzer
Option 001 SDH test
Option 002 SONET/SDH test
HP 37719A Communications Performance Analyzer

- One-box solution for SDH, SONET/SDH, PDH, PDH/DSn, ATM, and jitter generation and measurement up to 622 Mb/s
- In-service and out-of-service measurements
- ATM cell generation and analysis, and ATM service layer test
- Comprehensive jitter test capability
- Works with HP E4540A distributed network analysis software

HP 37717C

HP 75000 Series 90

HP 37717C Communications Performance Analyzer

The HP 37717C offers SDH or dual SONET/SDH testing to STM-4/OC-12. It is a modular, upgradeable single-unit solution designed for installation, maintenance and manufacturing of SDH and SONET networks and network elements. The instrument is both rugged and portable and provides full PDH/T-carrier capability and SDH/SONET plus ATM capability. The HP 37717C has a large color display, optional graphics printer plus integral 3.5 inch disk drive for results storage/retrieval and firmware upgrades.

The HP 37717C supports optical interfaces at 52, 155 and 622 Mb/s (STM-0/OC-1 through to STM-4/OC-12). Optical 1310 nm and 1550 nm interfaces are supported as well as electrical interfaces at 52 and 155 Mb/s. Key measurements include SONET/SDH error/alarm generation, APS times, mixed payloads generation/detection, pointer sequence generation, overhead sequence generation and detection.

The instrument is available with PDH interfaces only or can combine PDH/SDH capability. PDH interfaces are supported at ITU-T rates of 2, 8, 34 and 140 Mb/s plus T-carrier rates of DS1 and DS3. Full mux/demux is available, as is PDH/DSn error/alarm generation.

Jitter and Wander

Jitter generation/measurement is available from 622 Mb/s through 155 Mb/s to PDH rates from 140 Mb/s to 2 Mb/s. Automatic jitter tolerance and automatic narrowband jitter transfer testing is available to ITU-T G.958 for SDH network elements and ITU-T G.823 for PDH network elements. Full jitter and wander generation to ITU-T G.825 is available, plus transient pointer jitter measurement to ITU-T G.783 and SDH line rate jitter to ITU-T G.958 with RMS and peak-to-peak jitter measurement. Wander generation and wander measurements are also supported.

ATM

See page 455 for details.

Ordering Information

HP 37717C Communications Performance Analyzer
Accessories
HP 15744A Optical Power Coupler
HP 15770A Rackmount Kit
HP 15772B Hard Transit Case
HP 15910B Soft Vinyl Carrying Case
HP E4540A Distributed Network Analysis Software

HP 75000 Series 90 SONET/SDH Test System for 2.488 Gb/s and WDM

The HP 75000 Series 90 SONET/SDH test system can now be configured for WDM system test. Multiple optical transmitters at rates up to STM-16/OC-48 set at appropriate wavelengths conforming to SONET/SDH standards can be combined with receivers and optical switches to provide a very flexible and scalable test configuration. WDM tributaries can be tested individually with automatic optical switching, or tributaries can be fully loaded to check for WDM channel interaction. A range of optical transmitter wavelengths is available around 1550 nm using DFB laser technology. The Series 90 system can also be configured for jitter testing at 2.488 Gb/s. The Series 90 analyzer is controlled by a PC using the MS Windows 95 environment. For OC-192/STM-64 electrical testing, please refer to page 441.

Ordering Information

HP 75000 Series 90 SONET/SDH Test System

North American Standards

HP E4480A
HP E4487A

- Field-portable test sets for SONET, ATM and T-carrier testing
- Flexible configuration for evolving network testing needs
- Available with OC-12c/OC-3c and ATM testing capabilities

CERJAC 156MTS

CERJAC 156MTS and Series 31XE SONET, ATM and T-carrier Maintenance Test Sets

HP-IB

The field-portable HP E4480A CERJAC 156MTS combines SONET, ATM and T-carrier testing for installation, qualification, and maintenance testing from OC-12 to DS0. The instrument provides a wide array of options to support evolving network measurement needs. "Auto" and "Troublescan" capabilities quickly synchronize with complex network configurations to report errors on a high-contrast display. A full suite of BER test patterns with alarm, error, and pointer monitoring and generation capability is included for T-carrier, clear-channel and ATM payloads.

The HP E4487A CERJAC Series 31XE provides identical capability for testing from STS-1 electrical to DS0.

SONET Applications

- SONET testing at OC-12/3/1 optical interfaces (156MTS only)
- SONET testing at STS-1/B3ZS interface
- Transmission and multiplexer testing
- Alarm stimulus/response testing
- Transport overhead and path trace programming and display
- STS-1 jitter measurements
- Error injection and analysis

ATM Applications

- STS-12c/3c ATM payload testing (156MTS only)
- DS3/HEC, DS3/PLCP, E1, DS1 ATM payload testing
- Foreground and background channel testing
- Cell loss, cell delay and inter-arrival cell delay measurements
- AAL0 and AAL1 BERT testing
- Automatic VP/VC scan and cell capture with filtering

T-carrier Applications

- Full DS3/DS1/FT1/E1/FE1/DS0 transmission testing
- DS1/DS0 testing via M13 or VT1.5 async and byte sync
- E1/TS testing and DS3 mapped E1 testing
- DS3, DS1 and E1 jitter measurements
- DS3 pulse mask measurements
- DS1 in-band and out-of-band loop-up and loop-down testing

Measurement Summary

Common to both products unless otherwise stated.

Optical Interfaces (156MTS only): 622.08 Mb/s (OC-12), 155.52 Mb/s (OC-3), 51.84 Mb/s (OC-1). 1310 nm and 1550 nm intermediate and long reach lasers and interchangeable connectors available. Receive optical power and frequency measurements.

Electrical Interfaces: 51.84 Mb/s (STSX1/B3ZS), 44.763 Mb/s (DSX3/B3ZS), 2.048 Mb/s (E1/AMI/HDB3), 1.544 Mb/s (DSX1/AMI/B8ZS). Receive peak electrical level and frequency measurements.

Frame Formats and Mappings
SONET (156MTS only): STS-12, STS-12c, STS-3, STS-3c.
SONET: STS-1, DS3 and VT1.5 async or byte sync structured.
ATM: AAL0 and AAL1.
DS3: M13, C-bit and unframed, DS1 and E1 structured.
DS1/FT1: D4, ESF, SLC, MBLT and unframed.
E1/FE1: TS0, TS0/16, TS0/CRC, TS0/16/CRC and unframed.

Timing References: Internal Stratum 3, DS1 BITS, loop timing and external.

Drop and insert interfaces: STS-1, DS3, E1, DS1, DCC, V/F.

Payloads (156MTS only): STS-12c, STS-12c/ATM, STS-3c, STS-3c/ATM.
Payloads: DS3, DS3/ATM-HEC, DS3/ATM-PLCP, DS3/DS1/DS0, DS3/E1/TS and VT1.5/DS1/DS0.

Internally Generated Patterns: PRBS23, PRBS20, PRBS15, PRBS11, PRBS9, PRBS6, QRSS, all 1's, all 0's, 3 in 24, 0/1, 55 octet and programmable user patterns.

Jitter Measurements: STS-1 to GR.253, DS3/DS1 to GR.499, E1 to ITU-T G.823, measurement range 0.1-12UI peak-peak, resolution 0.1UI, accuracy +/-5% +/-0.05UI, programmable hits threshold.

Alarm Testing
SONET: LOS, LOF, LOCLK, AIS-L, RDI-L, LOP-P, AIS-P, RDI-P, AIS-V, LOP-V, RDI-V.
ATM: LOS Cell sync, SCNR, LOPAT, VP AIS and RDI, VC AIS and RDI.
DS3: LOS, FFM, OOF, LOP, AIS, CV.
DS1: LOS, OOF, LOP, AIS, Yellow, COFA, Ones density, CDI (Idle).

Error Add and Monitor
SONET: BPV, Frame, B1, B2, B3, REI-L, REI-P, Data, VT1.5 BIP and REI-V.
ATM: HCS, Data, PLCP.
DS3: BPV, Frame, Data, C1, C2, C3, X-bit, FEBE.
DS1: BPV, Frame, CRC, Data.

Overhead Testing
Section: AI, A2, C1, E1, FI and D1-D3.
Line: K1, K2, D4-12, Z1, Z2, E2.
Path: B3, C2, G1, F2, Z3-Z5.
VT: V4, V5.

APS Message Testing: Message displayed in test form to Bellcore GR.253.

Path and VT Path Trace: Generates and monitors user programmable 64 byte sequence.

STS and VT Pointer Monitoring: Increment, decrement and new pointer.
Remote Control: RS-232 and HP-IB SCPI controllable, RS-232 remote front panel, field downloadable software upgrades via RS-232.

Ordering Information

HP E4480A CERJAC 156MTS SONET tester
- **Opt UQG** OC-3/1 testing with 1310nm IR optics
- **Opt UQK** OC-12/3/1 testing with 1310nm IR optics
- **Opt 203** STS-12c/ATM testing
- **Opt 206** 1550nm IR rear-panel laser
- **Opt UQN** STS-1 jitter measurement
- **Opt UQP** DS3 jitter filter

HP E4487A CERJAC Series 31XE tester
- **Opt UQP** DS3 jitter measurement

The following options are common to both products:
- **Opt URZ** Advanced ATM testing
- **Opt URR** DS3 test with drop/insert from STS-1
- **Opt 202** DS3 pulse mask measurements
- **Opt UQZ** Second DS3 transmitter and receiver
- **Opt URS** DS1/DS0 test with drop/insert from DS3
- **Opt UQA** VT1.5 mapping
- **Opt USO** Fractional T1 testing
- **Opt UQQ** DS1 jitter filter
- **Opt URQ** E1/TS test with E1 drop/insert from DS3
- **Opt UQR** E1 jitter filter
- **Opt UHR** HP-IB and RS-232 SCPI interface

HP E6322A DS3 pulse mask graphic software
HP E6347A Remote front panel software
HP E6348A Remote event logging software

- Dispatched and distributed ATM testing
- PVC and SVC ATM installation instrument
- Comprehensive ATM monitor and simulate
- Physical layer monitor and simulate
- Selection of interfaces from 1.5 Mb/s to 155 Mb/s
- AAL 1, 3/4, 5 monitor and simulate
- Extensive LAN and WAN over ATM analysis
- QoS and Traffic Performance Testing
- Compatible with the HP Broadband Series Test System (HP E4200B, E4210B)

HP E5200A

HP E5200A Broadband Service Analyzer

Hewlett-Packard's portable, dual-port E5200A Broadband Service Analyzer enables leading communications companies to deploy and maintain the latest broadband equipment and services simply and accurately. The service analyzer puts you in control immediately by providing service-focused measurements, not just test technology. The testing approach used by the service analyzer represents a fundamental change in measurement methodology from transport and protocol testing to one that gives a service-related view of network problems.

Applications

The HP E5200A Broadband Service Analyzer is a powerful and flexible measuring instrument designed to:
- minimize troubleshooting time
- help meet service delivery requirements
- characterize end-to-end Quality of Service
- enable rapid turn-up of both PVC and SVC ATM networks

Making a Complex Technology Accessible

Whether you have five days' or five years' experience in ATM technology, the HP E5200A Broadband Service Analyzer lets you test your ATM equipment or new installation thoroughly. The Link Monitor automatically detects and monitors ATM channels for content and errors. The Channel Monitor provides detailed, real-time analysis of any channel on the link. Online help offers suggestions on the source of the problem and possible solutions.

Real-Time Multi-Layer Correlation

The service analyzer performs 13,345 simultaneous, real-time measurements on 2048 channels on two ports to report traffic profile and vital alarms and errors, including end-to-end service level AAL errors. The Channel Monitor gives you a graphically-correlated view of the measurements for a selected channel. You can see immediately if service level problems are related to problems in other layers of the protocol stack.

Adaptable to any Environment

The service analyzer can be taken to an installation site to perform out-of-service testing. It comes with a carrying case with room for two additional interface pods, cabling, documentation, and optional PC display.

Compatible with the HP Broadband Series Test System

The HP E5200A Broadband Service Analyzer is compatible with the HP Broadband Series Test System — the industry standard broadband research and development test tool. Compatible data formats and scripts mean that field people can work closely with lab experts. You can take field data to the lab for further analysis, or take advanced test programs to the field.

Load Generation, Dispatched and Distributed Testing

The HP E5200A Broadband Service Analyzer can be scaled from a single port ATM instrument right up to a 20 port load generator. Additionally, the unique architecture of the service analyzer enables display on Win95 and HP-UX.

Specifications

Link Monitor: Allows navigation of a network reporting real-time channel alarms and errors including physical, ATM, AAL, and OAM measurements. Automatic detection of VPs/VCs and determination of AAL types. Bandwidth, bandwidth utilization, and top ten talkers.

Number of Channels: 2048 VPI/VCIs (performed continuously on every cell at up to 155 mb/s, real-time, total on two ports)

Channel Measurements: Cell count/bandwidth, AAL type, OAM alarm condition, errored cell count, high priority cell count, sequence number errors, PDU counts, cell loss count. Further, in-depth measurements can be made on any selected channel on the link.

QoS and Traffic Performance Testing: Automated SMARTtests provide one-touch Quality of Service testing. Tests include cell loss, cell error ratio, cell loss ratio, cell misinsertion, cell transfer delay and cell delay variation. Additionally, a dual-bucket GCRA traffic policing test, cell interarrival test, remote cell loss test, and network stress tests provide a complete insight into network performance.

Macro Programming: Macros are a programming tool using the industry standard Tcl language. Macros can be created using the service analyzer's inbuilt recorder. Macros can be saved to disk and distributed for use on multiple HP E5200A Broadband Service Analyzers.

Data Capture: Data can be captured, viewed, saved to a file, or used to regenerate traffic. Captured data can be processed in order to extract detailed reassembly information.

Simulate: A powerful and flexible traffic simulator allows you to customize data to be injected into a network, or select from predefined patterns and traffic types. Multiple traffic distributions are available and stress testing on multiple channels is made easy.

Data Services Analysis: Filtering at the frame layer on IP addresses (on PVC or SVC Networks) is made easy, and full details of the ATM and AAL layer can be obtained including LAN and frame relay protocols running over ATM.

UNI Signaling Analysis: Full bi-directional UNI Signaling Emulation test suites are available (UNI 3.0/3.1/Q.2931). Decode suites are continuously evolving on the service analyzer.

Physical Interfaces: Interface pods provide the connection to a number of network technologies and line rates and facilitate testing at the physical layer. Interfaces are interchangeable and you can have a mix of interfaces in the one unit. Interface connectivity options include:
- DS1/DS3 (1.5 Mb/s, 45 Mb/s)
- E1 (2.048 Mb/s)
- E3 (34 Mb/s)
- J2 (6.3 Mb/s)
- OC-3/STM-1 singlemode and multimode optical (155 Mb/s)
- STM-1/STS-3c electrical (155 Mb/s)
- ATM 25.6 (25.6 Mb/s)
- 155 UTP-5 solution (155 Mb/s)

Key Literature

Broadband Service Analysis–Coping with the Network Management Test Challenge, p/n 5965-1377E
HP E5200A Broadband Service Analyzer Brochure, p/n 5965-1378E
HP E5200A Broadband Service Analyzer Technical Data, p/n 5966-0714E

Ordering Information

HP E5200A Broadband Service Analyzer
HP E5120A Interface Pod, DS1/DS3
HP E5121A Interface Pod, E3
HP E5122A Interface Pod, OC-3/STM-1 Optical (FC/PC)
HP E5123A Interface Pod, STM-1/STS-3c Electrical (coax)
HP E5124A Interface Pod, OC-3/STM-1 Optical (SC)
HP E5125A Interface Pod, E1 Electrical
HP E5126A Interface Pod, J2 Electrical
HP E5129A Interface Pod, 25.6 Mb/s

HP E4200B
HP E4210B

NEW

HP E4200B/E4210B Broadband Series Test System

HP Broadband Series Test System

When ATM test results really matter, the best engineers turn to the world's most widely used ATM tester, the HP Broadband Series Test System (BSTS). Considered the industry standard ATM test system for both service providers and network equipment manufacturers, the BSTS provides the depth and breadth required for R&D and quality assurance, type approval, and conformance testing of ATM, signaling, IP performance, LAN interworking, WAN interworking, and more. It offers:

- The widest variety of standard interfaces
- The broadest, most comprehensive range of signaling capabilities
- The most complete range of automated conformance test suites
- Extensive range of higher layer protocols for testing LAN, WAN, and MPEG interworking with ATM
- Time-saving features for monitoring, emulation, simulation, load generation, performance, and automated conformance testing

True R&D Power

Each BSTS module and software application has a rich set of test features tailored for equipment design and network test applications. For example, the BSTS signalling emulation software application provides the full reference emulation according to standard specifications, ensuring independent verification of your equipment or network design. You can use the emulation protocol library to build customized test scripts using graphical menus that reflect terminology used in the standard specifications. The Tcl Tool Kit helps you create GUIs for scripted tests easily or you can use one of the many conformance test suites to test implementations of protocols such as UNI signalling.

Real-Time Quality of Service Measurements and Traffic Generation

NEW

The HP E6270A OAM Protocol Tester is the industry's first real-time test solution that helps network equipment manufacturers and service providers incorporate OAM capabilities into their ATM equipment and networks. The HP E6270A also offers features suited to traffic policing and Quality of Service testing. The HP E6287A ABR Emulator gives your BSTS the capability for traffic generation and protocol analysis of ABR RM flows.

High Speed ATM Testing Capabilities

NEW

In addition to the SVC test challenges, many customers require a solution that will enable them to analyze the ATM Adaptation Layer (AAL) and even the Service Layer (ie MPEG-2, LAN protocols, encapsulated Frame Relay) at high speeds. The HP E1618A 622 Mb/s Optical Line Interface provides full-rate 622 Mb/s OC-12c/STM-4c access to the system under test, and extensive SONET/SDH generation and analysis combined with the HP E1609A 0-622 Mb/s ATM Stream Processor. Access to the HP E4209B Cell Protocol Processor enables higher layer protocol testing over a 622 Mb/s interface. The HP E1609A 0-622 Mb/s ATM Stream Processor provides ATM and AAL-5 traffic generation and measurements. The HP E4210B Option 005 2.4 Gb/s ATM analyzer bundle provides extensive real-time SONET/SDH and ATM test capability.

Performance and Interworking Testing

NEW

After basic functional testing is completed, you need to verify your performance specifications. The new HP E1600A Multiport UNI Signalling performance test solution for the BSTS lets you verify the "real world" performance of ATM equipment and networks using the same system that performs your design and conformance testing. The HP E6282A Ethernet Frame Processor allows you to exercise 10/100 Mb/s Ethernet devices at all traffic levels and measure their interworking performance. This complements the extensive range of WAN interworking test products available for the HP BSTS. Now WAN/LAN/ATM interworking is possible from one test platform.

Comprehensive Conformance & Interoperability Testing

In today's multi-vendor open environment, buyers of network equipment and switches can no longer be locked into one supplier whose products are seamlessly integrated. Exhaustive conformance and interoperoperability test suites for the BSTS make it easier to verify that protocol implementation meet ATM standards. The wide range available include test suites for many signalling standards, LAN, SMDS, and ILMI address registration.

Specialized Test Modules

Specialized test modules include the HP E4219A ATM Network Impairment Emulator and the E 6270A OAM Protocol Test module. The HP E4219A lets you check the response of your network and devices by injecting real-world ATM impairments such as cell delay, cell loss, and cell error. The HP E6270A provides testing and emulation of all aspects of OAM and can be used to perform in-service and out-of-service Quality of Service measurements in real time.

System Architecture

Flexible architecture allows you to start with a basic, cost-effective configuration with the ability to expand your test capability as your testing needs change. The BSTS is a modular UNIX-based test system consisting of:

- Line interfaces which provide more than just physical access; they also test the physical, convergence and ATM layers.
- The HP E4209B Cell Protocol Processor (CPP) which tests ATM and AAL layers in real time. Higher layer protocol test software, such as signalling emulation, enables the tester to behave as an active device in the network.
- The new HP E1609A ATM Stream Processor which is a companion to the CPP and line interface that provides you with a new level of real-time ATM and AAL-5 traffic generation and analysis at high speeds of up to 622 Mb/s.

There are two basic systems to choose from. The HP E4210B Form-13 mainframe is a rackmounted chassis with 11 open slots for modules. The HP E4200B Form-7 transportable base, with 5 open slots and a built-in monitor and keyboard, is ideal for field trials. HP BSTS modules and software applications are the same for both systems.

X-Windows networking via TCP/IP at the Ethernet port is supported, which means that you can use the BSTS to solve problems remotely, or multiple users can share the same BSTS.

ATM Testing
E6287A ABR Emulator
E1609A ATM Stream Processor
E6270A OAM Protocol Tester
E4223A ATM Policing and Traffic Characterization Test Application
E4212A AAL Test Software
E4212B AAL Test Software (with AAL-2 support)
E1696A 155 Mb/s (STS-3c/STM-1) Optical Load Generator
E4219A ATM Network Impairment Emulation Module
E4209B Cell Protocol Processor (CPP)

ATM Forum Conformance Test Suites
E7820A UNI 3.0 ATM Layer ETS for Intermediate Systems
E7821A UNI 3.0 ATM Layer Interoperability Test Suite for Intermediate Systems
E7822A UNI 3.0 ATM Layer ETS for End Systems
E7830A UNI 3.1 ATM Layer ETS for Intermediate Systems
E7831A UNI 3.1 ATM Layer Interoperability Test Suite for Intermediate Systems
E7832A UNI 3.1 ATM Layer ETS for End Systems

Signalling
E1600A Multiport UNI Signalling Performance Test Solution
E1601A Quad OC-3C/STM-1 Multimode Port Adapter
E1602A Quad OC-3C/STM-1 Single-mode Port Adapter
E4214B B-ISDN UNI 4.0 Signalling Test Software
E4217B NNI B-ISUP Signalling Test Software
E5145A VB5 Signalling Test Software
E6280A PNNI Signalling Test Software
E6273B ILMI Emulation Test Software

ATM Forum Conformance Test Suites
E7823A UNI 3.0 Signalling ETS for the Network Side
E7833A UNI 3.1 Signalling ETS for the Network Side, Part 1
E7833C UNI 3.1 Complete Signalling ETS for Network Side
E7834A UNI 3.1 Signalling ETS for the User Side
E7842A UNI 3.0/3.1 ILMI Address Registration ETS for User side
E7843A UNI 3.0/3.1 ILMI Address Registration ETS for Network Side
E7844A UNI 4.0 Core Signalling ETS for Network Side
E7845A UNI 4.0 Core Signalling ETS for User Side

MPEG over ATM
E4226B MPEG-2 Protocol Viewer Test Software
E6271A MPEGscope ATM Test Application
E4219A ATM Network Impairment Emulator

WAN Interworking
Frame Relay
E4204A HSSI Line Interface
E4216A Frame Relay Test Software
E6278A Frame Relay SVC Protocol Viewer
E4206A T1/E1 Frame Processor
E4207A V Interface Frame Processor
E6279A Frame Relay over HSSI Test Software
E7840A Frame Relay/ATM Interworking Test Suite
Testing LAN over Frame Relay
E4215B LAN Protocols Test Software
Frame-based UNI
E6275A FUNI Test Software
SMDS
E4211A SMDS Test Software
SMDS DXI
E4213A SMDS DXI Test Software

LAN Interworking
E6282A Ethernet Frame Processor
E6283A LAN/ATM/Frame Relay Interworking Test Software
ATM Forum LAN Emulation
E6272B LAN Emulation Test Software
LAN over ATM
E4215B LAN Protocols Software
LAN Emulation Conformance Test Suite
E7293B ATM Forum LANE 1.0 Complete Service Test Suite

Productivity Tools
E7329A Test Manager API
E5576A Test Manager Integration Kit (TMIK)
E7310A TTCN Productivity Tools
E7313A HP ITEX TTCN Editor

Line Interfaces
SONET/SDH
E1697A 155 Mb/s (STS-3c/STM-1) Optical
E4203A 155 Mb/s Protocol Line Interface
E4205A 155 Mb/s (UTP-5)
E1612A 155 Mb/s (STS-3c/STM-1) Electrical
E1617A 52 Mb/s (STS-1/STM-0)
E1618A 622 Mb/s (STS-12c/STM-4) Analyzer Module
E4210B Opt 005 2.4 Gb/s Test Solution
E4210 Opt 004 622 Mb/s ATM Analyzer Bundle
E4210B Opt 040 622 Mb/s Real-Time ATM Analyzer Bundle
E4210B Opt 140 622 Mb/s Real-Time ATM Protocol Test Bundle
PDH
E1695A 45 Mb/s (DS3)
E1610A 34 Mb/s (E3)
E1613A 6.3 Mb/s (J2) Electrical
E1614A 6.3 Mb/s (J2) Optical
E1616A 1.5/45 Mb/s (DS1/DS3)
E4201A 2.048 Mb/s (E1)
Other
E1619B 25.6 Mb/s (4B/5B)
E1698A 100-140 Mb/s (TAXI 4B/5B)

For More Information
New modules and software test applications for the BSTS are introduced frequently. For up-to-date product information and specifications, visit our website: **http://www.hp.com/go/bsts**. For a copy of a catalog for the HP Broadband Series, contact the HP Call Center in your region and request publication number 5966-0035E.

HP E4829B

- For verification and debugging of today's cell-based communication designs such as ATM chips, hubs, switches and cross-connects
- Connects to 8/16 bit parallel interfaces like UTOPIA or similar proprietary ones
- Handles proprietary cell structures with a length of 16 to 128 words
- Mix of real-time generated and memory-based cell data
- Four independent traffic generators
- Real-time cell analysis includes HEC, CRC-10, BER and Cell Delay Variation (CDV)

HP E4829B Parallel Cell/Traffic Generator and Analyzer System

The HP E4829B parallel cell/traffic generator and analyzer system is a comprehensive verification and debugging tool for today's cell-based communication designs such as ATM chips, ASICs, hubs, switches and cross-connects. Connecting to parallel interfaces such as the 8/16 bit wide UTOPIA or similar proprietary ones, the system meets the requirements of design verification of chips, ASICs and sub-modules, as well as speeding up board/system debugging and root cause analysis.

The concept of building up cells out of single real-time generated and memory-based data segments allows the handling of standard ATM cells as well as proprietary ones, e.g. ATM cells with additional routing tags (see Figure 1).

Four independent traffic generators support CBR and burst-cell traffic, including single, periodic and random cell burst. Full deterministic cell traffic can be set up.

The cell trigger capabilities allow the user to detect dedicated cells, cell patterns, CRC-10 and HEC errors at real-time as an event. Single or multiple events can be combined to start cell acquisition, event count or real-time processing such as time stamp analysis for the measurement of cell delay variation.

Application Examples

- Validation of cell delay variation of switch fabrics under various load conditions
- Stimulation and analysis of proprietary cell formats
- Bring up and debug Line Interface cards (LIFs)
- Verification of UTOPIA implementation of PHY and ATM layer chips/ASICs

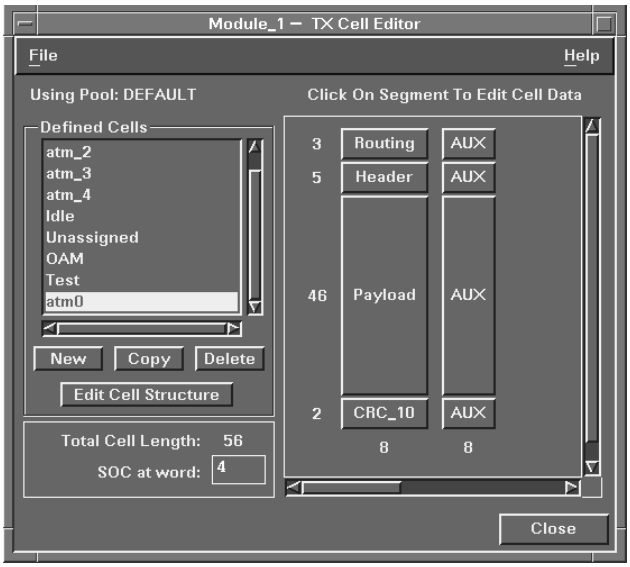


Figure 1: The flexible cell concept handles proprietary cell formats

Modular System

The VXI-based system can be configured for solutions with up to eight ports, which is ideal for switch fabric loading and verification. A single port holds one Transmitter (TX) and one Receiver (RX).

Two different pairs of PODs for custom/UTOPIA Level 1 or UTOPIA Level 2 (MultiPHY) interfaces are available. Both are active TTL-compatible.

The HP E4829B is a complementary product to the HP E4200/E4210 broadband series test system, the industry-standard ATM transmission and protocol tester. The parallel cell/traffic generator and analyzer modules can be added to existing HP E4200/E4210 systems.

Operating Specifications

Interface: 8/16 bit data, Start Of Cell (SOC), Data Valid, Parity and eight auxiliary signals
Handshake: UTOPIA Level 1 Rev. 2.01; UTOPIA Level 2 according to Chapter 4.2 and 4.3. Data Valid/Data Enable signal in custom mode
Data Clock: 90 kHz to 52 MHz, internal or external
Cell Structures: User-defined by single cell segments, cell length 16 to 128 words
Cell Segments: UNI/NNI ATM Header including real-time generated HEC, CRC-10, 32-bit time stamp, PRBS and memory
Transmit Data Memory: 128 KWord
Traffic Generator: Four independent traffic generators to determine the cell distribution of a sequence of cells continuously by varying:
- T_{cell} : the distance between two cells
- T_{pause} : the distance between two cell bursts
- **Count:** number of cells within one cell burst

Cell Trigger Masks: Eight independent trigger cell masks; mask can be set independently for each single bit of a cell
Cell Acquisition: 128 KWord acquisition memory
Real-Time Analysis: Count, CRC-10 errors, HEC errors, bit error rate (BER), cell delay variation

Key Literature

Product Overview 5964-1667E
Technical Data 5963-9923E
Configuration Guide 5964-1605E

For more information, visit our website: **http://www.hp.com/go/dvt**

Ordering Information

HP E4829B 1 Port Entry System
As Extension to the HP E4200B/E4210B

- ATM testing and LAN connectivity measurements
- Physical layer testing with jitter generation and analysis
- In-service and out-of-service testing supported for installation and maintenance or manufacturing test applications
- ANSI, ETSI and ATM Forum standards supported
- Full remote management with HP E4540 Distributed Network Analyzer software
- Portable and rugged; lid-based graphical printer available
- Designed to be soft-upgradeable, making it future proof
- Modular and configurable to suit your ATM test needs

HP 37717C Communications Performance Analyzer

The HP 37717C Communications Performance Analyzer provides solutions for broadband testing from the physical layer up to service layers. The modular nature of this flexible instrument allows it to be configured to match a wide range of applications including installation and maintenance and manufacturing test applications. It can operate at all the most common ANSI and ETSI wide-area transmission rates.

In-Service ATM Analysis

Use the Channel View feature to find and identify up to 1023 active virtual channels on an ATM link, including even single cell events. Observe real-time cell rate/count simultaneously on all found channels. Post analysis of each active channel is performed automatically to identify the AAL or OAM cell type in use; ATM layer alarms are also displayed. Perform detailed analysis at the ATM or higher layers. Monitor real-time in-service cell delay variation graphically using 1-point CDV measurements and count non-conforming cells to I.356. Analyse I.610 performance management OAM cells to obtain cell loss and misinsertion results from live traffic. Analyse AAL errors to gain a useful indication of problems at the ATM layer.

Out-of-Service ATM Analysis

Generate and analyse O.191 Test Cells to obtain measurements for 2-point CDV, cell loss, cell misinsertion and cell errors, according to I.356. Generate up to ten virtual channels, each with a user-definable profile of constant, Poisson or bursty traffic. In addition to Test Cells, generate and analyze single cell or cross-cell (segmented) pseudo-random binary sequences. Inject single or double header errors or payload impairments and generate and identify ATM layer alarms using the F4 and F5 OAM flows.

Physical Layer Features, including Jitter

Analyze physical layer errors, perform G.826 analysis and generate physical layer impairments, generate and identify physical layer alarms. Measure the received clock rate and optical power, and offset the analyzer's internally-generated clock rate. Generate and analyze physical layer jitter which, together with the frequency offset capability, make this analyzer an important tool for checking the jitter tolerance of ATM interfaces.

Ethernet Connectivity

Check LAN over WAN connectivity on Ethernet networks. Use "pings" and Ping History to check the end-to-end service.

Specifications

For information on jitter generation and analysis, and other features of the HP 37717C, see page 449.

Physical Layer (general)
Interfaces: DS1 (1.5Mb/s), DS3 (45Mb/s, direct and PLCP mapped ATM), E1 (2Mb/s), E3 (34Mb/s), E4 (139Mb/s), OC-3c (155Mb/s), STM-1e / STM-1o (155Mb/s)

Physical Layer Generation
Alarm Generation: LOS, LOF, AIS, RAI/RDI
Error Add: DS1: FAS, BPV/code, CRC-6; DS3: FAS, MFAS, BPV/code, parity (P bits), CP (parity), FEBE, EXZ; DS3 PLCP: B1, FEBE, C1, frame; E1: FAS, BPV/code, CRC-4, REBE; E3: BPV/code, BIP
DS3 FEAC: DS3 Loopback control

Physical Layer Analysis
Alarm Indication: LOS, LOF, AIS, RDI/RAI, Loss of DS3 PLCP Frame, Loss of CRC multiframe, DS3 FEAC

ATM Generation
Cell Headers: UNI and NNI, all fields programmable
Traffic Generation: 1 foreground and 9 background virtual channels, each independently settable in bandwidth and distribution (constant, Poisson, bursty (adjustable rate during burst); foreground payload: Test Cell (O.191), PRBS-15, PRBS-23, S-PRBS-9, user-programmed repeating byte
Error Add: Single and double header error; payload bit error
Alarm Generation: VP-RDI, VP-AIS, VC-RDI, VC-AIS

ATM Analysis
Channel View Capture: All VPs (or range) or VCs up to 1023
Channel View Display: Cells/s, cell counts, % bandwidth (numerically and histographically), AAL type or OAM cell type, ATM alarm
Payload Analysis: Test Cell (O.191) related results (to I.356): cell loss count/ratio, cell misinsertion count/rate, cell error count/ratio, mean transfer delay, 2-point cell delay variation; PRBS (as above) bit errors
Rate History: Up to 1000 samples showing histographically the minimum, mean and maximum cell rate within each sample period (1 second to 1 hour)
AAL Analysis: AAL-1: lost cells, corrected and uncorrected SNP errors, count of SAR-PDUs; AAL-3/4: SAR-PDU CRC-10 errors, lost cells, segment type errors, count of received CPCS-PDUs, count of received and aborted SAR-PDUs; AAL-5: CPCS-PDU CRC-32 errors, length errors, length over-run errors, received and aborted CPCS-PDUs
PM-OAM Analysis: Cell loss/misinsertion, BEDC errors
In-service Analysis: 1-point cell delay variation (to I.356)
Alarm Indication: VP-RDI, VP-AIS, VC-RDI, VC-AIS

LAN Connectivity
LAN type: 10 Mb/s Ethernet
Interface: UTP (RJ45) and AUI
Network Protocol: IP
LAN Generation: Single packet manually initiated, continuous ping rate up to 10 per second, end-to-end packet load, variable packet load level from 1 to 550 packets per second, file transfer simulation (bulk transfer-approx. length 1M byte)
LAN Measurement: Ping response time, ping packet return count, ping packet loss count, Ping History — graphically displays results over time, verification of file transfer.

Ordering Information

HP 37717C Communications Performance Analyzer

Protocol Analyzers

HP 37907A Brochure
5966-4022E
Technical Specifications
5966-3923E
3 Dimensional Network Testing AC
5963-1054EN/EUS
Announcing New Multiprong Testing Brochure
5091-7635E
Frame Relay Message Sets Technical Specifications
5963-0085EN/EUS
Frame Relay Test Software Technical Specifications
5963-6653EN/EUS
Frame Relay/SMDS Seminar Book Solution Note
5963-9501E
Group 4 Fax Testing Product Note
5091-2002E
Hewlett-Packard Protocol Testers Brochure
5091-7634E
Integrated FR Testing with PT502 Data Brief
5091-2003E
Integrated SMDS Testing with PT502 Data Brief
5091-2006E
ISDN Primary Rate Testing Solution Note
5963-2013EN/EUS
ISDN Testing Data Brief
5091-2141E
Executable Test Suites for PT Series Technical Specifications
5963-1090EN
Protocol Testing at Bank of Montreal Solution Note
5962-9750EN/EUS
PT Remote Manager Technical Data Technical Specifications
5962-8747E
PT Series Technical Specs Technical Specifications
5963-0082E
V3.0 Test Software Technical Specifications
5963-0086EN/EUS
X.25 Protocol Testing Tech Data Technical Specifications
5962-8746EN/EUS
X.25/X.32/X.75 Testing with HP PTs Brochure
5091-7847E
HP PT Series Protocol Testers
5091-7634E

(PN) SS7 Protocol Testing with PT Series Protocol Testers (PT500)
5962-9408EUS

Digital Transmission Testers

NIU Quick Isolation of DS3 Network Problems
5965-8345E
3-Slot and 12-Slot Equipment Shelves for E4586A DS3 NIU
5963-7141EUS
HP E485XA Serial Cell Generator and Analyzer
5963-9924A
HP 37741A Your Handheld Solution to T1 and FT1 Test
5962-9221E
HP 37701B Take a New Look at Combined T1 and Datacom Testing
5091-8851E
HP 37702A Take a New Look at Combined T1 and DDS Testing
5091-8850E
HP 37717B/C Accurate ATM Cell and Services Testing for Today's Hybrid PDH/SDH/ATM Networks
Data Sheet/Brochure
5965-4968E
HP 37717B/C Multi-Application Testing in a Modular Portable Test Set —To Ease Your Networks Migration to SDH and ATM
Data Sheet/Brochure
5964-0106E
HP 37722/32A "Test Your Telecom and Datacom Circuits with One Instrument" Brochure
5965-3192E
CERJAC Series 31XE Technical Data
5964-2463EUS
HP 37722/32A Configuration Guide
5965-3194E
HP 37722/32A Technical Specifications
5965-3193E
HP E4540A DNA Software "Distributed Testing of PDH, SDH and ATM" Brochure
5964-2240E
HP 71603B Brochure
5965-1431E
HP 71612A Brochure
5963-5269E
T1 Test Advisor Testing Just Got Easier Brochure
5967-6060E
E1 Test Advisor Brochure
5967-6161E
HDSL Installer's Assistant Brochure
5965-8937E

(PN E4540A) Automated Test Sequences for More Effective Testing of SDH and ATM Networks
5965-4911E
(PN E4540E) Interactive Diagnosis for More Effective Support of SDH and ATM | Networks
5965-4912E

SONET/SDH Test Sets

CERJAC 156 MTS Installation and Maintenance Testing for SONET, ATM and T-Carrier
5966-2243E
HP 75000 Series 90 Technical Specification
5965-5817E
HP 37717C Brochure
5964-0106E
HP 37718A Brochure
5976-5870E
Technical Specifications
5968-0974E
HP 37719A Brochure
5968-0761E
Technical Specifications
5968-0976E

(PN E4480A/87A and E4595) Enhanced, Easy-to-Use SONET and T-Carrier Testing
5965-3650E
(PN E4480A/87A) Graphical Control, Measurement and Analysis
5965-3648E
(PN 37778A) Avoiding Synchronization Problems in SDH Networks
5965-4910E
(PN 37717B/C-5) PDH Digital Radio Test
5965-4885E
(PN 37717B) Tributary Jitter Testing of SDH Network Equipment Using ITU-T G.783 Pointer Sequences
5965-4862E
(PN 37717B/C) Automatic Verification of Network Equipment to ITU-T Jitter Tolerance Recommendations
5965-4863E
(PN 37717B/C) Physical Layer Jitter Testing in an ATM Environment
5965-4861E
(PN 37717B/C) Resolve Finger-Pointing Problems on 140 Mb/s Transport Signals
5965-4886E
(PN E4505A-2) Test Sequences for More Effective Testing of SDH and ATM
5965-4911E
(PN E4505A-2, 37717B/C) Interactive Diagnosis For More Effective Support of SDH and ATM Networks
5965-4912E

Many of these literature pieces are available at:
http://www.hp.com/go/tmc99

ATM/Broadband Test Systems

1993 B-ISDN Seminar Handbook Primer
5962-8794E
1994 B-ISDN Seminar Handbook Primer
5962-0011E
1995 Broadband Communications Map
5963-9489E
BSTS Product Ordering Guide
5964-0393E
Conformance and Interlop Testing—What You Must Know
5965-1457E
HP Broadband Series Test System Product Information
5966-0035E
Implementing ATM Signalling Solution Note
5963-7514E
MPEG-2 Digital Video Technology Solution Note
5963-7511E
Traffic Policing Solution Note
5963-7510E
WAN Interworking with ATM Solution Note
5963-7512E
HP E4829B Product Overview
5964-1667E
HP E4829B Technical Data Sheet
5963-9923E
Ease Your Network's Migration to ATM Brochure
5965-4968E
ATM Testing and LAN Connectivity Measurements Under One Handle Brochure
5966-3293E
HP E5200A Broadband Service Analyzer Technical Data
5965-1376E
Broadband Service Analysis–Coping with the Network Test Challenge White Paper
5965-1377E
(PN E4200, 10, 17A) NNI Signalling Test Software Helps Ensure Seamless ATM Networks
5965-6307E
(PN) Proceedings of the 1995 B-ISDN/ATM Protocol Testing Seminar (E4200B, E4210B)
5964-3579E
(PN E4821A, E4829B, E4885A) Implementation of UTOPIA Level 2 for Parallel Cell/Traffic Generator and Analyzer
5965-4856E
(PN E4829B) Cell Transfer Time Measurement Using the Parallel Cell/Traffic Generator and Analyzer
5965-5297E
(PN E482xA/B, E4889A) Real Time Bit Error Rate Analysis at Parallel Interfaces (UTOPIA) with HP E4829B
5965-4855E

Network Management/Monitoring Systems

(PN J3318A) How to calculate a Payback Analysis for HP NetMetrix Distributed WAN Monitoring System
5965-5924E

HP's Test & Measurement Web site.
The more you visit, the more you'll know.

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- Usage Tips
- Application Note Library
- Service, Support and Training
- Sales and Service Contacts
- Selection Guides
- Newsletters
- Feature Stories Showing Products in Use
- Information on Your Industry
- News Releases
- Country-Specific Sites

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Hewlett-Packard Wireless Solutions

1 RF source only.
2 Supports FLEX, FLEX-TD, and POCSAG.
3 Audio measurement only.
4 HP 8920 does LTR, MPT 1327, and EDACS formats.
5 Analog only.
6 Off-the-air monitoring.
7 RF source only, analog only.
8 Available with TDMA only.

Digital Systems

Products	WCDMA	CDMA	CDMA (PCS)	CDPD	CT2-CA1	CT3	DCS 1800	DECT	GSM 900	Paging	PCS 1900	PDC	PHS	TDMA (NADC)	TDMA (NADC) PCS	TETRA
11759C RF Channel Simulator		•	•	•	•	•	•	•	•		•	•	•	•	•	•
307X Series Board Test System		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
37741/42 Transmission Test Set		•	•	•			•		•		•	•		•	•	•
37900D Signal Test Set		•	•				•		•		•			•	•	•
4291B RF Impedance Material Analyzer		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
4352S VCO/PLL Test System		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
4396B RF Network/Spectrum Impedance Analyzer		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
53310 Opt 031/Opt 305 Modulation Domain Analyzer		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
58000 Series Time/Frequency Reference Distribution System		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
663XX DC Power Sources		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
84000 Series RFIC Test System		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
85150B MDS/E4600 Series IV Design System		•	•	•	•	•	•	•	•	•	•		•	•	•	•
8560 Series Portable Spectrum Analyzer	•															
8590 Series Portable Spectrum Analyzer		•	•		•		•	•	•		•	•	•	•	•	
8648A Opt 1EP Signal Generator										2						
8648 and ESG Series Signal Generators																
8711/12/13/14C, 8757 Scalar and Vector Network Analyzers																
8752/53, 8720, 8510 Vector Network Analyzers																
8643/44/47/56/57/62/63/64/65 Signal Generators																
8901A/B Modulation Analyzer																
8903B/E Audio Analyzers																
8920A/B/D/DT RF Communications Test Set											•	•	•	•	•	
8921A Cell Site Test Set, Analog, TDMA, CDMA, CDPD Options		•	•	•										•	•	
8922S/M GSM MobileTest Set							•		•		•					
8923B DECT Test Set								•								
8924C CDMA Mobile Station Test Set		•	•													
8924E CDMA Mobile Station Service Test Set		•	•													
8935 Series Base Station Test Set (CDMA or TDMA)		•	•	8										•	•	•
89400 Series Vector Signal Analyzers	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
94000 Mixed Signal LSI Test System		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
E2507B Multiformat Communications Signal Simulator[1]		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
E2747/48A Vector Waveform Generators		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
E4900 Series Spectrum Monitoring System[6]		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
E7450A RF Coverage Measurement System		•	•													
EPM Series Power Meters		•	•													•
ESA-L1500 Series Portable Spectrum Analyzer																
ESG-D Series Digital Signal Generators	•	•	•				•	•	•		•	•	•	•	•	•
RF Components		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
X-RAY Test System		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

Analog Systems

Products	AM	AMPS/EAMPS	FM/ΦM	JTACS	NAMPS	NMT 450/900	NTACS	TACS/ETACS	TRUNKING
11759C RF Channel Simulator	•	•							
307X Series Board Test System	•	•	•	•	•		•	•	•
37741/42 Transmission Test Set		•		•	•		•	•	
37900D Signal Test Set	•	•	•	•	•		•	•	•
4291B RF Impedance Material Analyzer	•	•	•	•	•		•	•	•
4352S VCO/PLL Test System	•	•	•	•	•		•	•	•
4396B RF Network/Spectrum Impedance Analyzer	•	•	•	•	•		•	•	•
53310 Opt 031/Opt 305 Modulation Domain Analyzer	•	•	•	•	•		•	•	•
58000 Series Time/Frequency Reference Distribution System	•	•	•	•	•		•	•	•
663XX DC Power Sources	•	•	•	•	•		•	•	•
84000 Series RFIC Test System	•	•	•	•	•		•	•	•
85150B MDS/E4600 Series IV Design System	•	•	•	•	•		•	•	•
8560 Series Portable Spectrum Analyzer	•		•						
8590 Series Portable Spectrum Analyzer	•		•						
8648A Opt 1EP Signal Generator	•		•						
8648 and ESG Series Signal Generators	•		•						
8711/12/13/14C, 8757 Scalar and Vector Network Analyzers									
8752/53, 8720, 8510 Vector Network Analyzers									
8643/44/47/56/57/62/63/64/65 Signal Generators	•	•	•	•	•	•	•	•	•
8901A/B Modulation Analyzer	•		•						
8903B/E Audio Analyzers	•	•	•	•	•		•	•	•
8920A/B/D/DT RF Communications Test Set	•	•	•	•	•	•	•	•	4
8921A Cell Site Test Set, Analog, TDMA, CDMA, CDPD Options	•	•	•		•			•	
8922S/M GSM MobileTest Set									
8923B DECT Test Set									
8924C CDMA Mobile Station Test Set		•		•	•		•	•	
8924E CDMA Mobile Station Service Test Set		•		•	•		•		
8935 Series Base Station Test Set (CDMA or TDMA)	•	•	•		•				
89400 Series Vector Signal Analyzers	•	•	•	•	•	•	•	•	•
94000 Mixed Signal LSI Test System	•	•	•	•			•	•	•
E2507B Multiformat Communications Signal Simulator[1]									
E2747/48A Vector Waveform Generators	•	•	•	•	•	•	•	•	•
E4900 Series Spectrum Monitoring System[6]	•	•	•	•	•	•	•	•	•
E7450A RF Coverage Measurement System									
EPM Series Power Meters	•	•	•	•	•		•	•	•
ESA-L1500 Series Portable Spectrum Analyzer	•		•						
ESG-D Series Digital Signal Generators	•		•						
RF Components	•	•	•	•	•		•	•	•
X-RAY Test System	•	•	•	•	•		•	•	•

Measurements

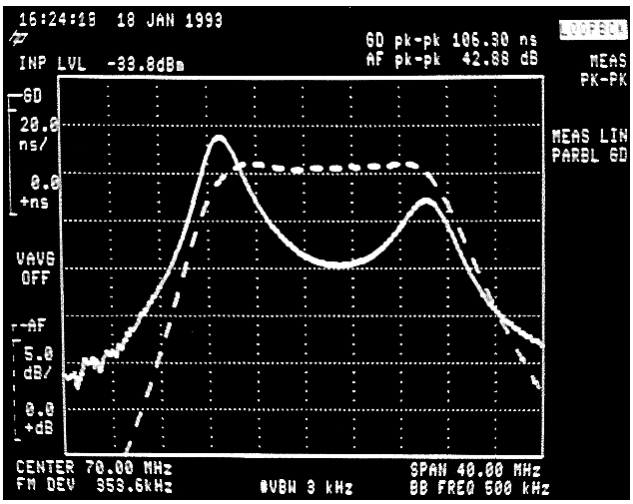
Products	Call Processing	Device Trans./Reflection	Device Complex Imped.	Device Group Delay	Fading Simulation	Functional Test	In-Circuit Test	Receiver Out-of-Channel	Receiver In-Channel	Signaling/Protocol	Spectrum Analysis	Spectrum Monitoring	Transmitter Power	TX Frequency	TX Mod. Quality	TX Ampl. Envelope	R&D	Manufacturing	Field Services
11759C RF Channel Simulator					•												•		
307X Series Board Test System						•	•											•	
37741/42 Transmission Test Set										•									•
37900D Signal Test Set										•									•
4291B RF Impedance Material Analyzer			•														•	•	
4352S VCO/PLL Test System		•		•													•	•	
4396B RF Network/Spectrum Impedance Analyzer		•	•	•							•		•			•	•	•	
53310 Opt 031/Opt 305 Modulation Domain Analyzer															•		•		
58000 Series Time/Frequency Reference Distribution System		•	•			•		•	•		•		•		•		•	•	•
663XX DC Power Sources		•	•	•				•	•		•		•				•	•	
84000 Series RFIC Test System		•	•	•				•	•		•		•				•	•	
85150B MDS/E4600 Series IV Design System		•	•	•	•			•	•		•		•	•	•	•	•		
8560 Series Portable Spectrum Analyzer		•									•		•	•		•	•		
8590 Series Portable Spectrum Analyzer		•									•		•	•	•	•	•	•	•
8648A Opt 1EP Signal Generator						•											•	•	
8648 and ESG Series Signal Generators									7								•	•	
8711/12/13/14C, 8757 Scalar and Vector Network Analyzers		•	5	5													•	•	•
8752/53, 8720, 8510 Vector Network Analyzers		•	•	•													•	•	
8643/44/47/56/57/62/63/64/65 Signal Generators								7	7								•	•	
8901A/B Modulation Analyzer														•	•	•		•	
8903B/E Audio Analyzers								3	3								•	•	
8920A/B/D/DT RF Communications Test Set	•					•		•	•		•		•	•	•	•	•	•	•
8921A Cell Site Test Set, Analog, TDMA, CDMA, CDPD Options						•		•	•		•		•	•	•		•	•	•
8922S/M GSM MobileTest Set	•					•		•	•		•		•	•	•	•	•	•	•
8923B DECT Test Set	•					•		•	•		•		•	•	•	•	•	•	•
8924C CDMA Mobile Station Test Set	•					•		•	•		•		•	•	•		•	•	•
8924E CDMA Mobile Station Service Test Set	•					•		•	•		•		•	•	•				•
8935 Series Base Station Test Set (CDMA or TDMA)						•		•	•		•		•	•	•		•	•	•
89400 Series Vector Signal Analyzers											•		•	•	•	•	•		
94000 Mixed Signal LSI Test System					•													•	
E2507B Multiformat Communications Signal Simulator[1]					•			•	•								•	•	
E2747/48A Vector Waveform Generators																			
E4900 Series Spectrum Monitoring System[6]											•	•		•					•
E7450A RF Coverage Measurement System											•	•		•					•
EPM Series Power Meters													•				•	•	•
ESA-L1500 Series Portable Spectrum Analyzer											•		•	•			•	•	•
ESG-D Series Digital Signal Generators								1	1								•	•	
RF Components																	•	•	
X-RAY Test System																		•	

HP 11758V
HP 11770A
HP 11757B
HP 3708A

- Performs important installation and maintenance measurements
- Easy to use
- Portable and rugged construction
- Group delay and amplitude flatness measurement option

HP 11758V

- An economical way to add high-performance, end-to-end group delay measurements to your spectrum analyzer
- Ideal for digital radio, satellite, and cable testing
- Measures any two-port device between 300 kHz and 2.9 GHz



HP 11758V Digital Radio Test System

The HP 11758V combines several popular HP instruments into one portable system. This combination provides you with an all-in-one portable system that is ideal for the installation and maintenance of microwave radios, and is especially suitable for work in rugged terrain or remote areas.

The HP 11758V can be configured to have all your necessary measurement functions available during radio installation and maintenance. The spectrum analyzer can even control other HP-IB instruments to automate measurements for quicker and more reliable results.

Test Functions

Spectrum Analysis: 50 kHz to 22 GHz (26 GHz optional)
Swept Source: 300 kHz to 2.9 GHz (options to 24 GHz)
Group Delay and Amplitude Flatness: 300 kHz to RF source maximum frequency (Option 201)
Multipath Signature Test Set: 40 MHz to 90 MHz (options to190 MHz)
Power Meter: 10 MHz to 18 GHz (options to 26 GHz)
Frequency Counter: 50 kHz to 22 GHz (options to 26 GHz)
Intermodulation Test Signal: 70 and 140 MHz bands available and more

Key Literature

Data Sheet, p/n 5091-4651E

HP 11757B Multipath Fading Simulator/ Signature Test Set

- Automatic multipath signature measurements
- Measures and prints static M-curves, dynamic M- and S-curves, recovery signatures, recovery times, and dispersive fade margin
- High-performance, lightweight, and economical

The HP 11757B characterizes the equalizers in modern digital microwave radios by introducing a precisely-controlled notch in and around the radio's transmission bandwidth. This allows precise measurements of the equalizers' ability to compensate for multipath fading. The HP 11757B records the measurement automatically on a built-in printer.

Key Literature

Data Sheet, p/n 5091-1052EN
Application Note 355-1, *Tools for Digital Microwave Radio Installation and Maintenance*, p/n 5962-9920E

HP 11770A Link Measurement Personality

Accurately-adjusted group delay and amplitude flatness is critical to the proper performance of virtually every wideband digital or analog communication network. The HP 11770A link measurement personality adds group delay and amplitude flatness measurement capabilities to the HP 11758V, with Option 201, (or to an HP 8593E/94E/95E/96E spectrum analyzer configured with Option 111 group delay and amplitude flatness plus tracking generator). This makes it ideal for testing digital and analog terrestrial radios as well as other broadcast and transmission media like satellite and cable networks.

When this personality is installed in a spectrum analyzer, the HP 11770A is far more portable than any previous solution that makes the same group delay and amplitude flatness measurements, plus it maintains the ease-of-use features you expect from standalone test equipment. This measurement configuration also provides important link analysis functions at a significantly lower cost when compared to using separate pieces of test equipment. DADE and return loss measurements can also be made with the optional switch and bridge.

Key Literature

Data Sheet, p/n 5091-4652E

HP 3708A Noise and Interference Test Set

- Carrier tracking maintains accurate and repeatable C/N and C/I conditions
- 10 to 200 MHz bandwidth accommodates 70/140 MHz IFs

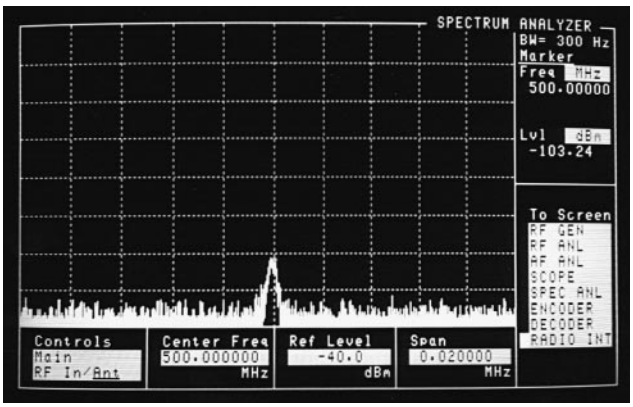
The HP 3708A provides an accurate method of assessing performance of microwave radio and satellite systems by providing carrier-to-noise (C/N) and carrier-to-interference (C/I) to make C/N and C/I versus Bit-Error Ratio (BER) measurements. The HP 3708A can also be used to assess performance of digital TV forward error correction (FEC) by checking the tolerance of quasi-error-free systems to injected noise and interference.

Key Literature

Data Sheet/Brochure, p/n 5953-5433

HP 8920A
HP 11807A

HP 8920A



HP 8920A Spectrum Analyzer displaying signal at –103.2 dBm (1.54 μV). Sensitive Receiver: 2 μV sensitivity (typically < 1 μV), available through the ANT IN port, allows for off-the-air monitoring of low-level signals. For measuring high-power signals, the HP 8920A can accept 100 W intermittently (for 10 seconds) or 60 W continuous.

HP 8920A RF Communications Test Set

The HP 8920A is a full-feature, one-box test set designed to meet service and repair needs in the cellular and land mobile communications market. Combining 22 instruments, the HP 8920A offers full functionality needed in testing cellular phones, land mobile radios, and communications systems up to 1 GHz.

Test and Troubleshoot Faster

The HP 8920A decreases test and troubleshooting time by simplifying standard measurement tasks and providing extensive capability in one box. Transmitters and receivers are simply characterized with single-key RX, TX, and duplex tests. Measured results are displayed on a single screen as either digital measurements or analog bar graphs. All settings and measurements are easily accessed and changed using the front-panel knob, and all settings can be saved in nonvolatile save/recall registers or on a SRAM card media for future access.

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Spectrum Analyzer with Tracking Generator and Adjacent Channel Power

The HP 8920A's optional synthesized spectrum analyzer measures signals from 400 kHz to 1 GHz with variable spans from 5 kHz to 1 GHz (full span). Display resolution is selectable from 1, 2, or 10 dB per division. The tuneable marker provides automatic readout of frequency and amplitude, or of relative frequency or amplitude from a reference. The tracking generator included with the spectrum analyzer allows for swept characterization of devices with fully settable amplitude and sweep spans (to 1 GHz). The newly added adjacent channel power measurement capability includes both variable bandwidths and variable frequency offsets. Typical performance is –70 dBc.

Signaling Encoder and Decoder

The optional signaling encoder and decoder support all common signaling formats, including tone sequential, digital paging, DTMF, trunking, and cellular signaling. Common standards are list-selectable and easily modified for different user formats. The decoder displays the tone or digital sequence transmitted, and the duration of the tone or tone pair. For digital paging transmitters, the decoder will display the address/code, the message, and the transmission rate.

HP 11807A Radio Test Software

The HP 11807A is an easy-to-use software solution for automatic testing of radio receivers and transmitters. Running on the HP 8920A's built-in IBASIC computer, the HP 11807A offers a complete selection of tests for land mobile radios, cellular phones, and communication systems. Its flexibility and modularity allows the user to select and change test sequences, test parameters, and pass/fail limits without programming expertise. All test results are displayed on the screen and can be documented with hard-copy printouts when an external printer is added.

The HP 11807A system support tests (Option 100) give technicians automated test capability for commonly performed tasks on communications systems. System support tests include cable-fault location, intermodulation-products calculation, frequency scanning, and field-strength measurement.

International Cellular Phone Testing Solutions

The HP 8920A is capable of testing the world's most common cellular phones by using the HP 11807A radio test software. Three levels of testing are available: manual phone troubleshooting, quick functional checkout, and full parametric testing to system specifications. Cellular formats supported include AMPS, NAMPS, TACS, NTACS, JTACS, NMT 450, and NMT 900. HP 8920A Option 004 is required for cellular phone tests with HP 11807A software.

Trunked Radio Testing

Three HP 11807A software options are available for testing trunked mobile radios. The options support LTR, EDACS, and MPT 1327 trunked radio equipment with a variety of automated tests available to the user.

Through software control, the HP 8920A will test the ability of a radio to establish a link on a trunked system and can retrieve trunking parameters programmed into a mobile radio. The user can choose from manual operations or automated test sequences for full characterization. Detailed printouts of the radio's performance, with failures highlighted, are output when a printer is used with the HP 8920A. (HP 8920A Option 103 is required for printouts.)

HP 8920A Option 004 is required for trunked system tests with HP 11807A software.

Key Literature

HP 8920A Product Overview, p/n 5963-5197E
HP 8920A Price List, p/n 5966-1734EUS
HP 11807A/E Product Overview, p/n 5965-2783E
Service Applications/Brochure, p/n 5952-2795
Manufacturing Application/Brochure, p/n 5952-2796
Cellular Applications/Brochure, p/n 5091-7627E

HP 8920B Option 800

HP 8920B RF Communications Test Set

The HP 8920B is a full-function test set based upon the HP 8920A design but with increased measurement speed, accuracy, and larger user memory (928 kbytes standard). The HP 8920B uses PCMCIA memory cards for data storage and radio test programs. The HP 8920B has the functionality, speed, and accuracy for testing land mobile radios, cellular telephones and other communications systems while improving throughput and quality in manufacturing.

HP 8920B Option 800 – HP 83206A TDMA Cellular Adapter

The HP 83206A TDMA cellular adapter (HP 8920B Option 800) provides a complete π/4 DQPSK signal generator, π/4 DQPSK modulation analyzer, data source, and BER analyzer for TDMA measurements on DAMPS (IS-54) and DCCH (IS-136) phones. The HP 83206A supersedes the HP 83201B TDMA cellular adapter (HP 8920B Option 500) for making measurements on TDMA dual-mode DAMPS phones, adding digital control channel test features to fully characterize DCCH phones. This option replaces the HP 8920D for TDMA mobile test.

HP 83236B PCS Upgrade Path to 1900 MHz Bands

Extend DCCH test capabilities for future PCS (1900 MHz) phone test by adding the HP 83236B PCS interface to translate DCCH measurement capability to the International and U.S. PCS bands. Power measurement accuracy and speed are maintained at PCS band frequencies with an internal power meter for measurements on CW and TDMA (π/4 pulsed or continuous) signals. HP 8920B Option 801 is an order convenience option that includes the three units needed for PCS mobiles using IS-136 format. Includes: HP 83206A and HP 83236B host firmware integrates the functions of these three units. Also order Options 001, 004, 006, 051, with Option 800 to do IS-136 TDMA mobile test.

The HP 8920B Increases Throughput

The HP 8920B combines a faster processor, increased user memory, and other new features to gain measurement speed over standard HP-IB instruments and the HP 8920A.

Test Time Execution Comparison

HP 8920B compared to:	Typical test time decrease
Stand alone HP-IB instruments	15%
HP 8920A with internal IBASIC programs	30%
HP 8920A program load from memory cards	90%

HP 8920B Has High Performance and Accuracy as Standard Features

Along with speed enhancements, the HP 8920B has signal generator level accuracy or ±1dB at the duplex port and power measurement accuracy or ±5% for levels from 1 mW to 60 watts at the RF In/Out port. Residual FM is less than 7 Hz rms, CCITT. For audio tests, the variable frequency notch filter from 300 Hz to 10 kHz is standard. The FM deviation accuracy is 3.5% and FM distortion less than 0.5%. HP-IB, RS-232, and Centronics ports are standard.

New Call Processing

Cellular phone testing with the HP 8920B has a whole new look and feel with the new call processing subsystem. New front-panel screens simplify manual testing as well as HP-IB programmability. In call-processing mode, the HP 8920B emulates a cellular base station, allowing you to automatically establish and maintain a cellular link between the test set and cellular phone. Use the front-panel knob to register the phone, originate a call, page the phone, hand-off to other channels, change power and release calls as well as make fast parametric measurements while the phone is on an analog voice or a digital traffic channel.

Easier Programming

The new call-processing subsystem also creates a more user-friendly programming interface for automated cellular phone test. High-level HP-IB commands such as “page” and “register” simplify code generation for phone test.

HP VEE programmers will also benefit with the addition of HP 8920B-HP VEE drivers.

HP 11807E Radio Test Software

The HP 11807E radio test software family offers easy-to-use software programs for automatic testing of radio receivers and transmitters. The HP 11807E software family is the same set of tests as included in the HP 11807A family, but on PCMCIA cards to work with the HP 8920B. A complete selection of tests are available for land mobile radios, cellular telephones, and trunked radio communications systems. The new Option 024 software package is available to test cellular on PCS mobiles using AMPS, NAMPS, DAMPS, and DCCH/PCS formats.

Cellular Telephone and Trunked Radio Testing

The HP 8920B is capable of testing many of the world’s analog cellular and trunked radio systems using the software packages in the HP 11807E family. Cellular systems include: AMPS/EAMPS/NAMPS, TACS/ ETACS, JTACS/NTACS, and NADC-TDMA dual-mode, both DAMPS (IS-54) and DCCH (IS-136). The trunked radio system packages are LTR and EDACS (the trunked packages include FM tests).

Flash ROM Makes Firmware Upgrades Simpler

The HP 8920B firmware is contained in Flash ROM which can be upgraded via a PCMCIA card from the front panel in just minutes. The upgrade card can be reused. This helps maintain better process control on your production line by keeping the latest firmware version current with minimum downtime. One card upgrades the HP 8920B host, but a full digital upgrade requires a card set.

Key Literature

HP 8920B Brochure, p/n 5965-4832E
HP 8920B Technical Specifications, p/n 5965-1573E
HP 8920B Configuration Guide, p/n 5966-1736E
HP 8920B Price List, p/n 5966-1735EUS
HP 11807A/E Product Overview, p/n 5965-2783E

HP 8920A
HP 8920B
HP 8920DT
HP 83201B
HP 83206A
HP 83215A
HP 83215B
HP 83236B
HP 11807A
HP 11807E
HP 11807F

HP 8920DT

HP 8920DT Digital RF Communications System

The HP 8920DT system provides parametric test capability for cellular radios using the Personal Digital Cellular (PDC) and Personal Handy Phone System (PHS) formats. The required instruments used in the system are the HP 8920B, HP 83201B, HP 83215A/B, and the HP 11807F control software. The HP 83215A PDC/PHS interface and HP 83215B PHS-only interface provide accurate frequency conversion to bring the test signals into the range of the HP 8920B. The 83201B TDMA Cellular Adapter adds the specific digital signal processing needed for PDC and PHS. The HP 11807F radio test software controls the system to test PDC and PHS radios according to RCR STD-27E (PDC) and STD-28 (PHS). For additional capability, instruments such as spectrum analyzers and signal generators can be added to the system and will be controlled by the system software.

HP 83206A TDMA Cellular Adapter

The HP 83206A TDMA cellular adapter (HP 8920B Option 800) provides a complete π/4 DQPSK signal generator, π/4 DQPSK modulation analyzer, data source, and BER analyzer for TDMA measurements on DAMPS (IS-54) and DCCH (IS-136) phones. The HP 83206A supersedes the HP 83201B TDMA cellular adapter (HP 8920B Option 500) for making measurements on TDMA dual-mode DAMPS phones, adding digital control channel test features to fully characterize DCCH phones.

Key Literature

HP 8920DT Product Overview, p/n 5963-5519E

Ordering Information

HP 8920A RF Communications Test Set
- **Opt 001** High-Stability Timebase
- **Opt 102** Spectrum Analyzer with Tracking Generator and ACP
- **Opt 103** HP-IB/RS-232/Parallel dc Current Measurement
- **Opt 004** Tone/Digital Signaling
- **Opt 007** Low-Level RF Power Measurement
- **Opt 008** Cellular Mobile RF Power Measuring Range
- **Opt 010** 400 Hz High-Pass Filter
- **Opt 011** CCITT Weighting Filter
- **Opt 012** 4 kHz Bandpass Filter
- **Opt 013** C-Message Weighting Filter
- **Opt 014** 6 kHz Bandpass Filter
- **Opt 016** High power input option: 100 watts
- **Opt 019** Variable Frequency Notch Filter
- **Opt 020** Radio Interface Card
- **Opt 050** Dual-Mode Rear-Panel Connectors

HP 11807A Radio Test Software
- **Opt 001** North American FM Tests
- **Opt 002** European PM Tests
- **Opt 003** AM Tests
- **Opt 004** AMPS/EAMPS/NAMPS Cellular Tests
- **Opt 005** TACS/ETACS/NTACS Cellular Tests
- **Opt 006** NMT Cellular Tests
- **Opt 007** JTACS Cellular Tests
- **Opt 008** AMP/NAMPS/TDMA Dual Mode Cellular Tests
- **Opt 009** "Over-the-Air" TDMA Dual-Mode Cellular Phone Tests
- **Opt 010** LTR Trunked Radio Tests
- **Opt 011** EDACS2 Trunked Radio Tests
- **Opt 012** MPT 1327 Trunked Radio Tests
- **Opt 100** System Support Tests

HP 8920B RF Communications Test Set
- **Opt 001** High-Stability Time Base
- **Opt 004** Tone/Digital Signaling
- **Opt 006** 10 W to 50 μW Power Measurement Range
- **Opt 007** Low-Level RF Power Measurements
- **Opt 009** Electronic Attenuator Input Option
- **Opt 010** 400 Hz High-Pass Filter
- **Opt 011** CCITT Weighting Filter
- **Opt 012** 4 kHz Bandpass Filter
- **Opt 013** C-Message Weighting Filter
- **Opt 014** 6 kHz Bandpass Filter
- **Opt 016** High Power Input Option: 100 Watts
- **Opt 020** Radio Interface Card
- **Opt 031** Delete Handle and Cover
- **Opt 051** Dual-mode Rear-Panel Connectors
- **Opt 102** Spectrum Analyzer with Tracking Generator and ACP
- **Opt 500** HP 83201B Option 003 TDMA Cellular Adapter
- **Opt 800** HP 83206A IS-136 TDMA Cellular Adapter
- **Opt 801** Adds HP 83206A and 83236B for IS-136 Tests
- **Opt 1CM** Rackmount Kit Without Handle
- **Opt AXK** Rackmount Kit with Option 500 or 800
- **Opt 0B0** Delete Manual Set

HP 83206A IS-136 TDMA Cellular Adapter

HP 83236B PCS Interface
- **Opt AX4** Rack Flange Kit Without Handles

HP 11807E PCMCIA Radio Test Software for 8920B
- **Opt 001** North American FM Tests
- **Opt 002** European Phi-M Test
- **Opt 003** AM Tests
- **Opt 004** AMPS/EAMPS/NAMPS Cellular Tests
- **Opt 005** TACS/ETACS Cellular Phone Tests
- **Opt 007** JTACS/NTACS Cellular Phone Tests
- **Opt 008** TDMA Dual-Mode Cellular Phone Tests
- **Opt 009** AMPS/EAMPS/NAMPS/TDMA Dual-Mode Cellular Phone Tests
- **Opt 010** LTR Trunked Radio Tests
- **Opt 011** EDACS Trunked Radio Tests
- **Opt 014** AMPS/NAMPS/DAMPS/DCCH Dual-Mode TDMA Cellular Phones
- **Opt 024** AMPS/NAMPS/DAMPS and DCCH/PCS TMDA Cellular Phones
- **Opt 100** System Support Tests

HP8920DT Digital RF Communication System capability is provided using the following primary instruments plus required options:

HP 8920B RF Communication Test Set
HP 83215A RF Interface
HP 83215B PHS (only) RF Interface
HP 83201B TDMA Cellular Adapter
HP 11807F Radio Test Software with Option 021 or Option 022

Some of the following additional instruments may be necessary to perform some tests:

HP 8595E Spectrum Analyzer
HP 85720C PDC Measurement Personality
HP 85726B PHS Measurement Personality
HP 34401A Digital Multimeter
HP ESG-D300A E4432AR Digital and Analog Signal Generator
HP 8643A Synthesized Signal Generator
HP 6642A or HP 6643A DC Power Supply
HP 83219A Test Format Upgrade

Indicates QuickShip availability.

HP 8921A

HP 8921A Cell Site Test Set

The HP 8921A cell site test set is a highly-portable, integrated solution for the installation and maintenance of AMPS and TACS cell sites. The HP 8921A incorporates more than twenty powerful instruments into a compact, 38-pound package. The integral IBASIC controller in the HP 8921A runs the HP 11807B cell site test software to fully automate base station test and adjustment procedures. Automation combined with accurate measurements increases technician efficiency to speed installation and maintenance procedures.

HP 8921A Features Summary

- AM/FM signal generator
- AM/FM modulation analyzer
- Duplex offset generator
- RF power meter
- RF frequency counter/frequency error meter
- Audio frequency counter and power meter
- AC/DC voltmeter
- SINAD/SNR/distortion meter
- Two variable frequency AF generators
- Digital oscilloscope
- Built-in IBASIC controller
- Spectrum analyzer with tracking generator
- Adjacent channel power meter
- Signaling encoder and decoder
- High-stability timebase
- DC current meter
- HP-IB/RS-232/parallel remote interfaces
- Upgradability to TDMA, CDMA, CDPD, or PCS test capability
- Optional cellular base station test software
- Optional Amps cellular phone test software
- Optional radio interface card
- Optional Ericsson PCM reference

Upgrading for New Formats

Beyond testing analog AMPS and TACS base stations, the HP 8921A is ready to grow with your measurement needs for digital cellular systems with upgrades available for:

- TDMA
- CDMA
- CDPD
- PCS (1710–1990 mHz)

High-Performance Spectrum Analyzer

The spectrum analyzer of the HP 8921A has the wide dynamic range and synthesized frequency accuracy previously found only in expensive stand-alone spectrum analyzers. Wide dynamic range allows the HP 8921A to locate low level signals in the presence of high power transmitters. Synthesized frequency accuracy translates into high confidence that you've located the correct signals.

With frequency spans ranging from 1 GHz to as narrow as 5 kHz, the HP 8921A has the flexibility to look at the entire RF spectrum and then zoom in on the desired signals. The marker function displays the frequency and amplitude of any displayed signal. The marker-to-peak function displays the frequency and amplitude of the largest on-screen signal with a single keystroke.

Built-in Tracking Generator

The HP 8921A spectrum analyzer also includes a built-in tracking generator for tuning base station duplexers. With +13 dBm power output (over range), use the tracking generator as an input stimulus to the duplexer. The calibrated level of the spectrum analyzer ensures accurate adjustment of duplexers. Using the marker function of the spectrum analyzer, the rejection of the duplexer can be measured at any point of the filter response. Antenna return loss can be quickly and accurately measured onsite with the HP 8921A tracking generator. Using the tracking generator to drive the antenna through an external VSWR bridge, the reflected power can be measured on the HP 8921A spectrum analyzer. Other measurements performed with the tracking generator include insertion loss and frequency response of filters, cables, or attenuators. The tracking generator features calibrated output level from –137 to +7 dBm and variable frequency offset for IF to RF conversion measurements. Coupled with 1, 2, and 10 dB per division spectrum analyzer ranges, normalization, and marker capability, the tracking generator makes the HP 8921A ideal for all types of measurements and adjustments.

Automated Base Station Maintenance

For complex base station maintenance, the HP 11807B cell site test software, running on the HP 8921A's internal controller, guides the user through each step of the procedure. Graphical displays show connection diagrams and highlight key adjustment points when required. Technicians spend less time learning and more time testing with the HP 8921A cell site test set.

Another software package, the HP 11807B Option 120, provides AMPS system information. The software uses the HP 8921A to scan for and decode local control channels, display system data, and measure key transmitter characteristics.

Key Literature

HP 8921A Brochure, p/n 5965-1579E
HP 8921A Technical Specifications, p/n 5965-7062E
HP 8921A Configuration Guide, p/n 5965-7061E
HP 8921A Price List, p/n 5965-7063E
Also available are videos showing automated testing of cell site equipment:
Optimize Motorola Cell Sites Fast, p/n 5965-2988E
Install and Maintain Ericsson Cell Sites Fast, p/n 5965-2986E
Install and Maintain AT&T Cell Sites Fast, p/n 5965-2987E

HP 8921A Option 600, 602, 603

HP 8921A Option 500, 502, 503

HP 8921A Option 600, 602, 603 CDMA/CDPD Cell Site Test System

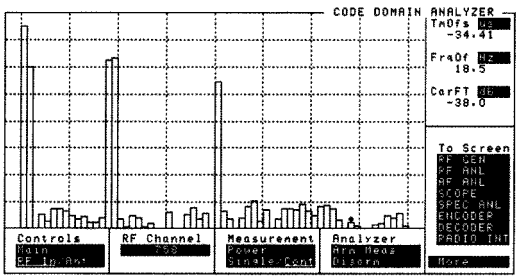
Option 600 for the HP 8921A adds the HP 83205A CDMA cellular adapter to the cell site test set to provide testing of CDMA (IS-95A and IS-97) base station equipment. This system provides signal generation and analysis of QPSK/OQPSK signals. The system measures power in each Walsh-coded signal, code channel timing, and code channel phase relative to the pilot.

The HP 83205A CDPD test option quickly and accurately tests key RF parameters on both the forward-channel transmitter and the reverse-channel receiver. CDPD software, included with all CDPD hardware, automates transmitter, receiver, and system tests—making it easy to standardize system maintenance with fast and accurate test procedures.

HP 8921A Option 600 Features Summary

All HP 8921A standard features, plus:

- Measurements of waveform quality "ρ" (rho), frequency error, time offset, and carrier feedthrough
- Code domain power, timing, and phase analysis
- Average power and CDMA channel power measurements
- CDMA QPSK/OQPSK RF source with data buffer and IS-95 reverse link coding
- Built-in AWGN (Added White Gaussian Noise) source for calibrated E_b/N_o settings



HP 83205A CDMA/CDPD Cellular Adapter

For those who already own HP 8921As, the HP 83205A Option 003 CDMA/CDPD cellular adapter can be added to upgrade the unit to perform the CDMA/CDPD tests described above for the HP 8921A. Note: Older HP 8921As may require an upgrade for complete CDMA capabilities.

HP 8921A Option 500, 502, 503 TDMA/CDPD Cell Site Test System

The HP 8921A Option 500 adds the HP 83204A to the HP 8921A to provide testing of TDMA (IS-136) base station equipment. This unit adds π/4 DQPSK signal generation and analysis to the powerful analog features of the standard HP 8921A. A custom screen provides control of the TDMA source and provides selection of several measurement modes, making all test results visible in one place.

The HP 83204A CDPD test option quickly and accurately tests key RF parameters on both the forward-channel transmitter and the reverse-channel receiver. CDPD software, included with all CDPD hardware, automates transmitter, receiver, and system tests—making it easy to standardize system maintenance with fast and accurate test procedures.

HP 8921A Option 500 Features Summary

All HP 8921A standard features, plus:

- Measurements of TDMA modulation accuracy, including phase error, magnitude error, and error vector magnitude (EVM)
- Measurements of I/Q origin offset and frequency error
- Measurements of adjacent and alternate channel power
- TDMA power measurement
- π/4 DQPSK signal generator
- π/4 DQPSK modulation analyzer
- Continuous/pulsed RF power meter
- Bit-error rate meter
- Baseband data source

HP 83204A TDMA/CDPD Cellular Adapter

For those who already own the HP 8921A cell site test set, the HP 83204A Option 003 TDMA/CDPD cellular adapter can be added to upgrade the unit to provide TDMA (IS-136) and CDPD tests on cell site equipment. Once added, all TDMA test features described above are available for manual use as well as under HP 11807B software control.

HP 83202A Interface Kits

Order the HP 83202A base station connection kit to receive the necessary cables, connectors, and adapters to connect the HP 8921A to a specific type of base station. Available options include connection kits for Motorola, General Electric/Nortel, Ericsson, and AT&T base stations. The 83202A provides everything needed to test base stations with the HP 8921A. Some connection kits also include an interface/switch box to more fully automate the testing process.

HP 83202A Base Station Connection Kits

- Option 032 Ericsson RBS 884 Connection Kit
- Option 040 Motorola Connection Kit
- Option 042 Ericsson Connection Kit
- Option 043 AT&T Connection Kit
- Option 044 GE and Nortel Connection Kit
- Option 070 Motorola AMPS/NAMPS MicroC•I•T•E Connection Kit
- Option 083 Lucent PCS Connection Kit

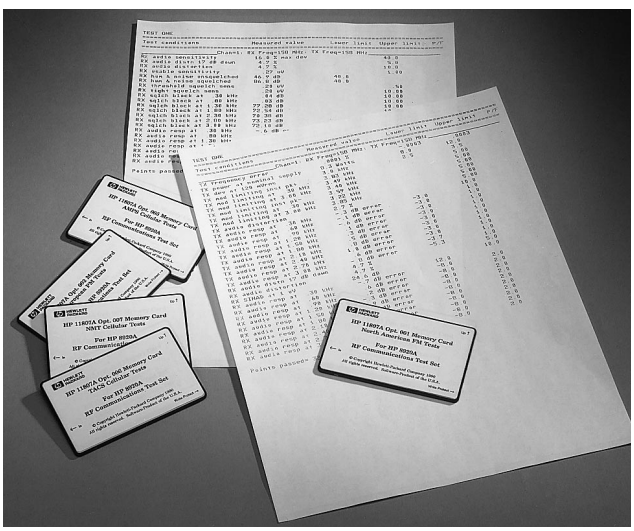
HP 83236B PCS Interface

HP 83236B PCS Interface

The HP 83236B PCS interface extends the HP 8921A CDMA and TDMA measurement capability to the International and U.S. PCS bands. The HP 83236B is controlled via HP-IB from an external controller or from the HP 8921A internal IBASIC controller. The HP 83236B hardware can be integrated with existing HP 8921A systems in the field.

HP 11807B Software for Automated Base Station Maintenance

Developed from manufacturers' recommended maintenance procedures, the HP 11807B cell site test software ensures complete test and adjustment of cell sites. Standardizing system maintenance with the HP 8921A and HP 11807B software increases system integrity. The fast measurement speed of the HP 8921A and HP 11807B software results in less off-line time for each transceiver during maintenance work. Since all cells are uniformly tested using the same test procedure, problems are detected earlier.



Hewlett-Packard has automated testing solutions for the following manufacturers' equipment:

- Motorola HDII, HDII/NAMPS, LD series, TACS, ETACS, UTACS, EUTACS, and MicroC•I•T•E AMPS/NAMPS
- GE standard, extended frequency, and compact RCU series
- Ericsson 882 and 882M analog, microcell, 882D DTRM, and 883, 883M TACS/ETACS, and 884
- Lucent Autoplex Series II analog, LMT microcell, and TDMA/CDMA
- Nortel DRU and P-series
- Hughes GMH 2000 AMPS

In addition to the automated maintenance procedures, the HP 11807B Option 120 provides detailed analysis of AMPS cellular networks. An automated application using the HP 8921A's receiver and decoder, the package displays a wealth of AMPS system data. The system can find local AMPS control channels and display decoded forward control channel data. Other modes decode reverse control channel data, follow calls, and perform measurements on sites or mobiles (see product overview, p/n 5963-6891 EUS).

Total HP Support for Your Cell Site Test Needs

HP offers a variety of options to support cell site testing and keep your solution up to date with the latest technology. The HP 11807B software Option +36H Start-Up Assistance provides one day of on-site training for up to five people. Additional HP consulting/training is also available as needed. Option +SAJ Software Update Subscription keeps your software current by ensuring you get all software enhancements/updates sent to you automatically.

Key Literature

HP 8921A Brochure, p/n 5965-7062E
HP 8921A Technical Specifications, p/n 5965-7062E
HP 8921A Configuration Guide, p/n 5965-7061E
HP 8921A Price List, p/n 5965-7063E
Also available are videos showing automated testing of cell site equipment:
Optimize Motorola Cell Sites Fast, p/n 1000-1300
Install and Maintain Ericsson Cell Sites Fast, p/n 1000-1297
Install and Maintain AT&T Cell Sites Fast, p/n 1000-1304

Ordering Information

AMPS/TACS and CDMA/TDMA/CDPD Cell Site Test
HP 8921A Cell Site Test Set
- **Opt 011** CCITT Weighting Filter
- **Opt 020** Radio Interface Adapter
- **Opt 042** Ericsson PCM Reference
- **Opt 500** TDMA Cell Site Test System
- **Opt 502** CDPD MDBS Cell Site Test System
- **Opt 503** TDMA/CDPD MDBS Cell Site Test System
- **Opt 600** CDMA Cell Site Test System
- **Opt 602** CDPD MDBS Cell Site Test System
- **Opt 603** CDMA/CDPD MDBS Cell Site Test System
- **Opt W30** Three-Year Warranty

HP 83204A TDMA Cellular Adapter
- **Opt 001** TDMA Cellular Adapter, upgradeable to CDPD
- **Opt 002** CDPD Cellular Adapter, upgradeable to TDMA
- **Opt 003** TDMA/CDPD Cellular Adapter

HP 83205A CDMA Cellular Adapter
- **Opt 001** CDMA Cellular Adapter, upgradeable to CDPD
- **Opt 002** CDPD Cellular Adapter, upgradeable to CDMA
- **Opt 003** CDMA/CDPD Cellular Adapter

HP 83236B PCS Interface

Software for Automated Base Station Maintenance
HP 11807B Cell Site Test Software
- **Opt 040** Motorola AMPS/NAMPS Test Software
- **Opt 041** General Electric AMPS Test Software
- **Opt 042** Ericsson AMPS/TDMA Test Software
- **Opt 043** AT&T AMPS/TDMA Test Software
- **Opt 044** Nortel AMPS/TDMA Test Software
- **Opt 045** Hughes AMPS Test
- **Opt 050** Motorola TACS/ETACS/UTACS Test Software
- **Opt 052** Ericsson TACS Test Software
- **Opt 070** Motorola AMPS/NAMPS MicroC•I•T•E
- **Opt 120** AMPS Call Analysis, Logging and Monitoring Software

Base Station Connection Kits
HP 83202A Base Station Connection Kit
- **Opt 032** Ericsson RBS 884 Connection Kit
- **Opt 040** Motorola Connection Kit
- **Opt 042** Ericsson Connection Kit
- **Opt 043** AT&T Connection Kit
- **Opt 044** GE and Nortel Connection Kit
- **Opt 070** Motorola MicroC•I•T•E
- **Opt 083** Lucent CDMA/TDMA Base Station Connector Kit
- **Opt 023** Lucent Cellular Base Station Test Software
- **Opt 032** Ericsson RBS884 Base Station Test Software

HP 8935

NEW

- New generation of base station test equipment
- Improve technician efficiency and enhance system performance
- New User Interface
- Rugged, portable design

HP 8935 Series Cellular/PCS Base Station Test Sets

The HP 8935 series is a flexible platform that currently includes two full featured, one-box test sets, for CDMA (E6380A) and for TDMA (E6381A). In addition, this platform will support additional wireless formats in the future. The 8935 series is designed to meet the needs of installation teams, service providers, and network equipment manufacturers. Building on the success of our previous generations of base station test equipment, this new generation of test gear heavily incorporates feedback from cellular and PCS users. For example, the HP 8935 series utilizes a new, larger, bright electro-luminescent display for easily read data. A new convenient connector section allows unobtrusive, out-of-the-way hook up. A suitcase form factor provides better portability. The HP 8935's new "rugged design" combines a membrane keypad, a gasketed display, stand up operation, filtered airflow and an enclosure to help protect itself from bumps and shocks.

More importantly, the new HP 8935 incorporates a less intimidating, user-friendly interface with Windows® type pull down menus. This new interface, coupled with the HP 8935's faster measurement speed and automated software for vendor specific base stations results in less off-line time and improved system performance. Errors due to test variability are reduced and measurement data can be output to a printer or to the PCMCIA memory card. Additionally, firmware is user upgradeable with a PCMCIA card to Flash PROM. New features and capabilities can be added without returning the unit to a service center. To round out HP's new instrument, the HP 8935 Series includes options for new technician training programs to provide install teams and service providers educational opportunities in CDMA technology and base station test.

HP 8935 Series Key Feature Summary

- Power measurements
  - Average power
  - Channel power
- Site Tests (requires E6554A - RF Tools Hardware Accessory Kit)
  - Return loss (SWR) measurements
  - Cable fault location measurements
  - Insertion loss measurements
- Ruggedized design
- Large, electro-luminescent screen (important for outdoor testing)
- Convenient connector placement
- One-button user interface keys
- Pull-down menus
- Optional automation software
- User upgradeable firmware - PCMCIA to Flash PROM
- AM/FM signal generator
- AM/FM modulation analyzer
- Duplex offset generator
- RF power meter
- RF frequency counter/frequency error meter
- Audio frequency counter and power meter
- Spectrum analyzer with tracking generator (200 kHz-1GHz, 1.7-2 GHz)
- DC current meter
- HP-IB/RS-232/parallel remote interfaces
- High-stability time base
- AC/DC voltmeter
- Digital oscilloscope
- Built-in I-BASIC controller
- Decoder for NAMPS

Rugged Design

The mechanical design of the HP 8935 Series addresses the physical requirements of today's PCS base station which may be exposed to environmental elements. Ruggedized attributes include:

- Membrane keypad-resists moisture and dirt, easily cleaned, high reliability
- Gasketed display-to keep moisture out
- Stand-up operation-needed for outdoor base stations with no place to set equipment
- Low center of gravity to minimize tip-overs when unit is standing
- Filtered air-flow keeps dirt and dust out of instrument for improved reliability and safety

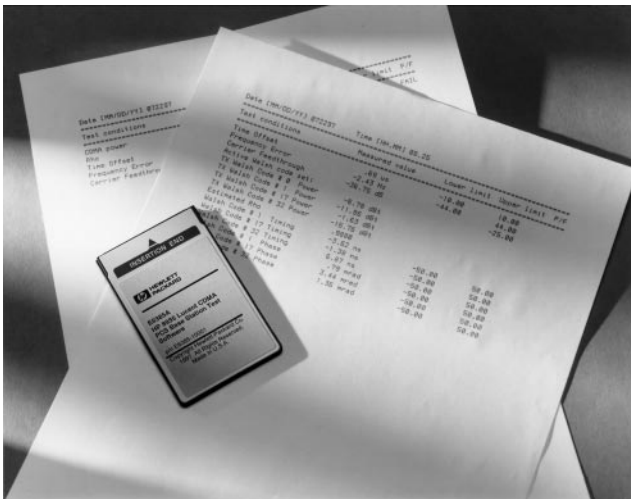
Portability

The newly enhanced mechanical design provides a "suitcase" form factor that is less bulky and more manageable. Total weight of the unit measures 49 lbs. No additional add-on boxes are required to implement receiver testing.

Key Literature

HP 8935 Series Brochure p/n 5966-4168E
HP 8935 CDMA Technical Specifications p/n 5966-0512E
HP 8935 TDMA Technical Specifications p/n 5966-4358E
HP 8935 Series Configuration Guide p/n 5967-6041E
HP 8935 CDMA Price List p/n 5966-0689EUS
HP 8935 TDMA Price List p/n 5967-6120EUS

The new user interface provides "pull-down" menus which replaces the previous lower right hand corner menu system. This increases usable viewing space making it less congested and easier to read.



E6380A CDMA Cellular/PCS Base Station Test Set

The E6380A is the CDMA member of the HP 8935 Series. This one-box solution characterizes Cellular (850MHz) AMPS/CDMA and PCS (1900 MHz) CDMA base stations. Specific CDMA oriented measurements made by the E6380A include:

- CDMA Signal quality measurements
  - Rho (ρ)
  - Non-intrusive Rho (ρ)
  - Time offset
  - Frequency error
  - Carrier feedthrough
- Code domain measurements
  - Code domain power (absolute + relative)
  - Code domain timing
  - Code domain phase
- Error vector magnitude, magnitude error, phase error
- PN offset search
- Reverse channel source with data buffer
- AWGN (built-in calibrated E_b/N_o levels)
- Support for CDMA reference clocks and triggers

E6381A TDMA Cellular/PCS Base Station Test Set

NEW

The E6381A is the TDMA member of the HP 8935 Series. This one-box solution characterizes Cellular (850 MHz) AMPS/TDMA and PCS (1900 MHz) TDMA base stations. The E6381A test set provides verification of base station performance using its built in TDMA analyzer. An optional rubidium oscillator is available which provides extremely accurate frequency error measurements. Specific TDMA measurements made by the E6381A include:

- Modulation quality
  - Error Vector Magnitude EVM
  - Phase Error
  - Magnitude Error
  - Carrier feedthrough
- Average power
- Frequency Error
- Adjacent channel power
- First and second alternate channel power

In addition, a pi/4 DQPSK TDMA signal generator is also included in the E6381A. This generator makes the E6381A receiver test capable.

HP 8935 Series Software for Automated Base Station Installation and Maintenance

Developed from manufacturer's recommended installation and maintenance procedures, the HP 8935 Series cell site test software ensures complete cell site testing. Software enhancements for vendor specific base station equipment provides structured, automated testing. A simple menu-driven user interface requires less technical expertise to retrieve consistent reported measurements. Less skilled technicians can make measurements with the same confidence as their highly skilled/experienced counterparts. The software is contained on a PCMCIA card.

HP 8935 Series Connection Kits

Order the HP 8935 Series base station connection kit to receive the necessary cables, connectors, and adapters to connect the HP 8935 Series to a specific type of base station. Connection kit hardware is housed in foam filled transit case.

Total HP Support for Your Base Station Test Needs

HP offers a variety of options to support base station testing and to keep your solution up-to-date with the latest technology. HP also offers start-up assistance and formal training programs. Additional HP consulting/training is also available as needed.

Ordering Information

E6380A (HP 8935) CDMA Cellular/PCS Base Station Test Set
- **Opt 1D5** High Stability Frequency Reference
- **Opt OBK** Paper and CD ROM Manual
- **Opt OBC** Manual on CD-ROM Only
- **Opt W30** Two years additional Warranty

E6381A HP 8935 Series TDMA Base Station Test Set
- **Option AY5** Rubidium Timebase
- **Option 0BK** Paper Manuals
- **Option W30** Two Years Additional Warranty
- **Option W50** Four Years Additional Warranty

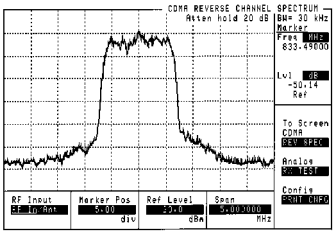
Software for the E6380A CDMA Base Station Test Set:
E6388A LGIC CDMA PCS Base Station Test Software
E6385A Lucent CDMA PCS Base Station Test Software
E6387A Nortel CDMA PCS Base Station Test Software
E6386A Samsung CDMA PCS Base Station Test Software

Software for the E6381A TDMA Base Station Test Set:
E8304A Ericsson RBS 882 AMPS/TDMA Base Station Test Software
E6555A Ericsson RBS 884 AMPS/TDMA Base Station Test Software
E6559A Lucent Cellular AMPS/TDMA Base Station Test Software
E6557A Lucent TDMA PCS Minicell Base Station Test Software
E6389A Nortel TRU/P-Series AMPS/TDMABase Station Test Software

Connection kits for the E6380A CDMA Base Station Test Set:
E8300A Lucent Base Station Connection Kit
E6550A Samsung CDMA Base Station Test Solution
E6554A RF Tools Hardware Accessory Kit

Connection kits for the E6381A TDMA Base Station Test Set
E6556A Ericsson RBS 884 Base Station Connection Kit
E6558A Ericsson RBS 882 and 884 Base Station Connection Kit
E8300A Lucent Base Station Connection Kit
E8302A Nortel TRU/P-Series Base Station Connection Kit
E6554A RF Tools Hardware Accessory Kit

HP 8924C



HP 8924C CDMA Mobile Station Test Set

The HP 8924C CDMA Mobile Station Test Set provides the key set of measurements to manufacture high quality Dual Mode CDMA mobile telephones in a single box. Acting as a calibrated, high performance CDMA base station, the HP 8924C verifies not only the parametric performance of CDMA phones, but also the functional aspects of phone performance. The HP 8924C is optimized to provide high accuracy measurements with the speed required for efficient manufacturing. The standard HP 8924C tests IS-95A-compliant CDMA phones for use with systems that operate from 500 MHz to 1000 MHz. In addition to its CDMA functionality, the HP 8924C includes full AMPS, NAMPS, TACS, NTACS and JTACS analog phone test capability. To extend the capabilities of the HP 8924C to test PCS CDMA phones, order Option 601 with the HP 8924C. This option adds the HP 83236B PCS Interface to cover the 1700 to 2000 MHz frequency range. When attached, the PCS Interface is transparently controlled by the HP 8924C. Together, the HP 83236B PCS Interface and HP 8924C operate as one instrument for both manual and HP-IB control applications. With the HP 8924C, you save cost by making both analog cellular and CDMA digital cellular/PCS measurements with one instrument.

CDMA Base Station Simulator

The HP 8924C includes a full QPSK signal generator that follows the TIA IS-95A CDMA air interface specifications for base stations. The CDMA Signal Generator supports an AWGN (Additive White Gaussian Noise) source as well as up to two CDMA sectors. Sector A supports the following CDMA channels: Pilot, Sync, Paging, Traffic, and OCNS. Sector B offers only a Pilot channel, Traffic channel and OCNS channel. Absolute power is individually settable for the AWGN source, Sector A, and Sector B in terms of total power in a 1.23 MHz bandwidth. The total CDMA signal generator power is the sum of these three settings.

Using industry standard ASIC's, the HP 8924C supports the protocol required to emulate a CDMA base station for mobile station test. The HP 8924C also includes a full OQPSK demodulator for CDMA mobile station transmitter and Frame-Error-Rate receiver measurements.

Functional CDMA Mobile Test

The HP 8924C supports both mobile or base station initiated call connect and disconnect. Enter the required RF channel number, wait for the mobile to acquire service, connect the CDMA mobile to the HP 8924C, and press the call key to make a CDMA phone call. To check voice quality, the HP 8924C offers a voice echo mode. When active, the voice echo mode delays and then re-transmits to the mobile-under-test any audio spoken into the CDMA mobile. An operator can quickly verify voice quality by speaking into the phone and then listening to the echoed audio in the mobile's handset.

CDMA Transmitter Tests

Transmitter tests include fast, DSP-based average power measurements from +38 dBm down to –10 dBm, and accurate channel power and access probe power measurements down to –50 dBm. The tuned channel power measurement reports the power in a 1.23 MHz bandwidth. By calibrating the tuned channel power measurement against the average power measurement, the HP 8924C achieves accurate low level CDMA power measurements. These two power measurement modes allow accurate verification of maximum power, minimum power, open loop power control, and closed loop power control.

The HP 8924C measures transmitted waveform compatibility by the IS-98A recommended correlated power method "ρ" (rho). This measurement returns the percentage of transmitted power that correlates to the desired code. In addition, the "ρ" measurement reports the frequency error, modulation phase and amplitude error, and the carrier feedthrough.

CDMA Receiver Tests

The key performance parameter for CDMA mobile station receivers is Frame-Error-Rate performance with and without the presence of AWGN. The built-in, high accuracy AWGN generator in the HP 8924C guarantees that FER tests provide a true picture of a CDMA mobile to correctly demodulate a signal in the presence of high interfering noise. The HP 8924C fully supports service Options 002 and 009 (RF loopback mode) to test receiver FER performance. The HP 8924C optimizes FER measurement time by employing confidence limit technology. With confidence limits, FER measurements are made in the fastest possible time.

Softer Handoff Verification

With two configurable CDMA sectors, the HP 8924C verifies the ability of a CDMA mobile to support softer handoffs. Softer handoff is similar to soft handoff and only differs in that the HP 8924C sends identical power control bits to both CDMA cell sectors. This advanced capability in a single instrument provides a low cost method of verifying soft handoff functionality without the expense of two base station simulators.

Analog Capabilities

In addition to its powerful CDMA test capabilities, the HP 8924C retains full analog cellular test capability. Based on the HP 8920B RF Communications Test Set, the HP 8924C is backwards compatible with most HP 8920B HP-IB commands. The HP 8924C includes as standard equipment a high stability timebase, a CCITT filter, a 6 kHz bandpass filter, and spectrum analyzer/tracking generator. In addition, the HP 8924C supports easy CDMA to analog handoffs and "one-button" analog cellular call processing for AMPS, NAMPS, TACS, NTACS, and JTACS phones . These analog features not only allow the HP 8924C to test dual mode phones, but also provides an effective suite of measurement tools for radio troubleshooting.

HP 83217A Dual-mode Mobile Station Test Software

Besides its many measurement functions, the HP 8924C includes a programmable IBASIC controller. This controller allows the creation of custom measurement software. The HP 83217A automates CMDA dual-mode mobile measurements using the HP 8924C. Automated testing improves consistency and reduces operator error resulting in lower operation costs and improved product quality.

The HP 83217A offers two options for testing cellular mobile stations. Option 001 supports testing of mobiles that are AMPS, NAMPS, and CDMA dual mode, while Option 004 supports PCS CDMA/AMPS, or NAMPS dual mode, dual-band phone testing. These software packages provide a comprehensive suite of analog and digital tests that can be freely arranged to fit specific requirements. Test points, test limits, and test sequences can be stored for future retrieval.

Short Message Service Testing

The HP 8924C supports mobile terminated SMS on both paging and traffic channels. It also supports service option 006 and 014 SMS traffic channels. Messages can be sent in both ASCII and HEX formats to support international character sets.

CDMA and AMPS Authentication Testing

Full-featured authentication testing supports both CDMA (US and Korean) and AMPS. The HP 8924C displays expected mobile phone values and actual values returned. SSD update, A-key entry, RANDC and other authentication procedures are supported.

Key Literature

HP 8924C Technical Specifications, p/n 5965-8436E
HP 8924C Brochure, p/n 5966-2249E
HP 8924C Price List, p/n 5965-8439EUS

Analog Mode Specification Summary

Signal Generator

RF Frequency Range
Standard: 30 MHz to 1000 MHz
With Option 601: 800 MHz to 960 MHz, 1710 MHz to 1990 MHz

Output
RF In/Out Connector
Level Range
Standard: –127 to –10.5 dBm into 50 ohms
With Option 601: –130 to –20 dBm into 50 ohms
Level Accuracy
Standard: ±1.2 dB (Level >= –127 dBm)
With Option 601: ±1.8 dB @ 25˚ C ±10˚ C
Reverse Power
Standard: 3 watts continuous
With Option 601: 10 watts continuous
Duplex Out/RF Out Only Connector
Level Range
Standard: –127 to +3.5 dBm into 50 ohms
With Option 601: –130 to –10 dBm into 50 ohms
Level Accuracy
Standard: ±1.0 dB (Level >= –127 dBm)
With Option 601: ±1.8 dB @ 25˚ C ±10˚ C
Reverse Power: 200 mW maximum

Maximum FM Deviation (rates > 25 Hz)
Standard: 100 kHz; 501 MHz to 1000 MHz
With Option 601: 100 kHz; 800 to 960 MHz, 1710 to 1990 MHz

RF Analyzer

Frequency Measurement Range
Standard: 30 MHz to 1000 MHz
With Option 601: 800 MHz to 960 MHz, 1710 MHz to 1990 MHz

RF Power Measurement (RF in/out connector only)
Measurement Range
Standard: –10 dBm to +35 dBm (0.1 mW to 3 W)
With Option 601: –13 dBm to +40 dBm (50 μW to 10 W)
Accuracy
Standard: ±5% of reading ±0.01 mW from 15˚ C to 35˚ C
With Option 601: ±5% of reading ±2.5 μW from 13˚ C to 33˚ C

Spectrum Analyzer

Frequency Range:
Standard: 30 MHz to 1000 MHz
With Option 601: 800 MHz to 960 MHz, 1710 MHz to 1990 MHz
Resolution Bandwidth (coupled to span): 300 Hz to 300 kHz
Display Range: 80 dB

AF Analyzer

Frequency Measurement
Measurement Range: 20 Hz to 400 kHz
Accuracy: ±0.02% + resolution + reference oscillator accuracy

SINAD Measurement
Fundamental Frequency Range: 300 Hz to 10 kHz ±5%
Accuracy: ±1 dB for Fc=300 to 1500 Hz, using the 15 kHz LPF
Residual THD+Noise: –60 dB or 150 μV, whichever is greater

Oscilloscope

Frequency Range (–3 dB BW): 2 Hz to 50 kHz
Scale/Division: 10 mV to 10 V
Time/Division: 10 μs to 100 ms

Remote Programming

HP-IB: Hewlett-Packard's implementation of IEEE Standard 488.2
RS-232: 3-wire RJ-11 connector used for serial data in and out
Centronics Port: Industry standard parallel printer port

Ovenized Reference

Aging Rate: <0.005 ppm pk-pk/day, <±0.1 ppm per year

CDMA Mode Specification Summary

CDMA Call Processing Functionality

Protocol Stack: IS-95, IS-95A, TSB-74, J-STD-008, and ARIB-T53
Service Option Modes: SO 001, SO 002 (9600 bps loopback), SO 003, SO 009 (14400 bps loopback), SO 32768, SO 006, and SO 014
Traffic Channel Data Rates: 9.6 kbps or 14.4 kbps
Call Control: BS call originate, BS call disconnect, MS call originate, MS call disconnect
Hand-off Support: CDMA to CDMA Hard (RF Frequency), CDMA Softer, CDMA to Analog (intraband), and CDMA PCS to Analog Cellular

CDMA Signal Generator

CDMA Channels
Additive White Gaussian Noise
Sector A – includes the following channels: Pilot Channel, Sync Channel, Paging Channel, Traffic Channel, and OCNS Channel
Sector B – includes the following channels: Pilot Channel, Traffic Channel,and OCNS Channel

Frequency Range
Standard: 501 MHz to 1000 MHz, usable from 30 to 248.9 MHz
With Option 601: 800 MHz to 960 MHz, 1710 MHz to 1990 MHz

Composite Signal Output Level Range
Standard:
RF In/Out: –109 dBm/1.23 MHz to –21.5 dBm/1.23 MHz
Duplex Out: –109 dBm/1.23 MHz to –7.5 dBm/1.23 MHz
With Option 601:
RF In/Out: –109 dBm/1.23 MHz to –20.01 dBm/1.23 MHz
RF Out Only: –109 dBm/1.23 MHz to –10.01 dBm/1.23 MHz

Composite Signal Output Level Accuracy (AWGN off)
Standard: ±1.5 dB, typically ±1.0 dB
With Option 601: ±1.8 dB at 25˚ C ±10˚ C , typically ±1.0 dB

Relative CDMA Channel Level Accuracy: 0.2 dB

CDMA Analyzer

CDMA Average Power Measurement
Input Frequency Range:
Standard: 30 MHz to 1000 MHz
With Option 601: 800 MHz to 960 MHz, 1710 MHz to 1990 MHz
Measurement Range (RF in/out connector only):
Standard: –10 dBm to +35 dBm (0.1 mW to 3 W)
With Option 601: –13 dBm to +37 dBm (50 μW to 5 W)

Measurement Accuracy
Standard: ±5% of reading ±1 μW from 15˚ C to 35˚ C
With Option 601: ±5% of reading ±2.5 μW from 13˚ C to 33˚ C

CDMA Channel Power Measurement
Measurement Range: –50 to +10 dBm/1.23 MHz
Calibration: Must be cross calibrated to Average Power Meter

CDMA Modulation Measurement
Input Level Range:
Standard: –20 dBm to +35 dBm, usable to –30 dBm
With Option 601: –25 dBm to +37 dBm, usable to –35 dBm
"ρ" **Measurement Accuracy:** "ρ" ±0.003.
Frequency Error Measurement Accuracy: ± 30 Hz
Other Reported Parameter with "ρ" Measurement: Static Timing, Carrier Feedthrough, Amplitude Error, Phase Error

CDMA Frame Error Rate Measurement
FER Measurement Method: Data loopback using Service Option 002 or 009 supporting Confidence limits per TIA IS-98A
FER Reported Parameters: Measured FER, Number of Errors, Number of Frames tested, Pass or Failed Confidence limit

General Specifications

Dimensions (HxWxD)
Standard: 177 H x 426 W x 574 D mm (7 x 16.75 x 23 inches)
With Option 601: 254 H x 426 W x 574 D mm (3.4 x 13 x 19 inches)

Weight
Standard: 27 kg, 59 lbs
With Option 601: 32.6 kg, 72 lbs

Operating Temperature: 0˚ C to +55˚ C

Power
HP 8924C: 100 V to 240 V, 50/60 Hz, nominally 400 VA
HP 83236B: 90 V to 132 V, 198 V to 264 V, 47 to 63 Hz, 100 VA

Ordering Information

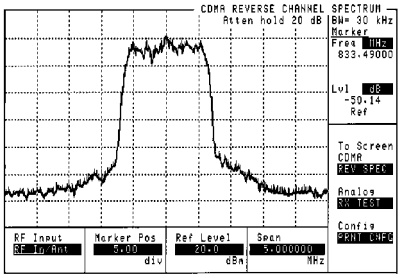
CDMA Mobile Station Test Set
HP 8924C CDMA Mobile Station Test Set
Opt 011 ETACS CCITT Filter
Opt 601 PCS CDMA Mobile Station Test System
Opt OBW Service Documentation
Opt OB1 Add Manual Set
Opt AX4 Rack Flange Kit
Opt W30 3 Years of Customer Return Repair Service
Opt W50 3 Years of Customer Return Repair Service

CDMA CDMA Dual-mode Mobile Station Test Software
Must order one and only one option per unit HP 83217A
HP 83217A CDMA Dual Mode MS Test Software
Opt 001 AMPS/NAMPS/CDMA
Opt 004 PCS CDMA/NAMPS/AMPS

HP 8924E

NEW

HP 8924E



HP 8924E CDMA MS Service Test Set

NEW HP-IB

The HP 8924E CDMA Mobile Station Test Set provides the key set of measurements to manufacture high quality Dual Mode CDMA mobile telephones in a single box. Acting as a calibrated, high performance CDMA base station, the HP 8924E verifies not only the parametric performance of CDMA phones, but also the functional aspects of phone performance. The HP 8924E is optimized to provide high accuracy measurements that correlate with CDMA mobile manufacturers' measurements. The standard HP 8924E tests IS-95A-compliant CDMA phones for use with systems that operate from 500 MHz to 1000 MHz. In addition to its CDMA functionality, the HP 8924E includes full AMPS, NAMPS and TACS analog phone test capability. To extend the capabilities of the HP 8924E to test PCS CDMA phones, order Option 601 with the HP 8924E. This option adds the HP 83236B PCS Interface to cover the 1700 to 2000 MHz frequency range. When attached, the PCS Interface is transparently controlled by the HP 8924E. Together, the HP 83236B PCS Interface and HP 8924E operate as one instrument for both manual and HP-IB control applications. With the HP 8924E, you save space and cost by making both analog cellular and CDMA digital cellular/PCS measurements with one instrument.

CDMA Base Station Simulator

The HP 8924E includes a full QPSK signal generator that follows the TIA IS-95A CDMA air interface specifications for base stations. The CDMA Signal Generator supports an AWGN (Additive White Gaussian Noise) source as well as a single CDMA sector. Absolute power is individually settable for the AWGN source, Sector in terms of total power in a 1.23 MHz bandwidth. The total CDMA signal generator power is the sum of these three settings.

Using industry standard ASIC's, the HP 8924E supports the protocol required to emulate a CDMA base station for mobile station test. The HP 8924E also includes a full OQPSK demodulator for CDMA mobile station transmitter and Frame-Error-Rate receiver measurements.

Functional CDMA Mobile Test

The HP 8924E supports both mobile or base station initiated call connect and disconnect. Enter the required RF channel number, wait for the mobile to acquire service, connect the CDMA mobile to the HP 8924E, and press the call key to make a CDMA phone call. To check voice quality, the HP 8924E offers a voice echo mode. When active, the voice echo mode delays and then re-transmits to the mobile-under-test any audio spoken into the CDMA mobile. An operator can quickly verify voice quality by speaking into the phone and then listening to the echoed audio in the mobile's handset.

CDMA Transmitter Tests

Transmitter tests include fast, DSP-based average power measurements from +38 dBm down to –10 dBm, and accurate channel power measurements down to –50 dBm. The tuned channel power measurement reports the power in a 1.23 MHz measured bandwidth. By calibrating the tuned channel power measurement against the average power measurement, the HP 8924E achieves accurate low level CDMA power measurements. These two power measurement modes allow accurate verification of maximum power, minimum power, open loop power control, and closed loop power control.

The HP 8924E measures transmitted waveform compatibility by the IS-98A recommended correlated power method "ρ" (rho). This measurement returns the percentage of transmitted power that correlates to the desired code. In addition, the "ρ" measurement reports the frequency error, modulation phase and amplitude error, and the carrier feedthrough.

CDMA Receiver Tests

The key performance parameter for CDMA mobile station receivers is Frame-Error-Rate performance with and without the presence of AWGN. The built-in, high accuracy AWGN generator in the HP 8924E guarantees that FER tests provide a true picture of a CDMA mobile to correctly demodulate a signal in the presence of high interfering noise. The HP 8924E fully supports service Options 002 and 009 (RF loopback mode) to test receiver FER performance. The HP 8924E optimizes FER measurement time by employing confidence limit technology. With confidence limits, FER measurements are made in the fastest possible time.

Analog Capabilities

In addition to its powerful CDMA test capabilities, the HP 8924E retains full analog cellular test capability. Based on the HP 8920B RF Communications Test Set, the HP 8924E is backwards compatible with most HP 8920B HP-IB commands. The HP 8924E includes as standard equipment a high stability timebase, a CCITT filter, a 6 kHz bandpass filter, and spectrum analyzer/tracking generator. In addition, the HP 8924E supports easy CDMA to analog handoffs and "one-button" analog cellular call processing for AMPS, NAMPS, TACS, NTACS and JTACS phones . These analog features not only allow the HP 8924E to test dual mode phones, but also provides an effective suite of measurement tools for radio troubleshooting.

HP 83217A Dual-mode Mobile Station Test Software

Besides its many measurement functions, the HP 8924E includes a programmable IBASIC controller. This controller allows the creation of custom measurement software. The HP 83217A automates CDMA dual-mode mobile measurements using the HP 8924E. Automated testing improves consistency and reduces operator error resulting in lower operation costs and improved product quality.

The HP 83217A offers two options for testing cellular mobile stations. Option 001 supports testing of mobiles that are AMPS, NAMPS, and CDMA dual mode, while Option 004 supports PCS CDMA/AMPS, or NAMPS dual mode, dual-band phone testing. These software packages provide a comprehensive suite of analog and digital tests that can be freely arranged to fit specific requirements. Test points, test limits, and test sequences can be stored for future retrieval.

Short Message Service Testing

The HP 8924E supports mobile terminated SMS on both paging and traffic channels. It also supports service option 006 and 014 SMS traffic channels. Messages can be sent in both ASCII and HEX formats to support international character sets.

CDMA and AMPS Authentication Testing

Full-featured authentication testing supports both CDMA (US and Korean) and AMPS. The HP 8924E displays expected mobile phone values and actual values returned. SSD update, A-key entry, RANDC and other authentication procedures are supported.

Key Literature

HP 8924E Technical Specifications, p/n 5966-3439E
HP 8924E Photo Card, p/n 5966-3440E
HP 8924E Brochure, p/n 5966-3441E
HP 8924E Price List, p/n 5966-4238EUS

Analog Mode Specification Summary

Signal Generator

RF Frequency Range
Standard: 30 MHz to 1000 MHz
With Option 601: 800 MHz to 960 MHz, 1710 MHz to 1990 MHz
Output
RF In/Out Connector
Level Range
Standard: –127 to –10.5 dBm into 50 ohms
With Option 601: –130 to –20 dBm into 50 ohms
Level Accuracy
Standard: ±1.2 dB (Level >= –127 dBm)
With Option 601: ±1.8 dB @ 25° C ±10° C
Reverse Power
Standard: 3 watts continuous
With Option 601: 10 watts continuous
Duplex Out/RF Out Only Connector
Level Range
Standard: –127 to +3.5 dBm into 50 ohms
With Option 601: –130 to –10 dBm into 50 ohms
Level Accuracy
Standard: ±1.0 dB (Level >= –127 dBm)
With Option 601: ±1.8 dB @ 25° C ±10° C
Reverse Power: 200 mW maximum

RF Analyzer

Frequency Measurement Range
Standard: 30 MHz to 1000 MHz
With Option 601: 800 MHz to 960 MHz, 1710 MHz to 1990 MHz
RF Power Measurement (RF in/out connector only)
Measurement Range
Standard: –10 dBm to +35 dBm (0.1 mW to 3 W)
With Option 601: –13 dBm to +40 dBm (50 μW to 10 W)
Accuracy
Standard: ±5% of reading ±0.01 mW from 15° C to 35° C
With Option 601: ±5% of reading ±2.5 μW from 13° C to 33° C

Optional Spectrum Analyzer

Frequency Range:
Standard: 30 MHz to 1000 MHz
With Option 601: 800 MHz to 960 MHz, 1710 MHz to 1990 MHz
Resolution Bandwidth (coupled to span): 300 Hz to 300 kHz
Display Range: 80 dB

AF Analyzer

Frequency Measurement
Measurement Range: 20 Hz to 400 kHz
Accuracy: ±0.02% + resolution + reference oscillator accuracy
SINAD Measurement
Fundamental Frequency Range: 300 Hz to 10 kHz ±5%
Accuracy: ±1 dB for Fc=300 to 1500 Hz, using the 15 kHz LPF
Residual THD+Noise: –60 dB or 150 μV, whichever is greater

Oscilloscope

Frequency Range (–3 dB BW): 2 Hz to 50 kHz
Scale/Division: 10 mV to 10 V
Time/Division: 10 μs to 100 ms

Remote Programming

HP-IB: Hewlett-Packard's implementation of IEEE Standard 488.2
RS-232: 3-wire RJ-11 connector used for serial data in and out
Centronics Port: Industry standard parallel printer port

Ovenized Reference

Aging Rate: <0.005 ppm pk-pk/day, <±0.1 ppm per year

CDMA Mode Specification Summary

CDMA Call Processing Functionality

Protocol Stack: IS-95, IS-95A, TSB-74, J-STD-008, and ARIB-T53
Service Option Modes: SO 001, SO 002 (9600 bps loopback), SO 003, SO 009 (14400 bps loopback), SO 32768, SO 006, and SO 014
Traffic Channel Data Rates: 9.6 kbps or 14.4 kbps
Call Control: BS call originate, BS call disconnect, MS call originate, MS call disconnect
Hand-off Support: CDMA to CDMA Hard (RF Frequency), CDMA to Analog (intraband), and CDMA PCS to Analog Cellular

CDMA Signal Generator

CDMA Channels
Additive White Gaussian Noise
Sector A – includes the following channels: Pilot Channel, Sync Channel, Paging Channel, Traffic Channel, and OCNS Channel
Frequency Range
Standard: 501 MHz to 1000 MHz, usable from 30 to 248.9 MHz
With Option 601: 800 MHz to 960 MHz, 1710 MHz to 1990 MHz
Composite Signal Output Level Range
Standard:
RF In/Out: –109 dBm/1.23 MHz to –21.5 dBm/1.23 MHz
Duplex Out: –109 dBm/1.23 MHz to –7.5 dBm/1.23 MHz
With Option 601:
RF In/Out: –109 dBm/1.23 MHz to –20.01 dBm/1.23 MHz
RF Out Only: –109 dBm/1.23 MHz to –10.01 dBm/1.23 MHz
Composite Signal Output Level Accuracy (AWGN off)
Standard: ±1.5 dB, typically ±1.0 dB
With Option 601: ±1.8 dB at 25° C ±10° C , typically ±1.0 dB
Relative CDMA Channel Level Accuracy: 0.2 dB

CDMA Analyzer

CDMA Average Power Measurement
Input Frequency Range:
Standard: 30 MHz to 1000 MHz
With Option 601: 800 MHz to 960 MHz, 1710 MHz to 1990 MHz
Measurement Range (RF in/out connector only):
Standard: –10 dBm to +35 dBm (0.1 mW to 3 W)
With Option 601: –13 dBm to +37 dBm (50 μW to 5 W)
Measurement Accuracy
Standard: ±5% of reading ±1 μW from 15° C to 35° C
With Option 601: ±5% of reading ±2.5 μW from 13° C to 33° C
CDMA Channel Power Measurement
Measurement Range: –50 to +10 dBm/1.23 MHz
Calibration: Must be cross calibrated to Average Power Meter
CDMA Modulation Measurement
Input Level Range:
Standard: –20 dBm to +35 dBm, usable to –30 dBm
With Option 601: –25 dBm to +37 dBm, usable to –35 dBm
"ρ" **Measurement Accuracy:** "ρ" ±0.003.
Frequency Error Measurement Accuracy: ± 30 Hz
Other Reported Parameter with "ρ" Measurement: Static Timing, Carrier Feedthrough, Amplitude Error, Phase Error
CDMA Frame Error Rate Measurement
FER Measurement Method: Data loopback using Service Option 002 or 009 supporting Confidence limits per TIA IS-98A
FER Reported Parameters: Measured FER, Number of Errors, Number of Frames tested, Pass or Failed Confidence limit

General Specifications

Dimensions (HxWxD)
Standard: 177 H x 426 W x 574 D mm (7 x 16.75 x 23 inches)
With Option 601: 254 H x 426 W x 574 D mm (3.4 x 13 x 19 inches)
Weight
Standard: 27 kg, 59 lbs
With Option 601: 32.6 kg, 72 lbs
Operating Temperature: 0° C to +55° C
Power
HP 8924C: 100 V to 240 V, 50/60 Hz, nominally 400 VA
HP 83236B: 90 V to 132 V, 198 V to 264 V, 47 to 63 Hz, 100 VA

Ordering Information

CDMA Mobile Station Test Set
HP 8924E CDMA Mobile Station Test Set
Opt 011 ETACS CCITT Filter
Opt 102 Spectrum Analyzer
Opt 601 PCS CDMA Mobile Station Test System
Opt OB1 Add Manual Set
Opt AX4 Rack Flange Kit
CDMA CDMA Dual Mode Mobile Station Test Software
Must order one and only one option per unit HP 83217A
HP 83217A CDMA Dual Mode MS Test Software
Opt 001 AMPS/NAMPS/CDMA
Opt 004 PCS CDMA/NAMPS/AMPS

Mobile/Cellular Radio Test Sets

GSM900, DCS1800, and PCS1900 Test Sets

HP 8922S
HP 8922M
HP 8922P
HP 8922R
HP 8922X
HP 8922Y

- Complete GSM/DCS/PCS mobile station test sets
- Designed to minimize prodution/service costs
- Built-in toolkit of instruments
- E-GSM and dual-band capability
- Fast and easy to use
- Accurate and repeatable GSM measurements
- Built-in IBASIC controller for easy automation

HP 8922M

HP 8922 M/S GSM Test Sets

The HP 8922M and 8922S are integrated test solutions for the prodution and servicing of GSM900, DCS1800, and PCS1900 radios. These test sets are based on a common, expandable platform. The HP 8922S is a standalone GSM mobile station tester. For service applications it includes a GSM base-station emulator and all the signaling capability to fully test a mobile without additional equipment. For manufacturing applications, the HP 8922M adds high-speed testing and additional flexibility to maximize production throughput.

Minimize Production/Service Testing Costs

The HP 8922M is built for manufacturing, with accurate and repeatable measurements; it provides the minimum test times under HP-IB remote control. The HP 8922S is tailored to the demanding needs of incoming inspection and mobile repair. It has all of the ingredients necessary to minimize the cost per phone, a rich set of features which balances fast testing with a built-in toolkit of instruments, and automatic test software. Features are bound together with an intuitive menu-driven user interface. Sharing a common RF measurement architecture, the HP 8922S/M guarantees consistent test results during each stage of a phone's life, minimizing the chances of good phones being rejected at incoming inspection, maximizing the quality of new and repaired phones.

GSM Radio Test Solutions

The HP 8922 contains a complete set of instrumentation for testing the RF sections of GSM radios. In addition to the frequency agile 0.3 GMSK RF generator, the RF analyzer has an agile local oscillator, coherent data demodulator, pulse demodulator, FM demodulator, global method analyzer for phase and frequency error, synthesized spectrum analyzer, and pulse power meter. The HP 8922S/M adds a bit-error-rate tester (BERT) for performing GSM receiver measurements, channel CODEC, and call control protocol to setup a phone call and maintain the link while performing measurements. Echo mode is facilitated by the voice CODEC for functional testing of a mobile, and the electrical man machine interface (EMMI) is implemented for controlling the mobile and supporting the digital audio interface (DAI). Flash memory on the HP 8922M allows easy upgrades.

Complete Tool Set

Aside from their complete complement of GSM measurements, the HP 8922 contains general-purpose tools useful for module test, troubleshooting, and debugging activities. The tools include a digital oscilloscope, CW RF synthesizer, spectrum analyzer, CW RF frequency counter, CW and peak RF power meter, ac voltmeter, dc voltmeter, 1 kHz distortion/SINAD meter, audio frequency counter, and synthesized audio source. The sum of these capabilities makes the HP 8922 an extraordinarily powerful tool for the manufacture, installation and repair of GSM radio equipment.

HP 83212C GSM/DCS1800/PCS1900 Mobile Test Software

The HP 83212C is an easy-to-use software solution for automatic testing of GSM900, DCS1800 and PCS1900 mobile stations. Running on the HP 8922S/M's built-in IBASIC controller, the HP 83212C offers a comprehensive set of tests ideal for incoming inspection and repair of GSM phones. Its flexibility and modularity allow you to select and change test sequences, test parameters, and pass/fail limits without programming expertise. Procedures can be simply saved on RAM cards and distributed to colleagues, guaranteeing consistent test methods. All test results are displayed on the screen and can be documented with hardcopy printouts when an external printer is added. Three levels of testing are available with the HP 83212C: manual mobile station troubleshooting, quick functional checkout, and full parametric testing. Automating your measurements provides repeatable results while allowing the user to test more mobile stations in less time. This increase in throughput lowers your testing cost.

HP 83220A/E DCS/PCS Test Sets

Adding an HP 83220A/E expands the capabilities of the HP 8922 family to comprehensively test DCS1800 and PCS1900 equipment. The HP 83220E provides a cost-effective solution for mobile testing. The HP 83220A has the frequency range to test both mobiles and base stations. All features of the HP 8922 are retained.

HP 8922P/R/X/Y Dual-band Test Sets

Combine the HP 8922S/M with the HP 83220A/E and new firmware to form a complete dual-band (GSM 900/DCS 1800) test solution. All the original HP 8922 features are retained but now, with dual-band intra-cell handover capability, the latest GSM mobiles can be tested seamlessly, at all frequencies, through a single RF connector.

HP 8922A
HP 8922B
HP 8922S
HP 8922AM

HP 8922S/M Specifications

RF Generator

Frequency Range: 10 MHz to 1000 MHz
Frequency Resolution: 1 Hz
Switching Speed: 577 μs
0.3 GMSK Modulation[1]: External clock and data
Pulse Modulation[1]: Normal and 30 dB
Output Power: –16 to –127 dBm

RF Analyzer

Frequency Range: 10 MHz to 1000 MHz
Frequency Resolution: 1 Hz (100 kHz in hop mode)
Switching Speed: 577 μs
Coherent Data Demodulation[1]: 0.3 GMSK at 270.833 Kb/s, 1 timeslot/frame
Analog Demodulation[1]: FM and pulse
Global Method: rms and peak phase error, frequency error
Amplitude Envelope: Rise, fall, and burst flatness over useful bits
Peak Transmitter Power: +10 dBm to +45 dBm (– 5 dBm to 41 dBm on HP 8922F/H)
Output RF Spectrum Measurements[2]: Due to modulation and switching transients
CW Frequency Counter: 10 MHz to 1000 MHz

Spectrum Analyzer[2]

Frequency Range: 10 MHz to 1000 MHz
Frequency Accuracy and Stability: Same as timebase
Display Range: 80 dB
Other Features: External trigger, marker

Digital Oscilloscope

Frequency Range: 2 Hz to 50 kHz
Sweep Times: 10 μs to 100 ms in 1, 2, 5, 10 steps

Audio Analyzer

Frequency Range: 20 Hz to 400 kHz
AC Voltage Range: 0 to 30 V_{rms}
DC Voltage Range: 100 mV to 42 V
THD + Noise: 1 kHz ± 5 Hz
Sinad: 1 kHz ± 5 Hz

Audio Source

Frequency Range: DC to 25 kHz
Output Level Range: 0.1 mV_{rms} to 4 V_{rms}

Reference Oscillator

External Reference Input Frequency: 13, 10, 5, 2, or 1 MHz
External Reference Output: 10 and 13 MHz

Remote Programming

HP-IB: IEEE-488.2
RS-232: 300, 1200, 2400, 4800, 9600, and 19200 baud

Internal Programming

Programming Language: Hewlett-Packard Instrument BASIC
Program Storage: 32 KB to 512 KB external memory cards

General Specifications

Size: 426 mm W x 177 mm H x 574 mm D (16.75 in x 7 in x 23 in)
Weight: 32 kg (70 lb)
Operating Temperature: 0° to + 55° C
Storage Temperature: – 40° to + 75° C
Power: 100, 120, 220, 240 Vac, 48 to 440 Hz, ±10% of line voltage

GSM Functionality

Broadcast Channel Capability: BCCH + CCCH or BCCH + CCCH +SDCCH/4
Control Channels: BCCH + CCCH, BCCH + CCCH + SDCCH/4, SDCCH/8 (non-hopped), SACCH/FACCH
Traffic Channels: TCH (FS/EFS)
Call Control Capabilities: BS originated call (FS/EFS), MS originated call (FS/EFS), MS camp on, BS call disconnect, MS call disconnect
Timing: Auto, manual, uplink-downlink offset measurement
Hopping: Cyclic only, two MA tables with offsets
Digital Audio Interface (DAI)[1]: Normal operation and test of acoustic devices and A/D & D/A
Electrical Man Machine Interface[1]: Control via HP-IB
Speech Encoding/Decoding: Full rate speech (FS)
Echo Mode
HP 8922S: 1 second delay
HP 8922M: user selectable delay, 0 to 5 seconds
Bit/Frame Error Rate Measurements: Class Ia, Ib, and II bits. New fast BER measurement has been added.
MS Power Output Level Control: 0 to 19, 30, 31 with RF analyzer auto adjust
Measurement Coordination: Flexible control of burst, ARFCN, and timeslot
SACCH MEAS Results: RXLEV, RXQUAL, timing advance
SMS Cell Broadcast, IMSI attach/detach

GSM Reference

External Reference Input Frequencies: 13, 10, 5, 2, 1 MHz, bit clock, or frame clock

HP 83220E Specifications

Frequency Range: 1805 to 1990 MHz

Ordering Information

HP 8922S GSM MS Service Test Set
HP 8922M GSM MS Test Set
HP 83212C GSM/DCS1800 PCS1900 MS Test Software
HP 83220A DCS/PCS MS/BS Test Set
HP 83220E DCS/PCS MS Test Set
HP 8922P Dual-band Test Set
Options for HP 8922S, 8922M and 8922P
Opt 001 High-Stability Timebase
Opt 002 Transit Protection (front panel cover, accessory pouch, and extended rear feet)
Opt 006 Spectrum Analyzer
Opt 007 GSM900 Test SIM Card
Opt 008 GSM900 Test Micro SIM Card
Opt 012 GSM/DCS1800/PCS1900 MS Test Software (HP 83212C)
Opt W30 3 years Return Repair Service
Options for HP 83220A/E and 8922S/M
Opt 0B1 Provides a total of two sets of Users Guides and Service Manuals (Users Guide only for A/E)
Opt AX4 Rackmount Flange Kit
Opt 0B3 Adds Service Manual

[1]Not applicable to HP 8922S
[2]Requires Option 006, Spectrum Analyzer, on HP 8922S/M

11

DECT Test Set

HP 8923B

- Test RF modules or fully assembled DECT PPs (Portable Parts) and FPs (Fixed Parts)
- Fast, accurate, repeatable measurements
- Measurements compliant with the DECT standards
- Easy to use

HP 8923B

HP 8923B DECT Test Set

HP-IB

The HP 8923B DECT test set is an integrated, one-box test solution for Digital European Cordless Telecommunications. The test set provides the functionality and the measurement speed required to meet the needs of high-throughput testing, essential in DECT production. In R&D applications it provides the measurement accuracy and traceability required to ensure a very high level of confidence during PP or FP design.

The HP 8923B includes the following key DECT measurements:

- Bit-error ratio/word error ratio
- Carrier power
- Power versus time (Top 40 dB)
- Center frequency, frequency deviation and drift
- Timing jitter
- Audio tests

To establish communication with the EUT (equipment-under-test), the HP 8923B implements protocol in the form of MAC (Medium Access Control) layer test messages. The use of MAC-layer test messages is the ETSI (European Telecommunications Standard Institute) recognized method of controlling the EUT during testing. The HP 8923B MAC-layer protocol supports the following features:

- Call setup on a defined slot and channel
- Identity extraction from the EUT
- Channel and timeslot handover
- Test patterns as defined in the DECT CTR-06 standard along with a user-definable test pattern
- Flexibility for propriety signalling (escape test message)

When testing RF components of the EUT, the tests can be made without MAC protocol. In this application, the HP 8923B can synchronize to the RF rise of the signal, or an external TTL trigger may be used to initiate the measurements.

These two approaches to testing mean that the HP 8923B can be used in various stages of the test process, e.g., calibration and test of RF modules, final testing of the assembled phone, or rework of faulty phones and modules.

Maximize Your Production Efficiency

The measurement techniques adopted in the HP 8923B are chosen to minimize the test time for the key DECT tests without compromising measurement integrity. All transmitter measurements are implemented using digital signal processing which delivers fast and repeatable measurement results. This measurement repeatability ensures that when the HP 8923B is used in module test, final test and re-work, inefficiencies caused by 'no-fault-founds' are minimized. All HP 8923B functions are accessible over HP-IB, allowing easy integration into production line test systems. THe HP 8923 firmware can be upgraded from a PCMCIA card, without removing the instrument covers. New firmware may be installed with minimal disruption to production.

Ease of Use

The HP 8923B user interface has been carefully designed to allow the user to quickly learn how to operate the instrument effectively and carry out the key measurements. The screen layouts are clear, and softkey menus make it easy to access the main measurement functions and parameters. These ease-of-use benefits ensure that the HP 8923B can be used manually in repair and re-work stations with the minimum of operator training.

Test System Integration

Hewlett-Packard can provide customized test solutions based around the HP 8923B tailored to your individual test requirements. This means that the HP can coordinate and manage:

- System integration
- Spares management
- Verification and testing to your requirements
- Delivery to agreed time scales
- Identical systems delivered and supported world-wide
- Revision and change control to ISO 9002

Contact the HP Call Center in your region for details.

HP 8923B Specifications

The following describe the instruments warranted performance and apply after a 30-minute warmup period. These specifications are valid over its operating/environmental range unless otherwise noted.

DECT Source Specifications

RF Carrier Frequency[1]
Range: 1880 to 1900 MHz at DECT channels
Frequency Drift Across the Burst: Negligible
(I/Q modulation technique used)
Accuracy: ± 5 kHz

RF Carrier Level
Range: –100 dBm to –10 dBm
Resolution: 0.1 dB
Accuracy: ± 1.0 dB
Reverse Power: 2 W continuous
SWR: 1.5:1

Transmitter Test Specifications

Note: The user is required to provide a signal from the device-under-test which matches the following criteria:
Frequency Presented to the HP 8923B: Within ± 200 kHz of DECT channel frequency
Amplitude Presented to the HP 8923B: Within ± 6 dB of HP 8923B setting
Normal Transmitted Power (NTP) Measurement
Range: –10dBm to +30 dBm
Accuracy: ± 0.6 dB ± noise effects (0.015 mW)
Power versus Time Template Measurement
Measurement Range: –10 dBm to +30 dBm
Dynamic Range: 40 dB
GFSK Measurement
Level: –10 dBm to +30 dBm
Peak Frequency Deviation Error:

Input Amplitude Setting Uncertainty	Frequency Deviation Measurement Uncertainty
± 1 dB	10 kHz
± 3 dB	12 kHz
± 6 dB	16 kHz

Centre Frequency Measurement Error: ± 1 kHz
Frequency Drift Measurement Error: < 1 kHz for drift < 20 kHz
Timing Jitter
Measurement Accuracy: 4 ns

Receiver Test Specifications

Residual Bit Error
Ratio: 10^{-6} for PRBS 2^9-1 (ITU-T 0.153)

Audio Source Specifications

Frequency
Range: 20 Hz to 21 kHz
Accuracy: 0.03% of setting
Level
Range: 0 V to 2 V_{pk-pk}
Output Impedance: 70 Ω
Accuracy: ± (4% of setting + resolution)

[1] Frequency = Fo -c x1728 kHz where Fo = 1897.344 MHz, c = 0,1,2,3,....9

Audio Analyzer Specifications

DC Voltmeter
Accuracy: (1% of reading + dc offset)
DC Offset: 45 mV
Audio Frequency Counter
Range: 30 Hz to 400 kHz
Accuracy: (0.05% + resolution + reference accuracy) for input > 30 mV
AC Voltmeter
Frequency Range: 50 Hz to 50 kHz
Input Impedance: 100 Ω
Input Range: 10 mV to 5 V
Digital Oscilloscope
Accuracy: ± 1.5% of reading +0.1 division
(For scale settings: 100 mV/div to 1 V/div)
Frequency Range: DC to 50 kHz

Reference Specifications

Standard Frequency Reference
Stability: 1 ppm (0 to 55° C)
Aging: 2 ppm/year
Warmup Time: < 30 seconds to be within 2 ppm of final frequency
Precision Frequency Reference (Option 1D5)
Stability: < 2.5 x 10^{-9} ppm/°C (0 to 55° C)
Aging: < 5 x 10^{-10} ppm/day after 24 hour warm-up; < 0.1 ppm/year for continuous operation
Warm-up Time: Within 5 x 10^{-9} ppm of final value 10 minutes after turn on at 25° C
External Interfaces
HP-IB: IEEE-488.2
RS-232: Serial port through RJ-11 connector used for serial data in and out
Baud Rates: 300, 1200, 2400, 4800, and 9600 baud
External Signal Generator Control: Data, clock and trigger signal to drive an external RF signal generator
Synch in/Synch out: Two RJ-11 connectors that allow multiple HP 8923Bs to be connected in series to ensure that all transmissions are time synchronized
Internal Programming
Programming Language: Hewlett-Packard Instrument BASIC

General Specifications

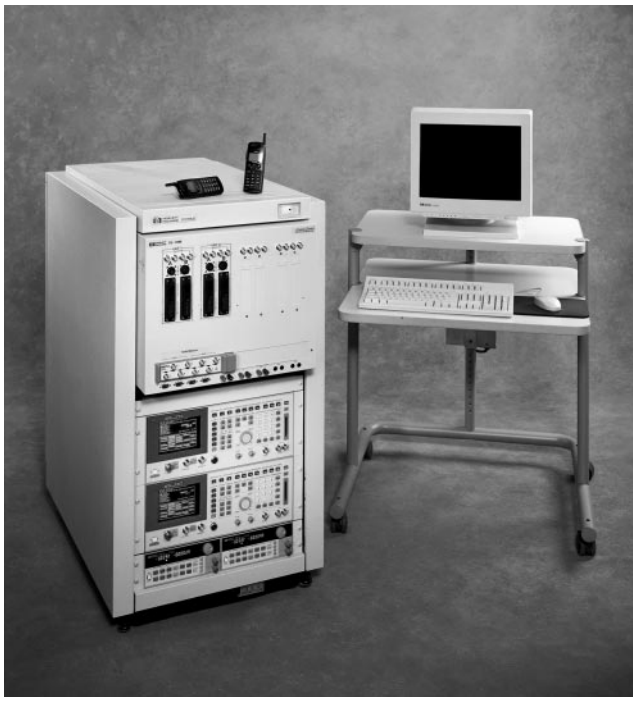
Size: 426 mm W x 177 mm H x 574 mm D (16.75 in x 7 in x 23 in)
Weight: 32 kg (70 lb)
Operating Temperature: 0° to 55°
Power: 100, 120, 220, 240, Vac, 48 to 440 Hz, ± 10% of line voltage

Ordering Information

HP 8923B DECT Test Set
Opt 0BF Programming Reference Manual
Opt AV4 Users Manual
Opt 0B3 Service Manual
Opt 1D5 High-Stability Frequency Reference
Opt 1CP Rackmount and Handle Kit

HP TS-5500

NEW



HP TS-5500 GSM/CDMA Cellular Phone Functional Test Platform

NEW

The HP TS-5500 Platform concept provides a universal test system core of both hardware and software, which can be easily modified to suit various cellular phone manufacturing test stages. Test system developers can customize the use of instruments and test routines to create a specific test stand. The HP TS-5500 Functional Test Platform can decrease test times, decrease floor space, and lower your test equipment costs, while getting your product to market faster.

HP TS-5500 is Measurement-Ready for Cellular Phone Testing Requirements

Testing GSM/CDMA Cellular Phones requires certain instruments for the specific tests and integration of this equipment into the manufacturing line. The HP TS-5500 has the best measurement equipment integrated with the software to do the job.

Turn-on tests of the cellular phone at board-level would include emulating the battery requirements, testing battery charging circuitry, probing points on the board and communicating to the phone. The HP TS-5500 has specific power supplies, a DMM and multiplexer, and RS-232 capabilities to handle these needs.

The standard VXI architecture for switching, DMM and phone communication offers a flexible method for configuring different test stands. VXI is the most cost-efficient architecture and will reduce equipment space when used to test multiple phones per test stand. HP's Dynamic Measurement Power Supplies are designed for cellular phone battery emulation and testing.

Calibration tests involve adjusting power levels in the phone circuitry to be able to make a phone call. For these RF measurements, the HP TS-5500 uses one HP 8922M/P (GSM Test Set) or 8924C (CDMA Test Set) for each phone. Today, the HP's 892x family of RF test sets is a core part of the system to produce quality phones at the best throughput and lowest cost.

Call processing may be verified in a final test station. This sequence of standard GSM tests uses the HP RF Test Set as the core measurement instrument. Other final tests include audio tests of the microphone and speakers. With the HP TS-5500 audio tests are performed with the VXI Audio Source and Digital Signal Processor.

With the high volumes of cellular phone manufacturing, computer-aided-test is of high value. The HP TS-5500 uses a single embedded VXI Pentium PC for controlling the instruments, running the tests, and interfacing to automation equipment. A software test executive, GSM measurement routines, software utilities, and an operator interface panel are provided.

HP TS-5500 System Lowers Integration Costs

HP integrates the functional test system to lower costs, since HP standardizes the racking, cabling, and mass interconnect. The economies of scale at HP provide a lower cost than one-of-a-kind integration by each test engineering project team. This more complete solution also eliminates steps in test development. Since one HP TS-5500 handles up to four phones with a minimum of one rack of equipment, integration costs are reduced versus building separate racks for each phone.

The HP TS-5500's ExpressConnect is a common, standardized connection point for the test fixtures, as well as system resources and instrumentation. While it is designed for up to four UUTs on the multiple-up testers, the HP ExpressConnect scheme is used on all configurations. All the system's non-RF resources are brought to the HP Express Connect.

HP TS-5500 Software Increases Productivity

The HP TS-5500 software is a complete test development and test execution environment for the entire software development job. The test executive environment is tuned for functional testing of electronic devices in manufacturing. The software runs on a PC with Windows NT 4.0 for optimum performance and it's pre-installed and ready to use. The HP TS-5500 software provides maximum re-use as a result of its hierarchical environment.

The HP TS-5500 Software Development Environment is for developing tests for cellular phones. It consists of re-useable tests, measurements, and utilities for performing specific functions related to GSM/CDMA phone testing. Templates and examples are provided to serve as a starting point for creating tests. The HP test executive allows you to organize and order tests, reconfigure the test stand, profile the execution speed, and debug tests. The HP-supplied library of tests, measurements, and utilities for GSM/CDMA cellular test are tuned for measurement performance.

The HP TS-5500 Software Test Execution Environment allows an operator to test up to four phones simultaneously and reports test information back to the operator. Using the software utilities, you can easily link the test executive with factory automation, bar code readers, and printers. This operator interface panel is created by the test developer. HP provides a sample operator interface that is easily modified, or you can use Visual Basic to quickly develop a custom operator interface.

Documentation, Training, and Support

Documenting a system can be difficult when test engineering's primary job is to keep production up and running. HP's TS-5500 provides complete documentation of its unique capabilities: cabling, mass interconnect, power distribution, and software. HP also offers training on the system platform to augment its extensive curriculum. Worldwide support on the hardware components and the unique platform features is provided by HP's team. When you deploy a system, all you have to worry about documenting and supporting is your customization of the platform.

Pre-built System Platform Cuts Development Time

From the universal HP TS-5500 Platform, you'll need to complete the system integration by adding the application specific software, fixturing, factory automation, robotics, etc. For example, test developers must add the appropriate phone communications and can customize the operator interface. Test programs and test plans need to be developed for the specific phones undergoing testing.

HP offers a complete range of services to complete the HP TS-5500. HP is experienced at building test systems for cellular phone manufacturers. We've provided project management, software, fixtures, robotics, automation, and vision systems. Additionally, HP has completed many projects that involve creating operator interfaces, final test programs, specific phone communications and custom circuitry .

Ordering Information

HP E2171B TS-5550LX Multi-up Base System for GSM
HP E2189A TS-5550LX Multi-up Base System for CDMA
Additional instrumentation and configuration choices must be added with system options.

HP E4406A

- New generation of transmitter testers
- Multiformat capability
- One button cdmaOne and GSM measurements
- Spectrum & time domain waveform analysis capability

NEW

HP E4406A

HP E4406A VSA Series Transmitter Tester

The HP E4406A vector signal analyzer (VSA) Series transmitter tester is a full-featured transmitter tester designed to meet the test needs of wireless equipment manufactures. The transmitter tester provides a wide range of analysis capability on digital modulated signals in an easy-to-use format. Wireless base station and mobile transmitters and their components can efficiently be tested with the transmitter tester. The multiformat capability of the transmitter tester makes it ideal for a flexible production line. Measurements are accessible at the touch of a button and are easily configured with the simple, straightforward menu structure.

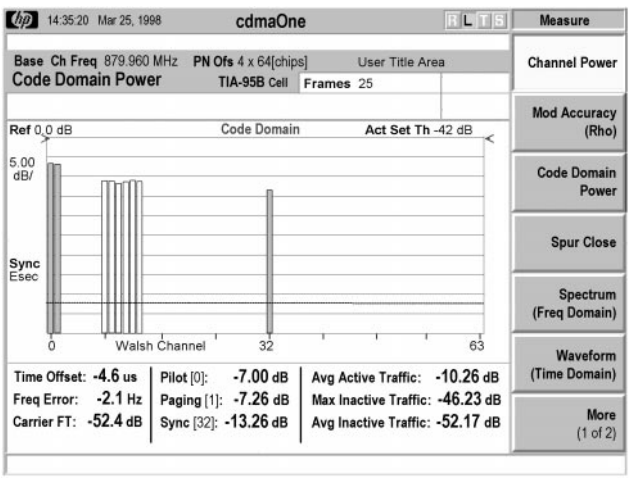
cdmaOne Measurements

Power Measurements
Channel Power
Power Spectral Density

Modulation Quality Measurements
Rho
Time Offset
Frequency Error
Carrier Feedthrough
Error Vector Magnitude
Phase Error
Magnitude Error

Code Domain Measurements
Code-Domain Power
Code-Domain Timing
Code-Domain Phase
Average Power for active traffic channels
Maximum Power for inactive traffic channels
Average Power for inactive traffic channels

Interference Measurements
Close-In Spurious Measurements
Adjacent Channel Power Ratio Measurements



Code-domain power measurement

11

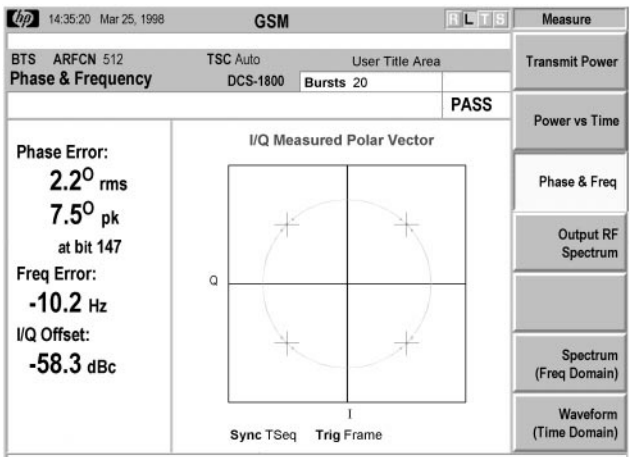
HP E4406A

GSM Measurements

Power Measurements
Transmit Power
Power versus time burst ramp

Modulation Quality Measurements
RMS Phase Error
Peak Phase Error
Frequency Error
I/Q offset
Demodulated Data

Interference Measurements
Output RF Spectrum Due to Modulation
Output RF Spectrum Due to Switching Transients

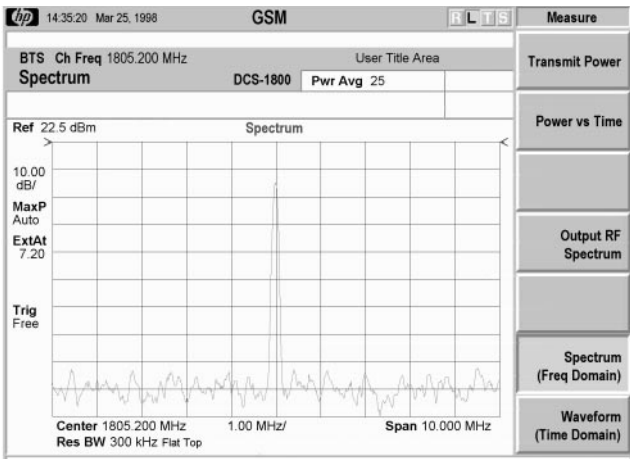


Transmitter Tester Key Features

Multiformat capability
User upgradeable firmware
HP-IB, LAN, and Parallel interfaces standard
High stability timebase standard
SCPI instrument command language
Large high-resolution color LCD display
One-button measurements
Softkey/hardkey user interface
Flexible card cage instrument architecture
Built-in 3.5-inch disk drive
Plug & Play drivers

General Purpose Measurements

Spectrum (Frequency Domain) Analysis
Waveform (Time Domain) Analysis



Physical Specifications

Weight: 19 kg (42 lb) net
Dimensions: 177 mm H x 426 mm W x 432 mm D
(7.0 in H x 16.8 in W x 17 in D)

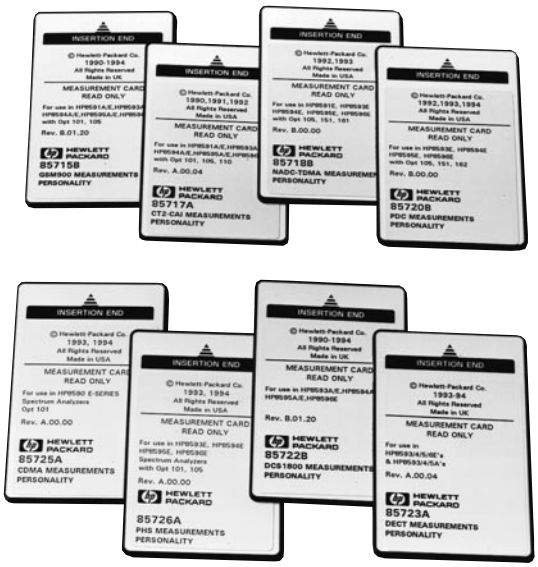
Key Literature

HP E4406A VSA Series Transmitter Tester Brochure, p/n 5966-4762E
HP E4406A VSA Series Transmitter Tester Technical Specifications, p/n 5966-4763E

Ordering Information

HP E4406A VSA Series Transmitter Tester
Opt BAC cdmaOne measurement personality
Opt BAH GSM measurement personality

- One-button measurements customized for your application
- Easy to use
- Solutions available for: CDMA, GSM, DCS1800, PCS1900, DECT, CT2-CAI, NADC-TDMA, PDC, PHS



Measurement Personalities for Customized Transmitter Testing

Measurement personalities are software programs provided on ROM-based memory cards that customize your HP 8590 series spectrum analyzer to perform complex transmitter tests simply and quickly with the push of a button from easy-to-follow screen menus. They automatically set the analyzer controls and perform calculations required to test to the industry standard for the communications format.

Quick, Easy, One-Button Measurements

Using a measurement personality with an HP 8590 series spectrum analyzer reduces complex transmitter systems or component measurements to single-button operations. Easy-to-use softkey menus are labeled with familiar format-specific measurement names.

Power, Frequency, Timing, and Modulation Accuracy

With a properly-configured spectrum analyzer, most personalities allow you to perform power-, frequency-, timing-, and modulation-accuracy measurements of your signal. Measuring modulation quality for some of the formats requires a digital demodulator option in the spectrum analyzer: for example, error vector magnitude (EVM) for $\pi/4$ DQPSK signals of NADC-TDMA, PDC and PHS, and global phase and frequency error for 0.3 GMSK signals of GSM900, DCS1800 and PCS1900. There are other demodulator option cards for the spectrum analyzer for the 0.5 GFSK signals of CT2-CAI and DECT.

Product Development and Production Troubleshooting

Evaluate your design and thoroughly troubleshoot failures. Measurements can be run continuously, allowing real-time equipment adjustments and troubleshooting. Waveform and graphical results add key visual information to numerical results. Pass/fail messages draw attention quickly to system problems. Test limits can be modified from the front panel, external keyboard, or computer so that you can set your own test goals.

High-Speed Production Testing

Reduce costs with increased test throughput. Since all of the customized measurements are programmable, each is executed with a single command. We've written the code for you.

Reliable Accuracy

Most of our solutions offer an improved amplitude accuracy option on the spectrum analyzer, so you can measure your transmitters with near-power-meter accuracy.

Features to Make Your Measurements Easier

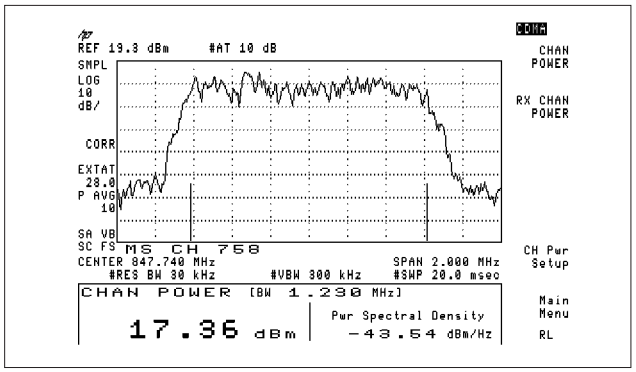
The measurement personalities contain one or more added features to make your measurements even easier such as automatic tuning by channel number, frequency-band monitoring, and combiner tuning. The newest addition to HP's portfolio of measurement personalities for transmitter testing, the HP 85725C for CDMA has an on-screen help feature to guide you through your measurements.

Accessories

For many of the measurements on burst signals, a TTL transition is required to synchronize the measurement system with the transmitter-under-test. The synchronization signal must occur once per frame. If an external signal is unavailable, the HP 85902A burst-carrier trigger may be used. Many other accessories are available from HP to help you make your measurements.

Ordering Information

Refer to the next few pages in the catalog for more details about each of the measurement personalities. See pages 24.9 to 24.14 for detailed information about the HP 8590 series spectrum analyzers, all available analyzer options and measurement personalities for other applications.



HP 85725C CDMA Measurement Personality

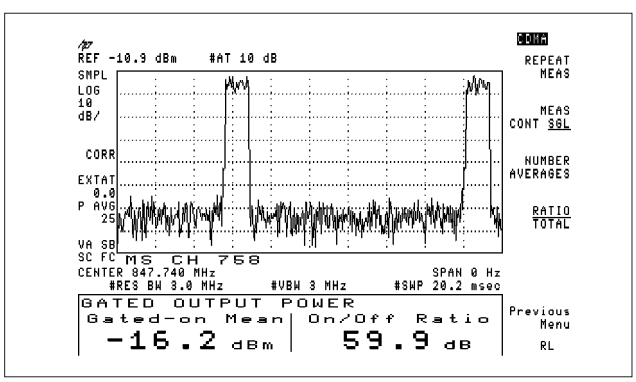
Simplify your measurements of cellular, PCS and other spread spectrum transmitters based on EIA/TIA IS-95, -97, -98 and J-STD-008 standards with the HP 85725C. Both frequency- and time-domain measurements are provided. The C version of this personality adds the adjacent channel power ratio (ACPR) measurement. The HP 85725C is designed with a great amount of flexibility, including on-screen help messages, so measurements can easily be configured to meet your special needs.

Measurements

Frequency Domain
- RF channel power
- Receive RF channel power
- Spurious emissions
- Standby output power (mobile)
- Spectral regrowth
- Occupied bandwidth
- Adjacent channel power ratio (ACPR)

Time Domain
- Gated output power
- Gated output power time response
- Time response of open loop power control

General Frequency- and Time-Domain Measurements
- Channel spectrum
- Monitor channel
- Monitor band
- Time-domain analysis
- Amplitude probability density
- Mean and peak-to-mean power



Built-In Flexibility for PCS and Other Wireless Applications

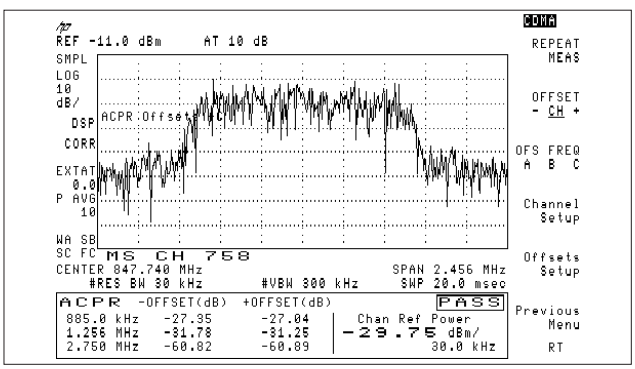
If you are involved with designs at other frequencies, for other services and even using technologies other than IS-95 or J-STD-008, you will appreciate the greater flexibility we have designed into the CDMA personality. You can configure the personality to make the measurements you need to make.

Flexibility Features

- Define your own tuning scheme based on the frequency allocation of your system. The configuration for channel-number tuning has an IS-95A, J-STD-008, ARIB STD-T53, Korean PCS setup and a custom setup.
- Change the pass/fail limit lines from the default settings to meet your requirements. For example, you may want to add test line uncertainty, additional margin or alternative limits.
- Measure your signal channel power in a channel bandwidth other than the IS-95A and J-STD-008 (for example: AMPS, or FCC Part 15). You can easily define the signal measurement bandwidth and viewing span.

Adjacent Channel Power Ratio (ACPR) Measurement

Easily test Adjacent Channel Power on CDMA components with the new one-button measurement.The flexibility allows the user to make measurements according to the two different Qualcomm definitions, or a faster HP-defined method. Integration bandwidths, resolution bandwidths, and frequency offsets can easily be changed in the ACPR setup menu to fit any application.



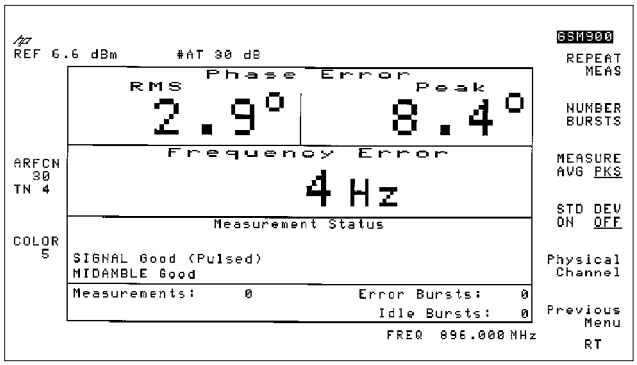
Recommended Configuration

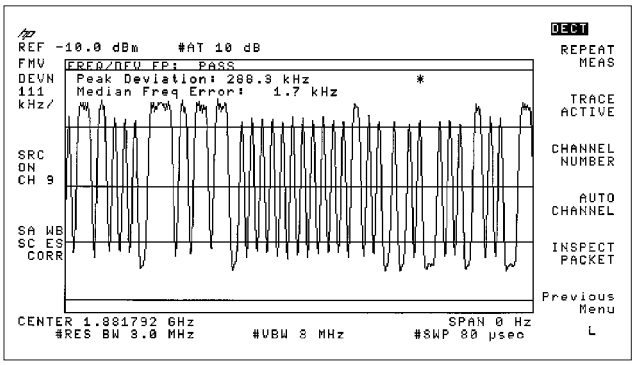
HP 85725C CDMA Measurements Personality
and
HP 8591E, HP 8594E, HP 8595E, HP 8596E, or HP 8593E Portable Spectrum Analyzer with the following options:
With DSP (Opt 151) for high speed measurements
- **Opt 004** Precision Frequency Reference
- **Opt 053** Improved Amplitude Accuracy for CDMA Cellular Bands
- **Opt 151** Digital Signal Processor
- **Opt 160** PDC/PHS/NADC/CDMA Firmware for Option 151

Without DSP
- **Opt 004** Precision Frequency Reference
- **Opt 053** Improved Amplitude Accuracy for CDMA Cellular Bands
- **Opt 101** Fast Time-Domain Sweeps

Key Literature

Portable CDMA Spectrum Analyzer, p/n 5963-9969E





HP 85715B GSM900, HP 85722B DCS1800 and HP 85727A GSM Multi-Band Transmitter Measurement Personalities

The HP 85715B, HP 85722B and HP 85727A provide all the GSM900 and DCS1800 transmitter measurements specified in the GSM 11.10 (mobile) and GSM 11.21 (base station) recommendations. GSM Phase II specification limits are used and the extended GSM (E-GSM) frequency bands are supported. GSM-based PCS measurements only at 1900 MHz may be made using the HP 85722B special Option H19.

For next generation GSM systems inter-working between GSM900, DCS1800, and PCS1900, the HP 85727A measurement personality assures that your new multi-band systems conform to worldwide GSM standards.

Measurements

- Phase and frequency error
- Demodulated data bit display
- Mean transmitted carrier power
- Power versus time
- Output RF spectrum
- Spurious emissions
- Intermodulation attenuation
- Combiner tuning

Recommended Configuration

HP 85715B GSM900 Transmitter Measurements Personality
or
HP 85722B DCS1800 Transmitter Measurements Personality
or
HP 85722B H19 PCS1900 Transmitter Measurements Personality
or
HP 85727A GSM Multi-band Measurements Personality
and
HP 8594E, HP 8595E, HP 8596E, or HP 8593E Portable Spectrum Analyzer with the following options:

With Phase and Frequency Error Measurement
- **Opt 004** Precision Frequency Reference
- **Opt 105** Time-Gated Spectrum Analysis
- **Opt 151** Fast ADC and Digital Demodulator
- **Opt 163** GSM/DCS Firmware for Option 151

Without Phase and Frequency Error Measurement
- **Opt 004** Precision Frequency Reference
- **Opt 101** Fast Time-Domain Sweeps
- **Opt 105** Time-Gated Spectrum Analysis

Related Spectrum Analyzer Options
- **Opt J62** Enhanced Power Measurement Accuracy in the GSM900 Band (880 to 960 MHz)
- **Opt J63** Enhanced Power Measurement Accuracy in the DCS1800 Band (1710 to 1880 MHz)
- **Opt J66** Enhanced Power Measurement Accuracy in the PCS1900 Band (1850 to 1990 MHz)

Key Literature

Portable GSM/DCS Transmitter Measurement Systems, Technical Data, p/n 5091-0235
GSM900 and DCS1800 Transmitter Testing, White Paper, p/n 5962-9942E

HP 85723A DECT Measurement Personality

The HP 85723A adds the key DECT measurements to the HP 8590 E-series spectrum analyzers. Option 012 on the spectrum analyzer adds a built-in DECT source which can be used as a stimulus for module testing or sensitivity measurements. The DECT demodulator Option 112 on the analyzer gives the capability to demodulate and analyze GFSK data in the DECT burst.

Measurements

- Carrier power
- Power versus time
- Center frequency
- Frequency deviation
- Adjacent channel power
- Spurious emissions
- Intermodulation attenuation

Recommended Configuration

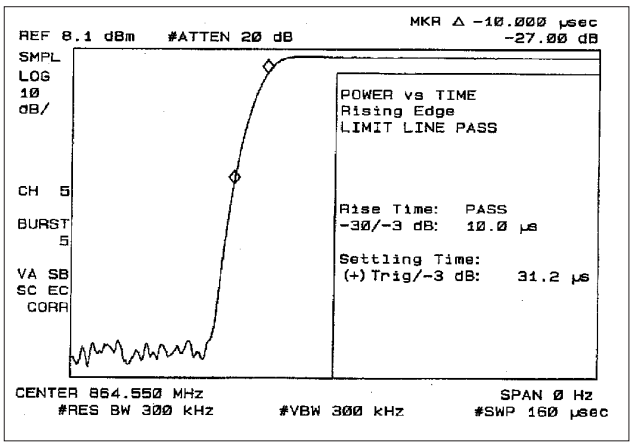
HP 85723A DECT Measurements Personality and
HP 8594E, HP 8595E, HP 8596E, or HP 8593E Portable Spectrum Analyzer with the following options:
- **Opt 004** Precision Frequency Reference
- **Opt 012** DECT Source
- **Opt 101** Fast Time-Domain Sweeps
- **Opt 105** Time-Gated Spectrum Analysis
- **Opt 112** DECT Demodulator Card

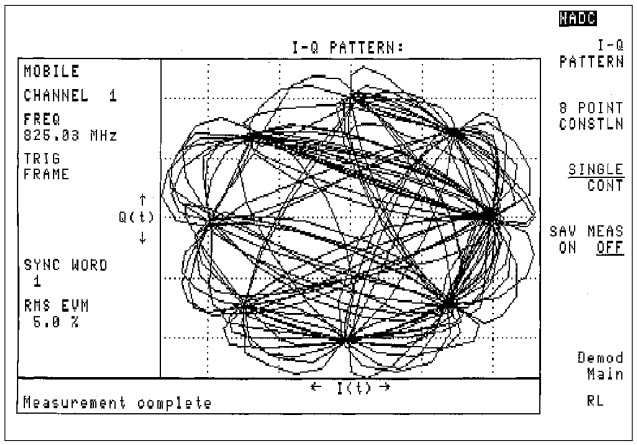
Or as an ordering convenience, the spectrum analyzer may be ordered with Option E67 which contains the options listed above.

Key Literature

HP 8590 E-Series DECT Measurement Solutions Technical Data, p/n 5091-7761E

HP 85717A
HP 85718B





HP 85717A CT2-CAI Measurement Personality

The HP 85717A simplifies I-ETS 300-131 and MPT 1375 RF transmitter testing of second-generation cordless telephones with common air interface (CT2-CAI). All of the required transmitter tests are provided by the personality for both cordless fixed parts (bases) and cordless portable parts (handsets). Added flexibility allows you to define your own custom channel tuning plan and band edge frequencies, as well as set up spurious emissions parameters for your particular needs.

Measurements

- Mean carrier power
- Carrier-off power
- Adjacent channel power
- Out-of-band power
- Spurious emissions
- Intermodulation attenuation
- Frequency error and deviation

Recommended Configuration

HP 85717A Measurements Personality
and
HP 8591E, HP 8594E, HP 8595E, HP 8596E, or HP 8593E Portable Spectrum Analyzer with the following options:

Opt 004 Precision Frequency Reference
Opt 101 Fast Time-Domain Sweeps
Opt 105 Time-Gated Spectrum Analysis

For Frequency Error and Frequency Deviation Measurements also order:

Opt 110 CT2 Demodulator Card
or
HP 53310A Modulation Domain Analyzer (requires Option 041 HP-IB interface on the spectrum analyzer)

For Improved Amplitude Accuracy in the CT2-CAI Band Order:

Opt 010 Built-In Tracking Generator
HP 437B Power Meter
HP 8481A or 8482A Power Sensor
HP 8491A/B Opt 006 6 dB Fixed Attenuator

Key Literature

HP 85717A CT2-CAI Measurements Personality, p/n 5091-2986E

Ordering Information

More information about the HP 8590 E-series spectrum analyzers and all analyzer options, including ordering information, can be found on pages 248 to 253.

HP 85718B NADC-TDMA Measurement Personality

Based on the complete set of transmitter measurements required by EIA/TIA IS-54-B, -55-A, and -56-A standards, the HP 85718B provides tests for North American Dual-mode Cellular (NADC) time-division multiple-access radio systems. NADC-based PCS measurements at 1900 MHz (IS-136 standard) can also be made with the HP 85718B. The push of a button allows you to select between IS-54 800 MHz, IS-136 800 MHz, and IS-136 1900 MHz tuning plans.

Measurements

- Carrier power and carrier-off power
- Channel power
- Occupied bandwidth
- Adjacent and alternate channel power leakage
- Attack and release time
- Intermodulation spurious
- Power steps

Modulation Accuracy Measurements

- RMS error vector magnitude (EVM) and peak EVM
- RMS magnitude error and phase error
- Carrier frequency error
- Amplitude droop
- I-Q origin offset

Recommended Configuration

HP 85718B Measurements Personality
and
HP 8594E, HP 8595E, HP 8596E, or HP 8593E Portable Spectrum Analyzer with the following options:

With Modulation Accuracy Measurements

Opt 004 Precision Frequency Reference
Opt 050 Improved Accuracy for NADC Cellular and PCS Bands
Opt 105 Time-Gated Spectrum Analysis (mobiles only)
Opt 151 Fast ADC and Digital Demodulator
Opt 160 PDC/PHS/NADC/CDMA Firmware for Option 151

Without Modulation Accuracy Measurements

Omit **Opt 151 and 160**
Add **Opt 101** Fast Time-Domain Sweeps (mobiles only)

Note: In a configuration without modulation accuracy measurements, the HP 8591E is also supported.

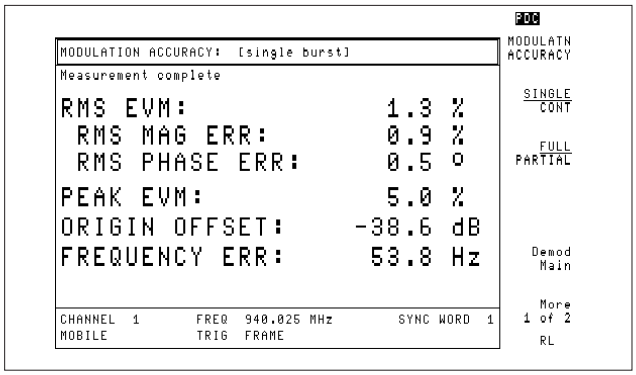
Key Literature

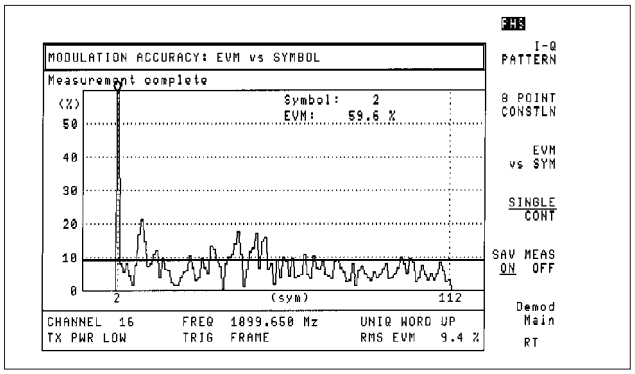
Portable NADC-TDMA Transmitter Tester, p/n 5962-6217E

Ordering Information

More information about the HP 8590 E-series spectrum analyzers and all analyzer options, including ordering information, can be found on pages 248 to 253.

HP 85720C
HP 85726B





HP 85720C PDC Measurement Personality

The HP 85720C provides transmitter measurements for Personal Digital Cellular (PDC) time-division multiple-access radio systems. This personality provides tests that are customized based on the RCR STD-27C standard for both high and low PDC frequency bands. Also the HP 85720C test times have been reduced by up to 30 percent as compared to the HP 85720B.

Measurements

- Antenna power
- Carrier-off leakage power
- Channel power
- Occupied bandwidth
- Adjacent channel power leakage
- Burst ramp-up and ramp-down power vs. time
- Transmitter intermodulation
- Spurious emissions
- Power step

Modulation Accuracy Measurements
- RMS error vector magnitude (EVM) and peak EVM
- RMS magnitude error and phase error
- I-Q origin offset
- Carrier frequency error

Recommended Configuration

HP 85720C PDC Measurements Personality
and
HP 8594E, HP 8595E, HP 8596E, or HP 8593E Portable Spectrum Analyzer with the following options:
With Modulation Accuracy Measurements
- **Opt 004** Precision Frequency Reference
- **Opt 051** Improved Accuracy for PDC Bands
- **Opt 105** Time-Gated Spectrum Analysis (mobiles only)
- **Opt 151** DSP, Fast ADC, and Digital Demodulator
- **Opt 160** PDC/PHS/NADC/CDMA Firmware for Option 151

Without Modulation Accuracy Measurements
- Omit **Opts 151 and 160**
- Add **Opt 101** Fast Time-Domain Sweeps (mobiles only)

Note: In a configuration without modulation accuracy measurements, the HP 8591E is also supported.

Key Literature

Portable PDC Transmitter Tester, p/n 5963-9971E

HP 85726B PHS Measurement Personality

The HP 85726B measurement personality provides transmitter tests for Personal Handy Phone System (PHS) radios based on the RCR STD-28 standard. Most tests are also based on the methods of measurement called out by the MKK. In addition to modulation accuracy measurements, this personality has reduced test times by up to 50 percent as compared to the HP 85726A.

Measurements

- Antenna power
- Adjacent channel power
- Burst ramp-up and ramp-down power vs. time
- Carrier-off time leakage power
- Spurious emission
- Occupied bandwidth

Modulation Accuracy Measurements
- RMS error vector magnitude (EVM) and peak EVM
- EVM vs. symbol
- RMS magnitude and phase error
- I-Q origin offset
- Carrier frequency error

Recommended Configuration

HP 85726B PHS Measurements Personality
and
HP 8594E, HP 8595E, HP 8596E, or HP 8593E Portable Spectrum Analyzer with the following options:
With Modulation Accuracy Measurements
- **Opt 004** Precision Frequency Reference
- **Opt 052** Improved Amplitude Accuracy for PHS Band
- **Opt 105** Time-Gated Spectrum Analysis
- **Opt 151** DSP, Fast ADC, and Digital Demodulator
- **Opt 160** PDC/PHS/NADC/DCMA Firmware for Option 151

Without Modulation Accuracy Measurements
- Omit **Opts 151 and 160**
- Add **Opt 101** Fast Time-Domain Sweeps

Key Literature

Portable PHS Transmitter Tester, p/n 5964-0110E

HP 8560 E-Series

- Accurate, automated ACP measurements on TDMA and TDD signals
- Measure according to NADC-TDMA, PDC, PHS, and other standards
- Measurement accelerators speed up ACP testing
- Carrier on/off power
- Total channel power, percent occupied bandwidth
- Burst-timing measurements

HP 8564E HP 8565E

Accurate and Easy-to-Use Power Measurements Using the HP 8560 E-Series Spectrum Analyzers

Many wireless communications systems today employ burst-carrier techniques such as time-division multiple access (TDMA) and time-division duplex (TDD) to maximize system capacity. The HP 8560 E-series spectrum analyzers offer power measurements for both continuous and burst signals that are accurate, and easy to make. Measurement capability includes adjacent channel power (ACP), carrier power, channel power, and occupied bandwidth. These analyzers provide the greatest measurement flexibility and RF performance, making them powerful tools for R&D designers working with current wireless standards, or on systems with standards still under development.

The HP 8562E Spectrum Analyzer

The HP 8562E Spectrum Analyzer was designed specifically for digital comms. Its frequency coverage of 13.2 GHz means that now you can use the same analyzer for harmonic and spurious testing both in- and out-of-band. The increased dynamic range and third-order intercept (TOI) capability allows wireless communications engineers to test high-performance components in burst operation systems. See pages 254 to 257 for details.

Measurement Utility Increases Speed and Repeatability

The HP 85672A Spurious Response Measurements Utility makes measurements fast and easy with the touch of a button. Works on all HP8560 E-Series spectrum analyzers. See page 255 for details.

Adjacent Channel Power

The ability to measure ACP on today's wireless telephones, pagers, and other transmitters is critical in R&D, manufacturing and in the field. The HP 8560 E-series spectrum analyzers provide ACP measurements for a variety of wireless communication systems, including support for NADC-TDMA, PDC, and PHS digital formats. Many of the implementation difficulties of the established standards have been addressed, providing fast, accurate, and easy-to-use ACP measurements. Use an HP8560 E-Series spectrum analyzer with the HP8563E Option E35 APCR test set to meet the needs of the emerging W-CDMA specifications.

In addition to the standard analog method for making ACP measurements (used for FM mobile telephones and continuous digital formats), the analyzers support four other methods used for burst-carrier measurements of TDMA and TDD signals:

- Peak (for PDC and PHS)
- Two-bandwidth (for PDC)
- Time-gated (for NADC-TDMA)
- Burst-power (an HP proprietary method)

The burst-power method overcomes many of the problems of the other standards, and is suitable for all formats. These methods can easily be adapted to measure other transmitters besides those used for cellular or cordless telephones. Configuration parameters that can be set by the user include channel spacing and bandwidth, number of alternate channels, burst period and width, and values for root-raised-cosine frequency weighting. Measurement results can be displayed in both graphic and tabular formats for ease of data interpretation and documentation. Measurement accelerators are available that give ACP results in just a few seconds, allowing real-time transmitter adjustments.

METHOD: ANALOG PEAK 2BW BURSTPWR **GATE**		METHODS
ACCELERATOR: **NORMAL** FASTEST		
(ERROR: 0dB <2dB)		ACCELERAT
CHANNEL SPACING:	30.00kHZ	
CHANNEL BANDWIDTH:	33.00kHZ	SPACING/ BANDWIDTH
ALTERNATE CHANNELS:	2	
BURST PERIOD:	20.0ms	BURST/
BURST WIDTH:	6.53ms	WEIGHTING
FREQ WEIGHTING: **ROOT-RAISED-COS** OFF		ACPSTATE
WEIGHTING T :	41.0 us	DFL CURR
WEIGHTING :	.350	
MEASUREMENT STATE: **DEFAULT** CURRENT		PREV MENU

Setup menu for adjacent channel power measurements

Carrier Power

The carrier power feature provides the user with a quick means of measuring the average "on" and "off" power of the burst carrier. This measurement is performed in the time domain, using zero span.

Channel Power

The channel-power feature quickly provides the user with information on total power within a specified channel bandwidth, as well as power density within the channel. This feature greatly simplifies this common measurement, as the spectrum analyzer automatically performs the necessary integration across the desired frequency band.

Occupied Bandwidth

Occupied bandwidth is a way of determining the spectral spread of a signal. It is defined as the bandwidth which contains the specified percent of the total transmitted power. The user may specify the percentage to be anywhere from 0.1 to 99.99 percent.

Burst Timing

Complete timing measurements can be made on the burst-carrier signal using Option 007, which provides digitized, fast time-domain (zero span) sweeps. Using sweep times as fast as 50 µs, edge times, burst width, and time between bursts can easily be measured.

More Information

More information about the HP 8560 E-series spectrum analyzers, including ordering information, can be found on pages 254 to 257.

HP 89441A
HP 89410A
HP 89441V
HP 89411A
HP 89450A
HP 89451A

- Flexible digital-modulation analysis
- Advanced time- and frequency-domain analysis
- Offset QPSK (optional)
- Accurate frequency selective power measurements
- Direct burst-carrier settling analysis
- Adaptive equalization for digital comms (optional)

HP 89441A

HP 89441A DC to 2.65 GHz Vector Signal Analyzer

HP-IB

A Signal Analyzer for Communications Designers

Designers of communications systems can now spend their time verifying and improving their designs rather than creating specialized testing tools for each component, new signal, or modulation type. Using vector-signal analysis and advanced DSP techniques, signals that formerly required much time and effort to measure can be viewed with ease.

The HP 89441A offers many types of measurements for characterizing performance or locating problems throughout the block diagrams of transmitters and receivers—from baseband to RF stages. Analyze burst, transient, or modulated signals with simultaneous views of time, frequency, phase, and amplitude. Using this flexibility, measurements such as LO stability, phase noise, and transient characteristics are direct, easy, and reduce the overall amount of required test equipment.

Flexible Vector-Modulation Analysis

Measurements of RF or IF signals are simplified since no external filters, coherent carriers or symbol-timing signals are required. Baseband I and Q signals can also be analyzed simultaneously with the optional second 10 MHz input channel. Modulation including BPSK, QPSK, Offset QPSK, DQPSK, π/4DQPSK, 8PSK, 16-256QAM, VSB, MSK, and 2- to 4-level FSK are supported. Various filter types with adjustable parameters and user-defined filters, in addition to burst length, symbol rate, and carrier frequency can all be selected by the user. To simplify measurements, the parameters for systems such as CDMA, GSM, NADC, PDC, PHS, DECT, and CDPD can be set with a single button.

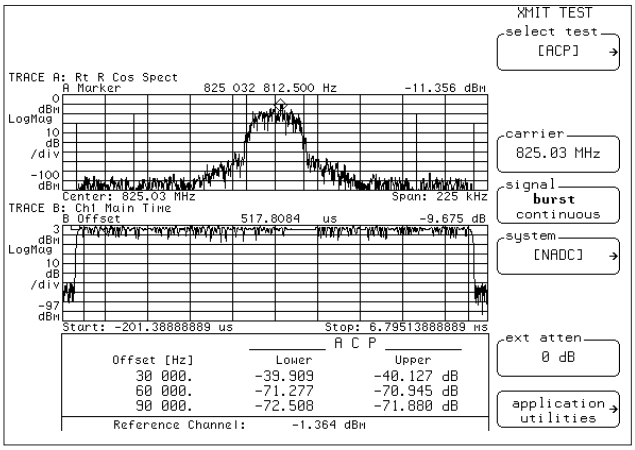
Measurement results can be displayed in various formats and tables. Constellation, vector, and eye diagrams provide familiar tools for analyzing vector-modulated signals. Detected data tables display the received binary bits and show results of modulation quality including amplitude droop and quadrature error. The vector-modulation analysis option also offers error measurements by generating an ideal reference signal to compare to the received signal. Results include error vector magnitude, phase error, and magnitude error.

W-CDMA Code Domain Power Analysis

The new W-CDMA CDP analysis option allows designers to verify their W-CDMA transmitter designs. The CDP measurement allows designers to view code power for all symbol rates on a single display, to measure power in a single code channel using markers, to zoom screen views for more display resolution of code channel power, and to determine code power in each of the 16 timeslots in a frame.

Radio Test Personality

The HP 89451A personality adds "one-button" measurements to quickly set up and test NADC, PDC, PHS, and user-defined systems. Occupied bandwidth, adjacent channel power, modulation accuracy, and frequency tolerance are included in the suite of measurements that can be made on burst or continuous signals. Accuracy required for R&D applications, ease-of-use, and measurement speed are all provided as well as the flexibility to change any of the demodulation parameters or access any of the HP 89441A measurement modes to troubleshoot difficult system problems.



Specialized display from the HP 89451A Radio Test Personality

DMCA Radio Test Personality

The HP 89450A DMCA (Digital Multi-Channel Access) personality adds "one-button" tests and modulation analysis of M16QAM signals, meeting the measurement standards outlined in the RCR-32 DMCA radio standard.

Special option H01 provides specific testing capability for the iDEN standard and compatible systems. This includes BER (Bit Error Rate) testing along with carrier, power and digital modulation tests similar to those described for DMCA.

Adaptive Equalization

The adaptive equalization option (AYJ) works with digital demodulation to remove linear errors, such as frequency response and reflections, from transmitted signals. This allows measurements in some impaired channels and can be used to isolate linear vs. non-linear error mechanisms. For more information, see page 265.

CAE Simulator Link

Testing "concurrently designed" systems typically requires waiting for an entire system to be physically prototyped and its subsystems assembled. The HP 89441A analyzer in conjunction with HP Advanced Design System reduce overall system development time by emulating signals that the hardware will actually generate—but, before the hardware exists. The built-in arbitrary source can provide this emulated signal as stimulus to subsequent sections of the system that have been completed. Also, real-world measurement results can be used in system simulations prior to prototyping. Compatible data formats in Advanced Design System and the HP 89441A links theory to reality, lowering system development time barriers.

Solutions for Microwave Frequency Coverage

The HP 89441A is a complete solution for characterizing systems up to 2.65 GHz. To extend the vector-signal analysis capabilities to higher frequencies, the HP 89410A, 89411A, plus an external spectrum analyzer provide microwave coverage.

See page 264 for more detailed descriptions, specifications, and complete vector-signal analyzer ordering information.

For more information, visit our website: **http://www.hp.com/go/89400**

HP E4430B
HP E4431B
HP E4432B
HP E4433B

- Built-in digital modulation formats for CDMA, DECT, GSM, NADC, PDC, PHS and TETRA
- <1% rms EVM for NADC, PDC, PHS, TETRA
- 0.75° rms global phase error for GSM
- First alternate channel power for NADC of –80 dBc (typical)
- Rho of 0.996 (typical) for CDMA signals

HP ESG-D Series E4433B

Meet Complex Digital Requirements Using the HP ESG-D Series of Digital Signal Generators

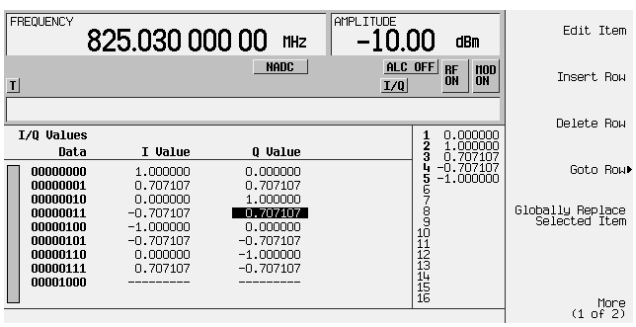
HP-IB

The HP ESG-D series of digital RF signal generators are ideal for testing in a variety of wireless communication applications. Digital receivers or their components can efficiently be tested with the digital modulation capabilities of an ESG-D series with options. These options provide standard TDMA signals such as DECT, GSM, NADC, PDC, PHS, TETRA and the flexibility to create variations of these standards or proprietary modulations. Test CDMA mobile components and receivers by generating single or multiple Walsh coded channels. Flexibility and wide I/Q bandwidth allow the generation of wideband signals including W-CDMA. All these digital modulations are easily configured with the simple straightforward menu structure.

Custom Modulation

The ESG-D series has two optional implementations of baseband generators to meet any digital modulated signal requirements.

Option UN8, real-time I/Q baseband generator, provides internal symbol generation via a custom ASIC. Choose from MSK, PSK, QAM and FSK modulation signals, Gaussian, root Nyquist, Nyquist filters, data types and symbol rates to build proprietary or unique digitally modulated signals. Achieve maximum flexibility by defining the required modulation in an I/Q table and required filtering with FIR coefficients.

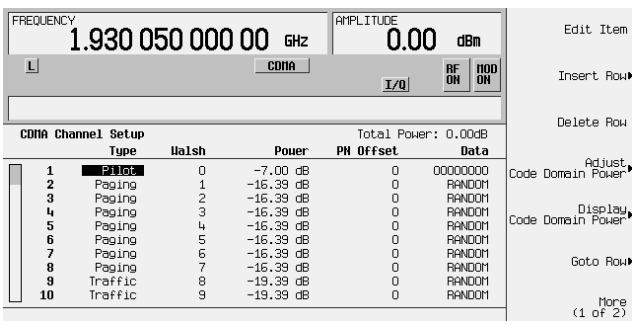


I/Q Table Editor

Option UND is an internal dual arbitrary waveform generator. Any mathematically generated digitally modulated signal can be replayed. The dual arb has high signal fidelity (14 bit DACs) and deep memory (1 Msample/channel non-volatileRAM) for replaying complex waveforms.

CDMA and W-CDMA Personalities

Several CDMA personalities (H03, UN5) and W-CDMA (H97, H98) extend the power of the optional baseband generators. The CDMA options generate single or multiple Walsh-coded channels to test mobile and base-station components and receivers. Individually configure, channel type (traffic, paging, sync), Walsh codes (0–64), PN offsets (0–511) and power to simulate base-station transmissions. W-CDMA personalities include pre-defined channel configurations for Perch and multiple DTCH channels (1-127).



CDMA Table Editor

TDMA Standards

DECT, GSM, PDC, PHS, NADC, TETRA standards are included with Option UN8. These standards include easy to configure frames and timeslots. Each timeslot within a frame can be configured independently to simulate different types of traffic, control or synchronization channels (or bursts). Modify the digitally modulated signals by changing filter factor, data or data rate to fully characterize components and systems.

High Spectral Purity

The ESG-D series signal generators are an excellent choice for adjacent channel selectivity measurements of digital receivers. By providing low SSB phase noise at wide offsets, you can measure out-of-channel characteristics of digital receivers with high spectral purity performance. Spectral purity is maintained even when the modulators are on.

More Information

More information about the HP ESG (analog) and HP ESG-D (digital and analog) series signal generators, including ordering information, can be found on pages 208 and 214, or visit our website:
http://www.hp.com/go/esg

HP 8903B
HP 8903E

- Measures distortion, SINAD, signal-to-noise
- Measures true-rms ac volts, dc volts, frequency
- Low-distortion programmable source
- rms, average, and quasi-peak detection

HP 8903B

- Measures distortion, SINAD
- Measures true-rms ac volts, dc volts, frequency
- rms, average, and quasi-peak detection

HP 8903E

HP 8903B Audio Analyzer and HP 8903E Distortion Analyzer

HP-IB

The HP 8903B audio analyzer and HP 8903E distortion analyzer provide unparalleled versatility and performance for audio measurements from 20 Hz to 100 kHz. The HP 8903B combines the functionality of a low-distortion audio source, high-performance distortion analyzer, frequency counter, ac voltmeter, dc voltmeter, and SINAD meter into one compact package. With microprocessor control of source and analyzer, the HP 8903B can perform stimulus-response measurements, such as signal-to-noise ratio and swept distortion, automatically, with no additional equipment. The HP 8903E distortion analyzer is the analyzer portion of the HP 8903B audio analyzer. (The HP 8903E has no source.)

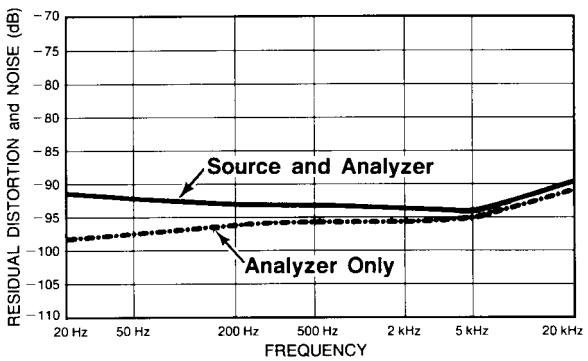
For ease of use, most measurements on the HP 8903B and HP 8903E are made with only one or two keystrokes. Both instruments automatically tune and autorange for maximum accuracy and resolution. For quick identification of input signals, the analyzer counts and displays the input frequency in all ac measurement modes.

Low-Frequency Applications

The HP 8903B/E have many features that make difficult audio measurements easy. These include flexible data display formats, a selectable balanced or unbalanced input, plug-in filters, and automatic notch filter tuning. With the ratio key, you can establish a reference in % or dB and directly make frequency-response and 3 dB bandwidth measurements without computation. A fully balanced analyzer input allows testing of the bridged power amplifiers found in many radios and car stereos, as well as professional balanced audio equipment.

With 2 internal plug-in filter slots and 6 optional filters to choose from, we simplify your audio measurements by providing the filter networks required by international standards. (See the next page for a complete list of filters.) The HP 8903B and HP 8903E both use true-rms detection (for all signals with crest factor 3) for accurate measurement of complex waveforms and noise. Average and quasi-peak detectors are also available. (Quasi-peak is selectable only via HP-IB on the HP 8903E.) Accurate distortion measurements typically can be made down to less than –90 dB (0.003%) from 20 Hz to 20 kHz.

For receiver testing, both instruments have a tunable SINAD notch filter. On the HP 8903B, the filter is automatically tuned to the source frequency. With the HP 8903E, a front-panel key allows the operator to lock the notch filter at any given input frequency.



Typical residual THD + noise for source and analyzer combined (source voltage set to 1.5 V, 80 kHz BW). Dashed line represents typical residual THD + noise for the analyzer only.

HP 8903B and HP 8903E Specifications

System Specifications (HP 8903B only, source and analyzer combined)

Distortion
Residual Distortion and Noise (the higher of):
80 kHz BW: –80 dB (0.01%) or 17 μV, 20 Hz to 20 kHz
500 kHz BW: –70 dB (0.032%) or 50 μV, 20 Hz to 50 kHz; –65 dB (0.056%) or 50 μV, 50 kHz to 100 kHz
Signal-to-Noise
Frequency Range: 50 Hz to 100 kHz
Display Range: 0 to 99.99 dB
Accuracy: ±1 dB
Input Voltage Range: 50 mV to 300 V
Residual Noise (the higher of): –85 dB or 17 μV, 80 kHz BW; –70 dB or 50 μV, 500 kHz BW

Source Specifications (HP 8903B only)

Frequency
Range: 20 Hz to 100 kHz
Resolution: 0.3%
Accuracy: 0.3% of setting

Output Level
Range: 0.6 mV to 6 V open circuit
Resolution: 0.3% or better
Accuracy (open circuit): 2% of setting 60 mV to 6 V, 20 Hz to 50 kHz; 3% of setting 6 mV to 6 V, 20 Hz to 100 kHz; 5% of setting 0.6 to 6 mV, 20 Hz to 100 kHz
Flatness (1 kHz reference): ±0.7% (±0.06 dB), 20 Hz to 20 kHz; ±2.5% (±0.22 dB), 20 Hz to 100 kHz
Distortion and Noise (the higher of):
80 kHz BW: –80 dB (0.01%) or 15 μV, 20 Hz to 20 kHz
500 kHz BW: –70 dB (0.032%) or 38 μV, 20 Hz to 50 kHz; –65 dB (0.056%) or 38 μV, 50 to 100 kHz
Impedance: 600 Ω ±1% or 50 Ω ±2%, front-panel selectable (HP-IB programmable)
Sweep Mode: Log sweep with up to 500 points per decade or 255 points total between entered start and stop frequencies

11

HP 8903B
HP 8903E

Analyzer Specifications (Both HP 8903B and HP 8903E)

Distortion
Fundamental Frequency Range: 20 Hz to 100 kHz
Display Range: 0.001% to 100% (–99.99 to 0 dB)
Accuracy: ±1 dB, 20 Hz to 20 kHz; ±2 dB, 20 kHz to 100 kHz
Input Voltage Range: 50 mV to 300V
Residual Distortion and Noise (the higher of):
80 kHz BW: –80 dB (0.01%) or 15 μV, 20 Hz to 20 kHz
500 kHz BW: –70 dB (0.032%) or 45 μV, 20 Hz to 50 kHz; –65 dB (0.056%) or 45 μV, 50 kHz to 100 kHz
Supplemental Characteristics
3 dB Measurement Bandwidth: 10 Hz to 500 kHz
Detection: True-rms or rms-calibrated average

SINAD
Fundamental Frequency Range: 20 Hz to 100 kHz
Display Range: 0 to 99.99 dB
Residual Distortion and Noise: Same as listed under Distortion
Accuracy: ±1 dB, 20 Hz to 20 kHz; ±2 dB, 20 to 100 kHz
Input Voltage Range: 50 mV to 300 V
Supplemental Characteristics
Detection: True rms or rms-calibrated average
Tuning: HP 8903B: Notch filter is tuned to the internal source frequency. HP 8903E: Notch filter is tuned to the counted input frequency. Notch filter hold function available on front panel.

AC Level
Full Range Display: 300 V, 30 V, 3 V, 0.3 V, 30 mV, 3 mV, 0.3 mV
Overrange: 33%, except on 300 V range
Accuracy: ±2%, 50 mV to 300 V, 20 Hz to 20 kHz; ±4%, 0.3 to 50 mV, 20 Hz to 100 kHz; ±4%, 50 mV to 300 V, 20 to 100 kHz
Supplemental Characteristics
AC Converter: True-rms responding for signals with crest factor up to 3, rms-calibrated average detection and quasi-peak
3 dB Measurement Bandwidth: >500 kHz

DC Level
Full Range Display: 300 V, 48 V, 16 V, 4 V
Overrange: 33%, except on 300 V range
Accuracy: ±1.0% of reading, 600 mV to 300 V; ±6 mV, V_{in} 600 mV

Frequency Measurement
Measurement Range: 20 Hz to 150 kHz (20 Hz to 100 kHz in distortion and SINAD modes)
Resolution: 5 digits (0.01 Hz for input frequencies <100 Hz)
Accuracy: ±(0.004% + 1 digit)
Sensitivity: 50 mV in distortion and SINAD modes, 5.0 mV in ac level and signal-to-noise (HP 8903B only) modes

Standard Audio Filters
30 kHz Low-Pass Filter
3 dB Cutoff Frequency: 30 kHz ±2 kHz
Rolloff: Third-order Butterworth; 18 dB/octave or 60 dB/decade
80 kHz Low-Pass Filter
3 dB Cutoff Frequency: 80 kHz ±4 kHz
Rolloff: Third-order Butterworth; 18 dB/octave or 60 dB/decade
Internal Plug-In Filter Options
Both the HP 8903B and HP 8903E have two internal plug-in filter slots, each of which will accept one of 6 optional filters. The standard HP 8903B/E come with 30 kHz and 80 kHz low-pass filters, but with no plug-in filters. The appropriate filter options must be ordered for the analyzers to have any of the filters listed below. Each filter option has two option numbers: the 010 series for the left filter slot and the 050 series for the right filter slot. Each filter option ordered (maximum of two) adds additional cost to the instrument.

Filters	Option Numbers Filter Position Left slot	Right slot
400 Hz High-Pass	010	050
CCITT Weighting Filter	011	051
CCIR Weighting Filter	012	052
C-MESSAGE Weighting Filter	013	053
CCIR/ARM Weighting Filter	014	054
"A" Weighting Filter	015	055

Analyzer Input
Input Type: Balanced (full differential)
Input Impedance: 100 kΩ ±1% shunted by <300 pF, each side to ground. (In dc-level mode the input resistance is 101 kΩ ±1%.)
Max. Input (maximum peak input voltage, any combination of ac/dc):
HP 8903B: 425 V peak, applied differentially or between either input to ground
HP 8903E: 42 V peak, low side to ground
425 V peak, differentially or high side to ground
CMRR: >60 dB, 20 Hz to 1 kHz, Vin <2 V; >45 dB, 20 Hz to 1 kHz; >30 dB, 20 Hz to 20 kHz

General
Temperature: Operating, 0° to 55° C; storage, –55° to 75° C
Power: 100, 120, 220, or 240 V (+5, –10%); 48 to 66 Hz; 100 or 120 V (+5, –10%); 48 to 440 Hz; 100 VA maximum
Size: 425 mm W x 146 mm H x 462 mm D (16.8 in x 5.75 in x 18.2 in)
Weight: HP 8903B: Net, 12.3 kg (27 lb); shipping, 16.4 kg (36 lb); HP 8903E: Net, 11.8 kg (26 lb); shipping, 15.9 kg (35 lb)

Key Literature

HP 8903B Technical Specifications, p/n 5953-8243

Ordering Information

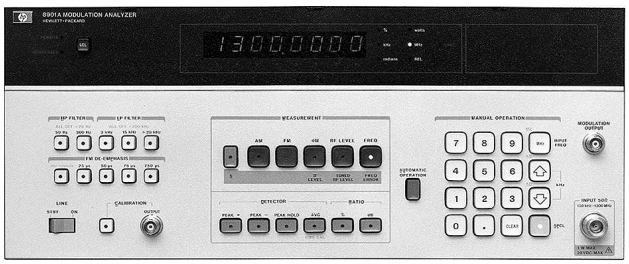
Analyzer Mainframes
HP 8903B Audio Analyzer[1]
Opt 001 Input/Output Connectors on Rear Panel Only
Opt 910 Two sets of Operation/Calibration (08903-90079) and Service Manuals (08903-90062)
Opt 915 Service Manual (08903-90062)
Opt W30 Extended Repair Service
Opt W32 Calibration Service
HP 8903E Distortion Analyzer[1]
Opt 001 Input/Output Connectors on Rear Panel Only
Opt 910 Additional Operation and Calibration Manual (08903-90053) and Two Service Manuals (08903-90065)
Opt 915 Add Service Manual (08903-90065)
Opt W30 Extended Repair Service
Opt W32 Calibration Service
Options for both HP 8903B and HP 8903E
Opt 010 or 050 400 Hz High-Pass Filter
Opt 011 or 051 CCITT Weighting Filter
Opt 012 or 052 CCIR Weighting Filter
Opt 013 or 053 C-Message Weighting Filter
Opt 014 or 054 CCIR/ARM Weighting Filter
Opt 015 or 055 "A" Weighting Filter
Opt 907 Front Handle Kit (5061-9689)
Opt 908 Rack Flange Kit (5061-9677)
Opt 909 Rack Flange Kit (5061-9683) with Front Handles

[1]HP-IB cables not included.

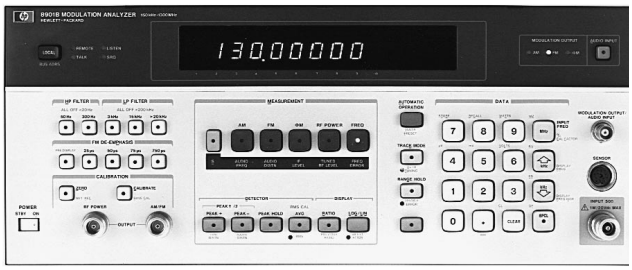
Indicates QuickShip availability.

- Measures AM and FM to 1% accuracy
- Measures RF frequency
- Measures RF power
- Low internal noise
- Completely automatic

HP 8901A
HP 8901B
HP 11715A



HP 8901A



HP 8901B

HP 8901A and HP 8901B Modulation Analyzers

The HP 8901A and HP 8901B modulation analyzers combine the capabilities of several RF instruments to give complete, accurate characterization of modulated signals in the 150 kHz to 1300 MHz frequency range. Both instruments very accurately measure modulation and recover the modulation signal. They determine RF frequency and measure RF power. The major additional capabilities of the HP 8901B are its improved power-meter accuracy, its ability to use external power sensors, its ability to make adjacent-channel power measurements or carrier-noise measurements (with Options 030 through 037), and its ability to count audio frequencies and measure distortion on 400 Hz and 1 kHz signals. Both instruments are fully automatic and make all major measurements at the press of a key or under HP-IB control.

Transmitter Testing

The HP 8901A/B have the features required to perform standard transmitter measurements. They measure transmitter power, count frequency, and measure the signal modulation very accurately. The HP 8901B also characterizes the demodulated audio signal's frequency, level, and distortion. With Option 030 the HP 8901B can quickly and accurately make adjacent-channel power measurements to CEPT standards.

RF Signal Characterization

The HP 8901A/B are excellent lab and production tools for accurately characterizing RF signals.

Use the HP 8901A/B to make accurate AM/FM and FM/AM conversion measurements of phase- and amplitude-sensitive devices such as bandpass filters and multiple-channel receivers. Excellent isolation between AM and FM make it simple to separate the AM and FM of AM stereo, the incidental AM of FM transmitters, and the AM, FM, and FM components of complex signals.

Automatic Test Systems

The HP 8901A/B are important components of automatic RF test systems. All functions are fully automatic and easily programmed. With these measurements combined into one instrument, interfacing requirements, hardware costs, and software-development time are reduced.

HP 8901A and HP 8901B Specifications

RF Input
Frequency Range: 150 kHz to 1300 MHz
Operating Level: 12 mV rms to 7 V rms
Input Impedance: 50 Ω nominal
Tuning: Manual frequency entry, automatic, or track
Acquisition Time (automatic operation): ~1.5 s
Maximum Safe Input Level (typical): 35 V rms (25 W for source SWR <4), ac; 40 V, dc

Frequency Modulation
Rates: 20 Hz to 200 kHz
Deviations: To 400 kHz
Accuracy:
±2% of reading ±1 digit, 20 Hz to 10 kHz rates, 250 kHz to 10 MHz;
±1% of reading ±1 digit, 50 Hz to 100 kHz rates, 10 to 1300 MHz
Demodulated Output Distortion: <0.1% THD
AM Rejection (for 50% AM at 400 Hz and 1 kHz rates): <20 Hz peak deviation measured in a 50 Hz to 3 kHz BW
Residual FM (50 Hz to 3 kHz BW): <8 Hz rms @ 1300 MHz, decreasing linearly with frequency to <1 Hz rms for 100 MHz and below
Maximum Deviation Resolution: 1 Hz
Stereo Separation (50 Hz to 15 kHz): >47 dB typical

Phase Modulation
Carrier Frequency: 10 to 1300 MHz
Rates: 200 Hz to 20 kHz; typically usable from 20 Hz to 100 kHz with degraded performance
Deviation: To 400 radians
Maximum Deviation Resolution: 0.001 radian
Accuracy: ±3% of reading ±1 digit
Demodulated Output Distortion: <0.1% THD
AM Rejection (for 50% AM at 1 kHz rate): <0.03 radian peak deviation (50 Hz to 3 kHz BW)

Amplitude Modulation
Rates: 20 Hz to 100 kHz
Depth: To 99%
Accuracy
±2% of reading ±1 digit, 50 Hz to 10 kHz rates, 150 kHz to 10 MHz;
±1% of reading ±1 digit, 50 Hz to 50 kHz rates, 10 to 1300 MHz
Flatness (variation in indicated AM depth for constant depth on input signal): ±0.3% of reading ±1 digit
Demodulated Output Distortion: <0.3% THD
FM Rejection (at 400 Hz and 1 kHz rates, 50 Hz to 3 kHz BW): <0.2% AM
Residual AM (50 Hz to 3 kHz BW): <0.01% rms
Maximum Depth Resolution: 0.01%

Frequency Counter
Range: 150 kHz to 1300 MHz
Accuracy: ±3 counts of least significant digit ± reference accuracy
Internal Reference
Frequency: 10 MHz
Aging rate: <1 x 10^{-6}/month (optional: 1 x10^{-9}/day)
Maximum Resolution
HP 8901A: 10 Hz for frequencies <1 GHz;
100 Hz for frequencies ≥1 GHz
HP 8901B: 1 Hz

HP 8901A RF Level (Peak Voltage Responding, RMS Sine Wave Power Calibrated)

Range: 1 mW to 1 W
Instrumentation Accuracy: ±1.5 dB
SWR: ≤1.3, 150 kHz to 650 MHz; ≤1.5, 650 to 1300 MHz
Maximum Resolution: 0.001 mW for levels <0.01 W

HP 8901A
HP 8901B
HP 11715A

HP 8901B RF Level (True RMS)

Frequency Range with HP 11722A: 100 kHz to 2.6 GHz
Power Range: –20 to +30 dBm
RF Range-to-Range Change Error: ±0.02 dB/RF range change from reference range
Input SWR: <1.15, using HP 11722A sensor module
Zero Set (digital settability of zero): ±0.5% ±1 digit of full scale on lowest range (decrease by a factor of 10 for each high range)
RF Power Resolution: 0.1% of full scale in watts or volts mode; 0.001 in dBm or dB relative mode

HP 8901B Selective Power Measurements (Options 030 through 037)

Frequency Range: 10 MHz to 1.3 GHz
Carrier Power Range: +30 to –20 dBm, 12.5, 25 and 30 kHz filters; +30 to –10 dBm, carrier noise filter
Dynamic Range: 115 dB
Carrier Rejection (temp. ≤35° C): >90 dB for offsets ≥1 channel spacing or 5 kHz, whichever is larger
Relative Accuracy: ±0.5 dB, levels ≥–95 dBc or levels ≥–129 dBc/Hz

Power Reference
Power Output: 1.00 mW, factory set to ±0.7%, traceable to the U.S. National Institute of Standards and Technology
Accuracy: ±1.2% worst case (±0.9% rss) for one year (0° to 55° C)

Audio Filters
High-Pass (3 dB cutoff frequency): 50 Hz and 300 Hz
Low-Pass (3 dB cutoff frequency except >20 kHz filter): 3 kHz, 15 kHz, >20 kHz
De-emphasis Filters: 25 μs, 50 μs, 75 μs, and 750 μs

Calibrators (Standard HP 8901B, Option 010 HP 8901A)
AM Calibrator Depth and Accuracy: 33.33% depth, nominal; internally calibrated to an accuracy of ±0.1%
FM Calibrator Deviation and Accuracy: 34 kHz peak deviation, nominal; internally calibrated to an accuracy of ±0.1%

General Characteristics

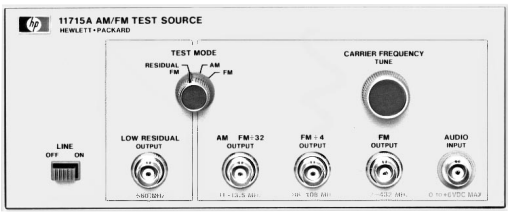
Operating Temperature Range: 0° to 55° C
Power Requirements: 100, 120, 220, or 240 V (+5%, –10%); 48 to 66 Hz; 200 VA max.
Size: HP 8901A: 425 mm W x 190 mm H x 468 mm D (16.8 in x 7.5 in x 18.4 in);
HP 8901B: 425 mm W x 190 mm H x 551 mm D (16.8 in x 7.5 in x 21.7 in)
Weight: HP 8901A: Net, 20 kg (44 lb); shipping, 25 kg (55 lb);
HP 8901B: Net, 23 kg (52 lb); shipping, 31 kg (69 lb)

Ordering Information

HP 8901A Modulation Analyzer[1]
- **Opt 001** RF Connectors on Rear Panel Only
- **Opt 002** 1x10^{-9}/Day Internal Reference
- **Opt 003** Connections for External Local Oscillator
- **Opt 004** Operation from 48 to 440 Hz Power (temp. <40° C)
- **Opt 010** AM and FM Calibrators
- **Opt 907** Front Handle Kit (5061-9690)
- **Opt 908** Rack Flange Kit (5061-9678)
- **Opt 909** Front Handle and Rack Flange Kit (5061-9684)
- **Opt 910** Two Sets of Operating (08901-90135) and Service Manuals (08901-90136)
- **Opt 915** Service Manual (08901-90136)
- **Opt W30** Extended Repair Service
- **Opt W32** Calibration Service

HP 8901B Modulation Analyzer[1]
- **Opt 021** Add HP 11722A Sensor Module
- **Opt 030** High Selectivity (select only 2 filter options) (Options 032 through 037 require Option 030; Option 030 includes Option 003 connections for external local oscillators)
- **Opt 032** 12.5 kHz Adjacent Channel Filter
- **Opt 033** 25.0 kHz Adjacent Channel Filter
- **Opt 035** 30.0 kHz Adjacent Channel Filter
- **Opt 037** Carrier Noise Filter
- **Opt 910** Two Sets of Operation/Calibration (08901-90113) and Service Manuals (08901-90114)
- **Opt 915** Service Manual (08901-90114)
- **Opt W30** Extended Repair Service
- **Opt W32** Calibration Service

[1]HP-IB cables not included.



HP 11715A

HP 11715A AM/FM Test Source

The HP 11715A AM/FM test source provides very flat, wide-bandwidth, and low-distortion amplitude- or frequency-modulated RF signals. Designed primarily for performance tests and adjustments of the HP 8901A/B modulation analyzer and HP 8902A measuring receiver, it will also serve as a high-quality modulated test oscillator where its frequency ranges apply.

The major components of the HP 11715A are a low-noise voltage-controlled oscillator (VCO), 2 digital dividers, and a double-balanced mixer. The VCO is the primary signal source, with a typical frequency range of 330 to 470 MHz at the FM output. FM is produced by directly coupling the external modulation source to the VCO's tune input, providing very wide bandwidth modulation with low phase shift. This design also ensures very little incidental AM.

The HP 11715A can also be used in conjunction with an HP 8901A/B and an HP 8902A as a calibrated signal source for special applications. In particular, the U.S. commercial FM broadcast band of 88 to 108 MHz is covered by the FM 4 4 output of the HP 11715A.

HP 11715A Specifications

FM Outputs
Frequency Range:
11 to 13.5 MHz, AM FM 4 32 output
88 to 108 MHz, FM 4 4 output
352 to 432 MHz, FM output
Peak Deviation:
>12.5 kHz, 11 to 13.15 MHz carrier
>100 kHz, 88 to 108 MHz carrier
>400 kHz, 352 to 432 MHz carrier
Distortion: <0.025% THD (<–72 dB) for

Carrier frequency	Peak deviation	Modulation rate
12.5 MHz	12.5 kHz	<10 kHz
100 MHz	100 kHz	<100 kHz
400 MHz	400 kHz	<100 kHz

Flatness: ±0.1%, dc to 100 kHz rates ±0.25%, dc to 200 kHz rates
Stereo Separation (88 to 108 MHz carrier, 75 kHz peak deviation, 1 kHz rate): >60 dB typical

AM Output
Frequency Range (AM/FM ÷ 32 output): 11 to 13.5 MHz
Depth: To 99%
Distortion:
<0.05% THD (<–66 dB), 50% AM, 20 Hz to 100 kHz rates
<0.1% THD (<–60 dB), 95% AM, 20 Hz to 100 kHz rates
Flatness: ±0.1%, 50 Hz to 50 kHz rates; ±0.25%, 20 Hz to 100 kHz rates
Linearity: ±0.1%, <95% AM; ±0.2%, <99%

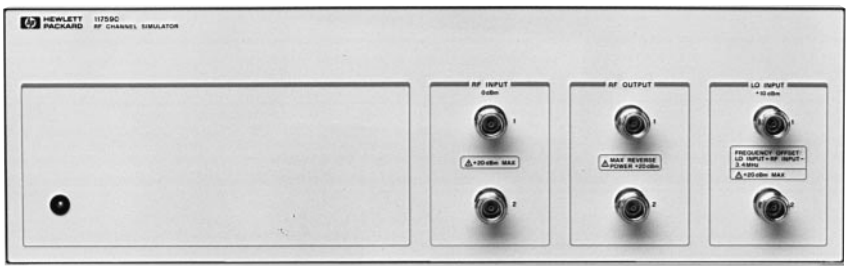
Ordering Information

HP 11715A AM/FM Test Source
Opt 910 A Total of Two Sets of Operating and Service Manuals (11715-90004)

Indicates QuickShip availability.

HP 11759C

- Simulates realistic signal propagation for CDMA, NADC (TDMA or E-TDMA), GSM, PDC, DCS1800, PHS, and more
- Rayleigh, Rice, or Log-normal fading
- RF bandwidth >6.0 MHz
- Doppler to 425 Hz
- Delay intervals to 186 µ in 1 ns steps
- PC controlled



HP 11759C

HP 11759C RF Channel Simulator

The HP 11759C RF channel simulator has all the features and performance characteristics that make it ideally suited for testing digital cellular radios under RF multipath conditions. Whether the radio is designed for operation with the CDMA (Option H30), GSM, NADC, DCS1800 or PDC cellular systems, it is easy to simulate the fast and slow fading, time dispersion and Dopplers experienced in the mobile radio environment. The HP 11759C is also suitable for testing many other analog and digital wireless communications systems with RF bandwidths to 6.0 MHz under multipath fading conditions.

The HP 11759C consists of the applications software and the RF processing hardware. To complete the RF multipath simulation system, two user-supplied components are necessary—a PC acting as a user-interface and a synthesized LO used to determine the RF operating frequency and to supply a 10 MHz clock signal.

Two Multipath Channels Provide Test Flexibility

The HP 11759C contains two independent 40 MHz to 2700 MHz RF channels of three paths each. Each path can be Doppler-shifted or Rayleigh or Log-normal faded, delayed and attenuated relative to the others. In addition, under Rayleigh fading conditions, the correlation factor for path pairs in the two channels is adjustable from 0 to 1.

For test applications requiring more paths per channel (e.g., GSM or DCS1800), the HP 11759C Option 001 configures the HP 11759C as one channel of six paths. By pairing two HP 11759C Option 001 units and controlling them from a single PC, the full 12-ray testing requirements of the GSM and DCS1800 systems can easily be accomplished. And, to make it even easier, the 12- and 6-ray propagation models are pre-stored in memory for easy recall and setup.

With an external power divider and/or power combiner, and two separate channels available, it is easy to configure the HP 11759C(s) for single-channel 6 (or 12) path tests, co-channel interferer tests, adjacent and alternate channel tests, and space and/or frequency diversity tests. This flexibility is particularly important during the radio R&D phase and also important for manufacturing test and type acceptance testing.

Easy to Use Manually or Remotely

Simple-to-use onscreen menus guide the user through the task of creating complex RF multipath signals for testing a mobile or base station radio. These same menus are accessed remotely by installing a HP-IB interface card in the PC.

HP 11759C Partial Specifications

See Technical Data Sheet for complete specifications.

RF Channel Specifications

Independent RF Channels: 2 of 3 paths each
(1 of 6 paths with Option 001)
RF Input/Output Frequency Range: 40 to 2700 MHz
RF Bandwidth (1 dB): >6.0 MHz typically
Path Insertion Loss: Typically 24 dB ±3 dB
LO Input Frequency Range: RF input frequency less 6 MHz

Channel Simulation Specifications

Number of Independent Paths per Channel: 3 (6, Option 001)
Independent Rayleigh (Classical) fading, Delay, Doppler and level available on each path
Path Attenuation Range: 0 to 50 dB, in 0.1 dB steps
Path Delay Interval Range: 0 to 186 µs, in 1.0 ns steps
(Delays to 1.48 ms are available by special order)
Simulated Vehicle Speed Range (at 900 MHz): 0 to ±509 km/h
Simulated Doppler Range: 0 to ±425 Hz
Rayleigh (Classical) Amplitude Distribution: Available on all paths for vehicle speeds from 1 to 509 km/h (at 900 MHz)
Repetition Interval: >27 seconds
Deviation from Rayleigh CDF (typical):
<±1.0 dB from +10 to –20 dB relative to the mean power
<±3.0 dB from –20 to –30 dB relative to the mean power
Level Crossing Rate Accuracy (+10 to –30 dB of the mean power level): Typically deviates from theoretical <±5% of the simulated Doppler
Remote Control: Available through optional HP-IB interface card installed in user supplied PC controller

General

Operating Temperature Range: 0° to 55° C
Specifications Warranted: +15° to +35° C
Power: 90 to 132/190 to 264 V; 48 to 66 Hz; 325 VA maximum
Size: 425 mm W x 146 mm H x 620 mm D (16.8 in x 5.7 in x 24.4 in)
Weight: Net, 13.6 kg (30 lb); shipping, 19 kg (42 lb)

Ordering Information

HP 11759C RF Channel Simulator
Opt 001 One Channel of 6 Paths
Opt 002 Rear-Panel-Only RF Connectors
Opt 003 One Channel of 6 Paths with Rear-Panel-Only RF Connectors

CDMA and GSM Drive Test Solutions

HP E7450B
HP E7451A
HP E7452A
HP E7460A
HP E7461A
HP E7470A
HP E7471A
HP E7472A

NEW

- Wireless network optimization
- Site selection and evaluation
- Network performance characterization
- Troubleshooting
- Speed network turn-up
- Optimize network performance
- Maximize productivity
- Minimize drive test cost

HP E7470A with otpions 010, 200, 410, 700, 710 and customer supplied phone

Integrated RF and Call Performance Coverage

A critical measure of the quality of a wireless network is the performance of the air interface. Drive testing is critical to maintaining top network performance. In order to understand how well service is being delivered to subscribers you must characterize the performance of your network as a function of location.

The primary underlying factor that defines air interface performance is RF coverage. How well are the RF signals being propagated? Are there coverage holes? Is there intrasystem interference: CDMA pilot pollution, GSM co-channel interference, etc.? Is there external interference from signals outside of the network?

The measures of performance that a subscriber experiences are call-based parameters: dropped calls, blocked calls, poor voice quality, and failed terminations. Both call-based and RF parameters must be measured as a function of location in order to both characterize the performance and to understand the underlying cause of performance problems.

The HP E74xx family of air interface measurement tools provides a comprehensive, scaleable set of drive testing capabilities for wireless networks. All of the systems are based on the same easy-to-use graphical user interface. The software foundation automates the data collection process. The user has complete control over which measurements are logged – any or all. Sophisticated alarm capabilities notify the user of specific conditions.

CDMA Drive Test Solutions NEW

The HP E7450B and E7452A RF Coverage Measurement Systems provide comprehensive characterization of the RF environment for CDMA networks in the PCS and cellular bands, respectively. The HP E7460A Service Quality Analysis System measures call-based performance parameters for CDMA networks in either the PCS or cellular band. The HP E7470A and E7472A Integrated Air Interface Measurement Systems combine all of the capabilities of the RF coverage and service quality analysis systems into complete solutions for CDMA drive testing in the PCS and cellular bands, respectively.

The HP E7450B combines the E6450B PCS band digital receiver with Windows95 (WindowsNT compatible) software. The HP E7452A is functionally equivalent to the E7450B, but it integrates the HP E6452A cellular band digital receiver. These systems make RF measurements as a function of location. They measure the power (Ec, Io, and Ec/Io) of any or all pilot channel signals in IS-95 and J-STD-008 CDMA networks. All measurements are made independently from network parameter settings providing a completely objective view of the pilot signal environment. These systems also provide CW and channel power measurements for site evaluation/selection testing as well as spectrum display capability for diagnosis of RF problems.

The HP E7460A integrates a CDMA mobile phone (or multiple phones) with Windows95 (WindowsNT compatible) software. Easy-to-use controls of phone functionality allow the user to characterize network performance parameters such as Frame Erasure Rate (FER), dropped call rate, and blocked call rate. The system displays rake receiver finger activity and pilot measurement information. Messaging information is displayed in a clear tree-oriented format, and the user has control over which sets of messages are displayed: paging, access, etc.

The HP E7470A and E7472A combine the capabilities of the E7460A with the E7450B and E7452A, respectively, to deliver complete drive test capability. RF and call-based measurements are controlled from an integrated user interface. As the phone delivers critical performance indicators: dropped calls, blocked calls, etc., the receiver provides a complete characterization of the RF coverage. The phone indicates what the problem is (e.g., dropped call), and the receiver shows you why it occurred (e.g., neighbor list error). In other words, the phone provides the "What" and the receiver provides the "Why".

GSM Drive Test Solutions

The HP E7451A RF Coverage Measurement System provides comprehensive characterization of the RF environment for GSM networks. The HP E7461A Service Quality Analysis System measures call-based performance parameters for GSM networks in either the 900 MHz (E-GSM) or 1800 MHz (DCS) band (or both). The HP E7471A Integrated Air Interface Measurement System combines all of the capabilities of the RF coverage and service quality analysis systems into a complete solution for GSM drive testing in the 900 MHz band.

The HP E7451A combines the E6451A digital receiver with Windows95 (WindowsNT compatible) software. This system makes RF measurements as a function of location. They measure the power of any or all frequency channels in GSM900 networks. All measurements are made independently from network parameter settings providing a completely objective view of the broadcast channel signal environment. The system also provides CW and channel power measurements for site evaluation/selection testing as well as spectrum display capability for diagnosis of RF problems and interference measurements.

The HP E7461A integrates a GSM test mobile phone (or multiple phones) with Windows95 (WindowsNT compatible) software. Easy-to-use controls of phone functionality allow the user to characterize network performance parameters such as RxQual, RxLev, Timing Advance, Mobile TX Power, dropped call rate, and blocked call rate. Messaging information (Layer III) is displayed in a clear tree-oriented format, and the user has control over which sets of messages are displayed: paging, access, etc.

The HP E7471A combines the capabilities of the E7461A with the E7451A to deliver complete drive test capability. RF and call-based measurements are controlled from an integrated user interface. As the phone delivers critical performance indicators: dropped calls, blocked calls, etc., the receiver provides a complete characterization of the RF coverage. In other words, the phone provides the "What" and the receiver provides the "Why".

Integrated CDMA and GSM Testing

The HP E74xx family of drive test solutions can integrate CDMA and GSM drive testing capability in one tool controlled from a single user interface. This provides a powerful solution for competitive analysis applications as well as providing a common platform for providers who need to manage networks using each technology.

Multiple Receiver Capability

The HP E7450B, E7451A, E7452A, E7470A, E7471A, and E7472A each includes one HP E645x receiver as part of the system. Each of these systems can integrate up to four receivers controlled from a single interface. To add an additional receiver to a system simply order that receiver. The cables necessary for interconnection of the receivers are included.

Selected Key Specifications

HP E6450B and E6452A CDMA Receiver
Frequency Range (HP E6450B): 1850 to 1910 MHz; 1930 to 1990 MHz
Frequency Range (E6452A): 824 to 849 MHz; 869 to 894 MHz
Frequency Accuracy: ±1 ppm
w/GPS Time Synchronisation: ±0.05 ppm characteristic
IF Bandwidth:1.25 MHz; 30 kHz characteristic
Amplitude Accuracy (1.25 MHz IFBW): ±1 dB (20˚ to 30˚C); ±2 dB (0˚ to 55˚C)
Amplitude Accuracy (30 kHz IFBW): ±1.5 dB (20˚ to 30˚C); ±2.5 dB (0˚ to 55˚C)
Noise Figure: 8 dB typical

HP E6451A GSM900 Receiver
Frequency Range: 880 to 915 MHz; 925 to 960 MHz
Frequency Accuracy: ±1 ppm
IF Bandwidth: 200 kHz; 1.25 MHz
Amplitude Accuracy:±0.5 dB typical (-25 to –100 dBm) (0˚ to 55˚C)
Noise Floor (RBW 200 kHz): –112 dBm characteristic
Noise Figure: 8.5 dB

Key Literature

HP E7450B and E7452A Technical Specification, p/n 5966-3852E
HP E7451A Technical Specification, p/n 5968-0030E
HP E7460A Technical Specification, p/n 5966-3850E
HP E7461A Technical Specification, p/n 5968-0029E
HP E7470A and E7472A Technical Specification, p/n 5966-3851E
HP E7471A Technical Specification, p/n 5968-0028E
HP E74xx Series CDMA Configuration Guide, p/n 5966-2976E
HP E74xx Series GSM Configuration Guide, p/n 5968-0034E

Convenient, easy setup with lightweight, portable system

Ordering Information

HP E7450B CDMA PCS RF Coverage Measurement System
HP E7451A GSM RF Coverage Measurement System
HP E7452A CDMA Cellular RF Coverage Measurement System
HP E7460A CDMA Service Quality Analysis System
HP E7461A GSM Service Quality Analysis System
HP E7470A CDMA PCS Integrated Air Interface Measurement System
HP E7471A GSM Integrated Air Interface Measurement System
HP E7472A CDMA Cellular Integrated Air Interface Measurement System
- **Opt 010** Portable Laptop PC
- **Opt 20** Replace 1 port serial card with 2 port card
- **Opt 200** Internal GPS receiver
- **Opt 210** External GPS/Dead Reckoning System
- **Opt 211** Adapter cable for Trimble Placer GPS/DR
- **Opt 212** Adapter cable for Trimble Placer GPS 455
- **Opt 310** Mapping Software
- **Opt 410** 1900 MHz PCS Band antenna-magnetic mount
- **Opt 430** 850MHz Cellular Band antenna-magnetic mount
- **Opt 440** GSM900 Band antenna-magnetic mount
- **Opt 510** Vehicle Mount Kit (brackets, screws)
- **Opt 530** Briefcase Carrier
- **Opt 700** Control capability for Qualcomm-based phones
- **Opt 710** Cable for Qualcomm QCP-800, 1900 phones
- **Opt 711** Cable for Qualcomm QCP-820, 1920, 2700 phones
- **Opt 712** Cable for Samsung SCH-1000 phone
- **Opt 800** Sagem OT-35G GSM900 Test Mobile (Only orderable as part of E7461A or E7471A)
- **Opt 801** Sagem OT-35D DCS1800 Test Mobile (Only orderable as part of E7461A or E7471A)

HP E6450B CDMA Digital Receiver 1850-1910 MHz / 1930-1990 MHz
HP E6451A GSM Digital Receiver 880-915 MHz / 925-960 MHz
HP E6452A Digital Receiver 824-849 MHz / 869-894 MHz

For more information, visit the Drive Test Solutions website:
http://www.hp.com/go/drive_test

Pager Test Equipment

Synthesized Signal Generator Subheader

HP 8648A
Option 1EP

- 100 kHz to 1.0 GHz
- POCSAG, FLEX, and FLEX-TD
- Pager testing you can depend on

HP 8648A with Option 1EP

Easy, Economical, One-Box Pager Testing Using the HP 8648A Option 1EP

HP-IB

The HP 8648A Option 1EP provides a complete, economical, one-box pager test solution. It includes the digital pager encoder that supports the popular worldwide standard, POCSAG (Post Office Code Standardization Advisory Group), and the newer paging standards, FLEX and FLEX-TD (RCR-43, for Japan).

Offering Key FLEX Specifications

The specifications of the HP 8648A Option 1EP are ideal for the stringent FLEX and FLEX-TD test requirements. It offers 60 Hz frequency shift keying (FSK) deviation accuracy within specific pager service bands. This is the most important FLEX specification. Also, it typically offers 40 Hz carrier frequency accuracy (relative to CW in dcFM).

Faster, Easier Testing

Now test time is reduced and simplified with the HP 8648A's semi-automated features:

- Customize your result with user-defined messages of up to 40 characters
- Reduce test time with 5 built-in test messages
- Increase test reliability with 70 internal storage registers capable of storing the entire protocol configuration

Performance Summary

Frequency: 100 kHz to 1 GHz
Frequency Accuracy with Option 1E5: Typically 0.15 x 10^{-6} x carrier frequency in Hz, or typically 0.092 x 10^{-6} x carrier frequency in Hz within 90 days of calibration
Output Level: +10 dBm to –136 dBm
Output Level Accuracy: 1 dB (> –127 dBm)
Carrier Frequency Accuracy: (relative to CW in dcFM) 100 Hz (typically 40 Hz), deviation < 10 kHz (within one hour after dcFM calibration)

Pager Signaling

Supported Pager Protocols: POCSAG, FLEX and FLEX-TD

POCSAG

Speed: 512, 1200, and 2400 bps
Message Format: Tone only, Numeric, Alphanumeric

FLEX/FLEX-TD

Speed: 2 Level FSK: 1600 and 3200 bps; 4 Level FSK: 3200 and 6400 bps
Message Format: Tone only, Numeric (standard and special), Alphanumeric, HEX/binary
Address Type: Short, long (messaging accessible from front panel or HP-IB)
Message Types: Five fixed (built-in), one user-defined message
Length: 40 characters maximum
Repetition Modes: Single, burst, continuous (messaging accessible only over HP-IB)
FLEX/FLEX-TD: 128 frames
POCSAG: 128 batches
Data Rate Accuracy: 5 ppm

Key Literature

HP 8648A Pager Test Option, p/n 5964-6686 E

Ordering Information

HP 8648A Synthesized Signal Generator
Opt 1EP Pager Signalling
Opt 1E5 High-Stability Timebase (FLEX, FLEX-TD only)
FLEX Code Word Generation Software
download from the web

Digital Microwave Radio Test Equipment

(PN 3708A-5) Testing Satellite Systems with the HP 3708A
5954-9555

Mobile/Cellular Radio Test Sets

(PN 892X) Techniques for Programming the HP 892X Family of Instruments
5965-6120E
(PN 83236A/B) Writing Control Software for the HP 83236A/B
5965-5626E
(PN 8920-1) Using the IBASIC Programming Environment on the HP 8920 Test Set Family
5963-0046E
(PN 83204A/5A) CDPD Conceptual Overview
5965-6326E
(PN 83204A/5A/21A) CDPD MDBS Cell Site Test Software Troubleshooting
5965-7060E
(PN 8921-1) HP 8921A Cell Site Test Set
5962-9475E
(PN 8320NX/8921A) Step by Step Testing Procedure for PCSI CDPD MDBS Radios
5965-7345E
(PN 8921-2) HP 8921A Cell Site Test Set TACS Base Station Testing
5962-0157

Cellular/PCS Transmitter & Receiver Test Equipment

(PN 89400-1) Frequency and Time-Selective Power Measurements with the HP 89400 Series Vector Signal Analyzers
5091-7194E
(PN 89400-2) Measuring Phase Noise with the HP 89400 Series Vector Signal Analyzers
5091-7193E
(PN 89400-3) CDMA Measurements with the HP 89400 Series Vector Signal Analyzers
5091-7196E
(PN 89400-4) Characterization of Digital Communications Channels with the HP 89400Series Vector Signal Analyzers
5091-7195E
(PN 89400-5) Measuring Transmitter Transients with the HP 89400 Series Vector Signal Analyzers
5962-9493E
(PN 89400-6) Translated Frequency Measurements with the HP 89440A
5091-7412E
(PN 89400-7) The Dynamic Range Benefits of Large-Scale Dithered Analog-to-Digital Conversion in the HP 89400 Series VSAs
5091-7668E
(PN 89400-8) Using Vector Modulation Analysis in the Integration, Troubleshooting, and Design of Digital RF Communication Systems
5091-8687E
(PN 89400-9) Downconverted Measurements Using the HP 89410A and HP 89441A
5091-8691E
(PN 89400-10) Time-Capture Capabilities of the HP 89400 Series Vector Signal Analyzers
5091-8686E
(PN 89400-11) Phase Noise Performance of the HP 89400 Series Vector Signal Analyzers
5963-0039E
(PN 89400-12) Understanding Time and Frequency Domain Interactions in the HP 89400 Series Vector Signal Analyzers
5962-9217E
(PN 89400-14) Using Error Vector Magnitude Measurements to Analyze and Troubleshoot Vector-Modulated Signals
5965-2898E

Cellular/PCS Spectrum Monitoring & RF Measurement Systems

HP E4915A Crystal Impedance Meter
5965-1172E

(PN E4915/6A) Crystal Resonator Measurements Using the HP E4915A/E4916A
5965-1363E

Pager Test Equipment

(PN 8648A-1) Pager Testing Using the HP 8648A with Internal Pager Encoder Option 1EP
5965-1131E
(PN 8648A-2) Servicing and Repairing Pagers Using the HP 8648A Option 1EP
5965-1132

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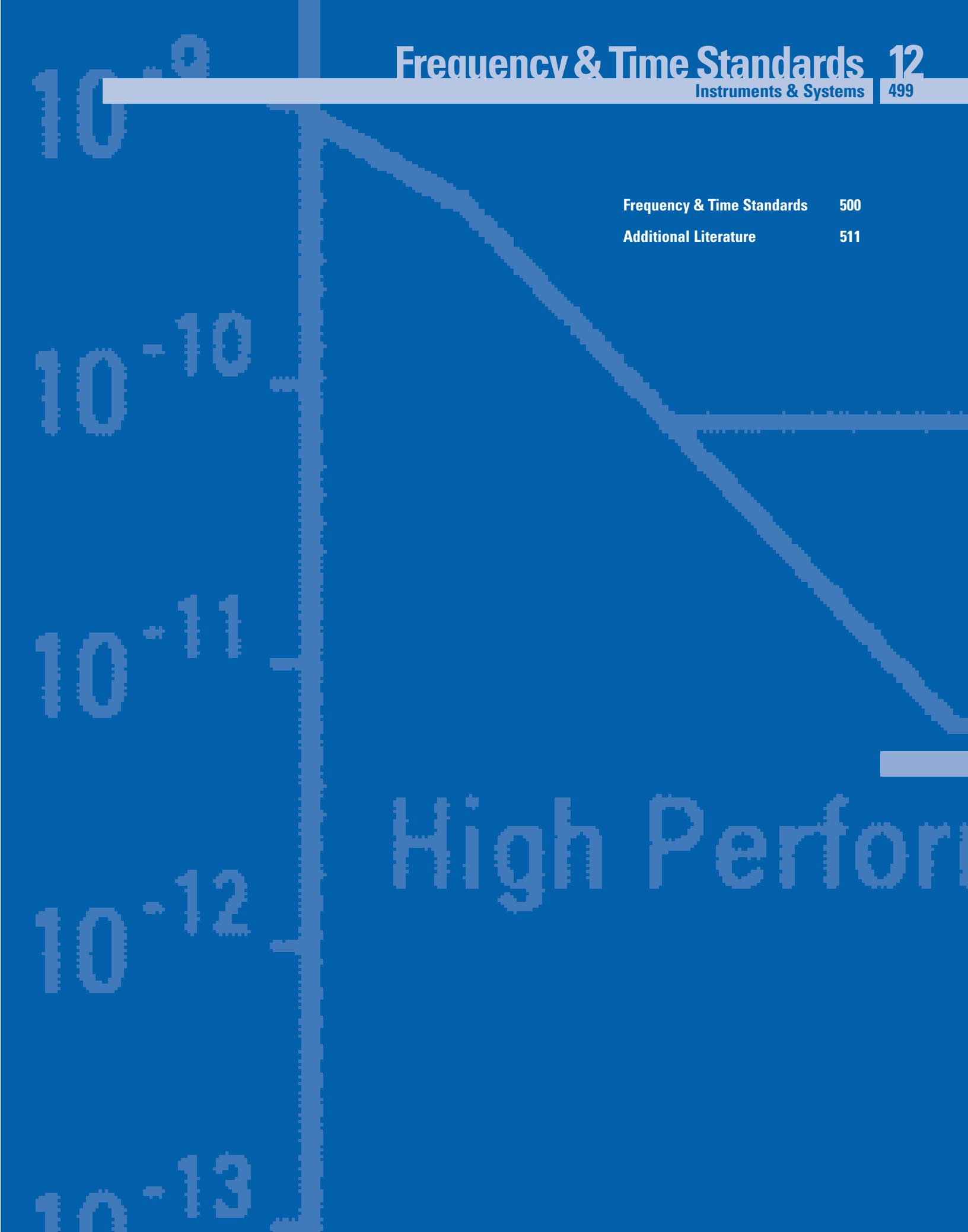
- News Releases
- Country-Specific Sites

These features are only a snapshot of what's available at the Web site. Bookmark it—and visit it regularly—to stay completely up to date on all of HP's test and measurement solutions.



HP Keeps the World's Time

HP's industry-leading cesium frequency standards set and keep the world's time and frequency at national timekeeping bureaus and standards labs around the globe. HP cesium clocks, which provide more than 80 percent of the weighting of Universal Coordinated Time (UTC), virtually define the world's standard second and the stability of the atomic second.

For decades, HP has led the industry, not only with the world's most stable cesium standard, but also with quartz and counter/modulation-domain analyzer (MDA) technology. HP's quartz has reliability greater than 500,000 hours mean time between failures (MTBF). HP's counters provide 20 picoseconds of resolutions per single shot time-interval measurement and MDAs provide 50 picoseconds of time-interval resolution. MDA technology—developed by HP in 1991—allows users in the lab and on communication networks to view signal dynamics without fear of missing events by making continuous, back-to-back measurements.

Today, global positioning system's (GPS) precise time and frequency and breakthrough intelligent oscillator technology (see "HP SmartClock Technology" in "Key Technologies" on page 501) have been added to HP's comprehensive family of timing and synchronization solutions. HP SmartClock Technology adds intelligence in the form of firmware algorithms to oscillators that are referenced to GPS or other time-reference signals. This intelligence improves the performance of low-cost, highly-reliable quartz to near-cesium quality when locked to GPS and to near-rubidium quality during holdover when the primary reference is not available.

High reliability is a key feature of HP SmartClock Technology. Because the technology continuously calibrates the oscillator to GPS and steers the oscillator during holdover when the reference signal is not available, time-consuming and expensive calibration is no longer needed. The combined technologies of GPS, HP SmartClock and quartz have revolutionized timing by making available low-cost, highly-precise solutions.

Timing/Frequency Sources

Different levels of precise time and frequency are provided by sources ranging from the GPS and cesium atomic clocks to rubidium and quartz clocks:

Cesium: Before GPS and HP SmartClock Technology, the more expensive the frequency source, the better its accuracy. Cesium atomic clocks, for example, maintain accurate frequency indefinitely without the need for calibration. Because cesium oscillators are higher cost, they are applied only to the most critical applications as primary reference clocks at the top of a network's hierarchy. By using cesium, networks and labs gain independence from other potentially less-reliable timing references.

Rubidium: Rubidium atomic oscillators are lower cost than cesium and have excellent short-term stability (ability to consistently produce accurate time and frequency), but require frequent access to a primary reference signal or synchronization source to maintain long-term, cesium-level accuracy.

Quartz: High-quality quartz oscillators are extremely reliable, inexpensive and have excellent short-term stability. But until HP SmartClock Technology, the effects of aging and temperature on signal stability have made quartz oscillators less accurate over time than either cesium or rubidium.

GPS: Global positioning system (GPS) is the satellite system that provides continuous access to precise time and frequency anywhere on Earth. It is available for commercial use at no cost.

Oscillator Continuum

	Cesium	Rubidium	Quartz	Quartz w/GPS
Long-Term Accuracy	$\pm 7 \times 10^{-12}$ for life of cs. beam tube	$\pm 3 \times 10^{-11}$/mo.	$\pm 5 \times 10^{-10}$/day	$<1 \times 10^{-12}$/day avg. when locked to GPS
Long-Term Aging	N/A	1×10^{-12}/day	1×10^{-10}/day	N/A
Oscillator Reliability (MTBF)*	120,000–150,000 hrs.	50,000–150,000 hrs.	>500,000 hrs.	>500,000 hrs.

*Mean time between failures

Standards Labs

HP's frequency standards and clocks provide accurate frequency, time-interval and timekeeping capabilities to compare against national standards in timekeeping, R&D and standards labs.

Cesium-beam frequency standards are used in labs where the goal is a very high-accuracy primary frequency standard. HP quartz oscillators are used in virtually every frequency-control application, including atomic standards. The excellent short-term stability and spectral purity of the quartz oscillators contributes to the high quality of the output signal. For less demanding applications where some long-term drift can be tolerated, quartz oscillators are used as independent frequency sources.

HP's own standards lab in Santa Clara, CA is designated as the U.S. Naval Observatory (USNO) West Coast time-reference station. The lab maintains an ensemble of three high-performance HP cesium-beam standards to verify timing accuracy using GPS time-transfer techniques.

Communication and Power Utility Networks

Leveraging this expertise and leadership in timing, HP continues to broaden its family of timing synchronization solutions for wireline and wireless telecommunication service providers, power utilities and network equipment manufacturers.

Timing Synchronization Systems and Services

Responding to the needs of customers, HP has taken a comprehensive systems approach to help plan, implement, manage and support the increasingly complex timing synchronization system:

- HP's growing line of products improve timing and synchronization to enable networks to operate reliably and accurately at higher speeds. Even with increasing customer loads, quality of service is improved. Products include a cesium primary-reference clock (PRC), quartz or rubidium GPS primary-reference source (PRS), and quartz or rubidium synchronization supply unit (SSU). A complete line of accessories is available.
- Custom-designed timing subsystems enable network equipment manufacturers to improve time to market and reduce project risk by outsourcing this increasingly-specialized engineering task. HP acts as the manufacturer's off-site R&D team to design a custom module and move quickly to prototype and high-volume production.
- A network synchronization audit uses cesium and MDA technology to quantify timing performance and identify the locations of poor timing.
- Services such as synchronization planning help network designers plan and deploy their increasingly complex timing synchronization subsystems.
- HP's telecom support organization is specially trained in timing to help carriers keep their synchronization networks running smoothly, 24-hours per day, seven days per week. Network equipment manufacturers also rely on the support organization to provide service for the timing subsystem that is not their core competency.
- Synchronization network management software manages synchronization across the entire multivendor network. A major development, HP's software is the first to provide operators a comprehensive view of the synchronization of all network offices and elements, allowing prompt identification of problem areas. The software operates on the telecom industry's defacto platform—HP OpenView—and is the final piece of HP's total network management solution that includes computers, software and interconnectivity products.

Why is Better Timing Needed?

For telecom carriers who are beginning to deploy on a large scale broadband services based on next-generation SONET/SDH, the potential problems are many. When timing or synchronization are inadequate, quality issues range from distorted, unreadable faxes and corrupted or lost data to frozen images on video-conference screens and unintelligible encryption messages requiring re-transmission.

Similarly, wireless carriers—who are increasing capacity and moving from older, analog technologies to next-generation CDMA, TDMA and two-way paging technologies—face timing-related problems of crosstalk and blocked or dropped calls. Wireless carriers are also learning that the timing they receive from the T1 or E1 lines of their wireline counterparts—who are often competitors—does not always provide the accuracy needed.

Frequency Standards and Synchronization Systems Applications

	Wireless Communications	Wireline Telecommunications	Power Transmission	Defense/Aerospace	General Purpose
Network Equipment Manufacturers	**HP 58000 Series and 58503B, 58533A, 58534A, 58540A** Base station frequency and timing synchronization	**HP 58000 Series** **HP 55300A and 55400A** Central office frequency and timing synchronization	**HP 59551A** Fault location Wide area sync for higher capacity	N/A	N/A
Service Providers	**HP 55300A and 58503B, 58533A, 58534A, 58540A** MTSO, BSC, BTS frequency and timing synchronization **HP 55460A and 55461A*** Sync audit and planning services	**HP 5071A and 55000 Series** International Gateway timing **HP 55300A and 55400A** Main Office, Central Office and Local Exchange timing synchronization **HP 55460A and 55461A*** Sync audit and planning services	**HP 59551A** Fault location Wide area sync for higher capacity	N/A	N/A
R&D, Manufacturing and Production Test	**HP 58503B, 58533A, 58534A, 58540A** Frequency and time reference	**HP 58503B and 55300A, 58533A, 58534A, 58540A** Frequency and time reference	**HP 58503B and 59551A, 58533A, 58534A, 58540A** Frequency and time reference	**HP 58503B and 5071A, 58533A, 58534A, 58540A** Frequency and time reference	**HP 58503B, 58533A, 58534A, 58540A** Frequency and time reference
Metrology and Calibration	**HP 5071A, 105B and 55000 Series** Frequency standards and ensembles **HP 58503B** Inexpensive time and frequency reference **HP 58533A + 58540A** Low cost, compact size time & frequency reference receivers	**HP 5071A, 105B and 55000 Series** Frequency standards and ensembles **HP 58503B** Inexpensive time and frequency reference **HP 58533A + 58540A** Low cost, compact size time & frequency reference receivers	**HP 5071A, 105B and 55000 Series** Frequency standards and ensembles **HP 58503B** Inexpensive time and frequency reference **HP 58533A + 58540A** Low cost, compact size time & frequency reference receivers	**HP 5071A, 105B and 55000 Series** Frequency standards and ensembles **HP 58503B** Inexpensive time and frequency reference **HP 58533A + 58540A** Low cost, compact size time & frequency reference receivers	**HP 5071A, 105B and 55000 Series** Frequency standards and ensemble **HP 58503B** Inexpensive time and frequency reference **HP 58533A + 58540A** Low cost, compact size time & frequency reference receivers

* Contact HP for pricing and details on the HP 55460A Sync Audit Service and the HP 55461A Sync Planning Service.

Note: Products in this table are described on the following pages:
HP 105B, page 508
HP 5071A, page 502
HP 55000 Series, page 502
HP 55300A and 55400A, pages 515 and 517
HP 58000 Series, page 510
HP 58503B, page 504
HP 59551A, page 518
HP 58533A, HP 58534A, HP 58540A, pages 505 and 506

Key Technologies

The following new technologies have revolutionized timing by making low-cost, highly-precise solutions available to communication networks and in the lab:

Global Positioning System Precise Time

The global positioning system (GPS) provides continuous access to precise time and frequency, at low cost—anywhere on Earth. The 24-satellite global positioning system, designed by the United States as a dual-use system for commercial and military applications, transmits data for precise time and position (latitude, longitude and altitude).

The signal is accurate to within 340 nanoseconds of Universal Coordinated Time (UTC). All ground stations for monitoring and providing master control for the GPS system are based on HP atomic clocks.

HP SmartClock Technology

HP SmartClock Technology adds intelligence to oscillators that are referenced to GPS or other time-reference signals.When locked to a reference signal, HP SmartClock Technology compares the frequency of the unit's oscillator to that of the reference signal and uses this information to adjust the frequency of the oscillator to match the reference signal. Corrections automatically are issued over time, keeping the performance of the oscillator as close as possible to that of the reference source.

If the incoming reference signal is lost, HP SmartClock Technology automatically switches the timing system into an intelligent holdover mode. HP SmartClock Technology takes control of the oscillator so that it continues to distribute highly-stable synchronization outputs. Having learned the oscillator's behavior (aging rate and effects of temperature) when it was locked to the reference signal, HP SmartClock Technology adjusts the oscillator as needed. When the reference signal is restored, the unit automatically relocks.

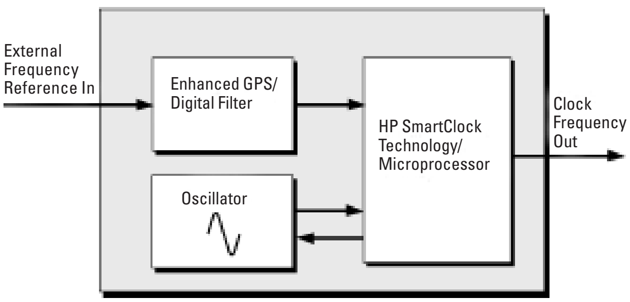
HP SmartClock Technology also evaluates the received GPS signal data. Bad data resulting from a satellite malfunction, temporary reception problems or an erroneous upload to a satellite is not used. As a result, the HP SmartClock Technology unit avoids errant timing that causes errors in the timing system.

HP Quartz Oscillator

HP's oven-controlled quartz oscillators provide best-in-the-industry performance. The HP 10811D/E quartz oscillator (see page 508), currently used in most HP timing products, has a proven record of reliability with mean time between failures (MTBF) of more than 500,000 hours.

HP Enhanced GPS/Digital Filter

The adverse effects of selective availability (SA), which occur because jitter is added to the GPS signal to maintain security for U.S. military applications, are minimized by a digital filter called HP Enhanced GPS. HP uses a similar filter technology to remove jitter from other external reference sources such as T1 or E1 lines from the wireline network.



HP SmartClock Technology Block Diagram

- Accuracy: ±5 x 10^{-13}
- Settability: ±1.0 x 10^{-9}
- "Flicker floor": ≤ 5.0 x 10^{-15} typical
- Fast warmup
- No adjustments before or during operation
- Remote operation

HP 5071A

HP 5071A Primary Frequency Standard

The HP 5071A primary frequency standard delivers unsurpassed accuracy and stability for both laboratory and field applications. Its improved cesium-beam tube reduces the effects of Ramsey pulling. New beam optics use cesium more efficiently. The combined results—increased accuracy and stability, and increased tube life—ensure that your calibration lab services are available longer.

The HP 5071A is easy to use. Automatic startup is simple and requires no adjustments. A logical menu structure simplifies front-panel operations, selections, and status reporting.

The HP 5071A can be operated and maintained anywhere. All controls are programmable, status can be checked remotely, and no adjustments or alignments are necessary during operation. An internal battery provides 45 minutes of backup in case of ac power failure.

Unmatched Accuracy and Stability

The HP 5071A uses Cesium II technology to double the accuracy of its predecessor, the HP 5061B. Cesium II technology includes a new cesium tube and redesigned electronics. The improved accuracy ensures that any HP 5071A Option 001 can power up to within ±5 x 10^{-13} of the accepted standard for frequency. This is achieved under full environmental conditions in 30 minutes or less.

Cesium II technology brings a new level of stability to the cesium clock. The HP 5071A is the first cesium standard to specify its stability for averaging times longer than a day. It is the first standard to specify a "flicker floor"—the point at which the standard's stability does not change with longer averaging. Under laboratory conditions, the standard HP 5071A has a flicker floor better than 5 parts in 10^{14}.

Hewlett-Packard has been producing cesium frequency sources since 1964. The exceptional accuracy and stability of the HP 5071A are a result of this experience and are characterized by improved reliability. Backing up this reliability is a ten-year warranty on the standard cesium tube and a three-year warranty for the optional high-performance tube.

Ease of Use

Startup and operation of the HP 5071A are extremely simple. Once connected to an ac or dc power source, the instrument automatically powers up to its full accuracy specifications. No adjustments or alignments are necessary during powerup or at any time during the lifetime of the cesium tube.

Intuitive menus logically report status and facilitate control of the instrument. These menus—Instrument State, Clock Control, Instrument Configuration, Event Log, Frequency Offset, and Utilities—are accessible via the front-panel LCD display and keypad.

High-Performance Tube: Option 001

For the most demanding operations, the HP 5071A Option 001 high-performance cesium-beam tube offers increased performance. Accuracy is two times better than the standard tube, and stability is superior as well. The high-performance tube allows a flicker floor of better than 1 x 10^{-14} and measurements at NIST show that the flicker floor is typically better than 5.0 x 10^{-15}.

Telecommunications Options

The HP 5071A primary frequency standard may be optionally equipped to provide output frequencies, impedances, and signal formats required of a Primary Reference Clock in modern telecommunication networks. Configurations are available for both DSI and CEPT standards. The HP 5071A can also be equipped to operate from a 48 Vdc central office battery.

Clock rates of 1.544 and 2.048 Mb/s are available. Impedance choices and signaling formats for all current ITU-T specifications are available. The HP 5071A with 2.048 Mb/s options are ITU-T G.811 compliant. All features found in a standard HP 5071A are retained when a 1.544 or 2.048 Mb/s option is installed. This includes both programmable 5/10 MHz outputs and the 1 MHz and 100 kHz outputs. The 1 pps output and sync are only available on the front panel of the instrument.

The HP 5071A Option 048 equips the frequency standard to operate from 48 Vdc power. Two independent 48-volt power sources may be supplied. The power sources must be of the same polarity but either polarity may be used. The frequency standard draws power from the source with the higher voltage. Upon source failure the frequency standard will automatically switch to the good source—ensuring uninterrupted operation.

The HP 5071A Option 048 automatically uses a 48 Vdc source if one is present. The instrument will attempt to use ac power if no dc source is available. The internal battery normally supplied with the HP 5071A is not available when Option 048 is installed.

HP 55000 Series

Ultra-Precise Time and Frequency Systems

The HP 55000 series Precision Time and Frequency Systems offer unsurpassed accuracy and stability in a reliable, redundant platform. These systems integrate the leading cesium technology, GPS receivers, distribution amplifiers, and backup power supplies from Hewlett-Packard with a sophisticated Time Measurement System from Timing Solutions Corporation. Metrology, communications, and electronic intelligence can all benefit from this cost-effective and fault-tolerant system.

The HP 55000 series solutions deliver state-of-the-art cesium in a complete rackmounted system. An intelligent controller manages the system, resulting in higher performance and increased reliability. The versatility of this system allows configuration and performance to be tuned to meet your needs. As needs change and the demands continue to increase, the HP 55000 series is easily updated to enhance performance.

Two or more HP 5071A primary frequency standards, or primary reference clocks, contribute to the system output. The Time Measurement System continuously monitors all clock outputs and can automatically adjust their phase and frequency. Over time, it learns each clock's characteristics and compensates for hardware deviations and reduces random noise.

Short-term stability is improved. Long-term stability is greatly enhanced and exceeds the results of any single clock contributor in the system. Distribution of the frequency output to various locations is easily accomplished by integrating HP's distribution amplifiers .

Specifications

Accuracy and Stability

Full Environmental Range
Conditions (any combination of):
Temperature: 0° to 50° C
Humidity: 0 to 80% (40° C maximum)
DC Magnetic Field: 0 to 2 gauss
Warmup Time (typical):
15 minutes to normal operating status
30 minutes to full specs
Settability
Resolution: 6.3×10^{-15}
Range: $\pm 1.0 \times 10^{-9}$
Frequency Change Due to Environment: $\pm 1 \times 10^{-13}$ ($\pm 8 \times 10^{-14}$ Option 001)
Accuracy: $\pm 1 \times 10^{-12}$ $\pm 5 \times 10^{-13}$ (Option 001)

Time domain stability[1], 5/10-MHz outputs:

Averaging Times	HP 5071A	HP 5071A Option 001
10^4 s	$\leq 2.7 \times 10^{-13}$	$\leq 8.5 \times 10^{-14}$
10^5 s	$\leq 8.5 \times 10^{-14}$	$\leq 2.7 \times 10^{-14}$
5 days	$\leq 5.0 \times 10^{-14}$	$\leq 1.0 \times 10^{-14}$
30 days	$\leq 5.0 \times 10^{-14}$	$\leq 1.0 \times 10^{-14}$
30 days (typical)	$\leq 1.5 \times 10^{-14}$	$\leq 5.0 \times 10^{-15}$

[1] Based on long-term measurement at NIST.

Flicker Floor:
$\leq 5.0 \times 10^{-14}$ ($\leq 1.5 \times 10^{-14}$ typical)
$\leq 2.0 \times 10^{-14}$ (Option 001 $\leq 5.0 \times 10^{-15}$ typical)
Reproducibility: $\leq 5.0 \times 10^{-13}$

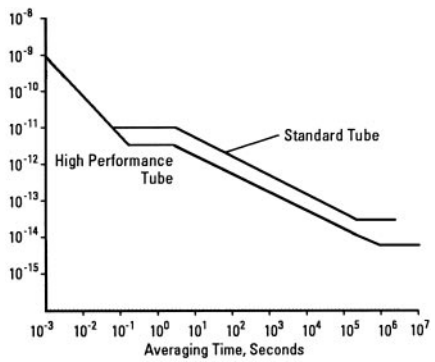
Sinusoidal Output Characteristics (all located on rear panel)

Parameter	Ports 1 and 2[2]	1 MHz, 100 kHz
Amplitude into 50 Ω load	>1 V rms	>1 V rms
Isolation between ports	>110 dB (typ.)	not specified
Harmonic and sub-harmonic signals (typical)	< –40 dBc	< –40 dBc
Non-harmonic distortion	< – 80 dBc	not specified
Connector type	N	BNC
Source impedance (nominal)	50 Ω	50 Ω

[2] Each output can be set to either 5 or 10 MHz from the front panel or by remote command.

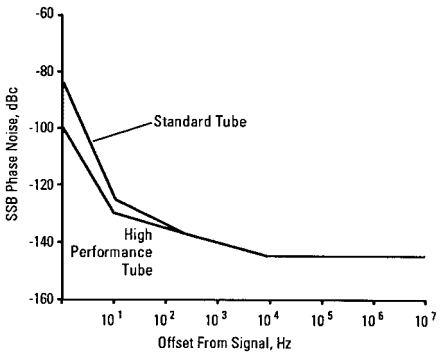
Frequency Stability (5/10-MHz Outputs)

Time Domain Stability (Allan Deviation)



	σy(2, τ)	
Averaging time (seconds)	Standard cesium-beam tube	High-performance cesium-beam tube (Option 001)
10^{-2}	$\leq 7.5 \times 10^{-11}$	$\leq 1.5 \times 10^{-10}$
10^{-1}	$\leq 1.2 \times 10^{-11}$	$\leq 1.5 \times 10^{-11}$
10^0	$\leq 1.2 \times 10^{-11}$	$\leq 5.0 \times 10^{-12}$
10^1	$\leq 8.5 \times 10^{-12}$	$\leq 3.5 \times 10^{-12}$
10^2	$\leq 2.7 \times 10^{-12}$	$\leq 8.5 \times 10^{-13}$
10^3	$\leq 8.5 \times 10^{-13}$	$\leq 2.7 \times 10^{-13}$
10^4	$\leq 2.7 \times 10^{-13}$	$\leq 8.5 \times 10^{-14}$
10^5	$\leq 8.5 \times 10^{-14}$	$\leq 2.7 \times 10^{-14}$
5 days	$\leq 5.0 \times 10^{-14}$	$\leq 1.0 \times 10^{-14}$

Frequency Domain Stability



	SSB Phase Noise dBc	
Averaging time (seconds)	Standard cesium-beam tube	High-performance cesium-beam tube (Option 001)
10^0	≤ –85	≤ –100
10^1	≤ –125	≤ –130
10^2	≤ –135	≤ –135
10^3	≤ –140	≤ –140
10^4	≤ –145	≤ –145
10^5	≤ –145	≤ –145

Internal Standby Battery (nominal values)

Capacity: 45 minutes at 25° C from full charge
Charge Time: 16 hour maximum from fully discharged state
Charge Source: AC input power only

Remote System Interface and Control

RS-232-C (DTE configuration)**:** Complete remote control and interrogation of all instrument functions and parameters
Interface Circuits: Optically isolated
Software Command Set: SCPI, version 1990.0
Connector: 9-pin male rectangular D subminiature type
Status Output: Logic output for externally monitoring normal and abnormal operation (user-defined)
Output: TTL open collector with internal pull-up resistor
Circuit Sink Capability: Up to 10 mA
Connector: BNC on rear panel

Environmental and Physical

Temperature
Operating: 0° to 55° C
Non-operating: –40° to +70° C
Size: 425.5 mm W x 133.4 mm H x 523.9 mm D (16.75 in x 5.25 in x 20.63 in)
Weight: 30 kg (65 lb)

Ordering Information

HP 5071A Primary Frequency Standard
Opt 001 High-Performance Cesium-Beam Tube
Opt 0B2 Extra Operating and Programming Manuals
Opt 0BW Assembly-Level Service Manual
Opt 908 Rack Flange Kit (for use without handles)
Opt 913 Rack Flange Kit (for use with handles included with HP 5071A)
Opt W30 Extended Repair Service (see page 584)
Opt W50 Extended Repair Service (not available with Option 001)
HP 55000 Series Precision Time and Frequency Systems

Telecommunications Options
Opt 048 48 Vdc Power
Opt 104 or 105 1.544 Mb/s, 100 Ω Balanced
Opt 220, 221 or 222 2.048 Mb/s, 120 Ω Balanced
Opt 270, 271 or 272 2.048 Mb/s, 75 Ω

- Reduce the cost for precise time and frequency
- Eliminate calibration through GPS technology
- Improve reliability through HP quartz oscillators

HP 58503B Option 001

HP 58503B GPS Time and Frequency Reference Receiver

GPS Makes Precise Time and Frequency Affordable

The HP 58503B is well-suited for a broad range of applications. Regardless of industry, it meets the needs of manufacturing, development, calibration labs and services. Through a unique combination of technology, the HP 58503B GPS Time and Frequency Reference Receiver provides a highly-reliable, low cost source of precision time and frequency.

The HP 58503B is based on Hewlett-Packard's proven quartz technology. This provides unsurpassed reliability and confidence, as well as excellent short-term stability. The core of the design is an oscillator with >500,000 hours of field-proven mean-time-between-failures (MTBF). This delivers superior performance and reliability while eliminating the need for periodic oscillator replacement as required in GPS rubidium sources.

By locking its quartz oscillator to the GPS signal, the HP 58503B provides frequency accuracy of better than 1 part in 1012. This gives you the long-term performance of GPS with the superior short-term stability of a state-of-the-art quartz oscillator. Time accuracy compared to UTC (USNO MC) is better than 110 ns—even in the presence of Selective Availability (SA).

When the GPS signal is interrupted, the HP 58503B automatically enters an intelligent holdover mode using HP SmartClock technologies. This minimizes frequency drift and compensates for environmental changes, maintaining accuracy to better than 1×10^{-10} per day.

This unique combination of technology provides you superior value - lower cost, smaller size, higher performance, and excellent reliability. For a more detailed description of the technologies, see "Key Technologies", page 501.

Year 2000 Compliant

The HP 58503B has been thoroughly tested to be sure it reliably will move from the year 1999 to the year 2000. This transition was tested while locked to satellites (via simulator), in holdover mode, and when the new year requires a leap second. Further testing proved that the unit recognized that 2000 is a leap year, and that it operates through the GPS system clock rollover in August of 1999. This thorough testing is testimony to HP's uncompromising dedication to quality products - products you can count on.

Using Technology to Solve Problems

Development labs and manufacturing now have a convenient source for frequency and time—both 10 MHz and 1 pps outputs are standard. The HP 58503B is a cost-effective in-house standard. By using the HP 58503B as an external frequency reference for test equipment, time-base aging is eliminated - improving the quality of test results while eliminating the need for periodic time-base calibration.

Metrology and calibration labs find the HP 58503B essential. For smaller labs where cost is a key concern, the HP 58503B provides a low-cost alternative for precise time and frequency. For more advanced labs, the HP 58503B offers an excellent time reference.

The communications industry also benefits from the convenience of the HP 58503B. When telecom reference signals are unavailable or unreliable, a high-quality reference signal is required. Output options for the HP 58503B provide highly-accurate reference signals with signal formats consistent with all ITU-T specifications.

Abbreviated Characteristics and Specifications

GPS Receiver

- 8-channel, parallel-tracking
- HP SmartClock/HP Enhanced GPS
- DC power options available

10 MHz Output Characterizations
Frequency Accuracy (Locked): $<1 \times 10^{-12}$ for a one day average
Holdover Aging (Unlocked): $< 1 \times 10^{-10}$ per-day average frequency change in 24 hours of unlocked operation
Output Level: >1V p-p sine wave into 50 Ω load.

Phase Noise (Locked):

Offset From Signal (Hz)	SSB Phase Noise (dBc)
1	-85
10	-125
100	-135
1,000	-140
10,000	-145

Time Domain Stability (Locked):

Averaging Time (Seconds)	Root Allan Variance
0.01	1.5×10^{-10}
0.1	1.5×10^{-11}
1	5×10^{-12}
10	5×10^{-12}
100	5×10^{-11}
1,000	5×10^{-11}

1 pps Output Characteristics
Jitter on Leading Edge (Locked): <750 ps rms
Time Accuracy (Locked): <110 ns with respect to UTC (USNO MC) –95% probability when unit is properly installed and calibrated
Accumulated Time Error (Unlocked): <8.6 µs/accumulated in 24 hours after three days of locked operation with a fixed antenna location
Output Level: >2.4 V pulse into 50 Ω load
Pulse Width: 26 µs

Power Requirements
Standard (ac power)*: 90 to 132 Vac or 198 to 264 Vdc, automatically selected; 50 to 60 Hz
Option AWQ* +19 Vdc to +59Vdc (> +23 Vdc required to start)
Input Power (all power options): <35 watts nominal
*Only one power supply may be selected. The standard unit operates only from the ac line voltages described above. If either the 24V or 48V power input options are selected, the unit will operate only from that voltage. For backup power, we recommend an appropriate UPS (uninteruptable power supply). These units are inexpensive and can be selected to provide backup power for various amounts of time.

Ordering Information

HP 58503B GPS Time and Frequency Reference Receiver
Opt 001 Front-Panel Display
Opt AWM 48 Vdc Power
Opt AWR 24 Vdc Power
Special Output Frequencies
Including telecom T1 and E1 reference signals and even second output options; contact HP for availabiltiy and price.
GPS Antenna System and Accessories
See page 509 for the complete line of GPS Accessories.

HP 58533A
HP 58540A

NEW

HP 58533A GPS Time and Frequency Reference Receiver

HP 58540A GPS Time and Frequency Reference Receiver

HP 58533A GPS Time and Frequency Reference Receiver NEW

The HP 58533A is a small, low-cost source of GPS time and frequency. Affordable and compact, it is a candidate for integration applications, but is suitable for bench-top use as well. The HP 58533A provides a 10 MHz output with a frequency accuracy of better than $1x10^{-11}$ for a one day average, and a 1PPS output with time accuracy within 110 ns of UTC (USNO MC) when locked to GPS. In addition, the HP 58533A features an alarm output and RS-232 interface for monitoring operation remotely, and T-RAIM satellite error detection.

Abbreviated Characteristics and Specifications

GPS Receiver
- 8-channel, parallel-tracking
- C/A code, L1 carrier

10 MHz Output Characteristics
Frequency Accuracy (locked): $<1x10^{-11}$ for a one-day average
Holdover Aging (unlocked): $<2x10^{-8}$ per day maximum
Output Level: 1 Vp-p sine wave into 50 Ω load.

Phase Noise (locked):

Offset from Signal (Hz)	SSB Phase (dBc)
10	–120
100	–135
1000	–140
10000	–140

Time Domain Stability(Locked): Root Allan Variance = $1x10^{-9}$ at tau = 1 second
1 pps Output Characteristics (locked):
Time Accuracy (POSITION HOLD mode): < 110 ns with respect to UTC (USNO MC) – 95% probability when unit is properly installed and calibrated.
Pulse-to-pulse Jitter of Leading Edge:
POSITION HOLD Mode: 40 ns typical
SURVEY Mode: 110 ns typical
Front-Panel Indicators (LED):
Alarm: Red LED, blinks once every two seconds when an alarm condition is present.
Remote Interface: RS-232-C DTE configuration
RS-232 Connector: 9-pin male rectangular D subminiature on front panel
Power Requirements: dc power (standard); +15 Vdc nominal, ±5%, 600 ma; +5 Vdc nominal, ±5%, 300 ma
Weight and Size: 308g, 50 mm H x 100 mm W x 125 mm L

HP 58540A GPS Time and Frequency Reference Receiver NEW

The HP 58540A is a small, cost-effective source of GPS time and frequency. Though designed to meet the particular needs of an array of system integration applications, the HP 58540A can be used in laboratories and manufacturing facilities as an accurate frequency reference, as well.

The package of the HP 58540A is similar to the HP 58533A: the dimensions are 50 mm H x 100 mm W x 125 mm L, and the weight is approximately 300 grams. However, the HP 58540A generally provides a higher level of performance. Also, the HP 58540A can be configured through options to support the special timing requirements of Paging, GSM, CDMA, or E-911 location applications.

Standard Configuration: 10 MHz, 1PPS, and 1PP2S

In its standard configuration, this GPS-based reference receiver produces precise 10 MHz and 1 pulse per second (1PPS). Phase coherency is maintained between the outputs, supporting those applications in which the relationships of the outputs must be known. When the crystal oscillator is locked to the GPS signal, the frequency accuracy of the 10 MHz signal is better than 1×10^{-11} (one-day average), and the 1PPS signals are synchronized to UTC (USNO MC) within 110 ns.

Optional Configurations to Meet Needs of Paging, GSM, CDMA, and E-911 Applications

Optional configurations/OCXO's are available to cover a range of timing and frequency applications that includes Paging, GSM, CDMA, and E-911. For example, an even second output, 1 PP2s option can be ordered for CDMA. Contact the HP Call Center in your region for detailed information.

Antenna System

Hewlett Packard recommends the use of HP GPS antenna system accessories, seen on page 506, with HP GPS Time and Frequency Reference Receivers.

Ordering Information

Contact the HP Call Center in your region for price and options information.

HP 58534A GPS Timing Antenna

GPS Antenna and Receiver All in One Rugged, Weatherproof Package

The HP 58534A GPS Timing Antenna is a highly reliable, user-friendly, super-low cost source of precision GPS time. An antenna, GPS receiver, interface, and power supply are all integrated into one rugged, weatherproof, easy-to-install package. A one pulse per second (1 PPS) signal synchronized to UTC within 110 ns is automatically provided when the HP 58534A is locked to GPS.

Up to 150 meter Cable Runs with Minimal Power Consumption

The HP 58534A conveniently operates on a wide range of input voltages and consumes minimal power, yet it can support long cable runs. Between +8 to + 36 volts, and less than 1.5 watts will power the unit. RS-422 drivers inside the HP 58534A allow it to easily operate 150 meters of interconnect cable. Please consult HP for installations requiring longer cable lengths.

Fast Reacquisition Time Following Power Loss

If power is lost, the RAM (Random Access Memory) which stores the navigation and satellite data continues to be powered by a super-capacitor up to 2 hours. This lets the HP 58534A reacquire satellites within 20 seconds after power is restored.

Excellent Immunity to Noise Interference

The HP 58534A is engineered for reliable operation in the toughest environments. Outstanding immunity to RF interference is imparted by three robust dielectric bandpass filters incorporated in the design. Furthermore, true 2-bit A/D conversion as opposed to 1-bit in competing products, is used to digitize the GPS signal to reduce noise interference. SAW filtering technology also results in improved interference immunity.

Corrupt satellite data is rejected and multipath is mitigated by the HP 58534A's TRAIM (Timing Receiver Autonomous Integrity Monitor) algorithm.

Mounting Hardware Kit and Extended Operating Temperature Range Available: Options AUB and 1GK

Two options available to the HP 58534A are Options AUB and 1GK. Option AUB provides a mounting hardware kit, complete with a galvanized stainless steel mounting mast, mounting brackets, and hardware. Option 1GK provides an HP 58534A guaranteed to withstand an extended operating temperature range of -40˚ C to +80˚ C.

User-friendly Evaluation Kit with HP 58531A GPS Timing Receiver Analysis and Control Software: Option 001

Analysis and control of the HP 58534A is a simple task with the HP 58534A GPS Timing Antenna Evaluation Kit. When you order HP 58534A Option 001 you will receive the HP 58534A GPS Timing Antenna, a copy of the HP 58531A GPS Timing Receiver Analysis and Control Software, an RS-422 to RS-232 PC Interface box, a 50-meter length of interconnect cable that is terminated on both ends in order to mate with the HP 58534A and the PC Interface box, mounting hardware, and an operating manual diskette.

The HP 58531A GPS Timing Receiver Analysis and Control Software is a PC Windows-based program (for Windows NT 4.0 or Windows 95) that controls the HP 58534A, and processes and displays information received from it. The program has tools to help in analyzing the receiver data, and can log the information to a file for analysis using other tools.

The HP 58531A program includes these features:

- Convenient configuration of the software and HP 58534A
- Real-time information update
- Control and query the HP 58534A via menu-driven commands
- Generate a data log file for analysis
- Generate an error log file for analysis
- Plot instant or average position in real time
- Plot satellite history, such as PRN, C/N, elevation, DOP
- Calculate and display average or maximum C/N and associated elevation and azimuth angles
- Demo Mode capability in case a physical HP 58534A is not available

Twisted Pairs Interconnect Cables Available Through HP 58522A

The HP 58522A series of interconnect cables provides a length of cable composed of bundled twisted pairs. Each HP 58522A cable is terminated on one end to mate to the HP 58534A output connector. The remaining end is unterminated. Choose from a selection of convenient lengths.

Specifications

Electrical Specifications and Characteristics

Receiver Architecture: 8 parallel channels; L1 1575.4 MHz; C/A code (carrier aided tracking); 2-bit A/D conversion; SAW filtering
Antenna: Active micro strip patch; High jamming immunity: triple dielectric bandpass filtering
Update Rate: 1 Hz
Absolute Timing Accuracy (1 pulse per second, 1PPS), with S/A: < 110 ns with respect to UTC (USNO) – 95% probability when unit is properly installed and locked to GPS.
Timing output valid with one satellite acquired in Position Hold mode.
Jitter: 40 ns (1s, typical) in Position Hold Mode; 110 ns (1s, typical) in Survey Mode
Position Accuracy: 25 m SEP* without S/A; *Spherical Error Probable
Acquisition Time to First Fix (TTFF): Cold Start: < 2 minutes typical
Reacquisition: < 20 seconds typical after loss of power**; **Almanac < 1 month old and Ephemeris < 4 hours old

Power Specifications: +8 Vdc to +36 Vdc; < 1.5 Watts; Reverse Voltage Protection, <300 V; Back up power provided by super-capacitor to GPS RAM, 2 hours (typical)

Serial Communications

Interface: 9600 Baud; RS-422 Input/Output; HP proprietary protocol based on NMEA language
Extended Cable Support: RS422 differential pair capable of supporting 150 meters of cable

Mechanical Specifications and Characteristics

Dimensions: HP 58534A (without cable and connector): 16.5 cm H x 15.0 cm D; Mounting Mast (Option AUB): 457.5 mm L x 31.5 +/- .125 mm D
Mounting: Quick-fit clamp (glass-filled, high modulus nylon for secure clamp)
Weight: 684 g
Cable and Connector: 30.5 cm cable (12 conductor, 6 twisted pairs, shielded); 12 pin round, waterproof connector (Deutsch MMP 21C-2212P1)

Environmental Specifications

Operating Temperature
Standard: –35° C to +75°
Option 1GK: –40° C to +80°
Storage Temperature: –40° C to +85° C

Ordering Information

HP 58534A GPS Timing Antenna
Option 001 GPS Timing Antenna Evaluation Kit
Option AUB Mounting Hardware Kit
Option 1GK Extended Operating Temperature Range
HP 58531A GPS Timing Receiver Analysis and Control Software
HP 58522A Twisted Pairs Interconnect Cable
Option 005 5-meter Cable
Option 010 10-meter Cable
Option 050 50-meter Cable

- 12-Channel broadband (0.1 to 10 MHz) sine wave distribution
- Low output phase noise and spurious signals
- High isolation/low cross-talk between output channels
- Available internal oscillator for standalone operation or backup
- Autoswitching between two inputs
- Easy-to-read front panel status lights
- Channel fault alarm

HP 58502A

Introduction

The HP 58502A Broadband Distribution Amplifier is the one frequency standard distribution system that provides multiple features to ensure continuous distribution of your critical signals. It is designed to meet today's demanding requirements for frequency distribution in manufacturing, R&D, and standards lab environments. It also provides economical distribution of precision signals from cesium, rubidium, quartz or GPS frequency standards.

The HP 58502A Broadband Distribution Amplifier features low signal distortion and high isolation between output channels. Low output phase noise and exceedingly low spurious signal content help maintain signal integrity.

Continuous Availability of Critical Frequencies

The following features ensure your critical frequencies are always present, 1) When the unit detects one of its inputs is removed or the amplitude of the input is greatly reduced, it will automatically switch (autoswitch) to the other input; 2) The HP 58502B is compatible with the alarm signals from the HP 58503B GPS Time and Frequency Reference Receiver and the HP 5071A Primary Frequency Standard. If the alarm of one of these sources is active, and this source is driving the distribution amplifier outputs, the HP 58502A will automatically switch to a backup source. In addition, this change will be reflected in the HP 58502A alarm outputs so it may be monitored by external equipment.

Autoswitching between two inputs ensures continuous availability of critical frequencies, and a fault alarm is activated when the system does not function correctly. These alarm and switching features can also be monitored and controlled through the unit's RS-232C interface.

Great Flexibility

Flexibility of the HP 58502A is enhanced when purchased with its optional internal oscillator. With this option, the HP 58502A can be used as a high quality quartz reference source with 12 outputs. Or, if operated with one external source, the HP 58502A will switch to its optional internal oscillator should the external source fail.

Simplified Verification of System Health

The RS-232C interface allows you to query the individual distribution input and output channels for the presence or absence of a signal. Easy-to-read front panel status lights also provide you with a quick visual indication of individual channel health. These features greatly simplify monitoring the system.

Performance for Your Demanding Applications

While cost per channel has been lowered, no compromises have been made in signal distribution quality. The amplifier provides high channel-to-channel isolation and low phase noise for demanding applications. The HP 58502A has an internal automatic gain control that ensures extremely low AM-to PM conversion.

HP's Complete Solution

The HP 58502A is an excellent companion to the HP 58503A or B GPS Time and Frequency Reference Receiver or the HP 5071A Primary Frequency Standard. Combined, with these products, the HP 58502A provides you a very clean, stable, redundant frequency reference.

Specifications

Electrical Specifications
Input, A or B
Frequency Range: 0.1 MHz to 10 MHz
Impedance: 50 Ω nominal; SWR <1.5
Amplitude: +15 dBm maximum; +7 dBm minimum
Connector: BNC (female)

Outputs (Into 50 Ω)
Amplitude: +13 dBm, +1 dB/-3 dB
Harmonics: ≤32 dBc
(for Option 010): ≤20 dBc
Spurious: ≤110 dBc, ≤113 typical
(for Option 010): ≤80 dBc
Connectors: BNC (female)

Mechanical Specifications
Weight: 2.95 kg
Shipping Weight: 6.35 kg
Dimensions: Height: 45 mm; Width: 426 mm; Depth: 344 mm

Supplemental Characteristics
Outputs

Single Sideband Phase Noise (1 Hz bandwidth)	
Offset Frequency	**Phase Noise**
100 Hz	≤127 dBc/Hz
1 kHz	≤142 dBc/Hz
10 kHz	≤148 dBc/Hz
Port-to-Port Isolation:	≤100 dBc typical
(measured by switching between open and short loads on output port and measuring associated phase noise on adjacent output port)	

Environmental
Temperature:
Operating: 0° C to +55°C
Non-operating: -40° C to +70° C
EMI: CISPR 11, Group 1, Class B
Remote System Interface and Control Data Communicators: RS-232C, DTE
Connector: DE-9P (male)

Alarm/Status Input and Output
Connector: DE-9P (male)
Normal State: TTL High
Alarm State: TTL Low
Output Configuration: Open-collector output, 10 k Ω pull-up to 5 vDc

Power Requirements
ac input: 100-132 or 175-240 Vac; 47-63 Hz; 80 VA Max

Stability:
Temperature Stability: 6×10^{9} (0 to +55°C)
Aging/Day: 5×10^{16}
Aging/Year: 1×10^{7}
Tuning Range: 7×10^{7} (minimum)

Ordering Information

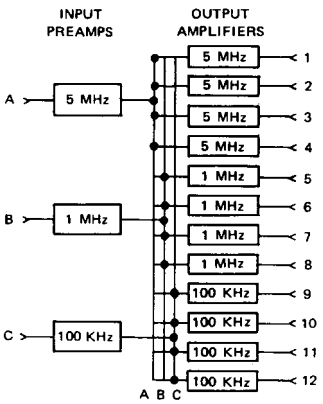
HP 58502A Broadband Distribution Amplifier
Opt 010 Internal Backup Oscillator
Opt AX4 Rack Mount Kit
Contact factory for dc option

HP 5087A
HP E1750A
HP E1752A
HP 105B
HP 10811 D/E

HP 5087A Distribution Amplifier

The HP 5087A distribution amplifier provides the flexibility needed for distribution of frequency standard outputs, where multiple-output frequencies are required. The modular construction allows you to configure the product for a variety of distribution needs.

Several configurations are available, and special combinations of input and output modules can be supplied. Amplifiers can be added or the configuration easily changed with the HP 10812A options.



HP 5087A with Option 031

HP 5087A Specifications

Inputs: Up to three rear-panel BNC
- **Frequencies:** 10 MHz, 5 MHz, 1 MHz, or 100 kHz
- **Level:** 0.3 to 3.0 V rms, 50 Ω

Outputs: Up to 12 rear-panel BNC
- **Frequencies:** 10 MHz, 5 MHz, 1 MHz, or 100 kHz
- **Level:** 0 to 3 V into 50 Ω (screwdriver adjustment)
- **Harmonic Distortion:** > 40 dB below rated output
- **Non-Harmonic Distortion:** > 80 dB below rated output

Isolation
- **Load** (open or short on any other channel)
  - **Amplitude Change:** 0.1%
  - **Phase Change:** < 0.1 ns at 5 or 10 MHz; < 0.5 ns at 1 MHz; < 5.0 ns at 100 kHz
- **Injected Signal:** 1 V signal up to 50 MHz applied to any output except 10 MHz, will be down >60 dB in all other outputs; 10 MHz output channel will be down >50 dB

SSB Phase Noise (5 MHz): >145 dB below signal in 1 Hz BW for frequencies >1 kHz from carrier

Short-Term Stability Degradation (5 MHz): $<1 \times 10^{-12}$ in 10 kHz bands (1-s average)

Environmental
- **Temperature:** MIL-E-16400, class 4
- **Operating:** 0° to 50° C
- **Storage:** –62° to +75° C

Stability
- **Amplitude:** ±0.5 dB, 0° to 50° C
- **Phase:** <0.1 ns/° C, 5 and 10 MHz
- **Humidity:** 95% at 40° C
- **Altitude:** Up to 30,000 ft.

General
- **Power:** 115 or 230 V ±10%, 48 to 440 Hz, 20 VA, maximum, or 22 to 30 Vdc, 600 mA, maximum
- **Size:** 425 mm W x 88 mm H x 286 mm D (16.7 in x 3.5 in x 11.3 in)
- **Weight:** Typical, Option 031; net, 7 kg (15 lb)

HP E1750A VXI Distribution Amplifier

These VXI distribution amplifier modules buffer and distribute standard clock and other signals in laboratory, factory, and general ATE environments. They feature one input and six outputs per module, and are suited to distributing a wide variety of signals in a single ATE system or throughout a building. Principal features of the product include:

- Broadband sine wave or pulse buffering/distribution
- Built-in AGC for no level adjustments
- Preservation of input phase and frequency characteristics with changing environment (temperature, humidity, etc.)

General Specifications

Input Ranges

	HP E1750A	HP E1752A
Freq. min.	100 KHz	1 pps
Freq. max.	10 MHz	10 million pulses per second
Level, min.	+7 dBm	Logic LO: ≤0.8 V
Level, max.	+19 dBm	Logic HI: 2.0 V ≤ V_{in}
Damage	+27 dBm	+14 V, –9 V
Impedance	50 Ω	50 Ω
HP E1750A Outputs, 50 Ω load		
Level		+13 dBm ±1 dBm
Phase noise		< –145 dBc
Port-to-port isolation (open/short loads)		
phase modulation		< –100 dBc
phase change, peak		< ±.0012°
HP E1752A Outputs, 50 Ω load		
Rise-fall time		<5 ns
Pulse amplitude		>3.5 V
Propagation delay		22 ns, typical
Jitter		<1 ns rms

Ordering Information

HP 5087A Distribution Amplifier Mainframe
- **Opt 908** Rack Flange Kit

Normal Configurations (input and output amplifiers)
- **Opt 031** 5, 1, 0.1 MHz Inputs; 4 Outputs at each
- **Opt 032** Single 5 MHz Input and 12 Outputs
- **Opt 033** Single 10 MHz Input and 12 Outputs
- **Opt 034** Single 5 MHz Input, 4 each; Outputs at 5, 1, and 0.1 MHz

Special HP 5087A Configurations
- **Input Preamplifiers** (up to 3 total)
- **Opt 004** Input Preamplifier (0.1 to 10 MHz)
- **Opt 005** 5 to 1 MHz Input Divider
- **Opt 006** 1 to 0.1 MHz Input Divider
- **Opt 011** 5 to 10 MHz Input Doubler
- **Opt 013** 10 to 5 MHz Input Divider
- **Opt 014** 10 to 1 MHz Input Divider
- **Output Amplifiers** (up to 12 total)
- **Opt 001** 5 MHz Output Amplifier
- **Opt 002** 1 MHz Output Amplifier
- **Opt 003** 0.1 MHz Output Amplifer
- **Opt 012** 10 MHz Output Amplifier

HP E1750A Broadband Distribution Amplifier
- **Opt AV9** Delete Operation and Programming Manual

HP E1752A Pulse Distribution Amplifier
- **Opt AV9** Delete Operation and Programming Manual

HP 10811D/E Oscillators

The HP 10811D/E crystal oscillators are oven-controlled, high-performance component oscillators. Both offer unmatched quality, high performance, and low cost. The low aging rate and fast warmup time reduce maintenance costs and downtime. Low power consumption gives the HP 10811D/E oscillators longer battery-backup time. Low phase noise translates to lower system phase noise when using HP oscillators.

The HP 10811D has a PCB connector for all external connections; the HP 10811E uses filter feedthrough terminals for power connections and oven monitor. The HP 10811E also has SMB snap-on RF connectors for the 10 MHz output and EFC input, and provisions for shock mounting.

The HP 105B quartz frequency standard uses the HP 10811D and is available as a complete standalone instrument.

Ordering Information

HP 105B Quartz Frequency Standard
- **Opt 908** Rack Flange Kit
- **Opt 910** Extra Manual

HP 10811D 10 MHz Oscillator, PCB/Edge Connector

HP 10811E 10 MHz Oscillator, SMB Connectors

Options for HP 10811D or HP 10811E
- **Opt 001** Low Aging Rate
- **Opt 002** Low Phase Noise
- **Opt 003** Integrated Option 001 and Option 002
- **Opt 100** Reduced Specifications

HP 5087A Distribution Amplifier

Note: Options are mutually exclusive; no mixing.

- Complete solutions for GPS antenna systems
- High reliability GPS accessories
- Broad range of products to meet every need

HP 58515A
HP 58516A
HP 58517A
HP 58518A
to 58521A
HP 58518AA
to 58521AA
HP 58529A
HP 58530A
HP 58532A
HP 58538A
HP 58539A

HP GPS Accessories

Complete Your GPS-Based Solution with Confidence

High-quality Hewlett-Packard Global Positioning System (GPS) accessories let you configure a complete GPS antenna system with confidence and reliability. These products simplify installation while providing high signal integrity. By providing a range of GPS accessories, HP offers a complete solution—from the GPS antenna to precise time and frequency reference receivers.

HP GPS accessories include antennas, antenna assemblies, line amplifiers, lightning arresters, distribution amplifiers/splitters, bandpass filters, cables and cable kits—everything you need for your complete antenna system.

GPS L1 Reference Antenna

The HP 58532A GPS L1 Reference Antenna delivers L1 carrier frequency signals to GPS receivers. Based on a design with proven reliability in tens of thousands of installations, the HP 58532A, like its predecessors, is characterized by low noise and high gain to provide optimum signal quality. The HP 58532A also features excellent filtering, with narrow bandwidth and steep rolloff, to preserve the GPS signal while attenuating RF interference signals near the L1 carrier.

Designed for easy installation in outdoor locations, the HP 58532A features a durable, cone-shaped cover to prevent snow and debris buildup. In addition, a sturdy aluminum mounting base allows easy attachment to an optional antenna mast. With this type of mounting, the antenna/cable connector (type N) is protected from the weather. If your system requires the new HP 58529A Antenna Line Amplfier with Filter or the HP 58530A L1 Bandpass Filter, then these cylinder shaped products can fit directly inside the antenna mast to be sheltered from the weather as well.

Option 001 includes an N Plug to TNC Jack adapter to accommodate TNC cable users.

Antenna Specifications

Frequency Range: 1575.42 ± 10 MHz (L1 carrier)
Total Gain: > 30 dBi (38 dB typical at elevation angle 90˚)
Operating Environment: -40˚C to +85˚C

Lightning Arrestors

The HP 58538A Lightning Arrestor is a small, waterproof unit designed to take much of the energy out of a nearby lightning strike. This unit is typically installed where the antenna cable enters the building. The HP 58538A must be used in conjunction with the HP 58539A described below.

The HP 58539A Lightning Arrestor is a larger package which can reduce the energy from a nearby lightning strike to a level where it will not harm downstream equipment. In systems with short in-building cable lengths (less than 4 meters), a single 58539A installed where the antenna cable enters the building is sufficient. Systems that have long in-building cable lengths should have one 58539A at the entrance to the building and one relatively near the receiver to divert to ground any voltages induced in the in-building cable by electromagnetic fields generated by lightning strikes. The 58538A can replace the 58539A at the cable entrance into the building, for a more cost effective solution.

The HP 58539A, when properly installed near the antenna, will protect the antenna and nearby components such as line amplifiers from voltages and currents that can be induced in the antenna cable by lightning.

Both the HP 58538A and the HP 58539A have an integrated gas-filled surge arrestor capsule. Many competing products that use gas capsule technology do not have replaceable capsules, making periodic maintenance expensive since the whole arrestor must be exchanged. Replacement capsules to the 58538A and 39A are offered as Option 001.

Line Amplifier with Bandpass Filter

The HP 58529A GPS Line Amplifier with L1 Bandpass Filter has 20 dB of gain and also contains a bandpass filter (20 MHz wide at 1.575 GHz) to significantly reduce nearby interfering signals. The package is a small (approximately 3 cm wide) cylinder, which easily fits into the mounting mast for the antenna where it is protected from the weather. The unit is weatherproof so it can also be mounted outside if desired. Power for the HP 58529A comes from the GPS receiver via the RF cable.

Line Amplifier Specifications

HP 58529A

Amplifier Gain: >20 dB (24 dB typical)
Frequency Range: 1575.42 ± 20 MHz (L1 Carrier)
Filter Attenuation: > 7 dB at L1 ± 35 MHz > 30 dB at L1 ± 140 MHz

Bandpass Filter

The HP 58530A GPS L1 Bandpass Filter is an antenna line filter for those applications where signal amplification is not needed, but additional filtering is desired. The HP 58530A filter characteristics and package are the same as the HP 58529A, but the HP 58530A has no amplifier and does not require power.

Bandpass Filter Specifications

Frequency Range: 1575.42 ± 20 MHz (L1 Carrier)
Filter Attneuation: >7 dB at L1 ±35 MHz, >30 dB at L1 ±140 MHz
Operating Environment: –40˚C to +80˚C

Distribution Amplifier/Splitters

The HP 58515A, 58516A and 58517A distribution amplifiers/splitters distribute the GPS signal to two, four or eight output ports, respectively. For ease of installation and configuration, these units feature built-in amplification to provide unity gain from input to each of the output ports. High isolation between output ports eliminates the risk of interaction between GPS receivers connected to the distribution amplifier.

Distribution Amplifier/Splitter Specifications

Frequency Range: 1575.42 ± 20 MHz (L1 carrier)
Gain (input to output)
HP 58515A: 3 dB ± 3 dB; HP 58516A: 0 dB ± 3 dB;
HP 58517A: 0 dB ± 4 dB
Isolation (typical)
HP 58515A and HP 58516A: – 40 dB; **HP 58517A:** – 35 dB
Operating Environment: 0˚C to +55˚C

Cables and Cable Kits

HP offers a complete line of antenna cables and interconnect cables for completing your antenna system. The HP 58518A and HP 58519A RG-213 cables provide increased flexibility for installation ease. The HP 58520A and HP 58521A LMR 400 cables feature low-loss and are ideal for installations requiring greater cable lengths. All cables are available in a variety of lengths ranging from 1 meter to 50 meters for RG-213 cables and 1 meter to 330 meters for LMR 400 cables.

For installations requiring greater flexibility or where cables must be pulled through conduit, cable kits are available. These kits provide the raw cable with connector kits. This allows the connectors to be installed once the cable is in place. The HP 58518AA and 58519AA are kit versions of the RG-213 cables and the HP 58520AA and 58521AA are the kit versions of the LMR 400 cables.

Cables and Cable Kits Specifications

Impedance: 50 Ω typical
Signal Loss at L1 Frequency
RG-213 Cables: 7.9 dB per 20 meters
LMR 400 Cables: 3.35 dB per 20 meters
Cable (Propagation) Delay
RG-213 Cables: 5.05 ns per meter
LMR 400 Cables: 3.93 ns per meter
Connectors or Connector Kits
HP 58518A/AA, 58520A/AA: One TNC(m) and One N(m)
HP 58519A/AA, 58521A/AA: Two N(m)

Contact the HP Call Center in your region for pricing.

HP 58000 Series

Drawing on decades of experience building the world's most accurate cesium and most reliable quartz clocks, HP designs and manufactures custom timing subsystems for network equipment manufacturers. Acting as an off-site R&D team, HP engineers are responsive to the needs of manufacturers. HP designs a custom module and then moves quickly to prototype and high-volume production. By outsourcing the timing subsystem, manufacturers can focus on other critical design issues to achieve faster time-to-market. HP's leadership in timing, decades of experience, and proven technologies remove manufacturer's risk for this increasingly-complex piece of base stations and network nodes.

90's Technologies

HP's areas of expertise include the technologies of the 90's: global positioning system's (GPS) precise time and frequency, advanced quartz oscillators and breakthrough intelligent oscillator technology (see "Key Technologies," page 115.2). Together, these technologies revolutionize wireless base station and wireline network timing by making low-cost, highly-reliable timing available. Manufacturers can now replace the rubidium technology of the 80's with this trio of technologies for near-cesium performance when locked to GPS and near-rubidium performance during holdover. Because quartz is more reliable than rubidium (see "Oscillator Continuum", page 115.1), time-consuming and costly base station and transit node service is dramatically reduced. GPS further stabilizes the quartz, making recalibration that is required for rubidium or standalone quartz unnecessary. Maintenance is dramatically reduced.

The HP 58000 Series custom timing modules are designed and built for any level of accuracy and stability needed by manufacturers. HP meets and exceeds the standards for CDMA, TDMA and GSM, analog, special/private mobile radio (SMR/PMR) and paging technologies. For stratum 2, 3 and 3E transit node and local area clocks, we meet or exceed ANSI, ETSI and Bellcore standards. We match your requirements for size and form factor with a box, card or board. And we match each manufacturer's specific requirements for space, power, configuration and price.

HP 58000 Series OEM Custom Timing Modules

Important decisions that affect performance and price are:
Intelligent Oscillator: HP SmartClock Technology, which adds intelligence to the base station or local office oscillator, vastly improves the clock's performance during normal conditions as well as during holdover when the GPS antenna is down or the reference source is not available.
Holdover Capability: Lower-performance base stations can be designed without holdover capability. But for a high-performance network, rubidium or high-performance quartz oscillators will provide holdover timing when the external frequency reference source is not available. Fluctuations in temperature at the base station site and length of desired holdover are the key factors that affect initial cost. Lifetime cost is lower with quartz because it is more reliable than rubidium and, unlike rubidium, does not need to be replaced after 8 or 10 years.
Special Features: HP responds to any request. We'll provide autoswitching, a scheme that automatically switches a base station from one timing module to another without any change in output. Or you might need a special frequency—19.6608 MHz for CDMA or 13 MHz for GSM.
Frequency Reference Source: Although GPS timing combined with HP SmartClock Technology gives the best price/performance, T1 or E1 can also be used as a frequency reference source. Other levels of performance can be achieved without an external frequency reference source. The local clock—a quartz or rubidium oscillator used with or without HP SmartClock Technology—can provide the frequency for less stringent performance requirements.

Ordering Information

Contact the HP Call Center in your region for more information and design consultation for a custom solution.

Example Configurations for Different Performance Requirements

	Performance Required						HP Custom Solution	
	Frequency Outputs	Temperature	Holdover Requirement	Accuracy	Accuracy during holdover	Timing sync between cell sites	MTBF (hrs.)	
High-performance timing module for CDMA base station	10 MHz; 19.6608 MHz; 1 pps	0° to 50° C	24 hrs. in loss of GPS	$1x10^{-11}$ for 1 day avg. when locked	$1x10^{-10}$ for 24 hrs.	±1 µsec. locked ±7 µsec. unlocked	>100,000	Frequency Reference: GPS HP SmartClock Technology HP 10811 double-oven quartz oscillator Enhanced GPS/digital filter
Medium-performance timing module for TDMA base station (GSM or IS-54 standard)	13 MHz	0° to 50° C	1 week	$1x10^{-10}$ for 1 day avg. when locked	$1x10^{-9}$/ week	N/A	>100,000	Card-based, multi-function Frequency Reference: E1 or GPS HP SmartClock Technology HP 10811 single-oven quartz oscillator Telecom digital filter
Medium-performance timing module for paging base station	10 MHz, 32 kHz, 100 kHz; 1 pps	0° to 50° C	6 µsec./ 6 hrs.	$1x10^{-11}$ for 1 day avg. when locked	$5x10^{-10}$/ 6 hr.	<600 nsec.	>100,000	Card-based Frequency Reference: GPS HP SmartClock Technology HP 10811 single-oven quartz oscillator
Timing for SMR/PMR analog base station	10 MHz	–30° to +60° C	None	5×10^{-10}	N/A	N/A	>100,000	HP 10811 single-oven quartz oscillator Frequency Reference: None 12-channel distribution system Compact box

GPS & SmartClock Technology

HP 58533A GPS Time and Frequency Receiver
5967-5835E
HP 58502A Broadband Distribution Amplifier
5966-3413E/EUS
HP 58529A Line Amplifier
5966-3885E/EUS
HP 58530A L1 Bandpass Filter
5966-3886E/EUS
HP 58532A Reference Antenna
5966-3887E/EUS
HP 58534A Timing Antenna
5966-3888E/EUS
HP 58538A/58539A Lightening Arrestor
5966-3889E/EUS
Dependable Accessories for Your GPS Installation
5966-3894E
Designing Your GPS Antenna System
5964-9068E

General Purpose

HP 58503A Precise Time and Frequency Anywhere in the World
5966-3891E
5966-3892E
5966-3893E
HP 5071A Sync Family Brochure
5964-9932E
HP 5071A Unsurpassed Stability in the Lab or Field
5091-6013E
HP 55000 Series Unsurpassed Performance and Reliability in Time and Frequency Systems
5962-6227E

Wireless OEM Timing Modules

HP 58000 Series Time and Frequency Reference Distribution Systems
5963-3504E
QUALCOMM Taps HP for CDMA Timing System
5964-9063E
HP 58503A Precise Time and Frequency Anywhere in the World
5966-3891E
5966-3892E
5966-3893E

Many of these literature pieces are available at:
http://www.hp.com/go/tmc99

HP's Test & Measurement Web site.
The more you visit, the more you'll know.

News and information you need, 24 hours a day. Get the most complete support available for all of HP's Test & Measurement tools. Immediate access to information, 24 hours a day, means always getting the most from your instruments:

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- Usage Tips
- Application Note Library
- Service, Support and Training
- Sales and Service Contacts
- Selection Guides
- Newsletters
- Feature Stories Showing Products in Use
- Information on Your Industry
- News Releases
- Country-Specific Sites

These features are only a snapshot of what's available at the Web site. Bookmark it—and visit it regularly—to stay completely up to date on all of HP's test and measurement solutions.

Timing Synchronization Systems and Services

Responding to the needs of customers, HP has taken a comprehensive systems approach to help audit, plan, implement, manage and support the increasingly complex synchronization network:

- HP's growing line of products improve timing and network synchronization to enable networks to operate reliably and accurately at higher speeds. Even with increasing customer loads, quality of service is improved. Products include a cesium primary reference clock (PRC), a primary reference source (PRS) based on the global position system (GPS), synchronization supply unit (SSU), sync network management software, modulation domain analyzer technology (MDA) for sync quality management, and GPS measurements sync module for power transmission (HP 59551A).
- A network synchronization audit uses cesium and MDA technology to quantify timing performance and identify the locations of poor timing.
- Services such as synchronization planning help network designers plan and deploy their increasingly complex timing synchronization subsystems.
- Synchronization network management software manages all GPS and SSU units in the synchronization network. A major development, HP's software is the first to provide operators a comprehensive view of the synchronization of all network offices and elements, allowing prompt identification of problem areas. The software operates on the telecom industry's defacto platform – HP OpenView – and is the final piece of HP's total network management solution that includes computers, software, and interconnectivity products.

HP 5071A Primary Reference Clock

The HP 5071A primary reference clock (PRC) delivers unsurpassed accuracy and stability for telecom applications. The unit requires no adjustments or maintenance. It will be up and running in 15 minutes, and far exceeds Stratum 1 requirements. All of these features are independent of environment.

The HP 5071A can be operated and maintained anywhere. All controls are programmable, status can be checked remotely, and no adjustments or alignments are necessary during operation.

HP 55300A GPS Primary Reference Source

The HP 55300A GPS primary reference source (PRS) provides a highly reliable, low cost source of precision timing for both wired and optical telecom digital networks. When locked to GPS, the HP 55300A delivers timing stability exceeding Stratum 1 requirements. During holdover, the HP 55300A delivers Stratum 2 performance for over 24 hours.

The unit is ideally suited for telecom service providers that are installing or upgrading existing networks with SONET/SDH equipment. These high speed technologies require highly accurate and stable network synchronization and distribution. This affordable synchronization solution can flatten hierarchical networks, providing cesium like performance at all points.

HP 55400A E1 Synchronization Supply Unit

The HP 55400A E1 Synchronization Supply Unit (SSU), is a modular, fully redundant, timing distribution unit for 2048 kbps primary rate networks. It is ideally suited for telecommunications networks where SDH technology is being deployed or expanded. The SSU tracks up to nine incoming reference signals from higher or equal levels of the network, qualifies the signals, then filters and distributes up to 400 precise timing signals to the nodes network equipment. Incoming reference signals may come from cesium standards at the top level of the network, GPS reference sources, or live traffic signals.

HP 55452A Sync Network Management

The HP 55452A open synchronization management framework helps service providers isolate synchronization related problems in their networks quickly so that immediate, corrective action can be taken.

The HP open synchronization management framework enables network operators to view synchronization network topology remotely and manage virtually every function of individual SSUs, which distribute accurate timing synchronization to equipment in telecom offices. It also lets network operators remotely manage faults (alarm and non-alarm events) for GPS PRSs on the network.

HP's synchronization management software also is available for local office applications or for small networks using Windows NT. To commission SSUs and perform local troubleshooting, service providers can install the HP 55450A synchronization management software for the PC on laptops running Microsoft Windows' operating systems.

HP E1725C/E1748A Network Synchronization Measurements

Network synchronization problems can lead to slips and degrading voice, fax, data, and video services. The HP E1748A network synchronization measurement software, available as Option 248 with the HP E1725C time interval analyzer (TIA), give network managers powerful tools for evaluating network synchronization and ensuring compliance with industry standards.

Jitter levels are accurately measured with the HP E1748A and the HP E1725C TIA. Its unsurpassed timing resolution of 100 ps rms, combined with the power of its Phase Power Spectral Density plot, deliver enough detail to determine which network components are improving or degrading incoming signals. The HP E1748A multiple channel network synchronization measurement software allows simultaneous recording of multiple channels. Overlay displays offer quick visual comparison of data obtained from multiple MTIE or TDEV measurements.

HP 55460A Network Sync Audit Service

The rapid growth of digital transport and integrated voice, data, and video services place stringent timing and accuracy demands on high-speed telecommunications networks. The HP 55460A network sync audit service helps network managers analyze the performance of existing networks. HP service engineers use precision timing instruments and sophisticated synchronization audit software to make measurements and assess network performance. The results present a data picture that not only shows the status of the network synchronization, but also enhances the design and management of advanced synchronization solutions.

HP 59551A GPS Measurements Synchronization Module

The HP 59551A GPS Measurements Synchronization Module meets the precision timing needs of wide-area electric power transmission systems. Based on advanced GPS receiver technology, the module has superior long-term timing accuracy and permits exhaustive measurement and analysis of power system performance.

The HP 59551A combines low cost and unmatched functionality, making it the timing solution of choice for a variety of applications. For monitoring existing wide-area transmission networks, the HP 59551A provides the timing synchronization and time-tagging required to efficiently locate faults, analyze network disturbances, and perform detailed sequence of events analysis. The newest, state-of-the-art transmission networks benefit from the highly accurate synchronization foundation provided by the HP 59551A.

Note: The products above are described on the following pages:

HP 5071A, page 502
HP 55300A, page 517
HP 55400A, page 515
HP 59551A, page 518
HP E1748A, page 149
HP 55452A, page 516

HP 55460A, publication number 5968-0407E

HP 55400A

- Provides precise timing synchronization signals
- For E1, 2048 kbps, primary rate systems
- Complies to ITU and ETSI requirements
- Designed for SDH deployment.
- Supports Synchronization Status Messages (SSM)
- Designed to be managed, locally or remotely
- Local management software
- TMN compliant remote management software
- Industry standard platform allowing easy integration with other management systems
- Industry-leading timing quality under stressed conditions
- Minimizes SDH pointer movements
- No phase hits with input reference switching
- Unprecedented reliability for maximum network uptime
- Oscillator MTBF > 500,000 hours
- Redundant hot swappable modules
- 1:1 output protection
- Downloadable firmware for easy upgrades
- Modular and expandable
- Customized systems available

HP 55400A E1 Synchronization Supply Unit

The HP 55400A synchronization supply unit (SSU) is a modular, fully redundant, timing distribution unit for 2048 kbps primary rate networks. It is ideally suited for telecommunications networks where SDH technology is being deployed or expanded. The SSU tracks up to nine incoming reference signals from higher or equal levels of the network, qualifies the signals, then filters and distributes up to 400 precise timing signals to the node's network equipment. Incoming reference signals may come from cesium standards at the top level of the network, GPS reference sources, or live traffic signals.

The HP 55400A SSU is compliant to ITU-T G.703, G.704, G.812, G.823, and ETSI prETS-300 462-4. It is compatible with current (PDH) and emerging (SDH/ATM) industry technologies and services for network synchronization.

Outstanding Holdover Performance

HP has developed breakthrough technology, called HP SmartClock, that delivers Stratum 2 holdover performance at less cost and higher reliability than rubidium (estimated 5x higher). HP SmartClock technology is a forward-looking correction process applied to the HP 10811 high-performance quartz oscillator; hence the lower cost and higher reliability. HP SmartClock evaluates the aging characteristics of the quartz oscillator via proprietary algorithms in conjunction with HP's high-precision counter technology. The result is outstanding holdover performance.

Various levels of holdover performance can be achieved through a selection of ITH cards with a choice of both quartz and rubidium oscillators: from 2 x 10^{-11}/day exceeding ANSI Stratum 2 requirements, to 1 x 10^{-8}/day exceeding the ITU-T G.812 Local Node requirements.

System Key Features

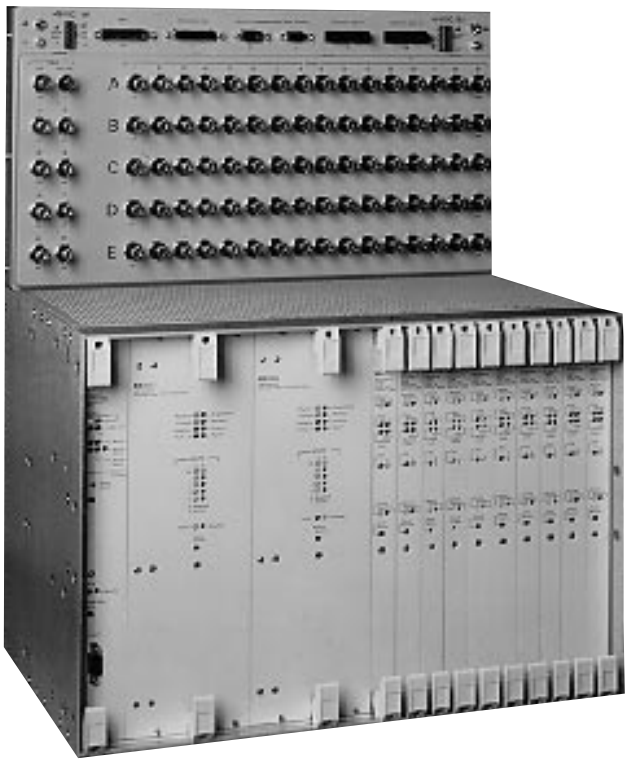
Compliant to:
- ITU-T G.703, G.704, G.812, G.823
- ETSI prETS-300 462-4

Up to 9 timing reference signals with 1:1 protection
- Built-in monitoring of MRTIE and TDEV
- Use all inputs as references or use some only for monitoring timing quality

Up to 400 outputs with 1:1 protection
- Up to 80 outputs with modular master subrack
- Up to 400 outputs total with modular expansion subracks

Designed to be managed
- Largest set of TL1 commands in the industry
- Local management with PC software for installation, configuration, commissioning and troubleshooting
- Remote management (TMN compliant) with HP UX software for complete synchronization network management

Modular, plug-in cards
- Input Track and Hold (ITH), various levels of holdover stability:
  - ANSI Stratum 2
  - ITU transit
  - ETSI compliant
  - Stratum 3E and local node



HP 55400A

- Management Cards (AIC, IMC, NIMC)
  - Alarm Management (critical, major, minor)
  - Information Management (alarm and local management)
  - Network Information Management Card (alarm, local and remote management through LAN X.25 or LAN)
- Output Cards
  - 2048 kbps with programmable traffic patterns
  - 2048 kHz
  - 1.544 Mbps
  - 64/8 kHz Composite Clock
  - 1, 5, 10 MHz

No phase hits on outputs during input reference switchover
Hot-swappable cards
Supports Sync Status Messaging (SSM)
Firmware upgrades are downloadable
–48 Vdc operation, fully redundant with dc-to-dc converters on each card
ETSI and NEBS rack mounting

Key Specifications

Internal Reverence: Quartz crystal oscillator or rubidium
Holdover Stability
- **Stratum 2 rubidium:** ± 2.0 x 10^{-11}/day
- **Stratum 2 quartz:** ± 3.0 x 10^{-11}/day for three days
- **Enhanced Transit Node quartz:** ± 1.0 x 10^{-10}/day
- **Transit Node quartz:** ± 5.0 x 10^{-10}/day
- **Stratum 3E and Local Node quartz:** ± 1 x 10^{-8}/day

Output Phase Variation
- **Reference switch-over:** < 1 ns
- **ITH card switch-over:** < 15 ns
- **Output card switch-over:** < 15 ns
- **ITH card failure:** < 15 ns
- **Output card failure:** < 1 μs

Ordering Information

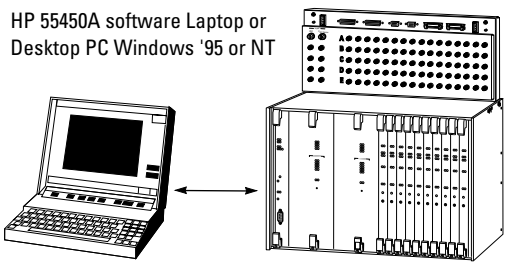
HP 55400A System

For detailed pricing and specific system configuration, contact the HP Call Center in your region.

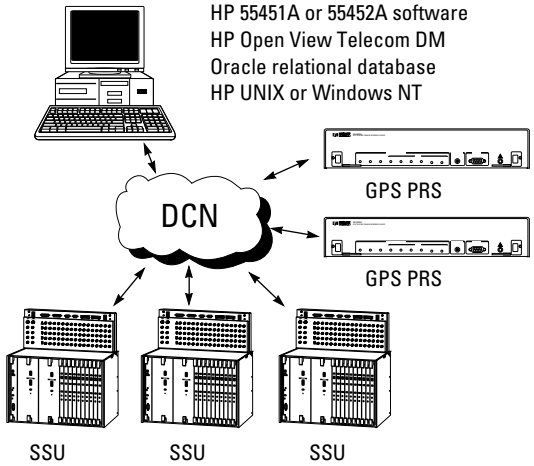
Synchronization Network Management

HP 55450A
HP 55451A
HP 55452A

- Makes your entire sync network visible
- Remote management from a single point
- Improves quality of service
- Reduces overall network costs
- Eases installation, configuration, and commissioning of SSUs
- Allows worry-free deployment of SDH services



HP 55450A software used for local control of an HP 55400A SSU



HP 55451A and HP 55452A software used for management of a network of HP 55400A SSUs and HP 55300A GPS PRSs interconnected by LAN

HP Family of Synchronization Network Management Software

HP's line of sync network management software makes your entire sync network visible and remotely accessible from a single node. These products help communication service providers correct network-timing problems before they affect customer service. There are three products currently in the line:

- HP 55450A for small networks
- HP 55451A for medium-sized networks
- HP 55452A for large networks

HP 55450A

The HP 55450A is primarily a tool used by crafts people to install, configure, commission, and troubleshoot HP 55400A SSUs. The software is typically installed on a laptop PC running Windows '95 or NT. The crafts person carries the PC to a local office and connects to the SSU using an RS-232 local port interface. Users change settings, view status and monitor performance of the SSU using an extensive, user-friendly GUI instead of TL1 commands. Users configure inputs and outputs, manage fault reporting (define how events and thresholds generate alarms), monitor performance (graphs of MTIE, TDEV and other measurements vs. standards), and define security access levels of users. A TL1 command terminal window is also included for direct control.

The HP 55450A software can also be loaded on a desktop PC using Windows NT to manage a small network of SSUs using a polling technique (accessing one SSU at a time). Connection to remote SSUs is made by modem, TCP/IP or X.25. Reasons to select the HP 55450A software over the other network management software products are:

- To install, configure, commission and troubleshoot HP SSUs
- To manage a small network of HP SSUs (up to around 10)
- When an interface to a higher-level network management system is not required
- When a database of performance and event (alarm) data is not required
- When a map of the synchronization network connectivity is not required
- When management of the HP 55300A GPS PRS is not required

HP 55451A and HP 55452A

The HP 55451A and HP 55452A software are full-featured sync network management platforms, providing complete fault, configuration, inventory, performance and security management. They give users the ability to remotely manage their sync networks and quickly isolate sync-related problems. Key functionality includes:

- Based on the open-architecture, robust platforms of HP OpenView Telecom DM and Oracle relational database
- Easy integration with higher-level network management systems using TCP/IP or SQL*Net
- Interface with the HP 55400A SSU and HP 55300A GPS PRS, using TCP/IP, X.25 or TP4
- Displays performance parameters for SSU input channels: TDEV, MRTIE, LMRTIE, FFOFF and SPREAD
- Reports events including alarms and alarm details
- Displays synchronization network connectivity
- Configurable network partitioning and management domains for operators
- Generates reports on events, performance and configuration

Differences between the HP 55451A and 55452A are listed below.

HP 55451A

- Used to manage a moderate network of HP SSUs and GPS PRSs (up to around 50 SSUs)
- Preferred when restraints make a PC the only platform of choice. The HP 55451A runs on Windows NT
- Used if ITU-T TMN compliance is not required. The HP 55451A is currently not TMN compliant. However, as Windows NT and HP OpenView Telecom migrate to TMN compliance, so will the HP 55451A software

HP 55452A

- Used to manage a large network of HP SSUs and GPS PRSs (from tens to thousands of SSUs)
- Preferred when UNIX is the platform of choice
- Used when TMN compliance is required
- TMN compliance allows an optional Q adapter (CMIP, OSI stack) connectivity to higher-level network management systems
- Optional standby management system for maximum uptime

Ordering Information

HP 55450A Software (per SSU)
HP 55451A Software (per SSU)
HP 55452A Software (per SSU)

For detailed pricing and specific system configuration, contact the HP Call Center in your region.

HP 55300A
HP 55310A
HP 55320A
HP 55322A

- Low-cost upgrade for office BITS clocks and SSUs
- Cesium-like timing performance
- Highly-reliable quartz oscillator with HP SmartClock technology
- Network Time Protocol to synchronize networked computers
- IRIG-B time of day fault location

HP 55300A module in the HP 553310A shelf

HP 55300A: Timing Synchronization for SONET/SDH

The HP 55300A GPS Telecom Primary Reference Source provides a highly-reliable low-cost source of precision timing for both wired and optical telecom digital networks.

The unit is ideally suited for telecom service providers that are installing or upgrading existing networks to comply with and integrate new standards such as SONET/SDH. These high-speed technologies require highly accurate and stable network synchronization and distribution. The HP 55300A exceeds the published specifications for primary reference sources. This affordable synchronization solution can flatten hierarchical networks, providing cesium-like performance at all points. Comparable in holdover performance to more expensive rubidium products, the HP source offers significantly better reliability and does not require the periodic service associated with rubidium alternatives.

Based on advanced GPS technology, the HP 55300A with enhanced GPS provides frequency accuracy of $<1 \times 10^{-12}$ using a 1-day average, even in the presence of Selective Availability. If the GPS signal is interrupted, the module enters an intelligent holdover mode ensuring that precise frequency is maintained for more than 24 hours.

The general-purpose HP GPS synchronization source can upgrade any office; the unit is not restricted to use with specific models of existing timing signal generators (TSGs), or synchronization supply units (SSUs). Modules can be configured for 1.544 Mb/s, 2.048 MHz, 2.048 Mb/s, and 10 MHz.

U.S. and International Versions

The HP 55300A consists of a plug-in card, which can be combined with a lightweight, compact rackmount frame. Configured in this manner, the unit can be hardwired into an office rack. For customers in the U.S., the HP 55300A GPS Telecom Primary Reference Source should be ordered with HP 55310A GPS NEBS/EIA Rackmount Frame. International customers can purchase the HP 55300A with the HP 55320A or HP 55322A GPS ETSI Rackmount Frame.

Integrated Time-of-Day Function

Each HP synchronization module takes advantage of the accuracy of the GPS reference to provide a time-of-day signal. The accurate time-of-day facilitates fault isolation, sequence-of-events analysis, and other emerging troubleshooting techniques that benefit service providers by improving the quality and availability of services.

Specifications Summary

Key Characteristics
Locked Accuracy: $<1 \times 10^{-12}$ using a 1-day average (when locked to GPS)
Holdover Stability: $<1 \times 10^{-10}$ per day
Outputs Available: 1.544 Mb/s and 2.048 Mb/s
Framing: Industry-standard formats available
Oscillator MTBF: >500,000 hours
Cold Start-up: GPS lock in < 30 minutes (assumes "normal" view of sky)

Front Panel
LEDs: Power, GPS Lock, Holdover, Critical, Major, and Minor Alarms, ACO Active
Push-buttons: Alarm Cut-Off (ACO) and ACO Reset
DS1/E1 Monitor Output: Bantam connector
Local Command Interface (Craft Interface)**:** RS-232C, DE-9 connector, DTE configuration, TL1 command/status structure

Rear Panel (HP 55310A); Top Front (HP 55320A and HP 55322A)
GPS Antenna: "N" connector
Power: Redundant –48 V power inputs; latching plug-in connectors for 14 to 28 gauge wire (secured by screws)
DS1/E1: Wire-wrap (HP 55310A); BNC or (HP 55320A); DE-9S (HP 55322A)
Alarms: Wire-wrap (HP 55310A); DB-25P (HP 55320A and HP 55322A)
Remote Command I/F: RS-232C at 9.6 kbps, DB-25S connector, DTE configuration, TL1 command/status structure
Time-of-day Output: HP SCPI I/F for connection to Network Time Protocol (NTP) server
Other: 1 PPS at RS-232C level, 10 MHz sine wave, IRIG-B time-of-day

Alarm Operation
Configurable Causes: Power failure, output failure, oscillator failure, synthesizer failure, GPS signal loss (holdover)
Remote and Local: Two separate sets of connections. Local set responds to ACO pushbutton.
Multiple Alarm Priorities: Critical, major, or minor for each
Relay Connection Outputs: Common, NO, NC

Environment/Installation
Rack Configuration: 19-, 21-, and 23-inch, NEBS/EIA or ETSI-compatible
Temperature: 0 to +50°C (operating); –40 to +80° C (storage)

Antenna
Active Antenna: 30 dB (typical) active gain with dielectric filter
Temperature: –30 to +80°C (operating); –40 to +85°C (storage)

HP 55300A module in the HP 55320A shelf

Ordering Information

NEBS (US) Version
HP 55310A GPS NEBS/EIA Rackmount Shelf
HP 55300A GPS Telecom Primary Reference Source Order Option 104 or 105
ETSI (International) Version (Unbalanced Outputs)
HP 55320A GPS ETSI Rackmount Shelf
HP 55300A GPS Telecom Primary Reference Source Order Option 270, 271 or 272
ETSI (International) Version (Balanced Outputs)
HP 55322A GPS ETSI Rackmount Shelf
HP 55300A GPS Telecom Primary Reference Source Order Option 220, 221 or 222
GPS Antenna Systems and Accessories
See page 509 for the complete line of GPS Accessories.

GPS Measurements Synchronization Module

HP59551A

- Tailored for power transmission networks
- Timing accuracy: 110 ns to UTC (USNO) @ 95% confidence level*
- HP SmartClock technology learns and adjusts frequency
- Time tagging (standard feature)

HP 59551A

HP 59551A GPS Measurements Synchronization Module

The HP 59551A GPS measurements synchronization module meets the precision-timing needs of wide-area electric power transmission systems. Based on advanced Global Positioning Systems (GPS) receiver technology, the module has superior long-term timing accuracy and permits exhaustive measurement and analysis of power system performance.

The HP 59551A combines low cost and unmatched functionality, making it the timing solution of choice for a variety of applications. For monitoring existing wide-area transmission networks, the HP 59551A provides the timing synchronization and time tagging required to efficiently locate faults, analyze network disturbances, and perform detailed sequence of events analysis. The newest, state-of-the-art transmission networks benefit from the highly-accurate synchronization foundation provided by the HP 59551A.

Time Tagging

Time tagging, a standard feature of the HP 59551A, allows event marking to a quantization of 100 ns. Up to 256 tagged events per channel are stored in buffer memory, which can be downloaded to a computer for in-depth failure or sequence-of-events analysis.

HP SmartClock Technology

The timebase for the HP 59551A is based on the HP 10811D quartz oscillator and HP SmartClock algorithm. The oscillator, proven to be a leader in reliability, offers exceptionally low sensitivity to temperature changes, low phase noise, and well-understood aging characteristics.

HP SmartClock compares the oscillator frequency with a GPS reference signal. By "learning" the aging behavior and the environmental effects on the oscillator over time and adjusting the oscillator output frequency accordingly, HP SmartClock can raise the performance of the HP 59551A to approach that of a rubidium-based solution—for a much lower cost. The superior performance is also achieved in holdover mode; the GPS signal can be lost for up to 24 hours with <8.6 μs loss in timing accuracy.

Versatile I/O

The HP 59551A incorporates many input/output features and enhancements. The range of inputs and outputs allow the HP 59551A module to be integrated with external processing solutions, or used with a variety of event and fault recorders. The versatile design also integrates with the newest designs for real-time applications (state estimation, demand-side management, and energy management systems).

*This specification has a 95% probability, and is based on availability of four or more GPS satellites during three days locked operation with a fixed antenna location. The temperature must remain within a 10° C range between 10° C and 40° C.

Highlights of the I/O capabilities include:

Separate Front/Rear RS-232 Ports: The HP 59551A can be controlled locally without interfering with output signals.
Standard IRIG-B
Alarm BITE: System fault or loss of satellite lock generates an alarm signal.
Time-Tag Inputs: Conditioned TTL signals can be time-tagged to a quantization of 100 ns.
Programmable Pulse Output: An output pulse or repetitive signal can be programmed at a specific time or repetition period.

Specifications

Performance

Timing Accuracy: <110 ns to UTC (USNO) @ 95% confidence level
Holdover: <8.6 μs accumulated in 24 hr. unlocked after 3 days of locked operation with antenna in fixed location, for any 10°C range, 10°C to 40°C.

Basic Module I/O

2 RS-232C Ports
- **Baud Rate:** 9600, other setting computer-selectable
- **Functions:** All required communication and control functions
- **Connectors:** 9-pin female rectangular D subminiature on front panel; 25-pin female rectangular D subminiature on rear panel

1 IRIG-B123 Output Port: BNC output interface
1 1-pps Output Signal: BNC output interface, risetime <5 ns
1 Alarm BITE Output
- **Basic Unit Output:** Solid state relay (NO) with closed contact indicating system fault or loss of satellite lock
- **Output Interface:** Twin BNC

3 Time-Tag Inputs
- **Received Signal:** Conditioned TTL
- **Time-Tag Accuracy:** The accuracy of the timing module
- **Input Interface:** BNC
- **Quantization:** 100 ns

3 Time-Tag Buffers: 256 events, retrievable via RS-232C port
- **Minimum Time Between Events:** 1 ms

Programmable Pulse Output
- **Output Pulse:** Single pulse at the time programmed via RS-232C port, or repetitive output pulse at a programmable repetition period from 1 sec to 1 year
- **Quantization:** 100 ns

Environmental

Antenna
- **Operating:** –30° to +80°C

Remainder of Timing Module
- **Operating:** 0° to +50°C
- **Power:** <35 watts @ 129 Vdc

Surge Withstand: Meets IEEE/ANSI C37.90, C37.90.1
RFI: No degradation when a 10 watt walkie-talkie is activated within 1 meter of the module (VHF/UHF)

More Information

There is no front-panel display or keypad. During installation and start-up, information is entered into and retrieved from the timing module with an HP-100LX or HP-200LX PalmTop computer or any DOS-compatible computer serial interface. A Windows® application is shipped with the instrument.

Ordering Information

HP 59551A GPS Measurements Synchronization Module (includes 129 Vdc power supply)
- **Opt 1CM** Rack Mount 19-inch
- **Opt AXQ** Rack Mount 23-inch
- **Opt AWM** RPower Supply (48 Vdc)
- **Opt 170** 90 to 132 Vac or 198 to 264 Vac, 50 to 60 Hz

HP 58532A GPS Antenna (required)
HP 58538A/39A Lightning Arrestor (optional)
HP 58529A Antenna Line Amplifier
HP 58530A GPS L1 Bandpass Filter
GPS Antenna Systems and Accessories
See page 509 for the complete line of GPS accessories.

HP 59552A and HP 59553A

HP 59552A/53A Fiber-Optic Dist Amp & Receiver

High-integrity distribution of a common clock is the backbone for power utility substation synchronization. The HP 59552A Fiber-Optic Distribution Amplifier and HP 59553A Fiber-Optic Receiver provide a simple, modular approach to signal routing. Immunity to electrical noise makes fiber-optic cable a superior choice for the challenging environment of the power substation.

The HP 59552A Fiber-Optic Distribution Amplifier receives a digital (TTL) signal and an analog signal via two BNC connectors. The HP 59552A combines the signals, and transmits the result on each of eight fiber-optic outputs. Signal integrity is even maintained over customer-supplied, fiber-optic cable lengths of up to a kilometer.

An HP 59553A Fiber-Optic Receiver resides near each remote equip ment installation. The HP 59553A receives the signal on fiber-optic cable, separates analog and digital waveforms, and outputs each signal on a BNC connector.

HP fiber-optic products are designed to provide clean timing quality transmission signals to monitoring, analysis and control equipment. In a typical application calling for distribution on 1 pulse per second (1 pps) and IRIG-B time code, each substation instrument receives an identical, synchronous, high-quality clock signal and precise time of day.

Coupled with the HP 59551A, the HP 59552A and HP 59553A form a complete master clock and distribution system for power substations. This system could be used for applications like fault location, adaptive relaying, and disturbance analysis.

HP 59552A Fiber-Optic Distribution Amplifier

Specifications

Inputs
One digital input typically used as 1PPS input
One analog input typically used as IRIG-B123 input
Digital Input
Input Signal Requirements: TTL
Input Impedance: 50 Ω to GND (default) or 1 kΩ to +5 volts configurable with internal jumper
Analog Input
Input Signal Requirements: 5 volts peak-to-peak (nominal)
Input Impedance: 600 Ω (default) or 10 kΩ configurable with internal jumper
Outputs
Number of Optical Outputs: 8
Optical Connector: Metal ST
Front-Panel LEDs Indicating
Power
Digital input active
Analog input active
Note that annunciator is activated at a minimum voltage of 1.6 volts pk-pk (nominal)
Power Requirements
dc Power (standard): 129 Vdc, 115 to 140 Vdc operating range
ac Power (Option 170): 90 to 132 Vac or 198 to 264 Vac, automatically selected; 50 to 60 Hz
Dimensions
Height: 88.5 mm
Width: 212.6 mm
Depth: 348.3 mm
Weight: 3 kg
Half-Rack module

HP 59553A Fiber-Optic Receiver

Specifications

Inputs
Number of Optical Inputs: 1
Optical Connector: Metal ST
Outputs
One digital output typically used as 1PPS output
One analog output typically used as IRIG-B123 output
Digital Output
Output Signal: TTL
Output Impedance: Drives 50 Ω to GND
Analog Output
Output Signal: 5 volts peak-to-peak (nominal)
Output Impedance: Drives 600 Ω to GND
Front-Panel LEDs Indicating
Power
Digital input active
Analog input active
Note that annunciator is activated at a minimum voltage of 1.6 volts pk-pk (nominal)
Power Requirements
dc Power (standard): 129 Vdc, 115 to 140 Vdc operating range
ac Power (Option 170): 90 to 132 Vac or 198 to 264 Vac, automatically selected; 50 to 60 Hz
Dimensions
Height: 87.1 mm
Width: 133.2 mm
Depth: 185.3 mm
Weight: 0.91 kg
Fiber-Optic Cable Core Size Recommendations: 62.5/125 μm

Ordering Information

HP 59552A Fiber-Optic Distribution Amplifier
HP 59553A Fiber-Optic Receiver
***Opt 170** 110 Vac operation

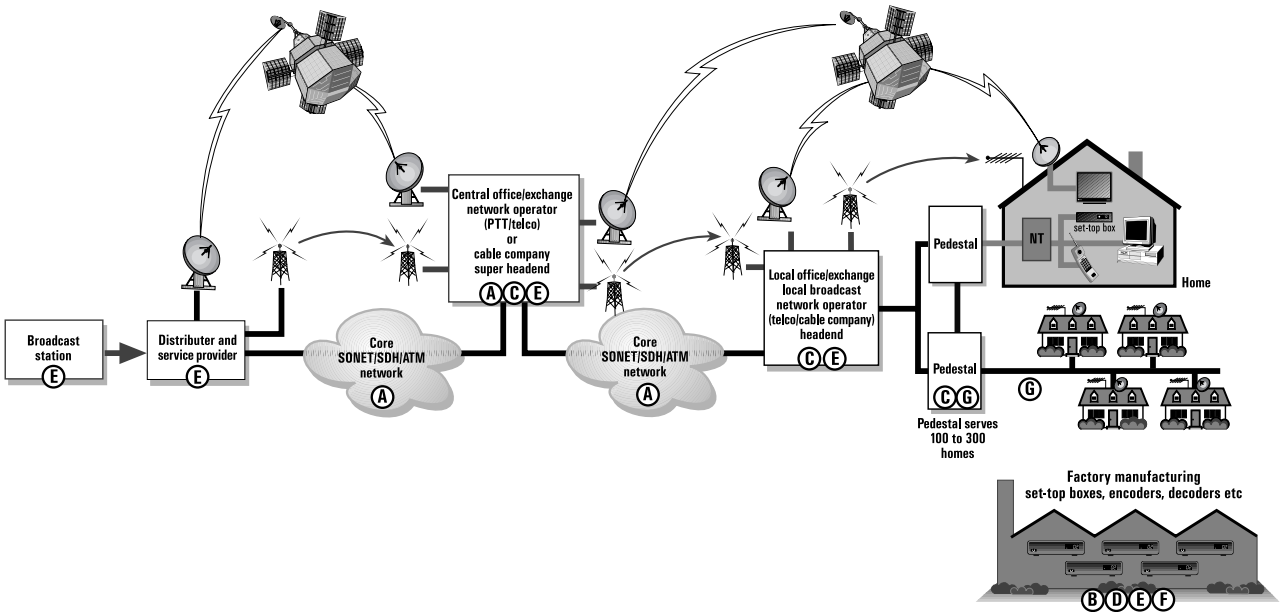
*HP 59552A/59553A come standard with 129 Vdc. For use with ac power, order Option 170.

Telecom Network Synchronization

HP 55300A GPS Telecom Frequency Reference Source
5966-4170E
5965-1682E/EUS
5966-3284E
HP 5071A Sync Family Brochure
5964-9932E
HP 5071A Unsurpassed Stability in the Lab or Field
5091-6013E
HP Innovation for 21st Century Network Synchronization
5964-9932E
HP 55400A Network Synchronization Unit
5966-0432E
HP 55452A Synchronization Management/UX
5966-1840E
HP E1748A Multiple-channel Network Synchronization Software
5965-6659E
5966-4094EUS
5966-4095E

Power Measurement Synchronization

HP 59551A GPS Measurements Synchronization Module
5965-2998E
Synchronize and Analyze Power System Performance
5964-0262E
GPS Synchronization for Power Transmission Systems
5964-2459E
HP 59552A Fiber Optic Distribution Amplifier and HP 59553A Fiber Optic Receiver
5964-8927E



Test Equipment for Digital Video Broadcast/Cable TV

Digital transmission is the key enabling technology that will allow cable systems to deliver a multitude of emerging services. Ensuring a high quality of service requires testing various aspects of the signal—data integrity, modulation, and RF signal quality. HP offers a wide range of instruments for testing all these aspects of digital video service development, deployment, and device manufacuring.

A
HP E6271A MPEGscope ATM
Real-time MPEG-2 tests over AAL-5, MPEG-2 transport quality of service measurements, real-time PSI table decodes. Runs on HP E4200 Broadband Series Test System. See page 527.

B
HP 89400 Digital Video Signal Analyzer
State-of-the-art modulation quality measurements for R&D and commissioning. See page 526.

C
HP 8594Q DVB-C QAM Analyzer
Comprehensive RF, modulation, and data quality measurements for cable system operators. See page 523.

D
HP ESG-D4000A Digital Signal Generator
Used with HP E4441A DVB QAM coder to produce highly accurate IF or RF signals. See page 214.

HP E2507B Multi-Format Communications Signal Simulator
Simulate varying return link traffic levels with multiple-modulated signals. See page 229.

E
HP E6277A MPEGscope Plus
Capture, analyze, and transmit transport streams, real-time transport stream analysis, bit error rate test, TS and PES protocol, DVB, and ATSC table decodes; optional ES compression analysis software. See page 527.

F
HP E4441A DVB QAM Coder
Fully DVB-C compliant modulation source with calibrated impairments for R&D and set-top test. See page 524.

G
HP CaLan 3010 R/H Sweep/Ingress Analyzer
Digital channel power, sweep and ingress measurements for network technicians. See page 530

- Field testing solution for DVB-C[1] cable TV systems
- Test from the headend to the subscriber drop
- Comprehensive suite of RF, modulation, and data quality measurements
- Verify your quality of service

HP 8594Q QAM Analyzer

HP 8594Q QAM Analyzer

The HP 8594Q QAM Analyzer is a comprehensive solution for RF installation and maintenance testing of DVB-C (Digital Video Broadcast via Cable) signals on cable TV systems. It gives engineers the measurement capability required to accurately verify the quality of service delivered to the subscriber. All measurements are easy to access and the results are presented in a clear graphical displays.

Applications

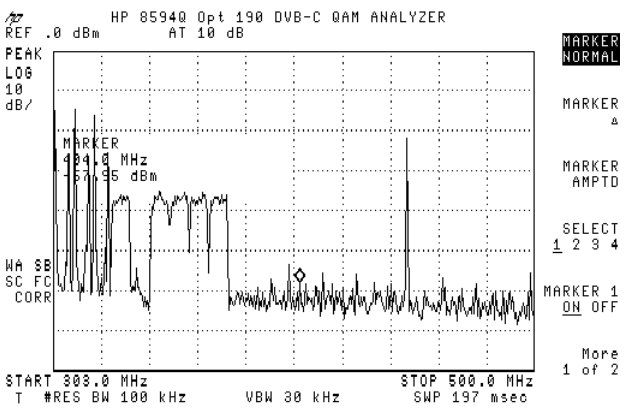
The HP 8594Q QAM Analyzer can help you during:
- Headend equipment installation and maintenance
- System verification
- Field installation and maintenance
- Modulator manufacturing or incoming inspection test
- Opt J91–Modulation measurements in 6 MHz channel bandwiths

Measurement Capability

The HP 8594Q QAM Analyzer demodulates and accurately measures the 16, 64 or 256 QAM signals carried through the DVB-C system. It provides new measurement metrics necessary to characterize these signals and troubleshoot problems. The graphical displays, clear user interface, and one-button measurement capability will help make the transition easy for analog cable TV engineers.

To accurately verify your quality of service, the HP 8594Q QAM Analyzer provides the following measurement capability:
- Average channel power—To verify the signals levels from the headend through the system to the subscriber drop
- Adjacent channel power—To make sure that transmissions are not leaking into and causing interference in adjacent channels
- Constellation display—Display the constellation points and quickly identify any modulation problems
- Error vector magnitude and modulation error ratio—To quantify the modulation quality of the signal transmitted through the system
- Equalizer response—Frequency, impulse, group delay and phase response plots can be displayed on screen to show distortions caused by the transmission channel
- Data measurements—Add Option 195 to the 8594Q QAM Analyzer to verify that the MPEG data has been correctly decoded from the DVB-C RF signal and check transport stream content. The option also proves a real-time output (both ASI and parallel), to allow access to the data stream for further analysis. The HP 8594Q option 195 includes a real-time FEC decoder. By monitoring the activity of the FEC decoder, analysis of byte and packet errors is provided.

The HP 8594Q QAM Analyzer makes all of these measurements quickly and accurately. In addition the HP 8594Q QAM Analyzer provides a fully featured 2.9 GHz spectrum analyzer.



Ordering Information

HP 8594Q QAM Analyzer
- **Opt 190**[2] DVB-C Measurement Capability
- **Opt J91**[2] Modified to operate in 6 MHz channel bandwiths
- **Opt 195**[3] Data Measurements
- **Opt 016** Soft Yellow Operating/Carrying Case
- **Opt 040** Front Panel Protective Cover with Storage
- **Opt 043** RS232/Parallel Interface
- **Opt 908** Rackmount Kit without Handles
- **Opt 909** Rackmount with Handles
- **Opt 910** Additional Manual Set

[1] DVB-C is a standard defined by the European Telecommunications Standards Institute.
[2] Opt 190 or Opt J91 required.
[3] Opt 195 measurements are specific to the DVB standard.

HP E4441A DVB QAM Coder

DVB-C Compliance

The HP E4441A DVB QAM coder is a fully compliant test source for testing DVB-C set-top boxes, devices, or networks. In conjunction with an ESG-D series digital signal generator, it produces DVB-C compliant test signals with programmable impairments for true bit error rate measurements.

Real-Time Encoding

The system can channel code and modulate either internally generated MPEG-2 null packets or an external MPEG-2 transport stream onto IF/RF to the DVB-C standard. This allows both test and real world signals to be generated. The internal MPEG-2 null packet source allows receivers to be fully characterized through bit error rate measurements or simply through FEC results. Via the external MPEG-2 input, real-life pictures or MPEG-2 stress patterns can be coded and modulated in real time.

Calibrated Impairments

The DVB QAM coder and digital signal generator combination provides a precision reference signal suitable for both laboratory and manufacturing test. To simulate poor signal conditions the DVB QAM coder includes an accurate Gaussian noise source. Noise can be added to the reference in a controlled and calibrated manner. The instrument combination can also produce a range of other signal impairments such as carrier leakage and I/Q imbalance to test the limits of receiver design or network performance.

Complete Flexibility

The DVB QAM coder is user configurable making it ideal for R&D, early manufacture, and system installation testing. Use of internal settings for 8, 6, 4 and 2 MHz channels and an external clock source, such as an HP 33120A function generator, allows the symbol rate (and hence the channel occupancy/bandwidth) to be varied continuously from 5.2 to 7 Mbaud. The DVB QAM coder generates a 64 QAM signal which is coded, mapped, and filtered according to the DVB-C standard. An intuitive Windows®-based graphical user interface allows coding, constellation size, symbol mapping, and filter characteristics to be changed easily and quickly.

For R&D and Manufacturing

The Windows-based graphical user interface controls both the DVB QAM coder and the digital signal generator for local operation. Both units are completely HP-IB compatible and easily racked, making them suitable for integration into manufacturing test systems.

Specifications

Modulation
- **Modulation Types:** 16, 32, 64, 128 and 256 QAM
- **Symbol Mapping:** DVB compliant, user defined
- **Error Vector Magnitude:** < 1% typical

Channel Characteristic
- **Channel Filter Type:** Root raised cosine, raised cosine, user defined
- **Channel Filter Alpha:** 0.15, 0.13

Symbol Rate (selectable):

Nominal channel bandwidth	Internal (Mbaud)	External (Mbaud)
8 MHz	6.890 6.872 6.875 6.900	5.2 to 7.0*
6 MHz	5.274	
4 MHz	3.445	2.6 to 3.5*
2 MHz	1.7225	1.3 to 1.75*

* Fully variable

Data Source
Data Source Type:
- Internal $2_{23} - 1$ PRBS
- Internal packetized $2_{23} - 1$ PRBS
- Internal MPEG-2 null packets
- Internal arbitrary fixed symbol
- External 188 byte MPEG-2 packet input
- External 204 byte MPEG-2 packet input

Channel Coding
Channel Coding: As per ETS 300 429
Channel Coding Control:
- Randomization on/off
- Sync inversion on/off
- Reed-Solomon encoding on/off
- Byte interleaving on/off
- Differential encoding on/off

Impairments
Gaussian noise, spurious tone carrier leakage, I/Q magnitude imbalance, I/Q quadrature imbalance, and inverted spectrum

I & Q Outputs
- **Level:** 0.28 V rms (nom.) into 50 ohms
- **Residual dc Offset:** < 300 µV
- **Connectors:** BNC

Symbol Clock Output
- **Type:** TTL compatible
- **Connector:** BNC

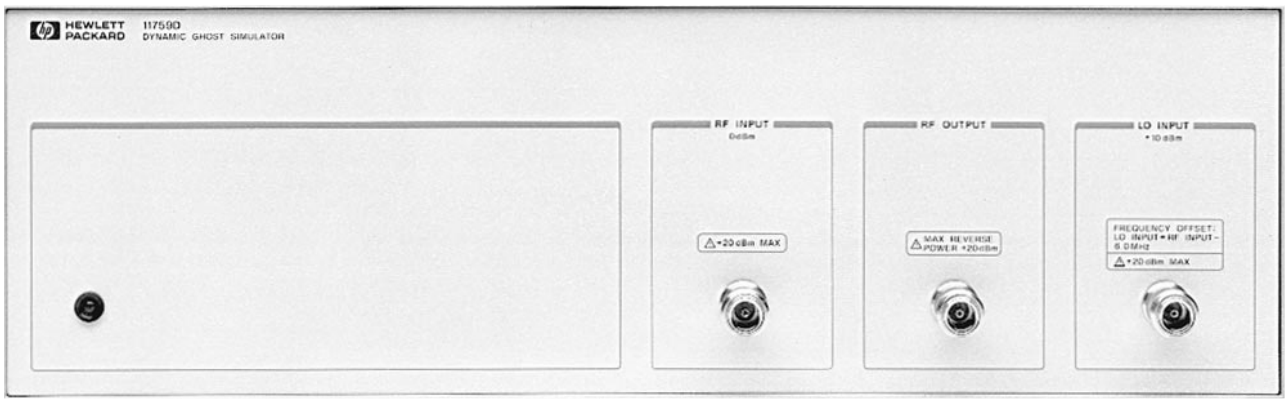
MPEG-2 Input
- **Type:** DVB-PI as per DVB document A010. Oct. 1995
- **Connector:** 25-pin sub-miniature D-connector

Ordering Information

HP E4441A DVB QAM Coder
- **Opt 001** Internal 6.872 Mbaud fixed symbol rate
- **Opt 002** Internal 6.875 Mbaud fixed symbol rate
- **Opt 003** Internal 6.900 Mbaud fixed symbol rate
- **Opt 004** Internal 5.274 Mbaud fixed symbol rate
- **Opt 1CP** Rackmount Kit

HP 11759D

- Simulates realistic propagation models for analog and digital television
- Static and time varying ghosts
- 12-bit processing for minimum distortion
- RF input/output for full IF/VHF/UHF coverage



HP 11759D

HP 11759D Dynamic Ghost Simulator

The HP 11759D dynamic ghost simulator easily simulates the ghosting and airplane flutter that commonly degrade terrestrial TV broadcasts. With the HP 11759D, ghost canceller or digital TV designs can be tested under the real-world conditions of multiple reflections and motion. The simulation of motion is required to account for the effects of tower sway, airplane flutter, and the movement of people, vehicles, and trees. The HP 11759D is ideally suited to simulate these phenomena.

The HP 11759D consists of the applications software and the RF processing hardware and requires two user-supplied components to complete the dynamic ghost simulation system—a PC acting as a user interface and a synthesized local oscillator with a 10 MHz timebase output.

Easy to Use Manually or Remotely

Simple-to-use on-screen menus guide the user through the task of creating complex RF multipath ghost signals for testing ghost cancelling systems or digital TV receivers. These same menus are accessed remotely by installing an optional HP-IB interface card in the PC.

HP 11759D Partial Specifications

(See Technical Data Sheet for complete specifications)
RF Channels: 1 of 6 paths
RF Frequency Range: 40 to 1,000 MHz (useable to 2700 MHz)
RF Bandwidth (1 dB): > 6 MHz typical
RF Input Level: –10 dBm (+ 97 dBμV) nominal
Path Insertion Loss: 24 dB ± 3 dB typical
Path Delay Range: 0 to ± 186 μs, maximum delay spread, 186 μs
Path Attenuation Range: 0 to 50 dB in 0.1 dB steps
Relative Phase Between Paths: Adjustable 0 to ± 360˚, 0.1˚ steps
Simulated Doppler Range: 0 to 425 Hz, in 0.01 Hz steps
For NTSC Modulated Signals
- **Chrominance-to-Luminance Delay Inequality:** < 10 ns typical
- **Chrominance-to-Luminance Gain Inequality:** < 4% typical
- **Differential Phase Distortion:** < 1 degree typical
- **Differential Gain Distortion:** < 1% typical

General
- **Power:** 90 to 132/190 to 264 V; 48 to 66 Hz; 325 VA maximum
- **Size:** 425 mm W x 146 mm H x 620 mm D (16.8 in x 5.7 in x 24.4 in)
- **Weight:** Net, 13.6 kg (30 lb); shipping, 19 kg (42 lb)

HP 89441V
HP 89400
Option AYH

- Adaptive equalization now included in Option AYH
- Peak-to-average power measurements
- Constellation, eye, and error magnitude analysis for QAM, VSB, and other modulation formats (Option AYH)
- Dynamic power measurements, including: peak, average, band-integrated, and adjacent channel
- Waveform capture and analysis
- Carrier phase noise measurements to –124 dBc/Hz (typical at 10 kHz offset)

HP 89400 Option AYH Digital Video Signal Analyzer

Meeting the needs of both broadcasters and system designers, the HP 89441V and the HP 89400 series with option AYH or COFDM analysis software precisely characterize RF signals in the emerging modulation formats of the digital video industry, including COFDM, QAM and VSB. Off-the-shelf, lab-quality spectrum and waveform measurements allow designers of ATV/HDTV components, equipment and systems to deliver higher-quality video signals faster and for less cost than with custom-built test tools.

Signal Quality Measurements

HP 89400 vector signal analyzers measure signal power and waveforms in the time, frequency, and modulation domains, making them extremely versatile design and troubleshooting tools. Their advanced DSP architecture provides measurements that are not only fast, but exceptionally accurate and informative—even for complex, broadband ATV signals. For more information about HP 89400 signal analysis capabilities, see page 250.

Digital-Modulation Analysis

The HP 89441V bundles option AYH with other necessary options for Digital Video Test in one prodect. Digital video analysis Option AYH equips HP 89400 analyzers to demodulate and characterize a wide variety of video-related signal formats. Results are shown via traditional eye and constellation displays, or as error vector magnitude and MER (Modulation Error Ratio) measurements. EVM quantifies the instantaneous difference between the actual input signal and an ideal, internally-generated reference signal containing the same data stream. It is a measurement technique now widely accepted among digital RF communications designers and international standards organizations. Expressed as a time waveform, an rms average or an error spectrum, EVM is sensitive enough to reveal the slightest degradations in signal quality, such as those which occur between the input and output of even a single amplifier stage. Use it to troubleshoot BER or other signal problems back to their root causes.

In digital demodulation mode, carrier lock, and symbol clock synchronization are automatic. This means external carrier reference or clock inputs are never required, making the HP 89400 analyzers useful even in remote or field test applications.

COFDM Modulation Analysis

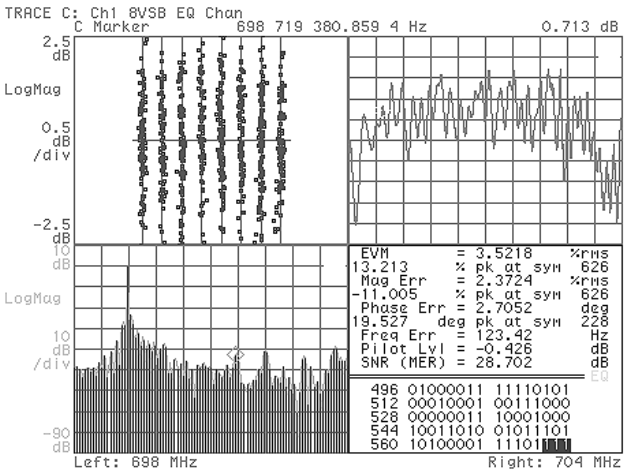
NEW

For modulation measurements to the European DVB-T (Digital Video Broadcast - Terrestrial) standard, HP has developed software for use with the 89441A and a PC for external data analysis.

DVB-T uses a COFDM (Coded Orthogonal Frequency Division Multiplex) modulation scheme, with either a nominal 2000 (“2k”) or 8000 (“8k”) carriers contained within a standard 8MHz RF channel. Each carrier is modulated with low-rate 64QAM.

The analysis software is a pre-configured HP VEE application, and is supplied on CD-ROM. As well as making all the normal RF tests on the signal, the system makes the following DVB-T modulation measurements:

1. Symbol magnitude spectrum
2. Symbol phase spectrum
3. Symbol IQ constellation
4. EVM magnitude spectrum
5. EVM complex
6. Equalizer magnitude spectrum
7. Equalizer phase spectrum
8. Error statistics summary table
9. Data power from nominal relative to pilots
10. TPS Power from nominal relative to pilots



New measurement displays include channel frequency response and impulse response of the equalization filter.

Adaptive Equalization

A new adaptive equalization capability is included with digital video analysis Option AYH and works with digital demodulation to remove linear errors, such as frequency response and reflections, from transmitted signals. Measurements more closely approximate the performance of real-world receivers and can be used to isolate linear vs. non-linear error mechanisms. New measurements in this option include displays of channel frequency response and impulse response of the equalization filter. This equalization does not require prior knowledge of the signal such as a training sequence.

For more information, visit our web site: **http://www.hp.com/go/89400**

Specifications

Frequency Range and Bandwidth

Model number	Frequency range	Sensitivity	Maximum bandwidth
HP 89410A	dc to 10 MHz	–144 dBm/Hz	10 MHz
HP 89441A	dc to 2650 MHz	–160 dBm/Hz	8 MHz
HP 89441V	dc to 2650 MHz	–160 dBm/Hz	8 MHz

Symbol Rates (Symbols/Sec)
VSB Formats: 10.77 M nominal (adjustable)
QAM Formats: Rate < (Analyzer BW)/(1 + α)
Examples:

Model number	QAM α = 0.2	DVB α = 0.15
HP 89410A	< 8.33 M	< 8.70 M
HP 89441A	< 6.09 M	< 6.96 M
HP 89441V	< 6.09 M	< 6.96 M

Maximum Measurement Size
1 sample/symbol: 4096 symbols
5 samples/symbol: 819 symbols

Modulation Formats
8, 16VSB
COFDM (using exteranal PC analysis software)
16, 32, 64, 256QAM
16, 32, 64QAM (DVB)
(QPSK, Offset QPSK, FSK, MSK, BPSK and other formats are supported by Option AYA–not available on HP 89441V)

Residual Error (instrument contributed)
QAM Formats: Symbol rate 5 to 7 MHz, 0.15 < α < 0.2, full-scale signal ≥ –25 dBm: ≤ 1.0% EVM typ. (≤ 40 dB SNR)
VSB Formats: Symbol rate 10.762 MHz, α = 0.1152, full-scale signal ≥ –25 dBm: ≤ 1.5% EVM typ. (≤ 36 dB SNR)

Required Options for 89410A and HP 89441A
AYA (vector modulation analysis)
UFG (4 MB extended RAM)

For complete product, literature, and ordering information, see page 264

HP E6277B
HP E6285A
HP E6288A
HP E6289A
HP E6290A

- Analyze and troubleshoot MPEG-2, DVB, and ATSC implementations
- Optimize digital video encoder performance (including 4:2:2 Profile and High Level)
- Test MPEG private table implementations

HP E6277B MPEGscope Plus

HP E6277B MPEGscope Plus

Comprehensive MPEG-2, DVB, and ATSC Testing

Today's increasing pressures to introduce products to market in ever shorter timeframes demand that you have the best tools available when developing your digital video products. The HP MPEGscope Plus is the most comprehensive tool for MPEG-2, DVB, and ATSC system development and qualification. This PC-based test system offers the perfect combination of real-time and post-analysis tools for MPEG-2 testing. It is ideal for R&D, product development, quality assurance and conformance testing. With the HP MPEGscope Plus and optional software test applications, it's quick and easy to verify and debug digital video network components, including encoders and decoders, multiplexers/demultiplexers, video servers, and much more.

With its PC-based Windows NT architecture and intuitive user interface, the MPEGscope Plus offers a familiar environment that allows you to quickly become effective in troubleshooting your digital video implementations.

- MPEG-2 transport stream capture and playback up to 90 Mb/s with precise timestamping
- Storage of MPEG-2 streams up to 9 GB (expandable to 18 GB)
- Real-time analysis with triggers to capture specific events
- ATSC (PSIP) and DVB (SI) Table Decodes
- define protocol decodes using your own private table definitions
- Compose your own MPEG-2 transport streams for testing
- Insert impairments into transport streams for decoder stress testing
- High-performance 300MHz Pentium II platform
- Standard DVB-SPI (parallel LVDS) interface provided, optional DVB-ASI, DHEI, and ARIB interfaces available.

In-depth Video Elementary Stream Analysis

The Video Elementary Stream Compression Analyzer allows you to test all aspects of MPEG video encoding. This optional MPEGscope Plus application will decompose the video elementary stream right down to an individual macroblock. Syntax and semantic protocol testing, bit rate and VBV buffer statistics, and detailed macroblock and motion vector analysis are all provided in this high-powered package. The video can even be displayed for visual verification. This software finds application in bitstream verification, development and optimization of compression algorithms, and troubleshooting encoder and decoder interoperability issues.

Most Complete Compliance Testing Available

The MPEG/DVB Compliance Verification Test Suite enhances the powerful MPEGscope Plus by providing incomparable compliance testing according to MPEG and DVB standards. This software performs an incredible 850 tests, the most comprehensive of any MPEG test system on the market. The automated tests quickly find errors in MPEG implementations, allowing interoperability problems to rapidly be solved and avoiding "finger-pointing" among equipment vendors. All errors are reported in detail, referencing the exact location in the bitstream of the error and the standard and clause that was violated.

Test Material

HP's complete MPEG testing solution also includes test material for encoders and decoders. The HP E6285A Encoder Stress Test Patterns is a videotape of synthetically produced test sequences that can be used to evaluate or optimize digital encoders. The HP E6288A MPEG Decoder Test Bit Streams is a CD-ROM containing MPEG streams that can be played out to a decoder or set-top box in order to verify its functionality.

Key Literature

E6277 MPEGscope Plus, Colour brochure, p/n 5966-2034E
E6277B MPEGscope Plus, Technical specification, p/n 5966-8194E
E6277A #010 Elementary CompressionAnalyzer Stream, Data sheet, p/n 5965-6491E
E6277A #011 & 012 MPEGDVB Compliance Verification Test Suites, Data sheet, p/n 5966-0375E
E6285A Encoder Stress Test Patterns, Data sheet, p/n 5965-6492E
E6288A MPEG Decoder Test Bit Streams, Data sheet, p/n 5965-1508E

Ordering Information

For assistance in defining your configuration, please contact your local HP sales office.

MPEGscope Plus
E6277B MPEGscope Plus
Opt 001 ASI and Serial ECL (DHEI) Interface
Opt 010 Video Elementary Stream Compression Analyzer
Opt 011/012 MPEG/DVB Compliance Verification Test Suite
Opt 020 12 Gigabyte DAT Drive
Opt 518 Expand hard-disk storage to 18GB
Opt ABJ Japanese localization
E6289A ARIB Interface Adapter for MPEGscope Plus
E6290A PerfecTV Decode Software for MPEGscope Plus

Test Material
E6285A Encoder Stress Test Patterns
E6288A MPEG Decoder Test Bit Streams

HP 8591C
HP 85721A
HP 85905A
HP 85921B

- Dedicated cable TV analyzer
- Portable and easy to use
- Non-interfering RF and video measurements
- New—Digital carrier power measurements
- New—Cable TV data management software

HP 8591C

HP 8591C Cable TV Analyzer

Industry's Only Cable TV Analyzer that Keeps Pace with Changing Regulations

The HP 8591C cable TV analyzer (1 MHz to 1.8 GHz) is the first economical, portable, one-box solution for making automatic, non-interfering cable TV RF and video measurements. The analyzer features a flexible hardware and software architecture that can be upgraded easily to protect your investment as new test requirements are introduced.

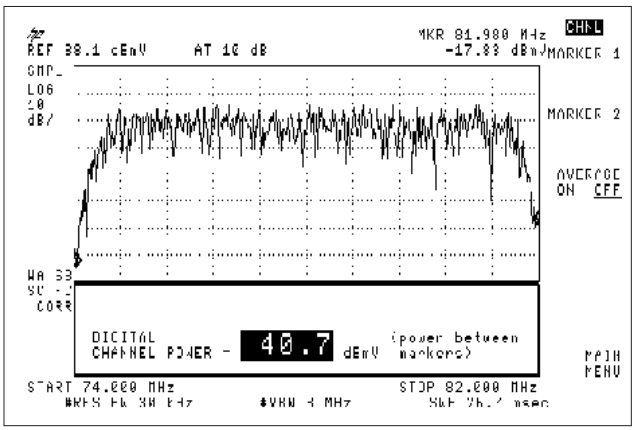
Included in the cable TV analyzer are the features you need for cable TV testing compatible with worldwide formats and standards, including all FCC proof-of-performance tests:

- HP 85721A cable TV RF/video measurements personality to simplify channel and system cable TV measurements
- 75 Ω input matches analyzer to cable TV impedance
- Built-in, internally switched preamplifier for improved carrier-to-noise measurements
- Precision frequency reference to accurately measure carrier frequency
- Fast time-domain sweeps for displaying individual TV lines
- TV trigger for selecting TV lines by number
- RS-232 and parallel interfaces for PC and printer operation, respectively
- HP 85702A 128K RAM card for storing test data
- Rugged, yellow, soft carrying case

Options add even greater measurement capability to the analyzer. These include a 75 Ω tracking generator, narrow resolution bandwidths, and non-interfering RF and video measurements.

Non-Interfering Measurements

Option 107 for the HP 8591C and the HP 8590 E-series spectrum analyzers adds the hardware needed to make non-interfering RF and video measurements. Non-interfering measurements let you perform required tests on multiple channels at multiple locations with no impact on customer programming. The video measurement capability allows you to perform required FCC color tests. Option 107 also enables simultaneous viewing of TV pictures and listening to program sound. The hardware demodulates NTSC-format television signals as well as versions of PAL and SECAM.



Digital Carrier Power Measurement on HP 8591C

Measurements for RF and Video Testing

The HP 85721A measurement personality card (included with the HP 8591C) customizes the analyzer for easy, non-interfering proof-of-performance measurements on NTSC-, PAL-, or SECAM-format signals. This software adds dedicated cable TV test functions and measurements that you can perform with the push of single keys. Measurements include the following functions and tests:

- Automatic tuning of cable TV and TV broadcast carriers
- Visual and aural carrier levels and frequencies
- Digital carrier power
- System channel survey
- Depth of modulation
- TV aural and FM broadcast carrier deviation
- Carrier-to-noise ratio (C/N)
- In-channel frequency response
- Hum/low frequency disturbances
- System frequency response
- Baseband TV line and field viewing
- TV aural and FM broadcast carrier demodulation
- Distortion (CSO/CTB)
- Crossmodulation
- Ingress and co-channel viewing

System monitor capability automates measurements, allowing the analyzer to test without assistance from the operator. It also allows you to design test plans and to turn test data into reports instantly. With Option 107 added to the cable TV analyzer, non-interfering measurements of carrier-to-noise, in-channel frequency response and distortions can be made, as well as video measurements:

- Differential gain
- Differential phase
- Chromiance-luminance delay inequality

Painless Reports and Data Archiving

Take the pain out of cable TV reports with the HP 85921B cable TV data management software. Running on IBM compatible PCs, it downloads test data from your HP 8591C, and HP CaLan 2010B, 3010, 3010B, and 3010R into a PC database for making reports and archiving data. The software compares measurement results to your specifications and displays pass/fail messages for each test. Test data can also be exported to a word processor or spreadsheet for other analysis.

You can print the results of every test run at each specified location in the cable system. The printout will list all the channels tested, as well as additional required information such as the date of the testing, the name and qualifications of the person who ran the test, and the serial number of the equipment used. Add Option 032 to automatically generate reports in a format compliant with the FCC regulations. All RF and video tests (except leakage) currently required by the FCC are included.

HP 8591C
HP 85721A
HP 85905A
HP 85921B

Specification Summary

Specifications apply to the HP 8591C cable TV analyzer with preloaded HP 85721A measurements personality, and to the HP 8591E spectrum analyzer with Options 001, 004, and 301, and the HP 85721A personality.

General

Channel Selection: Analyzer tunes to specified channels
Input: 75Ω, BNC
Frequency Range: 5 to 1002 MHz for channel model;
54 to 896 MHz for system mode;
1 MHz to 1.8 GHz for spectrum analyzer mode
Amplitude Range: –15 to +70 dBm V for S/N > 30 dB
Displayed Average Noise Level (1 kHz RBW, 0 dB atten.)
- **Without Preamplifier:** ≤ –63 dBmV (1 to 1500 MHz)
- **With Internal Preamplifier:** ≤ –83 dBmV (1 to 1000 MHz)
- **With External Preamplifier:** ≤ –83 dBmV (1 to 1000 MHz)

Cable TV Measurements

Visual Carrier Frequency (visual carrier frequency is counted)
Precision Frequency Reference
- **Resolution:** 100 Hz
- **Accuracy:** ±(1.2 x 10^{-7} x carrier freq. +110 Hz)
- **At 55.25 MHz** (ch. 2): ±117 Hz
- **At 325.25 MHz** (ch. 41): ±149 Hz
- **At 643.25 MHz** (ch. 94): ±187 Hz

Visual-to-Aural Carrier Frequency Difference [counted frequency difference between visual (vision) and aural (sound) carriers]
- **Difference Range:** 4.1 to 4.9 MHz
- **Resolution:** 100 Hz
- **Accuracy:** ±221 Hz for precision frequency reference

Visual Carrier Peak Level (measured to an absolute standard)
- **Amplitude:** –15 to +70 dBm V
- **Resolution:** 0.1 dB
- **Absolute Accuracy:** ±2.0 dB for S/N > 30 dB
- **Relative Accuracy:** ±1.0 dB relative to adjacent channels in frequency; ±1.5 dB relative to all other channels

Visual-to-Aural Carrier Level Difference [measured difference between peak amplitudes of visual (vision) and aural (sound) carriers]
- **Difference Range:** 0 to 25 dB
- **Resolution:** 0.1 dB
- **Accuracy:** ±0.75 dB for S/N > 30 dB

Digital Carrier Power
- **Accuracy (characteristic) :** ±0.75 dB
- **Readout Resolution:** 0.1 dB

Depth of Modulation, Characteristic (percent difference from horizontal sync tip to max. video level)
- **AM Range:** 50 to 93%
- **Resolution:** 0.1%
- **Accuracy:** ±2.0% for C/N > 40 dB

FM Deviation, Characteristic (peak reading of FM deviation)
- **Range:** ±100 kHz
- **Resolution:** 100 Hz
- **Accuracy:** ±1.5 kHz

Hum/Low Frequency Disturbance (measured for power-line frequency and low-frequency disturbance)
- **AM range:** 0.5 to 10%
- **Resolution:** 0.1%
- **Accuracy:** ±0.7% for hum ≤ 5%

Visual Carrier-to-Noise Ratio, C/N (calculated from visual-carrier peak level; min. noise level normalized to 4 MHz for NTSC format)
- **Range** (input level dependent): 63 dB max. for +25 dBmV input

C/N Resolution: 0.1 dB
C/N Accuracy (input level and measured C/N dependent): < ±1 dB for 50 dB C/N and +25 dBmV input with external preselector filter
Composite Second Order and Composite Triple Beat Distortion (CSO and CTB measured relative to visual-carrier peak)
- **Range** (input level dependent): 77 dB max. for 25 dBm V input
- **Resolution:** 0.1 dB
- **Accuracy** (input-level, measured-CSO/CTB dependent): <± 1.5 dB for 60 dB CSO/CTB and +25 dBm V input

Crossmodulation Characteristic (15.7 kHz horizontal-line related AM measured on unmodulated visual carrier)
- **Range:** 60 dB, usable to 65 dB
- **Resolution:** 0.1 dB
- **Accuracy:** ±2.6 dB for xmod < 50 dB, C/N > 40 dB

System Frequency Response (system amplitude variations measured relative to a reference trace stored during the setup)
- **Frequency Response Setup:** Reference-trace storage for 50 traces including analyzer states
- **Frequency Response Test:** Trace-flatness accuracy is ± 0.1 dB per dB deviation from a flat line and ±0.75 dB maximum cumulative error

Option 107 Operation (for video and non-interfering measurements)
TV Receiver Input
- **Frequency Range:** 50 to 850 MHz
- **Amplitude Range:** 0 to 40 dBm V

Non-interfering Color Test (requires FCC composite or NTC-7 test signal for NTSC format)
- **Differential Gain Accuracy:** ≤ ±4%[1]
- **Differential Phase Accuracy:** ≤ ±3°[1]
- **Chrominance-luminance Delay Inequality Accuracy:** ≤ ±45 ns, ±32 ns typical

Non-interfering Tests with Gate ON[2]
- **C/N and CSO:** Quiet line must be selected
- **In-channel Frequency Response Accuracy:** < ±0.5 dB within channel (requires sin x/x, Philips ghost canceling reference, or FCC/NTC-7 multiburst test signal for NTSC format)

Preamplifiers

HP 85905A 75 Ω Preamplifier (external)
- **Frequency Range:** 45 to 1000 MHz
- **Gain:** 20 dB ±1.0 dB
- **Noise Figure:** 7 dB maximum at midband

HP 8591C 75 Ω Preamplifier (internal)
- **Frequency Range:** 1 to 1000 MHz
- **Gain:** ≥ 24 dB
- **Noise Figure:** ≤10 dB

Ordering Information

HP 8591C Cable TV Analyzer (includes HP 85721A)[3]
- **Opt 107**[4] TV Receiver/Video Tester (includes 75 Ω coupler and cables)
- **Opt 011** 75 Ω Tracking Generator
- **Opt 015** Change Yellow to Tan Soft Carrying Case
- **Opt 030** Cable TV Data Management Software with FCC Reports
- **Opt 040** Front-Panel Cover (used without soft carrying case)
- **Opt 041**[5] HP-IB and Parallel[6] Interfaces
- **Opt 119** Noise Figure Card
- **Opt 130** Narrow Resolution Bandwidths
- **Opt 180**[7] TV Picture Display
- **Opt 701** Delete TV Trigger, AM/FM Demodulator, Fast Time-Domain Sweeps
- **Opt 704** Delete Precision Frequency Reference
- **Opt 908** Rackmount without Handles
- **Opt 909** Rackmount with Handles
- **Opt 915** Component Level Info. and Service Guide
- **Opt W30** Two Additional Years Return-to-HP Service
- **Opt W32** Two Additional Years Return-to-HP Calib.
- **Opt R07** Retrofit Kit for Option 107

Recommended Accessories
HP 85702A 128K RAM Card
HP 85721A[3] Cable TV Measurements and System Monitor Personality (for HP 8590 E-series)
HP 85901A Portable AC Power Source
HP 85905A 75 Ω Preamplifier
HP 85921B Cable TV Data Management Software
- **Opt 030** with FCC Reports

HP 24542U RS-232 Nine-Pin Cable (analyzer to PC)
HP 24542G RS-232 Nine-Pin to 25-Pin Cable (analyzer to PC)
HP C2950A Parallel Cable (analyzer to printer)
HP 10833A HP-IB (GPIB) Cable

[1] 20° to 30° C, ≥ 20 dBm V input
[2] Gate ON synchronizes the measurement to the TV line selected
[3] NTSC format only; worldwide options available
[4] Not compatible with Option 180
[5] Replaces standard RS-232 and parallel interfaces
[6] Print and plot control only
[7] Not compatible with Option 107

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Sweep/Ingress Analyzer

HP CaLan 2010
HP CaLan 3010

- Ingress detection
- Exclusive DigiSweep technology
- Built-in digital carrier power measurement
- TDMA and Bursted Power
- Built-in reverse sweep transmitter covers 5 to 1000 MHz
- Headend unit supports up to ten field units
- Rugged and easy to use

The HP CaLan 3010R and 3010H Sweep/Ingress Analyzer

HP CaLan 2010B and 3010B

Fast, Accurate Carrier Level Analysis

The HP CaLan 2010B is a field-rugged, easy-to-use signal measurement device that maintains accuracy in all environmental conditions. The 2010B comes with a standard frequency range of 5 MHz to 1 GHz and four modes of operation: single channel, four channel, spectrum scan, and a time-saving channel scan (60 channels in less than two seconds).

Programmed unattended measurements store results to 90 internal memories. Each memory will store picture and sound information for up to 158 channels. This data can also be analyzed by the built-in FCC Pass/Fail compliance reporter. The Pass/Fail report criteria is also user definable. Comparisons of levels over time can be done with the "normalize" and "motion on screen" functions.

The HP CaLan 3010 family combines the power of the 2010B with sweep features. This solution offers a system maintenance tool coupled with powerful measurement and signal analysis in one easy-to-use lightweight package.

HP CaLan Sweep/Ingress Analyzer

The HP CaLan sweep/ingress analyzer gives you confidence that your cable system is operating reliably by helping you to eliminate ingress. Designed with ingress in mind, this new solution consists of a portable field unit (HP CaLan 3010R) and a rackmount headend unit (HP CaLan 3010H).

When ingress corrupts return-path communication, the 3010H instantly detects the problem and transmits a "picture" of the ingress through the forward data pilot. This image will be displayed on the 3010R so your technician can begin troubleshooting immediately. The 3010H can support up to ten 3010Rs simultaneously. The display will advise you which 3010Rs are currently active in the field.

With the addition of Option 052 forward dual path option, you'll be armed with a complete forward, reverse sweep and ingress analysis tool. The forward sweep is still compatable with the 1777 transmitter.

Specifications Summary

Digital Signal Power Levels
- **Formats:** QAM, QPR (DMX), QPSK, and VSB
- **Amplitude Accuracy:** ± 1.5 dB (typical)

Frequency
- **Range:** 5 MHz to 1 GHz
- **Accuracy:** ± 25 kHz
- **Resolution:** 10 kHz
- **Tuning Configuration:** Standard, Off Air VHF/UHF, HRC, IRC, SECAM, PAL, and user-defined
- **IF Bandwidth:** 230 kHz
- **Video Bandwidth:** 300 kHz, automatic 10 Hz in C/N

Level
- **Range:** –45 to + 70 dBmV
- **Accuracy**
  - **Calibrator:** ± 0.25 dB @ 113.36 MHz, ± 0.2 MHz
  - **Frequency Flatness:** ±0.5 dB
  - **Attenuator:** ± 0.5 dB
  - **Log Linearity:** ± 0.5 dB
  - **Typical Overall Accuracy:** ± 1.0 dB
- **Resolution:** 0.1 dB
- **Difference Range:** 0–25 dB
  - **Relative Accuracy:** ± 0.75 dB
- **Input Impedance:** 75 ohms
- **Input Match:** > 14 dB, 0 dB attenuation; > 20 dB, attenuation > 0 dB

Hum
- **Range:** 0.5 to 5%
- **Resolution:** 0.1%
- **Accuracy:** ± (0.2% + 30% of reading)

Carrier-to-Noise (with external preselector)
- **Range:** 50 dB typical; 55 dB typical, measured in-band with carrier off
- **Accuracy:** ± 2 dB
- **Repeatability:** ± 1 dB

General
- **Size: HP 3010H:** 483 mm W x 133 mm H x 292 mm D (19 in W x 5.25 in H x 11.5 in D)
- **HP 3010R:** 95 mm W x 317 mm H x 267 mm D (10.5 in W x 12.5 in H x 3.75 in D)
- **Weight: HP 3010H:** 4.31 kg (9.5 lb.);
- **HP 3010R:** 4.8 kg (10.7 lb.) with battery
- **Power: HP 3010H:** 90 to 264 Vac, 47 to 63 Hz, 20 VA max.;
- **HP 3010R:** + 10 to +15 Vdc @ 550 mA max.
- **Battery:** 12 V (1.9 AH) rechargable lead acid
- **Usage Time:** 4 hrs. continuous; 12 hrs. typical; battery-saving sleep mode for 3010B
- **Display Area:** 127 mm x 33.8 mm (5.00 in x 1.33 in)
  - **Resolution:** 240 x 64 pixels
  - **Type:** LCD with EL backlight
- **Temperature**
  - **Operating: HP 3010H:** 0˚ to + 55˚C; 3010R: –20˚ to + 55˚C
  - **Storage: HP 3010H and HP 3010R:** –20˚ to + 70˚ C

Fiber Power Meter Option
- **Wavelength:** 1310 and 1550 nm
- **Measurement Range:** –38 to + 20 dBm @ 1310 nm; –38 to + 18 dBm @ 1550 nm
- **Resolution:** 0.1 dB
- **Accuracy:** ± 5%
- **Display:** dB, dBm, mW, microW, nanoW
- **Connector Styles:** ST, FC, biconic, D4, SMA, or bare fiber, rotary splice, RM

Ordering Information

HP 85960B HP CaLan 2010B SLM *Plus*
- **Opt 020** Fiber Power Meter

HP 85961B HP CaLan 3010B Sweep/SLM *Plus*
- **Opt 020** Fiber Power Meter

HP 85962B HP CaLan 3010R Sweep/Ingress Analyzer
- **Opt 052** Dual Path Sweep

HP 85963B HP CaLan 3010H Sweep/Ingress Analyzer
- **Opt 030** Cable TV Data Management Software with FCC Reports
- **Opt 031** Cable TV Data Management Software

Opt 050 Forward Sweep Transmitter
- **Opt 052** Dual Path Sweep

- RF and video tests for broadcast transmitters
- One-button, noninterfering measurements
- Wide selection of frequency coverage, options
- Easily upgraded with circuit cards and DLPs

HP 85724A and HP 8591E

Broadcast Transmitter Testing with the HP 8590 E-Series Spectrum Analyzers

The HP 85724A broadcast television measurement personality provides an HP 8590 E-series spectrum analyzer with one-button measurements that simplify the installation, maintenance, and troubleshooting of TV broadcast transmitters. You can perform nearly all RF and three key video measurements without interrupting your system, offering you convenience while keeping your customers happy.

A simple process configures the spectrum analyzer to work with your particular TV system. User-definable parameters include TV standard, default ITS lines, and noise-power bandwidths. You can tune to channels by entering the channel number and band; nonstandard TV channels or FM radio channels can be measured using the frequency tuning mode. The broadcast TV measurement personality supports PAL-I/B/G, NTSC-M, and SECAM-D/K formats.

RF and Video Measurements at the Push of a Button

The HP 85724A broadcast TV measurement personality provides the following tests:

RF Measurements

- Automatic tuning of vision, sound, and FM broadcast carriers
- Vision and sound carrier levels and frequencies (including NICAM for PAL-B/G/I)
- Vision to chrominance level
- Vision in sound (AM on FM)
- NICAM intermodulation (PAL-B/G/I)
- Intermodulation products
- Three-tone intermodulation test
- Spurious signals
- Depth of modulation (frame by frame)
- Depth of modulation (ITS line)
- Low-frequency error (hum)
- Field sync distortion
- FM deviation
- Carrier-to-noise ratio
- Simultaneous TV picture and sound[1]

Video Measurements[1,2]

- Differential gain
- Differential phase
- Chrominance-to-luminance delay inequality

Advanced Analyzer Features

The spectrum analyzer's built-in features include trace math, limit-line testing, Fast Fourier transforms, and storage for up to 50 traces and states. Adjustable markers display the amplitude and frequency of any signal; zero span markers display amplitude and time or inverse-time information. A built-in memory card reader allows you to store and load application-specific programs. Other features include local oscillator output option for compatibility with sideband adapters, optional HP-IB or RS-232 programming with a parallel printer port for direct printer or plotter output.

Flexible Operation

A built-in card cage allows you to add circuit-card options at any time for increased measurement capability. There are two important circuit-card options for broadcast TV measurements. Option 301 Fast Time Domain Sweeps adds Analog+, TV line triggering, and AM/FM demodulation to the analyzer. Option 107 TV Receiver/Video Tester adds capability to display TV pictures and to perform video measurements, and it provides time gating for non-interfering carrier-to-noise testing.

Bundled Options

You can order the spectrum analyzer and options individually (see Ordering Information), or you can order one of four system bundle options for a cost savings.

	HP 8591E 9 kHz to 1.8 GHz		HP 8593/4/5/6E See Note	
System Bundle Options	**E80**	**E81**	**E85**	**E86**
Preloaded HP 85724A Broadcast Measurement Personality	•	•	•	•
AM/FM demod. plus TV line trigger	•	•	•	•
Fast time domain sweeps	•	•	•	•
Analog+ display mode	•	•	•	•
Precision frequency reference	•	•	•	•
RS-232 and parallel interfaces	•	•	•	•
Rugged carrying case	•	•	•	•
Built-in 20 dB preamplifier	•	•	—	—
TV receiver/video tester	—	•	—	•

Note:
HP 8594E, 9 kHz to 2.9 GHz
HP 8595E, 9 kHz to 6.5 GHz
HP 8596E, 9 kHz to 12.9 GHz
HP 8593E, 9 kHz to 22/26.5 GHz

Ordering Information

HP 85724A Broadcast TV Measurement Personality
(for use with HP 8590 E-series spectrum analyzers)
Spectrum Analyzer (choose one)
HP 8591E, 8593E, 8594E, or 8596E Portable Spectrum Analyzer (See page 234 for prices and additional options.)
Options
Opt 041 HP-IB and Parallel Printer Interfaces
Opt 043 RS-232 and Parallel Printer Interfaces
Opt 301 Fast Time Domain Sweeps, TV Trigger and AM/FM Demod, ANALOG+ Display
Opt 107 TV Receiver/Video Tester
Opt 180[3] PAL/SECAM/NTSC Picture Display
Opt H02 LO Output (HP 8591E without Option 010)
Opt H38 LO Output (HP 8591E with Option 010)
Opt 009 LO Output (HP 8593/4/5/6E)
Recommended Accessories
HP 85702A Additional 128K RAM Card
HP 85901A Portable AC Power Source

[1] Requires Options E81, E86, or 107
[2] Requires Options E81, E86, or 107 and 301
[3] Incompatible with Option 107

For more informtion on compatible printers, visit:
http://www.hp.com/go/pcg

HP's Test & Measurement Web site.
The more you visit, the more you'll know.

News and information you need, 24 hours a day. Get the most complete support available for all of HP's Test & Measurement tools. Immediate access to information, 24 hours a day, means always getting the most from your instruments:

- Product Information
- Usage Tips
- Application Note Library
- Service, Support and Training
- Sales and Service Contacts
- Selection Guides
- Newsletters
- Feature Stories Showing Products in Use
- Information on Your Industry
- News Releases
- Country-Specific Sites

These features are only a snapshot of what's available at the Web site. Bookmark it—and visit it regularly—to stay completely up to date on all of HP's test and measurement solutions.

Electronic Manufacturing Test Systems 15

"Test" and its Role in Electronics Manufacturing

Critical success factors for world-class manufacturing include supplier management, activity-based cost analysis, process control, design for manufacturability, and test strategies. When you consider that an electronics product starts out as set of components, parts and ICs, and ends up as a highly sophisticated, complex system such as a computer, printer, telephone, satellite, or airbag control module, it becomes imperative that your production line give you a high level of confidence that three things are going to work right. One is that the design is correct, that the design is going to work and have some flexibility to small variations in the components and small variations in the manufacturing parameters. Second, you want to know that the components themselves are working the way they should and within their specifications. Third, that the assembly process—the mechanical part of the manufacturing process—is working. The result—field warranty issues that may be reaching your customers.

The only way to get this confidence is with some kind of inspection or testing process. At any given point, it is practically impossible to have 100 percent confidence because it would be prohibitively expensive to test a product in every possible configuration. Still, with the right kind of test that is matched precisely to your products and manufacturing processes, you can achieve a high level of coverage—and confidence.

World-class manufacturers are using structural and in-circuit process test to lower costs, increase quality and accelerate time-to-volume. Process test helps determine that the process is defined and in control, and that key parameters are within acceptable limits. Process test looks at things like solder structure and infers changes that might improve the paste and solder process. Some manufacturers use visual inspection or X-ray machines to inspect solder joints, not just for opens but also process drifts and variations. When process test does its job, problems can be eliminated before they occur.

While improved manufacturing processes and in-circuit process test have increased production yields, manufacturers are finding that their functional test requirements are still growing. Increasingly complex boards and sub-assemblies with mixed-signal content and decreasing nodal access shift more of the fault-detection burden to functional test stations. At the same time, products must meet rising customer expectations for quality. And companies must deal with increasingly stringent regulatory and documentation requirements.

The Road Ahead

At one time being an innovator and a quality leader was enough. Now to remain competitive, manufacturers must balance innovation and quality with accelerating cycle times. The products in the following chapter are designed to help you achieve your time-to-volume goals without affecting your ability to produce innovative and high quality board and semiconductor based products.

NEW

Testing Loaded Electronic Circuit Boards

Success in today's electronics manufacturing industry often comes down to how well you manage time: how quickly you bring a product to market, how rapidly you ramp up to volume production and how soon you turn a profit. Even in a stable environment these are big challenges, but the rapid pace of changing technologies magnifies the challenge. HP's selection of Structural Process Test systems, Electrical Process Test Systems and Functional Communications Test Systems are ready to help you win the race against time.

Structural Process Test

Defect detection early in the manufacturing process enables you to correct the process that caused the fault and thereby prevent further defects. HP offers two types of systems that inspect the physical integrity of loaded PC boards.

HP BV3000 Automated Optical Inspection Systems

The HP BV3000 system speeds up the manufacture of printed circuit boards by automating the visual inspection process and improving fault detection. Rapidly capturing optical images of the device under test, this system automatically analyzes the images with 95% repeatability. The HP BV3000 improves early fault detection of common manufacturing process faults such as misaligned or misplaced components and gross solder defects. This system is particularly appropriate to test the manufacture of high volume, low-to-medium complexity loaded printed circuit boards such as those found in personal computers, printers, disc drives and modems.

HP 5DX Automated X-ray Inspection System

The HP 5DX system adds another dimension of accuracy to early process fault correction, moving beyond automation of optical inspection into a new way of seeing what neither the human eye nor the camera can detect. In an operator-free, in-line environment, these systems rapidly detect a wide range of physical defects, including shorts, opens, insufficient solder and inadequate solder bonds. The X-ray does not require physical access to the board, so it is an ideal solution for complex, high density circuit boards such as cell phone boards, laptop computer boards and telecommunications boards. The 3-dimensial X-ray technology which the 5DX uses results in greater than 98% coverage of process defects on most circuit boards, independent of visual or physical access.

Electrical Process Test

HP 3070 Series 3 In-circuit/Combinational Test Systems

Using electrical measurements to find defects caused by the manufacturing process, the HP 3070 Series 3 family of systems extends the reach of in-circuit test coverage in an ever-shrinking world. The Series 3 includes a suite of tools for extending fault coverage on boards with as little as 50% probe access. And Series 3 systems test up to twice as fast as previous in-circuit test systems. The HP 3070 family covers a range of needs from unpowered in-circuit test with the HP 3272 system to the high-performance combinational communications test with the HP 3079CT system.

Functional Communications Test

HP 79000 Functional Communications Test System

The HP 79000 FCT system can dramatically decrease test development time, test time, and fault isolation time for functional testing of communications circuit boards and modules. Test development is easy even for the novice engineer thanks to HP Visual Test Advisor software. Test throughput is accelerated by HP's approach to testing up to eight channels in parallel. And HP Fault Detective software dramatically reduces fault isolation time—one of the most expensive aspects of functional test. The HP 79000 FCT has the capability to test existing as well as emerging communications technologies, including ADSL, ISDN, E1/T1, and POTS.

Ordering Information

Prices depend on system configuration.
Please contact the HP Call Center in your region for assistance.

HP BV3000 systems start at
HP 5DX Series II systems start at
HP 3070 Series 3 systems start at
HP 79000 FCT systems start at

Semiconductor Test Systems

VLSI, Digital, Memory/Logic, Mixed Signal, RF, Semiconductor Parametric

HP 83000
HP 94000
RF94000
HP 84000
HP V3300
HP 4071

- Hewlett-Packard Semiconductor Test Systems keep you one *STEP* ahead in **S**peed, **T**echnology, **E**xperience and **P**rice/Performance
- HP's Semiconductor Test Systems offer cost effective production test solutions for a broad range of markets
- VLSI Test Systems cover data rates from 1 Megabit per second to 1.3 Gigabits per second with up to 1024 pins and HP's Test processor-per-pin technology lets you test High Speed Processors with embedded memory. With additional Smart DSP and Waveform capability HP's VLSI test systems can address Systems-on-a-Chip, Multimedia, VLSI, PLL, and other state of the art building blocks
- Mixed-Signal Test Systems offer a very low noise floor with DC to real-time DSP to RF capability along with up to 256 pin digital capability.
- HP's Memory and Logic Test Systems lead the market in Wafer Level testing of Flash Memory, Non-Volatile Memory and field programmable devices.
- RFIC Test Systems and precision contactors provide the ability to test wireless ICs at RF frequencies at the test site up to 18 GHz
- HP's Semiconductor Parametric Test Systems offer high throughput, with links to SPECS modeling software, and maximize the instrumentation close to the wafer for maximum precision

HP 83000 Series VLSI IC Production Test Systems for "at speed test" of state of the art ICs

- Production test of microprocessors (CISC and RISC)/microcontrollers/VLSI/ASIC/Rambus ICs/Telecom ICs/Multimedia ICs/FSRAM/RDRAM
- Highest throughput Test processor-per-pin architecture
- Up to 660 MHz for "at speed test" with up to 1024 pins
- Timing flexibility with "Change Waveform On the Fly"
- Up to ± 50 p.s. measurement accuracy
- Smart DSP and Waveform Capture on some models
- High Speed Memory interface testing
- Algorithmic Pattern Generator per pin for memory testing
- High Speed DRAM and SRAM testing
- Efficient docking to handlers/probers
- Multisite testing capability up to 16 sites

For more information, contact your HP sales engineer or see our web site: **http://www.hp.com/go/semiconductor**

HP 94000 Series Mixed Signal IC Test System for testing telecom and data management ICs

- Production test IC test solutions for wireless and wired communications, graphics controllers, high speed PMRL HDD, integrated PC audio, digital subscriber line (xDSL), ATM, A/D and DAC
- Up to 256 pins at 532Mbps. digital capability
- Excellent Analog performance with low noise floor
- Full Analog/Digital synchronization
- Multisite Testing Capability
- Graphical software environment for rapid test development

For more information, contact your HP sales engineer or see our web site: **http://www.hp.com/go/semiconductor**

RF94000 Integrated RF/Mixed Signal IC Production Test System for testing wireless systems on a chip

- Production test of devices with integrated RF and Mixed Signal functions
- Sourcing up to 3GHz and measuring up to 6Ghz
- Technology to make spectral, vector, modulation,/de-modulation and noise figure measurements
- Simple menu-driven test setup for rapid test development and optimized test programs
- Simplified RF calibration

For more information, contact your HP sales engineer or see our web site: **http://www.hp.com/go/semiconductor**

HP 83000
HP 94000
RF94000
HP 84000
HP V3300
HP 4071

NEW

HP V3300 Mixed Memory /Logic IC Production Test Systems for Flash and Non-volatile memory devices

- Tester-per-Site architecture for high-throughput testing at eight independently operating parallel test sites with up to 64 I/O per site.
- Combined Site resource mode for up to 128 I/O per site ensures test floor flexibility for high pin count devices.
- Ability to test both memory and logic offers flexibility for a wide range of product test needs.
- Windows NT system software offers the power of UNIX(R) at the price of a PC.
- 20MHz data rates support Non Volatile Memory needs with 40MHz available through pin-pair multiplexing.
- Channel assignment module (CAM) provides software flexibility to assign any APL address or data channel to any I/O channel.

For more information, contact your HP sales engineer or see our web site: **http://www.hp.com/go/semiconductor**

Custom Support Products and Services for Semiconductor Test Systems

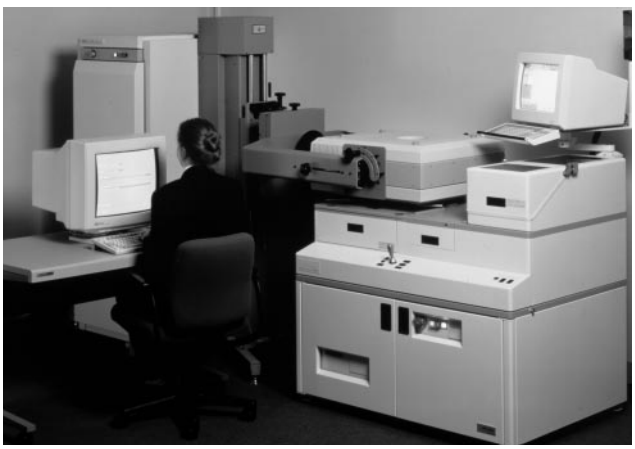
- Integration Services for Handler / Prober Interface
- IC Device Characterization Services'
- Test Program creation and conversion
- Custom services and support for 365 day/ 24 hour operations.

For more information, contact your HP sales engineer or see our web site: **http://www.hp.com/go/semiconductor**

HP 84000 RFIC Test Systems for testing RFIC'S Used in Wireless Systems

- Production test of wireless and RF ICs
- Up to 3 GHz or 18 GHz at the device contact for at speed test
- Configurations to test power amplifiers, LNAs, up/down converters, integrated transmitters, receivers, and complete transceivers
- Error corrected S-parameter, noise figure and power measurements
- Per-pin architecture for up to eight RF ports
- Simplified graphical environment for rapid test plan development
- Simplified RF calibration
- Complete DUT fixturing is available, including the HP YieldPro Contactor

For more information, contact your HP sales engineer or see our web site: **http://www.hp.com/go/semiconductor**



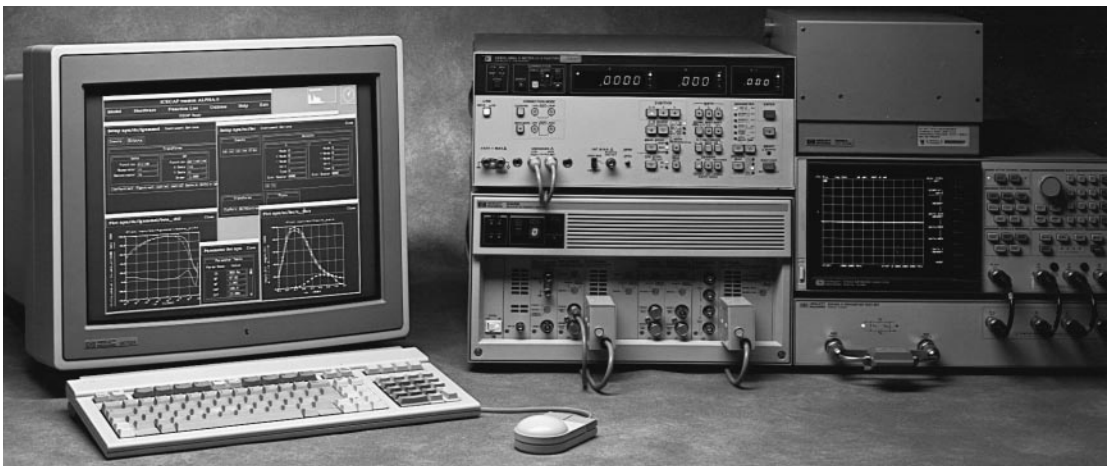
HP 4071 High-Speed Semiconductor Parametric Test Systems for monitoring the IC fabrication process

- Integrated tester-in-head design
- High throughput for all measurements
- Higher accuracy, resolution , repeatability
- Built-in diagnostics for fewer operator assists
- Direct docking to probe card for optimum performance
- Maintains laminar air flow for clean room operation
- HP SPECS new test shell for HP 4062UX and HP 4071A

For more information, contact your HP sales engineer or see our web site: **http://www.hp.com/go/semiconductor**

HP IC-CAP

- Minimize design iteration cycle
- Optimize the IC performance
- Create new device models and circuit macromodels with ease



IC-CAP

IC-CAP Circuit/Device Modeling Software

New Approach to Modeling

Over the last decade, semiconductor technology has gone through rapid advancements resulting in dramatic improvement in the performance of ICs. State-of-the-art IC technologies use devices that require careful attention to modeling the parasitics and second-order effects. Parasitics must be included as subnetworks formed around the transistors.

Subnetwork Characterization and Modeling

The success of an IC technology is rooted in its ability to achieve the desired performance while maintaining high product yield. Accurate prediction of the performance of an IC relies on the simulation models used and the capability to accurately extract device parameters as well as subnetwork component values for these models.

Simulating a Device or Subnetwork

IC-CAP provides a direct link to SPICE and other circuit simulators through an open interface and uses them for analysis and optimization of device or subnetwork performance. Direct use of the built-in SPICE simulators or your own simulator also eliminates any discrepancy between modeling and simulation tools.

Extracting Parameters/Statistical Analysis

IC-CAP's powerful extraction, optimization, and advanced utilities, coupled with a built-in or your own simulator, will help you generate the most accurate device model parameters or circuit element values for your designs. An improved user interface and a statistics package are now part of IC-CAP.

Macromodeling

Macromodels are simplified versions of complex circuits that are used for efficient simulation of circuits or systems. You describe the topology of the macromodel in the form of a subnetwork for IC-CAP. IC-CAP performs the analysis and measurements based on the inputs, and finds the optimum component or device parameter values for best performance.

IC-CAP Software Now From the HP EEsof Division

IC-CAP software is supplied by the HP EEsof division to better serve the needs of our customers. Please see pages 332 and 333 for more about HP EEsof's circuit and system simulators, as well as complete modeling systems.

Ordering Information

HP 85190A IC-CAP Modeling Suite
Includes:
HP 85199A IC-CAP Software Environment
HP 85199B IC-CAP Analysis Module
HP 85199C LCRZ Measurement Drivers
HP 85199D DC Measurement Drivers
HP 85199E AC Measurement Drivers

Other modules available:
HP 85199J IC-CAP Statistics Package

Measurement Drivers
HP 85199F Time Domain Measurement Drivers
HP 85199G Noise Measurement Drivers
HP 85199H Pulsed Measurement Drivers

MESFET/HEMT Device Models
HP 85191A HP Root FET Model Generator
HP 85192A High-Frequency FET Models
HP 85192B EEFET3 FET/EEHEMT1 Model
HP 85192Z FET/HEMTBundle Package
(includes HP 85191A, HP 85192A & HP 85192B)

BJT Device Models
HP 85193A Gummel-Poon BJT Models
HP 85193B EEBJT2 BJT Model
HP 85193C Philips MEXTRAM BJT Model
HP 85193D VBIC95 BJT Model
HP 85193Z BJT Bundle Package
(includes HP 85193A, B, C & D)

MOSFET Device Models
HP 85194A High-Frequency MOS Level 3 Model
HP 85194B Root MOS Model Generator
HP 85194C EEMOS1 MOS Model
HP 85194D UCB BSIM 1, 2 Model Extraction Module
HP 85194E UCB BSIM 3 Model Extraction Module
HP 85194H UCB MOS Level 2, 3 Model Extraction Module
HP 85194J Philips MOS Model 9
HP 85194Z MOS Bundle Package
(includes HP 85194A, B, C, D, E, H & J)

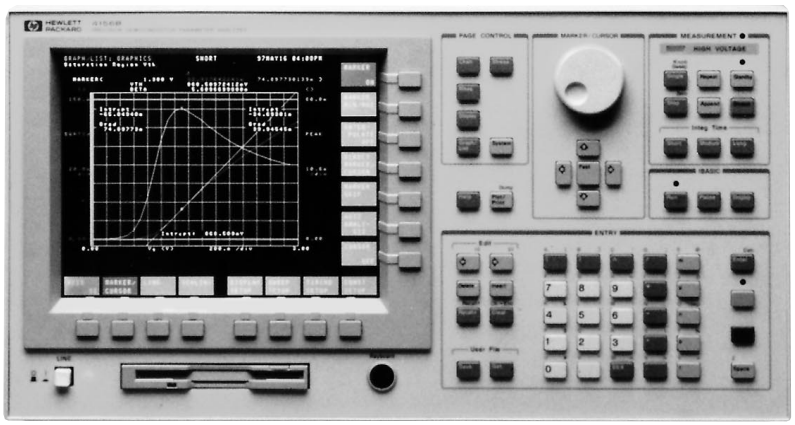
Thin-Film Transistor Models
HP 85194F HP a-SI TFT Model Extraction Module
HP 85194G UCB p-SI TFT Model Extraction Module

Diode Device Models
HP 85195A Root Diode Model Generator

Please contact the HP Call Center in your region for complete information on IC-CAP software, including data sheets, prices, and application assistance.

HP 4155B
HP 4156B

- High-resolution/accuracy and wide range. I: 1 fA to 1 A (20 fA offset accuracy), V: 1 μV to 200 V
- Fully-automated I-V sweep measurements with dc or pulse mode, expandable up to 6 SMUs
- Synchronized stress/measure function, two high-voltage pulse generator units (±40 V)
- Time-domain measurement: 60 μs–variable intervals, up to 10,001 points
- Easy to use: knob-sweep similar to curve tracer, automatic analysis functions
- Automation: built-in HP Instrument BASIC, trigger I/O capability



HP 4155B

Whether you are looking for a low-cost bench-top instrument or an automated test system, HP can meet your semiconductor test needs with its Just-Enough-Test line of semiconductor measurement instruments. This instrument family provides versatile coverage of application needs in process development, device characterization, process monitoring, reliability testing, failure analysis, and incoming inspection. The low leakage switching matrix, various useful accessories, and Windows-based interactive characterization software allow the instruments to be configured flexibly from a one-box solution to an integrated, automated system.

HP 4155B Semiconductor Parameter Analyzer HP-IB
HP 4156B Precision Semiconductor Parameter Analyzer

The HP 4155B and HP 4156B are the next generation in precision semiconductor parameter analyzers. You get the best digital sweep parameter analyzer plus a reliability tester, powerful failure-analysis tool, and automated incoming inspection station, all rolled into a single instrument.

This new family was explicitly designed to provide unprecedented accuracy and functionality for evaluating your sub-micron geometry devices. With one flexible instrument, you can improve your semiconductor quality starting from material evaluation and device characterization all the way through final packaged part inspection and field failure analysis.

Choose the Right Solution

The HP 4155B/56B offer four built-in source/monitor units (SMUs), two voltage source units (VSUs), and two voltage monitor units (VMUs). The HP 4155B is best suited for basic semiconductor applications with its non-kelvin connections, 10 fA/1 μV resolution, and 100 mA/100 V measurement range. For critical low-level characterization, the HP 4156B extends current resolution to 1 fA and accuracy to 20 fA. The HP 4156B utilizes full-kelvin remote sensing on each SMU.

At any time, you can add the HP 41501B SMU and Pulse Generator Expander, which is supplied with a 0 V/1.6 A Ground Unit. The expander accepts two 100 mA/100 V SMUs or one 1 A/200 V SMU, and two specially-synchronized 40 V/200 mA/1 μs pulse generators.

Setup and Measurement

HP 4155B/56B can perform staircase and pulse sweep measurement, and sampling (time-domain) measurement using many measurement units, including units in the HP 41501B, without changing connections. Moreover you can easily perform stress-measure cycling test for reliability evaluation such as hot carrier injection and flash EEPROM test.

Setup and measurement are made by setting up pages and filling in the blanks from front-panel keys, keyboard, or HP-IB (SCPI commands). You can also instantly measure and find setup conditions by using knob sweep capability, which is similar to curve tracer operation.

Display and Analysis

The measurement and analysis results are displayed on the color LCD, and you can superimpose stored graphics from four graphic memories for comparison. A number of powerful graphical analysis tools make it easy to analyze and extract many parameters such as hFE and Vth.

Once you find the parameter extraction conditions, you can automatically get the parameter by using the automatic analysis function.

Output and Storage

Setup, measurement, and analysis data can be output via HP-IB, parallel or network interface 10 Base-T LAN to a color plotter and printer. You can also save the data onto a disk via network or 3.5-inch disk in MS-DOS or LIF format. Graphic (HP-GL, PCL or TIF) output file allows you to transfer graphics to desktop publishing software.

Repeating and Automating Tests

The HP Instrument BASIC controller built into the HP 4155B/56B can construct an automatic measurement system using external instruments without a controller. HP 4155B/56B can be synchronized with external instruments by the versatile trigger I/O functions.

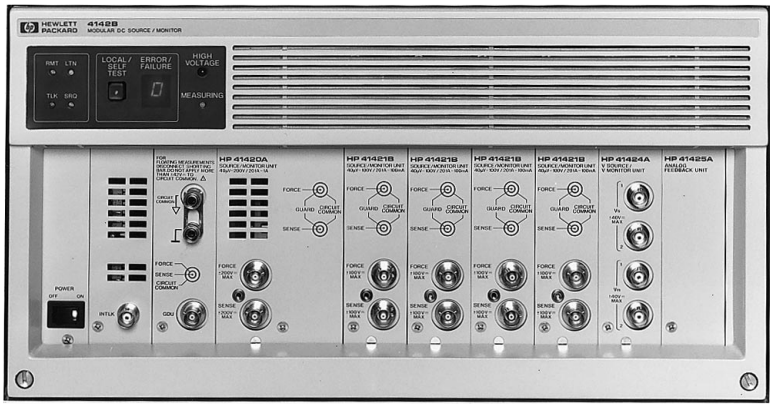
Product	Applications								
	Basic I-V	Low Current	Ultra Low Current	High Voltage & Current	Pulsed Meas.	Time Domain Meas.	C-V & C-t	Multi-freq. Meas/	Quasi-Static C-V
HP 4155B	V	V			V	V			
HP 4156B	V	V	V		V	V			
HP 4142B	V	V		V	V				
HP 4140B	V	V							V
HP 4280A							V		
HP 4284A								V	

HP Semiconductor Measurement Instruments for Applications

15

HP 4142B
HP E5230B

- Flexible, modular architecture
- Wide measurement range with high resolution
  V: ±4 μV to ±1000 V, 0.05%
  I: ±20 fA to ±10 A, 0.2%
- Pulse measurement capabilities
  Pulse width 1 ms to 50 ms, 100 μs resolution
- High-speed measurement (typical)
  Sourcing or monitoring: 4 ms
  Vth, hFE extracting: 12 ms
- Internal memory
  Program memory: >2000 commands (typical)
  Data memory: 4004 measurement points



HP 4142B

HP 4142B Modular DC Source/Monitor

HP-IB

Offering a wide measurement range and excellent sensitivity, the HP 4142B modular dc source/monitor is a system-use dc measurement instrument especially designed for high-throughput dc semiconductor testers. A completely user-definable system component, the HP 4142B features modular architecture that allows you to build a custom configuration to suit your measurement needs.

Eight plug-in module slots can accommodate any combination of the five presently-available modules; as new modules become available, you can upgrade your measurement capabilities with ease. Choose from two types of source/monitor units (SMUs) to force or measure up to ±200 V and ±1 A: a high-current source/monitor unit (HCU) up to ±10 A, a high voltage source/monitor unit (HVU) up to ±1000 V, a voltage source/voltage monitor unit (VS/VMU), and an analog feedback unit (AFU).The HP 4142B's instrument command and measurement data-storage capabilities, coupled with the high-speed HP-IB interface, minimize computer loading, enhance throughput, and simplify systemization.

Versatile SMUs and Reliable Measurement

For general-purpose dc or pulsed measurement, use the HP 41421B source monitor unit. The equivalent of four instruments, this precision module forces voltage up to ±100 V and simultaneously measures currents down to 20 fA. It can also force currents up to ±100 mA while measuring voltage down to 40 μV.

If you test high-power components or desire a wider measurement range, use the HP 41420A source monitor unit. This versatile SMU can source ±200 V or ±1 (14 W, dc or pulsed) and still maintain a measurement resolution of 40 μV and 20 fA. Both SMUs include a compliance feature that limits output voltage, current, or power to prevent damage to your device. Each SMU (HP 41420A or HP 41421B) acts as either a voltage source/current monitor or current source/voltage monitor. These complementary operating modes let you change the stimulus on a device without modifying the physical connections. This versatility reduces test time and eliminates instabilities caused by changing connections at the DUT.

Test Power Devices to 10 A and 1000 V

The HP 41422A HCU and the HP 41423A HVU expand the measurement range of the HP 4142B to 10 A and 1000 V. They dramatically expand the HP 4142B's ability to test power devices, such as power transistors, power MOSFETs, GaAs FETs, and smart ICs. Using a combination of the two units, measurements of up to 20 A and 2000 V are possible.

Using the HCU, fast pulse testing (100 μs minimum pulse width) at high current increases test reliability by minimizing the effects of thermal drift. Quasi-pulsed measurements by the HVU are effective for measuring breakdown voltage by minimizing the duration of the breakdown condition.

The HP 16087A module selector is a scanner that lets you remotely control the connection of the HP 41420A/41421B SMUs, the HP 41422A HCU, or the HP 41423A HVU to a test pin. It contributes to automatic testing for high-power devices with high-breakdown voltage. The built-in module selector can be specified as an option of the HP 16088B test fixture.

High-Speed Parameter Extraction by Analog Feedback Technique

To find important parameters that are specified at a given voltage or current, such as Vth or hFE, connect the HP 41425A AFU to two SMUs. The AFU modulates the output voltage of one SMU while monitoring the current or voltage of the other. Target currents and voltage are found with great speed (12 ms). This unique analog feedback network rapidly measures Vth, hFE, ΔL, or ΔW—parameters that would require excessive test time on other parametric testers.

You can also use the AFU to bias and test microwave devices. It can be integrated into the network analyzer system.

By using the AFU, you can eliminate the effect of device thermal drift and can hold the initial setting bias for ac measurement time.

Interactive Characterization Software (ICS)

The Windows-based HP E5230B Interactive Characterization Software together with the HP E5231B I-V Parametric Driver Library provides a uniquely-powerful instrumentation control and data analysis software package, and provides true point-and-click measurements, intuitive matrix control window, built-in database, and graphical analysis for total system solution. ICS delivers more than programming-free instrumentation control. Its spreadsheet windows and scientific plotting capability allow you to view and analyze data easily. ICS also includes valuable scientific and engineering data reduction tools necessary for interpreting test results, such as cursor assignments and curve fitting routines. ICS's resources include a robust file management system that allows you to create multiple databases without relying on external database software.

The I-V Parametric Driver Library controls the HP 4155A/B, 4156 A/B, 4142B and 4145A/B. The HP E5232B C-V Driver Library and HP E5233B Switch Driver Library control the HP 4284A and HP E5250A, respectively.

HP E5250A Features:
- Unique analog bus architecture to allow configuration as a 10 x 48 cross-point matrix or as a 384-channel multiplexer
- 100 fA offset current with 10 tera-Ω channel isolation for accurate current measurement
- 100 μV offset voltage and low contact resistance for accurate voltage measurements
- Plug-in module architecture

HP 4140B Features:
- Three basic semiconductor measurements: I, I-V, and quasi-static C-V
- Two programmable voltage sources: ±100 V programmable source/function generator ±100 V programmable dc voltage source
- Basic accuracy: 0.5%
- High resolution: 1 fA
- Quasi-static C-V: 0.1 pF to 1999 pF, dc voltage ramp rate 1 mV/s to 1 V/s in 1 mV/s increments

HP 4280A Features:
- Built-in sweepable dc source and timer for C-V and C-t (capacitance-time) measurements
- High-speed C-t measurements with minimum measurement interval of 10 ms (10 μs if an external pulse generator is used)
- Basic C measurement accuracy: 0.1%

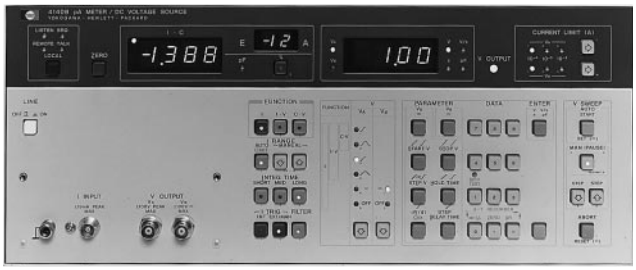
HP E5250A with HP 4155B

HP E5250A Low Leakage Switch

The HP E5250A switch mainframe has four slots for one to four 10 x 12 cross-point matrix modules or one to four 24-channel multiplexer modules. The cross-point matrix provides an automated solution for general parametric measurements while the multiplexer is ideal for long-term reliability measurements. The unique analog bus architecture ensures low noise internal interconnection of the plug-in modules without external cables. The four backside slots provide a maximum of 48 matrix outputs (one mainframe with four matrix modules installed) or 384 multiplexer outputs (four mainframes with four multiplexers installed in each mainframe).

When configured as a 10-input cross-point matrix, this configuration is ideal for general parametric measurements with six I-V triaxial inputs, low leakage (100 fA) performance, and four C-V coaxials, but can also be used for dc source/measure, and pulses up to 10 MHz.

When configured as a multiplexer, each module has 24 channels with an isolated external dc stress bias input for each set of eight channels. To safeguard other devices under stress from any surges when a device breaks down, each channel has a user-selected protection resistor to dampen the surge.



HP 4140B

HP 4140B pA Meter/DC Voltage Source

The HP 4140B pA meter/dc voltage source is part of component-measurement instrumentation. It consists of an extremely stable picoampere meter and two programmable dc voltage sources, one of which operates as a ramp and staircase generator as well as a dc source. These features make the HP 4140B ideal for making dc-characteristic measurements such as leakage current, current-voltage characteristics, and quasi-static C-V measurements, required by the semiconductor industry for new-product development and for improving production yields. It is equally useful in measuring electronic components and materials to determine leakage currents or insulation resistances.

The HP 4140B can contribute to the development, production, and quality control of semiconductor devices and to improvements in the reliability of electronic components and equipment.

HP 4280A

HP 4280A 1 MHz C Meter/C-V Plotter

The HP 4280A 1 MHz C meter/C-V plotter measures the capacitance and conductance of semiconductor devices and materials as functions of applied voltage (C-V) or time (C-t). The HP 4280A consists of a precision 1 MHz C-G meter, a programmable dc bias source that can be swept in staircase fashion, and accurate timing control.

The HP 4280's internal dc bias source has a range of 0 V to ±100 V with 1 mV resolution on the most sensitive range. Various measurement parameters for C-V and C-t measurements can be manually set from the front panel, or these parameters can be set under program control via the HP-IB. Settable range for C-t measurement interval is 10 ms to 32 s with a best-case resolution of 10 μs. If an external pulse generator is used, however, measurement intervals as short as 10 μs can be set. Up to 9,999 readings can be set for a C-t measurement. These capabilities make it possible for the HP 4280A to measure the C-t characteristics of virtually any device.

The HP 4280A can measure either floating or grounded devices. Thus, it can be connected to a wafer prober and still provide stable, accurate C and G measurements.

HP's TestSpan Series of Products & Services

The HP Test Span Series of Products & Services
5964-1576E

(PN E6230A/TS-5430) Air Bag Systems ECU Test Platform
5965-6505E
(PN E6230A/TS-5430) Antilock Brake/ Traction Control ECU Test Platform
5965-6507E
(PN TS-5400) Family of Test Systems
5965-5226E
(PN TS-5430) HP TS-5430 Automotive Electronics Test Platform
5965-5289E

Board Test & Inspection

HP 3070 Quick Verify Platform for ICT Plus Functional Product Verification
5965-8060E
It's About Time and Cost
5966-3829E
HP 3279CT Communications Board Test System Photo Card
5965-4879E
It's About Time and Money–HP Automated Process Test Solutions
5966-3830E
HP 5DX Series II automated X-ray inspection system improves product and process-in-line, off-line, real-time
5966-3392E

(PN 3070) HP Performance Port Fixturing Product
5965-8567E
(PN 3070) RPM Invitation, Color Piece
5965-6622E

Semiconductor Test Systems

Testing Digital Series to Their Limits Data Sheet
5962-7010E
HP V1100/V2100 Test Systems
5963-6941E
HP 83000 Pay-Per-Use
5964-0094E
HP 83000 The Key to More Quality Parts at Lower Cost
5965-5033E
HP 83000 **Model F660** Can You Test Your Most Advanced Devices to Their Limits?
5962-7011E
HP 84000 Series High Throughput RFIC Test Systems
5965-5272E
HP 4062 Series HP 4062UX Semiconductor Process Control System
5091-1070E
HP 9490 Series Real Mixed-Signal Test Solutions for Production
5963-7048E
HP V1100/2100 Test Systems
5963-6941E
HP V1200 Test Systems
5965-3343E
HP 4070 Series of Semiconductor Parametric Testers – HP SPECS Semiconductor Process Evaluation Core Software
5965-2723E
HP Modeling Systems Brochure
5964-9022E

(PN 4062-1) Sub-Pico Amp Measurement Using the Guarded Technique on an Automatic Wafer Prober
5090-0290
(PN 4062-2) Precision Evaluation of Flash Memory Cells
5091-6806E
(PN 4062PC-1) Effective Data Analysis Using Lotus 1-2-3– HP 4062PC Semiconductor Parametric Test System
5091-4993E
(PN) Characterizing Communications ICs with the HP 83000 Model F660
5962-9273EUS
(PN) Memory Test Software Provides Cost-Effective Solutions to Testing Advanced SRAMs (83000 F660)
5963-5078E

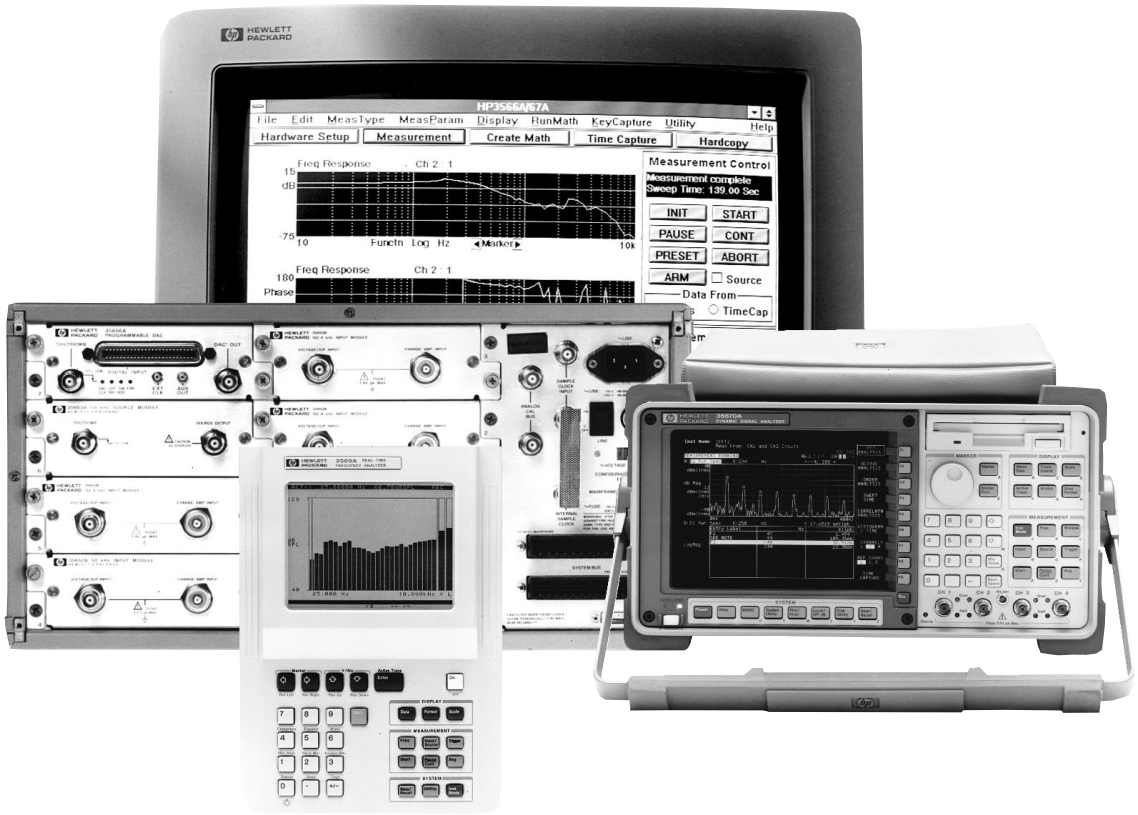
Semiconductor Measurement Instruments

(PN) HP 4155A/4156A Semiconductor Parameter Analyzer—Edition 1 Programming Guide for HP 4145A/B
5963-3201E
(PN 4142B-1) DC Characterization of Semiconductor Power Devices
5091-2744E
(PN 4145B) HP 4145B Preventing SMU Oscillation
5950-2909
(PN 4140A/B) HP 4140A 4140B Measurement Hints
5950-2921

Many of these literature pieces are available at:
http://www.hp.com/go/tmc99

FFT Dynamic Signal Analyzers

Overview



Hewlett-Packard dynamic signal analyzers use digital sampling and fast fourier transform (FFT) techniques to provide:

- Fast spectrum measurements
- Network analysis
- Transient event analysis

Some of these analyzers additionally provide real-time fractional octave measurements for acoustic analysis of rapidly changing signals, or to satisfy compliance tests.

Solve the Whole Problem

Because solving measurement problems often requires more than just an analyzer, HP offers an expanding selection of transducers suitable for general vibration, rotating machinery, and structural dynamics testing. Complete descriptions of these accessories are in the DSA Accessory Catalog, p/n 5966-2340E.

To help you arrive at solutions faster, we offer a variety of application and product notes and have application specialists available to deliver seminars and training. For advanced analysis of test results, several independent software vendors offer packages that are compatible with HP instruments and systems.

All HP dynamic signal analyzers support a standard data format (SDF). You can gather measurements in the field with a portable analyzer, then read the files into a benchtop or system-type DSA for advanced analysis at your desk. Cut and paste data and displays to your favorite PC software with HP 35639A data viewer.

Choosing the Right Analyzer

	Vibration and acoustics	Control system development	Signal analysis	Device testing
HP 3569A (page 545)	Portable 2-channel real-time octave analyzer with optional sound intensity, narrowband FFT, and reverberation measurements (battery powered)	—	Good portable analyzer for general-purpose measurement (battery powered) and lab quality acoustic measurements	Good portable analyzer for general-purpose measurement (battery powered) and lab quality acoustic measurements
HP 35670A (pages 546)	Extensive acoustic and rotating machinery measurement ruggedized for field work. NV RAM option. 2 or 4 channel options	Fast swept-sine and s-domain modeling options for analog systems, system controller option for automated testing	Deep capture memory, waterfall display, fast spectrum measurements, NV RAM option. 2 or 4 channel options	Automate measurements and external device control via HP Instrument BASIC programming option
HP 3565S (page 547) **or VXIbus** (page 545)	Modular PC or workstation-based systems for advanced structural testing and rotating machinery analysis	—	Create high speed multiple-input custom systems using HP 35635T software tools	Cost-effective solutions for automated testing of multiple devices simultaneously
HP 3566A HP 3567A (page 547)	A compact PC-based system with up to 48 channels and a choice of input modules and frequency ranges. HP 3567A offers higher frequency range.	Cost-effective solutions for automated test of multiple systems in parallel with optional swept sine. HP 3567A offers higher-frequency range.	Flexible data display and Microsoft Windows interface for analysis of waveforms and spectra. HP 3567A offers higher frequency range.	Cost-effective solutions for automated testing of multiple devices simultaneously. HP 3567A offers higher frequency range.
HP 89410A (pages 264–269)	Flexible frequency, time and modulation analysis for frequencies and spans to 10 MHz, 1 and 2 channel	Flexible frequency, time and modulation analysis for frequencies and spans to 10 MHz, 1 and 2 channel	Flexible frequency, time and modulation analysis for frequencies and spans to 10 MHz, 1 and 2 channel	Flexible frequency, time and modulation analysis for frequencies and spans to 10 MHz, 1 and 2 channel

For more information visit our website: **http://www.hp.com/go/data_acq**

HP 3569A
HP 35639A
HP E1432A
HP E1433A
HP E14334A
HP E1562D/E

HP 3569A

Real-Time Frequency Analysis in an Ultra-Portable Package

The HP 3569A is a 3.2 kg, portable, battery-powered real-time frequency analyzer designed for environmental noise, sound intensity, mechanical vibration, and room reverberation measurements in the field.

Octave and 1/3-octave resolution measurements are made in real time. Built-in microphone and BNC ICP inputs eliminate the need for external signal conditioning. A built-in noise source provides stimulus for reverberation and frequency response measurements.

The optional Real-Time Sound Intensity mode can be used to identify noise sources. I.E.C. 1043 Class 1 compliant sound power measurements are calculated easily and automatically in the analyzer.

The optional FFT mode allows single or cross-channel measurements with up to 1600 lines of frequency resolution which can help you identify vibration and acoustic problems..

The optional Reverberation Time mode calculates direct display of octave and 1/3-octave RT-60 decay times automatically.

Documentation and Analysis

HP 3569A measurement results can be printed on HP PCL printers or HP-GL plotters via RS-232. Stored data can be transferred to a PC via RS-232 and is compatible with Hewlett-Packard's SDF (Standard Data Format) which allows data transportability to other Hewlett-Packard analyzers and third party analysis packages. An optional utilities package for the HP 3569A (Option 550) allows easy data transfers to DOS PCs and special display utilities for the HP 95LX palmtop PC.

Key Literature

HP 3569A Technical Data Sheet; p/n 5091-4805E
HP 3569A Configuration Guide; p/n 5962-7919E
Standard Data Format Utilities; p/n 5061-8056
DSA Accessory Catalog, p/n 5964-8939E

For more information, visit our website:
http://www.tmo.hp.com/tmo/datasheets/English/HP3569A.html

Ordering Information

HP 3569A Real Time Frequency Analyzer
- **Opt AY1** Real-Time Intensity
- **Opt AY2** Narrowband FFT
- **Opt AY3** Reverberation Time
- **Opt 550** Enhanced Data Transfer Utilities for PC

HP 35639A Data Viewer

The HP 35639A lets you view and format saved measurement data on your personal computer from any instrument which uses SDF data storage and simplifies many report generation and printing tasks. It allows batch processing, labeling, multiple plots per page, many display types, display functions, and data markers.

Key Literature

HP 35639A Data Viewer Product Overview; p/n 5962-9499E
HP 35639A Data Viewer Demo Disk; p/n 5963-1834E
HP 35639A Data Viewer Demo Setup Inst; p/n 5963-1833E
Standard Data Format Utilities; p/n 5061-8056

Ordering Information

HP 35639A Data Viewer

VXI Measurement Platform for Mechanical and Acoustic Test

The HP E1433A 8-channel digitizer, E1432A 16-channel digitizer, and E1434A 4-channel arbitrary source provide both system excitation and digitization for the mechanical and acoustical tests common in the automotive and aerospace industries. The HP E1433A's 196-kSa/sec sample rate and onboard digital signal processing (DSP) boost total system performance while cutting system development time. The HP E1432A 16-channel 51.2 kSa/sec digitizer provides many of the same measurements and features as the E1433A, but at a lower sample rate and decreased cost. For system excitation, the HP E1434A arbitrary source provides multi-channel stimulus.

When combined with the existing HP E1562D/E/F SCSI data disk they form a comprehensive measurement platform for mechanical, acoustical, and electrical test. Now all functions necessary for these demanding applications: digitization, excitation, and highspeed data recording are available on an industry standard VXI hardware platform.

Minimize Complexity, Maximize Performance

The HP E1432A and E1433A simplify system integration by providing signal conditioning, filtering, digitization, and measurement computation, all in a single module. Built-in measurement computations such as FFTs and averaged power spectra off load work from the host computer, keeping it from becoming a computational bottleneck. The HP E1434A arbitrary source can playback continuous arbitrary wave forms, but also provides common test signals such as sine, random and burst random noise.

Software Support

Customers can develop their own custom software solutions using VXI *plug&play* drivers and common programming languages, or they can use Mathwork's Matlab or HP's VEE graphical programming environment. For turnkey software solutions, expect wide application support from the industry's leading third-party solution providers. Applications include rotating machinery analysis, modal analysis, acoustics, vibration control, and road simulation, as well as general-purpose multi-channel data acquisition and analysis.

Key Literature

HP E1432A, HP E1433A and HP E1434A Product Overview, p/n 5966-3062E

See VXI catalog for more details and additional modules.

For the latest information on HP's Data Acquisition products, see HP's website: **http://www.hp.com/go/data_acq**

See HP's Test & Measurement Channel Partner Program website: **http://www.hp.com/go/tmpartners**

Ordering Information

HP E1432A 16-Channel, 51.2 kSa/sec Digitizer + DSP
HP E1433A 8-Channel, 196 kSa/sec Digitizer + DSP
HP E1434A 4-Channel, 65 kSa/sec Arbitrary Source
HP E1562D VXI Data Disk, DAT and SCSI-2 Interface

Two- or Four-Channel Dynamic Signal Analyzer HP 35670A

HP 35670A

- Two or four channels (optional)
- Portable-fits under an airplane seat
- 1600 line frequency resolution
- 16-bit ADC/90 dB dynamic range (typical)
- 10 MB deep transient capture (optional)

HP 35670A Dynamic Signal Analyzer

The HP 35670A lets you make laboratory-quality measurements in the field, on an automobile test track, flying above a city, or in the narrow confines of a submarine. Small enough to fit under an airplane seat, the HP 35670A is a two, or four-channel (Option AY6), FFT-based spectrum/network analyzer. The standard instrument provides spectrum, network, time-domain, and amplitude-domain measurements from virtually dc to slightly over 100 kHz. Your ability to solve problems in the field is enhanced with the optional four-channel HP 35670A-measure noise at multiple locations inside vehicles, make triaxial vibration measurements, or gather data from several locations along a noise transmission path.

With the HP 35670A, you carry all your measurement and analysis tools in one package. Octave analysis (Option 1D 1) adds real-time measurements of l/1, 1/3, or 1/12 octave spectra at frequencies up to 40 kHz. Computed order tracking (Option 1D0) allows you to view spectra as a function of orders, or to view the amplitude of multiple orders as a function of RPM. Up to 8 MB of additional memory (Option UFC) provides deep transient time capture or extra space for up to four-hundred spectra. An arbitrary source (Option 1D4) lets you test devices with real-life test signals. With HP Instrument BASIC (Option lC2), you can automate measurements or customize your instrument interface. Everything you need to troubleshoot vibration and noise problems in the field is in one instrument. (You can retrofit all options-buy only the functionality you need today and add more as your needs change.)

A deep transient time capture memory can record up to four channels of data plus a tachometer signal for playback in the narrowband FFT, octave, order, correlation, or histogram instrument modes. Pre- and post-trigger delay functions let you capture the leading edge of one-time events or eliminate transmission delay in signals.

Real-Time Octave Analysis to 40 kHz (ANSI S1.11-1986)

Octave analysis (Option 1D1) adds a real-time octave analyzer to your HP 35670A for analysis in 1/1-, 1/3-, or 1/12-octave bands. Four LEMO connectors with power for microphones are provided by the microphone adapter and power supply (Option UK4). The 1/1- and 1/3-octave band filters in the HP 35670A comply fully with ANSI S1.11-1986 (Order 3 Type 1-D), DIN 45651, and IEC 225-1966. An overall total power band and an A-weighted overall power band can be activated as needed. All three octave band modes and the overall power band can be A-weighted with an analog filter in full compliance with IEC 651-1979 Type 0. The overall power band can be redefined as a broadband impulse detector that complies with IEC 651-1979 Type 0. A fan-off mode eliminates instrument noise from measurements. A pink noise source allows you to evaluate electroacoustic devices.

View Spectra in the Order Domain (Option 1D0)

View spectra as a function of orders or track up to five orders on four channels simultaneously with computed order tracking (Option 1D0). Orders as high as 200 can be tracked. An order map can be displayed as a function of RPM or time, using the waterfall function. Waterfall markers let you view the track of any order.

Computed order tracking is ideal for troubleshooting rotating machinery. Run-up or run-down measurements can be displayed in bode or polar formats. Oscilloscope-quality orbit diagrams are another benefit. Because the data is resampled with changes in RPM, a single-loop orbit display is maintained as the shaft RPM is varied. With four channels (Option AY6), two orbits can be measured simultaneously-at both ends of a shaft, for instance. An RPM measurement readout, available in any instrument mode, aids in the interpretation of measurement data from rotating machinery.

Computed order tracking provides alias-protected measurements without expensive and cumbersome external ratio synthesizers and tracking filters. This new technique uses a digital tracking algorithm that follows rapid changes in shaft RPM without time delay and eliminates the phase noise normally associated with ratio synthesizer techniques. Accuracy is enhanced over traditional methods.

HP 35670A

Swept-Sine or Broad Measurement Range (Option 1D2)

The swept-sine instrument mode expands the network analysis range of the HP 35670A to 130 dB. Higher noise rejection and accuracy are obtained by auto-ranging the instrument during the sweep. Automatic sweep resolution reduces measurement time without sacrificing accuracy. Alternatively, sweep resolution can be set by the user.

Advanced Modeling and Analysis Cut Design Time

Prototype revisions are reduced by modeling design modifications using curve fit and synthesis functions (Option 1D3). In a typical application, a model of the test device is created by curve fitting a frequency response measurement. Up to 20 poles and 20 zeros are used to describe the device; results can be output in pole/zero, pole/residue, or polynomial formats. The designer then transfers the circuit model to the synthesis function. Using synthesis, the model is modified by adding or deleting poles and zeros. The frequency response function of the modified model is then synthesized to test the design modification.

Automation Improves Productivity

HP Instrument BASIC (Option 1C2) replaces the external computer in small test systems. Like the computer, it can be used to automate measurements, create a custom user interface, synthesize new information from raw data, or control other instruments and peripherals. An optional external keyboard plugs into the rear panel. The HP 35670A provides direct control of external disks, plotters, and printers via HP-IB RS-232, or parallel interfaces, and is fully programmable via the HP-IB.

Option 100 software bundle

Bundles options 1D0 through 1D4 and UFC. 35% discount over the same options sold separately.

Key Literature

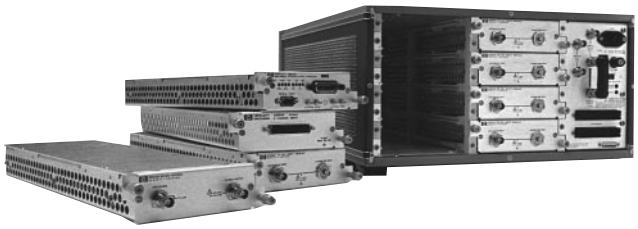
HP 35670A RotoDynamics Measurement, p.n 5966-0518E
HP 35670A Technical Data Sheet, p/n 5966-3064E
HP 35670A Product Overview, p/n 5966-3063E
DSA Accessory Catalog, p/n 5966-2340E
Standard Data Format p/n 5091-2945E

For more information, visit our website:
http://www.tmo.hp.com/tmo/datasheets/English/HP35670A.html

Ordering Information

HIP 35670A Dynamic Signal Analyzer
- **Opt AY6** Add 2 Input Channels
- **Opt 1D0** Computed Order Tracking Measurements
- **Opt 1D1** Real-Time Octave Measurements
- **Opt UK4** Microphone Adaptor and Power Supply
- **Opt 1D2** Swept-Sine Measurements
- **Opt 1D3** Curve Fit/Synthesis
- **Opt 1D4** Arbitrary Waveform Source
- **Opt 1C2** HP Instrument BASIC
- **Opt AN2** Add 4 MB Memory
- **Opt UFC** Add 8 MB RAM
- **Opt 100** Software Bundle
- **Opt UFF** Add 1 MB Nonvolatile RAM

Accessories
35250A DC Power Cable (3 m)
35251A DC Power Cable w/Cigaretter Lighter Adapter



HP 3565S

HP 3565S Multichannel Measurement System

The modular HP 3565S system is optimized for fast signal acquisition and analysis, acting as a measurement co-processor to your UNIX workstation. Each system may have up to 496 input channels.

Applications Software

System software for the HP 3565S is available from HP (HP 3566A and 3567A), and many independent software vendors, such as: Leuven Measurement Systems, Structural Measurement Systems, m & p international, Structural Dynamics Research Corp., and Creare Inc.

Please refer to the HP VXI Channel Partner Solution Catalog for more information: **http://www.hp.com/go/vxichanpart**

System Mainframes

System mainframes provide power and interconnection for a system. Up to eight HP 35650A 8-slot mainframes may be connected in a system. The HP 35650B 4-slot mainframe is for use in single mainframe or portable systems.

Signal Processing and SCSI-Interface Modules

Each system needs one signal processing module to perform computation and control tasks. The HP 35651C signal processor comes with 4 MB of RAM and one MC 56002 DSP; the HP 35654B signal processor uses two MC56002 DSP, and has 4 MB of RAM. RAM may be optionally increased to 16 MB. The HP 35659A SCSI interface module provides high-speed digital recording of input data. There is an optional internal 2 GB SCSI hard drive available.

Signal and Tachometer/Trigger Input Modules

All analysis input channels are equipped with an anti-alias filter, ADC, digital filter, FIFO, and ICP supply. They are sampled simultaneously to maintain cross-channel phase match. Both the HP 35652A/B 1-channel input modules are equipped with BNC and charge-amp input connectors.

The HP 35655A is a 12.8 kHz, 8-channel input module. The HP 35658A tachometer/trigger module produces input for rotating machinery analysis and system trigger needs.

Source Modules

The HP 35653C 102.4 kHz source supplies a variety of signals for measurement stimulus and system calibration. Arbitrary stimulus with 16-bit resolution is available from the HP 35656B Programmable DAC.

Key Literature

HP 3565S Technical Specifications, p/n 5966-3154E

For more information, visit our website:
http://www.tmo.hp.com/tmo/datasheets/English/HP3565S.html

Ordering Information

HP 35650A 8-Slot Expandable Mainframe
HP 35650B 4-Slot Portable Mainframe
HP 35651C Signal Processing Module
HP 35652A 51.2 kHz 1-Channel 80-dB Input Module
HP 35652B 102.4 kHz 1-Channel 80-dB Input Module
HP 35653C 102.4 kHz Source Calibration Module
HP 35654B Advanced Signal Processing Module
HP 35655A 12.8-kHz, 8-Channel 72-dB Input Module
HP 35656B Programmable DAC Module
HP 35658A Tachometer/Trigger Input Module
HP 35659A SCSI Interface Module

HP 3566A, 3567A Signal Analyzers

Up to 48 Channels of Time and Frequency Measurements

A rich measurement set makes the HP 3566A and 3567A excellent for mechanical test, signal characterization, control systems, rotating machinery analysis and production test. These Windows 95/NT based dynamic signal analyzers are configurable from 2 to 48 channels.

The HP 3566A and 3567A have the same measurement features set but differ in maximum frequency span and hardware configuration.

The hardware setup mode shows input, source, and DAC configurations for the users convenience.

High-speed transient captures may be made to signal processor RAM or to the optional HP 35659A SCSI interface module. Simultaneously monitoring up to 16 channels while the throughput occurs helps prevent costly mistakes. Portions of captures can be selected for analysis.

A full-function waveform calculator lets you integrate custom analysis of any measurement result into the standard user interface.

HP 35636A Order Tracking Software (Optional)

Distinguish order-related from other rotating machinery signals as you display accurate order-spectra independent of changing RPM. Optional HP 35658A-tachometer/trigger module is recommended with this optional software, but is not required.

HP 35637A Swept-Sine Software (Optional)

Swept-sine techniques provide transfer functions with 132dB dynamic range. Auto-range, auto-level, and auto-resolution can dramatically reduce measurement times.

HP 35638A Real-Time Octave Software (Optional)

The optional 1/1, 1/3/ and 1/12 octave software provides real-time 1/3 octave measurement results on 2 channels at 20 kHz or 4 channels at 10kHz. When the analysis is performed on throughput data, up to 20 channels at 20 kHz or 48 channels at 5kHz are available.

HP 35656A DAC Provides Arbitrary Waveforms (Optional)

A programmable, 16-bit DAC, DAC editor, and waveform calculator allow custom waveforms to be created and used as stimulus. Captured signals can be output through the DAC module simultaneous with measurements.

Key Literature

HP 3566A, 3567A Product Overview, p/n 5963-2340E
HP 3566A, 3567A Technical Specifications, p/n 5966-3155A
HP 3566A, 3567A Configuration Guide, p/n 5962-7080E
HP 3565S Technical Specifications, p/n 5966-3154A

For more information, visit our website:
http://www.tmo.hp.com/tmo/datasheets/English/HP3566A.html
http://www.tmo.hp.com/tmo/datasheets/English/HP3567A.html

Ordering Information

HP 3566A/3567A Spectrum/Network Analyzers
Includes HP 35650A Mainframe, HP 35653C Source Module, HP 35651 C Signal Processor, HP-IB cable, 1 year onsite hardware warranty, and HP 35634A time/frequency measurement software
HP3566A Spectrum/Network Analyzer
Includes I HP 35655A 8-channel, 12.6 kHz input
HP3567A Spectrum/Network Analyzer
Includes 2 HP 35652B 1-channel, 102.4 kHz inputs
Contact your Hewlett-Packard Sales Representative for a complete list of options.
HP 35636A Order Tracking (optional software)
HP 35637A Swept Sine (optional software)
HP 35638A Real-Time Octave (optional software)

Data Acquisition Systems

Overview

History and Applications

Hewlett-Packard has provided data acquisition solutions for over 25 years. The earliest systems were combinations of multiplexing scanners and digital multimeters. These early rack mounted solutions evolved into today's powerful modular data acquisition and control systems capable of not only analog and digital measurements but also analog and digital output for a wide variety of applications. Data acquisition and control solutions are used extensively to evaluate electromechanical product and process designs for industries supplying aerospace, automotive, consumer, industrial, medical and transportation products.

Measurements

Data can be gathered from a wide variety of sensors or may be measured directly. Voltage, resistance, temperature, strain, frequency, velocity, acceleration, noise, vibration, harshness and many other physical phenomena are measured. Sensor based data can be converted to engineering units during the measurement process. Many applications include digital parameters such as counters, timers, stepper motors, digital I/O, states, and pulses.

HP solutions can also provide a variety of control capabilities including setting alarms, stepper motor control, closed loop control with guaranteed latency, PID control, vibration control and more. Systems may also provide a stimulus to the test device. These may be analog or digital outputs for control of switches, valves, stepper motors, shakers, hydraulic rams or other devices.

HP's Data Acquisition and Control Products

HP DAC Express

NEW

If you want PC-based data acquisition but do not want to spend hours programming then HP DAC *Express* is the answer. A familiar spreadsheet environment makes it easy to configure, control and review your tests.

- E9800A DAC *Express*—Data Viewer. Review test data and hardware setups from files previously aquired with HP DAC *Express*-based systems. Also includes graphical displays and links to analysis and word processing packages. See page 550
- E9801A DAC *Express*—Data Aquisition/Recorder. Works with E9800A. to acquire, display and record multi-channel physical data using products like the HP E1413C, HP E1432A, E1433A and the HP E1562 Data Disk. See page 551

Portable, small channel counts:

- HP 34970A Data Acquisition Switch/Unit. For low cost data logging and system switching with precision 6-1/2 digit multimeter, temperature measurements with units conversion, up to 120 channels. Data logging software included. See pages 163–166.
- HP 75000 Series B (E1300A/01 mainframe based) Portable/Remote Data Acquisition and Control System. VXIbus, high-speed 5-1/2 digit multimeter, temperature, strain measurements, DAC, counter/timer, digital I/O; up to 112 channels. See page 554.

High Performance, medium channel counts:

- HP DAC1000 Multifunction Data Acquisition and Control System. VXIbus sensors-based measurements with high speed scanning ADC, analog signal conditioning, temperature/strain with units conversion, counter/timer, DAC, digital I/O, pulse width, PWM, stepper motor control. Up to 320 channels, HP VEE graphical programming language software. See page 553.
- HP 75000 Series B (E1302A mainframe based) Portable/Remote Data Acquisition and Control System. VXIbus, high speed 5-1/2 digit multimeter with separate 16-channel multiplexers or precision 16-bit 32-channel scanning ADCs, temperature, strain measurements, DAC, counter/totalizer, digital I/O; up to 320 channels. See page 554.
- HP 3566/67A 48 Channel time and frequency spectrum analyzer. Simultaneous ADC per channel, up to 48 channels. 12.8 kHz or 102.4 kHz spectrum analysis and time domain signal capture. See page 550.

High Performance, large channel counts:

- HP 75000 Series C Data Acquisition and Control System. VXIbus, high speed scanning ADC, specialized high-speed measurement module with up to 32 PID control loops, analog signal conditioning, temperature/strain measurements with units conversion, counter/totalizer, DAC, digital I/O, pulse width, PWM, stepper motor control, up to 768 channels. See page 554.
- HP 3852A Data Acquisition and Control System. 8 slot Mainframe or extender based system. 40 different measurement and control modules including high-speed ADC, scanning switches, digital I/O, DAC, counter/totalizer, stepper motor control. Up to 216 channels. See page 553.
- HP E1432A 16 Channel 51.2 kSa/sec Digitizer + DSP.
- HP E1433A 8 Channel 196 kSa/sec Digitizer + DSP. Both E1432A and E1433A include transducer signal conditioning, antialias filters, 16-bit digitizer/channel and high-speed measurement computation. Control by HP VEE, Matlab, C++ or other standard programming languages. Supports 100's of channels. See page 545
- HP E1563/64A 800 kSa/sec 2 or 4 Channel digitizers. High speed digitizers with up to 256 V input, up to 64 MB PC-SIMM style RAM. Ideal for fast acquisition of transient events. Common mode rejection of 113 dB, selectable 1.5, 6, 25 or 100 kHz input filters. See page 99–102.

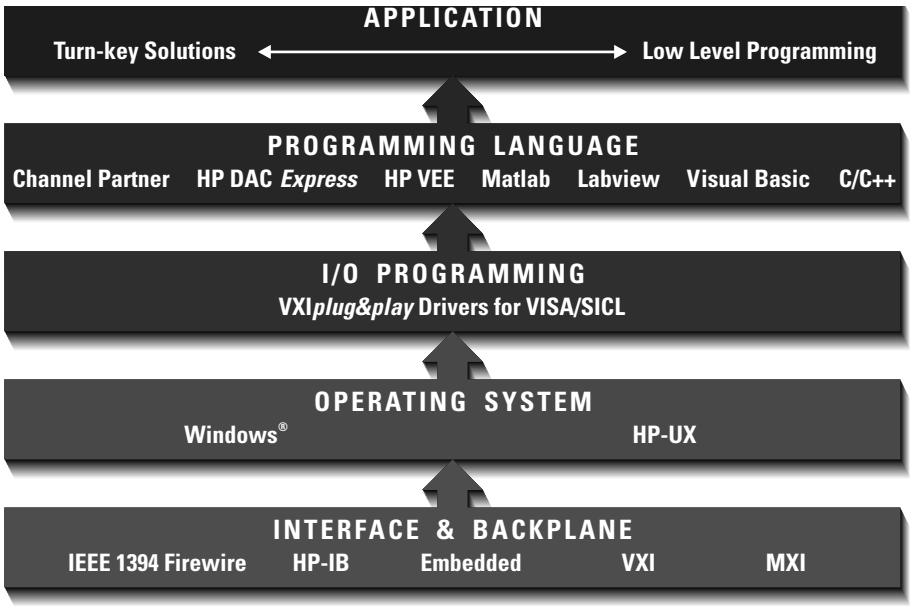
More Information

Additional information on the full line of HP VXIbus products is available in this catalog on pages 99–102. For the full line of HP VXIbus products request the HP System Builders Source Book and CD from your regional HP Call Center.

HP Data Acquisition and Control Product information is available online. Please visit our website: **www.hp.com/go/data_acq**

HP hardware is used by a large number of solution providers. These Channel Partners offer a broad variety of turn-key data acquisition solutions. See these solutions on-line: **www.hp.com/go/tmpartner**

- Broad Software Support
- HP VEE
- HP DAC *Express*
- Mathworks Matlab
- Visual C/C++
- Visual Basic
- Variety of Turn Key Solutions available from HP Channel Partners



Software is a Compelling part of VXI Hardware Story

Software is a key component to employing any hardware platform. Gone are the days that required months of programming effort to get a measurement system up and running. HP's VXI platform is a defacto standard that is used by major turn key solution providers to offer a broad range of measurement solutions. HP's Test & Measurement web site provides a growing list of HP Channel Partners that offer a wide variety of turn key measurement and data analysis solutions based upon VXI hardware.

HP VEE (Visual Engineering Environment)

HP VEE 5.0 is a popular, leading-edge graphical programming software environment that makes programming fast, easy and intuitive. With VEE's powerful icons and support for all VXI plug&play drivers, including those from other vendors, your support for VXI modules is comprehensive.

HP DAC Express

HP E9800A DAC *Express* Data Viewer Software coupled with HP E9801A DAC *Express* Data Acquisition / Recorder provides a turn key high performance data acquisition solution, right out of the box. HP DAC *Express* makes it easy to set-up a multi-channel measurement with multiple sampling rates. Use a low sampling rate for measurements like temperature and a high sampling rate for acoustic or vibration signals. Store up to 4 billion samples at aggregate sampling rates up to 7.5 million samples / sec.

Control HP E1432A / E1433A / E1434A VXI Hardware Directly from Mathworks's Matlab

If you are one of the more than 400,000 users of Matlab and need to directly control HP's high performance multi-channel digitizers and source modules, HP is now supplying this control capability as part of its standard Plug & Play library for the HP E1432A, HP E1433A and HP E1434A VXI modules. The combination of Matlab 5.2's n-dimensional arrays, matrix math, color surface shaded 3-D graphics, user interface building tools and HP's high performance measurement hardware provide most impressive results with a minimum of programming effort. This environment is really the "measurement engineer's programming language" that quickly turns measurements into insight.

Use C / C++ or Visual Basic Software Development Environments for Unique or Demanding Applications

Work in either Microsoft Win95 / WinNT software development environments using C/C++, Visual Basic or use HP-UX C/C++, to give you a great head start in developing your custom application solutions on top of standards based HP VXI hardware. The VXI plug & play software layer allows your code to be portable across platforms. The plug & play layer also allows you to support multiple hardware vendors from the various software environments

For more information

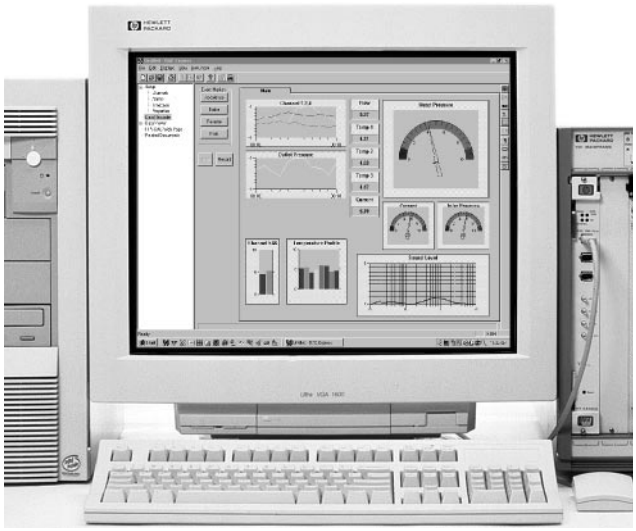
See HP's Test & Measurement Channel Partner Program web site:
http://www.hp.com/go/tmpartners
See HP's Test & Measurement Data Acquisition web site:
http://www.hp.com/go/data_acq

550 HP DAC Express Data Viewer Software

HP E9800A

NEW

- Simplifies viewing large data acquisition files of multi-channel measurements
- "Replay" your data and view in "Real-time" with on-line data displays
- Displays channel setups and scan rate parameters of data files
- Wide choice of data displays – strip charts, bar graphs, meters, etc
- Export data to popular analysis and word processing packages



HP E9800A shown with E9801A Data Acquisition / Recorder

HP DAC EXPRESS: Helps Make Sense of Your Data Fast

The HP E9800A is the data viewer portion of the HP DAC *Express* software family. The HP E9801A Data Acquisition/Recorder software not only makes it easy to set-up multi-channel measurements and save calibrated time data to disk, but it allows you to monitor the acquisition in real time to assure that the data you are saving is valid. The data obtained with the HP E9801A can be distributed via LAN or the Internet to other users with a copy of HP E 9800A.

HP DAC EXPRESS: Anyone With a PC Can Browse Existing Data

HP E9800A allows anyone with a PC to open HP DAC *Express* data files and browse through the data set with a wide variety of flexible display types. Customize your viewing screen to display just the channels of interest over any time frame. By providing a common environment for measurement setup and data displays, users can quickly acquire and then interpret data.

Instant Review of Data at Your Command

Think of the HP E9800A as your ideal data viewer. There is no need to visually scan through reams of tabular data on printouts. The data can be played back through a variety of graphical displays that make it easy to spot trends or anomalies. It also provides a flexible set of signal analysis functions with its built-in data processing editor.

Wide Choice of Data Displays

A rich collection of display choices is available to allow your data to be presented in the most useful format. These display formats can be used for on-line monitoring or used to interpret the data from the saved file. Each display can be labeled with application specific titles and calibrated in engineering units.

Repeatable Data Collection

One of the often-asked questions about data files is "How was the data collected?" The HP E9800A software is unique because the instrument setup parameters are stored with the data file so that you really can know what gain, filtering, or scan rate was used for each channel. This eliminates all ambiguity about trying to re-run the test and get repeatable results.

Turning Data Into Reports Is Now an Easy Job

Most test engineers know that the most tedious part of their job is converting the raw data into useful information with analysis and report generating tools. Now, with automated links to key software applications, this job is not a big time-consuming task. Once an analysis and word-processing process is implemented, the same process can be used automatically with new sets of data. No more tedious importing and formatting.

Export Your Data to Matlab and Excel

For cases where additional processing of the data is needed, built-in links to Mathworks Matlab and Microsoft Excel are provided to export your data in the data format required by the target applications. Links to channel partner software packages are also provided.

HP DAC EXPRESS Connects to Dependable Input I/O

The data in your file is no better than the capability of the equipment used to make the measurements. Hewlett Packard is known for dependable measurements and HP DAC *Express* relies on HP hardware for measurements of physical parameters.

A wide range of signal conditioning is available for optimizing the signal quality of the incoming signal. Many other types of measurements are possible with the appropriate transducers.

Key Literature

E9800A DAC *Express* Data Viewer Software Product Overview

For the latest information on HP's Data Acquisition products, visit out website: **http//www.hp.com/go/data_acq**

HPE9801A

- Easy, intutitive hardware setup
- Measure a variety of static and dynamic analog signals, simultaneously!
- Replaces analog or digital tape recorders and strip chart recorders
- Configurable with up to 128 dynamic channels and up to 768 static channels
- Simultaneous sampling up to 196,608 Samples/sec per channel
- Store > 8 Gbytes per session
- Continuous dynamic data recording at aggregate rates >7.5 Million Samples/sec
- Monitor data while recording

HP DAC EXPRESS - Easy Data Acquisition/Recording

Hewlett-Packard's HP DAC *Express* (HP E9801A) not only makes it easy to set-up a multi-channel measurement, saving calibrated time data to disk, but allows you to monitor the acquisition in real time to assure the data you are saving is valid. All the related measurement setup information is stored along with the data in HP SDF (Standard Data Format). Measurement setups can also be created without hardware actually being connected.

Replace Analog and Digital Tape Recorders

The HP E9801A combines the functionality of signal conditioning, digitization, instrumentation tape recorders and strip chart recorders in a single stand-alone product. It outperforms DAT-based tape recorders in channel count, per channel bandwidth, and depth of storage. It eliminates the need for separate strip chart recorders, since any of the various displays can be copied to attached printers.

Fast Simultaneous Sampling for Dynamic Signals

For dynamic signals, choose one or more 16-channel E1432A VXI modules with a maximum sampling rate of 51,200 Sa/s per channel or the 8-channel E1433A VXI module with a maximum sampling rate of 196,608 Sa/s per channel. Record as many as 128 channels using the 51,200 Sa/s per channel E1432A module or 64 channels with the E1433A.

Fast Scanning A/D for Temperature, Resistance & Strain

Choose one or more HP 1413C 64-Channel Scanning A/D for your high performance measurements of DC voltage, temperature, resistance and strain. Record as many as 768 channels using twelve E1413C VXI modules.

8.6 Gbytes of Contiguous Data Storage

The HP E1562D/E data disk module provides a very deep data storage capability. With the HP E1562E, you can record up to 8.6 Gbytes of data using both internal disks. With the HP E1562D, you can record 4.3 Gbytes to the single disk and then archive the data on the internal DAT drive. Both of the HP E1562 modules take full advantage of the Local Bus connection to the HP E1432/33A input module, yielding the fast data transfer rates of more than 7.5 MSa/sec. With 128 channels of E1432A's you can record for more than 5 hours with all 128 channels sampling at 51,200 Sa/s. With fewer channels or lower sampling rates you can record for proportionally longer times.

Capture to Host Disk

Data originating from the E1413C VXI module is recorded to the host system disk. For applications not needing HPE1432A or E1433A digitizers, the host system disk becomes the data storage device and the E1562 data disk is not needed.

Multiple Sampling Rates

The HP E9801A architecture allows a data system with a unique mixed sample rate, low sampling rates for measurements like temperatures and high sampling rates for acoustic or vibration signals. This unique mixed sampling rate capability is also always time correlated, allowing the user to determine the timing of a position signal relative to the transient response of a microphone or accelerometer signal.

New Event Marker Capability

A simple click of the mouse creates an event marker. Each event marker records the time of day and provides for including operator's notes of each event.

Easy Analysis and Report Generation

Acquiring data is only part of the job With HP DAC *Express*, easy exporting to MathWorks MathLab, MS Excel, and MS Word simplifies the rest of your job.

Key Literature

E9801A Data Recorder/Analyzer Product Overview

For the latest information on HP's data Acquisition products, visit our website: **http//www.hp.com/go/data_acq**

HP E1529A

NEW

- Lower cost strain conditioning for large numbers of channels
- Easier connection for individual strain gages
- Versatile choice of bridge configuration and shunt calibration

HP E1529A shown with VXI Data Acquisition System

HP E1529A 32Ch. Remote Strain Conditioning Unit

The HP E1529A is specifically designed to simplify stress and fatigue testing of large mechanical structures such as airframes and rockets. Each unit provides remote conditioning for 32 channels of strain bridge measurements in a configuration that is very easy to connect and calibrate. Additional units can be added to expand the system capability at any time.

Full Measurement Capability

The HP E1529A offers the following features:

- Low cost telecom connectors and cabling for strain gages
- Connection for external excitation to banks of eight gages
- Individual buffered output for each bridge signal
- Provision for custom shunt calibration resistors
- Up to 1000 feet (330 meters) cable lengths

A Modular, Reconfigurable Architecture

The HP E1529A provides external signal conditioning and multiplexing for a VXI-based data acquisition system. Up to two HP E1529A's are supported by a new Signal Conditioning Plug-on (SCP), the HP E1539A, that is installed on an HP E1422A Remote Channel DAC Unit.

The HP E1422A includes a 16 bit, 100KHz A/D, high speed DSP, and a 64,000 reading buffer in a single C-size VXI slot. Each HP E1422A can house up to eight SCP's which can be a mix and match of signal conditioning for strain, temperature, resistance, voltage, digital I/O or counter functions..

For a dedicated strain measuring configuration, each HP E1422A can support up to 512 channels. As many as ten HP E1422A's can be installed in a 13- slot C-size mainframe, thus providing a single system with 5120 channels of strain measurement.

Automated Calibration Saves Time

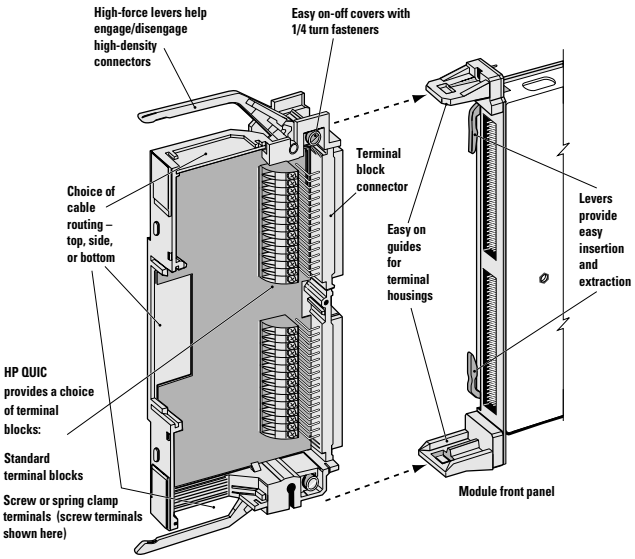
Each HP E1529A has an internal calibration source that is used to provide automatic input calibration, This automatic process takes only a few minutes for 512 channels. In addition, shunt calibration using an internal 50 kilohm or user supplied value is provided.

Key Literature

HP VXI Catalog p/n 5966-2815 EN/EUS

Flexible Wiring via Terminal Blocks

HP provides terminal blocks standard with all low-frequency multiplexer, matrix, general-purpose switch modules and scanning voltmeters. Several of the C-size modules have terminal blocks which incorporate HP's new HP QUIC (Quality Insertion and Connection). The HP QUIC terminal block provides you a convenient method of wiring to your application as shown in the accompanying illustration. A terminal block with screw or push-in spring-clamp terminals is provided as standard with HP QUIC-equipped VXI modules. HP QUIC also provides easy-in/easy-out levers and guides on the front panel to assure terminal block alignment when attaching the terminal block to the front panel of an instrument/switch module.



Rackmount Terminal Panel

- 96 terminals (32 3-wire channels)
- Built-in strain relief
- Includes pinouts and access to probe points
- System connections through 50-pin SCSI connectors
- Internal reference junction for 32 thermocouple channels

The HP E1586A Terminal Panel gives you maximum flexibility in configuring system wiring and interface solutions. In addition to the convenience of easy access for troubleshooting, the rackmount terminal panel gives you the flexibility you need to take advantage of money-saving wiring alternatives when system components are located at a distance from your mainframe. Within the Terminal Panel, the isothermal reference junction provides an internal reference junction for up to 32-wire thermocouple channels. The rackmount design provides easy access to the thermocouples for control and monitoring of distributed environmental temperatures, temperature control applications, and temperature control in material processing.

Optional RF filters on the terminal panel input channels filter out AC common-mode signals present in the cable connecting the terminal panel and the device under test. These filters are useful for filtering out small common mode signals below 5 Vp-p.

Connection to VXI modules with Option A3F requires either the HP E1588A six meter length cables or HP Z2220 Option 050 custom length cables

HP DAC1000 System

Data Acquisition and Control System with the New HP DAC EXPRESS

Multifunction Measurement

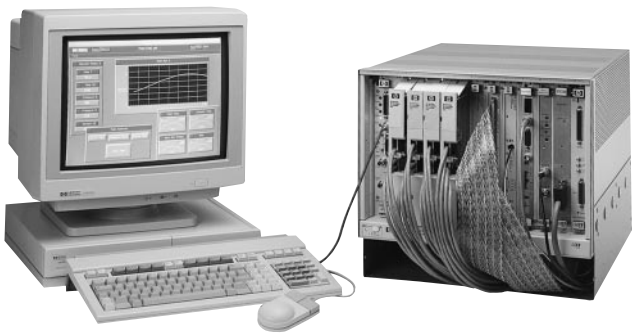
The HP DAC1000 data acquisition and control system is a cost-effective solution for characterizing the designs of electromechanical products and monitoring and controlling critical manufacturing processes. This precision 16-bit scanning A/D and control unit—ideal for a variety of sensor-based and mixed-signal acquisition and control applications—is used to verify design of electromechanical assemblies and physical processes. The DAC1000 system measures temperature using thermocouples, RTDs, or thermistors and other physical parameters such as displacement and strain. It also measures dc volts, currents, resistances, pulse counts, frequencies, digital state, and more. With several output possibilities—analog voltage and current DACs, pulse generators with PWM, and digital output—the system can control switches, valves, stepper motors, and other electromechanical devices.

Powerful Flexibility

The HP DAC100 combines the HP E1419A multifunction measurement and control module with the new HP E9800A DAC EXPRESS software and the new 3-slot VXI mainframe, E8408A with HP-IB or E8409A with Firewire. The HP Vee 5.0 graphical programming language can be used for applications requiring special implementations. The HP E1419A offers breakthroughs in flexibility of configuring I/O functions, ease of programming, performance and accuracy, at a surprisingly low price in VXI. It provides nearly all the functionality of separate modular cards and multiple benchtop meters including multimeters, function generators, and counters, PLUS on-board intelligent measurement analysis and control—all on a single module. The HP E1419A employs small palm-sized signal conditioning plug-ons (SCPs). These SCPs provide not only a choice of signal conditioned inputs (gain, attenuation, filtering), but a variety of input/output functions such as counter, totalizer, DAC, pulse generator, and digital input/output.

More Information

For more information, request HP DAC1000 Photo Card, HP p/n 5965-8641E, HP DAC1000 Product Note, HP p/n 5965-8642E, HP E1419A Technical Specifications, HP p/n 5965-8828E, and HP VEE Visual Programming Language Brochure, HP p/n 5965-6806EN. Additional information about HP VEE and VXI components of the HP DAC1000 may be found in the Test Software and Development Tools and the VXIbus Products sections in this catalog. For more information on-line, visit HP's data acquisition website: **http://www.hp.com/go/data_acq**



HP 75000 Series C VXI

HP 75000 Series C VXI Data Acquisition System: High-Performance

The HP 75000 Series C VXI data acquisition system products provide high-performance measurement, control, and computing capabilities that are well suited for solving major equipment, vehicle, and power system and many others—design problems. This data acquisition system is based on the HP E1413C high-performance scanning A/D, HP E1415A algorithmic closed-loop controller, new HP E1419A multifunction and control module, and the new HP E6237A real-time VXI computer or HP-UX controller.

All of HP's VXI scanning A/D and multifunction and control modules incorporate signal conditioning plug-ons (SCPs) for configuring the module for various measurement inputs and control outputs.

More Information

Please refer to the VXIbus Products section of this catalog for prices, or the Hewlett Packard System Builder's Source Book and CD, HP p/n 5965-5343E for more information on VXI Products.

For more information on-line, visit HP's data acquisition website: **http://www.hp.com/go/data_acq**

Measurement and Control VXI Modules

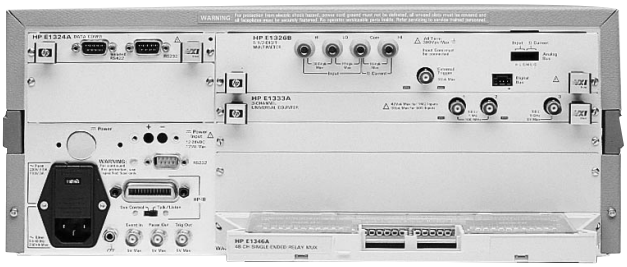
- **HP E1413C 64-Channel Scanning A/D:** This high-performance, 16-bit, 100 k-channels/s scanning A/D provides a variety of electrical and sensor-based measurements with signal conditioning (gain or attenuation and filtering). It is designed only for measurement tasks (i.e., no control outputs are available).
- **HP E1419A Multifunction Measurement and Control Module:** Similar in design to the HP E1413C, the HP E1419A is a 64-channel module with 32 channels dedicated only to non-programmable, fixed gain analog inputs. Its second 32 channels are configurable with programmable analog and digital inputs and outputs including counter, totalizer, analog output, and digital I/O for control of the device- or process-under-test.
- **HP E1415A Algorithmic Closed Loop Controller:** This 64-channel module combines the technology of the HP E1413C scanning A/D with unrestricted SCP choices (configurations for analog or digital inputs/outputs). Specialized control of 1 to 32 PID or custom control loops is available with multiple input/output connections. Algorithms with math are programmable in C.

High-Speed Transient Measurement Products

- HP E1428A Digitizing Oscilloscope
- HP E1430A 10 MSa/s 23 bit, A/D with Filter/Memory
- HP E1437A 20 MSa/s Digitizer with DSP
- HP E1563A, E1564A 800 KSa/s Digitizers

VXI Embedded Controllers (C-size)

- HP E6234A 166 MHz Intel Pentium
- HP E6237A Pentium Real-Time
- HP E1497A PA-RISC, HP-UX, 64 MHz
- HP E1498A PA-RISC, HP-UX, 100 MHz



HP 75000 Series B VXI–HP E1300A Mainframe

HP 75000 Series B VXI Data Acquisition System: Portable/Remote

The HP 75000 Series B DACQ is a family of portable data acquisition systems. These VXI-based solutions are suited for low to medium point-count applications where temperature, strain, pressure, flow, digital I/O, voltage, resistance, and frequency measurements are required. These systems may be used in a number of electro-mechanical applications where physical data must be collected. These include material evaluation, energy research, process characterization, facility monitoring, environmental control, or remote station monitoring and control.

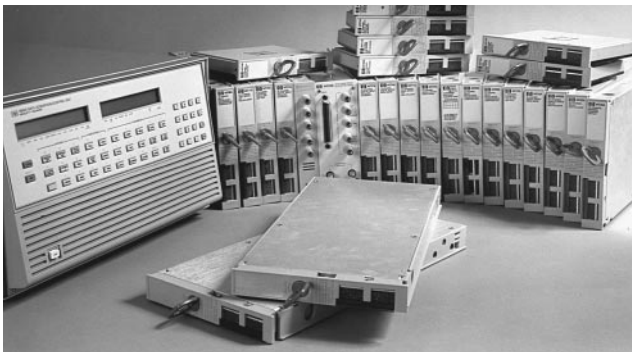
The HP E1300A/E1301A mainframes with built-in controller, optional interfaces, and battery backup, can perform remote, unattended measurements and download data via long distance phone lines to your host computer.

The HP E1302A 20-slot mainframe with HP E1306A command module may be configured as a standalone PC-based data acquisition system or integrated into a general-purpose HP-IB test system for switching applications. When combined with the HP E1313A scanning A/D, up to 64 channels per module may be scanned at a rate of 100 k-channels/s.

Ordering Information

VXI Mainframes
HP E1300A Mainframe with Blank Front Panel
HP E1301A Mainframe with Front Panel Keyboard
  Opt 009 Internal Multimeter
HP E1302A 20-Slot Mainframe
HP E1306A HP-IB Command Module

VXI Modules
HP E1313A 32/64-Channel Scanning A/D
HP E1328A 4-Channel D/A Converter
HP E1330B Quad 8-Bit Digital Input/Output
HP E1332A 4-Channel Counter/Totalizer
HP E1333A 3-Channel Universal Counter
HP E1345A 16-Channel Low-Offset Relay Mux
HP E1346A 48-Channel Single-Ended Relay Mux
HP E1347A 16-Channel T/C Low-Offset Relay Mux
HP E1351A 16-Channel Fet Multiplexer
HP E1352A 32-Channel Single-Ended Fet Mux
HP E1353A 16-Channel T/C Fet Mux
HP E1355A 8-Channel 120 Ohm Strain Relay Mux
HP E1356A 8-Channel 350 Ohm Strain Relay Mux
HP E1358A 8-Channel 350 Ohm Strain Fet Mux
HP E1364A 16-Channel Form C Switch



HP 3852A Data Acquisition and Control System

You can easily configure an HP 3852A data acquisition and control system to measure physical parameters. The HP 3852A is set up to handle many different transducer inputs, including thermocouples, thermistors, RTDs, and strain gages, as well as measuring dc volts, currents, resistances, pulse counts, frequencies, and more. The HP 3852A mainframe has eight (8) slots for plug-in function modules, and has provisions for extending the mainframe (the HP3853A) for large systems requiring more plug-in cards.

High Speed and Accurate Analog in One System

Choose from three digital voltmeters to meet your measurement needs. The voltmeters can be used in the mainframe or extenders, with multiple voltmeters allowed in each mainframe.

Versatility and Expandability

With the HP 3852A you can choose from a complete set of input and output plug-in modules providing a variety of measurement and output-controlling capabilities. Plug-in modules for the HP 3852A include a relay multiplexers, FET multiplexers, solid state relay multiplexers, analog outputs, digital inputs & outputs, a counter, and a stepper motor controller.

Front End, Computer, and Software-System

The HP 3852A has built-in, 68000-based processing to increase the speed and effectiveness of the system and to collect, analyze, and respond to data. Control decisions are handled quickly using subroutines running within the mainframe (not having to communicate via HP-IB to an external computer in every case). This intelligence can be used to return only the most significant data to the computer, increasing its efficiency with other tasks. The power of this front-end intelligence, in combination with an HP 9000 computer and data acquisition software, adapts easily to testing your product or characterizing your processes. Or, if you prefer, you may configure your system to run with a PC as the host computer, incorporating the HP-VEE graphical programming language.

Ordering Information

To order, specify an HP 3852A system with the appropriate software, controller, mainframe, extenders, function modules, racks, and extra terminal modules. The HP 3852A itself has no cost—each component of the system is priced individually. ROM revision is in brackets. Please contact The HP Call Center in your region for ROM upgrades, pricing, and information.

FFT Dynamic Signal Analyzers

DSA Accessory Catalog
5966-2340E
Standard Data Format Utilities
5091-2945E
HP 3560A Technical Data Sheet
5952-2990E
HP 35639A Demo Disk Set-Up Instructions
5963-1833E
HP 35639A Data Viewer Demo Disk
5963-1834E
HP 35639A Data Viewer Product Overview
5962-9499E
HP 3566/67A Configuration Guide
5962-7080E
HP 3566/67A Technical Specifications
5963-2343E
HP 3566/67A Product Overview
5963-2340E
HP 3569A Configuration Guide
5962-7919E
HP 3569A Technical Data Sheet
5091-4805E
HP 35665A Technical Data Sheet
5091-2492E
HP 35665A Technical Data Sheet for Acoustics
5091-2296E
HP Internet Advisor for Troubleshooting High-Speed LAN, WAN and ATM Internetworks J2300C, J2301B, J2302A, J2908A
5965-8049E
CHP 3565S Technical Data Sheet
5966-3154E
HP E1432A Technical Specification
5965-7193E
HP E1562D/E/F Technical Specifications
5965-6938E

Dimensional Measurements

Introduction to Laser Systems Brochure
5091-2507E
PC Compatible Technical Data Sheet
5091-8435E
HP 5527B Technical Data Sheet
5091-2508E

(PN 5527A/B-1) Rapid Data Collection with the HP 5527A/B Laser Position Transducer System
5952-7947
(PN 5527A/B-2) Achieving Maximum Accuracy and Repeatability with the HP 5527A/B Laser Position Transducer System
5952-7973
(PN 5527A/B-3) Advanced Measurement Techniques Using the HP 5527A/B Laser Position Transducer System
5952-8020

Data Acquisition Systems

HP DAC1000 Data Acquisition and Control System
5965-8642E
HP 34790A Data Acquisition/Switch Unit, Product Overview
5965-5290EN/EUS/EE

(PN E1415A) HP E1415A Algorithmic Closed Loop Controller
5965-3311E
(PN) HP E1413A/B/C, E1313A, and E1415A Recommended Wiring and Reduction Techniques
5965-1635E

Many of these literature pieces are available at:
http://www.hp.com/go/tmc99

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- Application Note Library
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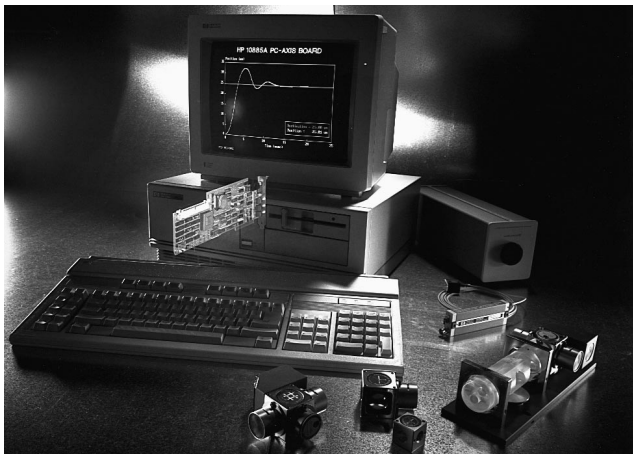
- Sales and Service Contacts
- Selection Guides
- Newsletters
- Feature Stories Showing Products in Use
- Information on Your Industry
- News Releases
- Country-Specific Sites

These features are only a snapshot of what's available at the Web site. Bookmark it—and visit it regularly—to stay completely up to date on all of HP's test and measurement solutions.

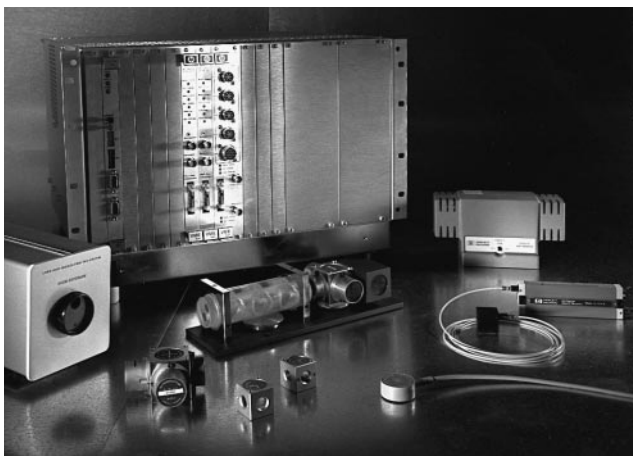
Laser Interferometers/Encoders 17

HP 5527B

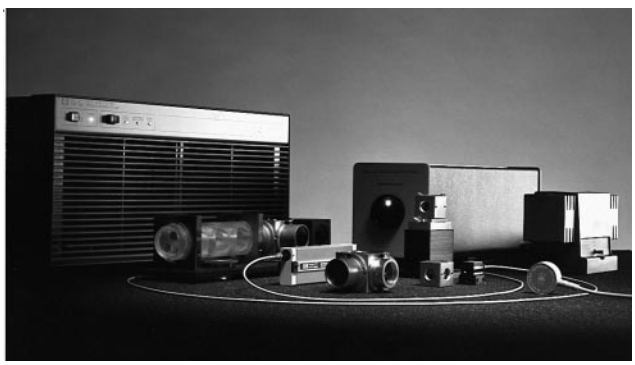
- PC-compatible and VMEbus electronics
- Resolutions to 0.3 nm, data rates to 10 MHz
- PC servo-axis board for closed-loop positioning
- Multiaxis measurements for greater control
- Wavelength-of-light compensation
- Remote sensing with fiber-optic receivers



PC-compatible laser interferometer electronics provide open- or closed-loop positioning and speed integration into the lowest-cost industry-standard backplane.



The HP 10897B High Resolution Laser Axis Board for VMEbus provides the highest position resolution commercially available and allows easy, cost-effective integration into this popular, 32-bit industry-standard backplane.



The HP 5527B Laser Interferometer Positioning System offers the greatest variety of output formats, including 32-bit position, servo-motor drive, and A-quad-B.

Precision Positioning Systems

Laser interferometer precision positioning systems—composed of electronic and optical components—provide very precise position or distance information for dimensional measurements and motion control. When built into manufacturing and inspection equipment, a laser interferometer system reports the position of a probe or controls the motion of a product platform with more accuracy than any other method.

Precision laser positioning systems improve product quality and reliability, increase manufacturing consistency for increased production yields, and allow the production of precision products that would otherwise be impossible to manufacture. Laser interferometer positioning systems are vital in many applications:

- Integrated-circuit fabrication, inspection, and repair
- Manufacture of high-capacity disk drives
- Precision machine tools
- Manufacture or calibration of other measurement scales
- Mechanical parts inspection/measurement
- Custom test and measurement
- Precise plotting
- Mechanical vibration analyis
- Antenna testing

Many of HP's innovations have resulted in products, such as digital programmable servo-control electronics for closed-loop positioning, that are unavailable from any other vendor.

System Components

Hewlett-Packard precision positioning systems combine Michelson interferometry with a two-frequency HeNe laser. HP's patented two-frequency design provides greater stability and reduced noise sensitivity, and extends the measurement range—up to 40 m (130 ft), or 80 m (260 ft) in certain circumstances. Three subsystems make up a laser interferometer system:

Laser: Supplies a monochromatic light source (or beam)
Optics: Directs the beam and generates the interference pattern
Electronics: Detects and counts the light and dark interference fringes, processes the data, and outputs distance information

HP offers the components needed to configure laser interferometer positioning systems for a broad range of applications and other requirements. All systems support the same laser sources, optics, and receivers and are primarily differentiated by the electronics.

Interferometer Electronics

HP interferometer electronics offer a choice of: backplane (interfacing characteristics), output formats, and environmental compensation options. Table 2 on page 561 summarizes the HP products based on these differentiators.

The HP product line offers interferometer electronics tailored for a variety of customer needs. For interfacing to industry-standard backplanes, the VMEbus provides a high-performance alternative and PC products provide the lowest-cost solution. Both are popular industry standards and offer system configuration flexibility. The proprietary HP 5527B offers a broader choice of output formats compared with the VMEbus and PC electronics.

Each of the electronics alternatives supports the complete range of lasers and optics. In addition, the HP 10780C receiver and HP 10780F remote receiver work with all electronics.

The HP 10737L and 10737R Compact Three-Axis Interferometers improve positioning accuracy of lower-cost equipment too compact to use the HP 10735A or 10736A.

Optics

The optics tailor each interferometer system for the physical layout and measurement requirements of each application.
HP 10702A Linear Interferometer: The basic optic for linear measurements
HP 10706A/B Plane-Mirror Interferometers: Commonly used with multiaxis stages
HP 10716A High-Resolution Interferometer: A plane-mirror interferometer with twice the resolution of the HP 10706A/B
HP 10715A Differential Interferometer: A plane-mirror interferometer for differential measurements
HP 10705A Single-Beam Interferometer: Physically smaller for confined spaces or low-mass, non-contact measurements
HP 10719A, HP 10721A One- and Two-Axis Differential Interferometers: For optimized accuracy and repeatability with IC fabrication equipment; the position of the wafer stage is directly referenced to the optics column
HP 10735A, HP 10736A Three-Axis Interferometers: Can be used in pairs to make 5 precise measurements (x, y, pitch, roll, and yaw) simultaneously for IC fabrication
HP 10737L/R Compact Three-Axis Interferometers: Multiaxis measurements for precise control of smaller, lower-cost equipment

See the table for a summary of HP reflector products and the configurations supported with HP optics.

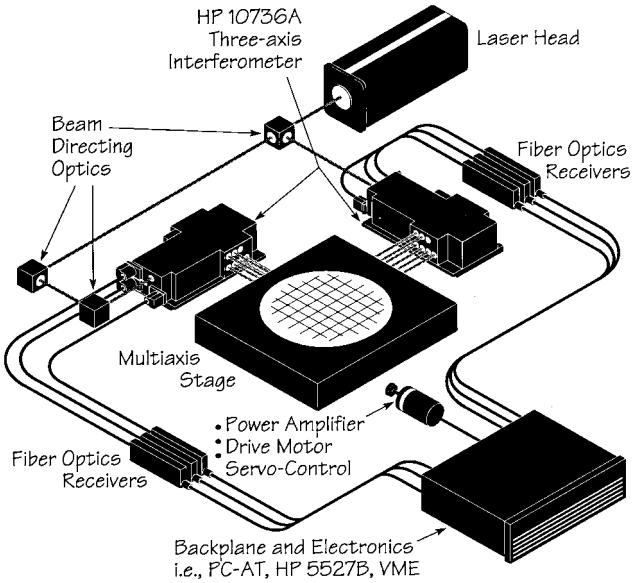
Laser Heads

Four laser heads are available for HP interferometer systems: the HP 5517A, 5517B (500-mm/second axis velocity for linear optics), 5517C (700 mm/second for linear optics), and 5517D (1000 mm/second for linear optics).

The total accuracy of an interferometer system is the sum of the errors from the laser head, the optics, and the effects of the environment. All HP laser heads have a vacuum wavelength accuracy of ±0.1 ppm. Option UK6, an NIST-traceable wavelength calibration service, is available. With this calibration, a laser's wavelength accuracy becomes ±0.02 ppm. HP laser heads have a demonstrated mean time between failure of greater than 50,000 hours.

Improving Accuracy and Repeatability

Maximum accuracy and repeatability require compensation for environmental conditions. The wavelength of light in air varies with the air's refractive index, which is a function of air temperature, pressure, and composition. In addition to the wavelength-of-light effects, errors can result from thermal expansion of the workpiece. To take full advantage of Hewlett-Packard's high-wavelength stability, the HP 10717A Wavelength Tracker compensates for changes in the air's refractive index. The HP 10780F Remote Receiver eliminates thermal effects due to the receiver electronics by using a remote, fiber-optic pickup. The HP 10896B, with wavelength-of-light compensation and material temperature measurement, increases accuracy and repeatability for VMEbus systems, and the HP 10886A provides these functions for PC-compatible systems. Product Note 5527A/B-2 (p/n 5952-7973) describes in detail how to achieve maximum accuracy and repeatability.



The HP 10735A and HP 10736A Three-Axis Interferometers offer greater accuracy for microlithography and other applications that require up to five degrees of freedom.

HP Reflectors and Interferometers: Supported Combinations

	Reflectors/Mirrors			
Interferometers	**HP 10703A, 10713B**	**HP 10704A, 10713C, D**	**HP 10724A**	**Custom Mirrors**
HP 10702A	•			
HP 10705A		•		
HP 10706A/B			•	•
HP 10716A			•	•
HP 10715A			•	•
HP 10719A, HP 10721A				•
HP 10735A, HP 10736A				•
HP 10737L/R			•	•

Key Literature

To configure and order an HP laser interferometer positioning system, please request the appropriate data sheets and ordering information from the HP Call Center in your region:

Introduction to Laser Systems Brochure, p/n 5091-2507E
Laser Head and Optics Technical Data Sheet, p/n 5964-6190E
PC Compatible Technical Data Sheet, p/n 5091-8435E
VMEbus Technical Data Sheet, p/n 5965-1569E
HP 5527B Technical Data Sheet, p/n 5091-2508E
Systems Ordering Information, p/n 5964-3700E

See the next page for information on laser system electronics.

Key Characteristics of HP Laser Interferometer Electronics

System	Backplane	Electronics	Output formats	Other differentiators
PC Compatible	ISA (PC/AT)	HP 10885A	32-bit digital (hardware output and backplane output)	Lowest-cost, most-popular, industry-standard backplane
		HP 10889B	Motor drive (in ±10 Vdc)	Servo-axis board Fast system development
		HP 10887B	32-bit digital	Part of HP 5529A calibration system
		HP 10887P	32-bit digital	Programmable version of HP 10887B
		HP 10886A	PC compensation board	Complete environmental compensation
VMEbus	VMEbus	HP 10895A	32-bit digital (hardware output and backplane output)	High-performance, robust, industry-standard 32-bit backplane
		HP 10897B	36-bit digital (hardware output and backplane output)	Highest resolution and data rate Fast system development
		HP 10896B	VME compensation board	Complete environmental compensation
HP 5527B	Proprietary	HP 5507B	32-bit digital, GPIO, HP-IB, motor drive (in ±10 Vdc, 16-bit digital, and pulse-width modulated), A-Quad-B, up/down pulse	High-performance, complete package Servo-axis board Fully compensated A-Quad-B for high-precision machine tools Complete environmental compensation

PC-Based Laser Interferometer Positioning System

The new HP 10889B PC servo-axis board is a programmable, digital servo with built-in motion control algorithms for closed-loop positioning that is compatible with the most popular PC backplane. Output is a ±10 V analog motor drive signal updated at 20 kHz. A trace function speeds and simplifies servo-loop characterization and tuning. The HP 10885A PC axis board provides a 32-bit digital, real-time position output via hardware, and position can also be read over the backplane. The HP 10886A PC compensation board increases accuracy and repeatability of systems using either the HP 10889B or HP 10885A by compensating for environmental conditions using HP environmental sensors. Combining the high performance of HP laser interferometers with the most popular, lowest-priced, industry-standard backplane speeds system development and reduces system costs.

VMEbus Laser Interferometer Positioning System

The HP 10897B high-resolution laser axis board provides the highest position resolution commercially available (up to 0.3 nm) at a 10 MHz rate for the most demanding applications. Position data is output in 36-bit format for very high performance closed-loop positioning systems. The HP 10895A laser axis board provides output in 32-bit format for typical applications. Both boards provide a hardware position output and also output position over the VMEbus backplane. The HP 10896B compensation board increases the accuracy and repeatability of systems using either the HP 10897B or 10895A by compensating for environmental conditions using HP or custom environmental sensors. All HP laser electronics for VMEbus are compatible with VME Rev. C.1 providing easy, cost-effective integration into VMEbus.

HP 5527B Laser Interferometer System

The HP 5527B can be configured for closed- or open-loop control, automatic compensation for environmental effects, and special prototyping abilities for custom electronics.

The HP 5507B system electronics for the HP 5527B combine superior perfomance with ease of use and full EMC compliance. The system is controlled with HP-IB, GPIO, or serial (RS-232). Five outputs are available depending on the boards used:

HP 10932B Axis Board: Open-loop measurements or position data for custom closed-loop positioning. Outputs are in 32-bit digital format, and are available directly and over HP-IB.

HP 10934A A-Quad-B Board: Provides high-resolution, A-Quad-B and Up/Down pulse outputs with full environmental compensation.

HP 10936B Servo-Axis Board: Closed-loop motor drive outputs for a range of motor amplifiers. Motor-drive outputs are ±10 V analog, 16-bit digital, or pulse-width modulated for precision positioning. The HP 10936B is a programmable digital servo with built-in motion control algorithms; custom algorithms can be downloaded. A trace function speeds and simplifies servo-loop characterization and position control.

HP 10941A Prototyping Board: Capabilities for custom electronic designs.

HP 10946C Automatic Compensation Board: With HP 10717A wavelength tracker and/or HP 10751A air sensor and HP 10757A material temperature sensor, automatically compensates for wavelength-of-light and material temperature effects.

System Specifications

	PC Compatible	VMEbus	HP 5527B
Accuracy			
Vacuum	0.1 ppm	0.1 ppm	0.1 ppm
Vacuum with MIL-STD-45662A	0.02 ppm	0.02 ppm	0.02 ppm
Maximum resolution			
Linear optics	5 nm	1.2 nm	10 nm
Plane mirror optics	2.5 nm	0.6 nm	5 nm
High-res. optics	1.2 nm	0.3 nm	2.5 nm
Maximum axis velocity			
Linear optics	1000 mm/s	1000 mm/s	700 mm/s
Plane mirror optics	500 mm/s	500 mm/s	350 mm/s
High-res. optics	250 mm/s	250 mm/s	175 mm/s
Maximum optical range	40 m	40 m	40 m
Maximum hardware data output rates			
Position/position error	3.0 MHz	10.0 MHz	3.0 MHz
A-Quad-B (transition rate)	N/A	N/A	5.2 MHz
Up-down pulse	N/A	N/A	5.2 MHz
Motor-drive	20 kHz	N/A	8 kHz
Environmental compensation	Yes	Yes	Yes

- Calibration of machine tools, CMMs, pick and place machines, robots, and machines with precision movement
- Comprehensive calibration
- Flexible triggering and parameter setting
- Minimum machine downtime with easy control through MS-Windows
- Graphical output provides conformance to seven international standards
- Complete localization in eight languages
- Customized compensation table enables improved performance

HP 5529A Dynamic Calibrator for Flexible, Comprehensive Calibration

The HP 5529A dynamic calibrator is a high-performance calibration tool for most equipment with precision movement. This calibrator minimizes downtime and enables conformance to international standards with its powerful measurement capability. The HP 5529A is a laser-based machine tool calibration system consisting of a laser head, optics, PC-based electronics, and Microsoft Windows®-based software that operates in an IBM-PC-style (ISA bus) computer.

Comprehensive Measurements

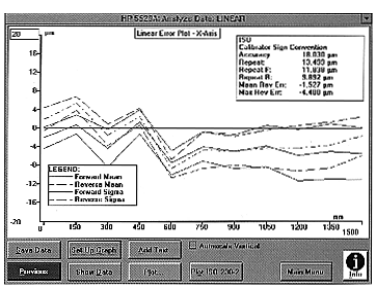
- Linear
- Angular
- Straightness
- Squareness
- Way straightness
- Parallelism
- Flatness
- Timebase
- Ballbar
- Diagonal
- Thermal drift
- 2-axis
- Rotary table

Flexible Triggering

- Manual
- Automatic
- A-Quad-B

Flexible Parameters

- Environmental compensation
- English/metric units
- 0 to 10 seconds averaging
- Measurement target lists
- CNC compensation table



Linear Plot Using ISO 230-2

Conform to Seven International Standards

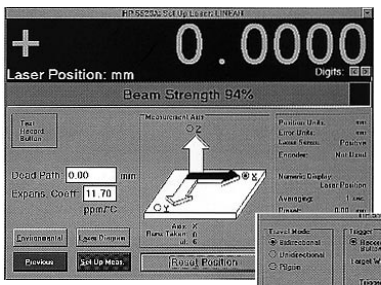
Today's world market requires many manufacturers to conform with a specific international standard. The HP 5529A provides graphical output that shows your machines' conformance with seven international standards:

- ISO 230-2
- NMTBA
- ANSI B5.54
- BSI
- VDI
- JIS
- GB 10931-89

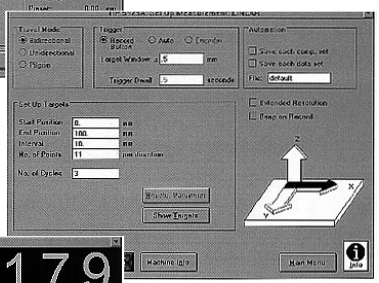
Minimize Machine Downtime

The HP 5529A is easy to control because of its simple-to-use Windows interface. Measurements are made in three steps: set up laser, set up measurement, then collect data. The standard user interface based on Windows provides in-depth help every step of the calibration, including detailed drawings showing the setup for each measurement.

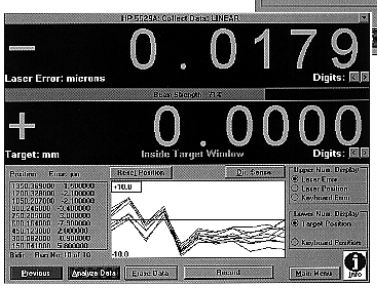
Training on the system is available at the HP factory, and HP consulting is available at your site.



Set Up Laser



Set Up Measurement



Collect Data

Available in Eight Languages

Complete documentation, control, and on-line help is available in eight languages:

- English
- French
- Spanish
- German
- Italian
- Japanese
- Chinese (PRC)
- Chinese (ROC)

Brief Specifications

Data Rate: Up to 33 kHz

Linear

Accuracy (range): ±0.02 ppm to ±3.0 ppm
Resolution: Down to 1 nm
Range: Up to 80 meters

Angular

Resolution: Down to 0.005 arc seconds
Range: ±20°

Key Literature

HP 5529A Brochure, p/n 5964-3568E
HP 5529A Price List, p/n 5966-3285EUS
HP 5529A Spec Sheet, p/n 5964-9307E

Ordering Information

HP 5529A Dynamic Calibrator

HP E1710A
HP E1720A

- Data Storage: Servo Writing, Spinstands, HGA Testers
- Dimensional metrology

NEW

Angular Encoder System (E1710A) with master arm assembly and mechanical pushpin

HP E1710A/E1720A Encoder Systems

The HP E1710A Angular and HP E1720A Linear Encoder Systems are PC-compatible sets of opto-mechanical and electronic components. They provide ultra-high resolution (16 nanoradians angular or 0.6 nm linear) measurements and servo-controlled positioning for use in dimensional metrology and motion control. They are compact, integrated solutions for precisely-controlled angular or linear positioning used in writing servotracks in the data storage industry. Individual components of the HP E1710A and HP E1720A systems are available if you wish to integrate specific HP E1710A or HP E1720A functions into systems of your own design. The HP E1710A is available with the HP E1710A Option 001 Master Arm Assembly. This combines a power amplifier, motor, arm and mechanical pushpin (HP E1710A Option 002) in an easy-to-use, integrated package.

Increase Storage Densities through Greater Track-to-Track Accuracy (10 nm)

The HP Encoder Systems are immune to turbulence created by spinning disks as well as from other changing conditions of the servotrack writing environment. This translates into superior track-to-track accuracy in measuring and controlling the drive arm.

Simplify Servo Designing Tasks with HP Electronics

Why spend valuable resources designing a custom servo capability when you can buy a cost-effective, easy-to-use electronics board from a leader in electronics for servotrack writing applications?

Lower Your System Cost

HP Encoder Systems are designed for cost efficiency. They have few components, and there is no need for alignment if you purchase an HP factory-assembled and fully-tested system, including the master arm assembly. Their rugged construction provides long-term reliable performance.

System Components

The HP E1710A and HP E1720A Encoder Systems consist of the components described below:

HP E1711A Sensor Head

The sensor head uses an infrared laser diode and interferometric technique to read the displacement of the scale relative to the sensor head. The lines on the scale are imaged onto a detector which at all times views and averages more than 10 radial markings. This results in highly linear measurements with relatively high immunity to dirt on the scale. The base of the sensor head has precisely machined holes for locating pins to facilitate accurate mounting in user-supplied hardware.

HP E1712A Scale (specify by option code)

The standard linear scale (Option 011) is 75 mm long, on a glass plate 1.5 mm thick. The standard angular scale (Option 038) is designed to be mounted so that the encoder markings are centered at a radius of 38.2 mm measured from the axis of rotation. Registration marks are provided on the angular encoder to assist in accurately positioning it at the design radius.

HP E1713A Scale Servo Axis Board

This new 8-bit PC/AT-compatible board processes the signals from the sensor head to provide a 32-bit position word at a dedicated connector and on the ISA bus. The position word can be used to control either the onboard servo or a user-provided servo. The onboard servo runs a proportional-integral-differential (PID) or infinite-impulse-response (IIR) equation for a single measurement axis, and generates a ±10-volt output signal to either the servo amplifier and Voice Coil Motor (VCM) of the HP E1714A Master Arm Assembly, or a user-provided servo-amplifier motor. The servo axis board also has a provision for adding a 16-bit value to the control loop for systems using multiple inputs. The board comes with the following software: Tune Program, Demo Program, and a library of functions (ANSI C source code). The user's manual (HP E1710A Option 101) includes the procedure for setting the PID coefficients. (The firmware and software used for servo functions are based on those used with the HP 10889B Servo Axis Board.)

HP E1714A (HP E1710A Option 001) Master Arm Assembly (applies to angular system only)

This assembly is specifically designed for servotrack writing applications. It is provided with the HP E1712A Scale attached at the proper radius on the master arm. It contains a Voice Coil Motor and servo amplifier which drive the master arm over a range of ± 20 degrees.

Non-Contact Push Pin Sensor, E1721A

HP E1721A Non-Contact Push Pin Sensor

The HP E1721A Non-contact Push Pin (NCPP) Sensor is an optical replacement for the mechanical push pin. Because no physical contact is being made with the head stack assembly (HSA), the NCPP offers the advantage of not introducing any new resonances to, or changing existing resonances in, the servtotrack writing process. Furthermore, stiction errors are eliminated.

The sensor head of the NCPP is attached to the servotrack writer's (STW's) master arm. It contains a laser diode, optics, and a detector. The laser diode's focused beam reflects off a target feature on the E-block or suspension of the HSA. The image formed by the target feature is itself imaged onto the detector. The detector signals are then electronically processed to provide an error signal which is proportional to the relative displacement between the master arm and the HSA. This signal is used to servo-control the position of the HSA to the position of the master arm with the HP E1723A DSP Servo-Axis Board or customer-supplied electronics.

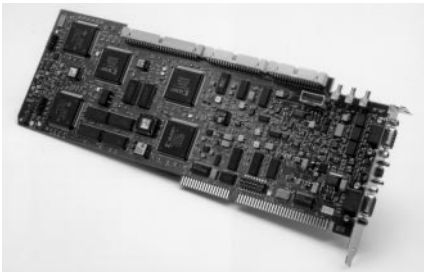
The HP E1721A is a Class II laser device with continuous power, single mode laser output, with a wavelength of 670 nm typical and an output power of 1mW max.

The following options are available with the HP E1721A Non-contact Push Pin Sensor:

HP E1721A Opt. 001: Add NCPP Cable (connects pre-amp module to HP E1723A DSP Servo-Axis Board)

HP E1721A Opt. 002: Add RS-232C cable 3m, 9M D to 9F D (connects 9F D connector to Customer-supplied electronics)

HP E1721A Opt. 101: Operating Manual (English version)



HP E1723A DSP Servo-Axis Board

The HP E1723A DSP Servo-Axis Board is a user-programmable, two-axis servo card with custom input circuitry for each axis. The board can be used with one axis controlling the HP E1710A or HP E1720A Encoder System (i.e., HP E1711A Sensor Head), and one axis controlling the HP E1721A Non-contact Push Pin (NCPP) Sensor.

You may choose to:

- Write your own low-level programming code (using program development information provided by HP and Texas Instruments) to control the DSP to implement specialized control systems, or
- Use the supplied software to download coefficients for running PID equations (with feedforward) or IIR (to 8th order) along with factors for notch and low-pass filters on each axis.

Axis #1

This axis accepts its input from the HP E1711A Encoder sensor head. In a typical system, the HP E1711A monitors the position of a linear or angular scale, and outputs an analog voltage used to control stage position.

Axis #2

This axis accepts its input from the HP E1721A Non-contact Push Pin (NCPP) sensor head. In the typical application, the NCPP sensor head monitors a target feature located on the stage to be controlled. The sensor head detects optically whether the target is to the right, left, or centered relative to the sensor head. A signal from the sensor is processed through the servo equation to produce a voltage used to control the stage carrying the target feature to keep it in a fixed position relative to the sensor head ("nulling servo").

Mechanical Dimensions

Standard full length AT-size board which supports 16-bit data bus transfers. The standard HP E1723A ships with 128k onboard memory.

The following options are available with the HP E1723A DSP Servo-Axis Board:

HP E1723A Opt. 001: Add NCPP cable
HP E1723A Opt. 002: Deep Memory (512k bytes)
HP E1723A Opt. 101: Add (English version) Operating Manual and System Software

HP E1710A/20A Encoder Systems(Sensor Head, Scale and Servo Board)

	HP E1710A[1] Angular Encoder	HP E1720A Linear Encoder
Repeatability	0.05 μrad	± 2 nm
System resolution (LSB)	16 nanoradians (8 nanoradians LSB)	0.6 nm (0.3 nm LSB)
Track-to-track accuracy	≤0.25 μrad (250 μrad span)	≤10 nm (10 μm span)
Long range accuracy	≤0.19%[3] (40 degree sweep)	±200 nm
Range	±20 degree	75 mm std.[4]
Sensor head dimensions	61 mm x 33 mm x 17 mm	61 mm x 33 mm x 17 mm
Scale dimensions	30 mm x 7 mm x 1.5 mm	75 mm x 9.2 mm x 1.5 mm[4]
Operating temperature range	15° C to 40° C	15° C to 40° C
Velocity	22.2 radians/s	850 mm/s
Power requirements[2] (via HP E1713A)	+5 Vdc @ 2 amps +12 Vdc @ 1.2 amps –12 Vdc @ 0.09 amp (with HP E1714A)	+5 Vdc @ 2 amps +12 Vdc @ 0.2 amps –12 Vdc @ 0.09 amp

[1] For angular system, scale radius =38.2 mm, other radii available
[2] Power for HP E1711A Sensor Head and HP E1713A Servo Axis Card
[3] 0.19%=0.0004% (scale tolerance) + mounting eccentricity
[4] Up to 150 mm length scale can be provided. Contact factory regarding your needs.

HP E1713A Scale Servo Axis Board

Motor Drive Output: ±10 volts with 0.3 mV resolution, updated at the sample rate. Programmable limit centered on zero volts.
Sample Rate: Up to 20 kHz (depends on equation used)
Hardware Position Output: 32-bit, updated at 400 kHz
Servo Equations: PID with feedforward or up to third order IIR
Data Age: 6.56 μsec (top connector)
Interface: Full size PC-compatible card. 8-bit ISA bus interface.

HP E1714A Master Arm Assembly

Track-to-Track Step and Settle Time:
5 msec typical for a 65 μrad step (2.5 μm step at R = 38.2 mm)
Servo Bandwidth: 200 Hz
Angular Range: ±20°
Mechanical Pushpin Radial Location Range: 15–55 mm
Operating Temperature: 0° C to 40° C
Torque: 0 –6V 0.0093 N–m/V; 6 –10V 0.056 N–m
Power Requirements: +12V @ 1 amp

Note: When ordered with the HP E1710A system, the master arm is ordered as HP E1710A Option 001.

HP E1721A Non-Contact Push Pin (NCPP) Sensor Specifications

Noise Equivalent Displacement: ≤ –1 nm rms (B/W = 3.5 kHz)
Error Slope Around Null: 0.18 mV/nm nominal
Operating Temperature Range: 15 - 40°C
NCPP Head Dimensions: 21.3 mm x 17.5 mm x 8.0 mm
Pre-amp Module Dimensions: 48 mm x 31.8 mm x 13.7 mm
Mass of Sensor Head: 6 g nominal
Standoff Distance, concave target: 14.0 mm nominal (24.75 mm +/- 0.25 mm from center of alignment holes to bottom of target feature)
Laser Output: 670 nm typical, single mode, continuous power, 1 mW max., Class II laser
First Mechanical Resonance: ≥ 4 kHz
Capture Range (before initialization)**:** ≥ 20 μm
Target Feature: The target is a reflective, concave or convex, cylindrical feature with radius of 0.5 mm +/- 0.1 mm
Cable and Connectors: The sensor head is connected to the remote pre-amp via a printed circuit flex cable. The remote pre-amp is terminated in a standard 9-pin D connector.
Mounting Method: Two locating holes are provided as well as tapped holes for M3 x 0.5 screws (clearance holes for M2 screws).

HP E1723A DSP Servo-Axis Board Specifications and Features

Axis #1 Resolution: 0.6 nm
Axis #2 Resolution: < 2 nm
Sample Rate: 50 kHz (both axes running, with each axis running 4 biquads to process the position error signal, and another 4 biquads that process the position error plus feed forward value)
DSP Used: Texas Instruments TMS320C32-60; DSP code customer programmable, and can be stored in flash memory
Input/Output: Auxiliary digital input port (16 bit) which can be directed to either servo; Auxiliary digital output port (16 bit) which can be directed to either servo; Auxiliary analog input and output port which can be connected to either servo; Output port (analog) for motor drive (+/- 10 V output, 0.305 mV resolution) on each axis

Ordering Information

HP E1710A Angular Encoder Sytem
(38.2 mm radius scale is standard)
HP E1711A Sensor Head (Sensor Head Cable included)
HP E1712A Scale (order with an option code)
HP E1713A Scale Servo Axis Board
HP E1714A Master Arm Assembly (with standard 38.2 mm scale included on arm)
HP E1720A Linear Encoder System
(75 mm lenth scale is standard)
HP E1721A Non-contact Push Pin (NCPP) Sensor
HP E1723A DSP Servo-Axis Board

For available options, contact your local HP Call Center.

HP 5529A/55291A Verify Machine Performance with the World Standard for Laser-based Technology
5968-0111E

HP E1710A/E1720A Encoder Systems
5966-4875E

HP E1710A/E1720A Push the Limits on Disk Drive Track Density with the Highest Available Resolution
5965-6899E

HP E 1721A Non-contact Push Pin and Pre-Amp Module
5966-1959E

HP E1723A DSP Servo-Axis Board
5966-1960E

HP 5529A Dynamic Calibrator
5964-9307E

HP 55290A Angular Position Measurement Kit
5965-0855E

HP 10895A/96A/97A High Performance Laser Interferometer Positioning Systems for VMEbus
5965-1569E

Choose from a Large Selection of Optical Components for System Design Flexibility
5964-6190E

HP E3660A
HP E3905A
HP E3661A
HP E3662A
HP E7590A

The Rack Solution for HP Systems

Hewlett-Packard offers 19-inch EIA (Electronics Industries Association) rack cabinets tailored to meet the needs of HP test and measurement instrumentation customers. Rackmounting is fast and easy with unique column and rail design features. A selection of options and accessories provides flexibility to meet the vast majority of racking applications.

Enhance Your Instrument Investment

HP racks are specifically designed for HP's test and measurement equipment, virtually ensuring a perfect fit. Designed for today's competitive environment, four heights are offered to accommodate any system: 1.1 m, 1.3 m, 1.6 m, and 2.0 m. All racks are deep enough to hold HP instruments of varying sizes.

The attractive exterior color, offered in parchment white or quartz gray, and contemporary design coordinate with HP instrumentation. Standard with all racks are the top, side panels, solid base, anti-tip foot, 3-inch heavy-duty casters, one pair of System II rails, and lockable rear door. Delivery is based on customer requirements.

Load a Rack in Less Time

The design of HP columns and support rails can cut in half the time required to install equipment in a rack. The rails hang on discrete slots on the vertical mounting columns, corresponding to each EIA unit in the rack. Vertical adjustment between instruments is minimized by selecting the proper rail. The system was specifically designed to minimize the time required to install HP instrumentation and computers, and can be used with other equipment as well.

Rack Systems Fast and Easy

Racks are shipped already assembled, ready for immediate configuration. No time is lost assembling racks or tracking down missing parts.

More than just a way of storing instruments, the racks reflect HP's reputation for quality and design. A sturdy frame provides structural integrity, which allows lightweight, easy-to-lift off side panels for installation and easy access to equipment and cables. Rails are placed into keyed slots in the vertical columns, resulting in quick and accurate positioning.

Use Vertical Space Efficiently

Vertical space within a rack is measured in industry-standard EIA units, where 1 EIA unit = 1.75 inches (44.5 mm). Equipment height is often specified in EIA units.

Triangle cutouts on the front of the vertical columns show the top and bottom of each EIA unit and help assure proper placement of each instrument. Counting EIA units from the base of the rack is also easy since every fifth rail cutout is notched for easy counting.

Manage Power Requirements

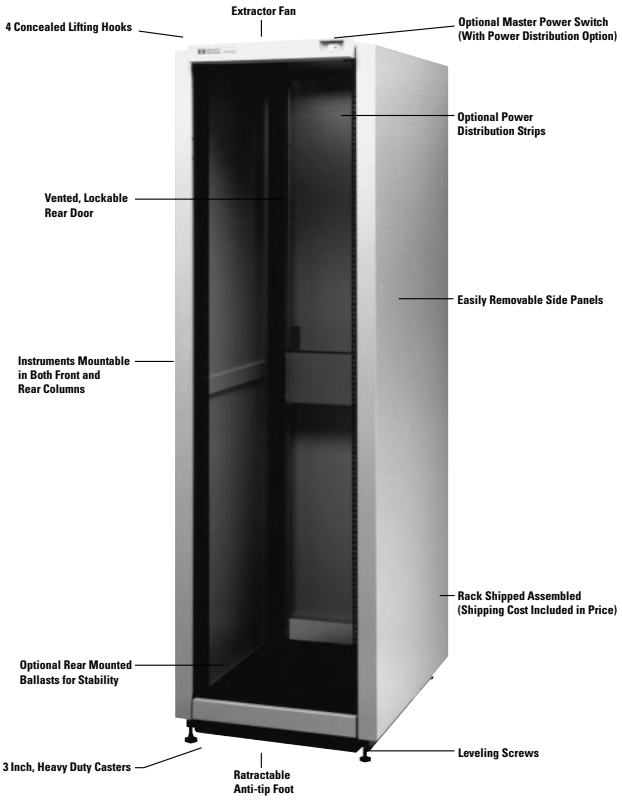
A power management system is available by selecting an optional power distribution unit (PDU) that is mounted to the rear column and supplies power to the cabinet. It is controlled by a single, illuminated master switch located on the front of the rack. This switch is included when power option is selected.[1]

Protect from Heat Buildup

System-generated heat is removed by natural convection through a ventilation path incorporated in the roof of the racks. For greater heat dissipation, an optional top-mounted extractor fan is available.

Secure Instruments During Test

Both the rear door and the optional Plexiglas front door can be locked to secure against disruption of tests or unauthorized removal of system components. The symmetrical door design allows it to be mounted for opening to either left or right, useful for multi-bay applications.



Move Racks Easily

Each rack is provided with four 3-inch diameter, smooth-rolling, heavy-duty casters to facilitate moving racks over short distances. Four lifting hooks conveniently concealed in the top of the rack allow for transport, even when fully loaded. Each hook can support 227 kg (500 lbs) to easily handle the maximum recommended gross weight for a loaded rack of 816 kg (1800 lbs).

Enhance Stability

A retractable anti-tip stabilizer that can be extended into place with ease is standard on all racks. It provides temporary anti-tip capability for slide-mounted products when they are in their extended position. Use the optional anti-tip ballast accessory when permanent anti-tip capability is desired.

Improve Cable Management

An additional 100 mm of internal space is available at the rear of the rack for installation of PDUs and as a convenient location for cables, which are routed out the bottom of the rack. The added rear space also enhances air flow.

HP Rack Options and Accessories

HP rack options and accessories provide configuration flexibility. To ensure the correct combination of options for each particular need, many options are designed to work together, such as a fan and a PDU.

[1] If a customer chooses to order a rack without the power option, the customer will receive the rack without the PDU and with a blank forehead bezel. A basic rack without the power options can be shipped to customers who want to develop their own power configuration. Racks ordered without the power option will be delivered to customers with a blank forehead bezel, which does not include a cut-out for the power switch. If a customer should decide to order a PDU in the future, that customer will have to order it with PDU Installation Kit (E4472A or E7685A) and PDU as an accessory product number.

HP E3660A/E3905A/E3661A/E3662A/E7590A Rack Specifications

	Height	Width	Depth	EIA units
E3660A				
Exterior	1120 mm (44.1 in.)	600 mm (23.6 in.)	905 mm (35.6 in.)	21
*Interior	933.45 mm (36.8 in.)	450.8 mm (17.8 in.)	851 mm (33.5 in.)	
E3905A/ E7590A				
Exterior	1320 mm (51.9 in.)	600 mm (23.6 in.)	905 mm (35.6 in.)	25
*Interior	1111.25 mm (43.8 in.)	450.8 mm (17.8 in.)	851 mm (33.5 in.)	
E3661A				
Exterior	1620 mm (63.8 in.)	600 mm (23.6 in.)	905 mm (35.6 in.)	32
*Interior	1422.5 mm (56.0 in.)	450.8 mm (17.8 in.)	851 mm (33.5 in.)	
E3662A				
Exterior	2020 mm (79.5 in.)	600 mm (23.6 in.)	905 mm (35.6 in.)	41
*Interior	1822.5 mm (71.8 in.)	450.8 mm (17.8 in.)	851 mm (33.5 in.)	

Front to rear column hole spacing: 610 mm (24 in.)
*Interior = EIA units = Rackmountable space

Weight

Rack:
E3660A 81 kg (179 lb) empty
E3905A/E7590A 89 kg (196 lbs) empty
E3661A 100 kg (221 lbs) empty
E3662A 116 kg (255 lbs) empty

Casters Rating:
318 kg (700 lbs) each, 816 kg (1800 lbs) total

Lift Hook Rating:
227 kg (500 lbs) each

Total system and cabinet weight is a maximum 816 kg (1800 lbs) static. Lift cabinet using all four (4) hooks.

Ordering Information

Racks
HP E3660A Rack, 1100 mm (1.1 m) (parchment white)
HP E3905A Rack, 1300 mm (1.3 m) (parchment white)
HP E7590A Rack, 1300 mm (1.3 m) (quartz gray)
HP E3661A Rack, 1600 mm (1.6 m) (parchment white)
HP E3662A Rack, 2000 mm (2.0 m) (parchment white)
Opt AW3 100/120 V North America PDU
For 1.1 m and 1.3 m rack (parchment only)
For 1.6 m and 2.0 m rack
Opt AW5 200/240 V International PDU
For 1.1 m and 1.3 m rack (parchment only)
For 1.6 m and 2.0 m rack
Bare Rack: Each bare rack model includes 3-inch heavy duty casters, solid base with retractable anti-tip foot, vented top, lifting hooks under vented top, System II rail kit. (Please order rear door and side panel as accessories.)
HP E3661A Option AXH Bare Rack Cabinet, 1.6 meter (63.8 inches) high, 32 EIA units
HP E3662A Option AXH Bare Rack Cabinet, 2.0 meter (79.5 inches) high, 41 EIA units

Rear Doors
HP E4476A 1.6 meter Solid Rear Door Kit (parchment white)
HP E4477A 1.6 meter Vented Rear Door Kit (parchment white)
HP E4478A 2.0 meter Solid Rear Door Kit (parchment white)
HP E4479A 2.0 meter Vented Rear Door Kit (parchment white)

Side Panels
HP E4458A 1.6 meter Side Panel Kit (parchment white)
HP E4459A 2.0 meter Side Panel Kit (parchment white)

Extractor Fans
HP E4470A 100/120 V Top-Mounted Extractor Fan
HP E4471A 200/240 V Top-Mounted Extractor Fan

Additional PDUs
HP E4451A 100/120 V North America PDU for E3660A, E3905A
HP E4452A 200/240 V North America PDU for E3660A, E3905A
HP E4453A 200/240 V International PDU for E3660A, E3905A
HP E4455A 100/120 V North America PDU for E3661A, E3662A
HP E4456B 200/240 V North America PDU for E3661A, E3662A
HP E4457B 200/240 V International PDU for E3661A, E3662A
HP E4472A PDU Installation Kit (parchment white)
Order one for first PDU in cabinet (1.1 m, 1.3 m, 1.6 m or 2 m) but not along with options AW3 or AW5. Includes PDU mounting bracket and replacement forehead bezel for mounting power switch.
HP E7685A PDU Installation Kit (quartz gray)

Lockable, Plexiglas Front Doors
HP E4460A 1.1 m Front Door for E3660A (parchment white)
HP E4461A 1.3 m Front Door for E3905A (parchment white)
HP E4462A 1.6 m Front Door for E3661A (parchment white)
HP E4463A 2.0 m Front Door for E3662A (parchment white)

Tie-Together Kits
HP E4466A 1.1 m Tie Kit for E3660A (parchment white)
HP E4467A 1.3 m Tie Kit for E3905A (parchment white)
HP E4468A 1.6 m Tie Kit for E3661A (parchment white)
HP E4469A 2.0 m Tie Kit for E3662A (parchment white)

Accessories
HP E3663A Support Rail (HP System II)
HP E3664A Support Rail (Third-party products)
HP E3665A Support Rail (HP VXI)
HP E3666A Plain Shelf
HP E3900A Keyboard Kit (parchment white)
HP E4079A Retractable Keyboard Kit (parchment white)
HP J1518A Retractable Keyboard Kit (quartz gray)
HP E7714A Fixed Keyboard Kit (quartz gray)
HP 35181C Drawer Unit (89 mm)
HP 35181G Drawer Unit (133 mm)
HP 46298R Mounting Hardware

Parchment	Quartz	
HP 40101A	**E7731A**	1-EIA Filler Panel
HP 40102A	**E7732A**	2-EIA Filler Panel
HP 40103A	**E7733A**	3-EIA Filler Panel
HP 40104A	**E7734A**	4-EIA Filler Panel
HP 40105A	**E7735A**	5-EIA Filler Panel
HP 40106A	**E7736A**	6-EIA Filler Panel
HP 40107A	**E7737A**	7-EIA Filler Panel

HP E3668A Feedthrough Panel (plain)
HP E3669A Feedthrough Panel (BNC)
HP C2790A Ballast 14 kg (30 lb)
HP 35199A Vectra SPU Rackmount Kit (HP 12679B Rail Kit required) (QS20)
HP J1519A Monitor Rackmount Kit (parchment white)
HP E7709A Monitor Rackmount Kit (quartz gray)
HP 5181-8707 IEC-320 Male Power Cable Replacement Plug
HP 8120-1575 IEC-320 Female-male Power Cables/ 720 mm (30 in) long
HP 8120-1860 IEC-320 Female-male Power Cables/ 1524 mm (60 in) long

For additional information, see the Rack Solutions Catalog, p/n 5965-9759EN/5965-9759EUS, or visit the Enclosures website:
http://www.hp.com/go/enclosures

HPC 2950A and C2951A Cables

HP 10834A HP-IB Adapter

ITEL 45CHVUC Converter

IEEE 1284-Compliant Parallel Printer Cables

HP DeskJet/Laser Parallel Printer Cables are IEEE-1284 compliant for the highest level of printer performance. These cables provide full access to the feature sets of today's advanced printers, allowing intelligent peripherals to "talk" and "listen" to their host, and resolving the bottlenecks that can occur when sending information from PC to printer and vice versa.

IEEE-1284 compliance is important. This industry standard defines the requirements for bi-directional parallel communication between personal computers and printers. It specifies electrical interfaces, cable construction, and interface hardware for high-performance cables, as well as three connector types: 1284-A, 1284-B, and the new 1284-C. These cables are designed for improved protection against radio frequency interference (RFI), electro-static discharge (ESD) damage, and data loss due to poor quality construction or crosstalk.

Because no defined, approved standard for printer cables existed prior to this, there was no consistency in cable quality and performance levels. The IEEE-1284 standard ensures a consistent level of high performance and access to features, like self-diagnostics and automatic font loading, provided by today's high performance printers.

Interface Converter for HP-IB Controllers

HP offers an inexpensive solution for HP-IB controllers: ITEL 45 CHVUC/EC converters. These converters enable users of HP-IB controllers to connect to a wide array of HP parallel printers, including the HP LaserJet and DeskJet family of printers.

These converters have been tested and approved by HP to work with HP-IB controllers without additional programming. Small and simple to install, they feature switch-selectable addresses and variable resolution to automatically adjust the size of graphics for HP printers, eliminating too-small and off-the-page printouts.

ITEL converters also allow Portrait-orientation printing on DeskJet Printers, as well as both Portrait- and Landscape-orientation printing on HP LaserJet and DeskJet 1200/1600 printers.

Because they also have HP-GL Mode, ITEL 45 converters allow HP LaserJet printers with PCL5 to be configured as plotters for instrumentation applications that do not require a response back from the plotter. Color and Speed modes also allow instruments designed to use HP PaintJet printers to print to most HP color DeskJet printers.

HP-IB Interconnection Cables

Cables for interconnecting HP-IB devices are available in six lengths. The connector block at both ends of the cable has a plug on one side and a matching receptacle on the other so that several cables may be conveniently daisychained, thus simplifying system interconnection. Lock screws securely mount each connector block to an HP-IB instrument or to another connector block.

HP 10833 cables feature an improved shielding design to help reduce RFI levels in systems. This series of cables has significantly lower radiated emissions than previous HP-IB cables.

The HP 10834A shielded HP-IB to HP-IB adapter provides additional clearance (approximately 2.3 cm) between the HP-IB cable and the rear panel of the instrument. This allows easier access to switches, cables, and other connectors in close proximity to the connector.

HP C2904A SCSI Terminator

SCSI Cables for Hosts and Peripherals

HP SCSI cables are the critical link for transferring information from host to peripheral, between hosts, or between peripherals.

SCSI-2 1-meter cables allow 16-bit data transmission at 20 megabytes per second, for shorter, slower-speed transmissions. For higher speed transmissions at longer lengths, select SCSI-3 10-meter cables. These cables allow 16-bit data transmission at 40 megabytes per second, and feature Ultra/Flex jacketing for greater flexibility and easier routing.

SCSI active terminators offer quality data transmission signals because the 110-ohm impedance matching series resistors and voltage regulation provided limit the line voltage between 2.7 volts and 2.85 volts. These terminators work with cable lengths of less than 3 meters.

SCSI differential terminators offer even higher quality data transmission, plus a noise-rejection feature to eliminate common mode noise, ground loops and crosstalk. These terminators allows cable runs as long as 25 meters.

Ordering Information

Parallel Printer Cables
HP C2950A HP LaserJet and DeskJet Printer Cable, IEEE 1284-compatible, A-B parallel 2 m (6.6 ft.)
HP C2951A HP LaserJet and DeskJet Printer Cable, IEEE 1284-compatible, A-B parallel 3 m (9.9 ft.)
HP-IB Cables
HP 10833A HP-IB Cable, 1 m (3.3 ft)
HP 10833B HP-IB Cable, 2 m (6.6 ft)
HP 10833C HP-IB Cable, 4 m (13.2 ft)
HP 10833D HP-IB Cable, 0.5 m (1.6 ft)
HP 10833F HP-IB Cable, 6 m (18.5 ft)
HP 10833G HP-IB Cable, 8 m (26 ft)
HP 10834A Adapter
Converters
ITEL 45CHVUC HP-IB to Centronics Parallel Bus Converter
ITEL 45CHVEC HP-IB to Centronic Parallel Bus Converter (European version)
Must order power supply separately. Ask for one of the following part numbers:
F1011A ABG Australasia
F1011A ABU United Kingdom
F1011A ABB European
F1011A ACQ South Aftrica
SCSI Cables
HP C2904A SCSI Terminator, Active
HP C2905A SCSI Terminator, Differential
HP C2908A SCSI Cable, 1 m, HDTS m/m
HP C2925A SCSI Cable, 10 m, HDTS68

Indicates QuickShip availability.

Ordering Information

Cable Assemblies

HP 10501A 112 cm 50 Ω Coax with One UG-88C/U BNC (m) Connector
HP 10502A 23 cm 50 Ω Coax with UG-88C/U BNC (m) Connector
HP 10503A Like HP 10502A, but 122 cm
HP 8120-1838 30 cm 50 Ω Coax with Two BNC (m) Connectors
HP 8120-1839 Like HP 8120-1838, but 61 cm
HP 8120-1840 Like HP 8120-1838, but 122 cm
HP 11000-60001 112 cm 50 Ω Coax with Dual Banana Plugs
HP 11001-60001 112 cm 50 Ω Coax, UG-88C/U BNC (m) to Dual Banana Plug
HP 11003A Test Leads: 152 cm, Probe and Alligator Clip to Dual Banana Plug
HP 18182A 152 cm WECO 310 to 2 Alligator Clips
HP 92219Z Centronics Cable 1 M
HP 92224F Female Gender Converter
HP 92224M Male Gender Converter

HP model no.	Frequency range (GHz)	Length cm (in)	Connectors	SWR	Ins. loss (dB)	
11500A	dc to 12.4	183 (72)	N(m) (2)	—	—	
11500B	dc to 12.4	61 (24)	N(m) (2)	—	—	
11501A	dc to 18	183 (72)	N(m)-N(f)	—	—	
11500C	dc to 18	61 (24)	Precision N(m) (2)	1.4	1.5	
11500D	dc to 18	152 (60)	Precision N(m) (2)	1.4	3.0	
11500E	dc to 26.5	61 (24)	APC-3.5 (m) (2)	1.4	2.0	
11500F	dc to 26.5	152 (60)	APC-3.5 (m) (2)	1.4	4.0	

Adapters, 2.4 mm

(See page 564 for technical description and performance)

HP 11900A 2.4 mm (m) to 2.4 (m)
HP 11900B 2.4 mm (f) to 2.4 (f)
HP 11900C 2.4 mm (m) to 2.4 (f)
HP 11901A 2.4 mm (m) to APC-3.5 (m)
HP 11901B 2.4 mm (f) to APC-3.5 (f)
HP 11901C 2.4 mm (m) to APC-3.5 (f)
HP 11901D 2.4 mm (f) to APC-3.5 (m)
HP 11902A 2.4 mm (m) to APC-7
HP 11902B 2.4 mm (f) to APC-7
HP 11903A 2.4 mm (m) to Type N (m)
HP 11903B 2.4 mm (f) to Type N (f)
HP 11903C 2.4 mm (m) to Type N (f)
HP 11903D 2.4 mm (f) to Type N (m)
HP 11904A 2.4 mm (m) to K (m) [5]
HP 11904B 2.4 mm (f) to K (f) [5]
HP 11904C 2.4 mm (m) to K (f)
HP 11904D 2.4 mm (f) to K (m)

Adapters Type N, Standard 50 Ω

HP 1250-0077 N (f) to BNC (m)
HP 1250-0082 N (m) to BNC (m)
HP 1250-0176 N (m) to N (f) Right Angle (use < 12 GHz)
HP 1250-0559 N tee, (m)(f)(f)
HP 1250-0777 N (f) to N (f)
HP 1250-0778 N (m) to N (m)
HP 1250-0780 N (m) to BNC (f)
HP 1250-0846 N tee (f)(f)(f)
HP 1250-1250 N (m) to SMA (f)
HP 1250-1636 N (m) to SMA (m)

Adapters Type N, Precision 50 Ω [1]

HP 1250-1472 N (f) to N (f)
HP 1250-1473 N (m) to BNC (m)
HP 1250-1474 N (f) to BNC (f)
HP 1250-1475 N (m) to N (m)
HP 1250-1476 N (m) to BNC (f)
HP 1250-1477 N (f) to BNC (m)

Adapters Type N, Standard 75 Ω [2]

HP 1250-0597 N (m) (50 Ω) to N (f)(75 Ω)
HP 1250-1528 N (m) to N (m)
HP 1250-1529 N (f) to N (f)
HP 1250-1533 N (m) to BNC (m)
HP 1250-1534 N (f) to BNC (m)
HP 1250-1535 N (m) to BNC (f)
HP 1250-1536 N (f) to BNC (f)

Adapters APC-3.5

HP 1250-1743 APC-3.5 (m) to N (m)
HP 1250-1744 APC-3.5 (f) to N (m)
HP 1250-1745 APC-3.5 (f) to N (f)
HP 1250-1746 APC-3.5 (m) to APC-7
HP 1250-1747 APC-3.5 (f) to APC-7
HP 1250-1748 APC-3.5 (m) to APC-3.5 (m)
HP 1250-1749 APC-3.5 (f) to APC-3.5 (f)
HP 1250-1750 APC-3.5 (m) to N (f)

Adapters Subminiature, SMA

HP 1250-1158 SMA (f) to SMA (f)
HP 1250-1249 SMA Right Angle (m) (f)
HP 1250-1397 SMA Right Angle (m) (m)
HP 1250-1462 SMA (m) to SMA (f)
HP 1250-1698 SMA tee (m) (f) (f)
HP 1250-1787 SMA (m) to BNC (m)
HP 1250-2015 SMA (f) to BNC (m)

Adapters APC-7

HP 11524A APC-7 to N (f)
HP 11525A APC-7 to N (m)
HP 11533A APC-7 to SMA (m)
HP 11534A APC-7 to SMA (f)

Adapters BNC, Standard 50 Ω

HP 1250-0069 BNC (m) to UHF (f)
HP 1250-0076 Right Angle BNC (UG-306/D)
HP 1250-0080 BNC (f) to BNC (f) (UG-914/U)
HP 1250-0216 BNC (m) to BNC (m)
HP 1250-0591 BNC (f) to WECO Video (m)
HP 1250-0595 BNC (f) to BNC Triaxial (m)
HP 1250-0781 BNC tee (m) (f) (f)
HP 1250-1263 BNC (m) to Single Banana Plug
HP 10110B BNC (m) to Dual Banana Plug
HP 1250-1830 BNC (f) to BNC Triaxial (f)
HP 1251-2277 BNC (f) to Dual Banana Plug
HP 1250-1236 BNC (f) to SMB (f)

Adapters BNC, Standard 75 Ω [3]

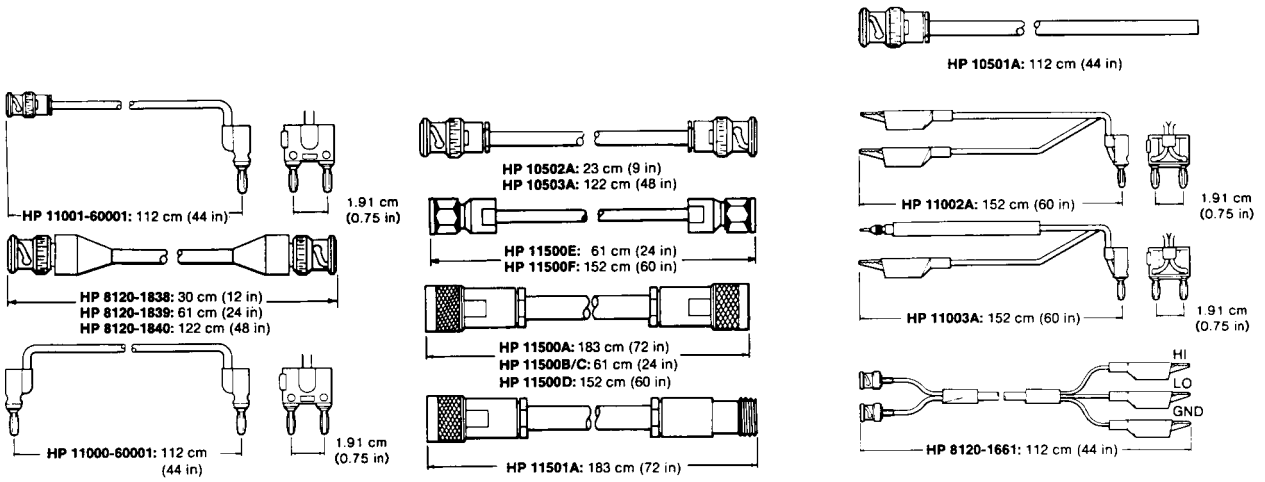
HP 1250-1287 BNC (f) to BNC (f)
HP 1250-1288 BNC (m) to BNC (m)

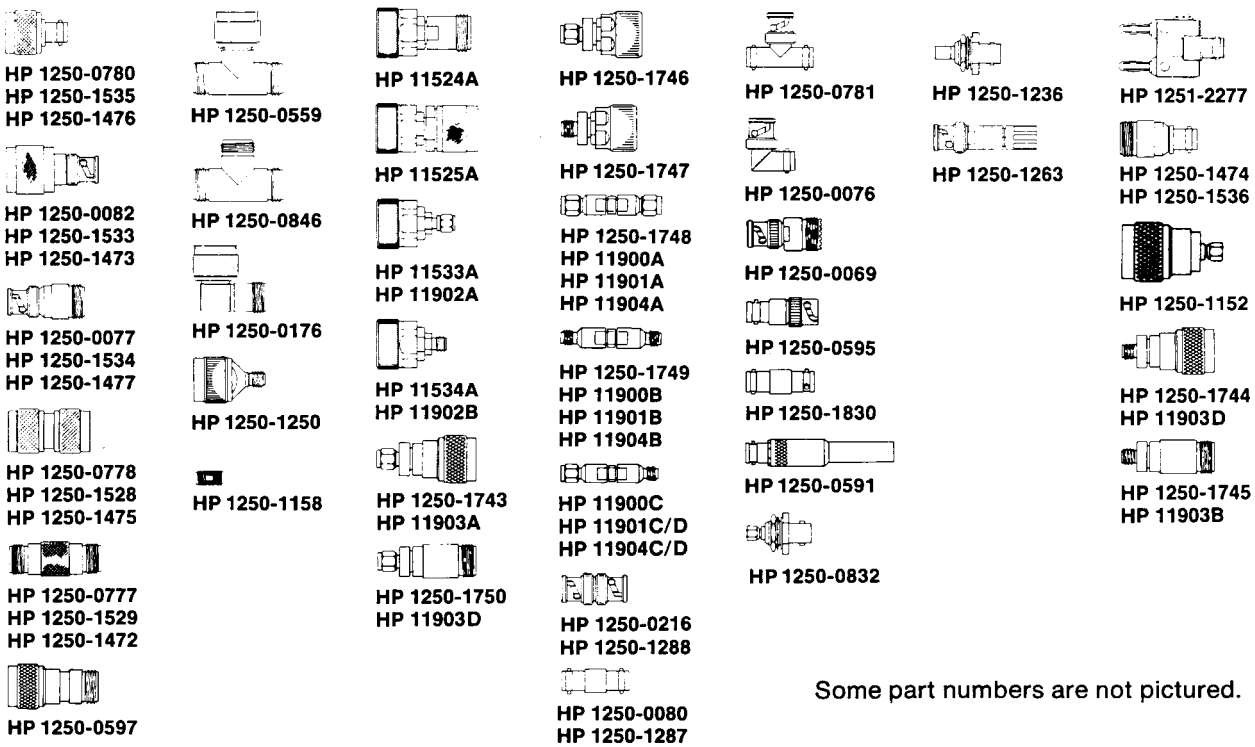
Adapters Subminiature, SMB, SMC [4]

HP 1250-0674 SMB (m) to SMA (f)
HP 1250-0832 SMC (f) to BNC (f)
HP 1250-1391 SMB tee (f) (m) (m)
HP 1250-1857 SMB (f) to BNC (m)
HP 1250-1152 SMC (f) to N (m)

[1] "Precision": typically ≥36 dB return loss to 1.3 GHz
[2] Type N outer conductor; center pin sized for 75 Ω characteristic
[3] BNC outer conductor; center pin sized for 75 Ω characteristic
[4] SMB and SMC are used often inside HP instruments for intermodule RF connections. SMB is snap-on configuration; SMC is screw-on configuration.
[5] The K-connector is developed and manufactured by the Wiltron Co., Morgan Hill, California.

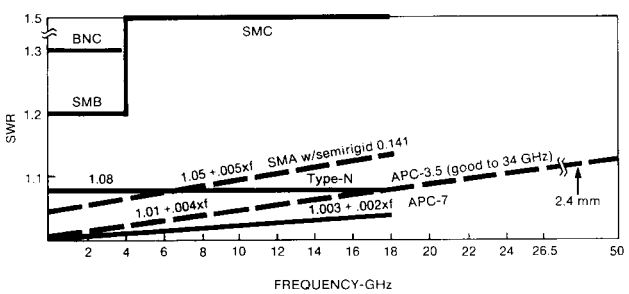
Indicates QuickShip availability.





Some part numbers are not pictured.

Coaxial Connector and Adapter Performance



Typical SWR for connector pairs

The performance curves in the graph will help you in choosing and applying HP cables, connectors, and adapters. SWR curves show design specifications for mated pairs of connectors of the type indicated. You can expect typical performance in that range.

For cross-series adapters, use the curve with the highest SWR in each case. For applications of Tee-adapters such as HP 1250-0559, 1250-0846, and 1250-0781, be sure to consider the extra shunt capacitance of the Tee.

Of course, when HP mounts various connectors onto RF and microwave products, the product specification predominates and SWR is often far superior to that shown in these utility curves. For example, the HP "precision" type-N adapters shown on these pages are for high accuracy use dc to 1.3 GHz where SWR <1.03.

For more information on history and performance of various coax connectors, see HP's *Microwave Test Accessories Catalog* (p/n 5952-2843 (D)).

HP 1180B
HP 1181A
HP 1182A

Shown left to right: the HP 1182A, HP 1181A, and HP 1180B testmobiles—the HP cart family

Specifications for HP Testmobile Carts

	HP 1180B	HP 1182A	HP 1181A
Testmobile Description	Scope cart	Instrument cart	System cart
Capabilities			
Tilt tray load	29.5 kg (65 lb)	68.0 kg (150 lb)	90.7 kg (200 lb)
Total load	59.0 kg (130 lb)	158.8 kg (350 lb)	226.8 kg (500 lb)
Cart net weight	18.1 kg (40 lb)	25.9 kg (57 lb)	39.0 kg (86 lb)
Size			
Tilt tray	457 mm x 457 mm (18 in x 18 in)	508 mm x 610 mm (20 in x 24 in)	559 mm x 660 mm (22 in x 26 in)
Height	721 mm (28.4 in)	721 mm (28.4 in)	721 mm (28.4 in)
Width	475 mm (18.7 in)	516 mm (20.3 in)	566 mm (22.3 in)
Depth	508 mm (20.0 in)	686 mm (27 in)	737 mm (29 in)
Vertical rack space*	N/A	N/A	533 mm (21 in)
Cart Selection Criteria			
Max. instrument depth	432 mm (17 in)	508 mm (20 in)	635 mm (25 in)
Host Products (examples)			
HP 1660, HP 1650, HP 1630	Yes	N/A	N/A
HP 54200, HP 54500	Yes	N/A	N/A
HP 8560, HP 8590 Series	N/A	Yes	N/A
HP 8720, HP 8750 Series	N/A	Yes	N/A
HP 16500B, HP 16501A, HP 8566B	N/A	N/A	Yes
HP 8703A, HP 8703B, HP 35600	N/A	N/A	Yes
HP Workstations, VXI, 70,000, 71,000	N/A	N/A	Yes
Accessories			
HP 35183A Work Surface	Yes	N/A	N/A
HP 35181A Printer/Plotter Stand	N/A	Yes	Yes
HP 35181B Keyboard Shelf	N/A	N/A	Yes
HP 35181C 89 mm (3½ in)-high Storage Drawer	N/A	N/A	Yes
HP 35181D Work Surface (533 x 305 mm)	N/A	Yes	Yes
HP 35181E Antistatic Mat for 35181D	N/A	Yes	Yes
HP 35181G 133 mm (5¼ in) Storage Drawer	N/A	N/A	Yes
HP 35182A 89 mm (3½ in)-high Storage Drawer, Support Shelf	N/A	Yes	N/A
HP 35182B 133 mm (5¼ in)-high Storage Drawer, Support Shelf	N/A	Yes	N/A
HP 5181-8723 Support Shelf, Drawer Cover	N/A	N/A	Yes
HP 5957-8476 Support Rails for Rackmounting	N/A	N/A	Yes
HP 92199B Power Strip (U.S.) (5 receptacles)	Yes	Yes	Yes
HP 92199E Power Strip (IEC 320) (4 receptacles)	Yes	Yes	Yes
International use of 92199E requires one or more of the cable assemblies below:			
HP 8120-1575 Cable, 762 mm (30 in)			
HP 8120-1860 Cable, 1.5 m (60 in)			
HP 8120-2191 Cable, 1.5 m (60 in) with Right-angle Plug			
HP 5181-8707 IEC-320 Male Power Cable Replacement Plug			

*Note: Vertical rack space is reduced the more the tilt tray is angled.

For additional information see the Rack Solutions Catalog, p/n 5965-9759EN/5965-9759EUS, or visit the Enclosures website: **http:www.hp.com/go/enclosures**

Operating & Transit Cases

Rugged Protection for Instruments

Typical Series 3000 workstation-style operating case

Typical System II Valise Transit (VT) Case

Tote-style transit case

Operating Cases

Hewlett-Packard operating cases protect instruments and equipment from the hazards of transportation and the rigors of the environment. They offer sturdy protection when instruments are transported and used on-site. Operating cases are compression-molded from a glass fiber reinforced composite material (FRP) that is lighter than aluminum and provides excellent strength and durability. Tests of this molded material show tensile and compressive strength exceeding 33,000 PSI and flexural strength exceeding 46,000 PSI.

Both standard and optional heavy-duty hardware afford excellent protection from damage and the elements. Conveniently placed, surface-mounted, spring-loaded handles fold flat when not in use, or they can be designed to reside in recesses. Front and back covers seal with O-ring gaskets and clamping latches.

Interior Configuration

Operating cases come equipped with shock-mounted aluminum frames that accept any standard 19-inch rack-mounting instrument (EIA-RETMA standard). Most full-size instruments and modular combinations of instruments can be rack mounted in any one of our operating cases. The frame arrangement and the ability to remove the front and back covers allows for convenience of operation without removing the instrument.

Transit Cases

Hewlett-Packard transit cases are sturdy containers for use when instruments must be frequently transported or used away from laboratory or office conditions. HP cases protect your instruments from shock, vibration, moisture, impact, and contamination to provide a secure enclosure for shipping. Transit cases are a necessity whenever equipment is frequently transported from one operating location to another.

Product Detail

Our transit cases are compression-molded from a glass-fiber-reinforced composite material (FRP) that is lighter than aluminum and provides excellent strength and durability. Tests of this molded material show tensile and compressive strength exceeding 33,000 PSI and flexural strength exceeding 46,000 PSI. All cases seal tightly with O-ring gaskets and clamping latches. They are rainproof under the standards of MIL-STD-810. Carrying handles are conveniently placed and are spring-loaded to fold flat when not in use.

HP cases are usually provided with foam cushions designed to cradle the instrument securely. The cushion inserts are typically molded polyurethane, or are fabricated from slabs of polyurethane or polyethylene flexible foams. Each case/cushion unit is designed as its own shock and vibration damping system, protecting against damage from handling, dropping, or crushing. All transit cases are available in tote style.

How to Order

Standard transit and operating cases can be ordered from HP in the United States by calling 1-800-227-8164. Custom cases (including those with optional casters) must be ordered through ECS Composites. To place custom orders, contact ECS Composites at (541) 476-8871/phone, (541) 474-2479/fax or send e-mail to ecs@ecscase.com.

On request, operating and transit cases can be fabricated to meet the requirements of USA and NATO military specifications.

Operating Cases Specifications

Nominal Rack Height		Instrument Weight Maximum		Minimum		Case Height		HP Part
ISO	in	kg	lbs	kg	lbs	mm	in	Number
3U	5.25	34	75	9.1	20	280.2	11.03	9211-1302
4U	7.00	34	75	9.1	20	348.7	13.73	9211-6472
5U	8.75	59	130	13.6	30	393.2	15.48	9211-1303
6U	10.50	59	130	13.6	30	438.9	17.28	9211-2635
8U	14.00	59	130	13.6	30	527.8	20.78	9211-1241
9U	15.75	59	130	13.6	30	572.3	22.53	9211-1242
10U	17.50	59	130	13.6	30	616.7	24.28	9211-1243
11U	19.25	59	130	13.6	30	661.2	26.03	9211-1244
12U	21.00	114	250	22.7	50	718.3	28.28	9211-1245
13U	22.75	114	250	22.7	50	762.8	30.03	9211-2636
14U	24.50	114	250	22.7	50	807.2	31.78	9211-1911
16U	28.00	114	250	227	50	896.1	35.28	9211-2638
17U	29.75	114	250	22.7	50	940.6	37.03	9211-2639
19U	33.25	114	250	22.7	50	1029.5	40.53	9211-1713
20U	35.00	145	320	31.8	70	1073.9	42.28	9211-6473
21U	36.75	145	320	31.8	70	1109.0	43.66	9211-6474
22U	38.50	145	320	31.8	70	1162.8	45.78	9211-6475
23U	40.25	145	320	31.8	70	1207.3	47.53	9211-6476
24U	42.00	145	320	31.8	70	1254.8	49.40	9211-6477
25U	43.75	145	320	31.8	70	1296.2	51.03	9211-6478
27U	47.25	145	320	31.8	70	1371.6	54.00	9211-2641

Typical System I full-module instrument

Typical System II full-module instrument

System I Cabinet Style Transit Cases Specifications

Full-Module Width Instruments
Instrument Width — 425.5 mm 16.75 in

Instrument Depth — 285.8 mm 11.25 in

Inst. Height mm	in	Standard HP p/n	Tote-Style HP p/n
88.9	3.50	9211-1288	9211-7800
133.4	5.25	9211-1289	9211-7527
177.8	7.00	9211-1290	9211-7528
222.3	8.75	9211-1291	9211-7501

Instrument Depth — 412.8 mm 16.25 in

Inst. Height mm	in	Standard HP p/n	Tote-Style HP p/n
133.4	5.25	9211-0839	9211-7502
177.8	7.00	9211-1293	9211-7503
222.3	8.75	9211-1294	9211-7504
311.2	12.25	9211-1313	9211-7505

Instrument Depth — 489.0 mm 19.25 in

Inst. Height mm	in	Standard HP p/n	Tote-Style HP p/n
133.4	5.25	9211-1296	9211-7507
177.8	7.00	9211-1735	9211-7508

Instrument Depth — 565.2 mm 22.25 in

Inst. Height mm	in	Standard HP p/n	Tote-Style HP p/n
311.2	12.25	9211-1297	9211-7509

Three-Quarters Module Width Instruments
Instrument Width — 3429 mm 13.5 in

Instrument Depth — 500.0 mm 19.7 in

Inst. Height mm	in	Standard HP p/n	Tote-Style HP p/n
88.9	3.5	83236-60001	9211-7530
190.5	7.5	08920-90141	9211-7529

Half-Module Width Instruments
Instrument Width — 300.4 mm 19.7 in

Instrument Depth — 279.4 mm 11.00 in

Inst. Height mm	in	Standard HP p/n	Tote-Style HP p/n
165.1	6.5	9211-1315	9211-7511

Instrument Depth — 406.4 mm 16.00 in

Inst. Height mm	in	Standard HP p/n	Tote-Style HP p/n
165.1	6.5	9211-1734	9211-7512

One-Third Module Width Instruments
Instrument Width — 130.2 mm 5.125 in

Instrument Depth — 279.4 mm 11.00 in

Inst. Height mm	in	Standard HP p/n	Tote-Style HP p/n
165.1	6.5	9211-1318	9211-7506

System II Cabinet Style Transit Cases Specifications

Full-Module Width Instruments
Instrument Width - 425.5 mm 16.75 in

Instrument Depth - 387.4 mm 15.25 in

Inst. Height mm	in	Standard HP p/n	Tote-Style HP p/n
88.9	3.50	9211-2642	9211-7514
133.4	5.25	9211-2643	9211-7515
177.8	7.00	9211-2644	9211-7516
222.3	8.75	9211-2645	9211-7517
311.2	12.25	9211-2647	9211-7518

Instrument Depth — 463.6 mm 18.25 in

Inst. Height mm	in	Standard HP p/n	Tote-Style HP p/n
88.9	3.50	9211-2648	9211-7519
133.4	5.25	9211-2649	9211-7520
177.8	7.00	9211-2650	9211-7521
222.3	8.75	9211-2651	9211-7522
266.7	10.50	9211-2652	9211-7523
311.2	12.25	9211-2653	9211-7478

Instrument Depth — 546.1 mm 21.50 in

Inst. Height mm	in	Standard HP p/n	Tote-Style HP p/n
88.9	3.50	9211-2654	9211-7479
133.4	5.25	9211-2655	9211-7480
177.8	7.00	9211-2656	9211-7481
222.3	8.75	9211-2657	9211-7482
266.7	10.50	9211-2658	9211-7483
311.2	12.25	9211-2659	9211-7484

Instrument Depth — 622.3 mm 24.50 in

Inst. Height mm	in	Standard HP p/n	Tote-Style HP p/n
88.9	3.50	9211-2660	9211-7485
133.4	5.25	9211-2661	9211-7486
177.8	7.00	9211-2662	9211-7487
222.3	8.75	9211-2663	9211-7488
266.7	10.50	9211-2664	9211-7489
311.2	12.25	9211-2665	9211-7490

Half-Module Width Instruments
Instrument Width — 215.9 mm 8.50 in

Instrument Depth — 247.7 mm 9.75 in

Inst. Height mm	in	Standard HP p/n	Tote-Style HP p/n
88.9	3.50	9211-2666	9211-7491
222.3	8.75	9211-2669	9211-7492

Instrument Depth — 323.9 mm 12.75 in

Inst. Height mm	in	Standard HP p/n	Tote-Style HP p/n
88.9	3.50	9211-2671	9211-7493
133.4	5.25	9211-2672	9211-7494
177.8	7.00	9211-2673	9211-7495
266.7	10.50	9211-2675	9211-7497

Instrument Depth — 400.1 mm 15.75 in

Inst. Height mm	in	Standard HP p/n	Tote-Style HP p/n
88.9	3.50	9211-2676	9211-7498
133.4	5.25	9211-2677	9211-7499
177.8	7.00	9211-2678	9211-7496

HP's Test & Measurement Web site.
The more you visit, the more you'll know.

News and information you need, 24 hours a day. Get the most complete support available for all of HP's Test & Measurement tools. Immediate access to information, 24 hours a day, means always getting the most from your instruments:

- Product Information
- Usage Tips
- Application Note Library
- Service, Support and Training
- Sales and Service Contacts
- Selection Guides
- Newsletters
- Feature Stories Showing Products in Use
- Information on Your Industry
- News Releases
- Country-Specific Sites

These features are only a snapshot of what's available at the Web site. Bookmark it—and visit it regularly—to stay completely up to date on all of HP's test and measurement solutions.

Refurbished Instruments 19

HP Refurbished Test and Measurement Product List Available on the Internet: http://www.hp.com/go/refurbished

Hewlett-Packard now offers a large inventory of high-quality refurbished equipment on the Internet for easy ordering. Follow these steps to select and order this high value, HP refurbished general purpose test equipment:

- Log onto our site at HYPERLINK **http://www.hp.com/go/refurbished**
- Select the product you need. For more information (in the U.S.), contact the HP Call Center at 1-800-452-4844 (for Call Center numbers outside the U.S., see the inside back cover of this Catalog). If you can't access the World Wide Web, and there is no Call Center in your area, please contact your local HP Sales Office (see page 582 for a complete listing).

www.hp.com/go/refurbished

Here is what you will find on the HP refurbished equipment site:

Overview

Learn about the benefits of purchasing refurbished equipment from Hewlett-Packard. Details about the one-year warranty on all HP refurbished equipment sold by HP are included here. This section answers the questions: "What is HP refurbished equipment?" and "Why buy HP refurbished equipment from HP?"

Refurbished Products

View a current list of more than 1,200 high-quality test and measurement products that are refurbished to HP "as manufactured" standards. This list represents the largest inventory of competitively priced, highly reliable HP refurbished test equipment available. Products listed include our own demo and lease-return products as well as selected items from resellers of HP equipment. All equipment, regardless of its original source, is refurbished to HP quality standards.

Details provided on the Internet include model number, options and product description.

Special Offers

Come back to the site often to find special clearance sales on selected models and on end-of-production run products. These models are priced to clear and provide an excellent purchasing opportunity. View these special clearance sales under the "Special Offers" link on the home page. You will be directed to your geographic region for worldwide special offers plus special sales designed specifically for your market.

Details provided on the Internet include model number, options, product description and whether volume end user, education and government discounts apply.

Services & Support

When you purchase refurbished equipment from Hewlett-Packard, our services and support also are available. Links are provided from the Refur-bished Equipment site to service and support contacts.

Sales Contacts

A convenient link is provided from the Refurbished Equipment site to a list of telephone numbers for Call Centers and Sales Offices around the world.

Convenient, One-stop Shopping
Now that we offer the largest available inventory of high-quality refurbished equipment, you can save valuable time by shopping for everything you need at Hewlett-Packard. Both new and refurbished equipment—as well as training and support—can be bundled conveniently into a single purchase order.

Financing
Complete HP financing options are available for refurbished equipment.

Have a Large Order?
When you have a large order, HP saves you valuable time by acting as your "virtual purchasing agent." We will hold refurbished equipment currently in our inventory while we search for other models you need among our extensive network of sourcing partners.

Technical Assistance
Best of all, when you are not certain what model to purchase, you can call the HP Call Center in your area for expert assistance from a qualified engineer. We provide the same expertise for refurbished equipment that we provide for new. HP field engineers help you select the best possible equipment for your specific application using the latest information from the factory. Don't hesitate to pick up the phone and ask our experts for advice.

Easy to Purchase
After you have selected the appropriate product, you can order through your field engineer or by telephone at 1-800-452-4844 (for Call Center numbers outside the U.S., see the inside back cover of this Catalog). You can also visit our web site: **www.hp.com/go/tmc99**. If you can't access the World Wide Web, and there is no Call Center in your area, please contact your local HP Sales office (see page 582 for a complete listing). Refurbished equipment quantities are limited, so first purchase order received tags the unit. (If someone purchased the unit just before we receive your purchase order, we will immediately search for another unit or offer you a close match if one is available.)

Extend Your Budget with Refurbished Equipment & Trade-In

The official "Hewlett-Packard Test & Measurement Refurbished Product" seal being placed on this refurbished unit by a manufacturing manager guarantees that the product has been refurbished to HP's quality standard before it is shipped.

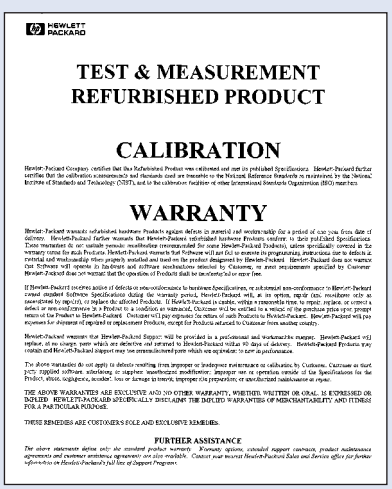
Hewlett-Packard's full-scale remarketing operation gives you two opportunities to stretch your test and measurement equipment budget. High-quality, used equipment—refurbished to HP standards and warranted by HP—is available for you to purchase. And trade-in allowances are available on some products in many parts of the world.

High-Quality, Refurbished Equipment
If your budget will not stretch far enough to purchase all of the new test and measurement equipment you need, you may want to consider adding some used instruments to your equipment pool. Used equipment sold by HP is refurbished to HP's original manufactured standards, carries a minimum one-year warranty that covers all components covered when the unit was sold new and includes complete accessories.

Here's what you get when you buy refurbished HP equipment from HP:

- Prices lower than for new equipment.
- Low cost of ownership because of the added benefits of HP warranty and support.
- Minimum one-year warranty for all components covered when the unit was sold new. HP extended warranties are also available on most refurbished products.
- New and refurbished equipment, in addition to training and support, can be bundled on a single purchase order.
- All units are calibrated and tested to HP original manufactured standards, using HP factory specifications and test procedures. Necessary safety and reliability upgrades identified by the factory are automatically made.
- Return policy same as for new HP products.
- Technical support, before and after the sale, is the same as for new equipment. HP field engineers help you select the best possible equipment for your application using the latest information from the factory.
- An HP Certificate of Calibration is shipped with the product, as appropriate.
- Accessories included are the same as when the product was sold new.

Trade Up to the Latest Technology
Taking advantage of HP's trade-in options, you can improve your ability to stay competitive by upgrading your equipment to the latest technology and performance. Our test and measurement trade-in programs are continuously available throughout the year in most parts of the world.


HEWLETT PACKARD

TEST & MEASUREMENT
REFURBISHED PRODUCT

CALIBRATION

WARRANTY

FURTHER ASSISTANCE

All HP refurbished equipment carries a minimum one-year warranty. HP extended warranties are also available on most refurbished products.

HP's Test & Measurement Web site.
The more you visit, the more you'll know.

News and information you need, 24 hours a day. Get the most complete support available for all of HP's Test & Measurement tools. Immediate access to information, 24 hours a day, means always getting the most from your instruments:

- Product Information
- Usage Tips
- Application Note Library
- Service, Support and Training
- Sales and Service Contacts
- Selection Guides
- Newsletters
- Feature Stories Showing Products in Use
- Information on Your Industry
- News Releases
- Country-Specific Sites

These features are only a snapshot of what's available at the Web site. Bookmark it—and visit it regularly—to stay completely up to date on all of HP's test and measurement solutions.

Financing, Ordering & Repair 20

Finance Options, Sales Offices & Service Centers 579

Why Hewlett-Packard?

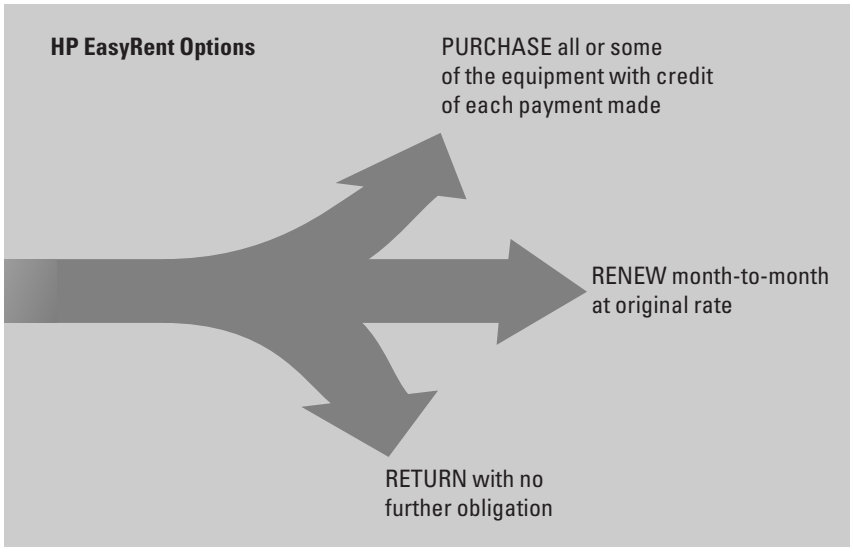
HP offers the ease of one-stop shopping. With HP Financing, your equipment is backed 100 percent by the company that knows it best. And HP's low cost of funds allow us to pass on to you very competitive rates. With competitive rates and flexibility, why not HP?

Why Financing?

Renting, leasing, or financing your instrumentation offers several important benefits: (1) you acquire the latest technology without a large cash outlay; (2) short-term projects can be managed economically; (3) upgrading and adding on is easy; and (4) you can match payments to your revenue stream.

To Learn More

To learn how an HP financing plan can be tailored to meet your needs, contact the HP Call Center at 1-800-452-4844 (for Call Center numbers outside the U.S., see the inside back cover of this Catalog). You can also visit our Web site at **www.hp.com/go/tmc99.** If you can't access the World Wide Web, and there is no Call Center in your area, please contact your local HP Sales Office (see page 582 for a complete listing).



HP EasyRent

HP EasyRent offers you a low-cost 12-month rental.

This unique plan is advantageous when you need an exceptionally low rate for shorter-term projects, built-in asset management, and off balance sheet financing.

A Full Range of Choices

This chart indicates the broad range of plans available in the United States. Similar plans are available worldwide.

Hewlett-Packard Financing Plans

	Key Benefits	Term (months)	Purchase Option	Minimum
HP EasyRent	Maximum flexibility with low monthly payments	12	Fixed or fair market value	$20,000 (USA)
HP Lease	Provides flexibility and low monthly payments	12 to 60	Fixed or fair market value	$20,000 (USA)
HP Installment	Buy without a large cash outlay	12 to 60	None (full payout)	$20,000 (USA)
HP State and Local Government	Special financing for state and local government customers	12 to 60	None (full payout)	$20,000 (USA)

Communicating with HP

Product information

Your entry point to the resources of HP is through the HP Call Center at 1-800-452-4844 (for Call Center numbers outside the U.S., see the inside back cover of this Catalog). Our sales representatives and order support specialists are well-equipped to provide you with pre-sale assistance in product selection, as well as related business information such as current product availability and price delivered to your location.

Most HP Call Centers are tied into a sophisticated intra-company communications system. This not only means prompt transmission of orders to any HP product responsible division, it also speeds the flow of regular messages among HP sales offices and factories.

Electronic Data Interchange

HP has established Electronic Data Interchange (EDI) links with many customers to allow more timely information regarding products and orders as well as provide a more efficient flow of purchase orders and invoices.

HP Web Site

Be sure to visit the T & M Area of the Web site for comprehensive technical, application, support, training and sales contact information: **www.hp.com/go/tmc99**

Pricing and Quotations

Prices in this catalog (if any) are U.S. list prices at the time of approval for printing. HP reserves the right to change prices. The prices for an order are determined by the prices prevailing at the time the order is received. Therefore, the prices in this catalog are intended only as budgetary information. To obtain destination prices, formal quotations, pro forma invoices, or other information you need before ordering, contact the Hewlett-Packard Call Center in your region.

Inside the USA:

Call the Test & Measurement Customer Business Center, 1-800-829-4444, or write, P.O. Box 4026, Englewood, CO 80155-4026. See page 582.

Outside the USA:

Request for quotations outside the USA should be placed with a HP Call Center or distributorship in the country of end use.

Placing Your Order

Because many products or configurations are changed or improved during the year, we suggest that you always contact your nearby HP sales office for current product and pricing information prior to placing your order.

HP wants to be sure the product delivered to you is exactly the one you want. Therefore, when placing your order, please specify the product model, accessory, or part number, as well as the product name. Be as complete as possible in specifying exactly what you want, including standard options.

If you want special features or capabilities, such as different color or a non-standard voltage, ask your local HP Call Center representative about availability and cost first. Then include special instructions and specification details with your order.

Terms of Sale

Inside the USA:

Hewlett-Packard's standard terms for established customers in the USA are net 30 days from invoice date. Other terms are contained in the customer's purchase agreement.

Leasing, rental and extended financing are available. However, the financing costs are not included in any product prices in this catalog. Your nearby HP office will be pleased to discuss your requirements and work with you in setting up an appropriate program.See also page 588.

Outside the USA:

Please contact your nearest Hewlett-Packard Call Center or an authorized HP subsidiary or distributor regarding terms for orders placed with them.

U.S. Government Sales

For U.S. government sales, contact the HP U.S. Government Business Center at 1-800-468-8347. Many products in this catalog are covered on GSA federal supply schedule multi-award contracts. GSA is the General Services Administration; the HP office can supply GSA contract numbers for government purchasing officers.

Product Changes

Although product information and illustrations in this catalog were current at the time it was approved for printing, HP, in a continuing effort to offer excellent products at a fair value, reserves the right to change specifications, designs, and models without notice.

Shipping

Inside the USA:

All prices include HP standard transportation and routing to any U.S. destination. If a different shipping method is needed, we will gladly ship to satisfy your requirements. Custom shipments are typically sent freight collect.

Outside the USA:

Shipments to destinations outside the USA are made by either surface or air, as requested. Contact your HP sales office for details.

Operating Environments

Hewlett-Packard provides solutions to customer needs through products that must operate in the numerous environments. To address these needs, all new hardware designs are tested and evaluated to internal HP standards on operating environments before manufacturing release. These internal HP standards are derived from HP's experience with existing environments at customer installations and from other well-known standards, such as IEC, ISO, ANSI, and MILITARY standards. These codes are not used for evaluating production units. The classification codes, used to identify expected environments where HP products or systems may be used, are as follows:

A1– Rugged Environment
A2– Outdoor Environment (Portable)
B1– Portable General-Purpose Environment
B2– General-Purpose Environment
C1– Controlled Office Environment
C2– Controlled Computer Room Environment

The classes range from the severe environments found in heavy industrial areas unsuitable for operating personnel (Class A1) to the controlled environments found in dedicated computer rooms (Class C2). Most HP hardware products are designed to meet Class B2, applying parameters commonly found in general-purpose applications of light industrial and commercial facilities.

If you are considering a specific product, ask your HP sales representative what code is applicable to the product it was designed to (A1, A2, B1, B2, C1, C2) and the limits it met for the environmental parameter of concern.

Warranty

As an expression of confidence that our products will continue to meet the high standards of reliability and performance that our customers expect, Hewlett-Packard products carry the following limited warranty:

HP products are warranted against defects in materials and workmanship. If HP receives notice of such defects during the warranty period, HP shall, at its option, either repair or replace hardware products which prove to be defective.

For more information on Hewlett-Packard Test & Measurement products, applications or services, please call your local Hewlett-Packard sales offices listed below. A current listing is also available at
http://www.tmo.hp.com/go/contacts99

Area Sales Offices *arranged alphabetically by region.*

Asia Pacific

Headquarters Offices

Australia/New Zealand
Hewlett-Packard Australia Ltd
31-41 Joseph Street
Blackburn, Victoria 3130
Australia
Tel: 1-800-629-485 (Australia)
1-800-738-378 (New Zealand)
Fax: (61-3)-9210-5489

Hong Kong
Hewlett-Packard
Hong Kong Ltd.
17-21/F Shell Tower,
Times Square
1 Matheson Street,
Causeway Bay
Hong Kong, SAR
Tel: (852) 2599-7777
Fax: (852) 2506-9284

Japan
Hewlett-Packard Japan, Ltd.
3-29-21, Takaido-higashi,
Suginami-ku
Tokyo 168-8585
Japan
Tel: (81/3) 3331-6111
Fax: (81/3) 335-1478

Local Offices

Australia

Melbourne
Hewlett-Packard Australia Ltd.
31-41 Joseph Street
Blackburn, VIC 3130
Tel: 1 800-629-485 (toll free)
(03)-9272-5408
Fax: (03)-9272-0749

Perth
Measurement Innovation
(WA) Pty Ltd
7 Watercress Gardens
Spearwood 6163
Western Australia
Tel: (+61 8) 9434 1990
Fax: (+61 8) 9434 5803

Sydney
Hewlett-Packard Australia Ltd.
17-23 Talavera Road
North Ryde, N.S.W. 2113
Tel: (61/2) 9950-7444
Fax: (61/2) 9888-9072

Bangladesh
Jiu International Ltd
60 East Tejturi Bazar, 2nd Floor
Farmgate Dhaka
Bangladesh
Tel: 880-2-913-0480
Fax: 880-2-871-034
jiu@bangla.net

Brunei Darussalam
Komputer Wisman Sdn Bhd
Block A, Unit 1, Ground Floor
Abdul Razak Complex
Jalan Gadong 3180
Negara Brunei Darussalem
Tel: 673-2-423918/425603
Fax: 673-2-441492

China

Beijing
China Hewlett-Packard
Co. Ltd.
HP Building
No. 2, Dong San Huan Nan Lu
Chao Yang District
Beijing 100022, PRC
Tel: (86-10) 6564-3888
or 800-810-0189
Fax: (86-10) 6566-8250
Telex: 085-22601 CTSHP CN
Cable: 1920 Beijing

Chengdu
China Hewlett-Packard
Co. Ltd.
22/F Daye Road
No. 39 Daye Road
Chengdu 610016 PRC
Tel: (86/28) 666-3888
Fax: (86/28) 666-5377

Guangzhou
China Hewlett-Packard
Co. Ltd.
7/F T.P.Plaza
9/109, Liu Hua Road
Guangzhou 510010 PRC
Tel: (86/20) 8669-3888
Fax: (86/20) 8669-5074
Telex: 44556 GPHGZ CN

Shanghai
China Hewlett-Packard
Co., Ltd.
10-12/F Novel Building
No. 887 Huai Hai Zhong Lu
Shanghai, 200020
Tel: (86/21) 6474-3888
Fax: (86/21) 6267-8523
Telex: 086-33577 CHPSB CN

Shenyang
China Hewlett-Packard Co., Ltd.
12/F Shenyang Sankei Torch Building No. 262 Shifu Road, Shenhe District
Shenyang 110013 PRC
Tel: (86/24) 2790170, 2790171
Fax: (86/24) 2790232

Xi'an Branch Office
3/F East New Technology Trade Center A16
Yanta Lu Zhong Duan
Xi'an 710054 PRC
Tel: (86/29) 552 9379
Fax: (86/29) 552 9243

Hong Kong
Hewlett-Packard (Hong Kong) Ltd.
17-21/F Shell Tower, Times Square
1 Matheson Street
Causeway Bay
Hong Kong, SAR
Tel: (852) 2599-7889
Fax: (852) 2506-9233

India
Bangalore
Hewlett-Packard India Pvt. Ltd.
Embassy Point
150 Infantry Road
Bangalore 560001
Tel: (91/80) 209-1808
Fax: (91/80) 225-6186
Telex: 845-2773 HP IN

Calcutta
Hewlett-Packard India Ltd.
708 Central Plaza
2/6 Sarat Bose Road
Calcutta 700 020
Tel: (91/33) 475-4755
(91/33) 474-7730/31
Fax: (91/33) 474-8571

Hyderabad
Hewlett-Packard India Pvt. Ltd.
5-9-13 Taramandal Complex
9th Floor, Saifabad
Hyderabad 500 004
Tel: (91/40) 232-679
Fax: (91/40) 220-012
(91/40) 231-756
Telex: 425-2422 HPIL IN

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Hewlett-Packard India Ltd.
Samrat Business Centre
The Metropolitan, 2nd floor
Bandra-Kurla Complex
Bandra (E)
Mumbai 400 051
Tel: (91/22) 643-1153
Fax: (91/22) 641-0744

New Delhi
Hewlett-Packard India Ltd.
Chandiwalla Estate
Ma Anandmai Ashram Marg, Kalkaji
New Delhi 110 019
Tel: (91-11) 682-6000
Fax: (91-11) 682-6030

Indonesia
Bandung
P.T. Berca Hardayaperkasa
Jalan Tengku Angkasa No. 33
Bandung 40132
Tel: (62-22) 250-8100
Fax: (62-22) 250-6757

Jakarta
P.T. Berca Hardayaperkasa
Jalan Abdul Muis No. 62
Jakarta 10160-Indonesia
Tel: (62/21) 380 0902
Fax: (62/21) 381 2044

Japan
For presale assistance in product selection and other product or general information:
Hewlett-Packard Japan, Ltd.
Test & Measurement
Measurement
Assistance Center
9-1, Takaura-cho, Hachioji-shi
Tokyo 192-8510, Japan
Tel: (81) 426 56 7832
International:
Tel: (+81 426) 48-0722
Fax: (+81 426) 48-1073

Aichi
Hewlett-Packard Japan Ltd.
Nagoya Kokusai Center Bldg.
1-47-1 Nakono Nakamura-ku,
Nagoya-shi
Aichi 450-0001

Hewlett-Packard Japan Ltd.
Nakane-Nissei Bldg.
4-25-18 Nishi-machi,
Toyota-shi
Aichi 471-0025

Akita
Hewlett-Packard Japan Ltd.
Nihonseimei Akita
Chuodori Bldg.
4-2-7 Nakadori, Akita-shi
Akita 010-0001

Chiba
Hewlett-Packard Japan Ltd.
WBG Malibu East Bldg. 19F
2-6 Nakase Mihama-ku,
Chiba-shi
Chiba 261-7119

Fukuoka
Hewlett-Packard Japan Ltd.
Daisan Hakata-Kaisei Bldg.
1-3-6 Hakataekiminami
Hakata-ku, Fukuoka-shi
Fukuoka 812-0016

Hiroshima
Hewlett-Packard Japan Ltd.
Nissei-Heiwakoen Bldg.
3-25 Nakajima-cho Naka-ku,
Hiroshima-shi
Hiroshima 730-0811

Hokkaido
Hewlett-Packard Japan Ltd.
Sumitomo-seimei
Sapporo Chuo Bldg.
1-1-14 Minaminijo-higashi
Chuo-ku, Sapporo-shi
Hokkaido 060-0052

Hyogo
Hewlett-Packard Japan Ltd.
1-3-2 Muroya Nishi-ku,
Kobe-shi
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(AN 200) Fundamentals of the Electronic Counters
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(AN 4156-3) Evaluation of Hot Carrier Induced Degradation of MOSFET Devices
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(AN 4156-4) Evaluation of Flash Memory Cells
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(AN 4156-6) Maximizing the Incoming Inspection Efficiency of Semiconductor Devices
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SS7 Protocol Testing With PT Series Protocol Testers
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Testing Amplifiers and Active Devices with the HP 8510 Network Analyzer
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Testing ATM at 622 Mb/s and Above
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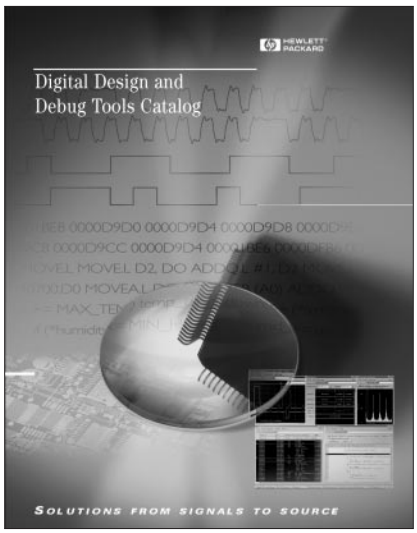


Digital Design and Debug Tools
5967-6335E

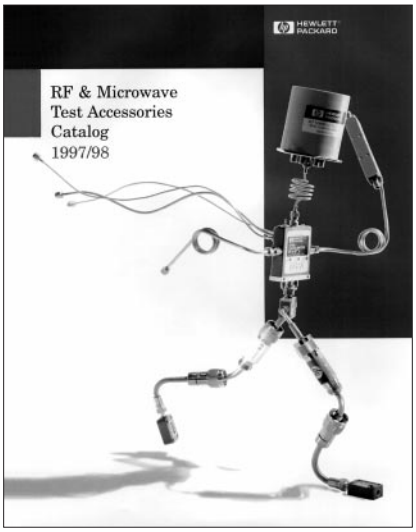
This catalog contains product information, specifications and pricing for HP's logic analysis and emulation solutions, mixed-signal and high performance oscilloscopes, data generator, PCI exerciser and pulse generators.

Digital designers may subscribe to the catalog to ensure that they are kept up-to-date on the latest digital debug solutions available from HP.

Test and Measurement Solutions for the Telecommunications Industry
5966-1038E

This catalog summarizes, in one convenient place, HP's test and measurement solutions for the telecommunications industry, with particular emphasis on the needs of network operators, both wireline and wireless. The over 100 products described ranging from portable protocol test sets to complete distributed monitoring systems. This makes it easy to find just the right instrument, or instruments, to match the need for ensuring the network quality of service and optimizing performance. In addition, there is a complete set of tools for developing the management information necessary to keep the network operating at a high level, as well as planning for its future needs.

These products are specifically for those responsible for local telephone service, long-distance communications service, cellular service, CATV operation, and private network operation. To help find the best complete solution, maintenance and management tools are organized by both network types, such as LAN, WAN Cellular; and by technologies, such as Ethernet, Token Ring, ATM/B-ISDN, PDH transmission, SDH/SONET, as well as microwave and fiber transmission.

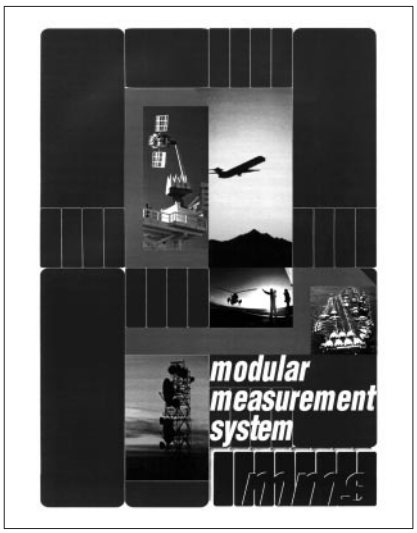


RF and Microwave Test Accessories Catalog
5964-9527E

This catalog contains general purpose RF and microwave accessories for test and measurement applications. Products featured in this catalog include switches, attenuators, amplifiers, detectors, couplers, waveguide and a variety of other products.

Large sections are prefaced with an applications discussion, key specification description, and product family overviews. Detailed specifications, drawings, and photographs are provided for a wide array of accessories.

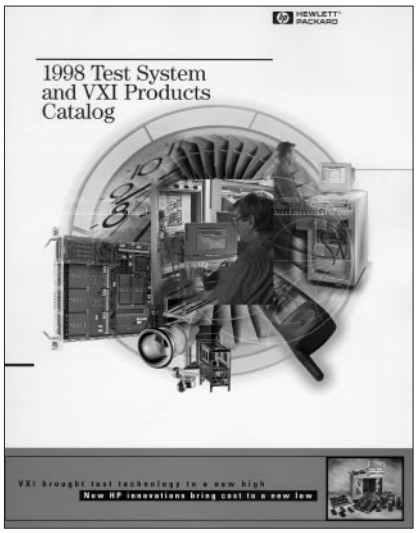
View the online version of the RF and Microwave Test Accessories Catalog or order a printed copy of the catalog from our website:
http://www.hp.com/go/mta_catalog



Modular Measurement System: HP 70000 Family and Others
5965-2818E

This 180-page Modular Measurement System (MMS) catalog contains product information on all MMS products available from HP and other third-party vendors. Catalog highlights include an MMS over-view, configuration examples, and 100 pages of instrument information (often including specifications and ordering information). Featured are the MMS high performance spectrum analyzers including the HP 71910A/P Wide Bandwidth Receiver.

System building blocks, including mainframes, displays, tracking generators, and an external mixer interface module show you how to configure an instrument or system for unique applications using off-the-shelf modules. The catalog also includes a comprehensive discussion of service and support, with a listing of documentation available through HP Call Centers.



1998 Test Systems and VXI Products Catalog & Supplement
5966-2815EN

The definitive source book of HP's VXI offerings, the 1998 HP 75000 Family of VXI Components, Systems, and Services catalog has a revised and expanded format that enables you to configure VXI systems and order appropriate products and services.

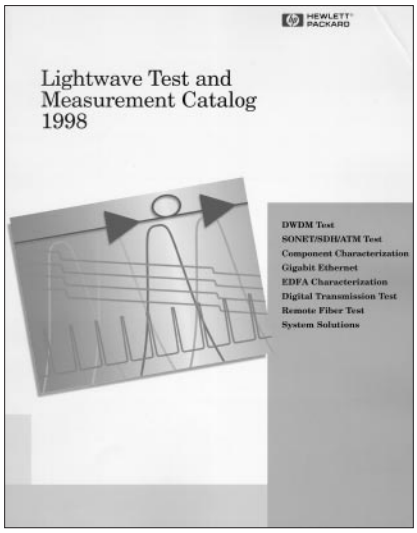
The catalog presents HP's extensive line of B- and C-sized mainframes, embedded controllers, scanning A/D converters, multimeters, switches, and disk storage devices. The VXI *plug & play* standard now supported on many HP VXI modules is highlighted. New and updated versions of software are covered, including HP VEE for Windows 95, HP TestExec SL, and HP BASIC for Windows. The '98 VXI catalog also describes new subsystems for general-purpose, automotive, and telecommunication applications.

Rack Solutions Catalog
5965-9759EN

This 86-page catalog showcases the racks used for organizing and managing all T&M products. It provides an overview about rack cabinets, including features and specifications. Sections on rack accessories and controller rack mount kits, instrument rack mount kits, and testmobile carts are included as well. Also, cable, uninterruptible power supply, and furniture information is provided.

A large section showcases integration information and guidelines. It describes how you can receive your equipment racked and ready to use, and discusses other issues such as safety design, ergonomic and aesthetic design, and racks, equipment installation and cabling services. A rack and accessories ordering guide and stability worksheets are also included.

To order any specialty catalog or directory, complete and return the business reply card at the end of this catalog.



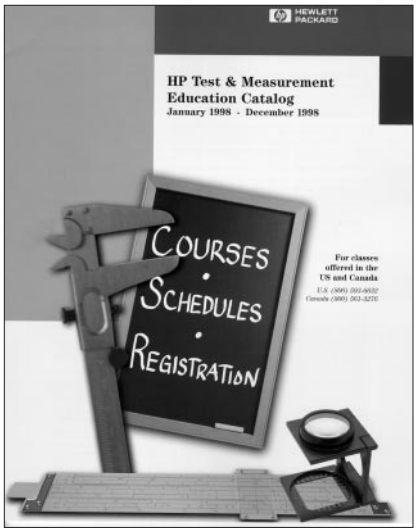
Lightwave Test and Measurement Catalog 1998
5966-0366E

This catalog offers a new products section, which covers the mini-OTDR, tunable laser source, broadband light and digital sources, digital communication analyzer, multi-wavelength meter and lightwave test system solutions. Chapters cover power, spectral, polarization, and return loss measurement techniques. A variety of analyzers are described, including: lightwave signal, lightwave component, time-domain, error performance, and SONET/SDH generators and analyzers. Optical accessories are also discussed.

Reference literature is provided along with tutorials on measurement applications.

1998/1999 HP Power Products Catalog
5966-1706E

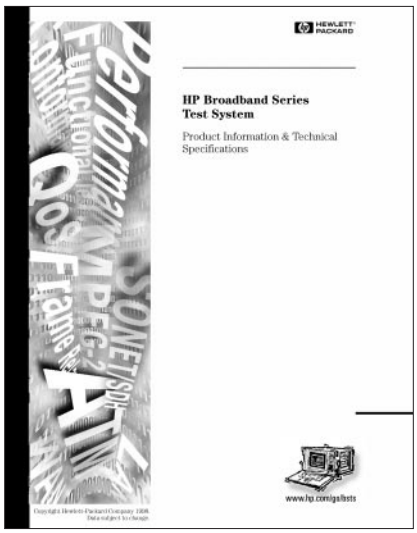
HP's entire line of power supplies, electronic loads, modular power systems, power test systems, ac sources, harmonic/flicker test systems, and solar array simulators are featured in this catalog. New products, such as the HP E4351B solar array simulator and the HP 6610 and 6630 series precision measurement single output system dc power supplies are included. Selection guides, complete product specifications, and application information help you make the right choice of power products for your applications.



HP Test & Measurement Education Catalog
5966-1395E

This publication lists all T&M customer education courses offered in the United States and Canada. It features 37 pages of scheduled, on-site, self-paced, and service-training courses, and includes several class offerings for each of the following subjects: quick-start training and productivity assistance, computer-aided test and general-purpose instruments, low-frequency signal analysis, RF and microwave, HP-EEsof, datacom/telecom, board test, digital design and characterization/embeddded software development, semiconductor test, ATS 2000, selected open systems, UNIX, HP-UX, and networking.

Registration information and phone numbers for further details about specific courses, as well as an HP course subject index, are provided. In addition, HP's new information line, which enables you to access current course scheduling, availability, data sheets, and new course offerings through a touch-tone phone and fax machine, is described.



HP Broadband Series Test System Product Information & Technical Specifications
5966-0035E

This catalog clearly shows the full depth and breadth of the HP Broadband Series Test System, the industry-standard ATM/BISDN test system for R&D engineering, product development, field trials and QA testing. The HP BSTS is a modular system designed so that you can expand your system as your testing needs evolve.

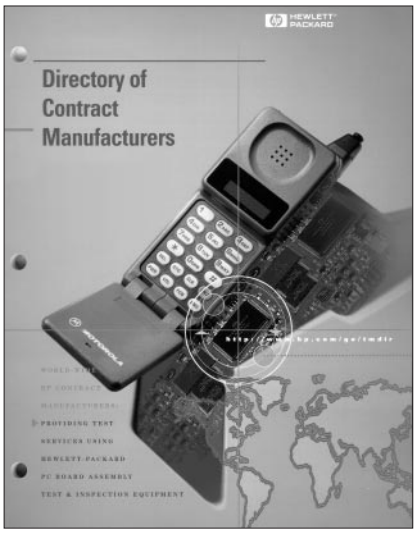
Included in the catalog are the technical specifications and product information for each BSTS hardware and software module, as well as the Broadband Communications Map, product listings and an index of available related literature such as application and solution notes.

DSA Accessory Catalog
5966-2340E

A wide variety of laboratory-quality sensors and supplies (from Hewlett-Packard and other leading manufacturers) that complement dynamic signal analyzers (DSAs) are presented in this 20-page catalog. These accessories empower you to perform accurate and successful measurements in acoustic, vibration, modal analysis, and other physical test applications.

Free field and pressure microphones, as well as microphone power supplies, preamplifiers, calibrators, adapters, and a microphone storage case are described. A new Sound Intensity Probe has been added which meets IEC 1043 Class 1 specifications.

Vibration transducers and several types of accelerometers, as well as an assortment of cables, are highlighted.



Directory of Contract Manufacturers
5965-9793E

If you currently outsource any of your manufacturing, or are considering doing it, this catalog is an invaluable guide for choosing a contract manufacturer (CM) to monitor manufacturing processes and your product quality using HP board test equipment.

The catalog lists more than 110 companies worldwide that manufacture loaded printed circuit boards under contract to OEMs and use HP 3070 or HP 5DX systems for in-circuit testing and x-ray inspection. Listings include the company and site contact name, address, phone, and fax number(s). Each contract manu-facturer describes services offered, geographic area services, industry certifications, and information about other pertinent equipment used at the facility.

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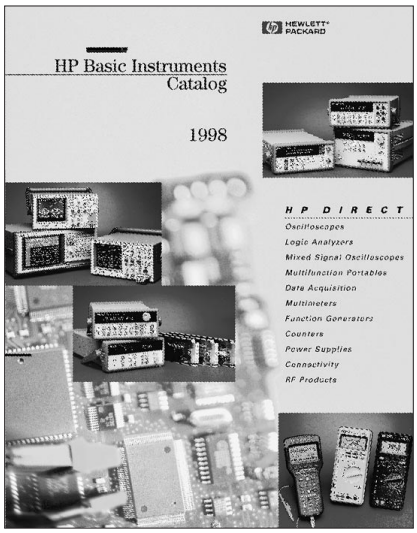

HP Basic Instruments Catalog
5968-0124EN

The most recent key specifications, photos, and descriptions of HP's line of basic instrument products are featured in this full-color, bi-annual catalog. Oscilloscopes, logic analyzers, digital multimeters, counters, power supplies and function/arbitrary waveform generator are highlighted. In addition, there's information on software, HP-IB cards, and cables. This one-stop shopping guide also includes the most current prices and ordering information.

Telecommunications News

If you work for a telecommunication service provider or network operator, you need the specialized information presented in Hewlett-Packard *Telecommunications News.* This quarterly newsletter is published in English, French, Italian, German, Russian, Spanish, and Chinese. Each issue provides technical and application information to help you meet the challenges of optimizing the performance of your networks and delivering improved services in a rapidly changing environment.

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These features are only a snapshot of what's available at the Web site. Bookmark it—and visit it regularly—to stay completely up to date on all of HP's test and measurement solutions.