HEWLETT PACKARD

HP 35660A Operating Manual Set

Includes:
Installation Guide
Getting Started Guide
Front-Panel Reference

Manual Part No. 35660-90000
Microfiche Part No. 35660-90200

8600 Soper Hill Road
Everett, Washingtion 98205-1298 U.S.A.

Printed: July 1988

HEWLETT PACKARD

HP 35660A Dynamic Signal Analyzer Installation Guide

Includes:

Operation Verification Tests
Performance Tests
Specifications

Manual Part No. 35660-90015
Microfiche Part No. 35660-90215

8600 Soper Hill Road
Everett, Washington 98205-1298 U.S.A.

Printed: July 1988

HEWLETT PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and the calibration facilities of other International Standards Organization Members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP software and firmware products which are designated by HP for use with a hardware product, when properly installed on the hardware product, are warranted not to fail to execute their programing instructions due to defects in materials and workmanship. If HP receives notice of such defects during their warranty period, HP shall repair or replace software media and firmware which do not execute their programming instructions due to such defects. HP does not warrant that the operation of the software, firmware or hardware shall be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

HEWLETT PACKARD

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure the safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

HEWLETT PACKARD

SAFETY SYMBOLS

General Definitions of Safety Symbols Used On Equipment or In Manuals.

⚠	Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.
ϟ	Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked.)
⏚ OR (⏚)	Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.
(⏚)	Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.
⊥ OR ⊥	Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.
∿	Alternating current (power line.)
⎓	Direct (power line.)
≂	Alternating or direct current (power line.)

WARNING ***The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which if not correctly performed or adhered to, could result in injury or death to personnel.***

CAUTION *The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.*

NOTE The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

Guide to Documentation

If You Are Interested In:	And You want to:	Read:
◆ Getting started	Install the HP 35660A Dynamic Signal Analyzer	HP 35660 Installation Guide
	Do performance verification tests	"
	Do operation verification tests	"
	Get comfortable with the HP 35660A	HP 35660A Getting Started Guide
	Make your first measurements	"
	Learn basic FFT principles	"
	Learn how to make basic measurements	"
	Learn what each key does	HP 35660A Front-Panel Reference
◆ Creating automated measurements	Install HP Instrument BASIC	HP 35680A Getting Started Guide
	Learn the HP Instrument BASIC interface	"
	Record keystrokes for a particular measurement	"
	Program with HP Instrument BASIC	HP Instrument BASIC Programming Reference
◆ HP-IB operation	Learn about the HP-IB	HP 35660A HP-IB Programming Reference
	Learn how to program over the HP-IB	"
	Find specific HP-IB commands	"
◆ Expanding analysis capabilities	Run the HP 35681A Analysis Pack	HP 35681A Operating and Programming Guide
	Adapt programs in the HP 35681A Analysis Pack for your own use	"

Table of Contents

Chapter 1
Introducing the HP 35660A

About the HP 35660A

The HP 35660A Dynamic Signal Analyzer is both a one-channel and a two-channel FFT signal analyzer. As a one-channel analyzer its frequency measurement range is from 488 μHz to 102.4 kHz; as a two-channel analyzer its frequency measurement range is from 244 μHz to 51.2 kHz. The analyzer also contains a built-in signal source and disc drive (however, the disc drive may be deleted).

On the front panel there are three active BNC connectors: channel 1 input, channel 2 input, and a source output. On the rear panel there are also three connectors: a BNC connector for an external trigger input, a 25-pin connector for the HP-IB, and a 9-pin connector (currently inactive).

About this Guide

The HP 35660A Installation Guide contains installation and operating information, along with the operation verification tests and performance tests. It is, therefore, included as part of the *HP 35660A Operating Manual Set* with an additional copy inserted into the optional *HP 35660A Service Manual.*

This book is organized with the specifications, operation verification tests, and performance tests near the beginning and the installation information at the back of the guide.

Options

The following options are available for the HP 35660A:

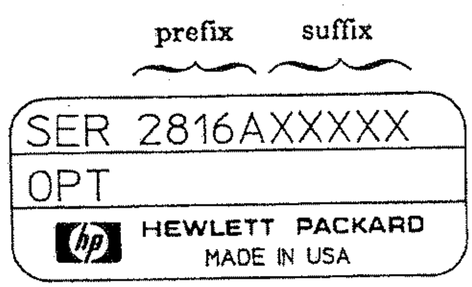
- 001 Add 2 Mbyte RAM
- 002 Delete disc drive
- 908 Rack mount kit (HP P/N 35660-86010)
- 910 Extra Operating Manual Set and HP-IB Programming Reference
- 915 Service Package
  Service manual (HP P/N 35660-90050)
  Service kit (HP P/N 35660-844401)
- 916 Extra operating Manual
  Similar to option 910, except does not include HP-IB Programming Reference
- 920 Extra HP-IB Programming Reference
- W30 Adds an additional 2 years to standard warranty
  (for a total of 3-years warranty)

Serial Numbers

This guide, as with all HP 35660A manuals, applies to analyzers with the serial number prefixes listed under SERIAL NUMBERS on the title page.

Hewlett-Packard makes frequent improvements to its products to enhance their performance, usability, or reliability, and to control costs. HP service personnel have access to complete records for each type of equipment, based on the equipment's serial number. Whenever you contact HP about your analyzer, have the complete serial number available to ensure obtaining the most complete and accurate information possible.

A serial number label is attached to the rear of the analyzer. The serial number has two parts: the prefix (the first four numbers and a letter), and the suffix (the last five numbers).



Software Revision Code

As with changes to the instrument hardware, Hewlett-Packard also makes changes to its software. To determine which version of software is in your analyzer, press the following keys:

< SPECIAL FCTN >

[Fault Log]
[Version]

An information block appears on the screen for about five seconds (pressing [Version] repeats the information). The first line of this information block contains the software version code.

Chapter 2
Specifications

Specifications describe the instrument's warranted performance and apply within ±5°C and 2 hours of last self-calibration. Specifications designated as "Typical" reflect supplemental, non-warranted characteristics.

Amplitude

Input Range: +27 dBV (31.7 Vpk) to -51 dBV (3.99 mVpk). Range is adjustable in 2 dB increments.

Dynamic Range: 70 dB
The following undesired responses will be < -70 dB relative to full scale input range:

Harmonic Distortion
Intermodulation Distortion
Alias Responses
Spurious or Residual Responses

Noise: **(–51 dBV range, Rs = 50Ω, 16 rms averages)**

160 Hz to 1.28 kHz < -130 dBV/$\sqrt{Hz}$ (.316 μV / $\sqrt{Hz}$)

1.28 kHz to 102.4 kHz < -140 dBV/$\sqrt{Hz}$ (.100 μV / $\sqrt{Hz}$)

NOTE: The following table shows the maximum span for each range at which noise will be < -70 dB relative to full scale for frequencies > 1.28 kHz. If you are using a span equal to or narrower than the spans shown below for each window/range combination, noise will not limit dynamic range.

Window Types

Ranges (dBV)	*Uniform*	*Hann*	*Flat Top*
+27 to -39	102.4 kHz	102.4 kHz	102.4 kHz
-41	102.4 kHz	102.4 kHz	51.2 kHz
-43	102.4 kHz	102.4 kHz	51.2 kHz
-45	102.4 kHz	51.2 kHz	25.6 kHz
-47	51.2 kHz	51.2 kHz	12.8 kHz
-49	25.6 kHz	25.6 kHz	12.8 kHz
-51	25.6 kHz	12.8 kHz	6.4 kHz

Common Mode Rejection: (Frequency ≤ 1 kHz)

-51 to -11 dBV Ranges (3.99 mVpk to 399 mVpk) > 80 dB (Typical)

-9 to +9 dBV Ranges (502 mVpk to 3.99 Vpk) > 60 dB (Typical)

+11 to +27 dBV Ranges (5.02 Vpk to 31.7 Vpk) > 40 dB (Typical)

Crosstalk : < -130 dB relative to the transmitting signal, or < -70 dB relative to the receiving channel range, whichever is greater.
(Receiving channel Rs = 50Ω)

NOTE: This specification applies to both channel-to-channel and source-to-input crosstalk.

Residual DC Response:

Input Range (dBV)	*DC Level*
+27 to -35 (31.7 Vpk to 25.1 mVpk)	< -30 dB relative to full scale
-37 to -51 (20.0 mVpk to 3.99 mVpk)	< -20 dB relative to full scale

(Rs = 50Ω)

Absolute Amplitude Accuracy: ± 0.5 dB ± 0.03 % of input range
(488 μHz to 102.4 kHz, DC coupled)

Worst case absolute amplitude accuracy is the sum of full scale accuracy, linearity, and flatness at any of the 401 calculated frequency points. If the input signal is not at the center of a frequency bin, the accuracy of the measured signal will be the sum of absolute amplitude accuracy and the flatness specification for that particular window (see window shape parameters).

Full Scale Accuracy: ± 0.15 dB (at 1 kHz)

Linearity: ± 0.15 dB (at 1 kHz) ± 0.03% of range

Flatness: ± 0.2 dB (relative to 1 kHz, DC coupled)

Frequency

Measurement Range: *Channel 1:* **488 μHz to 102.4 kHz, single** channel mode
Channel 1 and 2: **244 μHz to 51.2 kHz,** dual channel mode.

Accuracy: ± 0.003% of frequency reading

Resolution: Span/400, both channels, single or dual channel operation.

Spans:

	Single Channel	*Dual Channel*
# of spans available	20 (x2 sequence)	20 (x2 sequence)
min. span	195.3 mHz	97.6 mHz
max. span	102.4 kHz	51.2 kHz
time record length	400/span	400/span

Window Functions: Flat Top, Hann, Uniform, Force, Exponential

Window Shape Parameters:

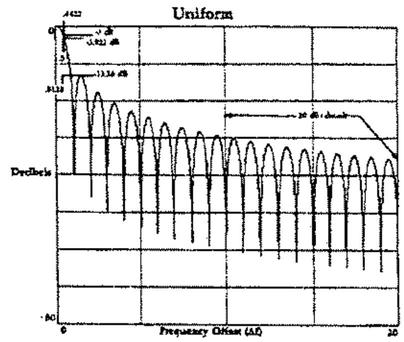
	Noise Equiv. BW (% of span)	*-3dB BW (% of span)*	*Shape Factor (-60dB BW/ -3 dB BW)*	*Window Flatness (dB)**
Uniform	0.25	0.25	716	+0, -4.0
Hann	0.375	0.37	9.1	+0, -1.5
Flat Top	0.955	0.9	2.6	± 0.005

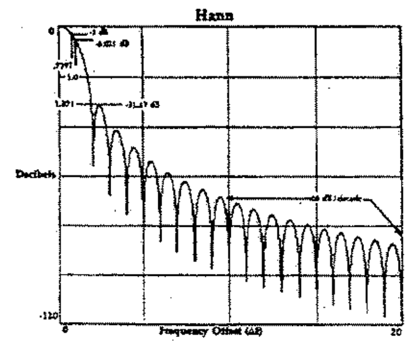
* relative to analyzer's 401 calculated frequency points (spectral lines)

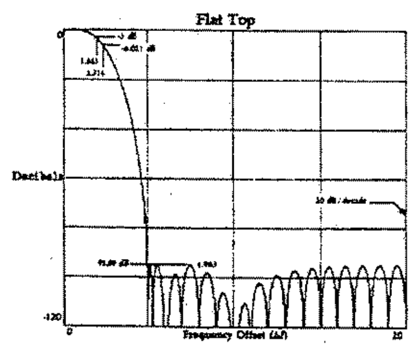
The HP 35660A functions as if the input signal were applied to a bank of 401 narrow-band filters in parallel. The drawings at right show the response of a single filter in the frequency domain when using Uniform, Hann or Flat Top windows. The left side of each drawing represents the center of the filter. The horizontal axis shows frequency offset (in unit of Δf) from the center of the filter. The units of Δf represent the spacing between adjacent bin centers. Only positive offsets are shown, as each filter is symmetrical.
NOTE: HP 35660A marker frequencies fall at the center of each filter.

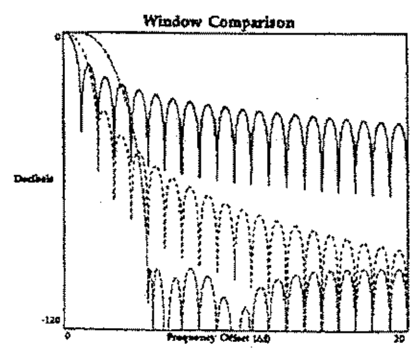
Typical Realtime Bandwidth: (random noise source off)

	Single Channel	*Dual Channel*
Averaging Off	800 Hz	400 Hz
Fast Averaging	3.2 kHz	1.6 kHz









Phase

Single Channel Phase Accuracy: 488 uHz to 10.24 kHz ± 4.0°
(relative to external trigger, 16 vector averages, amplitude ≥ -50 dB relative to full scale, DC coupled)

NOTE: For Hann or Flat Top windows, phase is relative to the center of the time record. For the Uniform, Force, and Exponential windows, phase is relative to the beginning of the time record.

Frequency Response

Gain Accuracy: ± 0.4 dB

Phase Accuracy:
488 uHz to 10.24 kHz ± 1°
10.24 kHz to 102.4 kHz ± 1.8°
(DC coupled, 16 rms averages, 488 μHz to 51.2 kHz, Ch1 range = Ch2 range, full scale periodic chirp input, Uniform window)

Inputs

Connection: Grounded or Floating

Input Impedance: 1 MΩ ± 10% shunted by < 100 pF

Low to chassis in floating mode:
1 MΩ shunted by < 0.01 μF (Typical)

Low to chassis in grounded mode: 50Ω (Typical)

Input Coupling: AC or DC coupling;
AC roll-off is < 3 dB at 1 Hz

Common Mode Range: ± 4V peak
(floating mode)

Source

Random, periodic chirp, fixed sine outputs are available from the front panel SOURCE output.

Output Impedance: < 5Ω

Max. Output Level: ± 5 Vpk

Max. Current: ± 20 mA

Max. Capacitive Load: 1000 pF

Sine:

Frequency range:
15.63 mHz to 102.4 kHz

Amplitude Accuracy:
± 4% Vpk (at 1 kHz, Vpk = .1V to 5V)

Flatness: ± 1.0 dB
(relative to 1 kHz, Vpk= .1V to 5V)

Harmonic, subharmonic, and other spurious responses:
488 μHz to 10 kHz:
< -60 dB relative to fundamental

10 kHz to 102.4kHz:
< -40 dB relative to fundamental

(Vpk= 0.1V to 5V)

Residual DC offset:
± 8.0 mV, ± 6.0% Vpk

Random:

Flatness: < 5.0 dB (Typical)
(passband,relative to minimum amplitude in the frequency domain, Vpk = .1V to 5V, full span)

Crest factor (Vpk/Vrms): 2.5 (Typical)
(center frequency > 0.7 • span frequency)

Trigger

Internal: Positive or negative slope
Level range: ± 100% of input range

External: TTL, positive or negative slope

Delay: Pre-trigger: from 0 to 6 samples less than 8 time records. Resolution is 1 sample.

Post-trigger: from 0 to 8191 seconds. Resolution is 1 sample.

(1 sample= time record (secs)/1024)

NOTE: the relative trigger delay between channel 1 and 2 can be no more than ± 7 time records. As you set delay on one channel, the analyzer will automatically adjust delay on the other channel, so that the difference in their delay does not exceed 7 time records.

General

Environmental Specifications:

Standard Instrument:

	Operating	*Storage (no disc in drive)*
Temperature	5°to 50°C	-20° to 60°C
Humidity	min. 8% max. 80% at 30°C non-condensing	5 to 95% non-condensing
Altitude	2150 m (7000 ft)	15,200 m (50,000 ft)

Delete Disc Option:

	Operating	*Storage*
Temperature	0°to 55°C	-40° to 70°C
Humidity	min. 5% max. 95% at 40°C	min. 5% max. 95% at 40°C
Altitude	4570 m (15,000 ft)	15,200 m (50,000 ft)

Power: 90 - 132 VAC, 48 to 440 Hz
198 - 264 VAC, 48 to 66 Hz
280 VA maximum

Weight: 22 kg (47 lbs) net
24 kg (52 lbs) shipping

Dimensions: 222 mm (8.75 in) high
425.5 mm (16.75 in) wide
538 mm (21.19 in) deep

HP-IB: Implementation of IEEE Std 488.1 & 488.2
SH1 AH1 T6 TE0 L4 LE0 SR1 RL1 PP0
DC1 DT1 C1,C2,C3,C12 E2

Peripherals: Disc Drives: SS/80 Protocol Disc Drives

Plotters: Hewlett-Packard Graphics Language (HP-GL) digital plotters

Printers: HP-IB printers, alpha and raster dumps.

(See ordering guide for a list of peripherals and accessories.)

Abbreviations: dBV = dB relative to 1 volt rms.
Rs = Resistance of source or termination connected to input.

Chapter 3
Operation Verification Tests and Performance Tests

Introduction

This section contains the operation verification tests and the performance tests. The operation verification tests give a high confidence level (>90%) that the instrument is operating properly and within specifications. Operation verification should be used for incoming and after-repair inspections.

The performance tests provide the highest level of confidence and are used to verify that the instrument conforms to its published specifications. Some repairs require a performance test to be done after the repair (see the *HP 35660A Service Manual* for this information).

Test Duration

Operation Verification Tests require approximately 2 hours to complete. The performance tests require approximately 4 hours to complete.

CAUTION *Before applying line power to the analyzer or testing its electrical performance, see Chapter 4, "Installation."*

Calibration Cycle

To verify the instrument is meeting its published specifications, perform the performance tests every 12 months.

Operation Verification and Performance Test List

The following tables list all the performance tests and operation verification tests.

NOTE To minimize the time required to change instrument configurations between tests, do the tests in the order shown. See How to Perform an Operation Verification or Performance Test following this test list.

Table 3-1 Performance Test and Operation Verification List

Performance Tests	Operation Verification Tests
1. Self Test	1. Self Test
2. DC Response	2. DC Response
3. Amplitude Accuracy and Flatness	3. Amplitude Accuracy and Flatness
4. Amplitude Linearity	5. Amplitude and Phase Match
5. Amplitude and Phase Match	7. Frequency Accuracy
6. Anti-alias Filter Response	9. Single Channel Phase Accuracy
7. Frequency Accuracy	13. Noise and Spurious Signals
8. Input Coupling Insertion Loss	15. Source Residual DC Offset
9. Single Channel Phase Accuracy	16. Source Amplitude Accuracy and Flatness
10. Input Impedance	17. Source Output Distortion
11. Harmonic Distortion	
12. Intermodulation Distortion	
13. Noise and Spurious Signals	
14. Cross Talk	
15. Source Residual DC Offset	
16. Source Amplitude Accuracy and Flatness	
17. Source Output Distortion	
18. Source Output Resistance	

Specification Versus Performance Tests

Table 3-2 Specification Versus Performance Tests

Specification	Performance Test
Frequency	Frequency Accuracy
Absolute Accuracy	Amplitude Accuracy and Flatness Amplitude Linearity
Residual dc Response	DC Response
Frequency Response	Amplitude and Phase Match
Noise Floor	Noise and Spurious Signal Level
Dynamic Range	Anti-Alias Filter Response Harmonic Distortion Intermodulation Distortion
Phase Accuracy	Single Channel Phase Accuracy
Input Impedance	Input Impedance
Input Coupling	Input Coupling Insertion Loss
Cross Talk	Cross Talk
Trigger	Single Channel Phase Accuracy
Source dc Offset	Source Residual DC Offset
Source Accuracy and Purity	Source Amplitude Accuracy and Flatness
Source Distortion	Source Distortion
Source Output Impedance	Source Output Resistance

Recommended Test Equipment

The equipment needed to perform performance tests and operation verification tests the HP 35660A is listed in Table 3-3. Other equipment may be substituted for the recommended model if it meets or exceeds the listed critical specifications.

Table 3-3 Recommended Test Equipment

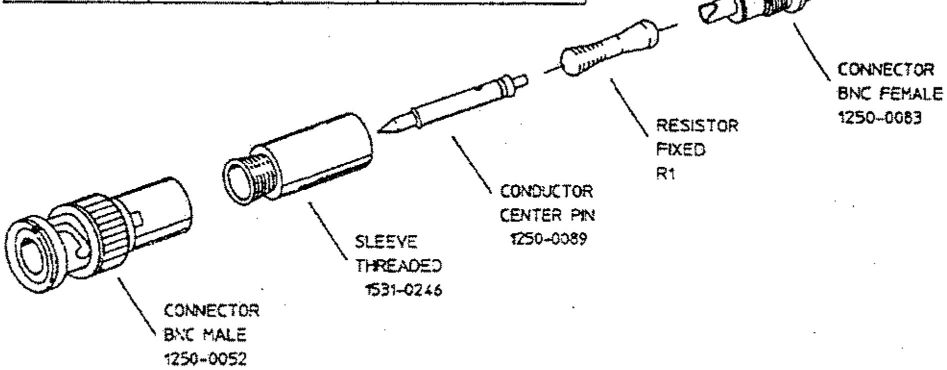
Instrument	Critical Specifications	Recommended Model
AC Calibrator	10 Hz to 102.4 kHz; 1 mV to 10V Amplitude Accuracy: ± .1% phase locking capability	Fluke 5200A Alternative: HP 745A Datron 4200
Frequency Synthesizer	Freq Range: 10 Hz to 1 MHz Frequency Accuracy: ≥7.5 ppm Amplitude Accuracy: 0.2 dB from 1 Hz to 100 kHz 1 dB from 100 kHz to 1 MHz Harmonic Distortion: ≤−70 dBc Spurious: ≤−70 dBc	HP 3326A Alternative: (2) HP 3325A Opt 001 (1) HP 339A (2) 1 kΩ resistors
Digital Voltmeter	5 1/2 digit True rms ac Voltage: 30 Hz to 100 kHz; 0.1 to 500V; ± 0.1%; ≥ 1 MΩ input impedance dc Voltage: 1V to 300V; ± 0.1%	HP 3455A Alternatives: HP 3456A HP 3457A HP 3478A HP 3468A/B
Feedthrough Termination (2)	50 Ω: ±2% at dc	Pomona Elect. Model 4119-50 Alternatives: HP 11048C HP 10100C
Cables (2)	BNC/Dual Banana Dual Banana/Dual Banana Cable BNC/BNC Cable 30 cm BNC/BNC Cable 122 cm	HP11001-60001 HP11000-60001 HP 8120-1838 HP 8120-1840
Adapters	BNC(m) to dual banana plug BNC (f) to dual banana male BNC (f) to BNC (f) BNC Tee (m)(f)(f)	HP 1250-1264 HP 1251-2277 HP 1250-0080 HP 1250-0781
Resistor (2)*	Value: 100 kΩ Accuracy: 1% Power: 0.25W	HP 0757-0465

* *see Figure 3-1 for suggested assembly*

The following illustration is a suggested assembly for the 100 kΩ Series Resistor. This assembly is required for the following Performance Tests:

10. Input Impedance
12. Intermodulation Distortion

Resistance	Tolerance	Power	-hp- Part Number
100kΩ	1 %	0.25W	0757-0465



Assembly

1. Cut resistor leads to 12mm on each end.
2. Solder one resistor lead to the center conductor of the BNC FEMALE connector.
3. Solder the CONDUCTOR CENTER PIN to the other lead of the resistor.
4. Screw the SLEEVE and BNC MALE connector into place. Tighten securely.

Figure 3-1. 100 kΩ Series Resistor Assembly

How To Perform An Operation Verification or Performance Test

Use the following procedure to perform the operation verification tests or performance tests:

NOTE The operation verification tests are a subset of the performance tests. At the beginning of each test is a shaded box telling if the test is used for the operation verification test in addition to the performance test. Also this box specifies if there are differences between the two types of tests. Any differences between the operation verification test and the performance test are contained in a shaded box within the test itself.

NOTE The operation verification test and the performance tests must be performed with automatic calibration ON. When the instrument powers up AUTOCAL is ON, do not turn it off.

1. Start each test by setting the test equipment to the test conditions listed in the individual test.
2. There are two types of keys on the HP 35660A, hardkeys and softkeys. The hardkeys are in brackets,

   < Freq >

   and the softkeys are in braces,

   [FREQ SPAN]

   For EXAMPLE, to set a frequency span of 10 kHz you would do the following:

   < Freq >
   [SPAN]< 1 >< 0 >[kHz]

   In the above example, you first press the hardkey < Freq > followed by the softkey [FREQ SPAN]. Then you enter the number 10 on the numeric keypad and finish by pressing the [kHz] softkey.

3. Record the position of the X and Y markers as indicated for each test. See the *HP35660A Getting Started Guide* for additional information.
4. Record the results of each test in the "Operation Verification Test Record"or the "Performance Test Record." These test records follow and may be reproduced without written permission of Hewlett-Packard.
5. If a test fails, see IF THIS TEST FAILS at the end of each test.

HP 35660A Operation Verification Test Record

HP 35660 Tested by ______________________
Serial No. ______________________
Customer Name______________________
Repair Order No. ______________________
Date ______________________
Temperature ______________________
Relative Humidity______________________

Instruments Used:

AC Calibrator
Model______________________
Serial No. ______________________

Frequency Synthesizer
Model______________________
Serial No. ______________________

Digital Voltmeter
Model______________________
Serial No. ______________________

Other ______________________
Other ______________________

Operation Verification Test Record

1. Self Test

	Pass	Fail

2. DC Offset

Range Setting	Measured Value Channel 1	Measured Value Channel 2	Specification
−51 dBVrms			<−71 dBVrms
−35 dBVrms			<−65 dBVrms

3. Amplitude Accuracy and Flatness

Full Scale Accuracy at 1 kHz:

Range Setting	AC Calibrator Amplitude	Lower Limit	Upper Limit	Measured Value Channel 1	Measured Value Channel 2
−51 dBVrms	2.8184 mVrms	−51.15 dBVrms	−50.85 dBVrms		
−27 dBVrms	44.668 mVrms	−27.15 dBVrms	−26.85 dBVrms		
−11 dBVrms	0.28184 Vrms	−11.15 dBVrms	−10.85 dBVrms		
9 dBVrms	2.8184 Vrms	8.85 dBVrms	9.15 dBVrms		
27 dBVrms	22.387 Vrms	26.85 dBVrms	27.15 dBVrms		

Flatness Relative to 1 kHz: **CHANNEL 1**

Range Setting	AC Calibrator Amplitude	Signal Frequency	Measured Value	Lower Limit	Upper Limit
−11 dBVrms	0.28184 Vrms	49 kHz		−0.2 dB	0.2 dB
9 dBVrms	2.8184 Vrms	49 kHz		−0.2 dB	0.2 dB
27 dBVrms	22.387 Vrms	49 kHz		−0.2 dB	0.2 dB
9 dBVrms	2.8184 Vrms	99 kHz		−0.2 dB	0.2 dB
27 dBVrms	22.387 Vrms	99 kHz		−0.2 dB	0.2 dB

CHANNEL 2

Range Setting	AC Calibrator Amplitude	Signal Frequency	Measured Value at 1 kHz dBVrms	Lower Limit	Upper Limit
−11 dBVrms	0.28184 Vrms	49 kHz		−0.2 dB	0.2 dB
9 dBVrms	2.8184 Vrms	49 kHz		−0.2 dB	0.2 dB
27 dBVrms	22.387 Vrms	49 kHz		−0.2 dB	0.2 dB

5. Amplitude and Phase Match

Frequency Span	Start Frequency	Range Setting	Measurement Peak Amplitude	Measurement Minimum Amplitude	Amplitude Limits
6.4 kHz	80 Hz	−23 dBVrms			±0.4 dB
6.4 kHz	3.84 Hz	1 dBVrms			±0.4 dB
51.2 kHz	0 Hz	7 dBVrms			±0.4 dB

Measurement Peak Phase	Measurement Minimum Phase	Phase Limits
		±1.0 °
		±1.0 °
		±1.8 °

7. Frequency Accuracy

Signal Frequency Hz	Lower Limit Hz	Upper Limit Hz	Measured Value
100 kHz	99.997 kHz		100.003 kHz

9. Single Channel Phase Accuracy

Relative to external trigger (TTL Level)

Signal Frequency	Trigger Slope	Lower Limit	Upper Limit	Measured Value Channel 1	Measured Value Channel 2
10.24 kHz	Positive	−94 °	−86 °		
10.24 kHz	Negative	86 °	94 °		

13. Noise and Spurious Signal Level

Range: −51 dBVrms

Spurious Signals:

Start Frequency	Frequency Span	Measured Value Channel 1	Measured Value Channel 2	Specification
160 Hz	200 Hz			<−121 dBVrms
360 Hz	200 Hz			<−121 dBVrms
560 Hz	200 Hz			<−121 dBVrms
760 Hz	200 Hz			<−121 dBVrms
1.28 kHz	1.6 kHz			<−121 dBVrms
24 kHz	1.6 kHz			<−121 dBVrms
30 kHz	1.6 kHz			<−121 dBVrms
34.2 kHz	1.6 kHz			<−121 dBVrms
49 kHz	1.6 kHz			<−121 dBVrms
61 kHz	1.6 kHz			<−121 dBVrms
68 kHz	1.6 kHz			<−121 dBVrms
74 kHz	1.6 kHz			<−121 dBVrms
76 kHz	1.6 kHz			<−121 dBVrms
92 kHz	1.6 kHz			<−121 dBVrms
100 kHz	1.6 kHz			<−121 dBVrms

Noise Level:

Range: −51 dBVrms

Start Frequency	Frequency Span	Measured Value Channel 1	Measured Value Channel 2	Specification
160 Hz	12.8 kHz			<−130 dBV/$\sqrt{Hz}$
1.28 kHz	50 kHz			<−140 dBV/$\sqrt{Hz}$
1.28 kHz	100 kHz			<−140 dBV/$\sqrt{Hz}$

15. Source Residual Offset

Source Level Vpk	Lower Limit	Upper Limit	Measured Value
0.00125V	−8.075 mV	8.075 mV	
5V	−308.0 mV	308.0 mV	

16. Source Amplitude Accuracy and Flatness

Amplitude Accuracy at 1 kHz:

Source Level Vpk	Range Setting Vpk	Lower Limit Vpk	Upper Limit Vpk	Source Amplitude Measured Value
0.1V	0.1V	96.0 mV	104 mV	
3V	3V	2.88V	3.12V	
5V	5V	4.8V	5.2V	

Flatness Relative to 1 kHz:

Signal Frequency	Measured Relative Value dB	Amplitude Limits
1 kHz		
10 kHz		±1 dB
50 kHz		±1 dB
99 kHz		±1 dB

17. Source Output Distortion

Source Frequency	Peak Distortion Value	Specification
10 kHz		<−60 dBc
100 kHz		<−40 dBc

HP 35660A Performance Test Record

HP 35660 Tested by ____________________
Serial No. ____________________
Customer Name ____________________
Repair Order No. ____________________
Date ____________________
Temperature ____________________
Relative Humidity ____________________

Instruments Used:

AC Calibrator
Model ____________________
Serial No. ____________________

Frequency Synthesizer
Model ____________________
Serial No. ____________________

Digital Voltmeter
Model ____________________
Serial No. ____________________

Other ____________________
Other ____________________

Performance Test Record

1. Self Test

	Pass	Fail

2. DC Offset

Range Setting	Measured Value Channel 1	Channel 2	Specification
−51 dBVrms			<−71 dBVrms
−35 dBVrms			<−65 dBVrms

3. Amplitude Accuracy and Flatness

Full Scale Accuracy at 1 kHz:

Range Setting	AC Calibrator Amplitude	Lower Limit	Upper Limit	Measured Value Channel 1	Channel 2
−51 dBVrms	2.8184 mVrms	−51.15 dBVrms	−50.85 dBVrms		
−43 dBVrms	7.0795 mVrms	−43.15 dBVrms	−42.85 dBVrms		
−35 dBVrms	17.783 mVrms	−35.15 dBVrms	−34.85 dBVrms		
−27 dBVrms	44.668 mVrms	−27.15 dBVrms	−26.85 dBVrms		
−11 dBVrms	0.28184 Vrms	−11.15 dBVrms	−10.85 dBVrms		
1 dBVrms	1.1220 Vrms	0.85 dBVrms	1.15 dBVrms		
9 dBVrms	2.8184 Vrms	8.85 dBVrms	9.15 dBVrms		
19 dBVrms	8.9125 Vrms	18.85 dBVrms	19.15 dBVrms		
27 dBVrms	22.387 Vrms	26.85 dBVrms	27.15 dBVrms		

Flatness Relative to 1 kHz: **CHANNEL 1**

Range Setting	AC Calibrator Amplitude	Signal Frequency	Measured Value	Lower Limit	Upper Limit
−11 dBVrms	0.28184 Vrms	49 kHz		−0.2 dB	0.2 dB
9 dBVrms	2.8184 Vrms	49 kHz		−0.2 dB	0.2 dB
27 dBVrms	22.387 Vrms	49 kHz		−0.2 dB	0.2 dB
9 dBVrms	2.8184 Vrms	99 kHz		−0.2 dB	0.2 dB
27 dBVrms	22.387 Vrms	99 kHz		−0.2 dB	0.2 dB

3. (continued)

CHANNEL 2

Range Setting	AC Calibrator Amplitude	Signal Frequency	Measured Value at 1 kHz dBVrms	Lower Limit	Upper Limit
−11 dBVrms	0.28184 Vrms	49 kHz		−0.2 dB	0.2 dB
9 dBVrms	2.8184 Vrms	49 kHz		−0.2 dB	0.2 dB
27 dBVrms	22.387 Vrms	49 kHz		−0.2 dB	0.2 dB

4. Amplitude Linearity

Linearity at 1 kHz, +27 dBV Range

AC Calibrator Amplitude	Lower Limit	Upper Limit	Measured Value	
			Channel 1	Channel 2
7.0795 mVrms	−72.32 dBVrms	−37.13 dBVrms		
35.481 mVrms	−31.01 dBVrms	−27.37 dBVrms		
0.17783 Vrms	−15.49 dBVrms	−14.53 dBVrms		
0.89125 Vrms	−1.217 dBVrms	−0.786 dBVrms		
4.4667 Vrms	12.84 dBVrms	13.16 dBVrms		
22.387 Vrms	26.85 dBVrms	27.15 dBVrms		

5. Amplitude and Phase Match

Frequency Span	Start Frequency	Range Setting	Measurement		Amplitude Limits
			Peak Amplitude	Minimum Amplitude	
6.4 kHz	80 Hz	−23 dBVrms			±0.4 dB
6.4 kHz	3.84 Hz	1 dBVrms			±0.4 dB
51.2 kHz	0 Hz	7 dBVrms			±0.4 dB

Measurement		Phase Limits
Peak Phase	Minimum Phase	
		±1.0°
		±1.0°
		±1.8°

6. Anti-alias Filter Response

Signal Frequency	Alias Frequency	Measured Value		Specification
		Channel 1	Channel 2	
162.144 kHz	100 kHz			< −79 dBVrms
81.072 kHz	50 kHz			< −79 dBVrms

7. Frequency Accuracy

Signal Frequency Hz	Lower Limit Hz	Upper Limit Hz	Measured Value
100 kHz	99.997 kHz	100.003 kHz	

8. Input Coupling Insertion Loss

Channel 1 Insertion Loss dc – ac	Specification	Channel 2 Insertion Loss	Specification dc – ac
	<3 dB		<3 dB

9. Single Channel Phase Accuracy

Relative to external trigger (TTL Level)

Signal Frequency	Trigger Slope	Lower Limit	Upper Limit	Measured Value Channel 1	Measured Value Channel 2
10.24 kHz	Positive	−94 °	−86 °		
10.24 kHz	Negative	86 °	94 °		

10. Input Impedance

Resistance Measurement:

Range Setting	Lower Limit	Upper Limit	Measured Value Channel 1	Measured Value Channel 2
27 dBVrms	0.900 MΩ	1.100 MΩ		
9 dBVrms	0.900 MΩ	1.100 MΩ		
−11 dBVrms	0.900 MΩ	1.100 MΩ		

Capacitance Measurement

Channel 1

Vin = Vrms

Vc = Vrms

Channel 1: 100 kHz

$$C = 15.9^{-12}\left(\frac{Vin}{Vc} - 2\right)$$

Channel 1 Measured Value = pF

Specification <100 pF

10. (continued)

Channel 2

Vin = Vrms

Vc = Vrms

Channel 2: 50 kHz

$$C = 31.8^{-12}\left(\frac{Vin}{Vc} - 2\right)$$

Channel 2		Specification
Measured Value =	pF	<100 pF

11. Harmonic Distortion

Range:1 dBVrms

Signal Frequency	Harmonic Frequency	Measured Value Channel 1	Measured Value Channel 2	Specification
24.96 kHz	49.92 kHz			<−69 dBVrms
16.64 kHz	49.92 kHz			<−69 dBVrms
49.92 kHz	99.84 kHz			<−69 dBVrms
33.28 kHz	99.84 kHz			<−69 dBVrms
24.96 kHz	99.84 kHz			<−69 dBVrms
19.97 kHz	99.84 kHz			<−69 dBVrms

12. Intermodulation Distortion

Input Amplitudes: −7 dBVrms (−6.02 dBfs)

Input Range: −1 dBVrms

Harmonic Frequency	Measured Value Channel 1	Measured Value Channel 2	Specification
20.25 kHz			<−71 dBVrms
30.50 kHz			<−71 dBVrms
1 kHz			<−71 dBVrms
50 kHz			<−71 dBVrms
10 kHz			<−71 dBVrms
79 kHz			<−71 dBVrms

13. Noise and Spurious Signal Level

Range: −51 dBVrms

Spurious Signals:

Start Frequency	Frequency Span	Measured Value Channel 1	Measured Value Channel 2	Specification
160 Hz	200 Hz			<−121 dBVrms
360 Hz	200 Hz			<−121 dBVrms
560 Hz	200 Hz			<−121 dBVrms
760 Hz	200 Hz			<−121 dBVrms
1.28 kHz	1.6 kHz			<−121 dBVrms
24 kHz	1.6 kHz			<−121 dBVrms
30 kHz	1.6 kHz			<−121 dBVrms
34.2 kHz	1.6 kHz			<−121 dBVrms
49 kHz	1.6 kHz			<−121 dBVrms
61 kHz	1.6 kHz			<−121 dBVrms
68 kHz	1.6 kHz			<−121 dBVrms
74 kHz	1.6 kHz			<−121 dBVrms
76 kHz	1.6 kHz			<−121 dBVrms
92 kHz	1.6 kHz			<−121 dBVrms
100 kHz	1.6 kHz			<−121 dBVrms

Noise Level:

Range: −51 dBVrms

Start Frequency	Frequency Span	Measured Value Channel 1	Measured Value Channel 2	Specification
160 Hz	12.8 kHz			<−130 dBV/√Hz
1.28 kHz	50 kHz			<−140 dBV/√Hz
1.28 kHz	100 kHz			<−140 dBV/√Hz

14. Cross Talk

Measurement	Measured Value	Specification
Channel 2 – to – Channel 1		<−121 dBVrms
Channel 1 – to – Channel 2		<−121 dBVrms
Source – to – Input		<−121 dBVrms

15. Source Residual Offset

Source Level Vpk	Lower Limit	Upper Limit	Measured Value
0.00125V	−8.075 mV	8.075 mV	
5V	−308.0 mV	308.0 mV	

16. Source Amplitude Accuracy and Flatness

Amplitude Accuracy at 1 kHz:

Source Level Vpk	Range Setting Vpk	Lower Limit Vpk	Upper Limit Vpk	Source Amplitude Measured Value
0.1V	0.1V	96.0 mV	104 mV	
3V	3V	2.88V	3.12V	
5V	5V	4.8V	5.2V	

Flatness Relative to 1 kHz:

Signal Frequency	Measured Relative Value dB	Amplitude Limits
1 kHz		
10 kHz		±1 dB
50 kHz		±1 dB
99 kHz		±1 dB

17. Source Output Distortion

Source Frequency	Peak Distortion Value	Specification
10 kHz		<−60 dBc
100 kHz		<−40 dBc

18. Source Output Resistance

R1 =

V1 = Vrms

V2 = Vrms

$$Rs = R1\left(\frac{V2 - V1}{V1}\right)$$

Specification

Measured Value = Ω <5 Ω

1. Self Test

Operation Verification — Yes

For this test, the Operation Verification Test and Performance Test are the same.

The self test checks the measurement hardware in the HP 35660A. No performance tests should be attempted until the analyzer passes this test. The self test takes approximately one minute to complete, and requires no external equipment.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

1. Press the HP 35660A keys as follows:

   < Preset >

   < Special Fctn >
   [SELF TEST]
   [TEST LOG]
   [RETURN]
   [CLEAR TEST LOG]
   [LONG CONF TEST]
   [START]

2. When the self test finished, check that all the tests have passed. Enter results on the test record.

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual*:

Section VII – Service: Assembly Level

2. DC Response

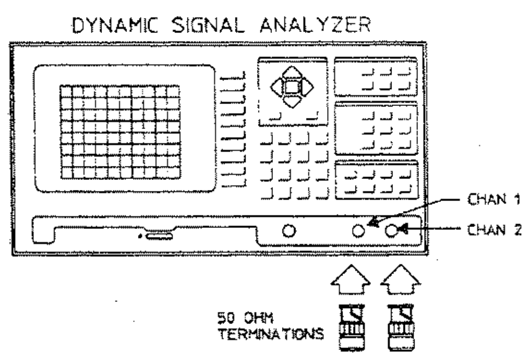
[illegible]

This test measures the level of residual dc offset generated within the HP 35660A.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

1. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



2. Press the HP 35660A keys as follows:

   < Preset >

   < Format >
   [UPPER/LOWER]

   < Meas Type >
   [2 CHANNEL 51.2 kHz]

   < Input >
   [CHANNEL 1 SETUP] [AC/DC] [RETURN]
   [CHANNEL 2 SETUP] [AC/DC]

   < Freq >
   [SPAN] < 3 > < . > < 2 > [kHz]

   < Average >
   [AVERAGE ON/OFF] [NUMBER AVERAGES] < 2 > [ENTER]
   [FAST AVG ON/OFF]

   < Active Trace > (this activates trace B)

   < Meas Data >
   [SPECTRUM CHANNEL 2]

   < Active Trace > (this activates trace A)

3. For each of the range settings listed below, perform steps a through c:

Range Setting
−51 dBVrms
−35 dBVrms

   a. Press the HP 35660A keys as follows:

      < Input >
      [CHANNEL 1 RANGE] (to range setting in table)
      [CHANNEL 2 RANGE] (to range setting in table)

      < Start >

      < Marker >
      [COUPLED ON/OFF] [X ENTRY] < 0 > [Hz]

   b. Record the "A Marker Y:" reading on the test record for the channel 1 measured value.

   c. Record the "B Marker Y:" reading on the test record for the channel 2 measured value.

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual*:

Section III – Adjustments
DC Input Offset Adjustment
ADC Offset and Reference Adjustment

Section VII – Service:Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

A3 Input 1
A4 Input 2/ADC

3. Amplitude Accuracy and Flatness

Operation Verification — Yes

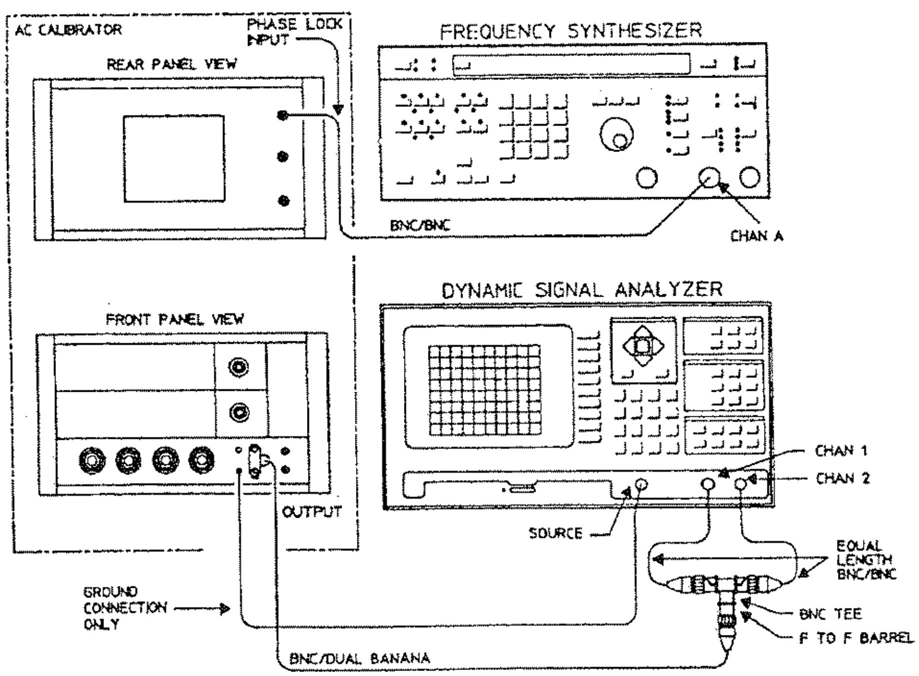
Differences between the Performance Test and the Operation Verification Test are noted in the shaded boxes.

This test determines amplitude accuracy and flatness for both channels of the HP 35660A. Using a frequency synthesizer and ac calibrator, a signal with an exact amplitude is input to both channels and measured. The amplitude of each channel is then compared to specifications.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

1. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



2. Configure the frequency synthesizer and the ac calibrator as follows:

Frequency Synthesizer

Mode ....2 Channel
Function ....Sine Wave
Frequency (Chan A)..........1 kHz
Amplitude (Chan A) ....0.5 Vrms
Phase ....0°
dc Offset 0V
Modulation ....OFF
Sweep ....OFF

AC Calibrator:

Frequency ....1 kHz
Amplitude ....2.8184 mVrms
Voltage ....OFF
Error ....%
Vernier 0
Mode ....OPER
Control ....LOCAL
Phase Lock ....ON
Sense ....INTERNAL

3. Press the HP 35660A keys as follows:

< Preset >

< Format >
[UPPER/LOWER]

< Meas Type >
[2 CHANNEL 51.2 kHz]

< Active Trace > (this activates trace B)

< Meas Data >
[SPECTRUM CHANNEL 2]

< Active Trace > (this activates trace A)

< Freq >
[SPAN] < 1 > < . > < 6 > [kHz]
[CENTER] < 1 > [kHz]

< Input >
[CHANNEL 1 SETUP] [AC/**DC**]
[RETURN]
[CHANNEL 2 SETUP] [AC/**DC**]

< Average >
[AVERAGE **ON**/OFF]
[NUMBER AVERAGES] < 4 > [ENTER]
[FAST AVG **ON**/OFF]

< Marker >
[COUPLED ON]

4. For each of the range settings listed below, perform steps a through e:

Use for Operation Verification

[illegible]

Use for Performance Test

Range Setting	AC Calibrator Amplitude
−51 dBVrms	2.8184 mVrms
−43 dBVrms	7.0795 mVrms
−35 dBVrms	17.783 mVrms
−27 dBVrms	44.668 mVrms
−11 dBVrms	0.28184 Vrms
1 dBVrms	1.1220 Vrms
9 dBVrms	2.8184 Vrms
19 dBVrms	8.9125 Vrms
27 dBVrms	22.387 Vrms

a. Press the HP 35660A keys as follows:

< Input >
[CHANNEL 1 RANGE] (to range setting in table)
[CHANNEL 2 RANGE] (to range setting in table)

< Marker>
[MARKER TO PEAK]

b. Set the ac calibrator to the amplitude in the table.

c. Press the HP 35660A keys as follows:

< Start >

< Scale >
[AUTO SCALE]

< Active Trace >(this activates trace B)
[AUTO SCALE]

d. Record the "A Marker Y:" reading on the test record for the channel 1 measured value.

e. Record the "B Marker Y:" reading on the test record for the channel 2 measured value.

5. Amplitude flatness is measured at several frequencies relative to 1 kHz. For each range listed below, perform steps a through m:

Measurement Type	Range Setting	Signal Frequency	AC Calibrator Amplitude
2 CHANNEL	−11 dBVrms	49 kHz	0.28184 Vrms
2 CHANNEL	9 dBVrms	49 kHz	2.8184 Vrms
2 CHANNEL	27 dBVrms	49 kHz	22.387 Vrms
1 CHANNEL	9 dBVrms	99 kHz	2.8184 Vrms
1 CHANNEL	27 dBVrms	99 kHz	22.387 Vrms

a. Set the ac calibrator to 1kHz, amplitude 0.28184Vrms

b. Set the frequency synthesizer to 1 kHz

c. Press the HP 35660A keys as follows:

< Meas Type > (to measurement type in table)

< Input >
[CHANNEL 1 RANGE] (to range setting in table)
[CHANNEL 2 RANGE] (to range setting in table)

< Freq >
[CENTER] < 1 > [kHz]

d. Set the ac calibrator to the amplitude in the table.

e. Press the HP 35660A keys as follows:

< Start >

< Marker >
[MARKER TO PEAK][OFFSET]
[OFFSET ON][OFFSET ZERO]

< Active Trace >
[OFFSET ON]
[OFFSET ZERO]

f. Set the ac calibrator to the signal frequency in the table.

g. Set the frequency synthesizer to the signal frequency in the table.

h. Press the HP 35660A keys as follows:

< Freq >
[Center] (to signal frequency in table)

< Start >

< Marker >
[MARKER TO PEAK]

i. Record the "A Offset Y:" reading on the test record for the channel 1 measured value.

j. When a two channel measurement is done, record the "B OffsetY:" reading on the test record for the channel 2 measured value.

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual*:

Section III — Adjustments
Second Pass Gain Adjustment
ADC Offset and Reference Adjustment
Filters Flatness Adjustment
Common Mode Rejection Adjustment

Section VII — Service: Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

A3 Input 1
A4 Input 2/ADC

4. Amplitude Linearity

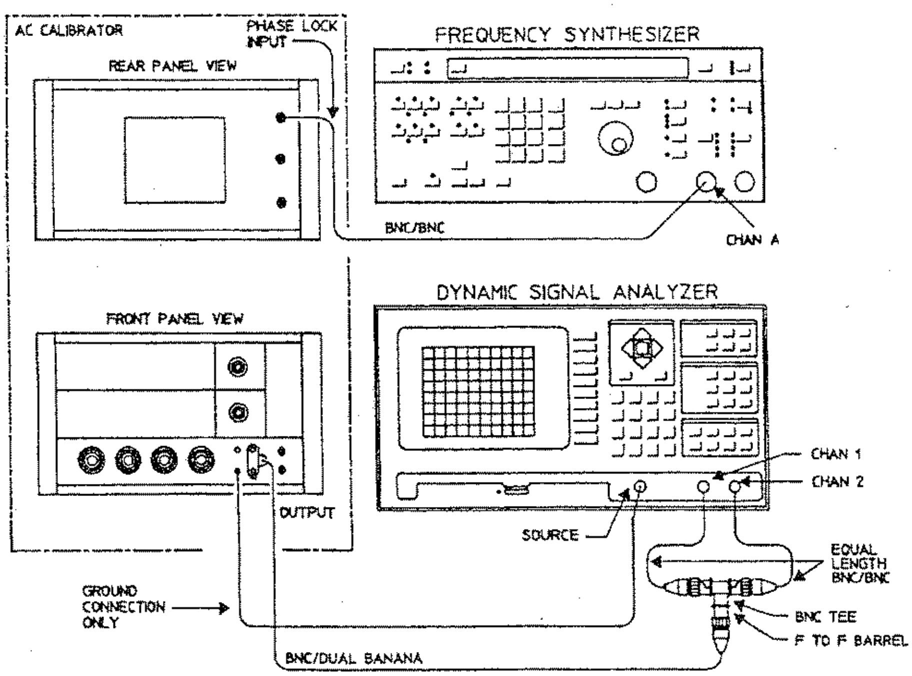
[illegible]

This test determines the amplitude linearity for both channels of the HP 35660A. Using a frequency synthesizer and ac calibrator, a signal with an exact amplitude is input into both channels and measured. The amplitude measured is then compared to specifications.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

1. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



2. Configure the frequency synthesizer and the ac calibrator as follows:

Frequency Synthesizer:

Mode .... 2 Channel
Function .... Sine Wave
Frequency (Chan A) .... 1 kHz
Amplitude (Chan A) .... 0.5 Vrms
Phase .... 0 °
dc Offset 0V
Modulation .... OFF
Sweep .... OFF

AC Calibrator:

Control ....LOCAL
Phase Lock ....ON
Sense ....INTERNAL
Mode ....OPER
Frequency ....1 kHz
Amplitude ....7.0795 mVrms

3. Press the HP 35660A keys as follows:

< Preset >

< Format >
[UPPER/LOWER]

< Meas Type >
[2 CHANNEL 51.2 kHz]

< Active Trace >(this activates trace B)

< Meas Data >
[SPECTRUM CHANNEL 2]

< Active Trace >(this activates trace A)

< Freq >
[SPAN] < 1 > < . > < 6 > [kHz]
[CENTER] < 1 > [kHz]

< Marker >
[COUPLED **ON**/OFF] < 1 > [kHz]

< Average >
[AVERAGE **ON**/OFF] [NUMBER AVERAGES] < 4 > [ENTER]
[FAST AVG **ON**/OFF]

< Input >
[CHANNEL 1 RANGE] < 2 > < 7 > [dBVrms]
[CHANNEL 1 SETUP] [AC/**DC**] [RETURN]
[CHANNEL 2 RANGE] < 2 > < 7 > [dBVrms]
[CHANNEL 2 SETUP] [AC/**DC**] [RETURN]

4. For each of the calibrator amplitude settings listed, perform steps a through d:

AC Calibrator amplitude
7.0795 mVrms
35.481 mVrms
0.17783 Vrms
0.89125 Vrms
4.4667 Vrms
22.387 Vrms

a. Set the ac Calibrator to the amplitude in the table.
b. Press < Start >on the HP35660A.
c. Record the "A Marker Y:" reading on the test record for the channel 1 measured value.
d. Record the "B Marker Y:" reading on the test record for the channel 2 measured value.

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual:*

Section III – Adjustments
Second Pass Gain Adjustment
ADC Offset and Reference Adjustment
Filters Flatness Adjustment
Common Mode Rejection adjustment

Section VII – Service: Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

A3 Input 1
A4 Input 2/ADC

4. For each of the calibrator amplitude settings listed, perform steps a through d:

AC Calibrator amplitude
7.0795 mVrms
35.481 mVrms
0.17783 Vrms
0.89125 Vrms
4.4667 Vrms
22.387 Vrms

a. Set the ac Calibrator to the amplitude in the table.

b. Press < Start >on the HP35660A.

c. Record the "A Marker Y:" reading on the test record for the channel 1 measured value.

d. Record the "B Marker Y:" reading on the test record for the channel 2 measured value.

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual:*

Section III – Adjustments
- Second Pass Gain Adjustment
- ADC Offset and Reference Adjustment
- Filters Flatness Adjustment
- Common Mode Rejection adjustment

Section VII – Service: Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

- A3 Input 1
- A4 Input 2/ADC

2. Press the HP 35660A keys as follows:

   < Preset >

   < Format >
   [UPPER/LOWER]

   < Meas Type >
   [2 CHANNEL 51.2 kHz]

   < Window >
   [UNIFORM]

   < Input >
   [CHANNEL 1 SETUP] [AC/**DC**] [RETURN]
   [CHANNEL 2 SETUP] [AC/**DC**]

   < Average >
   [AVERAGE **ON**/OFF] [NUMBER AVERAGES] < 1 > < 6 > [ENTER]
   [FAST AVG **ON**/OFF]

   < Source >
   [SOURCE **ON**/OFF] [PERIODIC CHIRP]

   < Trigger >
   [SOURCE TRIGGER]

   < Meas Data >
   [FREQUENCY RESPONSE]

   < Scale >
   [CENTER REFERENCE] < 0 > [dB]

   < Active Trace > (this activates trace B)

   < Meas Data >
   [FREQUENCY RESPONSE]

   < Trace Type >
   [PHASE]

   < Active Trace > (this activates trace A)

3. For each of the frequency settings shown, perform steps a through h to measure the amplitude match:

Frequency Span	Start Frequency	Range Setting	Source Level
6.4 kHz	80 Hz	−23 dBVrms	−23 dBVrms
6.4 kHz	3.84 Hz	1 dBVrms	1 dBVrms
51.2 kHz	0 Hz	7 dBVrms	7 dBVrms

a. Press the HP 35660A keys as follows:

< Freq >
 [SPAN] (to frequency span in table)
 [START] (to start frequency in table)

< Input >
 [CHANNEL 1 RANGE] (to range setting in table)
 [CHANNEL 2 RANGE] (to range setting in table)

< Source >
 [LEVEL] (to source level in table)

< Start >
 When the average is complete press:

< Marker >
 [MARKER TO PEAK]

b. Record the "A Marker Y:" reading on the test record as the peak amplitude measurement.

c. Press the HP 35660A keys as follows:

< Marker >
 [MARKER TO MINIMUM]

d. Record the "A Marker Y:" reading on the test record for the minimum amplitude measurement.

e. Press the HP 35660A keys as follows:

< Active Trace >(this activates trace B)

< Marker >
 [MARKER TO PEAK]

f. Record the "B Marker Y:" reading on the test record as the peak phase measurement.

g. Press the HP 35660A keys as follows:

< Marker >
 [MARKER TO MINIMUM]

< Active Trace >(this activates trace A)

h. Record the "B Marker Y:" reading on the test record as the minimum phase measurement.

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual:*

Section III – Adjustments
- Second pass Gain Adjustment
- ADC Offset and Reference Adjustment
- Filters Flatness
- Common Mode Rejection Adjustment

Section VII – Service: Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

- A3 Input 1
- A4 Input 2/ADC
- A1 Digital Processor

6. Anti-Alias Filter Response

Operation Verification Test — No

Do not perform this Test for Operation Verification.

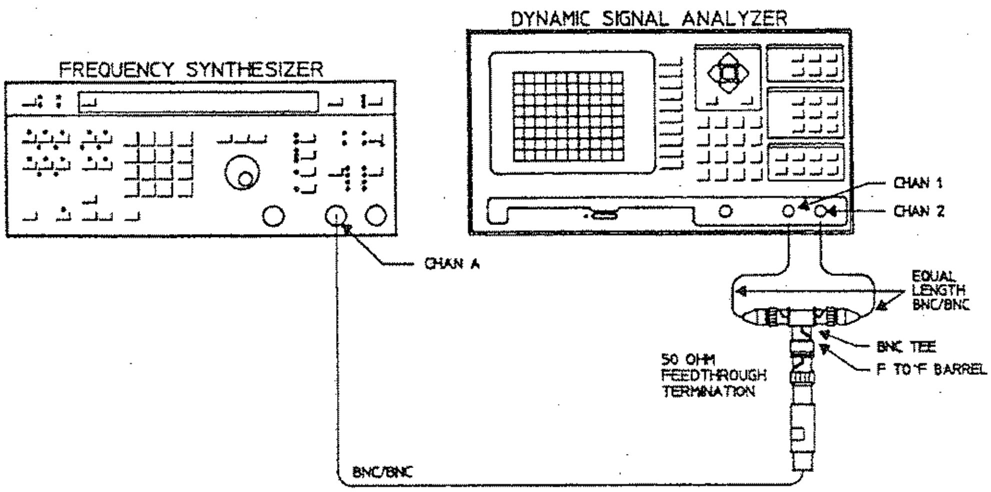
This test measures the ability of the 50 kHz and 100 kHz low pass anti-alias filters to reject frequencies caused by aliasing. Alias frequencies occur when the difference of the input signal frequency and the HP 35660A's sample rate both fall within the frequency range of interest. Using a frequency synthesizer, a signal known to cause an alias frequency is input to the HP 35660A. The HP 35660A then measures the alias frequency to determine how well the alias frequency was rejected.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

NOTE The HP 35660A may produce some spurious signals in the 0 to 100 kHz span. Ignore signals at frequencies other than those listed in the table when performing this test.

1. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



2. Configure the instruments as follows:

Frequency Synthesizer:

Mode .... 2 Channel
Function .... SINE WAVE
Frequency (Chan A) .... 80 kHz
Amplitude (Chan A) .... 354.8 mVrms
Phase 0
dc Offset 0V
Modulation .... OFF
Sweep .... OFF

3. Press the HP 35660A keys as follows:

   < Preset >

   < Format >
   [UPPER/LOWER]

   < Input >
   [CHANNEL 1 RANGE] < ±9 > [dBVrms]
   [CHANNEL 1 SETUP] [AC/**DC**] [RETURN]
   [CHANNEL 2 RANGE] < ±9 > [dBVrms]
   [CHANNEL 2 SETUP] [AC/**DC**]

   < Window >
   [HANNING]

   < Freq >
   [SPAN] < 1 > < . > < 6 > [kHz]
   [CENTER] < 8 > < 0 > [kHz]

   < Marker >
   [MARKER TO PEAK]

4. Adjust the amplitude of the frequency synthesizer until the Y marker reads −9 ±0.1 dBVrms.
5. Set the frequency synthesizer to 162.144 kHz.
6. Press the HP35660A keys as follows:

   < Average >
   [AVERAGE **ON**/OFF]
   [NUMBER AVERAGES] < 1 > < 6 >
   [ENTER]
   [FAST AVG **ON**/OFF]

   < Freq >
   [START] < 9 > < 9 > [kHz]

   < Start >

   < Scale >
   [AUTO SCALE]

   < Marker >

   < 1 > < 0 > < 0 > [kHz]

7. Record the "A Marker Y:" reading on the test record for the channel measured value at 100 kHz.
8. Set the frequency synthesizer to 81.072 kHz.

9. Press the HP35660A keys as follows:

   < Freq >
   [CENTER] < 5 > < 0 > [kHz]

   < Meas type >
   [2 CHANNEL 51.2kHz]

   < Active Trace >(this activates trace B)

   < Meas Data >
   [SPECTRUM CHANNEL 2]

   < Active Trace >(this activates trace A)

   < Start >(Wait until measurement is finished before proceding)

   < Scale >
   [AUTO SCALE]

   < Active Trace >(this activates trace B)

   < Scale >
   [AUTO SCALE]

   < Marker >
   [COUPLED ON/OFF] < 5 > < 0 > [kHz]

10. Record the "A Marker Y:" reading on the test record for the channel 1 measured value at 50 kHz.
11. Record the "B Marker Y:" reading on the test record for the channel 2 measured value at 50 kHz.

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual*:

Section III – Adjustments
Filters Flatness Adjustment

Section VII – Service: Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

A3 Input 1
A4 Input 2/ADC

7. Frequency Accuracy

Operation Verification – Yes

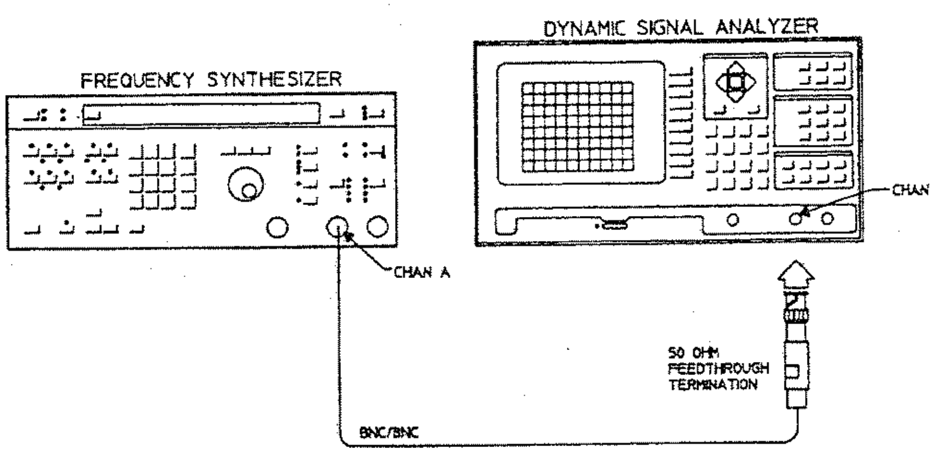
For this test, the Operation Verification Test is the same as the Performance Test.

This test uses a frequency synthesizer to measure the frequency accuracy of the HP 35660A.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

1. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



2. Configure the instruments as follows:

Frequency Synthesizer:

Mode	2 Channel
Function	Sine Wave
Frequency (Chan A)	100 kHz
Amplitude (Chan A)	1 Vrms
Phase	0°
dc Offset	0V
Modulation	OFF
Sweep	OFF

3. Press the HP 35660A keys as follows:

< Preset >

< Input >
[CHANNEL 1 RANGE] < 1 > [dBVrms]
[CHANNEL 1 SETUP] [AC/**DC**] [RETURN]

< Freq >
[SPAN] < 1 > < 0 > < 0 > [Hz]
[CENTER] < 1 > < 0 > < 0 > [kHz]

< Window >
[HANNING]

< Average >
[AVERAGE **ON**/OFF] [NUMBER AVERAGES] < 2 > [ENTER]
[FAST AVG **ON**/OFF]

< Start >
When the measurement is finished,

4. Press the HP 35660A keys as follows:

< Marker >
[MARKER TO PEAK]

5. Record the X marker reading as the measured value on the performance test record.

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual:*

Section III -- Adjustments
Frequency Reference Adjustment

Section VII -- Service: Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

A1 Digital Processor

8. Input Coupling Insertion Loss

Operation Verification Test — No

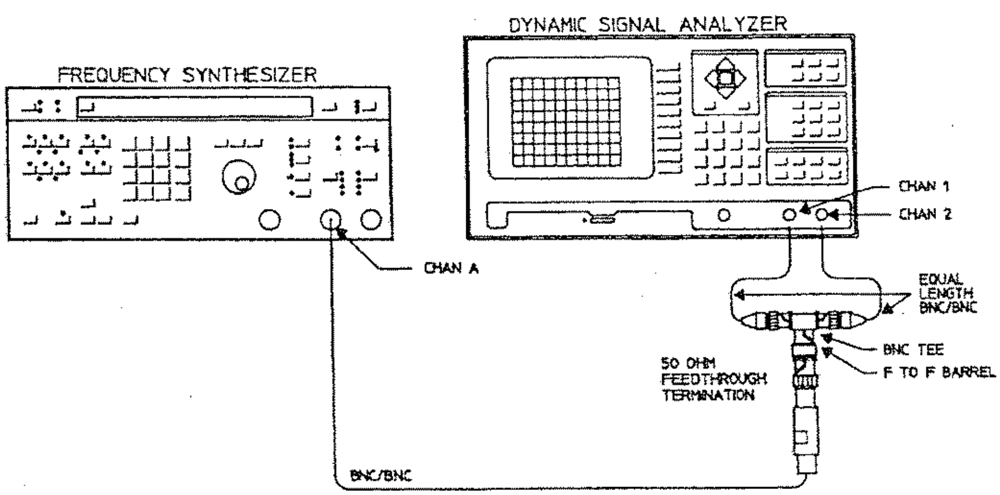
Do not perform this test for Operation Verification.

This test measures the input coupling insertion loss (caused by ac coupling capacitors) of the HP 35660A. The amplitude of a 1 Hz signal is measured in both ac and dc coupled modes and the values are used to determine insertion loss.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

1. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



2. Configure the instruments as follows:

Frequency Synthesizer:

Mode ....2 Channel
Function ....Sine Wave
Frequency (Chan A) ....1 Hz
Amplitude (Chan A) ....1 Vrms
Phase ....0 °
dc Offset 0V
Modulation ....OFF
Sweep ....OFF

3. Press the HP 35660A keys as follows:

< Preset >

< Format >
[UPPER/LOWER]

< Meas Type >
[2 CHANNEL 51.2 kHz]

< Window >
[HANNING]

< Input >
[CHANNEL 1 RANGE] < 1 > [dBVrms]
[CHANNEL 1 SETUP] [AC/**DC**] [RETURN]
[CHANNEL 2 RANGE] < 1 > [dBVrms]
[CHANNEL 2 SETUP] [AC/**DC**] [RETURN]

< Freq >
[SPAN]< 1 >< 0 >< 0 >[Hz]

< Average >
[AVERAGE **ON**/OFF] [NUMBER AVERAGES] < 4 > [ENTER]
[FAST AVG **ON**/OFF]

< Active Trace >(this activates trace B)

< Meas Data >
[SPECTRUM CHANNEL 2]

< Start >

< Scale >
[AUTO SCALE]

< Active Trace >(this activates trace A)

< Scale >
[AUTO SCALE]

< Marker >
[COUPLED **ON**/OFF] < 1 > [Hz]

4. Measure the relative value between ac and dc coupling for channel 1 and 2 by performing step a through d:

   a. When the measurement is finished, press the HP 35660A keys as follows:

      < Marker >
      [OFFSET]
      [OFFSET ON][OFFSET ZERO]

      < Active Trace > (this activates trace B)
      [OFFSET ON][OFFSET ZERO]

   b. Press the HP 35660A keys as follows:

      < Input >
      [CHANNEL 1 SETUP] [AC/DC] [RETURN]
      [CHANNEL 2 SETUP] [AC/DC]

      < Start >

   c. When the measurement is finished, record the "A Marker Y:" reading on the test record for channel 1, Insertion Loss.

   d. Record the "B Marker Y:" reading on the test record for channel 2, Insertion Loss.

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual:*

Section III – Adjustments
None

Section VII – Service: Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

A3 Input 1
A4 Input 2/ADC

9. Single Channel Phase Accuracy

Operation Verification = Yes

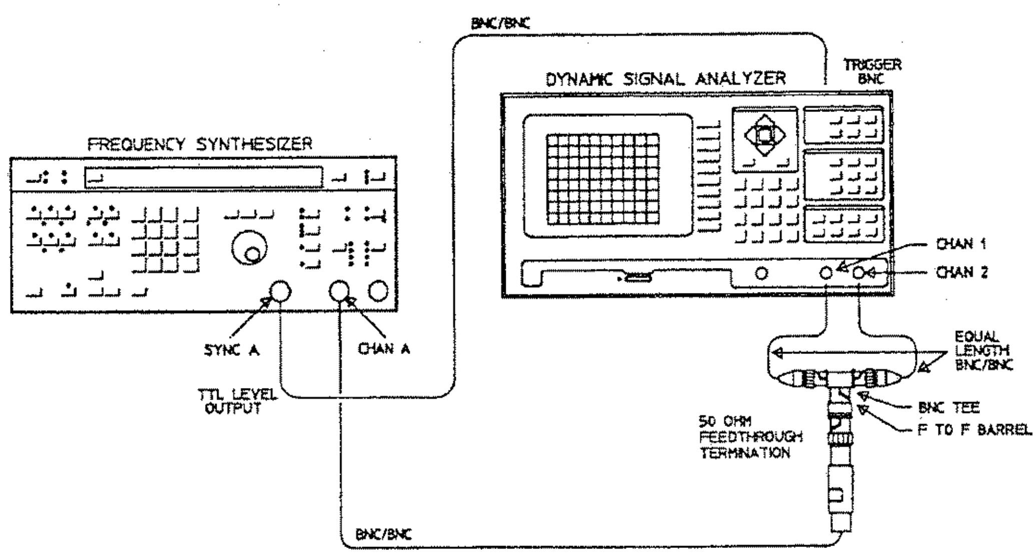
For this test, the Operation Verification Test is the same as the Performance Test.

This test measures the phase accuracy of the HP 35660A relative to the phase of a trigger signal. Using a frequency synthesizer, an identical square wave is applied to both channels and a synchronized TTL level signal to the trigger input. The phase between the trigger and each channel is then measured and compared to specification.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

1. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



2. Configure the frequency synthesizer as follows:

Frequency Synthesizer:

Mode .... 2 Channel
Function .... Square Wave
Frequency (Chan A) .... 10.24 kHz
Amplitude (Chan A) .... 1.122 Vrms
Phase .... 0 °
dc Offset 0Vdc
Modulation .... OFF
Sweep .... OFF

3. Press the HP 35660A keys as follows:

< Preset >

< Format >
[UPPER/LOWER]

< Window >
[UNIFORM]

< Meas Type >
[2 CHANNEL 51.2 kHz]

< Freq >
[SPAN] < 1 > < . > < 6 > [kHz]
[CENTER] < 1 > < 0 > < . > < 2 > < 4 > [kHz]

< Input >
[CHANNEL 1 RANGE] < 1 > [dBVrms]
[CHANNEL 1 SETUP] [AC/**DC**] [RETURN]
[CHANNEL 2 RANGE] < 1 > [dBVrms]
[CHANNEL 2 SETUP] [AC/**DC**]

< Trigger >
[EXTERNAL TRIGGER]

< Average >
[AVERAGE **ON**/OFF] [NUMBER AVERAGES]< 1 >< 6 > [ENTER]
[FAST AVG **ON**/OFF] [VECTOR AVERAGE]

< Trace Type >
[PHASE]

< Active Trace >(this activates trace B)

< Meas Data >
[SPECTRUM CHANNEL 2]

< Trace Type >
[PHASE]

< Marker >
[COUPLED ON/OFF]

< Active Trace > (this activates trace A)

< Marker >
[X ENTRY] < 1 > < 0 > < . > < 2 > < 4 > [kHz]

4. For each trigger slope listed below, perform steps a through d:

Trigger Slope
Positive Negative

< Trigger >
[TRIGGER SET UP]
[SLOPE POS/NEG] (to trigger slope in table)

< Start >

c. Record the "A Marker Y:" reading on the test record for the channel 1 measured value.

d. Record the "B Marker Y:" reading on the test record for the channel 2 measured value.

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual*:

Section III – Adjustments
None

Section VII – Service: Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

A1 Digital Processor
A3 Input 1
A4 Input 2/ADC

10. Input Impedance

Operation Verification Test

Do not perform this test for Operation Verification.

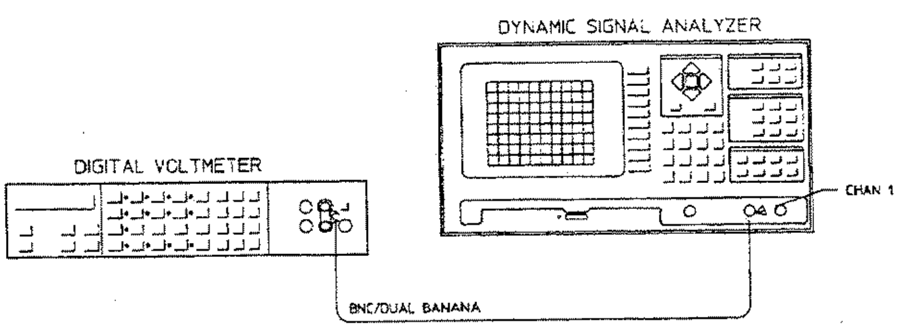
This test measures the input impedance for each channel of the HP 35660A. The input impedance appears as an input resistance and input capacitance. The input resistance is measured directly with a digital voltmeter. The input capacitance is determined using a frequency synthesizer, a digital voltmeter, and the formula in step 12.

NOTE An LCR meter (such as the HP 4261A or HP 4332A) can be used to measure the input capacitance directly.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

1. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



2. Configure the digital voltmeter as follows:

Digital Voltmeter

Function . . . . 2 WIRE kΩ
Range . . . . AUTO
Trigger . . . . INTERNAL
Sample Rate . . . . MAXIMUM
High Resolution . . . . ON
Auto Cal . . . . ON

3. Press the HP 35660A keys as follows:

< Preset >

< Meas Type >
[2 CHANNEL 51.2 kHz]

< Input >
[CHANNEL 1 SETUP] [AC/DC] [RETURN]
[CHANNEL 2 SETUP] [AC/DC]

4. For each of the following range settings, perform the following steps for channel 1. Record the digital voltmeter reading on the performance test record.

Range Setting
27 dBVrms
9 dBVrms
−11 dBVrms

Press the HP 35660A keys as follows:

< Input >
[CHANNEL 1 RANGE] (to each range setting above)

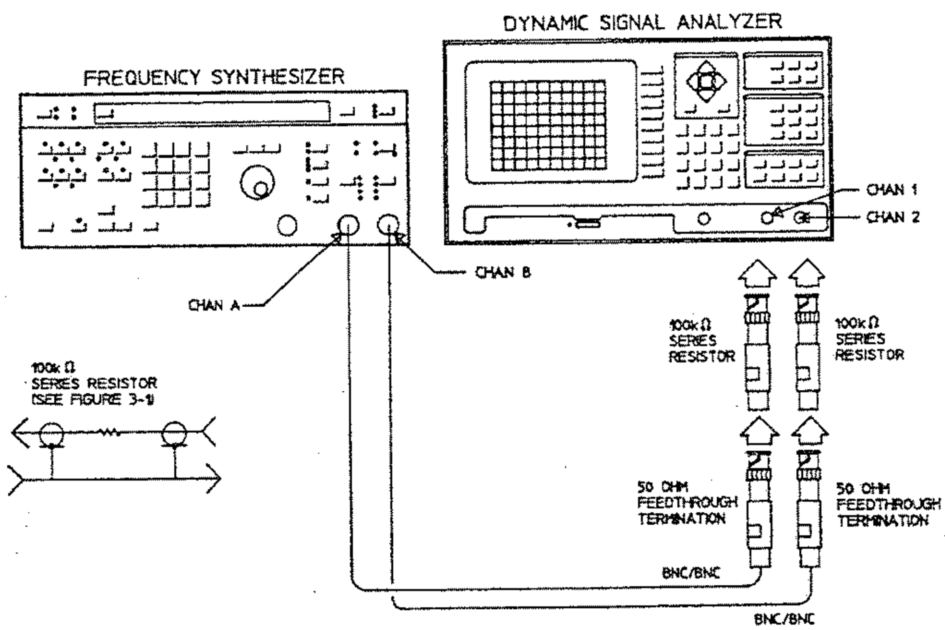
5. Change the BNC input connector to channel 2. For each of the following range settings, perform the following steps for channel 2. Record the digital voltmeter reading on the test record.

Range Setting
27 dBVrms
9 dBVrms
−11 dBVrms

Press the HP 35660A keys as follows:

< Input >
[CHANNEL 2 RANGE] (to each range setting above)

6. Connect the test instruments as shown below:



7. Set the frequency synthesizer as follows:

Frequency Synthesizer:

Mode .... 2 Channel
Function .... Sine Wave
Frequency (Chan A) .... 100 kHz
Amplitude (Chan A) .... 1 Vrms
Frequency (Chan B) .... 50 kHz
Amplitude (Chan B) .... 1 Vrms
Phase .... 0 °
dc Offset .... 0 Vdc
Modulation .... OFF
Sweep .... OFF

8. Perform the following steps:

a. Press the HP 35660A keys as follows:

< Meas Type >
[1 CHANNEL 102.4 kHz]

< Format >
[UPPER/LOWER]

< Window >
[FLATTOP]

< Input >
[CHANNEL 1 RANGE] < - > < 1 > < 3 > [dBVrms]

< Freq >
[SPAN] < 1 > < . > < 6 > [kHz]
[CENTER] < 1 > < 0 > < 0 > [kHz]

< Start >

< Average >
[AVERAGE **ON**/OFF] [NUMBER AVERAGES] < 1 > < 6 > [ENTER]
[FAST AVG **ON**/OFF]

< Trace Type >
[LINEAR MAGNITUDE]

< Scale >
[VERTICAL UNIT] [Vrms] [AUTO SCALE]

< Start >

< Marker >

< 1 > < 0 > < 0 > [kHz]

b. Record the "A Marker Y:" amplitude reading (in Vrms) on the test record for channel 1 (in the Vc position).

9. Remove the 100 kΩ resistor from the channel 1 signal path and connect the BNC cable with the 50Ω termination directly to the HP 35660A channel 1 input connector. Perform the following steps:

   a. Press the HP 35660A keys as follows:

      < Input >
      [CHANNEL 1 RANGE] < 1 >[dBVrms]

      < Start >

   b. Record the "A Marker Y:" amplitude reading (in Vrms) on the test record for channel 1 (in the Vin position).

10. Perform the following steps for the channel 2 measurement:

   a. Press the HP 35660A keys as follows:

      < Meas Type >
      [2 CHANNEL 51.2 kHz]

      < Active Trace >(this activates trace B)

      < Meas Data >
      [SPECTRUM CHANNEL 2]

      < Input >
      [CHANNEL 2 RANGE]< - > < 1 > < 3> [dBVrms]

      < Freq >
      [SPAN]< 1 > < . > < 6> [kHz]
      [CENTER]< 5 > < 0 > [kHz]

      < Trace Type >
      [LINEAR MAGNITUDE]

      < Scale >
      [VERTICAL UNITS] [Vrms] [AUTO SCALE]

      < Start >

      < Marker >
      < 5 >< 0 > [kHz]

   b. Record the "B Marker Y:" amplitude reading (in Vrms) on the test record for channel 2 (Vc position).

11. Remove the 100 kΩ resistors from the channel 2 signal path and connect the BNC cable with the 50Ω termination directly to the HP 35660A channel 2 input connector. Perform the following steps:

    a. Press the HP 35660A keys as follows:

        < Input >
        [CHANNEL 2 RANGE] < 1 > [dBVrms]

        < Start >

    b. Record the "B Marker Y:" amplitude reading (in Vrms) on the test record for channel 2 (Vin position).

12. Use the following formulas to calculate the input capacitance:

    Formulas:
    Channel 1: 100 kHz

    $$C = 15.9^{-12} \left(\frac{Vin}{Vc} - 2 \right)$$

    Channel 2: 50 kHz

    $$C = 31.8^{-12} \left(\frac{Vin}{Vc} - 2 \right)$$

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual:*

Section III – Adjustments
None

Section VII – Service: Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

A3 Input 1
A4 Input 2/ADC

11. Harmonic Distortion

Operation Verification Test - No

Do not perform this test for Operation Verification.

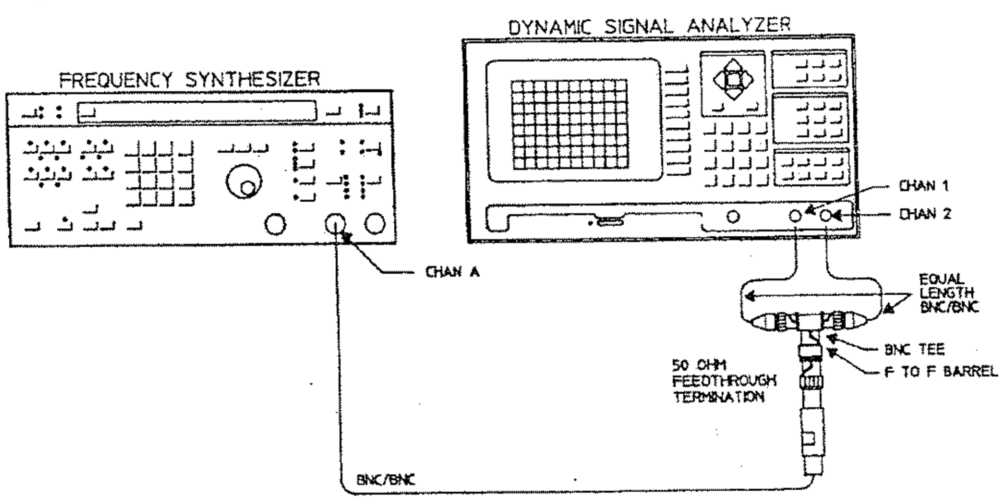
This test measures the harmonic distortion generated in the HP 35660A.

Using a frequency synthesizer, selected frequencies which have a harmonic at 49 kHz (for channel 2) or 99 kHz (for channel 1) are input to the HP 35660A. The amplitude of the harmonic frequency is then measured and compared to specifications.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

1. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



2. Configure the frequency synthesizer as follows:

Frequency Synthesizer

Mode . . . . .2 Channel
Function . . . . .SINE WAVE
Frequency (Chan A) . . . . .24.96 kHz
Amplitude (Chan A) . . . . .1.12 Vrms
Phase 0
dc Offset . . . . .0 V
Modulation . . . . .OFF
Sweep . . . . .OFF

NOTE This test requires a low distortion synthesizer with harmonic distortion ≤ -70 dBc.

---

3. Press the HP 35660A keys as follows:

< Preset >

< Format >
[UPPER/LOWER]

< Meas Type >
[2 CHANNEL 51.2 kHz]

< Input >
[CHANNEL 1 RANGE] < 1 > [dBVrms]
[CHANNEL 2 RANGE] < 1 > [dBVrms]
[CHANNEL 1 SETUP] [AC/**DC**] [RETURN]
[CHANNEL 2 SETUP] [AC/**DC**]

< Window >
[HANNING]

< Average >
[NUMBER AVERAGES] < 4 > [ENTER]
[FAST AVG **ON**/OFF]

< Scale >
[VERTICAL/DIV] < 1 > < 5 > [dB]

< Active Trace > (this activates trace B)

< Meas Data >
[SPECTRUM CHANNEL 2]

< Scale >
[VERTICAL/DIV] < 1 > < 5 > [dB]

< Active Trace > (this activates trace A)

< Marker >
[COUPLED **ON**/OFF]

4. For each of the two channel measurements listed below, perform steps a through f:

Measurement Type	Input Signal Frequency	Harmonic Number	Harmonic Frequency
2 CHANNEL	24.96 kHz	2nd	49.92 kHz
2 CHANNEL	16.64 kHz	3rd	49.92 kHz
1 CHANNEL	49.92 kHz	2nd	99.84 kHz
1 CHANNEL	33.28 kHz	3rd	99.84 kHz
1 CHANNEL	24.96 kHz	4th	99.84 kHz
1 CHANNEL	19.97 kHz	5th	99.84 kHz

a. Set the frequency synthesizer to the input signal frequency in the table.

b. Press the HP 35660A keys as follows:

< Average >
[AVERAGE ON/**OFF**]

< Marker > [Marker to Peak]

c. Adjust the amplitude of the frequency synthesizer until the Y Marker reading reads 1 ±0.1 dBVrms.

d. Press the HP 35660A keys as follows:

< Average >
[AVERAGE **ON**/OFF]

< Start >

< Marker > (to harmonic frequency in table)

e. Record the "A Marker Y:" amplitude reading on the test record as the harmonic frequency amplitude for channel 1.

Record the "B Marker Y:" amplitude reading on the test record as the harmonic frequency amplitude for channel 2.

5. Press the HP 35660A keys as follows:

< Meas Type >
[1 CHANNEL 102.4 kHz]

< Freq >
[FULL SPAN]

6. For each of the 1 CHANNEL measurements listed in the table in step 4, perform steps a through e:

   a. Set the frequency synthesizer to the input signal frequency in the table.

   b. Press the HP35660A keys as follows

      < Average >
      [AVERAGE ON/OFF]

      < Marker > [Marker to Peak]

   c. Adjust the amplitude of the frequency synthesizer until the y marker reading reads 1 ±0.1

   d. Press the HP 35660A keys as follows:

      < Average >
      [AVERAGE ON/OFF]

      < Start >

      < Marker > (to harmonic frequency in table)

   e. Record the "A Marker Y:" amplitude reading on the test record as the harmonic frequency amplitude for channel 1.

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual*:

Section III – Adjustments
2nd Pass Gain Adjustment
ADC Offset and Reference Adjustment

Section VII – Service: Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

A3 Input 1
A4 Input 2/ADC

12. Intermodulation Distortion

Operation Verification Test – No

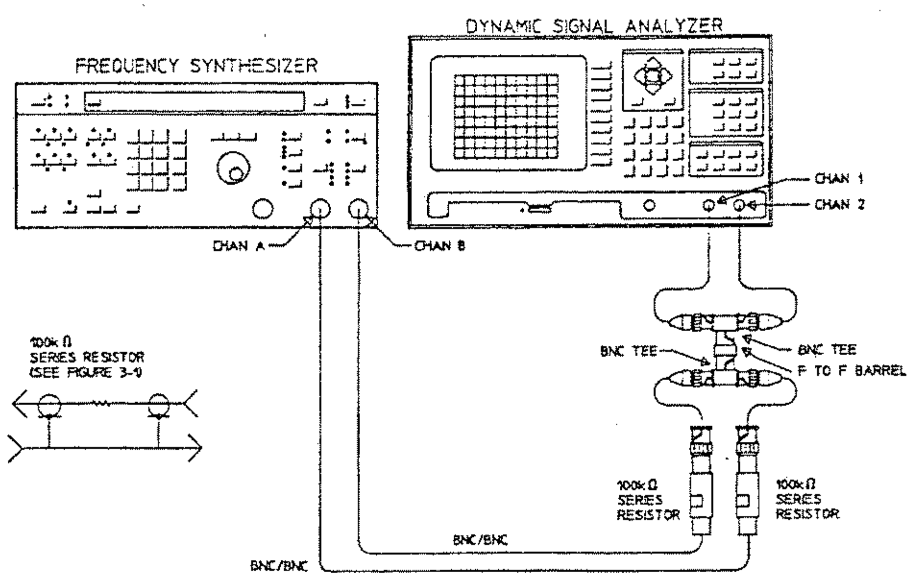
Do not perform this test for Operation Verification.

This test measures the level of intermodulation distortion products generated within the HP 35660A. This is done by mixing two signals to provide a modulated signal to the analyzer's input. Anytime two signals are mixed, the resultant signal includes the two fundamental frequencies plus their sum and difference frequencies (the sum and difference frequencies are the intermodulation products). The amplitude of each intermodulation product (which should be negligible) is measured with the HP 35660A to determine if it meets specifications.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

1. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



NOTE If the "COMBINED" mode is used on the HP3326A, use output from CHAN A with one 50Ω termination instead of the 100 kΩ series resistors.

2. Configure the frequency synthesizer as follows:

Frequency Synthesizer:

Mode ....Two-Tone
Function.........................SINE WAVE
Frequency (Chan A) ....10 kHz
Amplitude (Chan A) ....0.5 Vrm
Frequency (Chan B) ....10.25 kHz
Amplitude (Chan B) ....0.5 Vrm
Phase 0
dc Offset 0V
Modulation.......................OFF
Sweep ....OFF

3. Press the HP 35660A keys as follows:

< Preset >
< Format >
[UPPER/LOWER]

< Meas Type >
[2 CHANNEL 51.2 kHz]

< Input >
[CHANNEL 1 RANGE] < -1 >[dBVrms]
[CHANNEL 1 SETUP] [AC/DC] [RETURN]
[CHANNEL 2 RANGE]< -1 >[dBVrms]
[CHANNEL 2 SETUP] [AC/DC]

< Window >
[HANNING]

< Freq >
[SPAN]< 8 >< 0 >< 0 >[Hz]

< Scale >
[VERTICAL/DIV]< 1 >< 5 >[dB]

< Active Trace >(this activates trace B)

< Meas Data >
[SPECTRUM CHANNEL 2]

< Scale >
[VERTICAL/DIV]< 1 >< 5 >[dB]

< Active Trace >(this activates trace A)

< Marker >
[COUPLED ON/OFF]

< Average >
[NUMBER AVERAGES]< 1 >< 6 >[ENTER]
[FAST AVG ON/OFF]

4. For the 2 Channel measurements listed below, perform steps a through f:

   a. Set the frequency synthesizer to the Input Signals F1 and F2 as follows:

Measurement Type	Input Signals		Intermodulation Frequency
	F1	F2	
2 CHANNEL	10 kHz	10.25 kHz	20.25 kHz 30.50 kHz

   b. Press the HP35660A keys as follows:

      < Average >
      [AVERAGE ON/OFF]

      < Freq >
      [CENTER] (to the F1 frequency in table "Input Signals")

      < Marker > (to the F1 frequency in table "Input Signals")

   c. Adjust the amplitude of the synthesizer's channel A until "A Marker Y:" and " B Marker Y:" equals -7 ± 0.100 dBVrms.

   d. Press the HP35660A keys as follows:

      < Freq >
      [CENTER] (to the F2 frequency in table "Input Signals")

      < Marker > (to the F2 frequency in table "Input Signals")

   e. Adjust the amplitude of the synthesizer's channel B until "A Marker Y:" and "B Marker Y:"equals-7 ± 0.100dBVrms.

   f. For each intermodulation frequency listed in the table, preform the following steps, 1 through 3:

      (1) Press the HP35660A keys as follows:

         < Average >
         [AVERAGE ON/OFF]

         < Freq >
         [CENTER] (to intermodulation frequency in table)

         < Start >

         < Marker > (to intermodulation frequency in table)

      (2) Record the "A Marker Y:" reading on the test record for the channel 1 measured value.

      (3) Record the "B Marker Y:" reading on the test record for the channel 2 measured value.

g. Repeats step 4a through 4f for the following frequencies:

Measurement Type	Input Signals F1	F2	Intermodilation Frequency
2 CHANNEL	48 kHz	49 kHz	1 kHz 50 kHz

5. To make the 1 CHANNEL measurements, press the HP 35660A keys as follows:

   < Meas Type >
   [1 CHANNEL 102.4 kHz]

6. Repeat steps 4a through f for the 1 CHANNEL measurements (A display) for the following frequencies:

Measurement Type	Input Signals F1	F2	Intermodilation Frequency
1 CHANNEL	89 kHz	99 kHz	10 kHz 79 kHz

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the HP 35660A Service Manual:

Section III – Adjustments
Second Pass Gain Adjustment
ADC Offset and Reference Adjustment

Section VII – Service: Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

A3 Input 1
A4 Input 2/ADC

13. Noise and Spurious Signals

Operation Verification — Yes

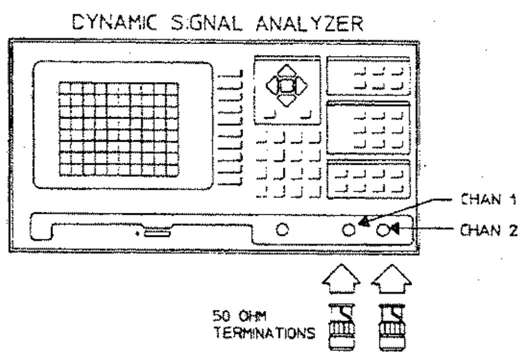
For this test, the Operation Verification Test is the same as the Performance Test.

This test measures the level of noise and spurious signals generated within the HP 35660A.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

1. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



2. Press the HP 35660A keys as follows:

< Preset >

< Format >
[UPPER/LOWER]

< Meas Type >
[2 CHANNEL 51.2 kHz]

< Input >
[CHANNEL 1 RANGE] < ± >< 5 >< 1 >[dBVrms]
[CHANNEL 2 RANGE]< ± >< 5 >< 1 >[dBVrms]
[CHANNEL 1 SETUP] [AC/**DC**] [RETURN]
[CHANNEL 2 SETUP] [AC/**DC**]

< Average >
[AVERAGE **ON**/OFF] [NUMBER AVERAGES]< 1 >< 6 >[ENTER]
[FAST AVG **ON**/OFF]

< Active Trace >(this activates trace B)

< Meas Data >
[SPECTRUM CHANNEL 2]

< Active Trace >(this activates trace A)

3. For each of the start frequencies listed, perform steps a through d:

Measurement Type	Start Frequency	Frequency Span
2 CHANNEL	160 Hz	200 Hz
2 CHANNEL	360 Hz	200 Hz
2 CHANNEL	560 Hz	200 Hz
2 CHANNEL	760 Hz	200 Hz
2 CHANNEL	1.28 kHz	1.6 kHz
2 CHANNEL	24 kHz	1.6 kHz
2 CHANNEL	30 kHz	1.6 kHz
2 CHANNEL	34.2 kHz	1.6 kHz
2 CHANNEL	49 kHz	1.6 kHz
1 CHANNEL	61 kHz	1.6 kHz
1 CHANNEL	74 kHz	1.6 kHz
1 CHANNEL	74 kHz	1.6 kHz
1 CHANNEL	92 kHz	1.6 kHz
1 CHANNEL	100 kHz	1.6 kHz

a. Press the HP 35660A keys as follows:

< Meas Type > (to measurement type in table)

< Freq >
[START] (to start frequency in table)
[SPAN] (to frequency span in table)

< Start >
When the average is complete, press

< Scale >
[AUTO SCALE]

< Marker >
[MARKER TO PEAK]

b. Record the "A Marker Y:" reading on the test record for the channel 1 measured value.

c. When a 2 CHANNEL measurement is done, press the HP35660A keys as follows:

< Active Trace >(this activates trace B)

< Scale >
[AUTO SCALE]

< Marker >
[MARKER TO PEAK]

< Active Trace >(this activates trace A)

d. When a 2 CHANNEL measurement is done, record the "B Marker Y:" reading on the test record for the channel 2 measured value.

4. Press the HP 35660A keys as follows:

< Meas Type >
[2 CHANNEL 51.2 kHz]

< Meas Data >
[PSD CHANNEL 1]

< Active Trace >(this activates trace B)
[PSD CHANNEL 2]

< Active Trace >(this activates trace A)

5. For each of the start frequencies listed below, perform steps a through d:

Measurement Type	Start Frequency	Frequency Span
2 CHANNEL	160 Hz	12.8 kHz
2 CHANNEL	1.28 kHz	51.2kHz
1 CHANNEL	1.28 kHz	102.4 kHz

a. Press the HP 35660A keys as follows:

< Meas Type > (to measurement type in table)

< Freq >
[START] (to start frequency in table)
[SPAN] (to frequency span in table]

< Start >
When the average is complete, press

< Scale >
[AUTO SCALE]

< Marker >
[MARKER TO PEAK]

b. Record the "A Marker Y:" reading on the test record for the channel 1 measured value.

c. When a 2 CHANNEL measurement is done, press the HP 35660A keys as follows:

< Active Trace >(this activates trace B)

< Scale >
[AUTO SCALE]

< Marker >
[MARKER TO PEAK]

< Active Trace >(this activates trace A)

d. When a 2 CHANNEL measurement is done, record the " B Marker Y:" reading on the test record for the channel 2 measured value.

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual*:

Section III – Adjustments
- Second Pass Gain Adjustment
- ADC Offset and Reference Adjustment
- Common Mode Adjustment

Section VII – Service: Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

- Check instrument screws are tight
- A3 Input 1
- A4 Input 2/ADC
- A1 Digital Processor

14. Cross talk

Operation Verification Test — No

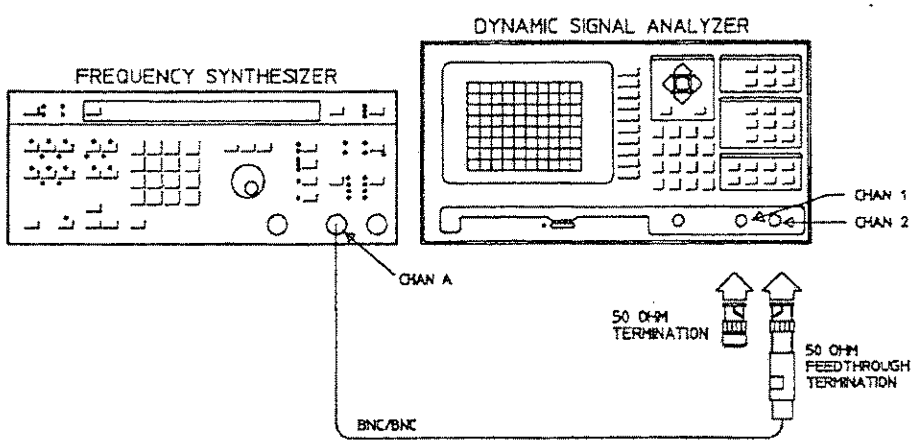
Do not perform this test for Operation Verification.

This test measures the amount of energy induced by a signal on another channel. This is done by placing a high signal level on one channel and then measuring the relative signal amplitude of the other channel.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

1. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



2. Configure the frequency synthesizer as follows:

Frequency Synthesizer:

Mode . . . . 2 Channel
Function . . . . SINE WAVE
Frequency . . . . 49 kHz
Amplitude . . . . 2.82 Vrms
Phase 0
dc Offset 0V
Modulation . . . . OFF
Sweep . . . . OFF

3. Press the HP 35660A keys as follows:

< Preset >

< Format >
[UPPER/LOWER]

< Meas Type >
[2 CHANNEL 51.2 kHz]

< Window >
[HANNING]

< Input >
[CHANNEL 1 RANGE] < ± > < 5 > < 1 > [dBVrms]
[CHANNEL 2 RANGE] < 9 > [dBVrms]
[CHANNEL 1 SETUP] [AC/**DC**] [RETURN]
[CHANNEL 2 SETUP] [AC/**DC**]

< Freq >
[SPAN] < 1 > < . > < 6 > [kHz]
[CENTER] < 4 > < 9 > [kHz]

< Active Trace >(this activates trace B)

< Meas Data >
[SPECTRUM CHANNEL2]

NOTE During this test the "Ovl" indicator may be on until the setups are completed. When setups are completed is should go off. This will not damage the instrument. However, measurements are not valid while the indicator is on.

---

4. Measure the amplitude on channel 1 relative to the signal amplitude on channel 2 by performing the following steps:

   a. Press the HP 35660A keys as follows:

      < Marker >
      [COUPLED ON/OFF] < 4 > < 9 > [kHz]

      < Scale >
      [AUTO SCALE]

      < Active Trace > (this activates trace A)
      [AUTO SCALE]

   b. Adjust the synthesizer until the "B Marker Y:" value read 9 ±0.1 dBVrms.

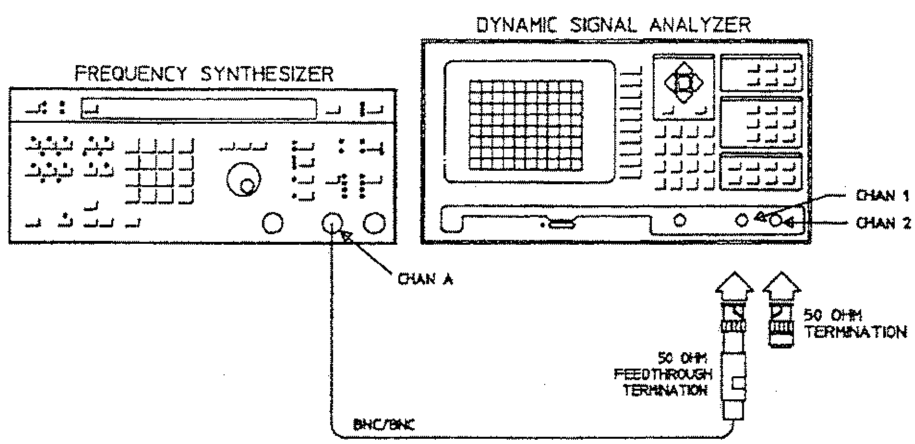
   c. Press the HP35660A keys as follows:

      < Average >
      [AVERAGE ON/OFF] [NUMBER AVERAGES] < 1 > < 6 > [ENTER]
      [FAST AVG ON/OFF]

      < Start >

   d. Record the "A Marker Y:" reading on the test record for the channel 2 to channel 1 cross talk value.

5. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



6. Measure the amplitude on channel 2 relative to the signal amplitude on channel 1 by performing the following steps:

   a. Press the HP 35660A keys as follows:

      < Input >
      [CHANNEL 1 RANGE] < 9 > [dBVrms]
      [CHANNEL 2 RANGE] < ± > < 5 > < 1 > [dBVrms]

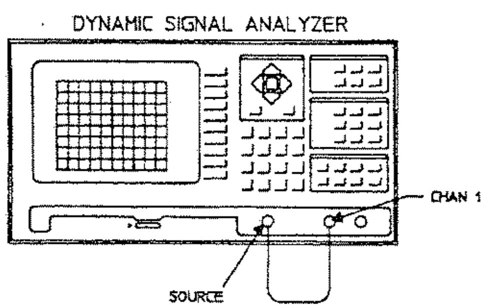
      < Start >

      < Scale >
      [AUTO SCALE]

      < Active Trace > (this activates trace B)
      [AUTO SCALE]

   b. Record the "B Marker Y:" reading on the test record for the channel 1 to channel 2 crosstalk value.

7. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



8. Measure the amplitude on channel 2 relative to the signal amplitude from the source by performing the following steps:

   a. Press the HP 35660A keys as follows:

      < Input >
      [CHANNEL 1 RANGE] < 9 > [dBVrms]
      [CHANNEL 2 RANGE] < ± > < 5 > < 1 > [dBVrms]

      < Source >
      [SOURCE ON/OFF] [LEVEL] < 9 > [dBVrms]
      [SINE FREQ ENTRY] < 4 > < 9 > [kHz]

      < Average >
      [ON/OFF]

   b. Adjust the sources level until the " A Marker Y:" value reads 9 ±0.1 dBVrms. By pressing the HP 35660A keys as follows:

      < Source >
      [LEVEL] (Use < ⇧ > < ⇩ > arrow keys to adjust source level)

   c. Press the HP 35660 keys as follows:

      < Average >
      [Average ON/OFF]

      < Start >

      < Active Trace >(this activates trace A)

   d. Record the "B Marker Y:" reading on the test record for the source-to-input crosstalk value.

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual:*

Section III – Adjustments
None

Service: Section VII – Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

Check that instrument screws are tight.
A3 Input 1
A4 Input 2/ADC

15. Source Residual DC Offset

Operation Verification Test

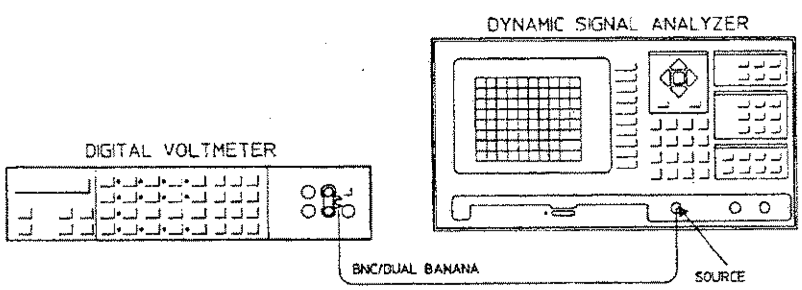
For this test, the Operation Verification Test is the same as the Performance Test.

This test measures the amount of residual dc offset generated by the source.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

1. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



2. Configure the digital voltmeter as follows:

   Digital Voltmeter:

   Function .... dcV
   Range .... AUTO
   Trigger .... INTERNAL
   Sample Rate .... MAXIMUM
   High Resolution .... ON
   Auto Cal .... ON

3. Press the HP 35660A keys as follows:

   < Preset >

   < Source >
   [SOURCE ON/OFF] [SINE FREQ ENTRY] < 1 > < 0 > < 0 > [kHz]
   [LEVEL] < . > < 0 > < 0 > < 1 > < 2 > < 5 > [V]

4. Record the digital voltmeter reading on the test record for the 1.25 mV setting.

5. Press the HP 35660A keys as follows:

   [LEVEL] < 5 > [V]

6. Record the digital voltmeter reading on the test record for the 5V setting.

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual:*

Section III – Adjustments
None

Section VII – Service: Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

A1 Digital Processor

16. Source Amplitude Accuracy and Flatness

Operation Verification — Yes

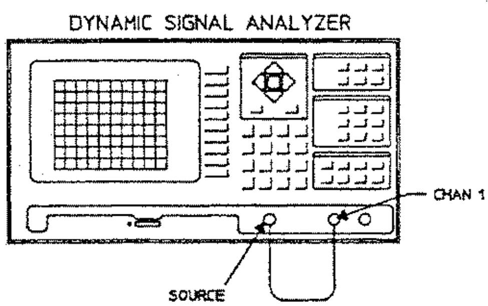
For this test, the Operation Verification Test is the same as the Performance Test.

This test measures the amplitude accuracy and flatness of the source.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

1. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



2. Press the HP 35660A keys as follows:

   < Preset >

   < Input >
   [CHANNEL 1 SETUP] [AC/DC] [RETURN]
   [CHANNEL 2 SETUP] [AC/DC]

   < Freq >
   [SPAN] < 1 > < . >< 6 > [kHz]
   [CENTER] < 1 > [kHz]

   < Average >
   [AVERAGE **ON**/OFF]
   [FAST AVG **ON**/OFF]

   < Source >
   [SOURCE **ON**/OFF]
   [SINE FREQ ENTRY] < 1 > [kHz]

   < Trace Type >
   [LINEAR MAGNITUDE]

   < Scale >
   [VERTICAL/DIV] < 1 > < V >

3. For each of the source levels shown, perform steps a and b:

Source Level	Range Setting
0.1 V	0.1 V
3 V	3 V
5 V	5 V

   a. Press the HP 35660A keys as follows:

      < Input >
      [CHANNEL 1 RANGE] (to range setting in table)

      < Source >
      [LEVEL] (to source level in table)

      < Start >

      < Marker >
      < 1 > [kHz]

   b. Record the "A Marker Y:" reading on the test record under the source amplitude measured value.

4. Press the HP 35660A keys as follows:

   < Input >
   [CHANNEL 1 RANGE] < 1 > < 1 > [dBVrms]

   < Trace Type >
   [LOG MAGNITUDE]

   < Source >
   [LEVEL] < 5 > [V]

   < Start >

5. After the measurement is complete, press the following keys on the HP 35660A:

   < Marker >
   [OFFSET]
   [OFFSET ON] [OFFSET ZERO]

6. Amplitude flatness is measured relative to 1 kHz. Follow the steps first to measure the amplitude at 1 kHz, then to measure the amplitude at the test frequency. Perform steps a through c:

Source Frequency
10 kHz
50 kHz
99 kHz

   a. Press the HP 35660A keys as follows:

      < Source >
      [SINE FREQ ENTRY] (to frequency in table)

      < Freq >
      [CENTER] (to frequency in table)

      < Start >

      < Marker >
      [MARKER TO PEAK]

   b. Record the "A Marker Y:" reading on the test record under relative flatness measured value .

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual:*

Section III – Adjustments
None

Section VII – Service: Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

A1 Digital Processor

17. Source Output Distortion

Operation Verification Tests

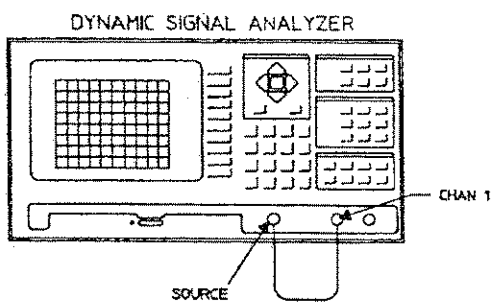
For this test, the Operation Verification Test is the same as the Performance Test.

This test measures the amount of distortion generated by the source.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

1. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



2. Press the HP 35660A keys as follows:

   < Preset >

   < Scale >
   [VERTICAL/DIV] < 1 > < 5 > [dB]

   < Freq >
   [START] < 1 > [kHz]

   < Input >
   [CHANNEL 1 SETUP] [AC/**DC**] [RETURN]
   [CHANNEL 2 SETUP] [AC/**DC**]

   < Average >
   [AVERAGE **ON**/OFF]
   [NUMBER AVERAGES] < 4 > [ENTER]
   [FAST AVG **ON**/OFF]

   < Source >
   [SOURCE **ON**/OFF]
   [SINE FREQ ENTRY] < 1 > < 0 > [kHz]
   [LEVEL] < 5 > [V]

   < Start >

   < Input >

   < Scale >
   [AUTO SCALE]

   < Marker >
   < 1 > < 0 > [kHz]
   [OFFSET]
   [OFFSET **ON**/OFF]
   [OFFSET ZERO]
   [RETURN]

   Use [NXT RIGHT PEAK] and [NXT LEFT PEAK] or marker arrow keys to determine the peak distortion value.

3. Record the peak distortion value (Δ offset Y:) on the test record.

4. Press the HP 35660A keys as follows:

   < Source >
   [SINE FREQ ENTRY] < 1 > < 0 > < 0 > [kHz]

   < Start >

   < Marker >
   < 1 > < 0 > < 0 > [kHz]
   [OFFSET]
   [OFFSET ZERO]
   [RETURN]

   Use [NXT RIGHT PEAK] and [NXT LEFT PEAK] or marker arrow keys to determine the peak distortion value.

5. Record the peak distortion value (A offset Y:) on the test record.

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual*:

Adjustments
None

Section VII – Service: Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

A1 Digital Processor

18. Source Output Resistance

Operation Verification Test — No

Do not perform this test for Operation Verification.

This test measures the source output resistance.

Procedure

NOTE All tests must be performed with Automatic Calibration ON. When the instrument powers up, AUTOCAL is ON, do not turn it off.

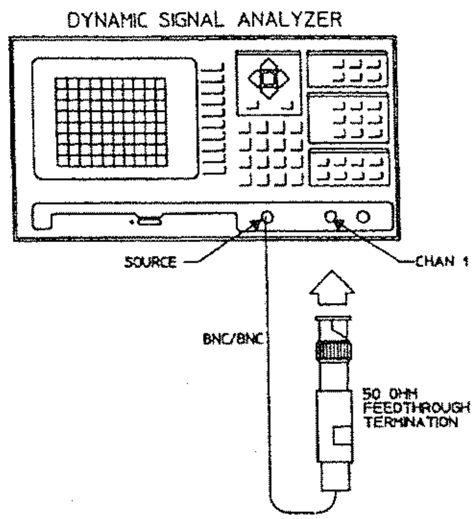
Preset the digital voltmeter as follows:

Digital Voltmeter

Function . . . . 2 wire k Ω
Range . . . . AUTO
Trigger . . . . INTERNAL
Sample Rate . . . . MAXIMUM
High Resolution . . . . ON
Auto Cal . . . . ON

1. Measure the resistance of the 50 Ω termination that is to be used in this test.
2. Record the resistance of the termination on the test record as R1.

3. Connect the test equipment as shown in the following illustration. For specific information about required test equipment see Table 3-3.



4. Press the HP35660A keys as follows:

< Preset >

< Input >
  [CHANNEL 1 RANGE] <±>< 1 > [dBVrms]
  [CHANNEL 1 SETUP]
  [AC/DC]

< Window >
  [UNIFORM]

< Freq >
  [SPAN] < 1 >< . >< 6 > [kHz]
  [CENTER] < 1 >< 0 > [kHz]

< Average >
  [AVERAGE ON/OFF]

< Source >
  [SOURCE ON/OFF]
  [LEVEL] < 1 >[dBVrms]
  [SINE FREQ ENTRY] < 1 > < 0 > [kHz]

< Start >

< Trace Type >
  [LINEAR MAGNITUDE]

< Marker >
  [MARKER TO PEAK]

5. Record the "A Marker Y:" measurement as V1 on the test record.
6. Remove the 50Ω termination from the signal path and connect the output directly to channel 1.
7. Press

   < Start >

8. Record the "A Marker Y:" measurement as V2 on the test record.

   $$Rs = R1\left(\frac{V2 - V1}{V1}\right)$$

9. Use the following formula to calculate the source output resistance:

If This Test Fails

If this test fails, contact your local Hewlett-Packard sales and service office or have a qualified service technician see the following sections in the *HP 35660A Service Manual*:

Section III — Adjustments
None

Section VII — Service: Assembly Level
One or more of the following is the most likely cause of the analyzer's failure:

A1 Digital Processor

Chapter 4
HP 35660A Installation

Getting Ready

Incoming Inspection

The HP 35660A Dynamic Signal Analyzer was carefully inspected both mechanically and electrically before shipment. It should be free of marks or scratches and in perfect electrical order upon receipt. Shipped with the analyzer is the power cord and the plastic transportation disc, part number HP 1150-1787 (unless disc drive is deleted, see options).

Inspect the analyzer for physical damage incurred in transit. If the analyzer was damaged in transit, save all packing materials, file a claim with the carrier, and call your Hewlett-Packard sales and service office.

CAUTION *If the analyzer is mechanically damaged, the integrity of the protective earth ground may be interrupted. Do not connect the analyzer to power if it is damaged.*

Incoming Tests

WARNING **Before applying line power to the analyzer or testing its electrical performance, see Chapter 4, "Installation."**

Finish incoming inspection by testing the electrical performance of the analyzer using the operational verification or the performance tests in chapter 3 of this installation guide – "Operation Verification Tests and Performance Tests." The operation verification tests verify the basic operating integrity of the analyzer; these tests take about two hours to complete. The performance tests verify that the analyzer meets all the performance specifications; these tests take about four hours to complete.

Dimensions and Weight

Weight and dimension specifications are listed in Chapter 2, "Specifications."

Power Requirements

The analyzer can operate from a single-phase ac power source supplying voltages as shown in Table 4-1. With all options installed, power consumption is less than 280VA.

The line-voltage selector switch is set at the factory to match the most commonly used line voltage of the country of destination; the appropriate fuse is also installed. To check or change either the line-voltage selector switch or the fuse see Figure 4-1, Table 4-1, and the following procedures.

WARNING **Only a qualified service person, aware of the hazards involved, should measure the line voltage.**

CAUTION *Before applying ac line power to the analyzer, ensure the line-voltage selector switch (on the rear panel) is set for the proper line voltage and the correct line fuse is installed in the fuse holder.*

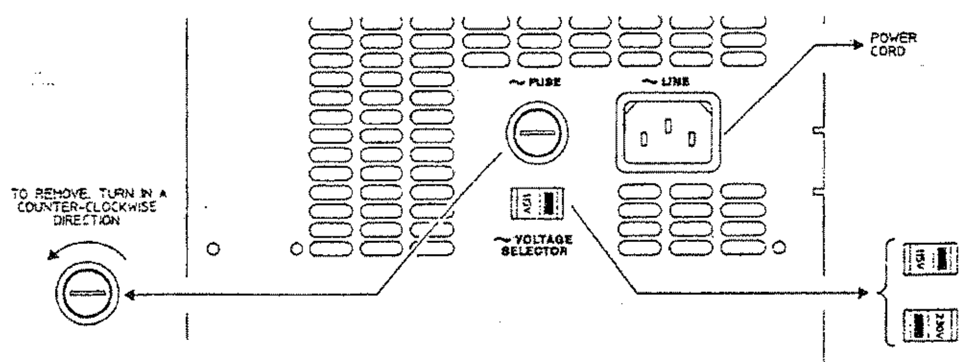


Figure 4-1 Voltage Selection and Fuse Replacement

Table 4-1 Line Voltage Ranges and Fuse Selection

AC Line Voltage Range	Frequency	Selector Switch	Fuse HP Part Number	Type
90-132Vac	48-440	115	2110-0056	6A 250V Fast Acting
180-264Vac	48-66	230	2110-0003	3A 250V Fast Acting

To change the line voltage selector switch:

See Figure 4-1 and Table 4-1

1. Unplug the power cord from the analyzer.
2. Slide the Line Voltage Selector switch to the proper voltage.

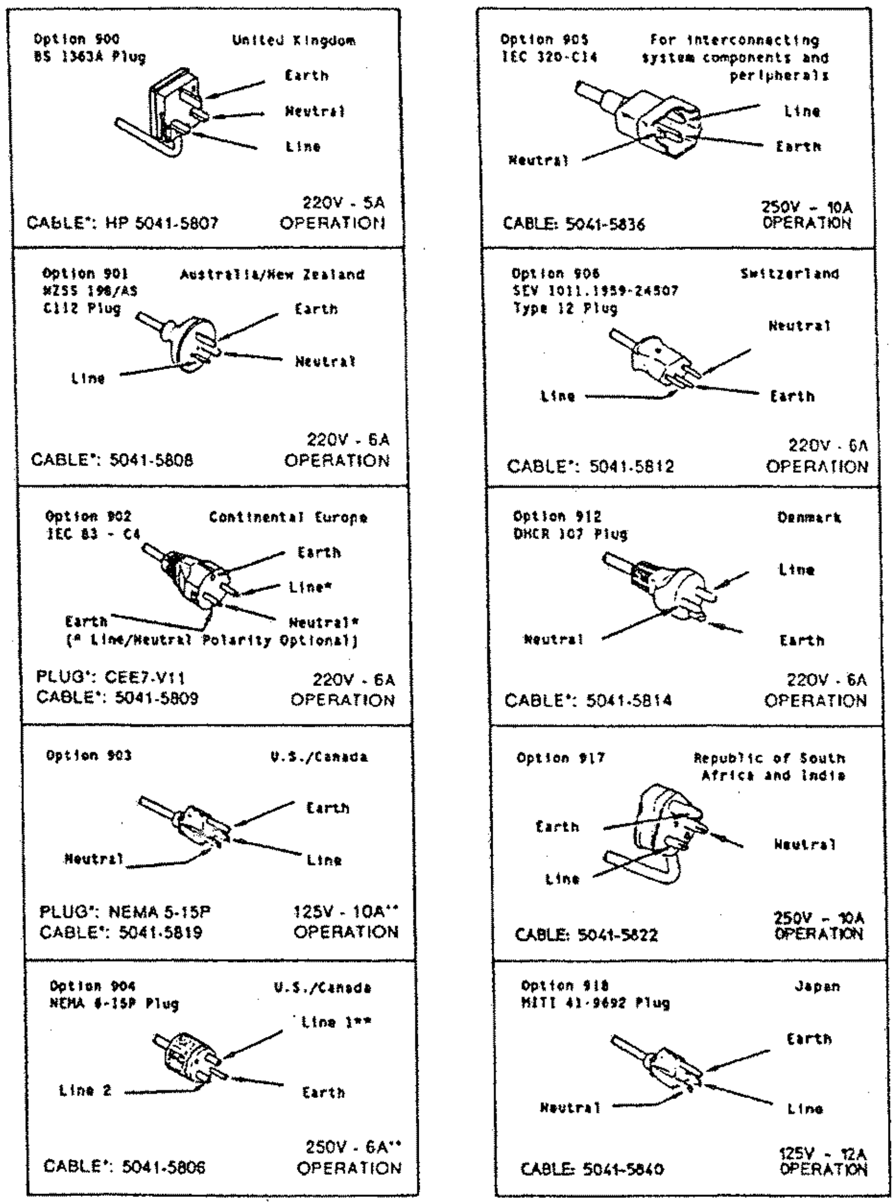
To change the fuse

See Figure 4-1 and Table 4-1

1. Unplug the power cord from the analyzer.
2. Using a small screw driver, turn the fuse holder cap to the left and remove, (counter-clockwise). When the fuse cap is free from the housing.
3. Pull the fuse from the fuse holder cap.
4. To reinstall, select the proper fuse and reverse the removal procedure.

Power Cable and Grounding Requirements

The analyzer is equipped with a three-conductor power cord which grounds the analyzer when plugged into an appropriate receptacle. The type of power cable plug shipped with each analyzer depends on the country of destination. See Figure 4-2 for the available power cables and plug configurations.



*The number shown for the plug is the industry identifier for the plug only
The number shown for the cable is an HP part number for a complete cable including the plug
**UL listed for use in the United States of America

WARNING **The power cable plug must be inserted into an outlet provided with a protective earth terminal. Defeating the protection of the grounded analyzer cabinet can subject the operator to lethal voltages.**

Screen (CRT) Cleaning

The analyzer screen is covered with a mesh (this is not removable by the operator). Under normal operating conditions the only cleaning required will be an occasional dusting with a soft brush. A household-type tack cloth, or other type of lint remover, may also be used.

However, if a foreign material adheres itself to the screen, dampen a soft, lint-free cloth, with a mild detergent mixed in water, and carefully wipe the screen.

WARNING **Do not apply any water mixture directly to the screen or allow moisture to go behind the front panel. Moisture behind the front panel will severely damage the instrument.**

To prevent damage to the screen, do not use cleaning solutions other than the above.

Analyzer Cooling

Cooling air enters the analyzer through the left side and exhausts through the rear panel. Install the analyzer to allow free circulation of cooling air.

Installation

The analyzer is shipped with plastic feet in place, ready for use as a portable bench analyzer. The plastic feet are shaped to make full-width modular instruments self-align when they are stacked.

To install the analyzer in an equipment cabinet, follow the instructions shipped with the rack mount kit, option 908.

Turning on the HP 35660A

First, apply proper line power to the analyzer, then press the rocker-switch in the lower left-hand corner of the analyzer to ON (I). The analyzer requires a few minutes to warm up and self-calibrate before any message appears on the display.

When turning on the analyzer for the first time, run the analyzer self test to ensure proper operation, see Chapter 3, "Operation Verification Tests and Performance Tests."

For measurement specific information, or other operating information, see the *HP 35660A Getting Started Guide*, or other appropriate manual, see the documentation map included with the analyzer.

HP-IB System Interface Connections

The analyzer is compatible with the Hewlett-Packard Interface Bus (HP-IB). The HP-IB is Hewlett-Packard's implementation of IEEE Standard 488.2. The analyzer is connected to the HP-IB by connecting an HP-IB interface cable to the connector located on the rear panel. Total allowable transmission path length is 2 meters times the number of devices or 20 meters, whichever is less. Operating distances can be extended using an HP-IB Extender.

For additional HP-IB programming information, see the *HP 35660A HP-IB Programming Reference.*

CAUTION *The analyzer contains metric threaded HP-IB cable mounting studs as opposed to English threads. Use only metric threaded HP-IB cable lockscrews to secure the cable to the analyzer. Metric threaded fasteners are black, while English threaded fasteners are silver.*

Operating Environment

The operating and storage environment specifications for the analyzer, with and without the disc drive, are listed in this guide in Chapter 2, "Specifications."

WARNING **To prevent potential fire or shock hazard, do not expose the analyzer to rain or other excessive moisture.**

Protect the analyzer from moisture and temperatures or temperature changes which cause condensation within the analyzer.

NOTE The disc drive is designed for operation in a typical office environment. Use of the equipment in an environment containing dirt, dust, or corrosive substances will drastically reduce the life of the disc drive and the flexible discs. The discs should be stored in a dry, static-free environment.

Storage and Shipment

Storage

Store the analyzer in a clean, dry, and static free environment. For other requirements, see environmental specifications in Chapter 2, "Specifications."

Shipment

CAUTION *When transporting the analyzer (with disc drive), insert the plastic disc protector, part number HP1150-1787, into the disc drive to prevent damage.*

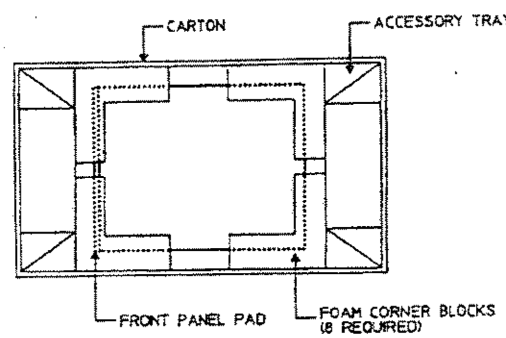


Figure 4-3 Repackaging for Shipment

Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices, see Figure 4-3. If the analyzer is being returned to Hewlett-Packard for service, attach a tag describing the type of service required, the return address, model number, and full serial number. Also, mark the container FRAGILE to ensure careful handling. In any correspondence, refer to the analyzer by model number and full serial number.

If it is necessary to package the analyzer in a container other than original packaging observe the following (use of other packaging is not recommended):

- Protect the front panel with cardboard and wrap the analyzer in heavy paper or anti-static plastic.
- Use a double-wall carton made of at least 350-pound test material and cushion the analyzer to prevent damage.
- Identify the shipment as above and mark FRAGILE.

CAUTION *Do not use styrene pellets in any shape as packing material for the analyzer. The pellets do not adequately cushion the analyzer and do not prevent the analyzer from shifting in the carton. In addition, the pellets create static electricity which can damage electronic components.*

Index

Hewlett-Packard Sales and Service Offices

To obtain Servicing information or to order replacement parts, contact the nearest Hewlett-Packard Sales and Service Office listed in HP Catalog, or contact the nearest regional office listed below:

In the United States

California
P.O. Box 4230
1421 South Manhattan Avenue
Fullerton 92631

Georgia
P.O. Box 105005
2000 South Park Place
Atlanta 30339

Illinois
5201 Tollview Drive
Rolling Meadows

New Jersey
W. 120 Century Road
Paramus 07652

In Canada
Hewlett-Packard (Canada) Ltd.
17500 South Service Road
Trans-Canada Highway
Kirkland, Quebec H9J 2M5

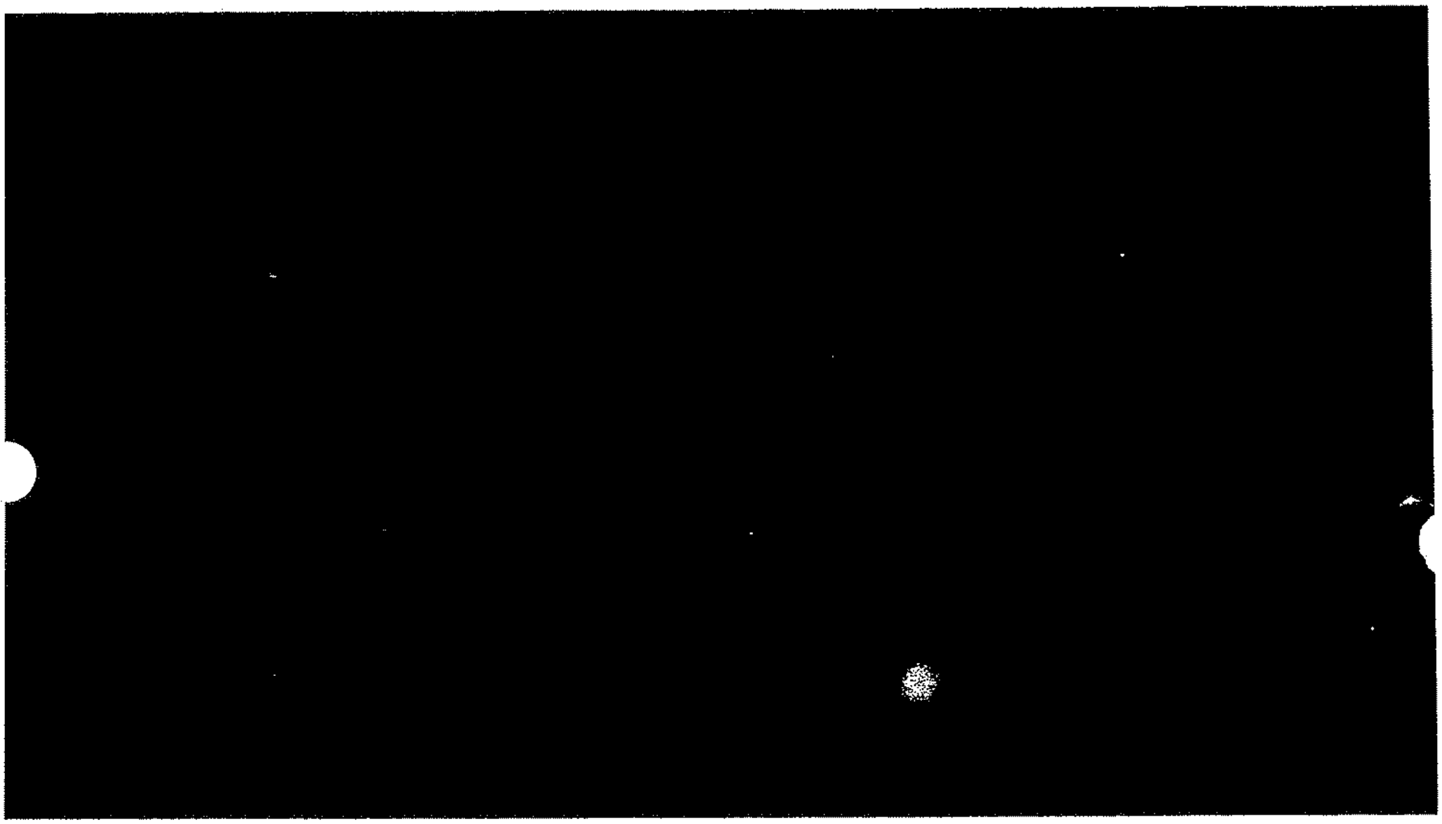
In France
Hewlett-Packard France
F-91947 Les Ulis Cedex
Orsay

In German Federal Republic
Hewlett-Packard GmbH
Vertriebszentrale Frankfurt
Berner Strasse 117
Postfach 560 140
D-6000 Frankfurt 56

In Great Britain
Hewlett-Packard Ltd.
King Street Lane
Winnersh, Wokingham
Berkshire RG11 5AR

In Other European Countries
Switzerland
Hewlett-Packard (Schweiz) AG
7, rue du Bois-du-Lan
Case Postale 365
CH-1217 Meyrin

In All Other Locations
Hewlett-Packard Inter-Americas
3155 Porter Drive
Palo Alto, California 94304

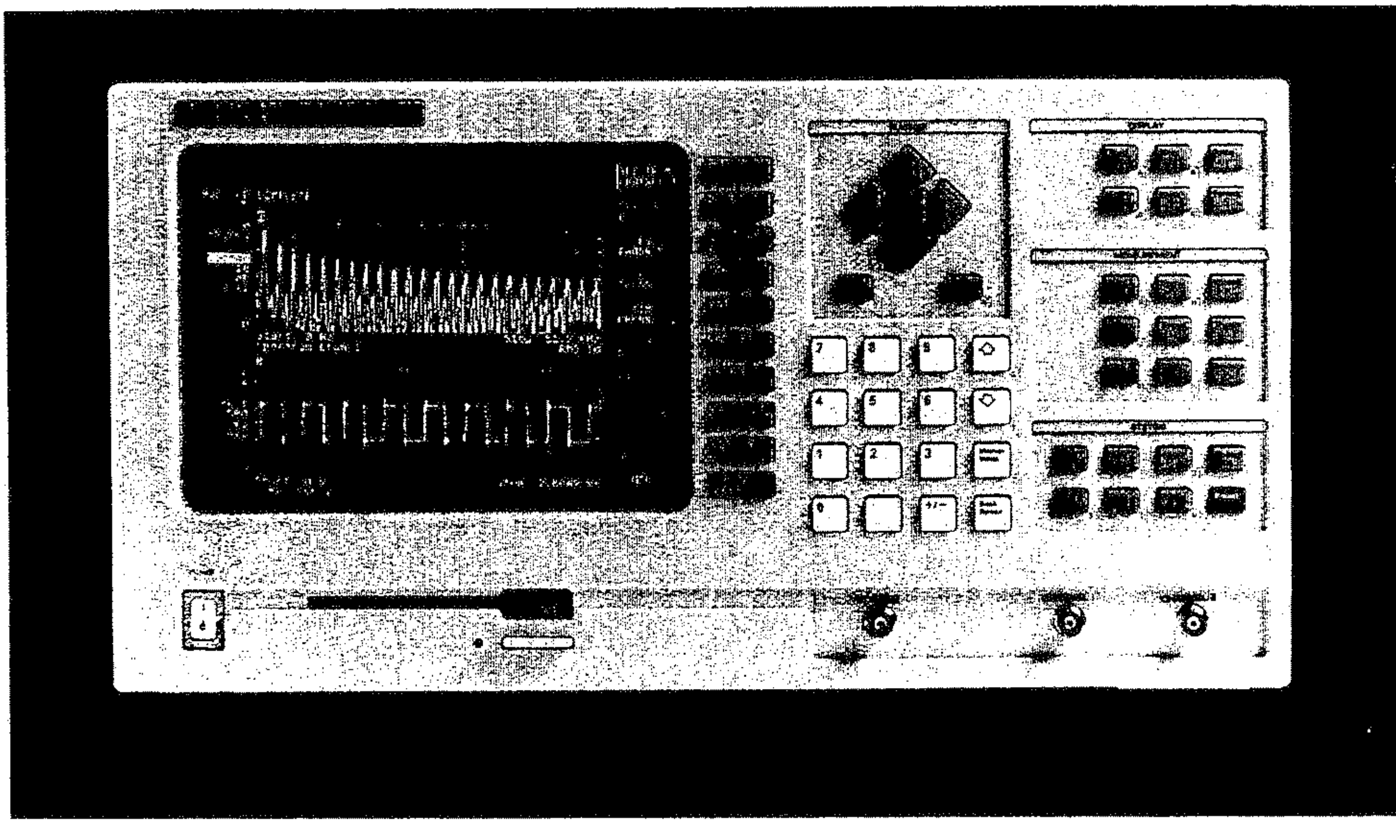


35660-90015

HEWLETT PACKARD

HP 35660A Dynamic Signal Analyzer
Getting Started Guide

HEWLETT-PACKARD



HP 35660A Dynamic Signal Analyzer Getting Started Guide

HEWLETT PACKARD

HP 35660A Dynamic Signal Analyzer Getting Started Guide

Manual Part No. 35660-90005
Microfiche Part No. 35660-90205

8600 Soper Hill Road
Everett, Washington 98205-1298 U.S.A.

Printed : Sept 1988

HEWLETT PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and the calibration facilities of other International Standards Organization Members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by -hp-. Buyer shall prepay shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to -hp- from another country.

HP software and firmware products which are designated by HP for use with a hardware product, when properly installed on the hardware product, are warranted not to fail to execute their programing instructions due to defects in materials and workmanship. If HP receives notice of such defects during their warranty period, HP shall repair or replace software media and firmware which do not execute their programming instructions due to such defects. HP does not warrant that the operation of the software, firmware or hardware shall be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

HEWLETT PACKARD

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure the safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

HEWLETT PACKARD

SAFETY SYMBOLS

General Definitions of Safety Symbols Used On Equipment or In Manuals.

⚠	Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.
ϟ	Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked.)
⏚ OR (⏚)	Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.
(⏚)	Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.
⏗ OR ⊥	Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.
∼	Alternating current (power line).
⎓	Direct current (power line).
≂	Alternating or direct current (power line).

WARNING ***The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which if not correctly performed or adhered to, could result in injury or death to personnel.***

CAUTION *The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.*

NOTE The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

Table of Contents

PART 1: The Basics

Chapter 1
Before You Begin

Please take a moment to read this introduction. Then go to Chapter 2, "Your First Measurement," to get comfortable with your new analyzer.

The Hewlett-Packard 35660A Dynamic Signal Analyzer helps you test, analyze, and design dc to 100 kHz electronic, electro-mechanical, and mechanical systems. If you've never used an FFT (Fast Fourier Transform) Dynamic Signal Analyzer before, you might think one difficult to use. Don't worry. Many measurements will be familiar to you – some are the same measurements made with swept-tuned analyzers.

How to Use this Book

Before you start using the analyzer, take a few minutes to read *Part I – The Basics*. This tells you what each measurement is all about – and a few hints that will help as you begin to use your analyzer. Even if you've used an FFT dynamic signal analyzer before, you might find a brief review of the basics useful.

If you already understand basic FFT measurements, you might want to proceed directly to the easy-to-follow measurement tasks. These are in two sections: *Part II – Making Spectrum Measurements* and *Part III – Making Network Measurements*. Each task steps you through a typical measurement procedure. To really learn how to use the analyzer, it's best if you gather the necessary equipment (outlined at the beginning of each task) and actually set up and make the measurements. The list of measurement tasks is by no means exhaustive – but after stepping through most of them, you'll have a good idea of what the analyzer can do for you.

After you've looked through the example measurements, spend some time with *Part IV – Beyond the Basics*. Here's where you'll learn about the analyzer's more sophisticated features.

And of course use, the *index* to quickly locate the information you need.

Where to find Additional Information

For quick information about specific hardkeys and softkeys, see the *HP 35660A Front-Panel Reference*. This book also contains softkey menu maps and a more detailed description of the analyzer's front panel.

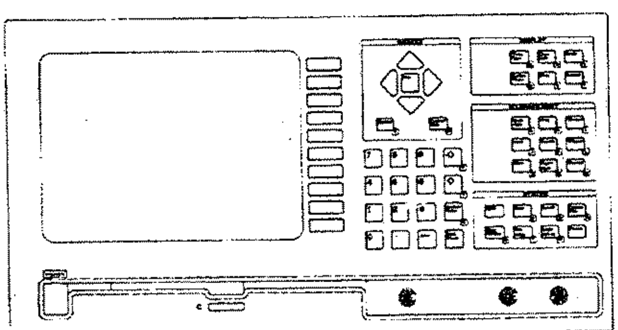
For specifications, installation instructions, and performance tests, see the *HP 35660A Installation Guide*.

To help you operate the analyzer remotely via HP-IB, see the *HP 35660A Programming Reference*.

Additionally, you will find applications information in numerous Hewlett-Packard Application Notes. These are available from your local HP Sales and Service Office. In particular, you might want to request a copy of the following application notes:

- AN 243 — The Fundamentals of Signal Analysis
- AN 243-1 — Effective Machinery Maintenance Using Vibration Analysis
- AN 243-2 — Control System Development Using Dynamic Signal Analyzers
- AN 243-3 — The Fundamentals of Modal Testing

About the Analyzer



The HP 35660A Dynamic Signal Analyzer is really two instruments in one — a network analyzer and a spectrum analyzer. You can make network or two-channel spectrum measurements, from 244 μHz to 51.2 kHz; or single-channel spectrum measurements from 488 μHz to 102.4 kHz. There's also a built-in signal source with choice of random noise, periodic chirp (fast sine sweep), or fixed sine wave.

The analyzer has three connectors on the front panel. One connector is a signal source. The others two connectors are the channel 1 input and the channel 2 input. On the back panel, there's a connector for an external trigger and one for the HP-IB. To learn more about these connectors, see the *HP 35660A Front-Panel Reference.*

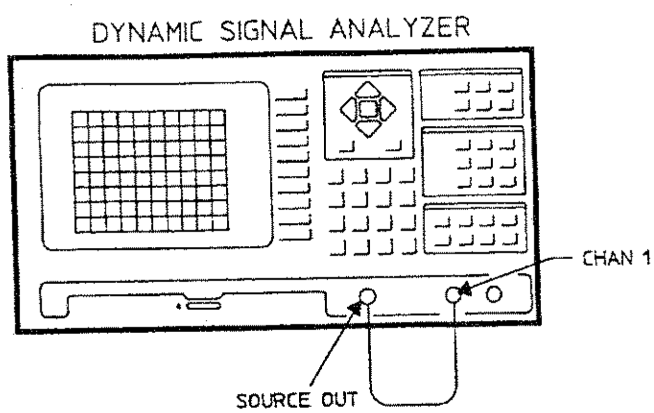
Chapter 2
Your First Measurement

If you haven't used the analyzer before, take a few minutes to make this first measurement. In this measurement, you will do the following:

- Look at the averaged power spectrum of a 1 kHz sine wave
- Check to see if the sine wave is really at 1 kHz
- Look for any harmonics of the fundamental frequency

[illegible]

Measurement Setup



As you step through the following task, you may find that your measurement results differ slightly from those shown here. Keep in mind that the tasks are designed to help you learn about the analyzer — not to duplicate specific measurement results.

1. If you've already turned on the analyzer, press < Preset >.

   If the analyzer is off, turn it on and wait until it warms up and calibrates. Then press < Preset >.

Pressing < Preset > returns most of the analyzer settings to the default positions.

2. Connect the analyzer's source to the Channel 1 input.

You do not need to terminate the analyzer's source, since the output impedance is less than 5Ω.

The analyzer's input channels have an impedance of 1 MΩ.

In this example you are using the analyzer's internal source as the test device. However, to test external signal sources designed to operate into a specific load (such as an oscillator with a 600Ω output), you must place an appropriate feedthrough terminator across the output of the test device.

3. Press < Source >

   [SOURCE ON/OFF]

   [FIXED SINE]

This turns on the analyzer's internal source and selects the fixed sine wave.

4. Press [SINE FREQ ENTRY]

   < 1 > [kHz]

This sets the sine frequency to 1 kHz.

5. Press [LEVEL]

   < 1 > [Vrms]

This sets the level of the sine wave to 1 Vrms.

6. Now look at the analyzer's screen. This is a display of the linear spectrum.

   This display appears in frequency domain.

   Because this is a full span (0 to 102.4 kHz), the relatively low frequency of the source waveform (1 kHz) is at the extreme left of the display.

   Because averaging is off, you will see the display change several times each second. Each display represents one FFT of a single time record.

7. Press < Freq >

   The < ⇩ > and < ⇧ > hardkeys are located in the numeric keypad.

   [SPAN]

   Now use the < ⇩ > hardkey to step through several spans.

   This changes the frequency span and lets us look at a smaller slice of the frequency spectrum. This gives a better view of the fundamental and the first two harmonics.

   Stop when you reach 3.2 kHz – if you step down too far, simply use the < ⇧ > hardkey to go back up to 3.2 kHz.

   You can also use the numeric keypad to specify a span (the analyzer takes the nearest acceptable value).

7a. If you don't see any harmonics, press < Input > [CHANNEL 1 RANGE]. Then press < ⇩ > twice.

   This intentionally overloads the analyzer's input to simulate a source with prominent harmonics.

8. Press < Average >

   [AVERAGE ON/OFF]

   Note how the word "ON" in this softkey label highlights when averaging is on.

   The analyzer should start an averaged measurement right away.

   The default averaging is rms averaging (with ten averages). For now, we'll stay with this type of average.

9. Press < Scale >

   [VERTICAL/DIV]

   < 1 > < 2 > [dB]

   This selects a vertical scale of 12 dB per division.

We've changed the scale to view both the top of the fundamental and the noise floor.

10. Press < Start >

Note how another averaged measurement begins.

11. Press < Marker >

    [MARKER TO PEAK]

This moves the marker to the largest frequency component on the display — in this case, the fundamental.

12. Note the frequency value indicated by the marker's x-axis position.

This value should be 1 kHz. This verifies that the sine source is indeed set at 1 kHz.

13. Note the amplitude value indicated by the marker's y-axis position.

This shows the absolute amplitude of the fundamental. In this case, the y-axis marker value indicates about 0 dBVrms — equivalent to about 1 Vrms.

14. Press the < ▲ > hardkey several times, until the marker moves to 3 kHz.

This moves the marker to the third harmonic.

The < ▲ > hardkey is the unlabeled key shaped like an up arrow in the MARKER group of front-panel keys.

Pressing < ▲ > jumps the marker to the next big peak to the right. Pressing < ▼ > works the same way, but jumps the marker to the left.

You can also use the < ◀ > and < ▶ > keys to move the marker.

15. Note the frequency value indicated by the marker's x-axis position.

This value should be about 3 kHz. Not surprising, since the third harmonic should be three times the fundamental's frequency.

16. Note the amplitude value indicated by the marker's y-axis position.

This value is about −70 dBVrms. Since the fundamental is about 0 dBVrms, the third harmonic is about 70 dB below the fundamental.

Chapter 3
Measurement Basics

Time Domain vs. Frequency Domain

If you haven't used a network analyzer or spectrum analyzer before, it's important to understand the difference between time-domain displays and frequency-domain displays.

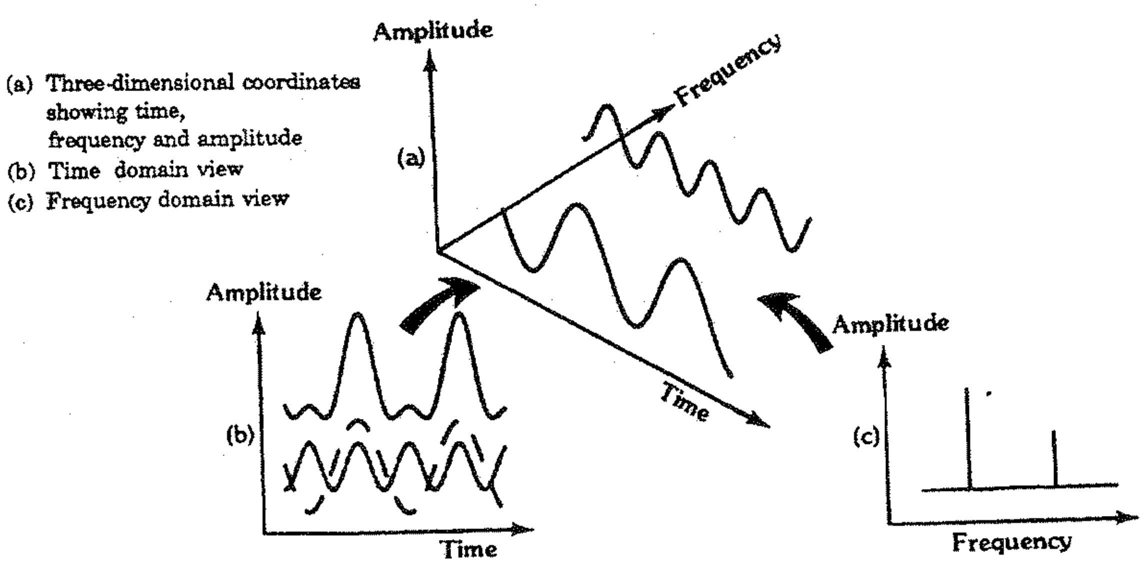
Time-domain displays show a parameter (such as amplitude) versus *time*. This is the traditional way of looking at a signal. Oscilloscopes display signals in the time domain.

Frequency-domain displays show a parameter (again, such as amplitude) versus *frequency*. The analyzer uses an FFT (Fast Fourier Transform) algorithm to convert an analog input signal – a time-domain signal – to a signal displayed in the frequency domain. The tremendous advantage of frequency-domain displays is they can reveal very small signals not visible in time-domain displays – signals such as noise and distortion products.

All analyzer measurements appear in the frequency domain except time records.

One type of measurement that appears in the frequency domain is a spectrum measurement. Spectrum measurements show the energy of each frequency component at sampled points along the frequency spectrum. Now look at the figure and note the difference between the time-domain and frequency-domain displays of the same input signal.

The Relationship Between the Time and Frequency Domains.



The Frequency Span

You can vary the size and the center frequency of the span to best suit your measurement needs. The HP 35660A Dynamic Signal Analyzer always presents data with a 401-point resolution – even when viewing very small spans. The tremendous advantage of FFT signal analyzers is that they have good frequency resolution for smaller frequency spans (they also make these measurements much more quickly than swept-tuned analyzers). And you can use much smaller spans with FFT analyzers as well.

Full-span measurements let you view the entire frequency spectrum on one display. For one-channel measurements, the spectrum will extend from dc to 102.4 kHz. For two-channel measurements, the spectrum will extend from dc to 51.2 kHz.

Alternatively, you may wish to view smaller slices of the frequency spectrum. You can select one of twenty different spans and position these spans where you want by specifying their start or center frequencies. This process of viewing smaller spans is sometimes called "band-selectable analysis." Measurements with spans that start at 0 Hz are called "baseband" measurements – those with spans that start at frequencies other than 0 Hz are called "zoomed" measurements.

There's more you should know about selecting an appropriate frequency span. We'll cover that later in this chapter.

First, the FFT

The Fast Fourier Transform (FFT) is a an implementation of the Discrete Fourier Transform, the math algorithm used for transforming data from the time domain to the frequency domain. Before the analyzer uses the FFT algorithm, it samples the input signal with an analog-to-digital converter (the Nyquist sampling theorem states that if samples are taken twice as fast as the highest frequency component in the signal, the signal can be reconstructed exactly). This transforms the continuous (analog) signal into a discrete (digital) signal.

Because the input signal is sampled, an *exact* representation of this signal is not available in either the time domain or the frequency domain. However, by spacing the samples closely, the analyzer provides an excellent approximation of the input signal.

The analyzer display appears to be one continuous trace. However, the display is really 401 discrete points connected together. Each point is called a frequency bin (or just bin for short).

Can the Analyzer Measure DC?

The analyzer is not designed to measure dc. However, it is designed to measure very low frequencies – as low as 244 μHz for two-channel measurements and 488 μHz for one-channel measurements. The analyzer can, in fact, measure dc, but not without including a dc offset of its own that can contribute to (or obscure) a dc offset in the input signal. This internal offset is caused by residual dc that originates in the analyzer's input amplifiers. Thus, dc measurements are not guaranteed to be accurate.

As you use the analyzer, you will notice a dc offset when making baseband measurements (those with spans that start at 0 Hz). This offset is always present in the 0 Hz bin (sometimes called the dc bin). The feedthrough that cause the offset may also leak into the first several bins as well. If this is a problem, start the frequency span several bins above 0 Hz to avoid the feedthrough.

The Time Record

A time record is the amount of time-domain data the analyzer needs to perform one FFT operation. The time record and its FFT are the building blocks the analyzer needs for all subsequent measurements.

The analyzer takes 1024 samples of time data to produce 512 points of frequency domain data. The analyzer usually displays the first 401 points of this data and discards the rest (this accommodates the anti-aliasing filters, but that's beyond the scope of our current discussion).

The relationship between a time record and the frequency data is relatively straightforward. If a signal component completes one cycle within the time record, it will show up in the first frequency bin (the first point on the analyzer's display). If a component takes two cycles to complete, it will show up in the second bin. And so forth.

So if a time record is 1 second long (and you start at 0 Hz), then the period of the signal for the first bin is also 1 second. And its frequency (1/period) is 1 Hz. Since there are 401 bins displayed, the span will be 400 Hz. The effective sampling frequency is simply 1024 divided by the length of the time record.

Why a Time Record?

Essentially, the time record is a block of time-domain sample points. Now since the actual Fourier Transform does not have explicit time or frequency references (it simply operates on a sequential collection of points), FFT analyzers must assign arbitrary start and finish times for data to be transformed. These blocks of input data are called time records.

Measurement Speed vs. Time Record Length

Frequency Span (Hz)	Time Record Length (sec)	Resolution * (Hz)
102400	.00390625	256
51200	.0078125	128
25600	.015625	64
12800	.03125	32
6400	.0625	16
3200	.125	8
1600	.25	4
800	.5	2
400	1	1
200	2	.5
100	4	.25
50	8	.125
25	16	.0625
12.5	32	.03215
6.25	64	.015625
3.125	128	.0078125
1.5625	256	.00390625
.78125	512	.001953125
.390625	1024	.0009765625
.1953125	2048	.00048828125

* **Frequency Span/400**

The size of a time record is inversely proportional to the frequency span. So for smaller spans, the analyzer needs a longer time record and therefore takes longer to make a measurement. For larger spans, the analyzer needs a shorter time record and can therefore make a measurement much faster. These differences will become noticeable as you start making measurements. This characteristic is a natural part of the FFT process and is common to *all* FFT analyzers, not just the HP 35660A. By the way, swept-tuned analyzers have similar limitations (and are, in fact, much slower than FFT analyzers for comparable measurements).

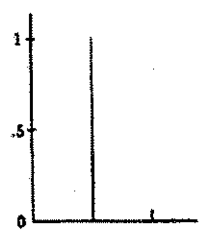
A dB Scale for the Y-Axis

Time-domain displays usually have a linear y-axis and a linear x-axis (think of an oscilloscope). However, frequency-domain displays must often use a *logarithmic* y-axis scale to show small signals with large signals.

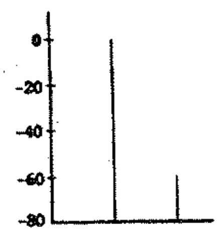
Let's look at the spectrum of a sine wave. Because the amplitude of any harmonic is small relative to the fundamental frequency, it's nearly impossible to view a harmonic on the same display as the fundamental unless the y-axis scale is logarithmic. So most magnitude measurements made with dynamic signal analyzers use a logarithmic y-axis scale with units based on decibels (dB). Because the dB scale is by definition logarithmic, there's no need to use logarithmically-spaced graticule lines.

The dB scale is convenient. It is also the scale you will probably use for most magnitude displays – particularly with spectrum or frequency response measurements.

Small Signals Can Be Measured with a Logarithmic Amplitude Scale.



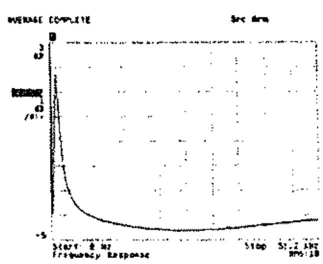
(a) Linear Amplitude Scale

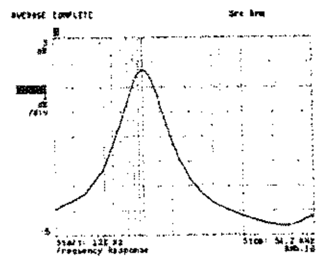


(b) Logarithmic Amplitude Scale

A Logarithmic Scale for the X-Axis

Sometimes it's convenient to use a logarithmic x-axis. Perhaps most familiar to you is the frequency response measurement. This is traditionally displayed with a log x-axis (frequency) versus a log y-axis (relative magnitude).





But most measurements do not require a logarithmic frequency scale. In fact, when making spectrum measurements it's easier to characterize harmonics with a linear x-axis scale since harmonics that are multiples of the same fundamental will appear at evenly-spaced intervals.

Here's what else you should know:

- The analyzer's frequency resolution is determined exclusively by the width of the span. So for the same span widths, frequency resolution for both linear and log scales is identical – both have a resolution of 401 points per display. The logarithmic scale simply displays these points on a logarithmic x-axis.
- For baseband measurements (spans that start at 0 Hz) the logarithmic scale shows the actual start frequency (the first bin) of the current span – not the nominal value of 0 Hz. So if you're looking at a 51.2 kHz frequency span, the first frequency shown on the logarithmic scale will be labeled 128 Hz (the analyzer does not show a value at 0 Hz since the log of 0 is minus infinity). As you would for a linear scale, change to smaller span to view lower-frequency components.

Measurement Type

Changing the analyzer from a spectrum analyzer to a network analyzer (or two-channel spectrum analyzer) is easy. Simply press < Meas Type > and select either [1 CHANNEL 102.4 kHz] or [2 CHANNEL 51.2 kHz]. One-channel measurements are spectrum measurements. Two-channel measurements can be spectrum measurements with two channels *or* network measurements.

Use the following matrix to help you select an appropriate measurement. Notice how some measurements (such as frequency response) are available only when the analyzer is operating as a two-channel analyzer. Press < Meas Data > and you'll see a menu listing the available measurements.

Measurement Type

Measurement	One Channel	Two Channel
Spectrum CH1	Yes	Yes
Spectrum CH2	No	Yes
PSD CH1	Yes	Yes
PSD CH2	No	Yes
Time CH1	Yes	Yes
Time CH2	No	Yes
Frequency Resp.	No	Yes
Coherence	No	Yes (average on)
Cross Spectrum	No	Yes

The measurements are as follows:

- Spectrum
- Power Spectral Density (PSD)
- Time record
- Frequency Response
- Coherence
- Cross Spectrum

Trace Type

Once you've made a measurement there are a number of ways to display the measurement data. The measurement data is called a trace. Press < Trace Type > to see the available measurement traces. On some dynamic signal analyzers, these trace types are called "coordinate types."

It's important to understand that selecting a measurement and selecting a trace type are two different things. When you specify the measurement type, you are asking the analyzer to acquire input data and process it. When you select a trace type, you are specifying how you want the processed measurement data displayed. First select a measurement; then specify a trace type.

The logarithmic magnitude display is the most common way to view measurement data. However, the other trace types are also useful and can reveal information not visible from the traditional log magnitude display.

These are the trace types:

- Linear Magnitude
- Logarithmic Magnitude
- Phase
- Group Delay
- Real Part
- Imaginary Part

Spectrum Measurements

Softkeys: [SPECTRUM CHANNEL 1] and [SPECTRUM CHANNEL 2]

Linear Spectrum or Power Spectrum?

The term "spectrum measurement" is used to describe several different measurements. These include linear spectrum, averaged linear spectrum, and power spectrum.

A *linear spectrum* is the most basic spectrum measurement. This is the FFT of a single time record. The analyzer filters the input data (to the desired frequency span) and then performs an FFT on a single time record. The resulting display is in the frequency domain and shows the spectral content of the input signal.

An *averaged linear spectrum* is a vector-averaged linear spectrum. With vector averaging, the analyzer averages complex values, point-by-point, in the frequency domain. This lowers noise because the real and imaginary components of the random signals are not in phase and therefore cancel each other – increasingly so with each average. Frequency components that are periodic do not cancel and therefore do not diminish with successive averages. Vector averaging produces results similar to time averaging (a feature found on many FFT analyzers). You'll learn more about vector averaging in Chapter 4, "More Basics."

A *power spectrum* is an rms-averaged linear spectrum. The analyzer filters the input data (to the desired frequency span). It then performs an FFT on each time record, and multiplies each resulting linear spectrum by its complex conjugate. The final results are rms averaged to a single spectrum – the power spectrum.

Should I use Linear Spectrum or Power Spectrum?

Use linear spectrum measurements (both single and averaged) if you need single-channel phase information (we'll explain single-channel phase in a moment). Additionally, use averaged linear spectrum measurements when you want to reduce noise as much as possible. With enough averages, linear spectrum measurements have noise levels approaching zero, limited only by the dynamic range of the analyzer.

Use power spectrum measurements if you're interested in rms values of frequency components and noise. Since the power spectrum does not *reduce* noise but simply provides a good approximation of the *actual noise level*, it's an ideal measurement for characterizing the performance of many electronic devices – particularly for audio-frequency and communications applications.

Spectrum Measurements (continued)

Linear Spectrum for Single-channel Phase Information

The linear spectrum can reveal single-channel phase relationships. We'll see why this is useful in a moment. But first, let's discuss single-channel phase.

When we talk about phase, we usually associate it with two-channel measurements (such as frequency response). That's because in the traditional sense, phase is used to indicate time relationships between *two* signals — usually input and output — measured at the device under test. This produces a phase trace showing relative phase differences between the two signals at every point in the selected frequency span. And the HP 35660A can, of course, make this type of measurement. But there's also single-channel phase.

Instead of using phase to show time relationships between frequency components of two signals, we can use phase to show time relationships between individual frequency components of one signal and a *fixed time reference* (an external trigger signal). This is useful when you're trying to determine the relative phase of a particular component with respect to other frequency components — a situation common to vibration measurements.

However, linear spectrum measurements will not yield meaningful phase information unless you've met these conditions:

- *The input signal is periodic.* In other words, the input signal must repeat continuously. This is not a problem for rotating machinery measurements, since the measured signal (the machine's "frequency signature") repeats with each rotation.
- *The analyzer has a trigger signal with a fixed relation to the input signal.* For rotating machinery measurements, you'll need to provide an external trigger signal from a tachometer, proximity probe, or other device. A reliable trigger signal is important, since phase is measured relative to the trigger occurrence. The trigger signal is at the beginning of the time record (unless you've selected a pre- or post-trigger delay) but the actual timing is not critical as long as the trigger is consistent.

Linear Spectrum for Lower Noise Levels

Averaged linear spectrum measurements are sometimes used because they have better signal-to-noise ratios than power (rms) spectrum measurements. This is because linear spectrum measurements use vector averaging instead of rms averaging. With enough vector averages, the input noise level approaches zero — limited only by the analyzer's dynamic range.

But linear spectrum measurements are not just for mechanical measurements. You can also take advantage of their better signal-to-noise ratios for electrical measurements. If the input signal is periodic and there's a good trigger signal, you can use the linear spectrum. Though many linear spectrum measurements require an *external* trigger, you can also use input triggering — provided the input waveform will trigger the analyzer consistently.

Spectrum Measurements (continued)

Power Spectrum to Find RMS Average

Power spectrum measurements show rms values for frequency components (and noise) of the input signal. This is the most common measurement used for analyzing the spectrum of audio-frequency devices and communications equipment.

Power spectrum measurement do not contain any phase information. This information is lost during the transition from linear spectrum to power spectrum. But most measurements that call for rms power do not require phase information.

Let's look at an example. You can look at the power spectrum of an oscillator to determine rms values for the fundamental frequency and harmonics — measured in relative terms (such as dB) or absolute levels (such as dBm). You can then use the analyzer's marker functions to measure noise and harmonic distortion.

Remember, rms averaging does not eliminate noise. It simply produces a statistical average of the input signal including noise. Additional averages provide a better statistical average, but will not actually *reduce* noise.

With rms averaging, the magnitude of individual frequencies also includes noise. So for very small signals, noise can add significantly to that component's magnitude. If you want to reduce that noise, you'll have to use linear averaging instead of power averaging — but remember that magnitude values will no longer be rms values.

We'll learn more about averaging in the next chapter.

PSD (Power Spectral Density) Measurements

Softkeys: [PSD CHANNEL 1] and [PSD CHANNEL 2]

What Is PSD?

PSD (Power Spectral Density) is similar to the power spectrum measurement, but the analyzer normalizes each component of the power spectrum to produce a display with values normalized to 1 Hz. Think of it this way – if you place the marker at a particular frequency, the marker value will show a value that *approximates the power within a 1 Hz band centered at the marker value.* This is true regardless of the frequency span you've selected.

PSD is sometimes called "noise density" or "spectral density," but the full name is "power spectral density."

Why Use It?

The magnitude of a measurement of white noise is proportional to the bandwidth the analyzer uses. So to make *comparative* noise measurements, the analyzer must use the same bandwidth to examine energy throughout the entire frequency span of interest. That's why PSD is so useful, since it uses a standard analysis bandwidth of 1 Hz.

Why Normalize to a 1 Hz Bandwidth?

Traditionally, swept-tuned analyzers used a tunable filter with a 1 Hz wide filter to produce a display with a resolution of 1 Hz. After a while, power spectrum measurements with a 1 Hz bandwidth became an industry standard.

However, FFT analyzers do not use tunable filters. In fact, the bandwidth at each frequency point varies with the frequency span and the window you've selected. So to simulate a 1 Hz bandwidth at each frequency point (401 points per display), the analyzer uses an algorithm that divides by the square root of the actual bandwidth. The algorithm also corrects for the type of window you're using.

Noise measurements made using PSD will approximate actual 1 Hz bandwidth measurements only if the noise is Gaussian (white noise).

PSD Measurements (continued)

What Do I Measure with PSD?

For electrical measurements, PSD can be used to make standardized noise measurements. For example, you can measure signal-to-noise ratios by comparing the level of a test frequency to the PSD of a typical point on the noise floor. This method yields a better apparent signal-to-noise ratio than referencing the test signal to wide-band noise, but may be preferable in cases where you want repeatable noise measurements referenced to a common standard.

PSD is also used to look at phase noise of high-frequency oscillators (such as microwave and radar) after these signals are mixed with a reference oscillator to bring the spectral components within the analyzer's range.

For mechanical measurements, PSD is routinely used to measure the energy of noise or other spectral components. The standard 1 Hz bandwidth allows meaningful comparison to measurements made with other analyzers (not necessarily FFT analyzers).

Time Record Measurements

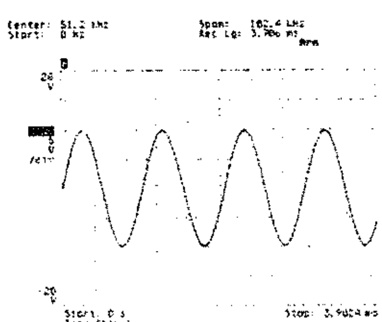
Softkeys: [TIME CHANNEL 1] and [TIME CHANNEL 2]

Time record displays appear in the time domain – that's why they look like oscilloscope traces. A time record is the amount of time-domain data the analyzer needs to perform one FFT operation. The time record and its FFT are the basic "building blocks" the analyzer needs for all subsequent measurements.

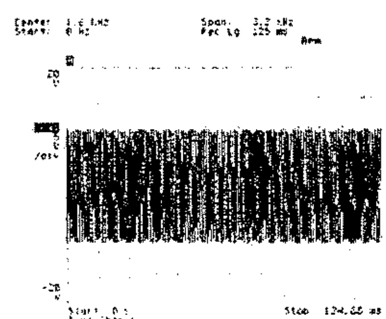
Time records are not calibrated, so they display only an approximate amplitude value. Still, time records are very useful. They show input data before the analyzer does any FFT processing.

Here's what you should know about input records:

- If you set the instrument to measure full span, the time record is called an "input time record." This is raw, unfiltered input data – the signal from which all subsequent measurements are based. Use the input time record to verify that there is indeed a signal. Additionally, you can use the time record when manually setting the input range.
- If you set the instrument to measure a specific bandwidth (something less than full span), the time record shows the raw input data after filtering. This lets you see if there's energy within the selected span.
- If the analyzer is making averaged measurements, the most recent time record added to the average is the one displayed. The analyzer does not show a time waveform that is a cumulative average, since all averaging is done after the time data has been transformed to the frequency domain.
- For zoomed time record displays (start frequency not equal to zero), the displayed amplitude is approximately one-half the actual amplitude.
- Although the time record is similar to an oscilloscope display, the analyzer is *not* a digital oscilloscope. The time record represents *samples* of a waveform. The samples have enough information to accurately reconstruct the input signal – but the human eye may not properly perform the reconstruction. In fact, for frequencies that are higher than about 10% of the frequency span, there will be noticeable *visible* distortion. However, in no way does this affect the accuracy of the measurement made from the time record.



Time Record of 1 kHz Sine Wave (102.4 kHz Span)



Time Record of 1 kHz Sine Wave (3.2 kHz Span)

Frequency Response Measurements

Softkey: [FREQUENCY RESPONSE]

Frequency response is one of the most useful measurements that two-channel analyzers perform. Frequency response shows how a system (a "network") will respond to a particular input. The network might be electrical (a filter, for example) or mechanical (a model airplane in a wind tunnel).

Frequency response measurements show the ratio of the input stimulus to the measured output. A flat response means the network responds equally to all input frequencies (a truly linear device). You can also view the phase of a frequency response measurement – to look at phase shift or phase accuracy of the network. Naturally, frequency response measurements are displayed in the frequency domain.

Traditionally, most analyzers made frequency response measurements by calculating the ratio between the network's output linear spectrum to its input linear spectrum. However, analyzers such as the HP 35660A calculate frequency response differently – by measuring the ratio of the cross spectrum to the input (channel 1) power spectrum. This method is more accurate, but a bit harder to understand. It's a good idea to understand the cross spectrum measurement, as both frequency response and coherence measurements are derived from cross spectrum calculations.

Measuring frequency response by calculating the ratio of cross spectrum to the input power spectrum provides a better statistical estimate of true frequency response. Here's why:

- Anomalies in the input signal are minimized, because the analyzer measures an averaged input signal – the power spectrum (an rms averaged linear spectrum).
- Measuring the cross spectrum instead of the linear output spectrum minimizes non-coherent (spurious) information that may be present in the network under test. In fact, measuring frequency response this way produces a useful by-product – coherence. See "Coherence Measurements."
- No trigger is required for averaging frequency response measurements (unlike the traditional method).

Coherence Measurements

Softkey: [COHERENCE]

Coherence is derived from a series of averaged frequency response measurements — the more averages, the better the coherence measurement (you'll need to take at least five to ten averages to get good results).

The coherence display appears in the frequency domain. It shows the portion of the output power spectrum actually caused by an input signal — sort of an "integrity check."

Coherence values have no units, but are measured with simple linear scale (from 0.0 to 1.0). A coherence value of 1.0 (perfect coherence) means that all power at the output was caused by the input signal. A value of 0.0 (no coherence — an extreme case) means that none of the power at the output was caused by the input signal. Most coherence values are between these extremes.

Poor coherence can be caused by many things. Possible sources of poor coherence are leakage errors (see "windowing" in chapter 4), poor signal-to-noise ratios (perhaps caused by improper range settings), non-linearities in the device under test, and extraneous noise. Coherence is a complex measurement and should be used and interpreted with great care.

Coherence and frequency response measurements are often used together. After averaging several frequency response measurements, you can use the coherence display to find places along the output power spectrum where the measurement data may be questionable — in other words, places with poor coherence.

Ideally, of course, a network under test — electronic or mechanical — should exhibit perfect coherence. That is, the only stimulus to the network is what you apply and the only response is that caused by this controlled stimulus. But in many cases, it's just not possible to completely isolate the network from noise, interference, or other anomalies. Here are some examples:

- For electronic measurements, coherence is used to identify frequency components that cannot be removed from the device under test. For example, when measuring the frequency response of a switching power supply with a very large component at the switching frequency.
- For mechanical measurements, coherence is used to minimize measurement error from external sources. For example, when measuring the frequency response of a certain machine component, coherence (used carefully) can help isolate frequency components originating from nearby machinery — especially important when nearby machinery cannot be turned off.

If the spurious signal is common to both channels, the coherence measurement will not flag the problem. This can occur with 60 Hz power line components, for example.

Cross Spectrum Measurements

Softkey: [CROSS SPECTRUM]

Cross spectrum measurements are an intimate part of both frequency response and coherence measurements. In fact, the analyzer calculates cross spectrum (but doesn't display it) to derive both frequency response and coherence measurements. Like frequency response and coherence measurements, cross spectrum is a two-channel measurement.

Cross spectrum measurements are not used as often as other measurements. For most applications, cross spectrum (used without other measurements) is rarely used.

What Does it Show?

Cross spectrum (sometimes called "cross power spectrum") is a measure of the mutual power between two signals at each point in the current frequency span. Cross spectrum measurements reveal both phase and magnitude information.

The phase display of the cross spectrum measurement shows the *relative* phase — at each frequency — between two signals. Because the phase relationship is relative, you can make cross spectrum measurements without using a synchronized trigger.

The magnitude display of the cross spectrum measurement is the product of the magnitudes of the two signals. If both signals have a large magnitude, the cross product will be large — if both are small, the cross product will be small. This makes cross spectrum a sensitive tool for isolating major signals common to both signals.

Why Use it?

You can use cross spectrum to analyze phase relationships between signals. These might be caused by time delays in a system, propagation delays, or multiple signal paths between source and destination.

You can also use the cross spectrum measurement to calculate acoustic intensity. Acoustic intensity is a vector quantity that indicates the direction and magnitude of sound propagation at a point in space. It is proportional to the imaginary part of the cross spectrum measurement between two closely spaced microphones in the sound field.

Cross spectrum measurements do not necessarily reveal causal relationships. For example, if you're using the analyzer to measure a network, the cross spectrum may show signals at the output (channel 2) not caused by the input (channel 1). The coherence measurement is a much better indicator of causality.

Linear Magnitude Trace

Softkey: [LINEAR MAGNITUDE]

The linear magnitude trace type shows the magnitude of the measurement defined for the active trace on a linear y-axis scale.

Here are some characteristics of the linear magnitude trace:

- For frequency-domain measurements, frequency is the x-axis.
- For time -domain measurements (time records), time is the x-axis.
- For linear magnitude displays, all points on the y-axis have a linear relationship (regardless of the vertical unit you've selected). Usually, it's more convenient to assign a linear unit (such as V or Vrms) as the vertical unit on linear magnitude displays. But even if you select a logarithmic unit (such as dBVrms or dBm), the spacing between points on the y-axis still remains linear.

Logarithmic Magnitude Trace

Softkey: [LOG MAGNITUDE]

The logarithmic magnitude trace type shows the magnitude of the measurement defined for the active trace on a logarithmic y-axis scale.

Here are some characteristics of the logarithmic magnitude trace:

- For frequency-domain measurements, frequency is the x-axis.
- For time-domain measurements (time records), time is the x-axis.
- For logarithmic magnitude displays, all points on the y-axis have a logarithmic relationship (regardless of the vertical unit you've selected). Usually, it's more convenient to assign a logarithmic unit (such as dBVrms or dBm) as the vertical unit on logarithmic magnitude displays. But even if you select a linear unit (such as V or Vrms), the spacing between points on the y-axis still remains logarithmic.

Phase Trace

Softkey: [PHASE]

The phase trace type shows the phase of the measurement defined for the active trace.

Here are some characteristics of the phase trace:

- Frequency is the x-axis.
- Phase is the y-axis, displayed in degrees or radians. Unless you specify otherwise, the analyzer will scale the y-axis at ± 180 °.
- Unwrapping begins to occur for scaling greater than 45 ° per division. To change the vertical units per division, use the <Scale> hardkey and its associated softkeys.
- Phase accuracy is reduced for signal levels that are low relative to the full scale input range.

Group Delay Trace

Softkey: [GROUP DELAY]

The group delay trace type shows the group delay for the measurement defined for the active trace. Group delay is related to phase, but shows phase delays in time (seconds, milliseconds, or microseconds) rather than degrees of phase shift.

Group delay is actually the derivative of phase (the slope) with respect to frequency. The analyzer uses a smoothing aperture to define the resolution of the group delay display – you can change the resolution by selecting different apertures. Larger apertures have more of a smoothing effect than smaller ones. You can select the following smoothing apertures:

- 0.5% of span
- 1% of span
- 2% of span
- 4% of span
- 8% of span
- 16% of span

Here are some characteristics of the group delay trace:

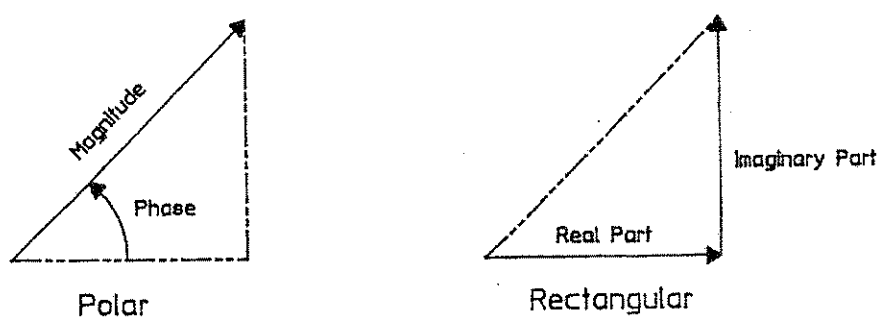
- Time is the y-axis.
- Group delay is plotted between the frequency points used to make the group delay measurement. For example, group delay for 100 Hz can be calculated by measuring the change in phase between 90 and 110 Hz. Therefore, no data is calculated for the end points of this segment (90 and 110 Hz). If you specified 90 as the start frequency, the first frequency point with any data will be 100 Hz – this means the trace will not extend to the left-hand side of the screen. This is more noticeable with larger group delay apertures.

Real and Imaginary Parts

Once an input signal is transformed from the time domain to the frequency domain, there are two ways to express values for the frequency components in each bin. One choice is to show the magnitude or phase of a component; the other is to show the real part or imaginary part of each component.

Polar Form (Magnitude and Phase). This is the most common way to characterize a frequency component. For example, when you select Log Mag and Phase as trace types, you are looking at magnitude and phase values for each frequency component. The magnitude represents the length of a vector and the phase is the angle of the vector.

Rectangular Form (Real and Imaginary parts). This is a less common way to characterize a frequency component. Still, it may be useful for some applications. For example, the imaginary part of the cross spectrum is used for acoustic intensity measurements.



The same frequency component can be expressed as a polar coordinate or a rectangular coordinate.

Real Part Trace

Softkey: [REAL PART]

The real part trace type shows the real part of the measurement defined for the active trace.

Here are some characteristics of the real part trace:

- Frequency (or time) is the x-axis.
- The real part of the active trace data is on the y-axis.
- For time record waveforms that are complex (zoomed measurements), the real part is scaled to be one-half the value of the waveform shown for real value (non-zoomed) time records.

Imaginary Part Trace

Softkey: [IMAGINARY PART]

The imaginary part trace type shows the imaginary part of the measurement defined for the active trace.

Here are some characteristics of the imaginary part trace:

- Frequency (or time) is the x-axis.
- The imaginary part of the active trace data is on the y-axis.
- If there's no imaginary data, the waveform will be a flat line, showing zero magnitude.
- For FFT data (all measurements excluding time records), the imaginary trace represents the imaginary part of the complex FFT data.
- For time waveforms, the imaginary trace represents the imaginary part of the Hilbert transform of the real part. For example, a 2 volt (peak) sine wave input in zoom mode will appear as a frequency-shifted 2 volt (peak) sine in the real part trace, and as a frequency- and phase-shifted 2 volt (peak) sine wave in the imaginary part trace.

Chapter 4
More Basics

Now that you've completed your first measurement and learned about basic measurements and trace types, it might be helpful to review some additional measurement basics. These include:

- Setting the input range
- Windowing
- Averaging
- Overlap processing
- Real-time bandwidth

Setting the Input Range

To make the best measurement possible, you should carefully consider the method you use to set the input range. You can set the input range automatically (using the autorange feature) or you can set the range manually. If you overload the current input range, an "Ovl1" or "Ovl2" message appears at the *top* of the analyzer's screen. If you exceed the analyzer's maximum range, an "OVLD" message also appears at the *bottom* of the screen.

Maximum Input Range:	27 dBVrms 30.01 dBV(peak) 22.39 Vrms 31.66 V(peak)
Minimum Input Range:	−51 dBVrms −47 dBV(peak) 2.818 mVrms 3.986 mV(peak)

The analyzer's input range extends from −51 dBVrms to +27 dBVrms.

Setting the Input Range with Autoranging

Autoranging for the HP 35660A is an "autorange up" feature. This means that when you start a measurement, the analyzer sets the input to the most sensitive range, and automatically steps through less-sensitive input ranges until the input channel is no longer overloaded.

If the input signal amplitude increases after the range is set (enough to overload the input), the analyzer will begin stepping through even less-sensitive ranges. Again, this stops when the input is no longer overloaded.

If the input signal amplitude decreases, the analyzer *will not* change to a different range. The input range will remain at the setting the analyzer found appropriate at the beginning of the measurement.

By the way, the analyzer does not autorange while averaging — so don't change the output of your test device during the averaging procedure. If an over-range condition occurs while averaging, an overload message appears but the analyzer does not abort the averaging procedure.

Setting the Range Manually

You can set the input range manually when you want to maintain a specific input range setting. Ideally, the signal peak should fall in the upper half of the currently-selected input range.

If you set the input range too low (more sensitive than necessary), the analyzer's input circuitry will introduce distortion into the measurement. But if you set the input range too high (less sensitive than necessary), the resulting loss of dynamic range will introduce additional noise — in some cases, the increase in the noise floor may even obscure low-level frequency components.

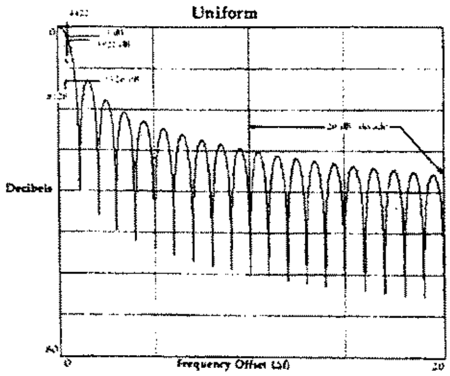
Windowing

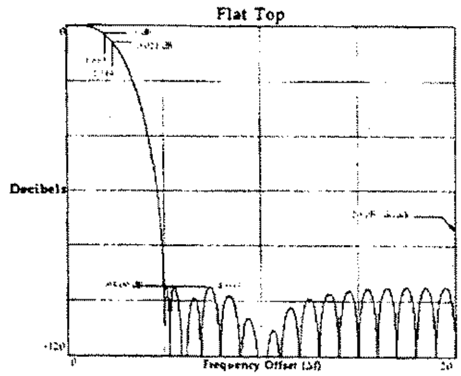
A "window" is a time-domain weighting function applied to the input signal – essentially, a way to filter out signals that are not periodic (and therefore spurious) within the input time record. Depending on the window, the analyzer attenuates certain parts of the input time record, to prevent "leakage" – a smearing of energy across the frequency spectrum, caused by transforming signals that are not periodic within the time record.

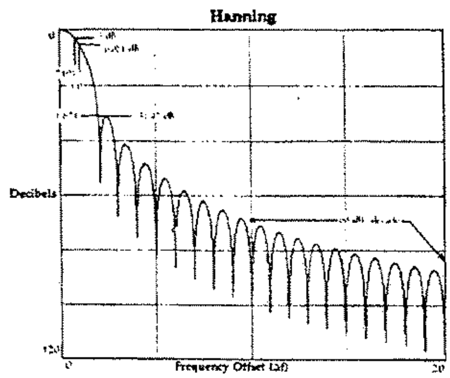
To learn more about leakage and windowing, see *Hewlett-Packard Application Note 243* (available from your local HP Sales/Service Office).

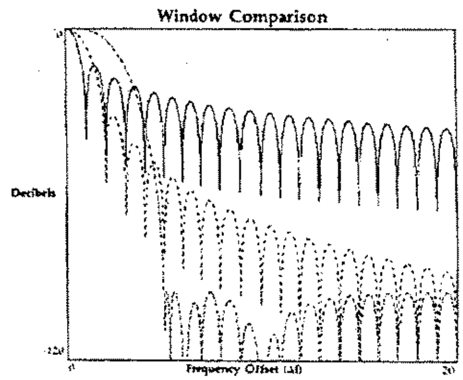
Here are the windowing functions available with the HP 35660A:

- Hanning
- Flat Top
- Uniform
- Force
- Exponential









The HP 35660A functions as if the input signal were applied to a parallel bank of 401 narrow-band filters. The drawings here show the frequency-domain response of a single filter when using Uniform, Hanning, or Flat Top windows.

The left side of each drawing represents the center of each filter. Since the filters are symmetrical, only the right side is shown (the left side is a mirror image). The horizontal axis shows the frequency offset from the center of the filter, in units of Δf — or in other words, the number of frequency bins away from the one where the filter is centered.

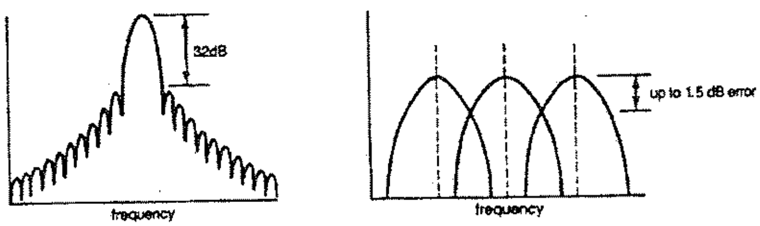
Think of each drawing as a template. If you position a sine frequency at the exact center of the filter, more of the sine wave's energy will show up at the center bin. Some of the energy will also show up in other bins. The amount of energy that spills into adjacent bins depends on the type of window you use. Notice how the Hanning window provides better frequency resolution than the Flat Top window — you can see how less energy spills into nearby bins with the Hanning window.

The Hanning Window

The Hanning window (sometimes called the Hann or Random window) attenuates the input signal at both ends of the time record. This forces the signal to appear periodic. The disadvantage of the Hanning window is some amplitude inaccuracy for sinusoidal signals (from 0 to minus 1.5 dB) compared to the Flat Top window. But its advantage is greater frequency resolution.

Here's what else you should know:

- The Hanning window is the most commonly-used window. It is particularly useful for random noise measurements.
- When you select the Hanning window, the function is applied to *both* input channels.



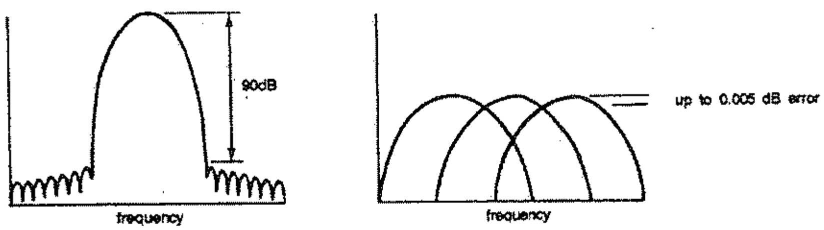
The Hanning Window

The Flat Top Window.

The Flat Top window (sometime called a sinusoidal window) compensates for the amplitude inaccuracy of the Hanning window. The flatter shape of the Flat Top window offers greater amplitude accuracy (plus or minus 0.005 dB). But the trade-off is lower frequency resolution.

Here's what else you should know:

- The Flat Top window is useful when you must measure the amplitude of a particular frequency component with great accuracy – for example, when using a fixed-sine source.
- When you select the Flat Top window, the function is applied to *both* input channels.



The Flat Top Window

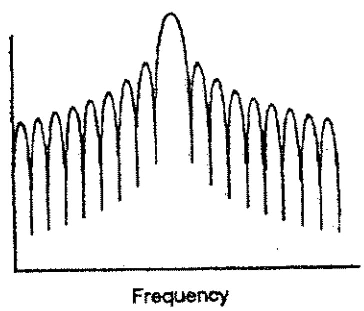
The Uniform Window

The Uniform window (sometimes called a transient window) has a rectangular shape that weights all parts of the time record equally. In other words, the Uniform window isn't really a window at all.

Because the Uniform window does not force the signal to appear periodic in the time record, it is normally used only with functions that are self-windowing, such a transients and bursts. The Uniform window has an amplitude accuracy uncertainty from 0 to minus 4.0 dB.

Here's what else you should know:

- For best results with the Uniform window, you should use signal sources that are periodic — for example, the analyzer's periodic chirp waveform.
- When you select the Uniform window, the function is applied to *both* input channels.



Uniform Window

Force Window

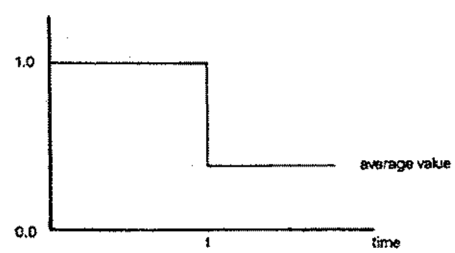
The Force window passes the first part of the time record and sets the last part to a fixed value. You can specify the width of the window, thus controlling where the fixed level begins. The width you specify determines how much of the signal is passed. Note that the width must be narrower than the time record for the force window to have any effect.

The analyzer calculates the average value of the time record's remaining data and sets the time record to this average level.

The force window is helpful in impact testing because is removes residual oscillations in lightly damped systems. It is often used with the Exponential window (see "Exponential Window").

Here's what else you should know:

- Unlike the other windows, you can apply the force or Exponential window to each channel individually. This allows you to mix the windows in measurements using both input channels, such as frequency response. This application is most commonly used when measuring properties of mechanical structures during impact testing.
- If you apply the Force window to channel 1 and the Exponential window to channel 2, the data for channel 1 is multiplied by both the Force and the Exponential windows.
- If you are using trigger delay and you want to set the force width using the marker, remember that the time record starts in negative time for pre-triggering. You may have to adjust the window width to allow for this.



The Force Window

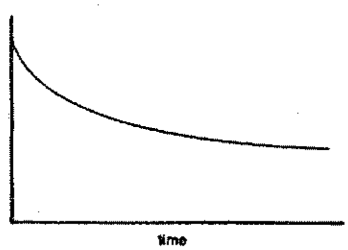
Exponential Window

The Exponential window attenuates the input signal at a decaying exponential rate determined by a specified time constant. You can enter a value between 0.1 μS and 9.99×10^6 Seconds.

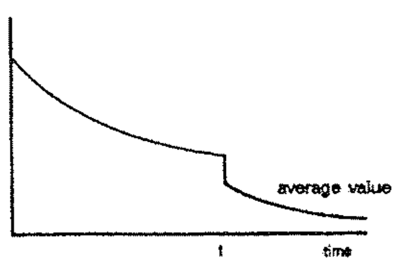
The Exponential window is often used in lightly damped systems with frequency responses that do not decay within one time record.

Here's what else you should know:

- Generally, the time constant should be set to one-fourth of the time record for the window to be effective.
- This window attenuates the input signal at a decaying exponential rate determined by the specified time constant.
- If you apply the Force window to channel 1 and the Exponential window to channel 2, the data for channel 1 is multiplied by both the Force and the Exponential windows.



The Exponential Window



The Combined Force and Exponential Windows

Type of Averaging

Although we introduced rms and vector averaging in the previous chapter, we will review these briefly and introduce some additional ways to make averaged measurements.

The HP 35660A has these types of averaging:

- Stable (normal) rms averaging
- Stable (normal) vector averaging
- Exponential averaging (either rms or vector)
- Peak hold averaging
- Fast averaging

RMS Averaging

To review, rms (power) averaging does not eliminate noise — it simply produces an approximation of the actual noise level. Increasing the number of rms averages provides a better statistical approximation of the noise, but will not actually reduce the noise.

Vector Averaging

With vector averaging, the analyzer averages complex values, point-by-point, in the frequency domain. This lowers noise because the real and imaginary components of the random signals are not in phase and therefore cancel each other — increasingly so with each average. Frequency components that are periodic do not cancel and therefore do not diminish with successive averages.

For mechanical applications, vector averaging is often used during vibration measurements to resolve low-level frequency components from background noise.

Vector averaging produces results similar to *time averaging*, a feature found on many FFT analyzers (time averaging means that the analyzer averages all time records first, then performs a single FFT on an averaged time record). Vector averaging accomplishes the same thing as time averaging, since the averaged linear spectrum derived from a series of vector-averaged linear spectra is equivalent to a single linear spectrum of time-averaged time records.

Although measurements made with vector averaging have better signal-to-noise ratios than rms averaging, there are some restrictions:

- The input signal must be periodic. In other words, the frequency components you want to measure must repeat with each time record. If these components are not periodic (not in phase with the start of each new time record), their real and imaginary values will cancel and the analyzer will not resolve these components.
- If you select vector averaging, you'll need to provide a trigger signal – from the analyzer's source or from an external signal. Of course, the analyzer will still make a measurement with continuous triggering (no trigger signal), but the amplitude of periodic signals will diminish with each successive average (since even periodic components have random phase with continuous triggering).

Exponential Averaging

You can select either rms exponential averaging or vector exponential averaging. Both work in a similar fashion. The only difference is that for vector exponential averaging, you'll need to provide a trigger signal.

Unlike stable (normal) averaging, exponential averaging weights new data more than old data. This is useful for tracking data that changes over time.

When using exponential averaging, the number of averages you select determines the weighting of old versus new data — not the total number of averages calculated. As the number of averages increases, new data is weighted less.

With exponential averaging, it's especially important to set the number of averages carefully — if there are too few averages in the measurement, the averaging will not smooth out variances. But if there are too many averages, the analyzer may not track subtle changes occurring within the data.

To calculate the exponential average, the analyzer uses this formula: $\{[(1/N)\times(\text{new})]+[((N\text{-}1)/N)\times(\text{old})]\}$, where N is a weighting factor (the number of averages you've specified).

When starting an exponential average, the analyzer sets N equal to 1 for the first analysis, then sets N equal to 2 for the second analysis, and so on — until N equals the number of averages you've specified.

Here's what else you should know:

- Once you start a measurement using exponential averaging, the measurement continues indefinitely. To stop the average, you must pause the measurement. This is different than stable averaging — stable averaging stops automatically after the specified number of averages are completed.
- For the first few averages, there's little difference between exponential averaging and stable averaging.

Peak-hold Averaging

When you request the peak-hold function, the analyzer will take data continuously, until you tell it to stop. The analyzer will compare each data point along the measured frequency span with the previous values. Only the largest values for each frequency bin will be saved.

Technically, peak-hold averaging is not really a type of averaging, since the results are not mathematically averaged. But it's still considered a type of averaging because it combines the results of several measurements into one final measurement result.

Here's what else you should know:

- With the peak-hold function, the analyzer mathematically compares each data point to its previous peak value. If the data point is larger than its last peak value, the new value is used. This is not the same thing as peak-holding the displayed trace.
- The peak-hold function works only with spectrum measurements, power spectral density (PSD) measurements, or time records.

Fast Averaging

Fast averaging is not a *type* of average. Rather, it's simply a way to have the analyzer make averaged measurements without having to update the screen after each average. You can use fast averaging with any type of averaging (rms, vector, rms and vector exponential, and peak-hold averaging).

You can specify the number of averages between screen updates for the fast average mode. If you enter an update rate of 5, for example, the analyzer will update the screen after every five averages. The update rate is important, since the number you select will affect the speed of the fast average (you can select values between 1 and 99,999).

By the way, fast averaging must be on to achieve maximum real-time bandwidths. See "Real-Time Bandwidth" later in this chapter.

Overlap Processing

As the span you select decreases, the corresponding time record length increases (see "Measurement Speed vs. Time Record Length" in Chapter 3, "Measurement Basics"). At some point, the time record length and the amount of time the analyzer needs to process each record are equal. If you continue to increase the record length, the FFT processor sits idle after processing the time record (while waiting for the next record to fill). But *overlap processing* allows you to overlap time records and compute the FFT from both previous *and* current time records.

Overlap processing offers several advantages. First of all, it lets you make a faster measurement (particularly with narrow spans). Overlap processing also reduces statistical variance caused by windowing. For a detailed discussion of overlap processing and real-time bandwidth, see *Hewlett-Packard Application Note 243* (available from your local HP Sales/Service Office).

Overlap processing is set in the < Average > menu. To specify the amount of overlap you want, use the [OVERLAP%] softkey. You can enter any value from 0 to 99%, in 1% increments.

Here's what else you should know:

- Overlap is not used if you're making triggered measurements. The analyzer must be in the continuous trigger mode.
- The amount of overlap possible varies with the frequency span. For wide spans (with short time records), little or no overlap is possible — the time record is small compared to the time it takes the analyzer to process the time record. For narrow spans (with long time records), considerable overlap is possible — the time record is long compared to the time it takes the analyzer to process the time record.
- The analyzer does not indicate the actual overlap percentage used. For example, if you specify an overlap of 90%, the analyzer will accept this value but may not actually use a 90% overlap if this is incompatible with the current frequency span.
- The analyzer will treat the overlap percentage as the maximum allowed. The actual overlap used depends on the current frequency span, the type of average selected, and how busy the analyzer is servicing the HP-IB and marker functions and key presses. The overlap percentage can change from time record to time record, but will always be less than or equal to the specified overlap percentage. If the analyzer indicates that the current measurement is in real time and the overlap percentage falls below 0%, the REAL TIME status message will be removed (if you're averaging and this occurs, no attempt will be made to re-enter real time until you start the average again — if averaging is off, real time processing will resume as soon as possible).

Real-Time Bandwidth

Overlap processing is easy to understand if you relate it to real-time bandwidth (RTBW). Real-time bandwidth is a specification used to characterize the performance of an FFT analyzer. The real-time bandwidth is the frequency span at which the FFT processing time equals the time record length – this means all input data is included in the average (in other words, there is no gap between the end of one time record and the beginning of the next). However, if you increase the span past the real-time bandwidth, the record length becomes shorter than the FFT processing time. Time records are no longer contiguous, and some input data is missed. Therefore, you can overlap records only when measuring below the real-time bandwidth, because the time record length must be longer than the FFT processing time to achieve any overlap.

The actual real-time bandwidth achieved varies with the amount of processing time the analyzer needs. As with overlap processing, this depends on the current frequency span, the type of average selected, and how busy the analyzer is servicing the HP-IB and marker functions and key presses. The following table shows typical real-time bandwidth for the HP 35660A:

	One-channel mode	Two-channel mode
Averaging Off	800 Hz span	400 Hz span
Fast Averaging	3.2 kHz span	1.6 kHz span

Typical Real-Time Bandwidths

Chapter 5
Spectral Purity of a Sine Wave

Task Overview — This chapter steps you through a series of measurements to characterize the spectral purity of a sine wave.

What you will need — gather the following items before starting this task:

- A connecting cable (BNC male to BNC male)

What you will measure — you will use the analyzer to do the following:

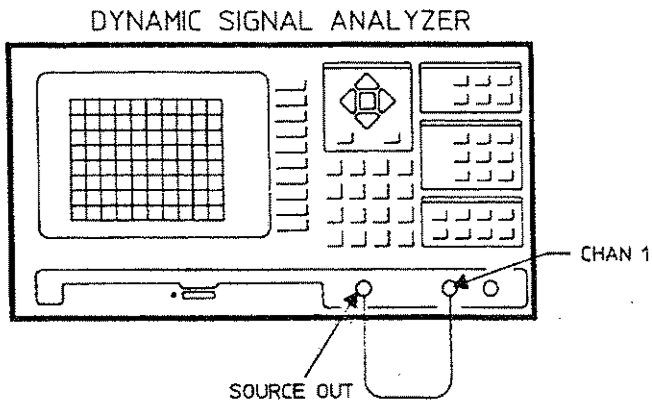
- Look for prominent harmonics of the fundamental frequency
- Measure Total Harmonic Distortion (THD)

What you will learn — In this chapter, you will be introduced to the following analyzer functions:

- Viewing a spectrum to reveal a fundamental frequency and its harmonics
- Setting the proper input range
- Selecting an appropriate scale
- Using the absolute marker, the offset marker, and the harmonic distortion marker

PART 2: Spectrum Measurements

Measurement Setup



As you step through the following task, you may find that your measurement results differ slightly from those shown here. Keep in mind that the tasks are designed to help you learn about the analyzer — not to duplicate specific measurement results.

1. If you've already turned on the analyzer, press < Preset >.

   If the analyzer is off, turn it on and wait until it warms up and calibrates. Then press < Preset >.

   Pressing < Preset > returns most of the analyzer settings to the default positions.

2. Connect the analyzer's source to the Channel 1 input.

   You do not need to terminate the analyzer's source, since the output impedance is less than 5Ω.

   The analyzer's input channels have an impedance of 1 MΩ.

   In the example here, you are using the analyzer's internal source as the test device. However, to test external signal sources designed to operate into a specific load (such as an oscillator with a 600Ω output), you must place an appropriate feedthrough terminator across the output of the test device.

3. Press < Source >

   [SOURCE ON/OFF]

   [FIXED SINE]

   This turns on the analyzer's internal source and selects the fixed sine wave.

4. Press [SINE FREQ ENTRY]

   < 1 > [kHz]

   This sets the sine frequency to 1 kHz.

5. Press [LEVEL]

   < 2 > [Vrms]

This sets the level of the sine wave to 2 Vrms.

6. Press < Input >

   [CHANNEL 1 AUTORANGE]

   This makes sure the input range is set correctly.

The default setting for the input is an "autorange up" feature. "Autorange up" means that when you start a measurement, the analyzer sets the input to the most sensitive range, and automatically steps through less-sensitive input ranges until the input channel is no longer overloaded. You'll see an "Auto-Ranging" message in the upper left corner of the screen.

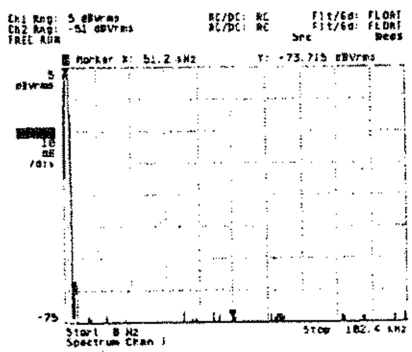
If the input signal amplitude increases after the range is set (enough to overload the input), the analyzer will begin stepping through even less-sensitive ranges. Again, this stops when the input is no longer overloaded.

If the input signal amplitude decreases, the analyzer *does not* change to a different range. The input range will remain at the setting the analyzer found appropriate at the beginning of the measurement.

If you *decrease* the output of your test signal during the measurement, you'll have to press < Input > and then press [CHANNEL 1 AUTORANGE].

7. Now look at the analyzer's screen. This is a display of the linear spectrum.

   This display appears in frequency domain.



Since this is a full span (0 to 102.4 kHz), the relatively low frequency of the signal (1 kHz) is at the extreme left of the display.

Because averaging is off, you will see the display change several times each second. Each display represents one FFT of a single time record.

8. Press < Meas Data >

   [TIME CHANNEL 1]

You are now viewing each time record as the analyzer acquires a new one.

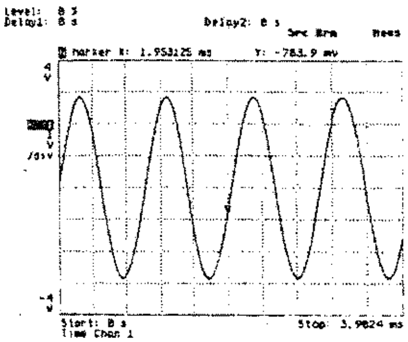
This is the time domain representation of the input data — that's why it looks like an oscilloscope trace.

Notice how the time record jitters. This is because the analyzer's trigger is set to continuous (the default condition). This means the analyzer will process time records as quickly as possible, without waiting for any kind of trigger signal.

Also note how some of the softkeys are de-emphasized. This means that these menu selections are not currently active. For example, [FREQUENCY RESPONSE] is a two-channel measurement and is not available right now because the analyzer is in the single-channel mode.

9. Press < Trigger >

    [CHANNEL 1 TRIGGER]



Notice how the time display becomes stable. With input triggering, the analyzer (when ready) does not begin a new measurement until the input signal reaches the predetermined trigger level.

The trigger level ranges from −100% to 100% of the input range (don't confuse this with the vertical units shown on the current display). The default value is 0% with a positive slope — this means the analyzer will trigger when the input signal crosses zero as the signal moves from negative to positive.

For now, it's not important to understand everything about triggering — but you should take comfort knowing that most of the analyzer's triggering features are similar to those found on standard oscilloscopes. To learn more about the analyzer's triggering capabilities, see the *HP 35660A Front-Panel Reference*.

10. Press < Meas Data >

    [SPECTRUM CHANNEL 1]

This returns you to the frequency domain.

11. Press < Freq >

    Press [SPAN]

    Now use the < ⇩ > hardkey to step through several spans.

The < ⇩ > and < ⇧ > hardkeys are located in the numeric keypad.

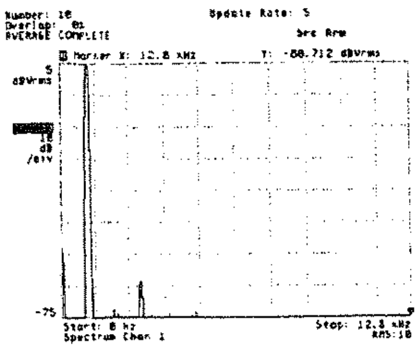
12. Stop when you reach 12.8 kHz — if you step down too far, simply use the < ⇧ > hardkey to go back up to a 12.8 kHz span.

This changes the frequency span and lets you look at a smaller slice of the frequency spectrum. This gives a better view of the fundamental and its harmonics.

You can also use the numeric keypad to specify a span (the analyzer takes the nearest acceptable value).

13. Press < Average >

[AVERAGE ON/OFF]



Note how the word "ON" in this softkey label highlights when averaging is on.

The default averaging is rms averaging (with ten averages). For now, this is the type of averaging you will use.

You are now looking at the averaged power spectrum. You can see the fundamental frequency and its harmonics. Because the span is large (full span), most of the harmonics are grouped at the left side of the display.

By the way, the analyzer does not autorange while averaging — so don't change the output of your test device (in this case, the analyzer's internal source) during the averaging procedure. If an over-range condition does occur while averaging, an overload message appears but the analyzer does not abort the averaging procedure.

13a. If you don't see any harmonics, press < Input >.
[CHANNEL 1 RANGE]
Then press < ⇩ > twice.

This intentionally overloads the analyzer's input to simulate a source with prominent harmonics.

14. Press < Start >

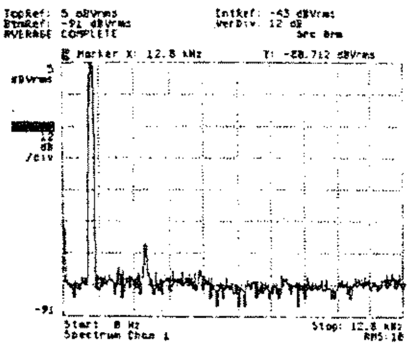
Note how another averaged measurement begins.

If you press < Pause/Cont > instead of < Start >, the analyzer makes another averaged measurement but adds the averages to the previous group of averages.

15. Press < Scale >

    [VERTICAL/DIV]

    < 1 > < 2 > [dB].



The display should now look like this. You changed the vertical scaling from 10 to 12 dB per division to see both the noise floor and the peak of the fundamental.

16. Press [AUTO SCALE]

Autoscaling means the analyzer automatically selects an appropriate scale for the input signal.

Alternatively, you could have pressed [VERTICAL/DIV] and entered the original scaling — in this case, 10 dB per division.

17. Press [VERTICAL/DIV]

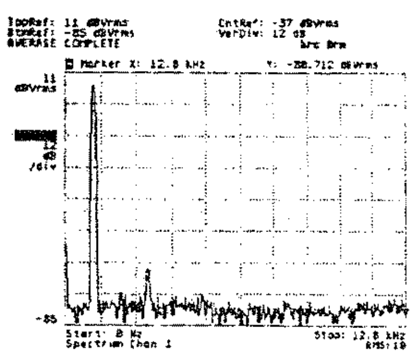
    < 1 > < 2 > [dB].

It's convenient to see the noise floor, so you can leave the vertical scale at 12 dB per division.

18. Press [TOP REFERENCE]

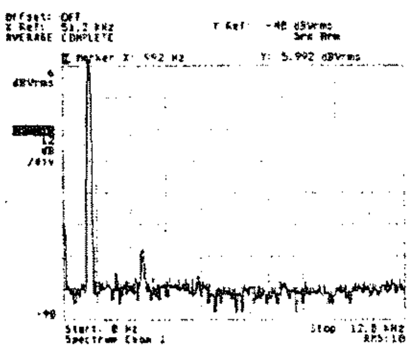
    Now use the < ⇩ > and < ⇧ > hardkeys to shift the entire display up or down.

See how easy it is to adjust the display to your liking?



19. Press < Marker >

[MARKER TO PEAK]



This moves the marker to the largest frequency component on the display (in this case, the fundamental.)

The marker you are using is an absolute marker. That is, it indicates the absolute x-axis and y-axis coordinate. There's also an offset marker — but you'll learn about that in a few moments.

The analyzer says that the x-axis marker value is 992 Hz. Remember, the analyzer's frequency resolution changes with the frequency span you've selected. For the current span (12.8 kHz), the resolution is 32 Hz. Soon you will change to a smaller span to get better resolution.

20. Note the amplitude value indicated by the marker's y-axis position.

This shows the absolute amplitude of the fundamental. In this case, the y-axis marker value indicates about 6 dBVrms (2 Vrms).

While absolute amplitude values are useful, *relative* amplitude values are more important when characterizing the spectral purity of a signal source.

21. Make sure the marker is at the fundamental frequency. If it isn't, press [MARKER TO PEAK] again.

Press < Freq >

[CENTER]

< Marker Value >

Don't worry if nothing seems to be happening. The analyzer is simply waiting to start a new average.

Pressing < Marker Value > specifies the current marker value (in this case, the fundamental frequency) as the center frequency for the new span that you've about to enter.

The < Marker Value > hardkey is convenient, because it lets you enter numeric values quickly without using the numeric keypad.

Pressing < Marker Value > enters the x-axis, y-axis, or both values for the marker's current position.

If the analyzer needs an x-axis value, pressing < Marker Value > enters the x-axis value. If the analyzer needs a y-axis value, pressing < Marker Value > enters the y-axis value. If the analyzer needs both values, pressing < Marker Value > enters both.

22. Press [SPAN]

Now use the numeric keypad or the < ⇩ > hardkey to specify a 100 Hz span.

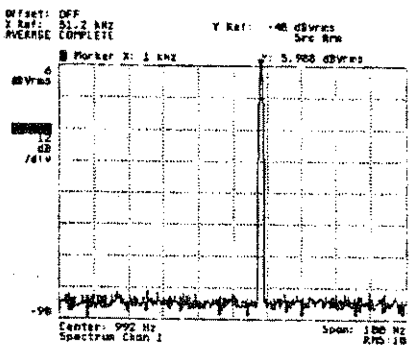
< Start >

After pressing < Start >, you'll have to wait a for the time record to fill. But don't worry — the "Rec Lg" message at the top of the screen indicates how long it takes to fill the time record (in this case, 4 seconds).

Another message appears every few moments indicating time remaining to fill the time record.

23. Press < Marker >

[MARKER TO PEAK]



After the first results are displayed, you can go ahead and check to see if the frequency resolution has improved. It's not necessary to wait for the analyzer to finish taking averages. You can use the marker during the averaging process.

The marker now indicates 1 kHz. This is a better approximation of the exact frequency.

24. Press < Freq >

[SPAN]

< 3 > [kHz]

This changes the span to more easily view the fundamental and the third harmonic.

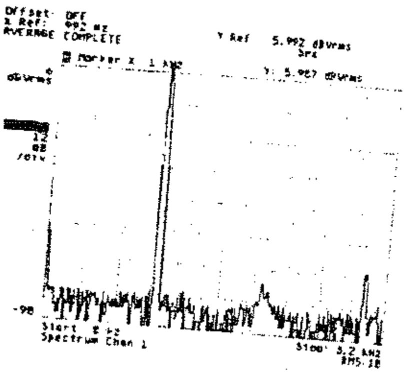
When you specified the span, notice how the analyzer changed your numeric entry (3 kHz) to the nearest acceptable value (3.2 kHz).

Press [ZERO START] to start the span at 0 Hz again.

Press < Start > to begin a new measurement.

25. Press < Marker >

[MARKER TO PEAK]

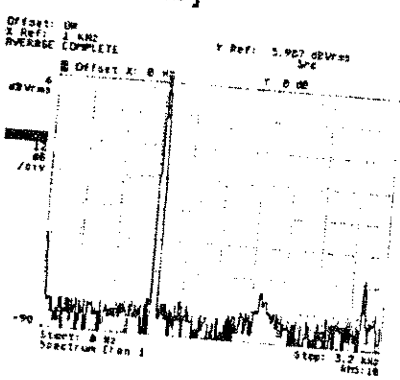


This ensures that the marker is at the fundamental frequency.

26. Press [OFFSET]

Press [OFFSET ON/OFF] to turn on the offset marker.

[OFFSET ZERO]



You've just turned on the offset marker, and zeroed it where the marker was. You will use the offset marker to find the amplitude and frequency of a harmonic relative to the fundamental.

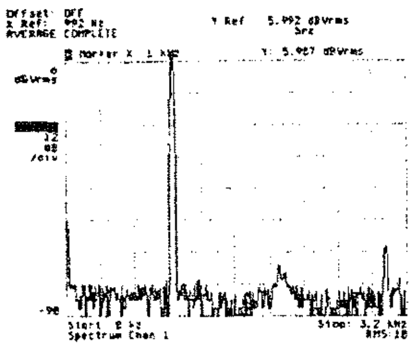
On some analyzers, the offset marker is called a "relative marker."

Zeroing the offset marker at the fundamental frequency establishes the peak of the fundamental as a reference point for both x-axis and y-axis marker values. As long as the offset marker is on, both marker values will indicated the amount of offset from the zeroed point (in this case, the peak of the fundamental).

Until you reset the offset marker at another point, the zero position remains where you set it, even if you turn the offset marker off and then back on again. But the zero position will be lost if you press < Preset > or turn the analyzer off.

25. Press < Marker >

[MARKER TO PEAK]

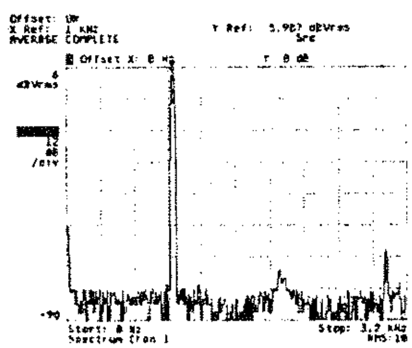


This ensures that the marker is at the fundamental frequency.

26. Press [OFFSET]

Press [OFFSET ON/OFF] to turn on the offset marker.

[OFFSET ZERO]



You've just turned on the offset marker, and zeroed it where the marker was. You will use the offset marker to find the amplitude and frequency of a harmonic relative to the fundamental.

On some analyzers, the offset marker is called a "relative marker."

Zeroing the offset marker at the fundamental frequency establishes the peak of the fundamental as a reference point for both x-axis and y-axis marker values. As long as the offset marker is on, both marker values will indicated the amount of offset from the zeroed point (in this case, the peak of the fundamental).

Until you reset the offset marker at another point, the zero position remains where you set it, even if you turn the offset marker off and then back on again. But the zero position will be lost if you press < Preset > or turn the analyzer off.

22. Press [SPAN]

Now use the numeric keypad or the < ⇩ > hardkey to specify a 100 Hz span.

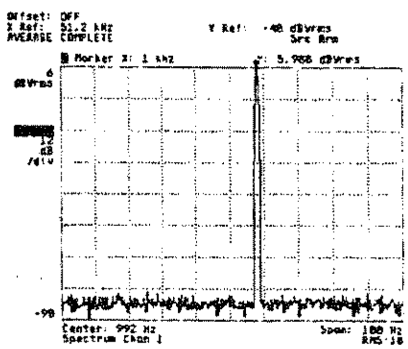
< Start >

After pressing < Start >, you'll have to wait a for the time record to fill. But don't worry — the "Rec Lg" message at the top of the screen indicates how long it takes to fill the time record (in this case, 4 seconds).

Another message appears every few moments indicating time remaining to fill the time record.

23. Press < Marker >

[MARKER TO PEAK]



After the first results are displayed, you can go ahead and check to see if the frequency resolution has improved. It's not necessary to wait for the analyzer to finish taking averages. You can use the marker during the averaging process.

The marker now indicates 1 kHz. This is a better approximation of the exact frequency.

24. Press < Freq >

[SPAN]

< 3 > [kHz]

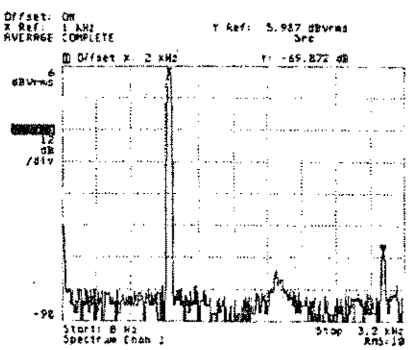
Press [ZERO START] to start the span at 0 Hz again.

Press < Start > to begin a new measurement.

This changes the span to more easily view the fundamental and the third harmonic.

When you specified the span, notice how the analyzer changed your numeric entry (3 kHz) to the nearest acceptable value (3.2 kHz).

27. Press the < ▲ > hardkey several times, until the marker indicates an offset of 2 kHz.



This moves the marker to the third harmonic.

The < ▲ > hardkey is the unlabeled key shaped like an up arrow in the MARKER group of front-panel keys.

Pressing < ▲ > jumps the marker to the next big peak to the right. Pressing < ▼ > is similar, but jumps the marker to the left.

You can also use the < ◄ > and < ► > keys to move the marker. But that takes longer, since the marker steps through each "bin" at a time. Or you could use < ◄ > and < ► > with the < fast > hardkey to move the marker faster.

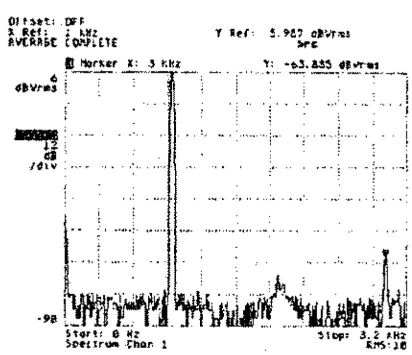
28. Note the frequency value indicated by the offset marker's x-axis position.

This value (actually the offset from the fundamental) is about 2 kHz. Not surprising, since the third harmonic should be offset from the fundamental by twice the fundamental's frequency.

29. Note the amplitude value indicated by the offset marker's y-axis position.

This value is about −70 dBVrms, referenced to the fundamental frequency's amplitude. In other words, the third harmonic is about 70 dB below the fundamental.

30. Press [OFFSET ON/OFF]



This turns off the offset marker. Notice how the marker values now reflect the absolute frequency of the third harmonic (3 kHz) and the absolute amplitude as well.

31. Press < Freq >

    [SPAN]

    < 1 > < 2 > [kHz]

Before measuring Total Harmonic Distortion (THD), let's change to a larger span. That way, you can see more harmonics.

32. Press < Average >

    [NUMBER AVERAGES]

    Now use the numeric keypad to specify 25 averages.

    [ENTER]

Because the analyzer is set for rms averaging, taking more averages produces a better approximation of rms values. Using more averages also provides a cleaner noise floor.

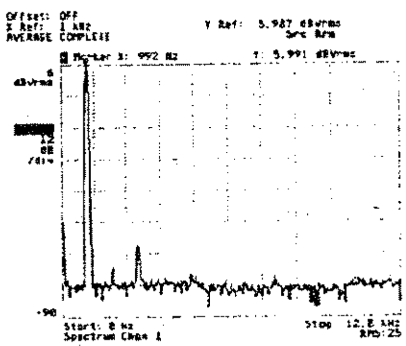
33. Press < Start >

    < Marker >

    [MARKER TO PEAK]

This begins another measurement and moves the marker to the fundamental frequency.

You can use either [MARKER TO PEAK] or the < ▼ > < ▲ > keys to move the marker.



34. Press < Marker Fctn >

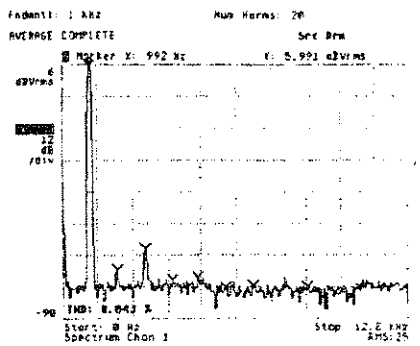
    [HARMONIC]

    [FNDMNTL FREQ]

    < 1 > [kHz]

You have to specify the fundamental frequency for the analyzer to make the distortion calculation.

Once you enter the fundamental frequency, the analyzer starts the distortion calculation. The distortion results appear at the lower left corner of the screen. Our test signal shows about 0.04% THD.



Note how the harmonic markers appear over the harmonic frequencies. Also note the "Num Harms" message that appears at the top of the screen — this indicates the number of harmonics the analyzer used to calculate THD. Because you didn't specify a number, the analyzer used the default value of 20 harmonics (sometimes only five or ten harmonics are necessary).

The THD results reflect the harmonics found in the current frequency span. The number of harmonics you specify is the *maximum* number the analyzer will use in the THD calculation. For example, if you press [DEFINE NUM HARM] and enter 10 harmonics, the THD calculation will not include all 10 harmonics if some of these harmonics are out of the range of the current span.

The analyzer calculates THD by comparing the energy of the fundamental to the energy at the harmonics. Noise and other signals at other points along the frequency spectrum are not taken into account (unless they happen to occur at the fundamental frequency or at the harmonics). This is different than older distortion analyzers that simply rejected the fundamental frequency and measured any remaining energy as harmonic distortion (more accurately, harmonic distortion plus noise).

35. Press [DEFINE NUM HARM]

< 1 > [ENTER]

The THD measurement varies with the number of harmonics used for the distortion calculation.

Note how the THD reading is lower — about 0.01% — because the analyzer is only using the fundamental and the second harmonic to make the calculation.

Chapter 6
Amplifier Noise Level

Task Overview – This chapter steps you through a noise measurement for a typical audio-frequency amplifier.

What you will need – gather the following items before starting this task:

- Audio-frequency amplifier
- Feedthrough terminator to match output impedance of the amplifier
- Appropriate connecting cables

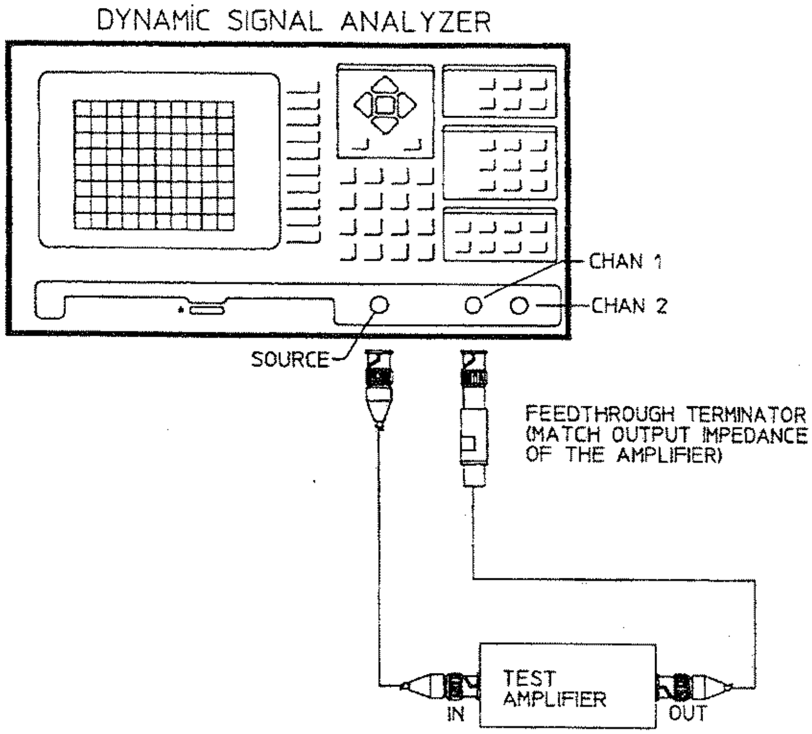
What you will measure – In this chapter, you will learn how to make these measurements:

- Wide-band noise
- Power Spectral Density (PSD) to obtain noise values normalized to a 1 Hz bandwidth
- Signal-to-noise ratios using both wide-band noise and PSD

What you will learn – In this chapter, you will be introduced to the following analyzer functions:

- Viewing a spectrum to reveal noise
- Using the band marker to calculate power within a specific frequency band
- Using the Power Spectral Density (PSD) measurement

Measurement Setup



As you step through the following task, you may find that your measurement results differ slightly from those shown here. Keep in mind that the tasks are designed to help you learn about the analyzer – not to duplicate specific measurement results.

1. If you've already turned on the analyzer, press < Preset >.

   If the analyzer is off, turn it on and wait until it warms up and calibrates. Then press < Preset >.

   Pressing < Preset > returns most of the analyzer settings to the default positions.

2. Connect the analyzer's source to the input of your test amplifier.

   The test device for this example is a typical audio-frequency amplifier.

3. Connect the output of the amplifier to the analyzer's channel 1 input.

   To make a noise measurement valid for typical operating conditions, place an appropriate terminating resistor across the amplifier's output.

4. Press < Source >

   [SOURCE ON/OFF]

   [FIXED SINE]

   This turns on the analyzer's internal source and selects the fixed sine wave.

5. Press [SINE FREQ ENTRY]

   < 1 > [kHz]

   This sets the sine frequency to 1 kHz.

6. Press [LEVEL]

   < . > < 1 > [Vrms]

   This sets the output of the analyzer's source to 0.1 Vrms.

   When making signal-to-noise measurements, you should set the output of the analyzer's source to a level that simulates the typical operating conditions for the amplifier under test. In this example, we used 100 mVrms.

   Your test amplifier may require a different input level. If so, use the numeric keypad to specify a different level for the analyzer's source.

7. Press < Input >

   [CHANNEL 1 AUTORANGE]

This ensures that the input range is set correctly.

8. Press < Scale >

   [AUTO SCALE]

It's often necessary to press [AUTO SCALE] after each measurement. This provides the best display for each trace.

This autoscales the display.

9. Press [VERTICAL/DIV].

   < 1 > < 2 > [dB]

For signal-to-noise measurements, you should view both the noise floor and the peak of the test frequency.

In this example, we used a vertical scale of 12 dB per division. You can use a different scale if it's more convenient.

10. Press < Average >

    [NUMBER AVERAGES]

    < 2 > < 5 >

    [ENTER]

    [AVERAGE ON/OFF]

This turns on averaging and selects 25 rms averages.

The default setting is for 10 rms averages — but for noise measurements, using 25 (or even 50) averages provides a better approximation of the actual rms noise level.

11. Press < Freq >

    [SPAN]

    < 2 > < 5 > [kHz]

This selects a span of 25.6 kHz.

12. Press < Marker >

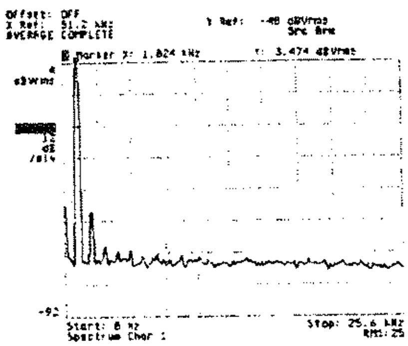
[MARKER TO PEAK]

Note the amplitude value indicated by the marker's y-axis position.

This moves the marker to the 1 kHz test frequency.

Write down the absolute amplitude of the test frequency — you will need it to make the first signal-to-noise measurement.

In this example, the amplitude of the test signal is about 4 dBVrms.



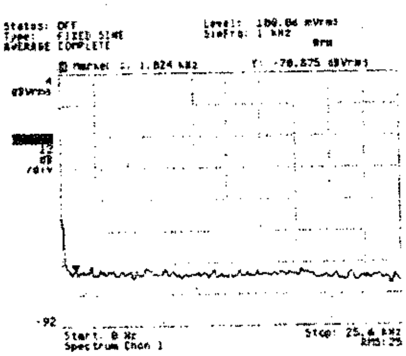
13. Press < Source >

[SOURCE ON/OFF]

This turns off the test signal.

14. Press < Start >

This starts another measurement — but this time, without the 1 kHz test signal.



15. Press < Marker Fctn >

    [BAND]

    [DEFINE LEFT FREQ]

    < 2 > < 0 > [Hz]

    [DEFINE RIGHT FREQ]

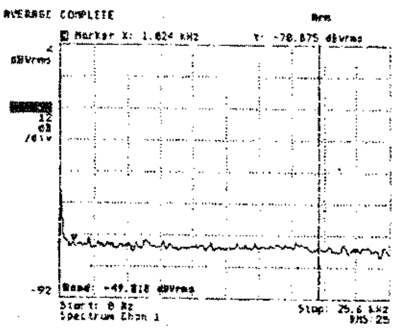
    < 2 > < 0 > [kHz]

    [RETURN]

This turns on the band marker and defines the left edge of the band at 20 Hz and the right edge at 20 kHz. The band marker measures the total energy within the specified frequency band.

One way to measure signal-to-noise is to compare the level of the test signal to the amplifier's wide-band noise. Wide-band noise is usually defined as the total rms noise within the amplifier's 3 dB bandwidth — but for audio measurements, a standard bandwidth of 20 Hz to 20 kHz is often used. In this example, we used this standardized bandwidth because we didn't know the actual 3 dB bandwidth.

16. Note the band marker value in the lower left-hand corner of the screen.



This is the rms value of the wide-band noise.

In this example, the absolute value of the wide-band noise is −50 dBVrms.

17. Subtract the level of the test signal from the wide-band noise.

    Discard the minus sign from the final result.

This gives you the amplifier's signal-to-noise ratio.

In this example, we subtracted 4 dBVrms, or a signal-to-noise ratio of 54 dB.

To be more precise, the test amplifier has a signal-to-noise ratio of 54 dB, using a 100 mV, 1 kHz test signal referenced to wide-band noise.

18. Press [OFF]

This turns off the band marker.

19. Press < Meas Data >

[PSD CHANNEL 1]

This selects the PSD measurement (Power Spectral Density).

20. Press < Source >

[SOURCE ON/OFF]

This again turns on the analyzer's internal source.

Notice when you turned on the source, the analyzer retained the settings you used previously. You don't have to re-enter the sine frequency or the output level.

21. Press < Start >

This begins another measurement. You may have to readjust the vertical scale to see the noise floor. For example, 12 dB/division.

22. Press < Marker >

[MARKER TO PEAK]

This moves the marker to the 1 kHz test frequency.

23. Press [OFFSET]

[OFFSET ON/OFF]

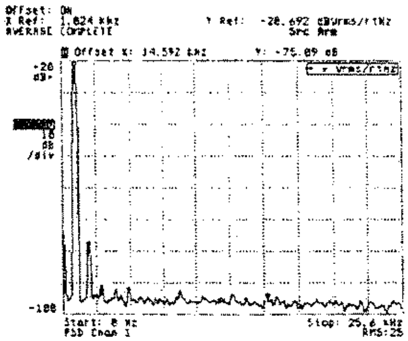
[OFFSET ZERO]

[RETURN]

This turns on the offset marker and zeros it at the test frequency.

24. Press the < ▶ > until the marker moves to a typical point on the noise floor.

    Note the amplitude value indicated by the offset marker's y-axis position.



The offset marker shows the relative amplitude between the test signal and a particular point on the noise floor. Remember that with PSD measurements, amplitude values are normalized to a 1 Hz wide bandwidth. (See Chapter 3, Measurement Basics).

In this example, the signal-to-noise ratio is about 75 dB.

The test amplifier now seems to have less noise (the previous measurement indicated a signal-to-noise ratio of 54 dB). That's because you are now measuring the test signal to only one point on the noise floor — not the combined noise of a larger frequency band (as you did when measuring wide-band noise).

Measuring signal-to-noise with PSD does not take into account wide-band noise. But, since all analyzers that measure PSD are standardized to measure with a 1 Hz resolution, PSD may be preferable in cases where you want standardized, repeatable noise measurements.

Chapter 7
Characterizing Acoustic Noise

Task Overview – This chapter steps you through a typical acoustic noise measurement for rotating machinery. Although this particular measurement shows how to pinpoint the frequency of a rotating fan blade, the principles shown are common to other acoustic measurements.

What you will need – gather the following items before starting this task:

- Microphone
- Impedance-matching transformer (if using a low-impedance microphone)
- Appropriate connecting cables

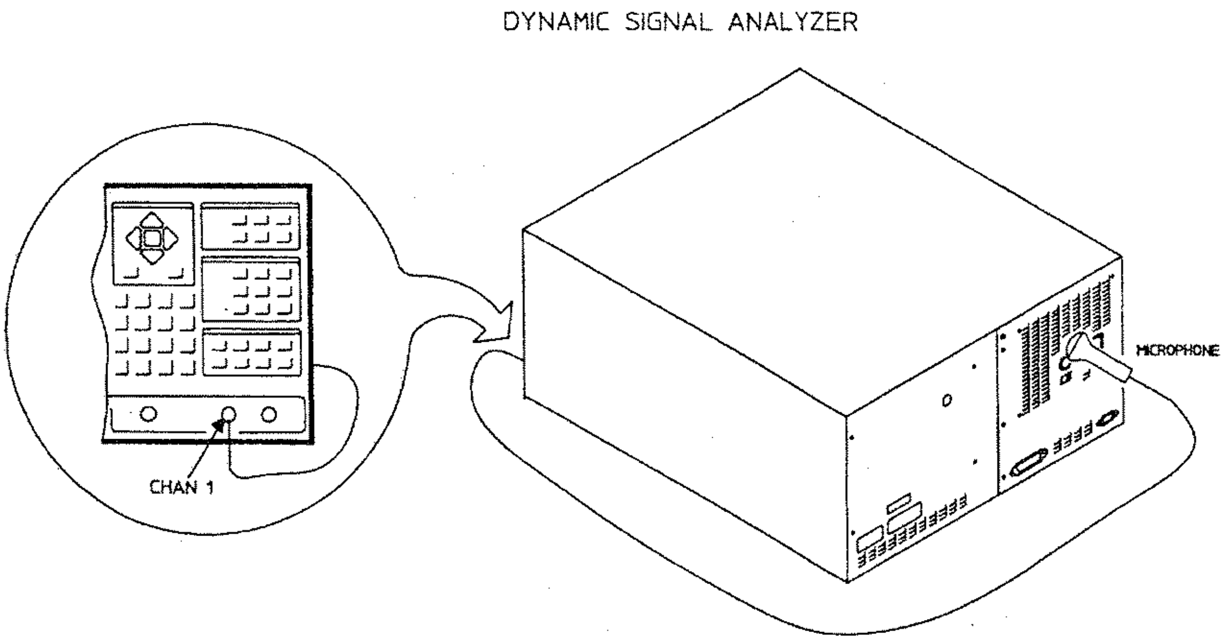
What you will measure – In this chapter, you will learn how to make these measurements:

- Power Spectrum to characterize acoustic noise (in this case, the noise from the analyzer's fan)

What you will learn – In this chapter, you will be introduced to the following analyzer functions:

- Creating a label for the displayed trace

Measurement Setup



As you step through the following task, you may find that your measurement results differ slightly from those shown here. Keep in mind that the tasks are designed to help you learn about the analyzer – not to duplicate specific measurement results.

1. If you've already turned on the analyzer, press < Preset >.

   If the analyzer is off, turn it on and wait until it warms up and calibrates. Then press < Preset >.

   Pressing < Preset > returns most of the analyzer settings to the default positions.

2. Connect the microphone to the channel 1 input.

   The impedance match between the microphone and the analyzer is not critical for this particular measurement.

   If you're using a high-impedance microphone, you can connect it directly to the analyzer's input.

   But if you're using a low-impedance microphone, you may have to use a low-to-high impedance matching transformer.

3. Place the microphone near the analyzer's rear panel, at the fan exhaust.

   Make sure you find a place where the fan noise is loudest.

4. Press < Input >

   [CHANNEL 1 AUTORANGE]

   This makes sure the input range is set correctly.

   You may have to autorange several times while setting up this measurement task — especially if you handle the microphone roughly or knock it against a hard surface.

5. Press < Freq >

   [SPAN]

   < 4 > < 0 > < 0 > Hz

   You will need a relatively small span to resolve fan noise from the ambient noise.

6. Press < Average >

   [AVERAGE ON/OFF]

   [NUMBER AVERAGES]

   Now use the numeric keypad to specify 25 averages.

   [ENTER]

   This turns on averaging and selects 25 rms averages.

   The default setting is for 10 rms averages — probably not enough averages for the type of measurement. Increasing to 25 averages should be sufficient.

7. Press < Scale >

   [AUTO SCALE]

   This autoscales the trace.

8. Press < Marker >

   [MARKER ON/OFF]

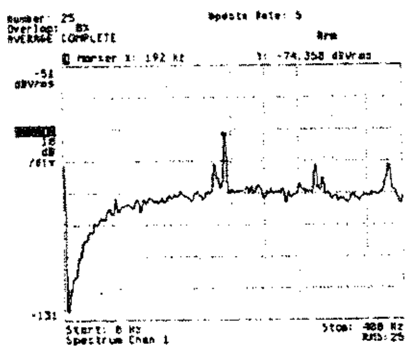
   [MARKER TO PEAK]

   Note the value indicated by the marker's x-axis position.

This turns on the marker and move the marker to the peak of the spectrum.

The peak should be around 200 Hz. There may be other noise components, but the largest one is the fundamental frequency of the rotating fan.

The magnitude of the peak is not important for this measurement.



9. Multiply the fundamental frequency by 60. Then divide this number by 5 (the number of fan blades).

This converts the fundamental frequency from Hz (cycles per second) to cycles per minute.

In our example, the fundamental frequency was 192 Hz, therefore :

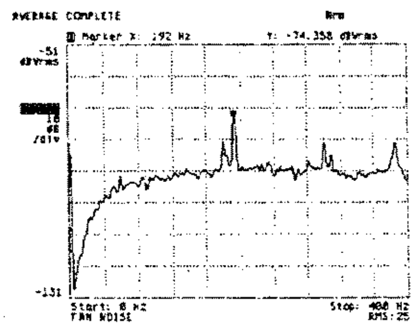
$$\frac{192 \times 60}{5} = 2304 \quad \text{(revolutions per minute)}$$

10. Press < Format >

    [TRACE TITLE]

    Then use both numeric and alpha-shifted keys to enter an appropriate trace title.

    [ENTER]



This lets you label a display trace.

After pressing [TRACE TITLE], the analyzer automatically shifts certain hardkeys to alpha entry keys (note the alpha characters engraved on the front panel below these hardkeys).

If you make a mistake, you can use the appropriate edit softkeys to fix the title. You can also specify uppercase or lowercase letters.

After pressing [ENTER], the analyzer automatically returns the alpha-shifted hardkeys to their normal functions.

PART 3: Network Measurements

Chapter 8
Filter Characterization

Task Overview — This chapter steps you through a series of measurements to characterize the performance of a band-pass filter.

What you will need — gather the following items before starting this task:

- 1 kHz Band-pass filter (individual filter or graphic equalizer)
- Feedthrough terminator to match output impedance of filter (if necessary)
- Appropriate connecting cables and BNC "T" adapter

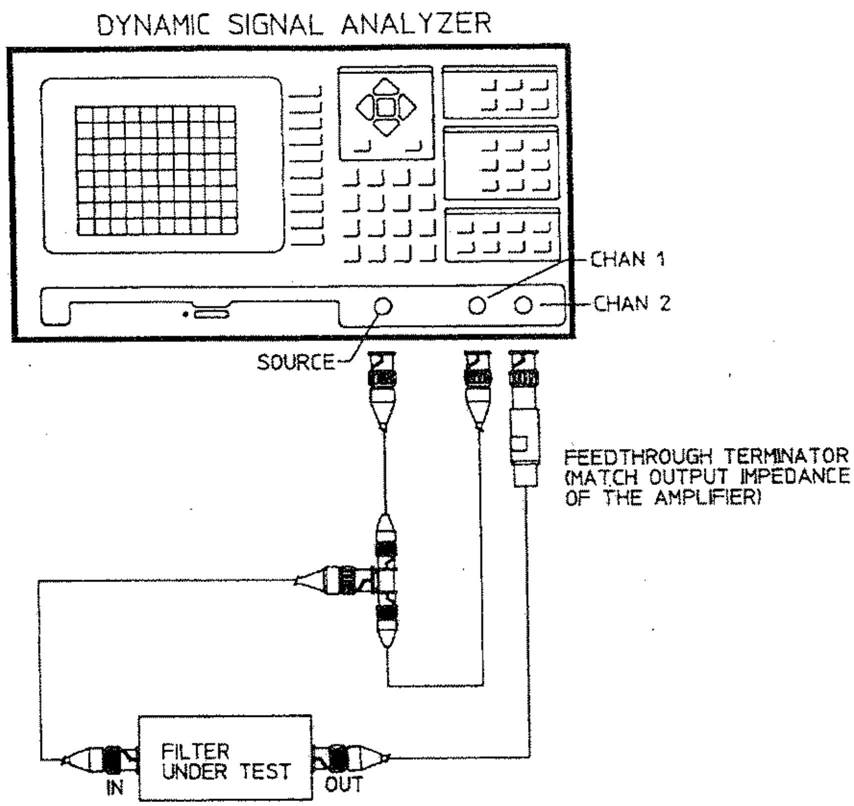
What you will measure — you will learn how to make these measurements:

- Frequency response (shape of filter)
- Resonant and passband frequencies
- Insertion loss
- Phase

What you will learn — In this chapter, you will be introduced to the following analyzer functions:

- Making frequency response measurements
- Viewing phase information
- Using different display formats
- Switching between the linear and logarithmic x-axis
- Using the marker search feature

Measurement Setup



As you step through the following task, you may find that your measurement results differ slightly from those shown here. Keep in mind that the tasks are designed to help you learn about the analyzer — not to duplicate specific measurement results.

1. If you've already turned on the analyzer, press < Preset >.

   If the analyzer is off, turn it on and wait until it warms up and calibrates. Then press < Preset >.

   Pressing < Preset > returns most of the analyzer settings to the default positions.

2. Place a BNC "T" adapter on the channel 1 input connector.

   Connect the analyzer's source to one side of the "T." Then connect the other side of the "T" to the input of the filter.

   Connect the output of the filter to the channel 2 input. If necessary, terminate the filter's output.

   To make network measurements, the analyzer's source is routed to both the input of the device and to the analyzer's channel 1 input. The output of the test device is always connected to channel 2.

   In the example here, the test device has an output impedance of 10 kΩ. So to best characterize the filter, you should place a 10 kΩ feedthrough terminator on its output.

3. Press < Meas Type >

   [2 CHANNEL 51.2 kHz]

   This places the analyzer into the two-channel mode. Now you can make network measurements (or two-channel spectrum measurements) from DC to 51.2 kHz.

4. Press < Source >

   [SOURCE ON/OFF]

   [PERIODIC CHIRP]

   [LEVEL]

   < 1 > [Vrms]

This turns on the analyzer's internal source, selects the periodic chirp waveform, and sets the output to 1 Vrms.

The periodic chirp is a fast sine sweep over the current frequency span that repeats with the same period as the time record. Because it's periodic within the time record, no windowing is required.

The periodic chirp can characterize non-linearities because the device under test is excited in exactly the same manner every time record, and the nonlinear distortion averages to its mean value (it does not average to zero).

The periodic chirp is similar to the analyzer's random noise waveform, but the periodic chirp has a much higher rms-to-peak ratio.

5. Press < Input >

   [CHANNEL 1 AUTORANGE]

   [CHANNEL 2 AUTORANGE]

This makes sure the input ranges are set correctly.

6. Press < Trigger >

   [SOURCE TRIGGER]

The trigger for this measurement is from the internal source.

7. Press < Window >

   [UNIFORM]

Since you are using the periodic chirp as the excitation source, there's no need to use a window function — the periodic chirp is periodic within the time record.

The uniform window is really no window at all, since it does not attenuate any part of the time record.

8. Press < Meas Data >

[FREQUENCY RESPONSE]

This displays the frequency response measurement.

9. Press < Trace Type >

[LOG MAGNITUDE]

This makes sure the trace type is set to logarithmic magnitude. The analyzer should already be in this state, since this is a default setting.

It's important to understand that selecting a measurement and selecting a trace type are two different things.

Press < Meas Data > to select a measurement for display (such as spectrum or frequency response). Then press < Trace Type > to specify *how* you want the measurement data displayed (for example, the log magnitude or phase of the measurement data).

10. Press < Freq >

[SPAN]

< 3 > [kHz]

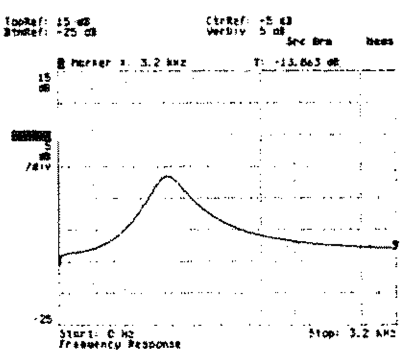
This changes the measurement frequency span to 3.2 kHz.

You could use another span, but the 3.2 kHz span provides good resolution for a 1 kHz band-pass filter.

11. Press < Scale >

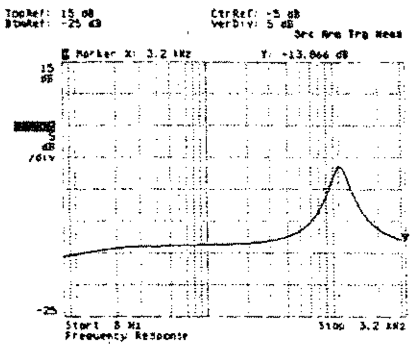
[AUTO SCALE]

As you learned in Measurement Task 1, you could use [VERTICAL/DIV] to change the vertical scale. But for this example, the vertical scale selected by pressing [AUTO SCALE] is fine.



12. Press

[X-AXIS LIN/LOG]



This displays the x-axis on a logarithmic scale. The default scale is a linear x-axis.

The logarithmic x-axis is both a convenient and traditional way to display frequency response measurements.

13. Press < Average >

[AVERAGE ON/OFF]

This turns on averaging.

The default setting is for ten rms averages. This is adequate for the example here, so you don't have to select additional items from the averaging menu.

14. Press < Scale >

[AUTO SCALE]

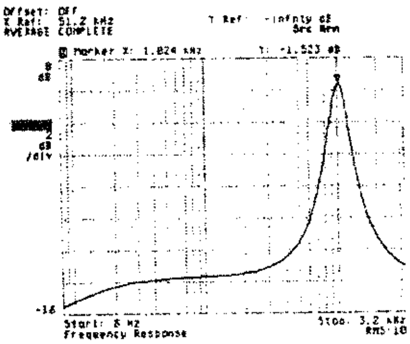
This autoscales again.

15. Press < Marker >

[MARKER ON/OFF]

[MARKER TO PEAK]

Note the values indicated by the marker's x-axis and y-axis position.



This turns on the marker and moves it to the peak of the frequency response.

The marker's x-axis value is the resonant frequency of the band-pass filter. In this example, the resonant frequency is about 1 kHz.

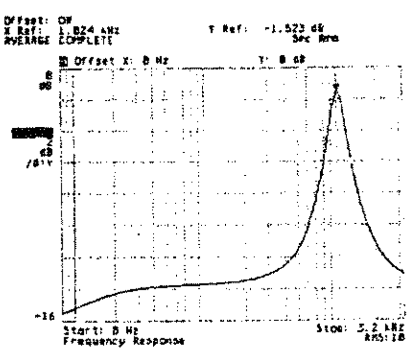
The y-axis position is the insertion loss (or gain) of the filter. The y-axis value is about −1 dB, so the filter has an insertion loss of about 1 dB.

16. Press [OFFSET]

[OFFSET ON/OFF]

[OFFSET ZERO]

[RETURN]



This turns on the offset marker and zeros it at the resonant frequency.

Now you can make measurements relative to the resonant frequency.

Notice that pressing [RETURN] moves you back to the main menu.

17. Press [SEARCH]

    [TARGET] < - > < 3 >

    [ENTER]

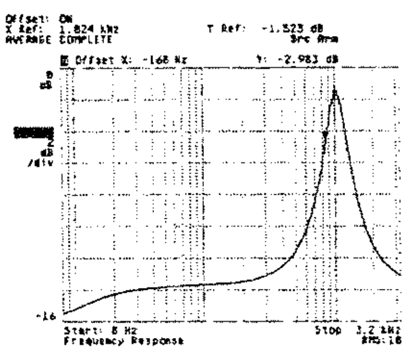
Pressing [Search] puts the analyzer into the search mode. This lets you move the marker quickly to a specific location.

The default setting for the search mode is [Target]. The target feature lets you search for a specific y-axis offset — in the example here, you will search for the 3 dB points on both sides of the resonant frequency.

You can use the [SEARCH] feature with both absolute and offset markers.

18. Press [LEFT]

    Note the frequency value indicated by the offset marker's x-axis position.



This moves the marker to the −3 dB point to the left of the resonant frequency.

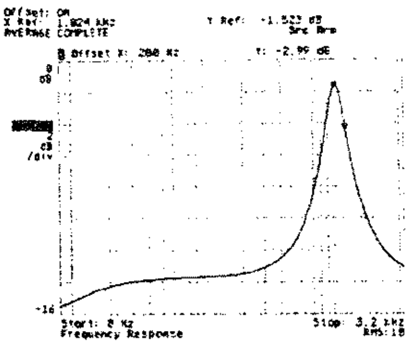
In this example, the offset to the left of the resonant frequency is about 200 Hz.

19. Press [RIGHT]

This moves the marker to the −3 dB point to the right of the resonant frequency.

Again, note the frequency value indicated by the offset marker's x-axis position.

Again, this example shows an offset of 200 Hz to the right of the resonant frequency.



Adding the left offset frequency and the right offset frequency of the −3 dB points gives you the filter's 3 dB bandwidth.

In the example here, the 3 dB bandwidth is about 400 Hz.

20. Press [RETURN]

[OFFSET]

[OFFSET ON/OFF]

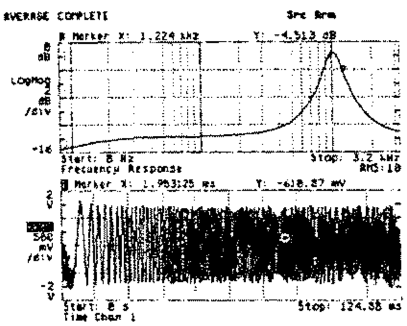
Pressing [RETURN] brings you back to the main marker menu. You can then turn off the offset marker.

You can press < Marker > and use the [SEARCH] and [TARGET] softkeys again, if you want to find the absolute frequency values of the −3 dB points.

21. Press < Format >

[UPPER/LOWER]

< Active Trace >



Pressing < Format > calls up a menu that lets you configure the analyzer's display.

Pressing [UPPER/LOWER] selects the upper/lower display format. Pressing < Active Trace > at this point selects Trace B (the lower one) as the active trace.

Trace A is the same log magnitude display of the frequency response measurement that you were looking at earlier.

Selecting the upper/lower format allows you to display two measurements (or different trace types) at once. In a few moments, you will put the log magnitude of the frequency response on the upper trace, and the phase of the frequency response on the lower trace.

Notice how the currently active trace has a highlighted box around the trace letter. Pressing < Active Trace > switches between Trace A and Trace B.

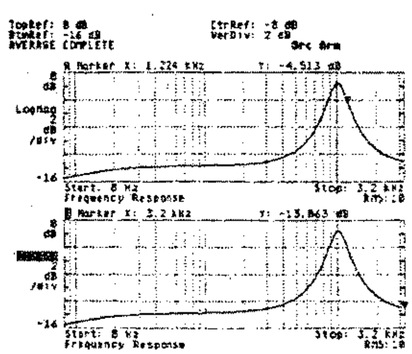
22. Press < Meas Data >

[FREQ RESPONSE]

< Scale >

[X-AXIS LIN/LOG]

[AUTO SCALE]



This puts the frequency response measurement on Trace B.

Because Trace A and Trace B are independent, you have to set up each trace individually.

23. Press < Trace Type >

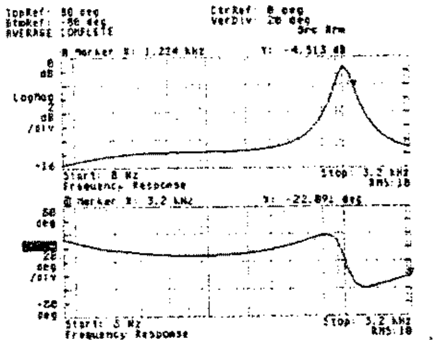
[PHASE]

This changes the trace type on Trace B to show phase information. You are now looking at phase versus frequency for the test device.

24. Press < Scale >

[AUTO SCALE]

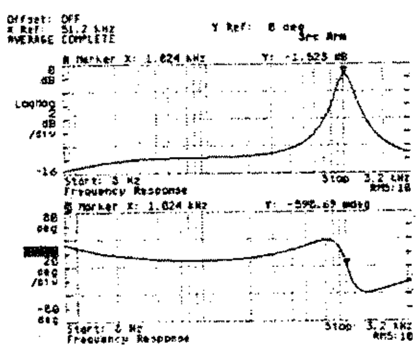
This autoscales the active trace.



25. Press < Marker >

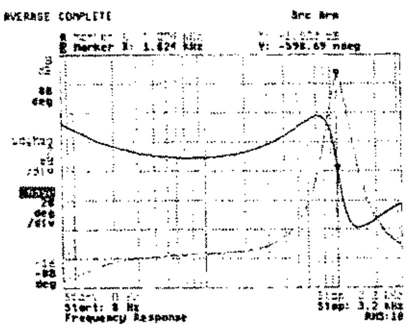
[COUPLED ON/OFF]

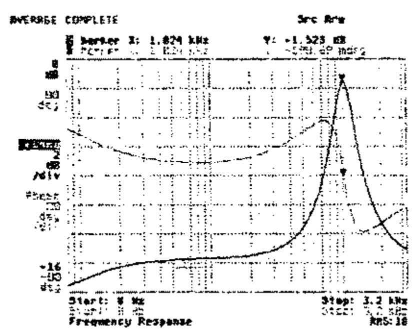
This turns on marker coupling. Marker coupling means that markers for both traces move together when you press the marker direction keys.



26. Press < Format >

[FRONT/BACK]





This selects the front/back display format. The two traces are now overlaid.

Notice how pressing < Active Trace > alternately brightens one trace and dims the other. The brighter trace is the currently active one.

Chapter 9
Impact Testing

Task Overview – This chapter steps you through a series of measurements to find the frequency response of a mechanical structure, using impact testing.

What you will need – gather the following items before starting this task:

- Test structure and support
- Impact hammer with built-in load cell
- Accelerometer with adhesive or threaded stud to mount the transducer
- Signal Conditioning (a current-source supply if you are using ICP devices, or a charge amplifier if you are using piezoelectric devices)
- Appropriate connecting cables

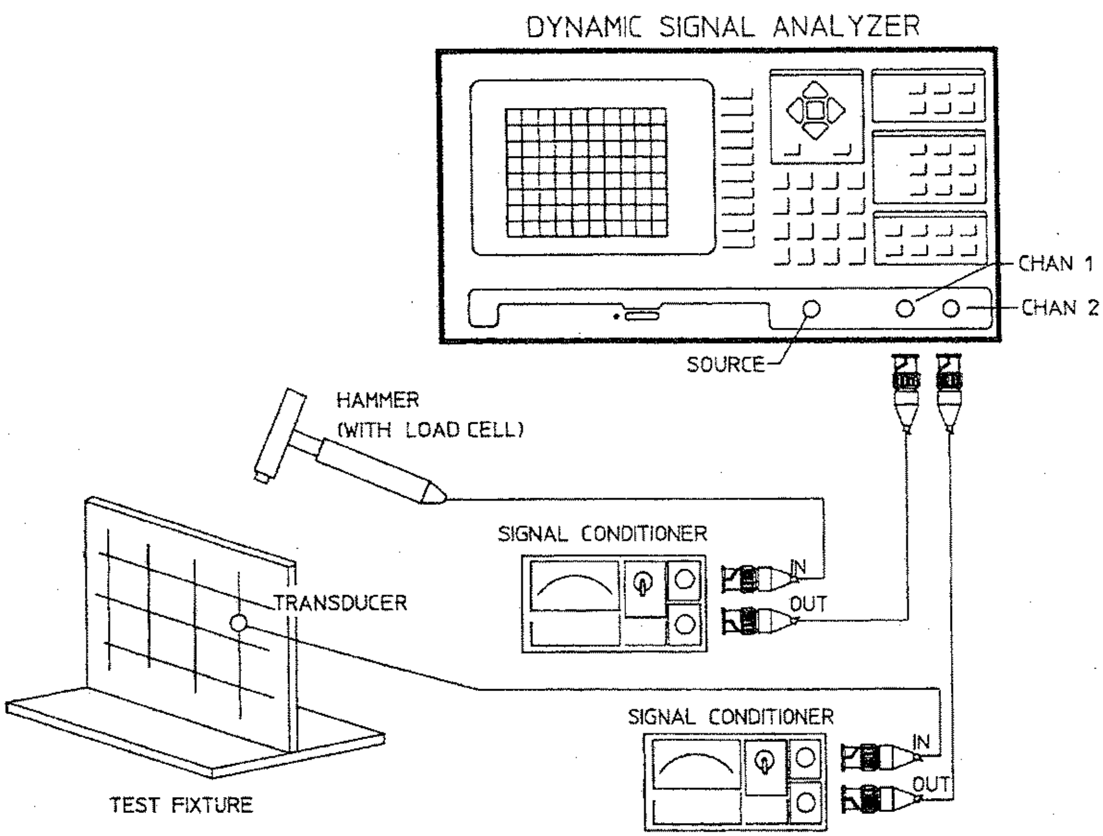
What you will measure – in this task, you will make these measurements:

- Frequency response function for a simple mechanical structure, using impact testing

What you will learn – In this chapter, you will be introduced to the following analyze functions:

- Setting input ranges manually
- Specifying a trigger delay
- Using the force window (and determining its duration)
- Using the exponential window (and determining its decay rate)

Measurement Setup



As you step through the following task, you may find that your measurement results differ slightly from those shown here. Keep in mind that the tasks are designed to help you learn about the analyzer – not to duplicate specific measurement results.

1. If you've already turned on the analyzer, press < Preset >.

   If the analyzer is off, turn it on and wait until it warms up and calibrates. Then press < Preset >.

   As always, you should preset the analyzer before beginning a new measurement task.

2. Connect the impact hammer to the analyzer's channel 1 input.

   Connect the transducer on the test structure to the analyzer's channel 2 input.

   As mentioned in the task overview, you will need to provide proper signal conditioning for the test equipment you are using.

   In our example we used a test kit comprising a hammer with load cell, transducer, and matching ICP current sources..

3. Press < Meas Type >

   [2 Channel 51.2 kHz]

   This places the analyzer in the two-channel mode.

4. Press < Freq >

   [SPAN]

   < 1 > < . > < 6 > [kHz]

   For this example, you will select a frequency span of approximately 2 kHz.

5. Press < Format >

   [UPPER/LOWER]

   To view the results of both the stimulus (the hammer taps) and the resultant response, you'll need to have two traces displayed.

   Trace A will show the hammer taps (in the time domain), while Trace B will show the response (in the frequency domain).

   It's important to monitor the hammer taps to ensure that you've made a clean hit. If the hammer bounces, (causing multiple hits within a single measurement), the response will be in error.

6. Press < Meas Data >

[TIME CHANNEL 1]

< Active Trace >

[FREQUENCY RESPONSE]

This selects the channel 1 time record for display on Trace A.

Pressing < Active Trace > and [FREQUENCY RESPONSE] activates Trace B and then selects frequency response for display on Trace B.

You now have time domain data on one trace and frequency domain data on the other.

7. Press < Input >

[CHANNEL 1 RANGE]

Using the numeric keypad, enter a value appropriate for your measurement equipment.

[CHANNEL 2 RANGE]

Again, enter a value appropriate for your measurement equipment.

In this example we set the channel 1 range to 0.5V and the channel 2 range to 1V.

You'll have to set the input ranges to accommodate your particular test devices.

8. Press < Trigger >

[TRIGGER SET UP]

[LEVEL]

< 1 > < 0 > [%]

The trigger level allows you to set the threshold level of the trigger to eliminate noise from your measurement.

Setting the trigger level to 10 percent of the input range is a good place to start. This should work well for many setups. However, if there's too much noise, you may need to use different trigger levels.

9. [CHANNEL 1 DELAY]

   < – > < 2 > [mSEC]

   [CHANNEL 2 DELAY]

   < – > < 2 > [mSEC]

   [RETURN]

   [CHANNEL 1 TRIGGER]

This places a minus 2 millisecond delay (2 millisecond pre-trigger)on channel 1. To be consistent, we've done the same with channel 2.

The delay allows you to see the leading edge of the hammer tap. This makes it easier to see if the hammer hit is good.

10. Press < Window >

    [FORCE EXPO]

    [FORCE CHANNEL1]

    < 1 > < 8 > [mSec]

    [EXPO CHN2]

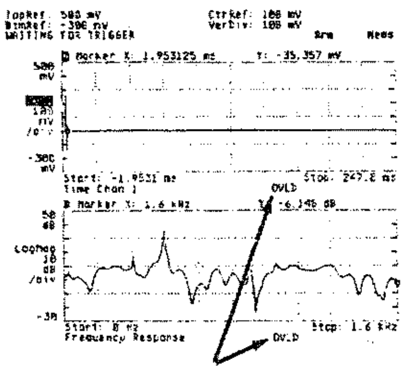
    < 6 > < 0 > [mSec]

In this example [FORCE CHANNEL 1] is set to 18 mSec. This establishes a 20 millisecond duration for the force window (–2 mSec pre-trigger plus 18 mSec duration). You can vary the duration to best suit your needs.

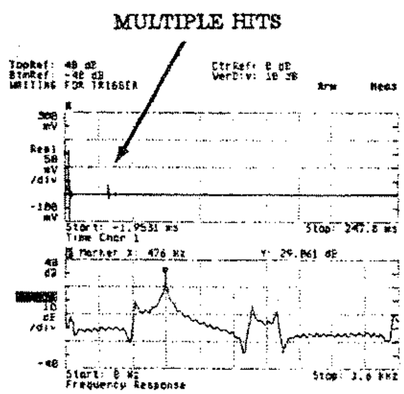
You must also specify an appropriate decay (the time constant) for the exponential window. As a rule of thumb, the period of the time record (displayed at the bottom of trace A) divided by 4 is a good place to start.

To learn more about force and exponential windows, see Hewlett-Packard Application Note 243-3 (*The Fundamentals of Modal Testing*).

11. The analyzer is now set up to receive data from your measurement.



Overloaded Inputs



Multiple Hammer Hits (Bounce)

When making your measurement, you must make sure that the input range for each channel is within the range settings of the analyzer.

Ideally, the dynamic range of the input should be just within the setting of the analyzer. If the stimulus is too high, you'll see an overload message (below each trace).

If the analyzer overloads repeatedly, reset the ranges of either or both channels. Each channel may require a different input range (as did our example here).

As we mentioned before, a good hammer tap should hit the test structure only once (there should be no bounce). After tapping your test object and autoscaling trace A, look to see if there is only one spike present. If there is more than one, it may be necessary to repeat the procedure.

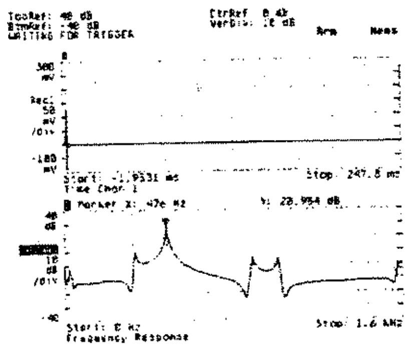
Examine the accompanying figures carefully; compare the test results on Trace B. Notice how overloading and multiple hammer taps have caused distortion in the measurement results.

12. Press < Scale >

[AUTO SCALE]

< Active Trace >

[AUTO SCALE]



Proper Measurement Technique

It's often necessary to press [AUTO SCALE] after each measurement. This provides the best display for each trace.

As in other measurements you have made, you may want to average your results. If you want to average, you will have to turn averaging on and, of course, press < Start > to begin each new series of measurements. To learn more about averaging modal tests, see Application Note 243-3 (*The Fundamentals of Modal Testing).*

PART 4: Beyond the Basics

Chapter 10

Plotting and Printing Measurement Results

Overview

You can use a variety of HP-IB plotters or printers to show measurement results. Contact your local Hewlett-Packard Sales/Service Office for a listing of currently-supported peripheral devices.

This chapter provides a brief overview of plotting and printing procedures. For more detailed information, see the *HP 35660A Front-Panel Reference.*

Preparing to Plot or Print

1. Connect the plotter/printer to the analyzer's HP-IB connector.

   The HP-IB connector is on the analyzer's rear panel.

2. Press < Local/HP-IB >

   [SYSTEM CONTROLLR]

   This sets the analyzer to be the system controller. The analyzer must have control of the HP-IB bus to plot or print anything.

   This procedure assumes that the analyzer is the only controller on the HP-IB. If you have more than one controller, see the *HP-IB Programming Reference*.

3. Determine the HP-IB address of the plotter/printer.

   You may need to refer to the operating guide for your particular plotter/printer.

   Make sure all external devices on the HP-IB have a unique address.

4. Press < Local/HP-IB >

   [PERIPHERL ADDRESS]

   This calls up a menu that lets you select the address of peripheral devices.

5. Press [PLOTTER ADDRESS]

   or [PRINTER ADDRESS]

   Now enter the appropriate address.

   The address you entered will be retained even if you turn off the analyzer's power.

Plotting or Printing

1. Check to see if the plotter/printer is ready.

   Make sure the plotter/printer is turned on, has paper, and is ON LINE.

2. Press < Plot/Print >

   Then press [PLOT SCREEN]

   or [PRINT SCREEN]

   Softkey labels do not appear on the plotted or printed results. Also, the analyzer does not send a form-feed command to the printer.

   If the "Plot/Print device not present" message appears, you need to:

   - Check the connection between the analyzer and the plotter/printer
   - Make sure that you have the correct address entered for the plotter/printer
   - Make sure there are no other controllers on the HP-IB

3. Press [ABORT PLOT]

   or [ABORT PRINT]

   This aborts the current plot or print in progress.

   When plotting or printing, the analyzer does not respond to any key presses, except [ABORT PLOT] or [ABORT PRINT].

Chapter 11
Save and Recall Operations

Overview

First, a brief overview. The analyzer lets you save (and later recall) the following:

- Traces
- Instrument setup states
- Math functions (and constants)
- Limit tables
- Data tables
- HP Instrument BASIC programs

There are three mass storage devices you can use:

- The analyzer's internal disc (this accepts standard 3.5" floppy discs)
- The analyzer's internal RAM disc (for fast, temporary storage)
- An external disc drive (must be HP-IB compatible)

Before doing any save or recall operations, make sure you've selected the correct mass storage device. Unless you've used a device specifier prefix (such as INT: for internal disc), the save/recall operation will use the currently-selected mass storage device.

Here are the device specifiers:

- INT – for internal disc
- EXT – for external disc
- RAM – for a RAM disc

The filename you use must have no more than ten characters. Also, all characters must be printable.

CAUTION *Files stored in internal RAM disc are temporary and will be lost when you turn off the analyzer. Use an external disc or the analyzer's internal disc drive for permanent storage.*

For detailed information about save and recall operations, see the *HP 35660A Front-Panel Reference.*

Saving and Recalling Traces

You can save (and recall) a trace to one of eight files in the current mass storage device – files 'TRACE1' through 'TRACE8'. You can also save the trace to a file with a name of your own choosing.

Saving and Recalling States

You can save (and recall) the current instrument state (or in other words, its configuration) to a file in the current mass storage device. Later, you can use this file to quickly set up the analyzer.

Here's what else you should know:

- When you save an instrument state, the analyzer remembers most settings, but does not remember some service tests and adjustments settings.
- You can save an instrument state to one of eight files in the current mass storage device – files 'STATE1' through 'STATE8'. You can also save the state to a file with a name of your own choosing.
- Because data tables and limit tables can use large amounts of memory (especially for larger, more complex tables), an "Insufficient disc space" message appears if the setup state is too large to save. If this happens, store each table to a separate file (for example, INT:LIMIT1), if you haven't done so already – do this by pressing < Save > and using the [SAVE DATA TBL] and [SAVE LIMIT] softkeys. Then clear all tables by pressing < Marker Fctn > and using the appropriate softkeys to delete all tables. This avoids duplicating the tables in the memory space allocated for saving setup states. An even better idea would be to store data tables and limit tables to another external mass storage device (to avoid running out of disc space).

Saving and Recalling Math Functions

You can save (and recall) a math function to one of eight files in the current mass storage device – files 'MATH1' through 'MATH8'. You can also save the trace to a file with a name of your own choosing. The five constants associated with each math function are also saved.

Saving and Recalling Limit Tables

You can save (and recall) a limit table to a file with a name of your own choosing.

Saving and Recalling Data Tables

You can save (and recall) a data table to a file with a name of your own choosing.

Typical Save and Recall Tasks

In a few moments you will step through typical save and recall operations, using the analyzer's internal disc drive. After completing these tasks, you can use similar procedures with the analyzer's internal RAM disc or an external disc.

Before starting the save and recall tasks, you must first designate the analyzer's internal disc as the current mass storage device. Afterwards, you will format a blank 3.5" floppy disc (if you haven't done so already).

Selecting the Current Mass Storage Device

1. Press < Recall >

   [STORAGE CONFIG]

   This calls up a menu that lets you designate the current mass storage device (sometimes called the "default" drive).

   The [STORAGE CONFIG] softkey is also available from the < Save > menu.

2. Press [INTERNAL DISC]

   This specifies the analyzer's internal disc drive as the current mass storage device.

3. If you have a disc already formatted, insert the disc in the analyzer's internal drive.

   Press [CATALOG ON/OFF]

   The analyzer will display the contents of the disc drive.

   To remove the catalog, press [CATALOG ON/OFF] once more.

Formatting a Blank Disc

1. Make sure the disc you're going to format is *not* write-protected.

The write-protect tab should be covering the square hole at the lower-left hand corner of the floppy disc.

2. Insert the disc in the analyzer's internal disc drive.

Note the eject button. To avoid damaging the disc, do not eject it when the "busy" light is on.

3. Press < Save >

   [DISC FUNCTIONS]

Pressing < Recall > also displays the disc function menu.

4. Press [FORMAT OPTION]

   < 0 >

This sets the format option to format ϕ. To learn more about format options, see the *HP 35660A Front-Panel Reference*.

5. Press [INTRLEAVE FACTOR]

   < 1 >

The interleave factor is the spacing between sectors on a disc. Setting the interleave factor lets you maximize the efficiency of disc operations. Although setting the most efficient interleave factor is not critical for smaller files, it will save lots of time when reading or writing very large files.

For the analyzer's internal disc drive, setting the interleave factor to 1 provides the most efficient disc operation.

6. Make sure you really want to format this disc.

Formatting a disc destroys any information previously written to the disc. To abort the operation now, press [CANCEL/RETURN].

Pressing [ABORT] after formatting has begun will *not* prevent loss of data.

7. Press [START FORMAT]

INT: should appear at the top of the screen (this indicates that the analyzer's internal disc is the default drive).

If RAM: or EXT: appears, press [CLEAR ENTRY] and enter INT: with the alpha-shifted hardkeys.

8. When INT: appears at the top of the screen, press [ENTER]

This starts the formatting operation.

If you'd like, you can use the alpha-shifted keys and enter a disc name after the INT: prefix.

Do not press [ENTER] *until the* INT: *prefix appears.*

Saving a Trace

1. Press < Save >

   [SAVE TRACE]

   Make sure the trace you want to save is the active trace.

   The active trace is the one with the highlighted trace label.

2. Press [INTO 'TRACE1']

   This saves the trace to a file called 'TRACE1.'

   You can save a trace to one of eight files in the current mass storage device — files 'TRACE1' through 'TRACE8.'

   You can also save the trace to a file with a name of your own choosing. For more information, see the *HP 35660A Front-Panel Reference*.

Recalling a Trace

1. Press < Recall >

   [RECALL TRACE]

   This calls up a menu that lets you recall a trace.

   You can also get this menu by pressing < Meas Data >, [MORE], and [RECALL TRACE].

2. Press [RCL FROM 'TRACE1']

   This recalls the trace from the file called 'TRACE1.' The recalled trace now appears on the screen in place of the currently-active trace.

   Make sure the trace you're recalling is in the current mass storage device.

   To learn more about recalling traces, see the *HP 35660A Front-Panel Reference*.

Chapter 12

File Utilities, Application Utilities, and Special Functions

Overview

File Utilities

In addition to save and recall operations, the analyzer lets you do the following from a file utilities menu:

- Rename a file
- Delete a file
- Delete all files
- Pack files
- Rename catalog
- Format a disc
- Copy a disc
- Set storage configuration (select a mass-storage device)

At the end of this chapter, you will learn how to copy one disc to another, using the analyzer's internal disc drive. This is particularly useful for making backup copies.

To learn how to format a disc, see Chapter 11, "Save and Recall Operations." For detailed information about file utilities (and to learn about additional utilities), see the *HP 35660A Front-Panel Reference.*

Application Utilities

There's also an application utilities menu. From here, you can do the following:

- List all applications loaded in the analyzer
- Install individual applications
- Load all applications
- Turn on or off the autoload feature (if on, the analyzer loads all applications with the _LD suffix at power-up)

Don't confuse programs that run in HP Instrument BASIC with applications. Although HP Instrument BASIC is itself an application, the programs that run in it are not – rather, they are loaded and saved like data tables and limit tables. For more information, see the *HP Instrument BASIC Getting Started Guide.*

For detailed information about application utilities (and to learn about additional utilities), see the *HP 35660A Front-Panel Reference.*

Special Functions

A special function menu lets you select:

- Calibration options
- Memory allocation
- Turning on the beeper
- Setting the clock and calendar
- Self-test functions

For detailed information about special functions, see the *HP 35660A Front-Panel Reference.*

Disc to Disc Copying

This procedure shows how to copy the contents of one disc to another, using the analyzer's internal disc drive. After completing this task, you can use a similar procedure to do related operations (for example, copying the analyzer's internal RAM disc to a disc in the internal disc drive).

Copying a Disc

1. Press < Save >

   [FILE UTILITIES]

   Pressing < Recall > also displays the file utilities menu.

2. Press [COPY DISC]

   The copy disc routine will erase all files on the destination disc (the disc you're going to copy to files to) before performing the copy operation.

   To add files to a disc, copy the files one at a time.

3. Press [SOURCE DISC]

   INT: should appear at the top of the screen (this indicates that the analyzer's internal disc is the default drive).

   If RAM: or EXT: appears, press [CLEAR ENTRY] and enter INT: with the alpha-shifted hardkeys.

4. When INT: appears at the top of the screen, press [ENTER]

   This specifies the source disc as the analyzer's internal disc drive.

   The source disc is the disc you're going to copy *from*.

5. Press [DESTN DISC]

   INT: should appear at the top of the screen (this indicates that the analyzer's internal disc is the default drive).

   If RAM: or EXT: appears, press [CLEAR ENTRY] and enter INT: with the alpha-shifted hardkeys.

6. When INT: appears at the top of the screen, press [ENTER]

   This specifies the destination disc as the analyzer's internal disc drive.

   For this particular operation (copying one internal disc to another), the internal disc is both the source and destination disc.

7. Insert the source disc into the analyzer's internal disc drive.

Make sure the source disc is write-protected.

This disc is write-protected if you can see through the square hole at the lower-left hand corner of the floppy disc.

8. Press [START COPY]

As the operation progresses, the analyzer will ask you to remove the source disc and insert the destination disc (possibly several times).

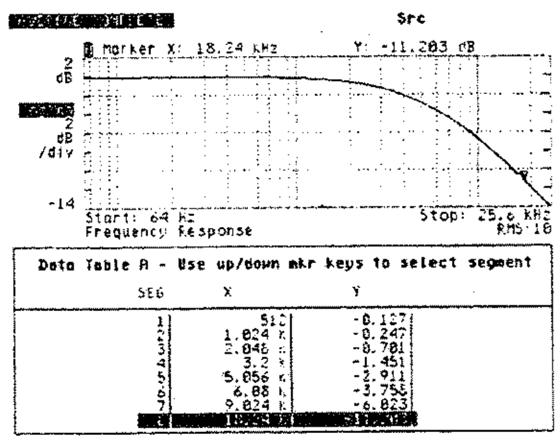
The copied disc is an image copy, so it will be an exact duplicate of the original disc.

Chapter 13
Data Tables

Overview

A data table is a list of x-axis values. For each x-axis value that you enter into a data table, the analyzer calculates the corresponding y-axis value.

There are two data tables; one for Trace A and one for Trace B. When you call up a data table calculation, the analyzer will select the appropriate data table for the trace that's active. And when you turn on data table calculation, the analyzer will automatically calculate the y-axis values.



Typical Data Table

Data tables are useful for quickly characterizing a measurement result by taking a "snapshot" of key points along the x-axis. Data tables save time because they let you easily record measurement results (in numeric form) without having to move the marker around and manually record marker values at various points. For more information about data tables, see the *HP 35660A Front-Panel Reference.*

You can also store a data table and apply it to subsequent measurement traces. This is particularly useful when using the analyzer remotely. For more information, see the *HP 35660A HP-IB Programming Reference.*

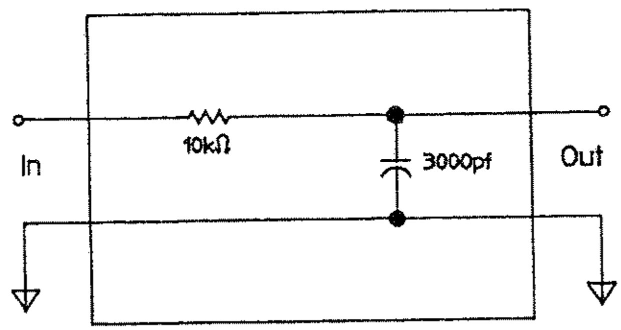
Here's what else you should know about the data table:

- You can specify 401 x-axis values for the data table. Of course, the more values you specify, the longer it takes for the analyzer to fill in the y-axis values.
- If data table calculations are on, the analyzer will update the data table after each measurement. Also, the data table does not have to be displayed for the calculation to occur.
- If data table calculations are off, the analyzer will not update the data table's y-axis values. However, the x-axis entries will remain unchanged.
- The analyzer does not store unit labels in the data table. For example, an x-value of 1.2 kHz is stored simply as "1.2K" and a y-value of −35 dBVrms as "−35." Before recalling a data table for use again, make sure the analyzer is set to use the same vertical units that you used when building the table initially. Otherwise, the calculated data table values will be in different units than the original data table. It's also a good idea to use the same frequency span.
- If you've turned on the offset marker, the analyzer will calculate y-axis values with respect to the current offset zero point (the little square). Otherwise, the analyzer shows absolute y-axis values.
- When editing the data table, use the < ▲ >and < ▼ > hardkeys to move to a particular x-axis value (if there's more than one page, pressing < ▲ > < Fast >moves to the previous page and < ▼ > < Fast > moves to the next page). If you're at the last entry, press < ▼ >to add a new one.
- The analyzer does not show markers for any of the data table points.
- You can use the data table for both frequency domain and time domain measurements.

A Simple Data Table

With this task, you will learn how to create a data table. Although this example uses a 5 kHz low-pass filter, you can use another type of filter if it's more convenient (the goal of this task is to learn how to build a data table — the choice of test device is not important).

The example low-pass filter has just two components and is very easy to build. The same device is also used in the first waveform math task (Chapter 15, "Waveform Math").



Low-pass Filter

A Simple Data Table (continued)

1. Connect the 5 kHz low-pass filter to the analyzer.

If you use another type of filter, you can follow along with this task, but you may need to use a different frequency span.

2. Make a frequency response measurement.

If you need review, use the procedures outlined in chapter 9.

3. Press < Freq >

[ZERO START]

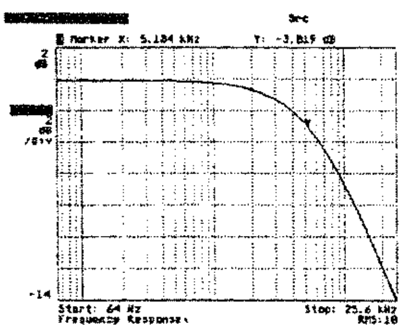
[SPAN]

< 2 > < 5 > [kHz]

This sets the span to 25.6 kHz.

4. Press < Scale >

[X-AXIS LIN/LOG]



This selects the logarithmic x-axis.

You can use the linear x-axis instead, if it's more convenient.

5. Press < Marker Fctn >

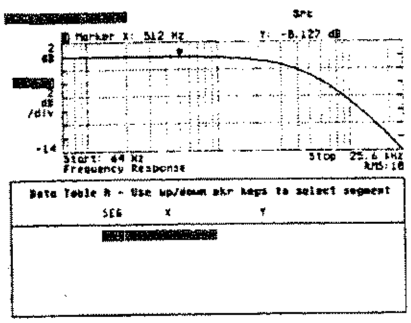
[DATA TABLE]

To delete an existing data table, press [DELETE ALL] and then [DO DELETE].

6. Move the marker to a point at the left side of the trace.

In the example here, we moved the marker to 512 Hz.

7. Press < Marker Value >



This enters 512 Hz as the first x-axis value in the data table.

You can also enter an x-axis value with the numeric keypad. However, if the x-axis value you specify is not a frequency bin for the current span, the analyzer will use the nearest available bin to calculate the y-axis value.

In the current span, for example, there isn't a bin at 500 Hz (but there are bins at 448 Hz and 512 Hz). So if you enter 500 Hz, the analyzer will put 500 Hz into the data table but the y-axis value it supplies will be the value at 512 Hz, since that's the nearest available frequency bin.

Of course, if you change to a narrower frequency span, the bins will be spaced more closely and the calculated y-axis values in the data table may be somewhat different. So if you're using a data table to characterize similar devices (for example, several filters of the same design), it's best to use a consistent frequency span.

8. Press < ▶ >

This moves the marker a little to the right.

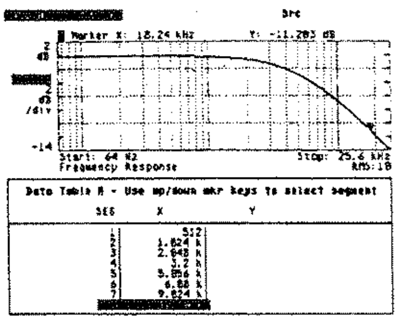
Press < ▼ >

Pressing < ▼ >adds another x-axis value.

< Marker Value >

9. Repeat the previous step several more times.

Stop after you've entered a few more x-axis values.

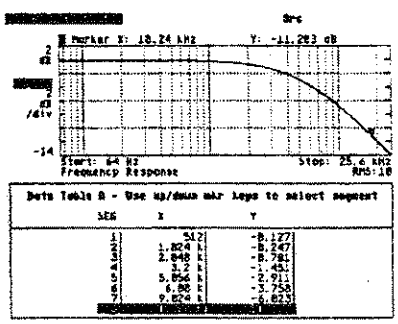


10. Press [CALC ON/OFF]

This turns on the calculation and displays the calculated y-axis values. These values will change as new measurement data appears on the active trace.

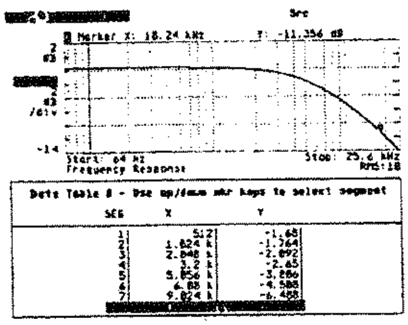
If data table calculations are on, the analyzer will update the data table after each measurement. Also, the data table does not have to be displayed for the calculation to occur.

If data table calculations are off, the analyzer will not update the data table. The entries in the data table will remain unchanged.



11. Modify the output of the test device

Press < Start >



In the example here, we put a 50 kΩ resistor across the output of the filter.

As the new measurement completes, note the corresponding difference in calculated y-axis values.

12. Press [RETURN TBL DOWN]

This exits the data table display.

To save the data table, press < Save >, [SAVE MORE]. Then press [SAVE DATA TABLE]. The analyzer will assign a filename for you. Then press [ENTER].

To use a different filename, enter a new name with the alphanumeric keypad. Then press [ENTER]. Be sure to use the proper prefix if you want the limit to go to a different (non-current) mass storage device.

13. Press < Format >

[SINGLE]

This returns to the single-trace display format.

Chapter 14
Limit Tables

Overview

A limit table is a list of values (referenced to their respective x and y coordinates) that the analyzer uses to compare with a current measurement or a stored trace. A limit appears as a line (or lines) defined by a series of line segments. These line segments are defined by points that you specify for each limit table.

Limit tables are useful for go/no go checking – they quickly tell you if a particular measurement result passes or fails the limits outlined with a particular limit table.

You can create both upper and lower limit lines for each limit table. When you turn on the limit testing feature, the analyzer indicates a "fail" condition if the trace you're testing exceeds an upper limit (or goes below a lower limit). If the trace is within the limit lines, the test passes. By the way, you don't have to use both upper and lower limit lines – for some types of testing, it may be more convenient to use only upper (or lower) limits.

Here's what else you should know:

- The analyzer does not store unit labels in the limit table. For example, an x-value of 1.2 kHz is stored simply as "1.2K" and a y-value of −35 dBVrms as "−35." Before using a limit table again, make sure the analyzer is set to use the same vertical units that you used when building the table initially. Otherwise, the limit testing will not work properly. It's also a good idea to use the same frequency span.
- When editing the limit table, use the < ▲ > and < ▼ > hardkeys to move to a particular segment (if there's more than one page of segments, pressing < ▲ > < Fast > moves to the previous page and < ▼ > < Fast > moves to the next page). If you're at the last segment, press < ▼ > to add a new segment.
- When adding a new segment, x-start and ystart values are copied from the x-stop and y-stop values of the previous segment. This lets you conveniently add a connecting segment to the previous one. There's no need to re-enter the x-start and y-start values — simply move the marker (with the < ▶ > hardkey) to the desired end point for the new segment. Then press [X-STOP] < Marker Value > and [Y-STOP] < Marker Value > .
- To copy a limit from Trace A to Trace B, use < Save > and related softkeys to save the limit for Trace A to a file (such as 'LIMIT1'). Then make Trace B active. Now, using < Recall >, recall 'LIMIT1' (you may have to backspace and use the numeric keypad to specify 'TRACE1'). You now have identical limits in both tables. To save the newly-created Trace B limit, again use < Save > and related softkeys; this time, save the limit to 'LIMIT2.'

For more information about limit tables, see the *HP 35660A Front-Panel Reference.*

To learn about operating the analyzer remotely, see the *HP 35660A HP-IB Programming Reference*.

A Simple Limit Table (upper limit only)

With this task, you will learn how to create a simple limit table (using just one limit line) to test the spectral purity of a sine source. Specifically, you're going to check the absolute amplitude of the second and third harmonics.

A Simple Limit Table (continued)

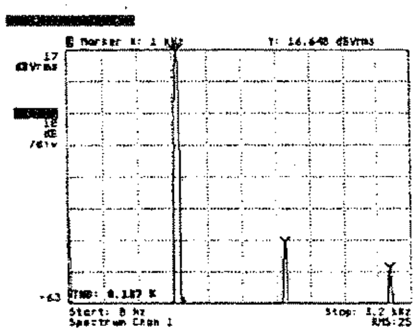
1. Connect a sine source to the analyzer's channel 1 input.

   Set the output to 1 kHz.

In the example here, we've used an external oscillator.

If you use the analyzer's internal source, you can overload the analyzer to simulate a sine source with prominent harmonics. See Chapter 4, "Spectral Purity of a Sine Wave."

2. Make a spectrum measurement of the 1 kHz test signal.

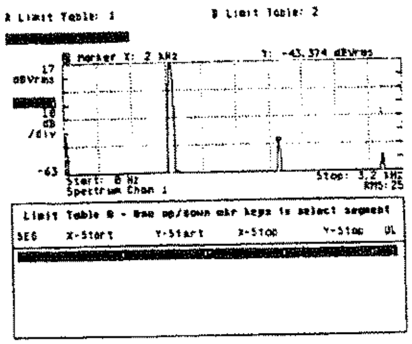


Use a span of 3.2 kHz.

If you need review, use the procedures outlined in chapter 4.

3. Press < Marker Fctn >

[LIMIT]



Note how a limit table appears at the bottom of the screen. The analyzer automatically shifts to the upper/lower display format.

4. Press [LIMIT CONFIG]

[X-START]

<1> <.> <8> [kHz]

This defines the x-axis starting point of the upper limit segment.

1.8 kHz is a convenient starting point because it's a little before the second harmonic.

5. Press [Y-START]

<–> <4> <0>

[ENTER]

This defines the y-axis starting point of the upper limit segment.

Entering –40 (dBV) specifies a point just above the current second harmonic.

Since the limit table stores only absolute values, the entry is recorded as –40, not –40 dBV.

6. Press [X-STOP]

<3> <.> <1> [kHz]

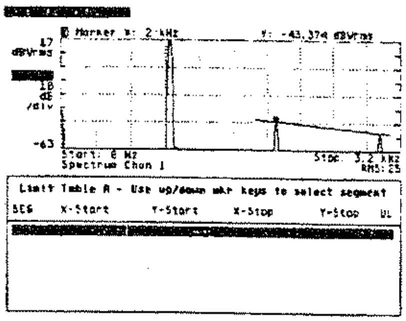
This defines the x-axis end point of the upper limit segment.

3.1 kHz is a convenient stopping point because it's a little after the third harmonic.

7. Press [Y-STOP]

   < – > < 5 > < 0 >

   [ENTER]



This defines the y-axis starting point of the upper limit segment.

Entering −50 (dBV) specifies a point just above the current third harmonic.

8. Press [OFFSET]

   [Y ADJUST ALL SEGS]

   < 1 > < 0 >

   [ENTER]

The offset feature lets you move an entire limit segment up or down.

See how easy it was to move the segment up 10 dBV? Also, notice how the analyzer automatically adjusted the values in the limit table to reflect this offset.

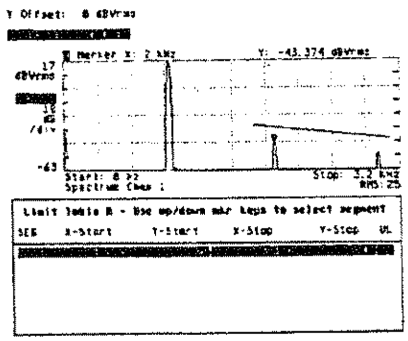
In similar fashion, you can use [X ADJUST ALL SEGS] to move a segment left or right.

9. Press < - > < 1 > < 0 >

   [ENTER]

   [RETURN]

This removes the 10 dBV offset and returns you to the original limit setting.



10. Press [LIMIT CONFIG]

    [TEST EVAL ON/OFF]

This turns on (or off) the limit testing.

When testing is on, a PASS or FAIL label appears on the screen.

11. Press [RETURN]

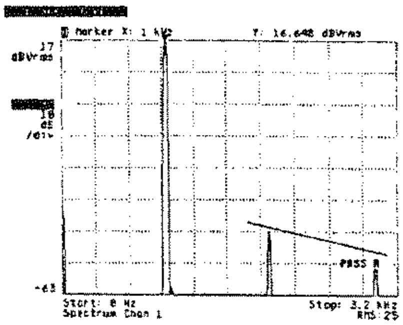
    [RETURN TBL DOWN]

This exits the limit table display.

Unless you turn off limit testing (using the [TEST EVAL ON/OFF] softkey), limit testing remains in effect. Also, limit lines remain on the screen unless you turn them off as well.

12. Press < Format >

[SINGLE]



This returns to the single-trace display format.

The test signal should pass the limit test. If it doesn't, go back and readjust the limit segment accordingly.

13. Press < Input >

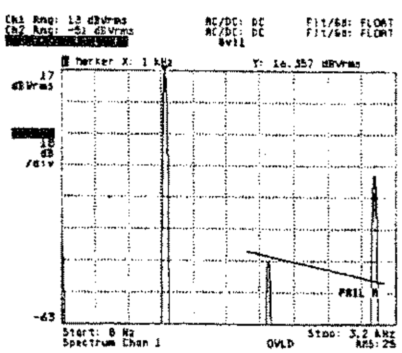
[CHANNEL 1 RANGE]

Then press < v > twice.

This intentionally overloads the analyzer's input to produce a distorted signal.

If you're using the analyzer's internal source (and you can't increase the harmonics any more), return to the limit menu. Then use [OFFSET] and related softkeys to lower the limit segment until the test fails.

14. Press < Start >



As the analyzer completes the measurement, note how the test signal now fails the limit test.

If you're not making an averaged measurement, you do not have to press < Start >.

15. This completes the limit test.

If you're finished with limit testing, go back to the limit menu. Then use [TEST EVAL ON/OFF] and [LINES ON/OFF] to turn off limit testing and the limit lines.

Another Limit Table (upper and lower limits)

With this task, you will learn how to create a simple limit table to check the shape of a band-pass filter. Although this example uses a 1 kHz band-pass filter, you can use another type of filter if it's more convenient (the goal of this task is to learn how to build a limit table – the choice of test device is not important). After a bit of practice, you should be able to build a limit table very easily.

Make sure you've read and understood the previous task ("A simple limit table") before starting this task.

Another Limit Table (continued)

1. Connect a 1 kHz band-pass filter to the analyzer.

This is the same test device used in Chapter 9, "Filter Characterization."

If you use another type of filter, you can follow along with this task, but you may need to use a different frequency span.

2. Make a frequency response measurement.

If you need review, use the procedures outlined in chapter 9.

3. Press < Freq >

   [ZERO START]

   [SPAN]

   < 2 > < 5 > [kHz]

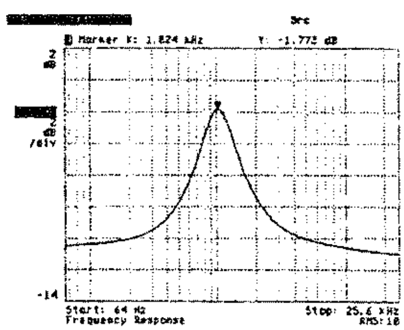
This sets the span to 25.6 kHz.

4. Press < Scale >

   [X-AXIS LIN/LOG]

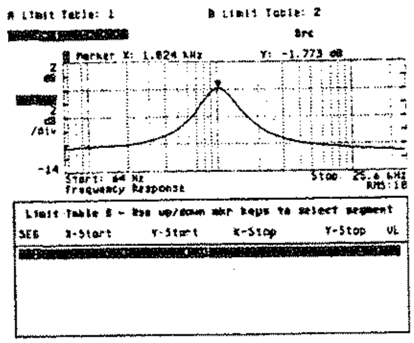
This selects the logarithmic x-axis.

You can use the linear x-axis instead, if it's more convenient.



5. Press < Marker Fctn >

[LIMIT]



To delete an existing limit, press [DELETE] and then [DELETE ALL].

6. Move the marker to the left of the filter peak.

Press [X-START]

< Marker Value >

[Y-START]

< Marker Value >

This defines the start of the first upper limit segment.

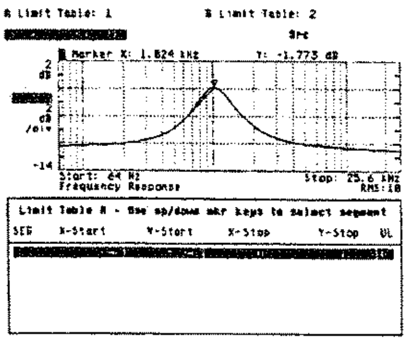
7. Move the marker to the filter peak.

   Press [X-STOP]

   < Marker Value >

   [Y-STOP]

   < Marker Value >



This defines the end of the first upper limit segment.

8. Press < ▼ >

Note how the x-stop and y-stop values are copied from the last segment.

When adding a new segment, the x-start and the y-start values are copied from the preceding segment. This lets you conveniently add a connecting segment to the previous one.

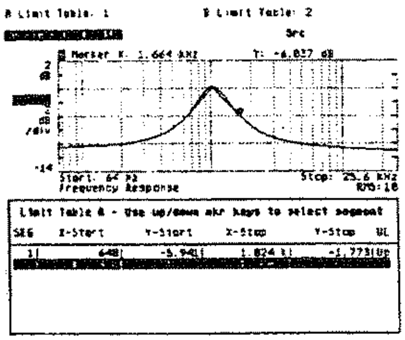
9. Move the marker to the right of the filter peak.

   Press [X-STOP]

   < Marker Value >

   [Y-STOP]

   < Marker Value >



The defines the end of the second upper limit segment.

There's no need to re-enter the x-start and y-start values, since the analyzer has already entered them.

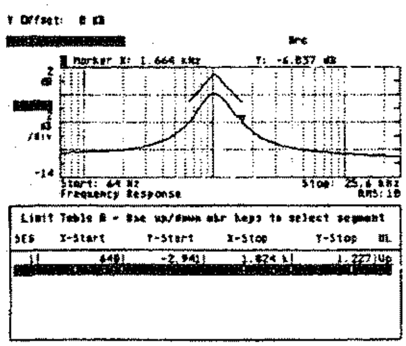
10. Press [OFFSET]

    [Y ADJUST ALL SEGS]

    < 3 >

    [ENTER]

    [RETURN]



This establishes an offset of 3 dB.

Later, you will use another offset to move both upper and lower limits at the same time.

11. Again, move the marker to the left of the filter peak.

    Press < ▼ >

    You are about to create the lower limit line.

12. Press [LIMIT UPPER/**LOW**]

    This designates the following segments as lower limits.

13. Press [X-START]

    This defines the start of the first lower limit segment.

    < Marker Value >

    [Y-START]

    < Marker Value >

14. Move the marker to the filter peak.

    This defines the end of the first lower limit segment.

    Press [X-STOP]

    < Marker Value >

    [Y-STOP]

    < Marker Value >

15. Press < ▼ >

    This adds yet another segment.

16. Move the marker to the right of the filter peak.

    The defines the end of the second lower limit segment.

    Press [X-STOP]

    < Marker Value >

    [Y-STOP]

    < Marker Value >

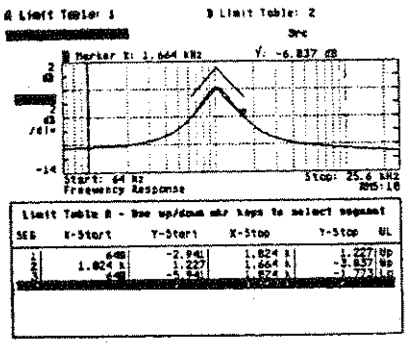
17. Press [OFFSET]

[Y ADJUST ALL SEGS]

< – > < 1 > < . > < 5 >

[ENTER]

[RETURN]

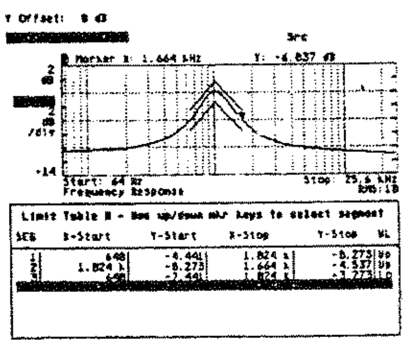


This establishes an offset of –1.5 dB.

The limits are now centered around the frequency response curve. If another filter has a response that differs by more than plus or minus 1.5 dB, the limit test will fail.

18. Press [LIMIT CONFIG]

[TEST EVAL **ON**/OFF]



This turns on the limit testing.

19. Press [RETURN]

[RETURN TBL DOWN]

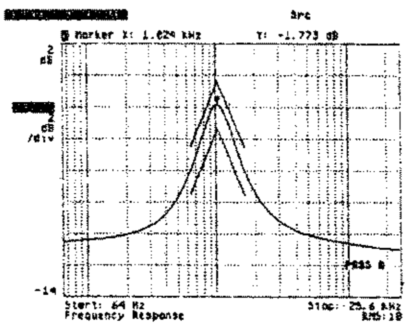
This exits the limit table display.

To save the limit table, press < Save >, [SAVE MORE]. Then press [SAVE LIMIT]. The analyzer will assign a filename for you. Then press [ENTER].

To use a different filename, enter a new name with the alphanumeric keypad. Then press [ENTER]. Be sure to use the proper prefix if you want the limit to go to a different (non-current) mass storage device.

20. Press < Format >

[SINGLE]



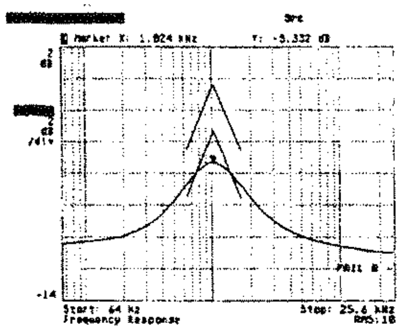
This returns to the single-trace display format.

The test signal should pass the limit test. If it doesn't, go back and readjust the limit segments accordingly.

By the way, the limit lines in this example are not very smooth — that's because each line is defined by only two segments. To get smoother-looking limit lines, you would have to enter more segments to define each limit.

21. If possible, adjust the filter to change its frequency response.

    Then press < Start >



As the analyzer completes the measurement, note how the test signal now fails the limit test.

If your filter does not have an adjustment, you can simply attenuate the filter's output to make the response curve fall outside the limit lines. Alternatively, you can go back and change the limit lines (using the offset softkeys).

22. This completes the limit test.

If you're finished with limit testing, go back to the limit menu. Then use [TEST EVAL ON/OFF] and [LINES ON/OFF] to turn off limit testing and the limit lines.

Chapter 15
Waveform Math Operations

Overview

Waveform math lets you perform a variety of operations on current (or stored) traces. Here's what you should know:

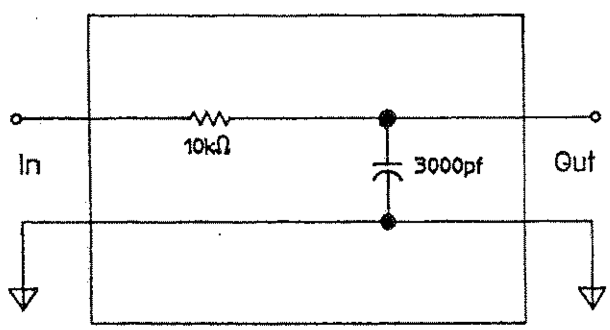
- Functions are specified by entering the definition with operands and operators in infix (standard algebraic) notation. After you enter a function, you can use it to perform waveform (trace) math operations with a combination of measurement data, stored trace data, and constants for display in the currently-active trace.
- Constants can be defined as real or complex quantities. To accomplish this, you are given the choice of defining the real part, imaginary part, magnitude, and phase of the constant — all independently.
- To view the results of a math operation, press < Meas Data > and use the appropriate softkeys to call up the math results.
- To exit any math menu without affecting any function of constant definitions, simply press any hardkey.
- If any data resulting from a math operation overflows the analyzer's floating point limits, an OVFLW message appears. For example, this occurs when a math function involves a divide-by-zero operation.
- When performing a math operation with stored traces, unexpected results may occur if the stored traces are not in the same domain (either the frequency domain or the time domain) or if the stored traces have different frequency spans (frequency-domain traces) or time record lengths (time-domain traces). For example, when multiplying two stored spectrum traces, make sure both traces have the same frequency span and the same start frequency.

To learn more about math operations, see the *HP 35660A Front-Panel Reference.*

A Simple Math Operation

Using waveform math, you will take a frequency response trace and invert it. Then you will multiply the frequency response by the inverted curve to produce a flat frequency response trace. Although this example uses a 5 kHz low-pass filter, you can use another type of filter if it's more convenient (the goal of this task is to learn how to perform a simple waveform math operation – the choice of test device is not important).

The example low-pass filter has just two components and is very easy to build. The same device is also used in Chapter 13, "Data Tables."



Low-pass Filter

A Simple Math Operation

(continued)

1. Connect the 5 kHz low-pass filter to the analyzer.

If you use another type of filter, you can follow along with this task, but you may need to use a different frequency span.

2. Make a frequency response measurement.

If you need review, use the procedures outlined in chapter 9.

3. Press < Freq >

   [ZERO START]

   [SPAN]

   < 2 > < 5 > [kHz]

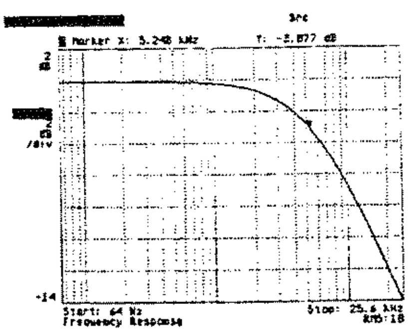
This sets the span to 25.6 kHz.

4. Press < Scale >

   [X-AXIS LIN/LOG]

This selects the logarithmic x-axis.

You can use the linear x-axis instead, if it's more convenient.



5. Press < Save >

   [SAVE TRACE]

   [INTO FILE 'TRACE1']

   This saves the frequency response trace to the 'TRACE1' file.

6. Press < Math >

   [DEFINE K1]

   Make sure the real part of constant K1 is set to 1.

   If it isn't, use the numeric keypad to enter 1, then press [ENTER].

7. Press [RETURN]

   < Math >

   [DEFINE F1]

   You are about to define math function F1.

8. Press [CONSTANT (K1-K5)]

   [CONSTANT K1]

   [/]

   [STORED DATA]

   [FILE 'TRACE1']

   [ENTER]

   This defines math function F1 as:

   K1/(stored frequency response)

   Since K1 (real part) is 1, the math expression is really:

   1/(stored frequency response)

9. Press < Meas Data >

   [MORE]

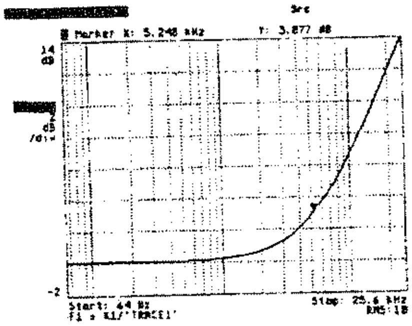
   [FUNCTION (F1-F5)]

   [FUNCTION F1]

   This performs the math function and displays the resulting trace.

10. Press < Scale >

[AUTO SCALE]



You may need to readjust the scale to display the entire trace.

In the example here, we used < ⇧ > and < ⇩ > to make additional adjustments to the trace.

Note how the trace is an exact copy of the original frequency response, but inverted. The label underneath the trace shows the math function used to produce this trace.

11. Press < Math >

[DEFINE F2]

[MEAS DATA]

[FREQUENCY RESPONSE]

[*]

[FUNCTION (F1-F5)]

[FUNCTION F1]

[ENTER]

This defines math function F2 as:

(current freq. response)*(F1)

In other words, when you display math function F2, the resulting trace will be the current frequency response data multiplied by function F2 (the inverted frequency response trace).

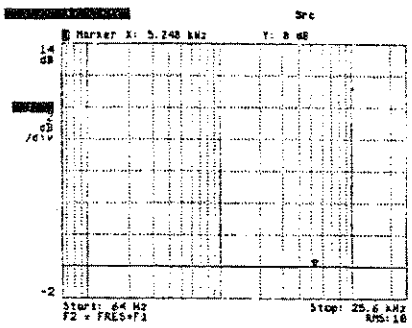
In this example, the purpose of math function F2 is to use the inverted trace to cancel the effects of the low-pass filter (the resulting trace should show a flat response).

12. Press < Meas Data >

[MORE]

[FUNCTION (F1-F5)]

[FUNCTION F2]



This performs the math function and displays the resulting trace.

If you did everything correctly, the resulting trace should show a flat response.

If you press < Start > again, math function F2 will be applied to the next frequency response trace (if you have time, modify the test device and take another frequency response measurement — the resulting trace from function F2 will not be flat anymore).

Another Math Operation

In this task, you will take a spectrum measurement and divide it by $j\omega$ (where $\omega = 2\pi f$). This operation is useful for mechanical measurements because it converts signals proportional to acceleration to a signal proportional to velocity.

Although this math operation is performed entirely in the frequency domain, the effect is the same as integrating a time-domain signal. Conversely, multiplying by $j\omega$ has the effect of differentiating a time-domain signal.

Another Math Operation (continued)

1. Connect a BNC cable from the analyzer's source to the channel 1 input.

   Turn on the periodic chirp and set it at 1 Vrms.

   By now, you should already know how to do this. If you need review, go back and complete the tasks in chapter 2, chapter 4, and chapter 9.

2. Select the Uniform window; then turn on rms averaging.

   Ten rms averages is sufficient to produce a smooth trace.

3. Press < Freq >

   [SPAN]

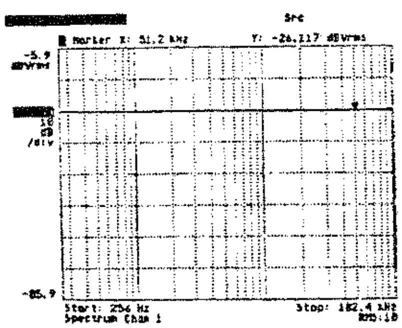
   [FULL SPAN]

   The span should be set to 102.4 kHz.

4. Press < Scale >

   [X-AXIS LIN/LOG]

   This selects the logarithmic x-axis.



5. Press < Math >

   [DEFINE F1]

You are about to define math function F1.

6. Press [MEAS DATA]

   [SPECTRUM CHANNEL 1]

   [/]

   [jOMEGA]

   [ENTER]

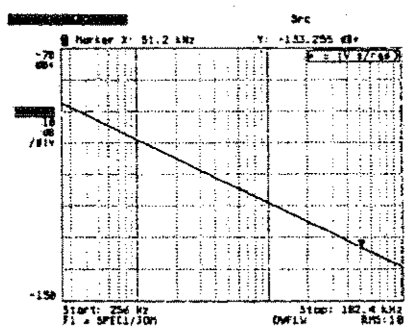
This divides the current channel 1 spectrum by $j\omega$.

7. Press < Meas Data >

   [MORE]

   [FUNCTION (F1-F5)]

   [FUNCTION F1]



This shows the results of the math function.

The "OVFLW" message underneath the trace indicates an overflow during a math operation. This is normal for this operation, since $j\omega$ is 0 at 0 Hz, and thus generates a divide-by-zero error.

8. Press < Scale >

   [AUTO SCALE]

You may need to readjust the scale to display the entire trace.

Index

Hewlett-Packard Sales and Service Offices

To obtain Servicing information or to order replacement parts, contact the nearest Hewlett-Packard Sales and Service Office listed in HP Catalog, or contact the nearest regional office listed below:

In the United States

California
P.O. Box 4230
1421 South Manhattan Avenue
Fullerton 92631

Georgia
P.O. Box 105005
2000 South Park Place
Atlanta 30339

Illinois
5201 Tollview Drive
Rolling Meadows

New Jersey
W. 120 Century Road
Paramus 07652

In Canada
Hewlett-Packard (Canada) Ltd.
17500 South Service Road
Trans-Canada Highway
Kirkland, Quebec H9J 2M5

In France
Hewlett-Packard France
F-91947 Les Ulis Cedex
Orsay

In German Federal Republic
Hewlett-Packard GmbH
Vertriebszentrale Frankfurt
Berner Strasse 117
Postfach 560 140
D-6000 Frankfurt 56

In Great Britain
Hewlett-Packard Ltd.
King Street Lane
Winnersh, Wokingham
Berkshire RG11 5AR

In Other European Countries
Switzerland
Hewlett-Packard (Schweiz) AG
7, rue du Bois-du-Lan
Case Postale 365
CH-1217 Meyrin

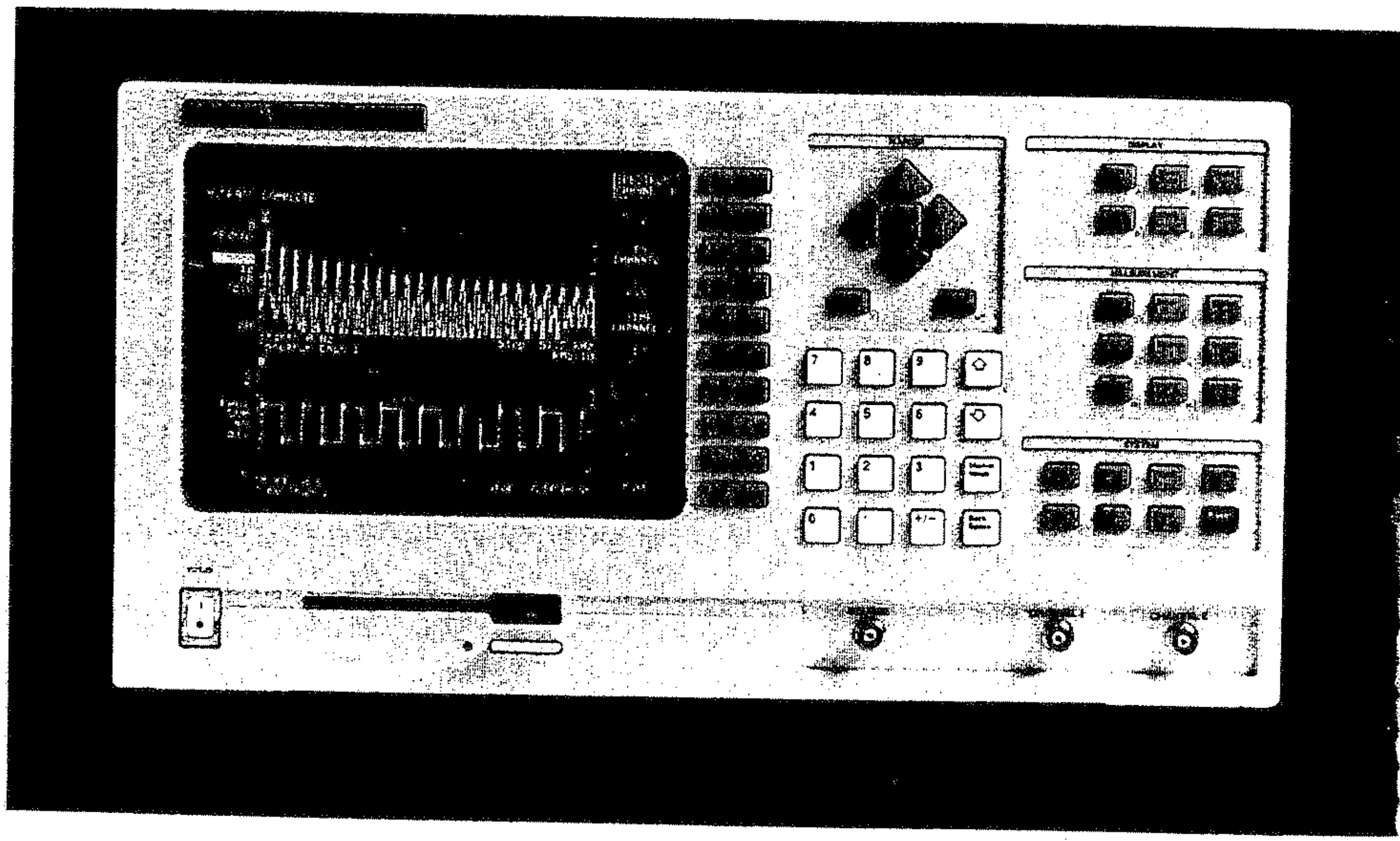
In All Other Locations
Hewlett-Packard Inter-Americas
3155 Porter Drive
Palo Alto, California 94304

35660-90005

HEWLETT
PACKARD

HP 35660A Dynamic Signal Analyzer
Front-Panel Reference

HEWLETT-PACKARD



HP 35660A Dynamic Signal Analyzer Front-Panel Reference

HEWLETT PACKARD

HP 35660A Dynamic Signal Analyzer
Front-Panel Reference

Manual Part No. 35660-90010
Microfiche Part No. 35660-90210

8600 Soper Hill Road
Everett, Washingtion 98205-1298 U.S.A.

Printed: July 1988

HEWLETT PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and the calibration facilities of other International Standards Organization Members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by -hp-. Buyer shall prepay shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to -hp- from another country.

HP software and firmware products which are designated by HP for use with a hardware product, when properly installed on the hardware product, are warranted not to fail to execute their programing instructions due to defects in materials and workmanship. If HP receives notice of such defects during their warranty period, HP shall repair or replace software media and firmware which do not execute their programming instructions due to such defects. HP does not warrant that the operation of the software, firmware or hardware shall be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

HEWLETT PACKARD

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure the safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

HEWLETT PACKARD

SAFETY SYMBOLS

General Definitions of Safety Symbols Used On Equipment or In Manuals.

⚠	Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.
ϟ	Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked.)
⏚ OR (⏚)	Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.
(⏚)	Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.
⏊ OR ⊥	Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.
∿	Alternating current (power line).
⎓	Direct current (power line).
≂	Alternating or direct current (power line).

WARNING ***The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which if not correctly performed or adhered to, could result in injury or death to personnel.***

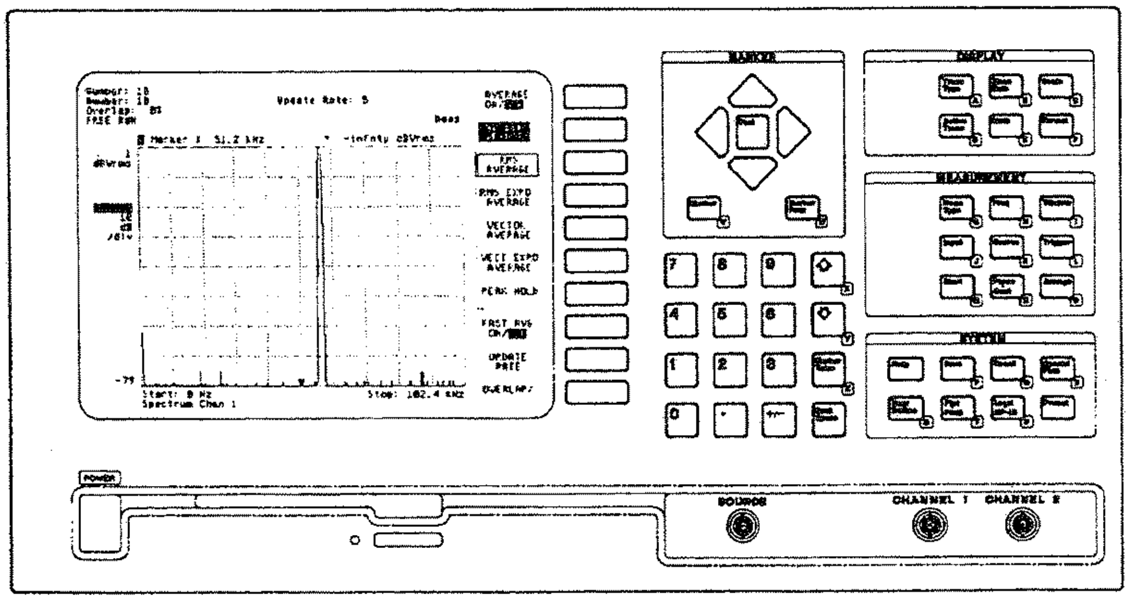
CAUTION *The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.*

NOTE The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

Table of Contents

Chapter 1
Before You Begin

About the Analyzer



The HP 35660A Dynamic Signal Analyzer is really two instruments in one – a network analyzer and a spectrum analyzer. You can make network or two-channel spectrum measurements, from 244 μHz to 51.2 kHz; or single-channel spectrum measurements from 488 μHz to 102.4 kHz. There's also a built-in signal source with choice of random noise, periodic chirp (fast sine sweep), or fixed sine wave.

How to Use this Book

This book is the most complete source of information about the front-panel operation of the HP 35660A Dynamic Signal Analyzer. It contains a great deal of information not included in the *HP 35660A Getting Started Guide,* the *HP 35660A Installation Guide,* and the *HP 35660A HP-IB Programming Reference.* The Front-Panel Reference also repeats important information presented in the other manuals. In short, this book provides a single reference for front-panel information after you are familiar with the analyzer.

Inside the Front-Panel Reference, you'll find a detailed description for each of the instrument's hardkeys and softkeys. There are also menu maps and an index to help you locate the information you need.

Please note that this book is not a tutorial. To learn about the analyzer, read the *HP 35660A Getting Started Guide.* The Getting Started Guide provides an introduction to FFT analyzers and some essential basics you should know before using the HP 35660A. Once you're familiar with the analyzer, you will probably use the Front-Panel Reference most of the time.

Where to find Additional Information

To learn about the analyzer, read the *HP 35660A Getting Started Guide.* The Getting Started Guide provides an introduction to FFT analyzers and some essential basics you should know before using the HP 35660A.

For specifications, installation instructions, and performance tests, see the *HP 35660A Installation Guide.*

To help you operate the analyzer remotely via HP-IB, see the *HP 35660A Programing Reference.*

Additionally, you will find applications information in numerous Hewlett-Packard Application Notes. These are available from your local HP Sales and Service Office. In particular, you might want to request a copy of the following application notes:

- AN 243 – The Fundamentals of Signal Analysis
- AN 243-1 – Effective Machinery Maintenance Using Vibration Analysis
- AN 243-2 – Control System Development Using Dynamic Signal Analyzers
- AN 243-3 – The Fundamentals of Modal Testing

Chapter 2
Front-Panel Overview

The analyzer's front panel keys are divided into six groups:

- Softkeys
- Measurement Keys
- Display keys
- Marker keys
- System keys
- Numeric entry keys

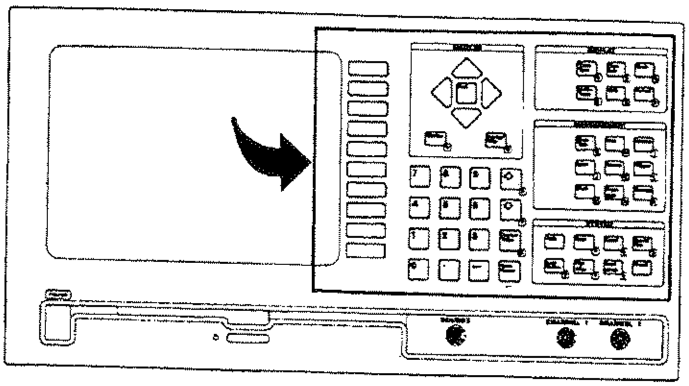
There are additional items on the front panel:

- CRT screen
- Source connector
- Input connectors
- Disc drive
- Power switch

And there are several items on the rear panel:

- HP-IB connector (25-pin)
- External trigger connector
- Fuse, voltage selection switch, and power receptacle
- Data connector (9-pin)

Front-Panel Keys



"Hardkeys" and "Softkeys"

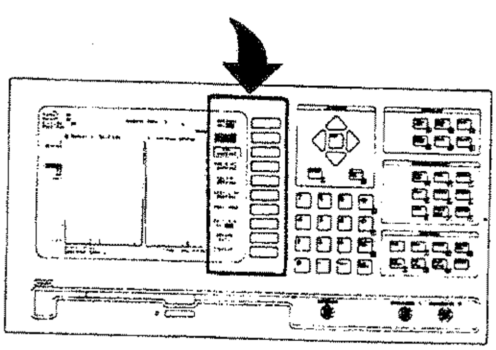
Before you use this book, it's important to understand the difference between hardkeys and softkeys.

Hardkeys are front-panel buttons whose functions are always the same. Most hardkeys have a label printed directly on the key itself. Throughout this book, they are printed like this: < HARDKEY >.

Softkeys are keys whose functions change with the analyzer's current menu selection. A softkey's function is indicated by a video label to the left of the key (on the edge of the analyzer's screen). Throughout this book, softkeys are printed like this: [SOFTKEY].

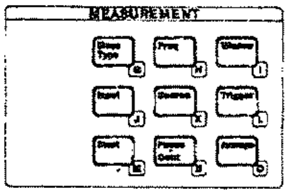
Softkeys

Use softkeys to select items from the menus that appear after pressing a hardkey.



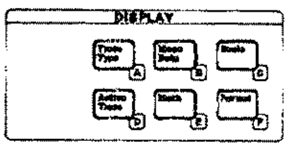
Measurement keys

Use these to set up and control measurements.



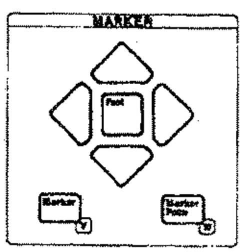
Display keys

Use these to specify how you want measurement results to be displayed; use them also to define waveform math functions.



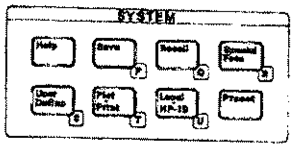
Marker keys

Use these to move the analyzer's markers; use them also to select additional marker functions, including THD, limits, and data tables.



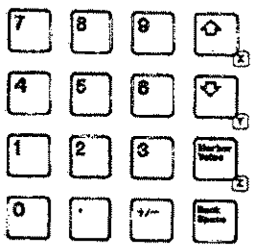
System keys

Use these for storage, HP-IB functions, and hardcopy operations; use them also for on-line HELP, preset, and special functions.



Numeric entry keys

Use these to enter numeric values. Numeric entry keys are often used with "alpha-shifted" keys.

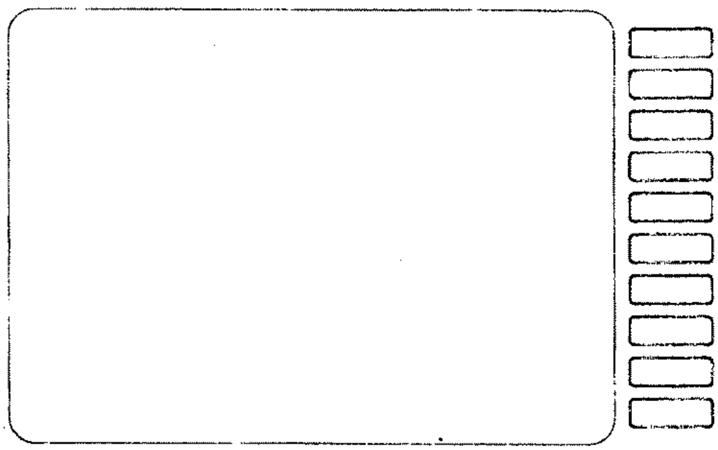


For those entries that require alpha characters, the analyzer automatically shifts certain hardkeys to alpha entry keys (note the alpha characters engraved on the front panel below these hardkeys). When it's no longer necessary to enter alpha characters, the analyzer automatically returns these hardkeys to their normal functions.

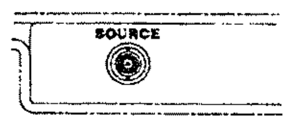
Other Controls

CRT screen

For care and cleaning of the CRT screen, see the *HP 35660A Installation Guide.*



Source connector



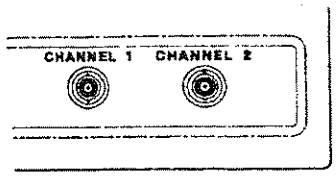
The analyzer has an internal signal source, with choice of sine, random noise, or periodic chirp waveforms. To learn more about each of these, see the < Source > hardkey and related softkeys later in this book.

You do not need to terminate the analyzer's source, since the output impedance is less than 5Ω.

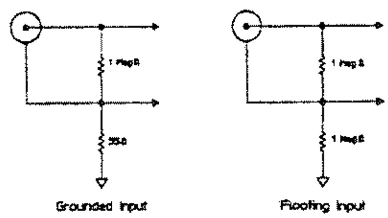
NOTE When you turn on the analyzer's power (and when you turn off power), a brief pulse may appear at the source output connector. In light of this, do not cycle power if you have sensitive test devices connnected to the analyzer's source.

Input connectors

The analyzer has two input channels. Both have input resistances of 1 MΩ, shunted by less than 100 pF of capacitance. The input channels can be ac or dc coupled.



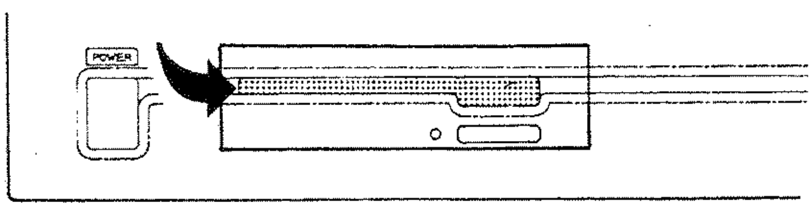
With ac coupling, the input signal rolls off 3 dB at 1 Hz. So for very small spans at low frequencies, you should use dc coupling to avoid measurement error.



You can select grounded or floating inputs for either input channel.

Disc drive

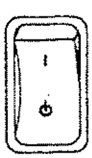
This is the analyzer's internal disc drive. It accepts standard 3.5" floppy discs (use only double-sided discs).



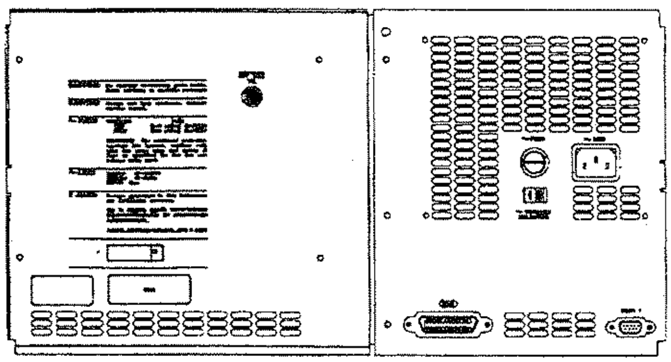
NOTE The disc drive is designed for operation in a typical office environment. Use of the equipment in an environment containing dirt, dust, or corrosive substances will drastically reduce the life of the disc drive and the flexible discs. The discs should be stored in a dry, static-free environment.

Power switch

The analyzer's power switch has two positions – on (I) standby (⏻)



Rear-Panel Items



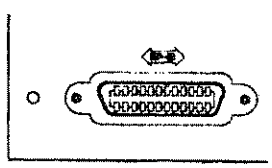
HP-IB connector (25-pin)

The analyzer is compatible with the Hewlett-Packard Interface Bus (HP-IB). The HP-IB is Hewlett-Packard's implementation of IEEE Standard 4882.

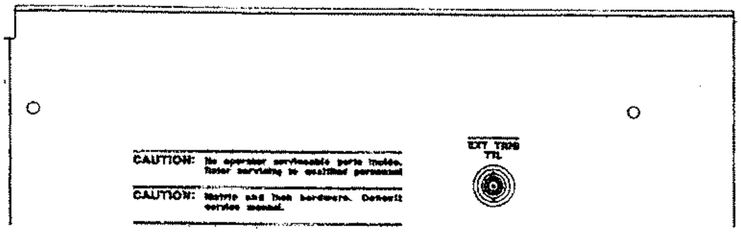
To connect the analyzer to a compatible HP-IB device, use an HP-IB interface cable. The total allowable transmission path length is 2 meters times the number of devices or 20 meters, whichever is less. Operating distances can be extended using an HP-IB extender.

To learn more about controlling the analyzer over the HP-IB, see the HP 35660A Programing Reference.

CAUTION *The analyzer contains metric-threaded HP-IB cable mounting studs as opposed to English threads. Metric-threaded HP-IB cable lockscrews must be used to secure the cable to the analyzer. Metric-threaded fasteners are colored black while English-threaded fasteners are colored silver.*



External trigger connector

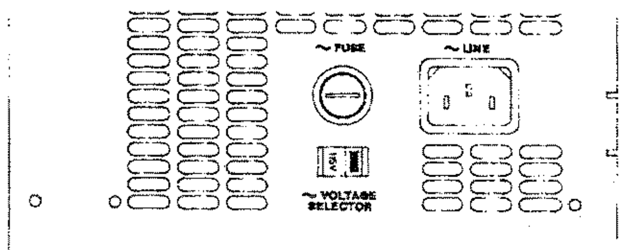


Connect an external trigger signal here. If you select external triggering, the analyzer will begin a measurement when the signal applied to the external trigger input connector goes from logic-low to logic-high (positive slope) or from logic-high to logic-low (negative slope).

NOTE Unlike input triggering and source triggering, external triggering requires a digital signal – make sure the signal applied to the external trigger input is at standard TTL levels.

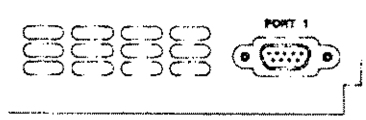
Fuse, voltage selection switch, and power receptacle

For information about these items, see the *HP 35660A Installation Guide*



Port 1 connector (9-pin)

This connector is not active at this time.



Chapter 3
Key Reference

Measurement Keys

< Meas Type >

Press < Meas Type > to call up a measurement selection menu. This menu lets you select a one-channel or a two-channel measurement.

[1 CHANNEL 102.4 kHz]

Press [1 CHANNEL 102.4 kHz] to specify a one-channel measurement. The analyzer will take data from channel 1 only.

NOTE The maximum frequency measurement range for a one-channel measurement is 488 μHz to 102.4 kHz.

[2 CHANNEL 51.2 kHz]

Press [2 CHANNEL 51.2 kHz] to specify a two-channel measurement. The analyzer will take data from channel 1 and channel 2.

NOTE The maximum frequency measurement range for a two-channel measurement is 244 μHz to 51.2 kHz.

< Input >

Press < Input > to call up an input selection menu. This menu lets you select an appropriate input configuration.

Here's what else you should know:

- If you overload the current input range, an "Ovl1" or "Ovl2" message appears at the top of the analyzer's screen. If you exceed the analyzer's maximum range, an "OVLD" message appears at the bottom of the screen.
- If you're making averaged measurements, the analyzer will initiate, automatically, another series of averages after you modify any items in the < Input > menu. For example, if you change input ranges, the analyzer will begin an averaged measurement right away, without waiting for you to press < Start >.

[CHANNEL 1 RANGE]

To manually set the channel 1 input range, press [CHANNEL 1 RANGE]. Then use the numeric keypad to enter an input range value.

NOTE The analyzer will round up your entered value to the next allowable value. You can also use the <⇧> <⇩> hardkeys to step through the allowable values.

You should set the input range manually when you want to maintain a specific input range setting. Ideally, the signal peak should fall within the upper half of the currently-selected input range.

If you set the input range too low (more sensitive than necessary), the analyzer's input circuitry will introduce distortion into the measurement. But if you set the input range too high (less sensitive than necessary), the resulting loss of dynamic range will introduce additional noise — in some cases, the increase in the noise floor may even obscure low-level frequency components.

[CHANNEL 1 AUTORANGE]

Press [CHANNEL 1 AUTORANGE] to activate autorange up for Channel 1. "Autorange up" means that when you start a measurement, the analyzer sets the input to the most sensitive range, and automatically steps through less-sensitive input ranges until the input channel is no longer overloaded.

If the input signal amplitude increases after the range is set (enough to overload the input), the analyzer will begin stepping through even less-sensitive ranges. Again, this stops when the input is no longer overloaded.

If the input signal amplitude decreases, the analyzer will *not* change to a different range. The input range will remain at the setting the analyzer found appropriate at the beginning of the measurement.

By the way, the analyzer does not autorange while averaging — so don't change the output of your test device during the averaging procedure. If an over-range condition occurs while averaging, an overload message appears but the analyzer does not abort the averaging procedure.

[CHANNEL 1 SETUP]

Press [CHANNEL 1 SETUP] to begin setup procedures for the channel 1 input.

[FLOAT/GND]

Press [FLOAT/GND] to select a pseudo-floating or grounded input for Channel 1. Both have input resistances of 1 MΩ, shunted by less than 100 pF of capacitance.

Here's what else you should know:

- The pseudo-floating input has a 1 MΩ resistance from the shell of the BNC connector to the analyzer's chassis ground – that's why it's called a "pseudo-floating" input, since the input connector ground is not completely isolated from the chassis ground.
- The grounded input has a 55Ω resistance from the shell of the BNC connector to the analyzer's chassis ground.
- Both pseudo-floating and grounded inputs have a 1 MΩ resistance from the center conductor to the shell of the BNC input connector.

[AC/DC]

Press [AC/DC] to select ac or dc coupling for channel 1.

NOTE With ac coupling, the input signal rolls off 3 dB at 1 Hz. So for very small spans at low frequencies, you should use dc coupling to avoid measurement error.

[UNITS]

Press [UNITS] to call up a menu that lets you assign appropriate units to the Channel 1 input signal.

[VOLTS]

Press [VOLTS] to tell the analyzer that you want the input signal to be interpreted as volts (peak).

[ENG UNITS]

Press [ENG UNITS] to tell the analyzer that you want the Channel 1 input signal to be interpreted as engineering units. An "engineering unit" is an arbitrary unit to which you can assign any voltage value.

Using engineering units, you can get the analyzer to show results in non-voltage units, such as mils, inches per second, or g's. This is useful when making rotating machinery or vibration measurements.

Engineering units are useful because they allow you to effectively convert a transducer's output voltage to any numerical value – and to assign a label to these units as well. However, the transducer must be a linear device. Engineering units are valid only when the relationship between the engineering unit and the transducer's output voltage is linear.

To use engineering units, you must enter an EU value (using the [ENG UNIT VALUE] softkey). The analyzer divides the input by this value to obtain the desired EU. You must also enter a descriptive label (using the [ENG UNIT LABEL] softkey).

For example, if a transducer is calibrated at 10 mV/G, you can enter "G" as the EU label and enter 10 mv as the EU value.

[ENG UNIT VALUE]

Press [ENG UNIT VALUE] to specify the number of volts per engineering units to be assigned to Channel 1. The value you enter must be between 1e−9 and 1e200.

[ENG UNIT LABEL]

Press [ENG UNIT LABEL] to assign a name to the Channel 1 engineering units.

[CHANNEL 2 RANGE]

To manually set the channel 2 input range, press [CHANNEL 2 RANGE]. Then use the numeric keypad to enter an input range value.

NOTE The analyzer will round up your entered value to the next allowable value. You can also use the <⇧> <⇩> hardkeys to step through the allowable values.

You should set the input range manually when you want to maintain a specific input range setting. Ideally, the signal peak should fall within the upper half of the currently-selected input range.

If you set the input range too low (more sensitive than necessary), the analyzer's input circuitry will introduce distortion into the measurement. But if you set the input range too high (less sensitive than necessary), the resulting loss of dynamic range will introduce additional noise — in some cases, the increase in the noise floor may even obscure low-level frequency components.

[CHANNEL 2 AUTORANGE]

Press [CHANNEL 2 AUTORANGE] to activate autorange up for Channel 2. "Autorange up" means that when you start a measurement, the analyzer sets the input to the most sensitive range, and automatically steps through less-sensitive input ranges until the input channel is no longer overloaded.

If the input signal amplitude increases after the range is set (enough to overload the input), the analyzer will begin stepping through even less-sensitive ranges. Again, this stops when the input is no longer overloaded.

If the input signal amplitude decreases, the analyzer will *not* change to a different range. The input range will remain at the setting the analyzer found appropriate at the beginning of the measurement.

By the way, the analyzer does not autorange while averaging — so don't change the output of your test device during the averaging procedure. If an over-range condition occurs while averaging, an overload message appears but the analyzer does not abort the averaging procedure.

[CHANNEL 2 SETUP]

Press [CHANNEL 2 SETUP] to begin setup procedures for the channel 2 input.

[FLOAT/GND]

Press [FLOAT/GND] to select a pseudo-floating or grounded input for Channel 2. Both have input resistances of 1 MΩ, shunted by less than 100 pf of capacitance.

Here's what else you should know:

- The pseudo-floating input has a 1 MΩ resistance from the shell of the BNC connector to the analyzer's chassis ground – that's why it's called a "pseudo-floating" input, since the input connector ground is not completely isolated from the chassis ground.
- The grounded input has a 55Ω resistance from the shell of the BNC connector to the analyzer's chassis ground.
- Both pseudo-floating and grounded inputs have a 1 MΩ resistance from the center conductor to the shell of the BNC input connector.

[AC/DC]

Press [AC/DC] to select ac or dc coupling for channel 2.

NOTE With ac coupling, the input signal rolls off 3 dB at 1 Hz. So for very small spans at low frequencies, you should use dc coupling to avoid measurement error.

[UNITS]

Press [UNITS] to call up a menu that lets you assign appropriate units to the Channel 2 input signal.

[VOLTS]

Press [VOLTS] to tell the analyzer that you want the input signal to be interpreted as volts (peak).

[ENG UNITS]

Press [ENG UNITS] to tell the analyzer that you want the Channel 2 input signal to be interpreted as engineering units. An "engineering unit" is an arbitrary unit to which you can assign any voltage value.

Using engineering units, you can get the analyzer to show results in non-voltage units, such as mils, inches per second, or g's. This is useful when making rotating machinery or vibration measurements.

Engineering units are useful because they allow you to effectively convert a transducer's output voltage to any numerical value – and to assign a label to these units as well. However, the transducer must be a linear device. Engineering units are valid only when the relationship between the engineering unit and the transducer's output voltage is linear.

To use engineering units, you must enter an EU value (using the [ENG UNIT VALUE] softkey). The analyzer divides the input by this value to obtain the desired EU. You must also enter a descriptive label (using the [ENG UNIT LABEL] softkey).

For example, if a transducer is calibrated at 10 mV/G, you can enter "G" as the EU label and enter 10 mv as the EU value.

[ENG UNIT VALUE]

Press [ENG UNIT VALUE] to specify the number of volts per engineering units to be assigned to Channel 2. The value you enter must be between 1e−9 and 1e200.

[ENG UNIT LABEL]

Press [ENG UNIT LABEL] to assign a name to the Channel 2 engineering units.

[dBm REF IMPEDANCE]

Press [dBm REF IMPEDANCE] to select a reference impedance for your test. The analyzer uses this impedance value for dBm calculations. The value you enter must be greater than zero and less than (or equal to) 10 MΩ. If you don't specify a value, the analyzer will use 50Ω as the default value.

[MOhm]

Press [MOhm] to specify the value you've just entered in MΩs.

[kOhm]

Press [kOhm] to specify the value you've just entered in kΩs.

[Ohm]

Press [Ohm] to specify the value you've just entered in Ωs.

< Source >

Press < Source > to call up a source selection menu. This menu lets you select a source waveform appropriate for the type of measurement you want to make. It also lets you set output levels for each waveform, as well as the frequency of the sine wave source.

NOTE When you turn on the analyzer's power (and when you turn off power), a brief pulse may appear at the source output connector. In light of this, do not cycle power if you have sensitive test devices connnected to the analyzer's source.

[SOURCE ON/OFF]

Press [SOURCE ON/OFF] to turn the analyzer's source on or off. When you first turn on the analyzer (or press [Preset]), the source selected will be fixed sine, and it will be turned off.

NOTE If you turn off the source and turn it on again, the output level will automatically return to the level you set previously – even if you've selected a different source waveform.

[LEVEL]

Press [LEVEL] to specify an output level for the analyzer's source – this level applies to all waveforms. You can specify peak volts, true rms volts, peak dBV, or rms dBV. If you don't specify a new output level, the output levels will remain at the level you set previously.

Keep in mind that the level you set for random noise or periodic chirp is the total wideband level (in other words, the summation of these waveforms measured at full span). If you're using smaller frequency spans, not all of this energy will appear in the measurement because some of the waveform's power will be outside the selected span.

If you specify the source level with one type of unit (V, for example) but want to see what this same level would be using a different unit (such as dBVpk), there's a convenient way to do this. For example, first enter a level of 1V. Once you've entered 1V, press < . > on the number keypad. Then press the softkey for the unit you prefer (for example, dBVpk). The source level is now displayed as 0 dBVpk.

Incidentally, this conversion feature works anytime the analyzer asks you to enter units – not just when setting the source level.

[RANDOM]

Press [RANDOM] to select the random noise waveform. Random noise yields a fast, linear estimate of the system under test. Because it is not periodic in the time record, random noise requires windowing (usually the Hanning window). See HELP for < Window > to learn more about windowing.

[PERIODIC CHIRP]

Press [PERIODIC CHIRP] to select the periodic chirp waveform. Periodic chirp is a fast sine sweep across the current frequency span that repeats with the same period as the time record.

Here's what else you should know:

- Because the chirp is periodic, it's best to use the Uniform window when making measurements using this waveform.
- The effect of the periodic chirp is similar to the random noise waveform, but the chirp has a much higher peak-to-rms ratio.

[FIXED SINE]

Press [FIXED SINE] to select the fixed sine waveform. Then press [SINE FREQ ENTRY] to specify the frequency.

[SINE FREQ ENTRY]

Press [SINE FREQ ENTRY] to specify the frequency of the sine waveform. Then enter the frequency. The analyzer will choose the nearest acceptable frequency.

< Frequency >

Press < Frequency > to call up the frequency menu. This menu lets you set the analyzer to look at a specific band of frequencies.

If you're making averaged measurements, the analyzer will initiate, automatically, another series of averages after you modify any items in the < Frequency > menu. For example, if you change the span, the analyzer will begin an averaged measurement right away, without waiting for you to press < Start >.

[SPAN]

Press [SPAN] to specify the frequency bandwidth you want the analyzer to measure. Then use the numeric keypad to enter this value. You can enter any value, but the analyzer will automatically switch to the nearest acceptable value. You can also use the <⇧> <⇩> hardkeys to step through available values for the frequency span.

Here's what else you should know:

- The maximum frequency span is 51.2 kHz for two- channel measurements, and 102.4 kHz for one-channel measurements.
- The span doesn't change when you change the span's start frequency. This is convenient, because it lets you look at different places in the frequency spectrum while still maintaining the same bandwidth.
- For very small spans at low frequencies, you should use dc coupling to avoid measurement error.
- When you change the frequency span, the length of the time record changes also – the exact length of the time record (measured in seconds) is 400 / span. The time record is the basic block of data the analyzer uses to calculate all measurements.
- And conversely, when you change the time record length, the frequency span changes. The time record length and the frequency span are simply different ways of looking at the same data.
- The analyzer's frequency resolution depends on the span you select. To summarize...

  Frequency resolution = Span / 400
  Frequency resolution = 1 / (time record length)
  Frequency span = 400 * 1 / (time record length)
  Time record length = 400 / Span

- The analyzer is not designed to measure dc. However, it is designed to measure very low frequencies — as low as 244 μHz for two-channel measurements and 488 μHz for one-channel measurements. The analyzer can, in fact, measure dc, but not without including a dc offset of its own that can contribute to (or obscure) a dc offset in the input signal. This internal offset is caused by residual dc that originates in the analyzer's input amplifiers. Thus, dc measurements are not guaranteed to be accurate. As you use the analyzer, you will notice a dc offset when making baseband measurements (those with spans that start at 0 Hz). This offset is always present in the 0 Hz bin (sometimes called the dc bin). The feedthrough that causes the offset may also leak into the first several bins as well. If this is a problem, start the frequency span several bins above 0 Hz to avoid the feedthrough.

[START]

Press [START] to specify the start frequency of the frequency band you want analyzed.

Here's what else you should know:

- Selecting a start frequency does not change the frequency span. The size of the span remains at its previous setting.
- As you use the analyzer, you will notice a dc offset when making baseband measurements (those with spans that start at 0 Hz). This offset is always present in the 0 Hz bin (sometimes called the dc bin). The offset is a normal part of the analyzer's operation and is caused by residual dc that originates in the analyzer's input amplifiers. The feedthrough that causes the offset may also leak into the first several bins as well. If this is a problem, start the frequency span several bins above 0 Hz to avoid the feedthrough. See HELP for [SPAN].
- If the (start frequency + frequency span) exceeds the analyzer's range, the analyzer will nonetheless display additional measurement data. For one-channel measurements, the analyzer will show data out to 115 kHz. For two-channel measurements, the analyzer will show data out to 57.5 kHz. Keep in mind though, that any data displayed above the analyzer's specified range (102.4 kHz for one-channel measurements, 51.2 kHz for two-channel measurements) is not guaranteed to be accurate.
- The analyzer does not display any frequency data less than 0 Hz. Therefore, if you specify a start value of less than zero, you won't see anything displayed to the left of 0 Hz.

[CENTER]

Press [CENTER] to specify the center frequency for the frequency band that you want to analyze.

Here's what else you should know:

- If the (center frequency) – (frequency span / 2) is less than zero, the analyzer will not display any data below 0 Hz.
- If the (center frequency) + (frequency span / 2) exceeds the analyzer's range, the analyzer will nonetheless display additional measurement data. For one-channel measurements, the analyzer will show data out to 115 kHz. For two-channel measurements, the analyzer will show data out to 57.5 kHz. Keep in mind though, that any data displayed above the analyzer's specified range (102.4 kHz for one-channel measurements, 51.2 kHz for two-channel measurements) is not guaranteed to be accurate.

[ZERO START]

Press [ZERO START] to select 0 Hz as the starting point of the frequency band to be analyzed. You can also do this by pressing [START] and then entering 0 Hz.

NOTE Setting the start to 0 Hz does not change the frequency span. The size of the span remains at its previous setting.

[FULL SPAN]

Press [FULL SPAN] to have the analyzer look at all frequencies from 0 Hz to its upper limit – 102.4 kHz for one-channel measurements, 51.2 kHz for two-channel measurements.

[STEP]

You can use the < ⇧ > < ⇩ > hardkeys to step through the range of acceptable frequency values, for both the [CENTER] and [START] softkeys. But you can also change the *size* of the step, by pressing [STEP] and then using the numeric keypad to enter the size of the step.

[RECORD LENGTH]

Press [RECORD LENGTH] to specify the length of the time record. Enter a value in seconds.

Here's what else you should know:

- The value that you enter for the time record is limited by the minimum and maximum frequency span that the analyzer will allow.
- When you change the time record, the length of the frequency span changes as well – the exact length of the span (measured in Hz) will be (400) / (time record, in seconds). The time record is the basic block of data the analyzer uses to calculate all measurements.
- When you change the time record, the analyzer continues to use either the start frequency you selected or the center frequency you selected – whichever frequency value you entered most recently. The analyzer can't use both values, since the span changes as the time record changes.

< Average >

Press < Average > to call up an average menu. This menu lets you select averaging appropriate for the type of measurement you want to make.

There are several types of averaging available:

- Stable (normal) rms averaging
- Exponential rms averaging
- Stable (normal) vector averaging
- Exponential vector averaging
- Peak hold averaging

You can also select a fast average mode — this lets the analyzer make averaged measurements without having to update the screen after every average.

By the way, the analyzer does not autorange while averaging — so don't change the output of your test device during the averaging procedure. If an over-range condition occurs while averaging, an overload message appears but the analyzer does not abort the averaging procedure.

[AVERAGE ON/OFF]

Press [AVERAGE ON/OFF] to turn on or turn off averaging.

When you turn on averaging, the analyzer will begin an averaged measurement right away, without waiting for you to press < Start >.

[NUMBER AVERAGES]

Press [NUMBER AVERAGES] to specify the number of averages you want the analyzer to perform for each measurement. You can enter any number from 1 to 99,999.

When using exponential averaging, the number of averages you select determines the weighting of old versus new data — not the total number of averages calculated. As the number of averages increases, new data is weighted less. To learn more, see HELP for [RMS EXPO AVERAGE] or [VECTOR EXPO AVERAGE].

[RMS AVERAGE]

Press [RMS AVERAGE] to select rms (power) averaging.

Remember that rms averaging does not eliminate noise, but simply produces an approximation of the actual noise level. Increasing the number of rms averages provides a better statistical approximation of the noise, but will not actually reduce the noise.

[RMS EXPO AVERAGE]

Press [RMS EXPO AVERAGE] to select exponential rms (power) averaging. Unlike stable (normal) averaging, exponential averaging weights new data more than old data. This is useful for tracking data that changes over time.

When using exponential averaging, the number of averages you select determines the weighting of old versus new data – not the total number of averages calculated. As the number of averages increases, new data is weighted less.

With exponential averaging, it's especially important to set the number of averages carefully – if there are too few averages in the measurement, the averaging will not smooth out variances. But if there are too many averages, the analyzer may not track subtle changes occurring within the data.

To calculate the exponential average, the analyzer uses this formula:

{[(1/N)*(new)] + [((N–1)/N)*(old)]},

where N is a weighting factor (the number of averages you've specified).

When starting an exponential average, the analyzer sets N equal to 1 for the first analysis, then sets N equal to 2 for the second analysis, and so on – until N equals the number of averages you've specified.

Here's what else you should know:

- Once you start a measurement using exponential averaging, the measurement continues indefinitely. To stop it, press < Pause/Cont >. This is different than stable averaging – stable averaging stops automatically after the specified number of averages are completed.
- For the first few averages, there's little difference between exponential averaging and stable averaging. In fact, for the first average, there's no difference between exponential and stable averaging.

[VECTOR AVERAGE]

Press [VECTOR AVERAGE] to select vector averaging.

With vector-averaging, the analyzer averages complex values, point-by-point, in the frequency domain. This lowers noise because the real and imaginary components of the random signals are not in phase and therefore cancel each other — increasingly so with each average. Frequency components that are periodic do not cancel and therefore do not diminish with successive averages.

For mechanical applications, vector averaging is often used during vibration measurements to resolve low-level frequency components from background noise.

Vector averaging produces results similar to *time averaging*, a feature found on many FFT analyzers (time averaging means that the analyzer averages all time records first, then performs a single FFT on an averaged time record). Vector averaging accomplishes the same thing as time averaging, since the averaged linear spectrum derived from a series of vector-averaged linear spectra is equivalent to a single linear spectrum of time-averaged time records.

Although measurements made with vector averaging have better signal-to-noise ratios than rms averaging, there are some restrictions:

- The input signal must be periodic. In other words, the frequency components you want to measure must repeat with each time record. If these components are not periodic (not in phase with the start of each new time record), their real and imaginary values will cancel and the analyzer will not resolve these components.
- If you select vector averaging, you'll need to provide a trigger signal — from the analyzer's source or from an external signal. Of course, the analyzer will still make a measurement with continuous triggering (no trigger signal), but the amplitude of periodic signals will diminish with each successive average (since even periodic components have random phase with continuous triggering).

[VECT EXPO AVERAGE]

Press [VECT EXPO AVERAGE] to select exponential vector averaging. You'll need to provide a trigger signal — from the analyzer's source or from an external signal.

Unlike stable (normal) averaging, exponential averaging weights new data more than old data. This is useful for tracking data that changes over time.

When using exponential averaging, the number of averages you select determines the weighting of old versus new data — not the total number of averages calculated. As the number of averages increases, new data is weighted less.

With exponential averaging, it's especially important to set the number of averages carefully — if there are too few averages in the measurement, the averaging will not smooth out variances. But if there are too many averages, the analyzer may not track subtle changes occurring within the data.

To calculate the exponential average, the analyzer uses this formula:

$$\{[\,(1/N)*(new)\,] + [\,((N-1)/N)*(old)\,]\},$$

where N is a weighting factor (the number of averages you've specified).

When starting an exponential average, the analyzer sets N equal to 1 for the first analysis, then sets N equal to 2 for the second analysis, and so on — until N equals the number of averages you've specified.

Here's what else you should know:

- Once you start a measurement using exponential averaging, the measurement continues indefinitely. To stop it, press < Pause/Cont >. This is different than stable averaging — stable averaging stops automatically after the specified number of averages are completed.
- For the first few averages, there's little difference between exponential averaging and stable averaging.

[CONTINUOS PEAK HOLD]

ress [CONTINUOS PEAK HOLD] to select the peak hold function. When you request the peak-hold unction, the analyzer will take data continuously, until you tell it to stop. The analyzer will ompare each data point along the measured frequency span with the previous values. Only ie largest values for each frequency point will be saved.

echnically, peak-hold averaging is not really a type of averaging, since the results are not athematically averaged. But it's still considered a type of averaging because it combines e results of several measurements into one final measurement result.

re's what else you should know:

- With the peak-hold function, the analyzer mathematically compares each data point to its previous peak value. If the data point is larger than its last peak value, the new value is used. This is not the same thing as peak-holding the displayed trace.
- The peak-hold function works only with spectrum measurements, power spectral density (PSD) measurements, or time records.

[VECTOR AVERAGE]

Press [VECTOR AVERAGE] to select vector averaging.

With vector-averaging, the analyzer averages complex values, point-by-point, in the frequency domain. This lowers noise because the real and imaginary components of the random signals are not in phase and therefore cancel each other – increasingly so with each average. Frequency components that are periodic do not cancel and therefore do not diminish with successive averages.

For mechanical applications, vector averaging is often used during vibration measurements to resolve low-level frequency components from background noise.

Vector averaging produces results similar to *time averaging*, a feature found on many FFT analyzers (time averaging means that the analyzer averages all time records first, then performs a single FFT on an averaged time record). Vector averaging accomplishes the same thing as time averaging, since the averaged linear spectrum derived from a series of vector-averaged linear spectra is equivalent to a single linear spectrum of time-averaged time records.

Although measurements made with vector averaging have better signal-to-noise ratios than rms averaging, there are some restrictions:

- The input signal must be periodic. In other words, the frequency components you want to measure must repeat with each time record. If these components are not periodic (not in phase with the start of each new time record), their real and imaginary values will cancel and the analyzer will not resolve these components.
- If you select vector averaging, you'll need to provide a trigger signal – from the analyzer's source or from an external signal. Of course, the analyzer will still make a measurement with continuous triggering (no trigger signal), but the amplitude of periodic signals will diminish with each successive average (since even periodic components have random phase with continuous triggering).

[VECT EXPO AVERAGE]

Press [VECT EXPO AVERAGE] to select exponential vector averaging. You'll need to provide a trigger signal — from the analyzer's source or from an external signal.

Unlike stable (normal) averaging, exponential averaging weights new data more than old data. This is useful for tracking data that changes over time.

When using exponential averaging, the number of averages you select determines the weighting of old versus new data — not the total number of averages calculated. As the number of averages increases, new data is weighted less.

With exponential averaging, it's especially important to set the number of averages carefully — if there are too few averages in the measurement, the averaging will not smooth out variances. But if there are too many averages, the analyzer may not track subtle changes occurring within the data.

To calculate the exponential average, the analyzer uses this formula:

$$\{[(1/N)*(new)] + [((N-1)/N)*(old)]\},$$

where N is a weighting factor (the number of averages you've specified).

When starting an exponential average, the analyzer sets N equal to 1 for the first analysis, then sets N equal to 2 for the second analysis, and so on — until N equals the number of averages you've specified.

Here's what else you should know:

- Once you start a measurement using exponential averaging, the measurement continues indefinitely. To stop it, press < Pause/Cont >. This is different than stable averaging — stable averaging stops automatically after the specified number of averages are completed.
- For the first few averages, there's little difference between exponential averaging and stable averaging.

[CONTINUOS PEAK HOLD]

Press [CONTINUOS PEAK HOLD] to select the peak hold function. When you request the peak-hold function, the analyzer will take data continuously, until you tell it to stop. The analyzer will compare each data point along the measured frequency span with the previous values. Only the largest values for each frequency point will be saved.

Technically, peak-hold averaging is not really a type of averaging, since the results are not mathematically averaged. But it's still considered a type of averaging because it combines the results of several measurements into one final measurement result.

Here's what else you should know:

- With the peak-hold function, the analyzer mathematically compares each data point to its previous peak value. If the data point is larger than its last peak value, the new value is used. This is not the same thing as peak-holding the displayed trace.
- The peak-hold function works only with spectrum measurements, power spectral density (PSD) measurements, or time records.

[OVERLAP%]

A time record is the basic block of data the analyzer uses to calculate all measurements. To make fast, accurate averaged measurements, the analyzer can overlap time records. To learn more about overlap processing, see the analyzer's Getting Started Guide.

Press [OVERLAP%] to specify the percentage of overlap you want the analyzer to use when making an averaged measurement. You can enter any value from 0 to 99%, in 1% increments.

Here's what else you should know:

- Overlap is not used if you're making triggered measurements. The analyzer must be in the continuous trigger mode.
- The amount of overlap possible varies with the frequency span. For wide spans (with short time records), little or no overlap is possible – the time record is small compared to the time it takes the analyzer to process the time record. For narrow spans (with long time records), considerable overlap is possible – the time record is long compared to the time it takes the analyzer to process the time record.
- The analyzer does not indicate the actual overlap percentage used. For example, if you specify an overlap of 90%, the analyzer will accept this value but may not actually use a 90% overlap if this is incompatible with the current frequency span.
- The analyzer will treat the overlap percentage as the maximum allowed. The actual overlap used depends on the current frequency span, the type of average selected, and how busy the analyzer is servicing the HP-IB and marker functions and key presses. The overlap percentage can change from time record to time record, but will always be less than or equal to the specified overlap percentage. If the analyzer indicates that the current measurement is in real time and the overlap percentage falls below 0%, the REAL-TIME status message will be removed (if you're averaging and this occurs, no attempt will be made to re-enter real time until you start the average again – if averaging is off, real time processing will resume as soon as possible).

[FAST AVG ON/OFF]

Press [FAST AVG ON/OFF] to select the fast average mode – this lets the analyzer make averaged measurements without having to update the screen after each average.

Here's what else you should know:

- Be sure to use the [UPDATE RATE] softkey to specify the number of averages between screen updates. This will affect the speed of the fast average.
- Fast averaging must be on to achieve maximum real-time bandwidths. To learn more about real-time bandwidth, see the analyzer's Getting Started Guide.

[UPDATE RATE]

Press [UPDATE RATE] to specify the number of averages between screen updates for the fast average mode. If you enter 5, for example, the analyzer will update the screen after every five averages. You can enter any whole number between 1 and 99,999.

<Window>

Press < Window > to call up a menu to select the type of input window you want.

A "window" is a time-domain weighting function applied to the input signal – essentially, a way to filter out signals that are not periodic (and therefore spurious) within the input time record. Depending on the window, the analyzer attenuates certain parts of the input time record, to prevent "leakage" – a smearing of energy across the frequency spectrum, caused by transforming signals that are not periodic within the time record.

Windowing is a concept basic to all FFT Dynamic Signal analyzers. To learn more about windowing, see the analyzer's Getting Started Guide.

[HANNING]

Press [HANNING] to select the Hanning window. This tells the analyzer to use the Hanning window to filter input data. The Hanning window is sometimes called the Hann window or Random window.

Here's what else you should know:

- The Hanning window offers better frequency resolution, but poorer amplitude accuracy than the Flat Top window. The Hanning window is the most commonly-used window, and is particularly useful for random noise measurements.
- When you select the Hanning window, the function is applied to *both* input channels.

To learn more about the Hanning window and its applications, see the analyzer's Getting Started Guide.

[FLAT TOP]

Press [FLAT TOP] to select the Flat Top window. This tells the analyzer to use the Flat Top window to filter input data. The Flat Top window is sometimes called a sinusoidal window.

Here's what else you should know:

- The Flat Top window has better amplitude accuracy, but poorer frequency resolution than the Hanning window. The Flat Top window is useful when you must measure the amplitude of a particular frequency component with great accuracy – for example, when using a fixed-sine source.
- When you select the Flat Top window, the function is applied to *both* input channels.

To learn more about the Flat Top window and its applications, see the analyzer's Getting Started Guide.

[UNIFORM]

Press [UNIFORM] to select the Uniform window. This tells the analyzer to use the Uniform window to process input data. The Uniform window is sometimes called a Transient window.

For best results with the Uniform window, you should use signal sources that are periodic – for example, the analyzer's periodic chirp waveform.

Here's what else you should know:

- The Uniform window is really no window at all, since the rectangular shape of the Uniform window does not attenuate any portion of the input time record (all data within the time record is treated equally). This is not the case with the Hanning or Flat Top windows.
- When you select the Uniform window, the function is applied to *both* input channels.

To learn more about the Uniform window and its applications, see the analyzer's Getting Started Guide.

[FORCE EXPO]

Press [FORCE EXPO] to select the Force and Exponential windows. This tells the analyzer to process input data using the windows identified by the softkeys [FORCE CHANNEL 1] or [EXPO CHANNEL 1], and [FORCE CHANNEL 2] or [EXPO CHANNEL 2].

Here's what else you should know:

- Unlike the other windows, you can apply the Force or Exponential window to each channel individually. This allows you to mix the windows in measurements using both input channels, such as frequency response. This application is most commonly used when measuring properties of mechanical structures during impact testing.
- If you apply the Force window to channel 1 and the Exponential window to channel 2, the data for channel 1 is multiplied by both the Force and the Exponential windows.

To learn more about the Force and Exponential windows and their applications, see the analyzer's Getting Started Guide.

[FORCE CHANNEL 1]

Press [FORCE CHANNEL 1] to select the Force window for channel 1. This tells the analyzer to use the Force window to process channel 1 input data. You may also specify the Force window's width. To do this, use the numeric keypad and enter a value between 100E−9 seconds (0.1 us) and 9.99E6 seconds (9.99 ks). The Force window is often used in impact testing to minimize unwanted signals occurring after the actual impact.

Here's what else you should know:

- The width should be less than the time record for the window to be effective.
- This window passes the input signal for the specified amount of time, then sets the signal to the average value of the time record's remaining data.

To learn more about the Force window and its applications, see the analyzer's Getting Started Guide.

[EXPO CHANNEL 1]

Press [EXPO CHANNEL 1] to select the Exponential window for channel 1. This tells the analyzer to use the Exponential window to process channel 1 input data. You may also specify the Exponential window's time constant. To do this, use the numeric keypad and enter a value between 100E−9 seconds (0.1 us) and 9.99E6 seconds (9.99 ks). The Exponential window is often used in lightly damped systems with frequency responses that do not decay within one time record.

Here's what else you should know:

- Generally, the time constant should be set to one-fourth of the time record for the window to be effective.
- This window attenuates the input signal at a decaying exponential rate determined by the specified time constant.

To learn more about the Exponential window and its applications, see the analyzer's Getting Started Guide.

[FORCE CHANNEL 2]

Press [FORCE CHANNEL 2] to select the Force window for channel 2. This tells the analyzer to use the Force window to process channel 2 input data. You may also specify the Force window's width. To do this, use the numeric keypad and enter a value between 100E−9 seconds (0.1 us) and 9.99E6 seconds (9.99 ks). The Force window is often used in impact testing to minimize unwanted signals occurring after the actual impact.

Here's what else you should know:

- The width should be less than the time record for the window to be effective.
- This window passes the input signal for the specified amount of time, then sets the signal to the average value of the time record's remaining data.

To learn more about the Force window and its applications, see the analyzer's Getting Started Guide.

[EXPO CHANNEL 2]

Press [EXPO CHANNEL 2] to select the Exponential window for channel 2. This tells the analyzer to use the Exponential window to process channel 2 input data. You may also specify the Exponential window's time constant. To do this, use the numeric keypad and enter a value between 100E−9 seconds (0.1 us) and 9.99E6 seconds (9.99 ks). The Exponential window is often used in lightly damped systems with frequency responses that do not decay within one time record.

Here's what else you should know:

- Generally, the time constant should be set to one-fourth of the time record for the window to be effective.
- This window attenuates the input signal at a decaying exponential rate determined by the specified time constant.

To learn more about the Exponential window and its applications, see the analyzer's Getting Started Guide.

< Start >

Press < Start > to begin a measurement.

Here's what else you should know:

- If the analyzer is already making a measurement, press < Start > to start the measurement over again.
- If the analyzer is paused, press < Pause/Cont > to continue the measurement.
- If you're in manual arm mode, pressing < Start > does not arm the trigger (you'll have to press [ARM] in the trigger menu to do that).
- Pressing < Start > does not provide a trigger signal. If you want to select a trigger signal, press < Trigger > and select an appropriate trigger option.

< Pause/Cont >

Press < Pause/Cont > to stop the analyzer in the middle of a measurement. The analyzer will display the measurement as completed so far. Press < Pause/Cont > once more to continue the measurement – the analyzer will begin where it left off. If you want to start the measurement over again, press < Start >.

Here's what else you should know:

- If you're using rms or vector averaging (stable averaging, not exponential averaging), pressing < Pause/Cont > after the averages are completed will cause the analyzer to run another group of averages. The additional averages will be added to the cumulative average results. Pressing < Pause/Cont > before the averages are completed will simply pause the measurement.
- If you're using exponential averaging (rms or vector) or peak hold averaging, pressing < Pause/Cont > will pause the measurement. Pressing < Pause/Cont > once more continues the measurement.

< Trigger >

Press < Trigger > to call up a trigger selection menu. This menu lets you specify a trigger signal appropriate for the type of measurement you want to make. It also lets you select triggering conditions — level, slope, and delay.

Here's what else you should know:

- You can use triggering with all measurements.
- If you're making averaged measurements, the analyzer will initiate, automatically, another series of averages after you modify any items in the < Trigger > menu. For example, if you change from continuous triggering to channel 1 input triggering, the analyzer will begin an averaged measurement right away, without waiting for you to press < Start >.

[CONTINUOS TRIGGER]

Press [CONTINUOS TRIGGER] to select continuous (free run) triggering. This means that the analyzer will process time records (input data) as quickly as possible, without waiting for any kind of triggering signal.

[EXTERNAL TRIGGER]

Press [EXTERNAL TRIGGER] to select external triggering. This means that the analyzer will trigger when the signal applied to the external trigger input connector goes from logic-low to logic-high (positive slope) or from logic-high to logic-low (negative slope).

Here's what else you should know:

- The external trigger connector is on the *rear* panel of the analyzer.
- Unlike input triggering and source triggering, external triggering requires a digital signal — make sure the signal applied to the external trigger input is at standard TTL levels.

[CHANNEL 1 TRIGGER]

Press [CHANNEL 1 TRIGGER] to select channel 1 as the input trigger source. This means the analyzer will begin a measurement when the channel 1 input signal meets the trigger conditions you've specified.

[CHANNEL 2 TRIGGER]

Press [CHANNEL 2 TRIGGER] to select channel 2 as the input trigger source. This means the analyzer will begin a measurement when the channel 2 input signal meets the trigger conditions you've specified.

[SOURCE TRIGGER]

Press [SOURCE TRIGGER] to select internal triggering from the analyzer's source.

Here's what else you should know:

- For source triggering, you can specify pre- or post-trigger delay — but not trigger level or slope.
- Source triggering is used with waveforms that are periodic (periodic chirp and fixed sine). For periodic chirp, triggering occurs at the beginning of each time record. For fixed sine, triggering occurs at a consistent (but not predictable) point within the time record.
- If you use the fixed sine waveform as the source trigger signal (and the span starts at zero), you should set the fixed sine frequency as a multiple of the frequency span / 400. This ensures that the sine wave will be periodic within that particular time record — otherwise, the analyzer won't trigger at the same point on the sine wave during subsequent time records (a problem if you're making phase measurements). If the span does not start at zero (zoomed measurements), you should make sure the center frequency is also a multiple of the frequency span / 400.
- There are fewer restrictions when using the periodic chirp with sine source triggering, but if the span does not start at zero (zoomed measurements), make sure the center frequency is a multiple of the frequency span / 400.
- The analyzer will trigger regularly with random noise, but there is no relationship between the trigger and any particular component of the random noise signal.

[HP-IB TRIGGER]

Press [HP-IB TRIGGER] to select HP-IB triggering. This means that triggering will occur when the analyzer receives appropriate HP-IB trigger commands — for example, the GET (Group Execute Trigger) or *TRG commands.

[AUTOMATIC ARM]

Press [AUTOMATIC ARM] to select automatic trigger arming. This means the analyzer will make a measurement as soon as it receives an appropriate trigger signal. After making the measurement, the analyzer automatically rearms the trigger — and will make another measurement when triggered again.

NOTE If you've just turned on the analyzer (or pressed < Preset >), automatic arming will be selected already.

[MANUAL ARM]

Press [MANUAL ARM] to select manual trigger arming. This means the analyzer cannot make a measurement until you manually arm the trigger — by pressing the [ARM] softkey. Once you arm the trigger, the analyzer will make a measurement if the trigger conditions are met.

NOTE To make additional measurements, you'll have to rearm the trigger each time.

[TRIGGER SET UP]

Press [TRIGGER SET UP] to call up a menu that lets you specify trigger conditions level, slope, and delay.

[LEVEL]

Press [LEVEL] to set the trigger level. Then enter a trigger level — not in volts, but as a percentage of the current input range (do not confuse the input range with the vertical scale). When the trigger signal crosses this level, the analyzer will make a measurement. The trigger level is an approximate value only.

For example, if your current input range is −5 dBV, you must first find the equivalent value in linear units (such as V or Vrms, not dBV or dBVrms). The equivalent of −5 dBV is 562.3 mVrms. Then find the percentage of this value that approximates the trigger level you want to use. A trigger level of 90% would mean a trigger level of about 500 mVrms.

To find an equivalent value quickly, press < Input >.

How the analyzer displays the current input range at the top of the screen. Then press either [CHANNEL 1 RANGE] or [CHANNEL 2 RANGE].

Now press the < . > key (on the number keypad. Then press the softkey for the unit you prefer (such as Vrms). The input range is now displayed with Vrms units. Use this equivalent value to make your trigger level calculations.

NOTE The trigger level applies to channel 1 triggering and channel 2 triggering only. Continuous, external, source, and HP-IB triggers are independent of the level setting.

[%]

Press [%] to specify a value in percentage.

[SLOPE POS/NEG]

Press [SLOPE POS/NEG] to select triggering on a rising or falling trigger signal.

NOTE The slope setting applies to channel 1 triggering, channel 2 triggering, and external triggering only. Continuous, source, and HP-IB triggers operate independently of the slope setting.

[CHANNEL 1 DELAY]

Press [CHANNEL 1 DELAY] to select a pre- or post-trigger delay on the channel 1 input. Then enter a time value (in seconds).

Here's what else you should know:

- You can enter a time delay in seconds, milliseconds, or microseconds.
- If you want a pre-trigger delay, enter a negative value (as in −10 milliseconds). The amount of pre-trigger delay possible varies with the width of the frequency span. You can specify up to 8 time records of pre-trigger delay.
- If you want a post-trigger delay, enter a positive value (as in 10 milliseconds). The maximum value allowed is approximately 10,000 seconds.

[CHANNEL 2 DELAY]

Press [CHANNEL 2 DELAY] to select a pre- or post-trigger delay on the channel 2 input. Then enter a time value (in seconds).

Here's what else you should know:

- You can enter a time delay in seconds, milliseconds, or microseconds.
- If you want a pre-trigger delay, enter a negative value (as in −10 milliseconds). The amount of pre-trigger delay possible varies with the width of the frequency span. You can specify up to 8 time records of pre-trigger delay.
- If you want a post-trigger delay, enter a positive value (as in 10 milliseconds). The maximum value allowed is approximately 10,000 seconds.

[ARM]

Press [ARM] to arm the analyzer's trigger — this applies only when you've selected manual trigger arming. After arming, the analyzer makes a measurement if the trigger conditions are met.

NOTE If you've selected manual trigger arming, you'll have to rearm the trigger before each measurement.

Display Keys

< Active Trace >

Press < Active Trace > to select Trace A or Trace B as the active trace – the active trace is the one with the highlighted trace label. Press once again to activate the other trace.

It's important to understand how the display traces work. Each of the analyzer's two traces is independent – that is, neither are dedicated to showing specific parameters. This means you can assign any parameter you want to either trace.

For example, when making frequency response measurements, you can set Trace A to show log magnitude and Trace B to show phase – or the other way around. Alternatively, you could set Trace B to show coherence.

Here's what else you should know:

- To modify a trace, you must first make it active. Then use the appropriate keys to modify it.
- The analyzer always has two traces, even if only one trace is displayed (single-trace format). In single-trace format, only the active trace is displayed. To view the other trace, press < Active Trace > again.

< Format >

Press < Format > to call up a menu that lets you configure the analyzer's display. For example, you can use this menu to choose a single trace format, an upper/lower trace format, or a front/back trace format.

[SINGLE]

Press [SINGLE] to display only the currently active trace. This will be Trace A or Trace B – whichever trace is active.

[UPPER/ LOWER]

Press [UPPER/ LOWER] to select the upper/lower display. This means the analyzer will show both traces on the screen. Trace A will be at the top, Trace B at the bottom.

[FRONT/ BACK]

Press [FRONT/ BACK] to select the front/back display. This means the analyzer will show both traces superimposed on a single grid.

[SETUP STATE]

Press [SETUP STATE] to view the analyzer's current configuration – how you've set the controls.

[TRCE GRID ON/OFF]

Press [TRCE GRID ON/OFF] to turn on or off the overlay grid (graticule) for the active trace.

NOTE If you turn off a trace grid, it will not appear on an external printer/plotter either.

[dB]

Press [dB] to specify a value in decibels.

In cases where you have a choice of [dB] or [ENTER], pressing [dB] specifies logarithmic units and [ENTER] specifies linear units.

[dBEUrms]

Press [dBEUrms] to specify a value in rms dBEU (dB engineering units).

[dBEUpk]

Press [dBEUpk] to specify a value in peak dBEU (dB engineering units).

[EUrms]

Press [EUrms] to specify a value in rms engineering units.

[EUrms^2]

Press [EUrms^2] to specify a value in rms engineering units squared.

[EU]

Press [EU] to specify a value in peak engineering units.

[EU^2]

Press [EU^2] to specify a value in engineering units squared.

[DEGREES]

Press [DEGREES] to specify a value in degrees.

[RADIANS]

Press [RADIANS] to specify a value in radians.

[Sec]

Press [Sec] to specify a value in seconds.

[mSec]

Press [mSec] to specify a value in milliseconds.

[EXP]

Press [EXP] before entering a value for exponential notation.

If you want to enter a negetive exponent (for example, 2E-13), press <±> after pressing [EXP].

[VERTICAL /DIV]

Press [VERTICAL /DIV] to specify the number of units per vertical scale division. If you want, you can also request a different unit for the scale.

Keep in mind that when you select a new scale spacing, the currently-active reference (TOP REFERENCE, CENTER REFERENCE, or BOTTOM REFERENCE) will be held the same and the rest of the scale adjusted around this level. The reference softkey that is highlighted is the currently-active reference.

[V (EU)]

Press [V (EU)] to specify a value in volts (peak), or in peak engineering units.

[Vrms (EUrms)]

Press [Vrms (EUrms)] to specify a value in rms volts, or in rms engineering units.

[V^2 (EU^2)]

Press [V^2 (EU^2)] to specify a value in volts squared, or in engineering units squared.

[Vrms^2 (EUrms^2)]

Press [Vrms^2 (EUrms^2)] to specify a value in rms volts squared, or in rms engineering units squared.

[V (EU)]

Press [V (EU)] to specify a value in volts (peak), or in peak engineering units.

[V^2 (EU^2)]

Press [V^2 (EU^2)] to specify a value in volts squared, or in engineering units squared.

[Vrms (EUrms)]

Press [Vrms (EUrms)] to specify a value in rms volts, or in rms engineering units.

[Vrms^2 (EUrms^2)]

Press [Vrms^2 (EUrms^2)] to specify a value in rms volts squared, or in rms engineering units squared.

[dB]
Press [dB] to specify a value in dB.

[DEGREES]
Press [DEGREES] to specify a value in degrees.

[RADIANS]
Press [RADIANS] to specify a value in radians.

[Sec]
Press [Sec] to specify a value in seconds.

[mSec]
Press [mSec] to specify a value in milliseconds.

[uSec]
Press [uSec] to specify a value in microseconds.

[V (EU)]
Press [V (EU)] to specify a value in volts (peak), or in peak engineering units.

[V^2 (EU^2)]
Press [V^2 (EU^2)] to specify a value in volts squared, or in engineering units squared.

[Vrms (EUrms)]
Press [Vrms (EUrms)] to specify a value in rms volts, or in rms engineering units.

[Vrms^2 (EUrms^2)]
Press [Vrms^2 (EUrms^2)] to specify a value in rms volts squared, or in rms engineering units squared.

[EXP]
If you are entering the number of averages using exponential notation, press [EXP] to allow you to enter the exponent value.

[V/rtHz]
Press [V/rtHz] to specify a value in volts (peak), normalized to a 1 Hz bandwidth. See HELP for [PSD CHANNEL 1] or [PSD CHANNEL 2].

[Vrms/rtHz]

Press [Vrms/rtHz] to specify a value in rms volts, normalized to a 1 Hz bandwidth. See HELP for [PSD CHANNEL 1] or [PSD CHANNEL 2].

[V^2/Hz]

Press [V^2/Hz] to specify a value in volts squared, normalized to a 1 Hz bandwidth. See HELP for [PSD CHANNEL 1] or [PSD CHANNEL 2].

[Vrms^2/Hz]

Press [Vrms^2/Hz] to specify a value in rms volts squared, normalized to a 1 Hz bandwidth. See HELP for [PSD CHANNEL 1] or [PSD CHANNEL 2].

[dBVrms/rtHz]

Press [dBVrms/rtHz] to specify a value in rms dBV, normalized to a 1 Hz bandwidth. See HELP for [PSD CHANNEL 1] or [PSD CHANNEL 2].

[dBVpk/rtHz]

Press [dBVpk/rtHz] to specify a value in peak dBV, normalized to a 1 Hz bandwidth. See HELP for [PSD CHANNEL 1] or [PSD CHANNEL 2].

[dBm/Hz]

Press [dBm/Hz] to specify a value in dBm, normalized to a 1 Hz bandwidth. See HELP for [PSD CHANNEL 1] or [PSD CHANNEL 2].

[EU/rtHz]

Press [EU/rtHz] to a value in engineering units, normalized to a 1 Hz bandwidth. See HELP for [PSD CHANNEL 1] or [PSD CHANNEL 2].

[EUrms/rtHz]

Press [EUrms/rtHz] to specify a value in rms engineering units, normalized to a 1 Hz bandwidth. See HELP for [PSD CHANNEL 1] or [PSD CHANNEL 2].

[EU^2/rtHz]

Press [EU^2/rtHz] to specify a value in engineering units squared, normalized to a 1 Hz bandwidth. See HELP for [PSD CHANNEL 1] or [PSD CHANNEL 2].

[EUrms^2/rtHz]

Press [EUrms^2/rtHz] to specify a value in rms engineering units squared, normalized to a 1 Hz bandwidth. See HELP for [PSD CHANNEL 1] or [PSD CHANNEL 2].

[dBEUrms/rtHz]

Press [dBEUrms/rtHz] to specify a value in rms dB (engineering units), normalized to a 1 Hz bandwidth. See HELP for [PSD CHANNEL 1] or [PSD CHANNEL 2].

[dBEUpk/rtHz]

Press [dBEUpk/rtHz] to specify a value in peak dB (engineering units), normalized to a 1 Hz bandwidth. See HELP for [PSD CHANNEL 1] or [PSD CHANNEL 2].

[VERTICAL UNITS]

Press [VERTICAL UNITS] to specify the units for the vertical scale.

Keep in mind that some units are not available with all measurements.

[V (EU)]

Press [V (EU)] to specify a value in volts (peak), or in rms engineering units.

Press [V (EU)] to display the minimum and maximum x-axis values in volts (peak), or in rms engineering units.

[V^2 (EU^2)]

Press [V^2 (EU^2)] to display the minimum and maximum x-axis values in volts squared, or in engineering units squared.

[Vrms (EUrms)]

Press [Vrms (EUrms)] to display the minimum and maximum x-axis values in rms volts, or in engineering units.

[Vrms^2 (EUrms^2)]

Press [Vrms^2 (EUrms^2)] to display the minimum and maximum x-axis values in rms volts squared, or in rms engineering units squared.

[V (EU)]

Press [V (EU)] to display the minimum and maximum x-axis values in volts (peak), or in rms engineering units.

[V^2 (EU^2)]

Press [V^2 (EU^2)] to display the minimum and maximum x-axis values in volts squared, or in engineering units squared.

[Vrms (EUrms)]

Press [Vrms (EUrms)] to display the minimum and maximum x-axis values in rms volts, or in engineering units.

[Vrms^2 (EUrms^2)]

Press [Vrms^2 (EUrms^2)] to display the minimum and maximum x-axis values in rms volts squared, or in rms engineering units squared.

[dB]

Press [dB] to display the minimum and maximum x-axis values in dB.

[DEGREES]

Press [DEGREES] to display the minimum and maximum x-axis values in degrees.

[RADIANS]

Press [RADIANS] to display the minimum and maximum x-axis values in radians.

[Sec]

Press [Sec] to display the minimum and maximum x-axis values in seconds.

[mSec]

Press [mSec] to display the minimum and maximum x-axis values in milliseconds.

[V (EU)]

Press [V (EU)] to display the minimum and maximum x-axis values in volts (peak), or in peak engineering units.

[V^2 (EU^2)]

Press [V^2 (EU^2)] to display the minimum and maximum x-axis values in volts squared, or in engineering units squared.

[Vrms (EUrms)]

Press [Vrms (EUrms)] to display the minimum and maximum x-axis values in rms volts, or in rms engineering units.

[Vrms^2 (EUrms^2)]

Press [Vrms^2 (EUrms^2)] to display the minimum and maximum x-axis values in rms volts squared, or in rms engineering units squared.

[V (EU)]

Press [V (EU)] to display the minimum and maximum x-axis values in volts (peak), or in peak engineering units.

[V^2 (EU^2)]

Press [V^2 (EU^2)] to display the minimum and maximum x-axis values in volts squared, or in engineering units squared.

[Vrms (EUrms)]

Press [Vrms (EUrms)] to display the minimum and maximum x-axis values in rms volts, or in rms engineering units.

[Vrms^2 (EUrms^2)]

Press [Vrms^2 (EUrms^2)] to display the minimum and maximum x-axis values in rms volts squared, or in rms engineering units squared.

[EXP]

If you are entering the number of averages using exponential notation, press [EXP] to allow you to enter the exponent value.

[X-AXIS LIN/LOG]

Press [X-AXIS LIN/LOG] to specify a linear or a logarithmic scale for the x-axis.

Here's what else you should know:

- The analyzer's frequency resolution is determined exclusively by the width of the span. So for the same span widths, frequency resolution for both linear and log scales is identical — both have a resolution of 401 points per display. The logarithmic scale simply displays these points on a logarithmic x-axis.
- For baseband measurements (spans that start at 0 Hz) the logarithmic scale shows the actual start frequency (the first bin) of the current span — not the nominal value of 0 Hz. So if you're looking at a 51.2 kHz frequency span, the first frequency shown on the logarithmic scale will be labeled 128 Hz (the analyzer does not show a value at 0 Hz since the log of 0 is minus infinity). As you would for a linear scale, change to a smaller span to view lower-frequency components. To learn more about bins and resolution, see the analyzer's Getting Started Guide.

Marker Keys

< marker up >

The < ▲ > hardkey does several things:

- If you're looking at a trace, press < ▲ > to move the marker to the next peak value on the right.
- If you're looking at text, press < ▲ > to move the highlighting bar to the previous line.
- You can use < ▲ > to move or scroll through entries in limit tables, data tables, and catalogs.
- You can use < ▲ > and < ▼ > to page through HELP displays.

< marker down >

The < ▼ > hardkey does several things:

- If you're looking at a trace, press < ▼ > to move the marker to the next peak value on the left.
- If you're looking at text, press < ▼ > to move the highlighting bar to the next line.
- You can use < ▼ > to move or scroll through entries in limit tables, data tables, and catalogs.
- You can use < ▲ > and < ▼ > to page through HELP displays.

< marker left >

Press < ◀ > to move the marker to the left, one "bin" at a time.

The analyzer's screen has a resolution of 401 points. Each point is called a "frequency bin" or just "bin."

< marker right >

Press < ▶ > to move the marker to the right, one "bin" at a time.

The analyzer's screen has a resolution of 401 points. Each point is called a "frequency bin" or just "bin."

< Fast >

Press < Fast > along with one of the marker direction keys to move the marker faster. For example, press < Fast > and < ▶ > to move the marker quickly to the right.

The longer you hold down the < Fast > key with another marker direction key, the faster the marker moves.

< Fast > <marker right>

Press both < Fast > and < ► > to move the marker quickly to the right.

The longer you hold down the < Fast > key with another marker direction key, the faster the marker moves.

< Fast > <marker left>

Press both < Fast > and < ◄ > to move the marker quickly to the left.

The longer you hold down the < Fast > key with another marker direction key, the faster the marker moves.

< Marker >

Press < Marker > to call up a menu that lets you select marker functions.

The markers appear as small triangles that point down. You can also move markers on both traces at the same time by turning on marker coupling.

This type of marker is often called the absolute marker (or main marker) because its values reflect the absolute x-axis and y-axis values. This is different than the offset marker (see HELP for [OFFSET ON/OFF] softkey).

Marker functions are extremely useful. You can use them to search for peaks, to search for minimum values, and to find specific values. You can also use the offset marker to find relative values between two points. In addition,

[MARKER ON/OFF]

Press [MARKER ON/OFF] to turn on and turn off the marker.

Each trace has its own marker. To turn on a marker for a particular trace, first make sure the trace is active (use the < Active Trace > hardkey). The marker options you select apply only to the marker on the active trace.

[COUPLED ON/OFF]

Press [COUPLED ON/OFF] to turn on and off marker coupling. Marker coupling means that the markers for both traces move together.

Marker coupling is quite useful. For example, if you display frequency response magnitude on the upper trace, and phase on the lower, you could use marker coupling to track both magnitude and phase at each frequency point.

[X ENTRY]

To move the marker to a specific location, press [X ENTRY] and enter the x-axis coordinate with the numeric keypad.

[OFFSET]

Press [OFFSET] to select marker offset options. The offset marker lets you determine relative distances between the main marker and another point on the trace.

[OFFSET ON/OFF]

Press [OFFSET ON/OFF] to turn on and off the offset marker. The offset marker appears as a small square.

When the offset is on, the main marker moves but the x-axis and y-axis values indicated are those relative to the position of the offset marker (the square), not absolute values. The marker label changes from "Marker" to "Offset" when the offset marker is in effect.

Here's what else you should know:

- Even when the offset marker is on, the marker movement keys and the [X Entry] softkey will move the main (absolute) marker, not the offset marker.
- To move the offset marker to a specific (absolute location), use the [REFERENCE X ENTRY] and [REFERENCE Y ENTRY] softkeys.

[OFFSET ZERO]

Press [OFFSET ZERO] to move the offset marker to the main marker. This zeroes the offset marker at the main marker's current position.

Pressing [OFFSET ZERO] also changes the X REFERENCE and Y REFERENCE values.

[REFERENCE X ENTRY]

Press [REFERENCE X ENTRY] to move the offset marker to a specific location. Then use the numeric keypad (or the < ▲ > < ▼ > hardkeys) to enter the *absolute* x-axis value for this location.

[REFERENCE Y ENTRY]

Press [REFERENCE Y ENTRY] to move the offset marker to a specific location. Then use the numeric keypad (or the < ▲ > < ▼ > hardkeys) to enter the *absolute* y-axis value for this location.

[MARKER TO PEAK]

Press [MARKER TO PEAK] to move the marker to the highest peak on the trace.

Here's what else you should know:

- Pressing [MARKER TO PEAK] moves the marker to the peak only for the trace that's currently active (but the marker on the inactive trace will also move if marker coupling is on).
- The analyzer will not move the marker to a peak at 0 Hz.

[NXT RIGHT PEAK]

Press [NXT RIGHT PEAK] to move the marker to the peak point to the right of the marker.

The marker moves to the next right peak only on the trace that's active (but the marker on the inactive trace will also move if marker coupling is on).

[NXT LEFT PEAK]

Press [NXT LEFT PEAK] to move the marker to the peak point to the left of the marker.

The marker moves to the next left peak only on the trace that's active (but the marker on the inactive trace will also move if marker coupling is on).

[MARKER TO MINIMUM]

Press [MARKER TO MINIMUM] to move the marker to the minimum point on the trace.

The marker moves to the minimum point only on the trace that's active (but the marker on the inactive trace will also move if marker coupling is on).

[PEAK TRK ON/OFF]

Press [PEAK TRK ON/OFF] to turn on or off peak tracking for the active trace. When peak tracking is on, the analyzer continuously moves the marker to the peak value on the trace.

Here's what else you should know:

- You can turn on peak tracking for Trace A, Trace B, or both traces. If you turn on peak tracking for both traces, each marker follows the peak for its respective trace (unless marker coupling is on).
- Because marker coupling takes priority over peak tracking, the marker will not track the peak value for the inactive trace if both marker coupling and peak tracking are turned on.

[SEARCH]

Press [SEARCH] to call up a menu that lets you move the main (absolute) marker to a specific point on the trace. This way, you can quickly find a point relative to the main marker. For example, you can find the −3 dB points on either side of the main marker.

[TARGET]

Press [TARGET] to specify a y-axis target value for the marker search. Then use the numeric keypad to enter the value.

[LEFT]

Press [LEFT] to move the main marker to the left, to find the first occurrence of the y-axis target value. The search starts from the current marker position.

NOTE If you've turned on the offset marker, the target is relative to the offset marker y-axis value.

[RIGHT]

Press [RIGHT] to move the main marker to the right, to find the first occurrence of the y-axis target value.

NOTE If you've turned on the offset marker, the target is relative to the offset marker y-axis value.

< Marker Fctn >

Press < Marker Fctn > to call up a menu that lets you select specialized marker functions. Marker functions are extremely useful. You can use them to search for harmonics and sidebands, to calculate harmonic distortion and sideband power, and to calculate power within a specific band of frequencies. You can also use marker functions to define and use limit tables and data tables.

NOTE The analyzer will not let you use more than one special marker at a time.

[OFF]

Press [OFF] to turn off any special function marker that is on.

[HARMONIC]

Press [HARMONIC] to display the harmonic marker. This marker shows the harmonics for a particular fundamental frequency.

Here's what else you should know:

- The analyzer displays the harmonics for the fundamental frequency that you specified most recently. To change the fundamental frequency (or the number of harmonics), use the [FNDMNTL FREQ] and [DEFINE NUM HARM] softkeys.
- The actual number of harmonics displayed depends on the fundamental frequency and the analyzer's bandwidth. Higher fundamental frequencies have fewer harmonics displayed, simply because it takes fewer harmonics to reach the top end of the analyzer's frequency range.

[FNDMNTL FREQ]

Press [FNDMNTL FREQ] to specify the fundamental frequency of the harmonic series you want to look at. The analyzer needs the fundamental frequency to find the appropriate harmonics and to make the harmonic marker calculations.

Be careful when using < Marker Value > to enter the fundamental frequency; the frequency entered could be off by as much as one-half the bin width. As a result, the analyzer may not position the harmonic markers accurately. See HELP for the [DIVIDE FNDMNTL] softkey.

NOTE For frequency-domain displays, the analyzer has a resolution of 401 points. Each point is called a "frequency bin" or just "bin."

[DEFINE NUM HARM]

Press [DEFINE NUM HARM] to specify the number of harmonics you want the analyzer to identify with the harmonic marker.

Here's what else you should know:

- If you don't specify a value for the number of harmonics, the analyzer will automatically set the number to 20.
- The THD results reflect the harmonics found in the current frequency span. The number of harmonics you specify is the *maximum* number the analyzer will use in the THD calculation. For example, if you press [DEFINE NUM HARM] and enter 10 harmonics, the THD calculation will not include all ten harmonics if some of these harmonics are out of the range of the current span.
- The analyzer displays the harmonics for the fundamental frequency that you specified most recently. To change the fundamental frequency, use the [FNDMNTL FREQ] softkey.
- The actual number of harmonics displayed depends on the fundamental frequency and the analyzer's bandwidth. Higher fundamental frequencies have fewer harmonics displayed, simply because it takes fewer harmonics to reach the top end of the analyzer's frequency range.

[DIVIDE FNDMNTL]

For measurements that use the fundamental frequency (such as THD), you can set a more accurate fundamental frequency by dividing the frequency of a known harmonic.

Here's how it works: Move the marker to a harmonic (use the [NXT RIGHT PEAK] and [NXT LEFT PEAK] soktkeys). Then enter this harmonic as the fundmental frequency with [FNDMNTL FREQ] and < Marker Value >. Now press [DIVIDE FNDMNTL] and enter the number of the harmonic you entered as the fundamental frequency. The analyzer will divide the fundamental to arrive at the actual fundamental.

NOTE Entering a higher harmonic as the "fundamental" will increase the accuracy of the resulting fundamental frequency after you finish the divide operation.

For example, if you know that the third harmonic of a particular fundamental is 65.75 kHz, press [FNDMNTL FREQ] and enter 65.75 kHz. Then press [DIVIDE FNDMNTL] and enter the number 3. The analyzer then displays the fundamental as 21.92 kHz.

[THD]

Press [THD] to calculate the total harmonic distortion for the current fundamental frequency.

Here's what else you should know:

- The analyzer displays THD as a percentage of the amplitude of the fundamental frequency.
- The analyzer calculates THD by comparing the energy of the fundamental to the energy at the harmonics. Noise and other signals at other points along the frequency spectrum are not taken into account (unless they happen to occur at the fundamental frequency or at the harmonics). This is different than older distortion analyzers that simply rejected the fundamental frequency and measured any remaining energy as harmonic distortion (more accurately, harmonic distortion plus noise).
- The THD results reflect the harmonics found in the current frequency span. The number of harmonics you specify is the *maximum* number the analyzer will use in the THD calculation. For example, if you press [DEFINE NUM HARM] and enter 10 harmonics, the THD calculation will not include all ten harmonics if some of these harmomics are out of the range of the current span.

[HARM PWR]

Press [HARM PWR] to calculate the total harmonic power (absolute) for the current fundamental frequency. Actually, this value represents the rms summation of all marked harmonics, but does not actually represent power unless you've specified dBm, dBVrm, Vrms, or Vrms^2 as the vertical unit.

Here's what else you should know:

- The analyzer displays the absolute harmonic power, measured in the currently selected vertical units. To find harmonic power relative to the fundamental frequency, use the [THD] softkey instead.
- The analyzer calculates harmonic power by measuring the absolute value of the harmonics of the fundamental frequency. Noise and other signals at other points along the frequency spectrum are not taken into account (unless they happen to occur at a harmonic frequency). This is different than older distortion analyzers that simply rejected the fundamental frequency and measured any remaining energy as harmonic power (more accurately, harmonic power plus noise).

[RESULTS ON/OFF]

Press [RESULTS ON/OFF] to specify whether you want the analyzer to display the results of the THD or harmonic power calculations.

[SIDEBAND]

Press [SIDEBAND] to display the sideband marker. This marker shows the sidebands (and sideband power) for a particular carrier frequency. The sideband power value represents the rms summation of all marked sidebands (this indicates power if you've specified dBm, dBVrms, Vrms, or Vrms^2 as the vertical unit).

Here's what else you should know:

- The analyzer displays the harmonics for the carrier frequency that you specified most recently. To change the carrier frequency (or the number of sidebands), use the [CARRIER FREQ] and [DEFINE NUM SDBND] softkeys.
- The analyzer can display up to 200 sidebands. The actual number of sidebands displayed depends on the carrier frequency and the analyzer's bandwidth.

[CARRIER FREQ]

Press [CARRIER FREQ] to specify the carrier frequency for the sidebands you want to examine. The analyzer needs the carrier frequency to find the appropriate sidebands and to make the sideband marker calculations.

NOTE The carrier frequency you specify does not have to be within the current frequency span.

[SIDEBAND INCREMENT]

Press [SIDEBAND INCREMENT] to specify the location of the sideband marker, relative to the carrier frequency. Then use the numeric keypad to enter a frequency value, in kHz, Hz, or mHz.

[DEFINE NUM SDBND]

Press [DEFINE NUM SDBND] to specify the number of sidebands you want the analyzer to identify with the sideband marker.

Here's what else you should know:

- If you don't specify a value for the number of harmonics, the analyzer will automatically set the number to 20.
- The analyzer displays the harmonics for the carrier frequency that you specified most recently. To change the carrier frequency, use the [CARRIER FREQ] softkey.
- The analyzer can display up to 200 sidebands. The actual number of sidebands displayed depends on the carrier frequency and the analyzer's bandwidth.

[RESULTS ON/OFF]

Press [RESULTS ON/OFF] to specify whether you want the analyzer to display the results of the sideband calculations.

[BAND]

Press [BAND] to call up a menu that lets you specify band markers. You can use band markers to define a frequency band and then calculate the rms summation of the values within this band. The resulting value indicates power if you've sepecified dBm, dBVrms, Vrms, or Vrms^2 as the vertical unit.

[DEFINE LEFT FREQ]

Press [DEFINE LEFT FREQ] to define the left limit (lower frequency) for the band within which you want the analyzer to calculate power.

[DEFINE RIGHT FREQ]

Press [DEFINE RIGHT FREQ] to define the right limit (higher frequency) for the band within which you want the analyzer to calculate power.

[DEFINE CENT FREQ]

Press [DEFINE CENT FREQ] to define the center frequency for the band within which you want the analyzer to calculate power.

[RESULTS ON/OFF]

Press [RESULTS ON/OFF] to specify whether you want the analyzer to display the results of the band calculations. The results are expressed using the currently-selected vertical units.

[LIMIT]

A limit table is a list of values (referenced to their respective x and y coordinates) that the analyzer uses to compare with a current measurement or a stored trace. A limit appears as a line (or lines) defined by a series of line segments. These line segments are defined by points that you specify for each limit table.

Limit tables are useful for go/no go checking — they quickly tell you if a particular measurement result passes or fails the limits outlined with a particular limit table.

You can create both upper and lower limit lines for each limit table. When you turn on the limit testing feature, the analyzer indicates a "fail" condition if the trace you're testing exceeds an upper limit (or goes below a lower limit). If the trace is within the limit lines, the test passes. By the way, you don't have to use both upper and lower limit lines — for some types of testing, it may be more convenient to use only upper (or lower) limits.

Here's what else you should know:

- The analyzer does not store unit labels in the limit table. For example, an x-value of 1.2 kHz is stored simply as "1.2K" and a y-value of −35 dBVrms as "-35." Before using a limit table again, make sure the analyzer is set to use the same vertical units that you used when building the table initially. Otherwise, the limit testing will not work properly. It's also a good idea to use the same frequency span.
- When editing the limit table, use the < ▲ > and < ▼ > hardkeys to move to a particular segment (if there's more than one page of segments, pressing <▲> <Fast> moves to the previous page and <▼> <Fast> moves to the next page). If you're at the last segment, press <▼> to add a new segment.

- When adding a new segment, x-start and y-start values are copied from the x-stop and y-stop values of the previous segment. This lets you conveniently add a connecting segment to the previous one. There's no need to re-enter the x-start and y-start values — simply move the marker (with the < ▶ > hardkey) to the desired end point for the new segment. Then press [X-STOP] < Marker Value > and [Y-STOP] < Marker Value >.
- To copy a limit from Trace A to Trace B, use < Save > and related softkeys to save the limit for Trace A to a file (such as 'LIMIT1'). Then make Trace B active. Now, using < Recall >, recall 'LIMIT1' (you may have to backspace and use the numeric keypad to specify 'TRACE1'). You now have identical limits in both tables. To save the newly-created Trace B limit, again use < Save > and related softkeys; this time, save the limit to 'LIMIT2.'

[X-START]

Press [X-START] to specify the x-axis starting point of a segment. You can specify a value with the numeric keypad, or simply press < Marker Value >.

[Y-START]

Press [Y-START] to specify the y-axis starting point of a segment. You can specify a value with the numeric keypad, or simply press < Marker Value >.

[X-STOP]

Press [X-STOP] to specify the x-axis end point of a segment. You can specify a value with the numeric keypad, or simply press < Marker Value >.

[Y-STOP]

Press [Y-STOP] to specify the y-axis end point of a segment. You can specify a value with the numeric keypad, or simply press < Marker Value >.

[LIMIT UPPER/LOW]

Press [LIMIT UPPER/LOW] to specify whether the segment you're working on should be part of the upper limit or part of the lower limit.

[INSERT SEGMENT]

Press [INSERT SEGMENT] to insert a segment into the limit table. The new segment will be inserted above the currently highlighted segment.

[DELETE]

Press [DELETE] to call a menu to allow you to delete a selected segment or all segments from the displayed limit table.

[DELETE SEGMENT]

Press [DELETE SEGMENT] to immediately delete the highlighted segment from the displayed limit table.

[BEEP ON/OFF]

Press [BEEP ON/OFF] to specify if you want the analyzer to beep if the limit test fails.

Here's what else you should know:

- Unless you specify otherwise, the analyzer will not beep if the limit test fails.
- There is a global beeper softkey under the < Special Fctn > menu that controls all beeping; both the global beeper and the limit beeper must be on if you want the limit beeper to work. The global beeper is set to the "on" position at power-up or after pressing < Preset >.

[SELECT LIMIT]

Press [SELECT LIMIT] to select a particular limit table for use (or for editing).

[L1 ACTIVE]

Press [L1 ACTIVE] to activate limit table L1.

[L2 ACTIVE]

Press [L2 ACTIVE] to activate limit table L2.

[L3 ACTIVE]

Press [L3 ACTIVE] to activate limit table L3.

[L4 ACTIVE]

Press [L4 ACTIVE] to activate limit table L4.

[L5 ACTIVE]

Press [L5 ACTIVE] to activate limit table L5.

[L6 ACTIVE]

Press [L6 ACTIVE] to activate limit table L6.

[L7 ACTIVE]

Press [L7 ACTIVE] to activate limit table L7.

[L8 ACTIVE]

Press [L8 ACTIVE] to activate limit table L8.

[SELECT SEGMENT]

Press [SELECT SEGMENT] to go to a particular segment for editing. First, specify the segment number with the numeric keypad. Then press [ENTER].

[CALC ON/OFF]

Press [CALC ON/OFF] to turn on or off data table calculations.

Here's what else you should know:

- If data table calculations are on, the analyzer will update the data table after each measurement.
- The data table does not have to be displayed for the calculation to occur.
- If data table calculations are off, the analyzer will not update the data table's y-axis values. However, the x-axis entries will remain unchanged.

[EDIT X]

Press [EDIT X] to enter an x-axis value for the highlighted entry on the current data table display. Enter the x-axis value with the numeric keypad, then press [ENTER].

You can also use the marker to specify an x-axis value, by pressing the < Marker Value > hardkey. However, if you've turned on the offset marker, the analyzer will calculate y-axis values with respect to the current offset zero point (the little square).

[INSERT X]

Press [INSERT X] to add an x-axis value just before the highlighted entry in the data table. Enter the x-axis value with the numeric keypad, then press [ENTER].

[MOVE TO ENTRY NUM]

Press [MOVE TO ENTRY NUM] to move the highlighted entry to another entry line. Use the numeric keypad to specify the new location. Then press [ENTER].

[DELETE ENTRY]

Press [DELETE ENTRY] to delete the highlighted entry.

[DELETE ALL]

Press [DELETE ALL] to indicate that you want to delete all entries from the data table.

NOTE The analyzer does not delete the entries until you press [DO DELETE].

[DO DELETE]

Press [DO DELETE] to delete all entries in the data table.

[RETURN TBL DOWN]

Press [RETURN TBL DOWN] to exit the data table display. The data table calculations (if turned on) remain in effect.

To stop the calculations, re-enter the [DATA TABLE] menu. Then press [CALC ON/OFF] to turn on or off the calculations.

< Preset >

Press < Preset > to reset the analyzer to its default conditions. This means nearly all controls will return to the settings they had when you first turned on the analyzer.

Keep in mind that pressing < Preset > is not the same thing as turning the analyzer off and then on again (power-up).

These are a few settings that do not change after pressing < Preset > but will change after cycling power. These include:

- Data tables
- Limit tables
- Math functions and constants
- Engineering unit labels
- Engineering unit values
- Autocal (resets to ON)

Additionally, there are even some settings that survive both < Preset > and power-up. These are the system configuration settings. To change these, you'll have to use the [SAVE SYS CONFIG] softkey. These settings include:

- Storage configuration
- HP-IB, Disc, Printer, and Plotter addresses
- Disc volume and unit numbers
- Time and date

< User Define >

Press < User Define > to run application software for the analyzer. If there is no application software installed, the analyzer will display the message "Application using this key is not installed."

< Help >

Press < Help > to learn more about a particular hardkey or softkey. Then press a key for which you want HELP. The analyzer then displays a brief explanation of this key.

Here's what else you should know:

- If there's more than one page of HELP, the analyzer will tell you so. Use the < ▲ > and < ▼ > hardkeys to page through HELP.
- To print a copy of HELP, use the < Plot/Print > hardkey and its associated softkeys.
- To get HELP for another key, simply press the key for which you want HELP.
- To remove HELP, simply press < Help > again.
- Requesting HELP is slightly different for those keys that retain their functions during the HELP display. These keys are: < Preset >, < ▲ >, < ▼ >, < Help >, and < Plot/Print > (and its related softkeys). To get HELP for any of these keys, you must press the desired key directly after pressing < Help >. After the first help screen appears, the key will operate in its normal fashion.

System Keys

< Save >

Press < Save > to call up a menu that lets you select save options. Here are some of the things you can do with this menu:

- Save a trace
- Save an instrument setup state
- Save math functions and constants
- Save a limit table or data table
- Access file utilities and disc functions

NOTE you can save to the analyzer's internal RAM disc, the analyzer's internal disc drive, or other external mass storage devices (such as compatible HP-IB disc drives).

[SAVE TRACE]

Press [SAVE TRACE] to call up a menu that lets you save the active trace to a file in a mass storage device.

Here's what else you should know:

- You can save a trace to one of eight files in the current mass storage device – files 'TRACE1' through 'TRACE8'. You can also save the trace to a file with a name of your own choosing.
- Make sure you've specified your choice of mass storage device beforehand – INTERNAL RAM DISC, INTERNAL DISC, or EXTERNAL DISC – because the analyzer will write files 'TRACE1' through 'TRACE8' to the *current* mass storage device. If you use the [DEFINE FILENAME] softkey though, you can specify a file to be written into *any* mass storage device – but don't forget to use the appropriate device specifier prefix.

[INTO FILE 'TRACE1']

Press [INTO FILE 'TRACE1'] to save the active trace to the 'TRACE1' file.

[INTO FILE 'TRACE2']

Press [INTO FILE 'TRACE2'] to save the active trace to the 'TRACE2' file.

[INTO FILE 'TRACE3']

Press [INTO FILE 'TRACE3'] to save the active trace to the 'TRACE3' file.

[INTO FILE 'TRACE4']

Press [INTO FILE 'TRACE4'] to save the active trace to the 'TRACE4' file.

[INTO FILE 'TRACE5']

Press [INTO FILE 'TRACE5'] to save the active trace to the 'TRACE5' file.

[INTO FILE 'TRACE6']

Press [INTO FILE 'TRACE6'] to save the active trace to the 'TRACE6' file.

[INTO FILE 'TRACE7']

Press [INTO FILE 'TRACE7'] to save the active trace to the 'TRACE7' file.

[INTO FILE 'TRACE8']

Press [INTO FILE 'TRACE8'] to save the active trace to the 'TRACE8' file.

[DEFINE FILENAME]

Press [DEFINE FILENAME] to save the active trace to a file. Then specify the name for this file. Be sure to use the appropriate device specifier prefix if you don't want the file to go into the *current* mass storage device.

Here are the device specifiers:

- INT — for internal disc
- EXT — for external disc
- RAM — for a RAM disc

NOTE The filename you use must have no more than ten characters (all characters must be printable). Also, do not use a colon (:) unless you use it to separate a device specifier from a filename.

[RETURN]

Press [RETURN] to return to the previous menu.

[SAVE STATE]

Press [SAVE STATE] to call up a menu that lets you save the current instrument state (its configuration) to a file in a mass storage device. Later, you can use this file to quickly set up the analyzer.

Here's what else you should know:

- When you save an instrument state, the analyzer remembers most settings, but does not remember some service tests and adjustments settings.
- You can save an instrument state to one of eight files in the current mass storage device — files 'STATE1' through 'STATE8'. You can also save the state to a file with a name of your own choosing.
- Make sure you've specified your choice of mass storage device beforehand — INTERNAL RAM DISC, INTERNAL DISC, or EXTERNAL DISC — because the analyzer will write files 'STATE1' through 'STATE8' to the *current* mass storage device. If you use the [DEFINE FILENAME] softkey though, you can specify a file to be written into *any* mass storage device — but don't forget to use the appropriate device specifier prefix.
- Because data tables and limit tables can use large amounts of memory (especially for larger, more complex tables), an "Insufficient disc space" message appears if the setup state is too large to save. If this happens, store each table to a separate file (for example, INT:LIMIT1), if you haven't done so already — do this by pressing <Save> and using the [SAVE DATA TBL] and [SAVE LIMIT] softkeys. Then clear all tables by pressing <Marker Fctn> and using the appropriate softkeys to delete all tables. This avoids duplicating the tables in the memory space allocated for saving setup states. An even better idea would be to store data tables and limit tables to another external mass storage device (to avoid running out of disc space).

[INTO FILE 'STATE1']

Press [INTO FILE 'STATE1'] to save the current instrument state to the 'STATE1' file.

[INTO FILE 'STATE2']

Press [INTO FILE 'STATE2'] to save the current instrument state to the 'STATE2' file.

[INTO FILE 'STATE3']

Press [INTO FILE 'STATE3'] to save the current instrument state to the 'STATE3' file.

[INTO FILE 'STATE4']

Press [INTO FILE 'STATE4'] to save the current instrument state to the 'STATE4' file.

[INTO FILE 'STATE5']

Press [INTO FILE 'STATE5'] to save the current instrument state to the 'STATE5' file.

[INTO FILE 'STATE6']

Press [INTO FILE 'STATE6'] to save the current instrument state to the 'STATE6' file.

[INTO FILE 'STATE7']

Press [INTO FILE 'STATE7'] to save the current instrument state to the 'STATE7' file.

[INTO FILE 'STATE8']

Press [INTO FILE 'STATE8'] to save the current instrument state to the 'STATE8' file.

[DEFINE FILENAME]

Press [DEFINE FILENAME] to save the current instrument state to a file. Then specify the name for this file. Be sure to use the appropriate device specifier prefix if you don't want the file to go into the *current* mass storage device.

Here are the device specifiers:

- INT — for internal disc
- EXT — for external disc
- RAM — for a RAM disc

NOTE The filename you use must have no more than ten characters (all characters must be printable). Also, do not use a colon (:) unless you use it to separate a device specifier from a filename.

[RETURN]

Press [RETURN] to return to the previous menu.

[SAVE MATH]

Press [SAVE MATH] to call up a menu that lets you save the entire math definition of five functions and five constants to a file in a mass storage device.

Here's what else you should know:

- You can save math functions to one of eight files in the current mass storage device — files 'MATH1' through 'MATH8'. You can also save the function to a file with a name of your own choosing.
- Make sure you've specified your choice of mass storage device beforehand — INTERNAL RAM DISC, INTERNAL DISC, or EXTERNAL DISC — because the analyzer will write files 'MATH1' through 'MATH8' to the *current* mass storage device. If you use the [DEFINE FILENAME] softkey though, you can specify a file to be written into *any* mass storage device — but don't forget to use the appropriate device specifier prefix.

[INTO FILE 'MATH1']

Press [INTO FILE 'MATH1'] to save all five functions and five constants to a file called 'MATH1' — this will be created in the *current* mass storage device.

[INTO FILE 'MATH2']

Press [INTO FILE 'MATH2'] to save all five functions and five constants to a file called 'MATH2' – this will be created in the *current* mass storage device.

[INTO FILE 'MATH3']

Press [INTO FILE 'MATH3'] to save all five functions and five constants to a file called 'MATH3' – this will be created in the *current* mass storage device.

[INTO FILE 'MATH4']

Press [INTO FILE 'MATH4'] to save all five functions and five constants to a file called 'MATH4' – this will be created in the *current* mass storage device.

[INTO FILE 'MATH5']

Press [INTO FILE 'MATH5'] to save all five functions and five constants to a file called 'MATH5' – this will be created in the *current* mass storage device.

[INTO FILE 'MATH6']

Press [INTO FILE 'MATH6'] to save all five functions and five constants to a file called 'MATH6' – this will be created in the *current* mass storage device.

[INTO FILE 'MATH7']

Press [INTO FILE 'MATH7'] to save all five functions and five constants to a file called 'MATH7' – this will be created in the *current* mass storage device.

[INTO FILE 'MATH8']

Press [INTO FILE 'MATH8'] to save all five functions and five constants to a file called 'MATH8' – this will be created in the *current* mass storage device.

[DEFINE FILENAME]

Press [DEFINE FILENAME] to save all five functions and five constants to a file. Then specify the name for this file. Be sure to use the appropriate device specifier prefix if you don't want the file to go into the *current* mass storage device.

Here are the device specifiers:

- INT – for an internal disc
- EXT – for an external disc
- RAM – for a RAM disc

NOTE The filename you use must have no more than ten characters (all characters must be printable). Also, do not use a colon (:) unless you use it to separate a device specifier from a filename.

[RETURN]

Press [RETURN] to return to the previous menu.

[SAVE MORE]

Press [SAVE MORE] to call up a menu that lets you save values for the current limit table or data table to a file in a mass storage device.

[SAVE LIMIT]

Press [SAVE LIMIT] to save a limit table (the one associated with the currently-active trace) to a file in a mass storage device.

Here's what else you should know:

- You can save a limit table to a file with a name of your own choosing.
- Make sure you've specified your choice of mass storage device beforehand – INTERNAL RAM DISC, INTERNAL DISC, or EXTERNAL DISC – because the analyzer will write your limit table file to the *current* mass storage device.

[RETURN]

Press [RETURN] to return to the previous menu.

[SAVE DATA TABLE]

Press [SAVE DATA TABLE] to save a data table (the one associated with the currently-active trace) to a file in a mass storage device.

Here's what else you should know:

- You can save either of the two data tables to a file with a name of your own choosing.
- Make sure you've specified your choice of mass storage device beforehand – INTERNAL RAM DISC, INTERNAL DISC, or EXTERNAL DISC – because the analyzer will write your data table file to the current mass storage device.

[RETURN]

Press [RETURN] to return to the previous menu.

[SAVE SYS CONFIG]

Press [SAVE SYS CONFIG] to call up a menu that lets you save the system configuration to the analyzer's EEPROM. Once you save these settings, they will survive both < Preset > and power-up. These settings include:

- Storage configuration
- HP-IB, Disc, Printer, and Plotter addresses
- Disc volume and unit numbers
- Time and date
- Choice of the analyzer as "System Controller" or as "Addressable Only"
- Most recent values sent with these HP-IB commands: *PCB, *PSC, *ESE, and *SRE
- Application autoload (on or off)

Remember that saving the system configuration is not the same thing as saving a measurement setup state. If what you really want to do is save a measurement setup state, use [SAVE STATE] instead. See HELP for [SAVE STATE] and < Preset >. Here's what else you should know:

NOTE The analyzer uses EEPROMs (Electrically Erasable Programmable Read-only Memory). Currently, this type of memory is only guaranteed to perform write operations about 10,000 times. To avoid unnecessary write operations, do not save the system configuration unless it's essential to do so.

[DO SAVE]

Press [DO SAVE] to save the system configuration to the analyzer's EEPROM.

Make sure you understand the save procedure. See HELP for [SAVE SYS CONFIG].

[FILE UTILITIES]

Press [FILE UTILITIES] to call up a menu that lets you select a number of file management options.

[RENAME FILE]

Press [RENAME FILE] to rename a file. Then specify the new name.

NOTE If you want to change the current disc device, go back to the storage configuration menu. Alternatively, you can specify the disc device in the filename (for example, "INT:TRACE1").

[DELETE FILE]

Press [DELETE FILE] to delete a file from the current disc device. Then specify the name of the file you want to delete.

NOTE If you want to change the current disc device, go back to the storage configuration menu. Alternatively, you can specify the disc device in the filename (for example, "INT:TRACE1").

[DELETE ALL FILES]

Press [DELETE ALL FILES] to delete all files from the current mass storage device. The analyzer will ask you if you really want to do this. Then specify by pressing [DO DELETE] or [CANCEL/RETURN].

NOTE If you want to change the current disc device, go back to the storage configuration menu. Alternatively, you can specify the disc device (for example, "INT:").

[DO DELETE]

Press [DO DELETE] to delete all files from the current mass storage device.

[PACK FILES]

Press [PACK FILES] to move all files to adjacent spaces on the disc. This creates additional memory space on the analyzer's internal disc drive and the RAM disc. It can also create additional memory space on external disc drives.

[RENAME CATALOG]

Press [RENAME CATALOG] to specify a new volume name for a group of disc files. Then enter the new name.

[COPY DISC]

Press [COPY DISC] to call up a menu that lets you copy the contents of one disc to another. If the source disc device is the same as the destination disc device (and the source disc is removable) then pressing [COPY DISC] will use the analyzer's memory as a buffer. The analyzer will ask you to swap source and destination discs (possibly several times) to complete the copy.

The copied disc is an image copy, so it will be an exact duplicate of the original disc.

[SOURCE DISC]

Press [SOURCE DISC] to specify the disc that you want to copy *from*. Then use the alphanumeric keypad to enter the name of the source disc.

[DESTN DISC]

Press [DESTN DISC] to specify the disc that you want to copy *to*. Then use the alphanumeric keypad to enter the name of the destination disc.

[START COPY]

Press [START COPY] to start the operation that copies the source disc to the destination disc.

[COPY FILE]

Press [COPY FILE] to call up a menu that lets you set up source and destination filenames for a file copy operation (and to start a copy operation).

[SOURCE FILENAME]

Press [SOURCE FILENAME] to specify the name of the source file you want copied. Then enter the name of the file.

You can use a volume specifier when entering the name of the source file. For example, 'INT:myconfig' would indicate a file named 'myconfig' located on the analyzer's internal disc.

Here are the device specifiers:

- INT – for an internal disc
- EXT – for an external disc
- RAM – for a RAM disc

[DESTN FILENAME]

Press [DESTN FILENAME] to specify the name of the destination file of the copied file. Then enter the name of the file.

You can use a volume specifier when entering the name of the destination file. For example, 'INT:myconfig' would indicate a file named 'myconfig' located on the analyzer's internal disc.

Here are the device specifiers:

- INT – for an internal disc
- EXT – for an external disc
- RAM – for a RAM disc

[START COPY]

Press [START COPY] to start a copy operation. The analyzer will use the source and destination filenames that you specified most recently.

The analyzer will prompt you to insert the source disc and then the destination disc. This allows you to copy a file from one disc to another.

[RETURN]

Press [RETURN] to return to the previous menu.

[STORAGE CONFIG]

Press [STORAGE CONFIG] to call up a menu that lets you select storage options.

You can select one of the following as the current mass storage device:

- the analyzer's internal RAM disc
- the analyzer's internal disc
- an external disc.

NOTE The internal RAM disc for the storage configuration uses EEPROMs (Electrically-erasable Read-only Memory). Currently, this type of memory is only guaranteed to perform write operations about 10,000 times. To avoid unnecessary write operations, do not toggle repeatedly between storage device choices. This is generally not a problem when using the analyzer from the front panel, but may occur with automated programs.

[DISC FUNCTIONS]

Press [DISC FUNCTIONS] to call up a menu that lets you select various disc operations.

[RETURN]

Press [RETURN] to return to the previous menu.

[STORAGE CONFIG]

Press [STORAGE CONFIG] to call up a menu that lets you select storage options. Memory;mass storage device, selecting

[INTERNAL RAM DISC]

Press [INTERNAL RAM DISC] to specify that you want the analyzer's RAM disc as the designated mass storage device.

[INTERNAL DISC]

Press [INTERNAL DISC] to specify that you want the analyzer's internal disc drive as the designated storage device.

[EXTERNAL DISC]

Press [EXTERNAL DISC] to specify that you want an external disc drive as the designated storage device.

[FORMAT ASCII/BIN]

Press [FORMAT ASCII/BIN] to select an ASCII or Binary output format for the analyzer.

NOTE ASCII files are more portable (the ASCII format is a universal standard), but binary files are generally more compact and therefore use less memory (except for state files).

Here's what else you should know:

- For the analyzer's internal RAM disc, the format option is an encoded value indicating the allocated memory size. You can format the disc to other sizes (up to the disc's maximum capacity). To do this, enter the number of bytes using the numeric keypad. The analyzer will format the disc to the nearest 1 kbyte. You should check the available memory before formatting the disc by pressing <Special Fctn>, then [MEMORY USAGE].
- For the analyzer's internal disc, the format option is limited to the numbers 0 through 5. Each number is an encoded value indicating the total amount of allocated memory, double sided format, and additional information. Though the internal drive can read and write single sided discs, it can only format double sided .
- For external disc drives, the format option can range from 0 to 254, depending on the drive you are using. Again, this is an encoded value indicating the total amount of allocated memory, single/double sided format, and additional information. To determine the appropriate format to use with an external disc, see the operating manual for that particular disc drive.

[INTRLEAVE FACTOR]

Press [INTRLEAVE FACTOR] to specify an appropriate interleave factor for disc formatting. You can enter an integer between 1 and 255. If you don't specify an interleave factor, the analyzer uses a default value of 1.

Here's what else you should know:

- The interleave factor is the spacing between sectors on a disc. Once you set the interleave factor, each newly-formatted disc will use this interleaving. Setting the interleave factor lets you maximize the efficiency of disc operations — essentially, it minimizes the time the drive must spend looking for the proper sector. Although setting the most efficient interleave factor is not critical for smaller files, it will save lots of time when reading or writing very large files.
- For the analyzer's internal disc drive, setting the interleave factor to 1 provides the most efficient disc operation.
- External disc drives may require different interleave factors for maximum read/write efficiency. For example, HP 9122 disc drives require an interleave factor of 2 to operate at maximum efficiency.

[START FORMAT]

Press [START FORMAT] to start the format operation. The analyzer will ask for the disc device to format. Enter the device, then press [ENTER].

When formatting an external disc, you'll have to check the external disc drive to see if the format operation is complete. The analyzer does not indicate when formatting is completed for external disc drives.

[STORAGE CONFIG]

Press [STORAGE CONFIG] to call up a menu that lets you select storage options.

[CATALOG ON/OFF]

Press [CATALOG ON/OFF] to turn on or off the catalog for the current mass storage device.

[RETURN]

Press [RETURN] to return to the previous menu.

< Recall >

Press < Recall > to call up a menu that lets you select recall options. Here are some of the things you can do with this menu:

- Recall a trace
- Recall an instrument setup state
- Recall math functions and constants
- Recall a limit table or data table
- Access file utilities and disc functions

NOTE You can recall from the analyzer's internal RAM disc, the analyzer's internal disc drive, or other external mass storage devices (such as compatible HP-IB disc drives).

[RECALL TRACE]

Press [RECALL TRACE] to call up a menu that lets you recall a trace from a mass storage device (the recalled trace is displayed on the active trace).

NOTE make sure you've specified your choice of mass storage device beforehand – INTERNAL RAM DISC, INTERNAL DISC, or EXTERNAL DISC – because the analyzer will look at the *current* mass storage device to find files 'TRACE1' through 'TRACE8'. If you use the [DEFINE FILENAME] softkey though, you can specify a file from *any* mass storage device.

[RCL FROM 'TRACE1']

Press [RCL FROM 'TRACE1'] to display the trace stored in the 'TRACE1' file.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'TRACE2']
Press [RCL FROM 'TRACE2'] to display the trace stored in the 'TRACE2' file.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'TRACE3']
Press [RCL FROM 'TRACE3'] to display the trace stored in the 'TRACE3' file.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'TRACE4']
Press [RCL FROM 'TRACE4'] to display the trace stored in the 'TRACE4' file.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'TRACE5']
Press [RCL FROM 'TRACE5'] to display the trace stored in the 'TRACE5' file.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'TRACE6']
Press [RCL FROM 'TRACE6'] to display the trace stored in the 'TRACE6' file.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'TRACE7']
Press [RCL FROM 'TRACE7'] to display the trace stored in the 'TRACE7' file.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'TRACE8']
Press [RCL FROM 'TRACE8'] to display the trace stored in the 'TRACE8' file.

NOTE The analyzer looks for this file in the *current* mass storage device.

[DEFINE FILENAME]

Press [DEFINE FILENAME] to specify the filename of the trace you want displayed. Then specify the name for this file. Be sure to use the appropriate device specifier prefix if the file is not in the *current* mass storage device.

Here are the device specifiers:

- INT – for an internal disc
- EXT – for an external disc
- RAM – for a RAM disc

[RETURN]

Press [RETURN] to return to the previous menu.

[RECALL STATE]

Press [RECALL STATE] to call up a menu that lets you recall an instrument state (its configuration) from a mass storage device. This lets you quickly set up the analyzer.

Here's what else you should know:

- When you recall an instrument state, the analyzer will automatically reconfigure its settings to reflect the settings stored in the instrument state file – this includes math functions, constants, limit tables, the data table, and user-defined functions (if any).
- Make sure you've specified your choice of mass storage device beforehand – INTERNAL RAM DISC, INTERNAL DISC, or EXTERNAL DISC – because the analyzer will look at the *current* mass storage device to find files 'STATE1' through 'STATE8'. If you use the [DEFINE FILENAME] softkey though, you can specify a file from *any* mass storage device.

[RCL FROM 'STATE1']

Press [RCL FROM 'STATE1'] to recall the instrument state stored in the 'STATE1' file. The analyzer's settings will reconfigure accordingly.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'STATE2']

Press [RCL FROM 'STATE2'] to recall the instrument state stored in the 'STATE2' file. The analyzer's settings will reconfigure accordingly.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'STATE3']

Press [RCL FROM 'STATE3'] to recall the instrument state stored in the 'STATE3' file. The analyzer's settings will reconfigure accordingly.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'STATE4']

Press [RCL FROM 'STATE4'] to recall the instrument state stored in the 'STATE4' file. The analyzer's settings will reconfigure accordingly.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'STATE5']

Press [RCL FROM 'STATE5'] to recall the instrument state stored in the 'STATE5' file. The analyzer's settings will reconfigure accordingly.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'STATE6']

Press [RCL FROM 'STATE6'] to recall the instrument state stored in the 'STATE6' file. The analyzer's settings will reconfigure accordingly.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'STATE7']

Press [RCL FROM 'STATE7'] to recall the instrument state stored in the 'STATE7' file. The analyzer's settings will reconfigure accordingly.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'STATE8']

Press [RCL FROM 'STATE8'] to recall the instrument state stored in the 'STATE8' file. The analyzer's settings will reconfigure accordingly.

NOTE The analyzer looks for this file in the *current* mass storage device.

[DEFINE FILENAME]

Press [DEFINE FILENAME] to specify the filename of the instrument state you want recalled. Then specify the name for this file. Be sure to use the appropriate device specifier prefix if the file is not in the *current* mass storage device.

Here are the device specifiers:

- INT – for an internal disc
- EXT – for an external disc
- RAM – for a RAM disc

[RETURN]

Press [RETURN] to return to the previous menu.

[RECALL MATH]

Press [RECALL MATH] to call up a menu that lets you recall the entire math definition of five functions and five constants from a file in a mass storage device.

NOTE Make sure you've specified your choice of mass storage device beforehand – INTERNAL RAM DISC, INTERNAL DISC, or EXTERNAL DISC – because the analyzer will look at the *current* mass storage device to find files 'MATH1' through 'MATH8'. If you use the [DEFINE FILENAME] softkey though, you can specify a file from *any* mass storage device.

[RCL FROM 'MATH1']

Press [RCL FROM 'MATH1'] to recall the math definition of all five functions and five constants from the 'MATH1' file.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'MATH2']

Press [RCL FROM 'MATH2'] to recall the math definition of all five functions and five constants from the 'MATH2' file.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'MATH3']

Press [RCL FROM 'MATH3'] to recall the math definition of all five functions and five constants from the 'MATH3' file.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'MATH4']

Press [RCL FROM 'MATH4'] to recall the math definition of all five functions and five constants from the 'MATH4' file.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'MATH5']

Press [RCL FROM 'MATH5'] to recall the math definition of all five functions and five constants from the 'MATH5' file.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'MATH6']

Press [RCL FROM 'MATH6'] to recall the math definition of all five functions and five constants from the 'MATH6' file.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'MATH7']

Press [RCL FROM 'MATH7'] to recall the math definition of all five functions and five constants from the 'MATH7' file.

NOTE The analyzer looks for this file in the *current* mass storage device.

[RCL FROM 'MATH8']

Press [RCL FROM 'MATH8'] to recall the math definition of all five functions and five constants from the 'MATH8' file.

NOTE The analyzer looks for this file in the *current* mass storage device.

[DEFINE FILENAME]

Press [DEFINE FILENAME] to specify the filename of the math definition of all five functions and five constants from the you want recalled. Be sure to use the appropriate device specifier prefix if the file is not in the *current* mass storage device.

Here are the device specifiers:

- INT – for an internal disc
- EXT – for an external disc
- RAM – for a RAM disc

[RETURN]

Press [RETURN] to return to the previous menu.

[RECALL MORE]

Press [RECALL MORE] to call up a menu that lets you recall limit tables and data tables from a mass storage device.

[RECALL LIMIT]

Press [RECALL LIMIT] to recall a limit table from a mass storage device.

Here's what else you should know:

- The recalled table is loaded into the table associated with the currently-active trace.
- Make sure you've specified your choice of mass storage device beforehand – INTERNAL RAM DISC, INTERNAL DISC, or EXTERNAL DISC – because the analyzer will look at the *current* mass storage device to find the limit table file.

[RETURN]

Press [RETURN] to return to the previous menu.

[RECALL DATA TABL]

Press [RECALL DATA TABL] to recall a data table from a mass storage device.

- The recalled table is loaded into the table associated with the currently-active trace.
- Make sure you've specified your choice of mass storage device beforehand – INTERNAL RAM DISC, INTERNAL DISC, or EXTERNAL DISC – because the analyzer will look at the *current* mass storage device to find the data table file.

[RETURN]

Press [RETURN] to return to the previous menu.

[APPLICATN UTILITIES]

Press [APPLICATN UTILITIES] to call up a menu that lets you list or load applications currently in the analyzer.

Here's what you can do from this menu:

- List all applications loaded in the analyzer
- Install individual applications
- Load all applications
- Turn on or off the autoload feature (if on, the analyzer loads all applications with the _LD suffix at power-up)

[LIST ON/OFF]

Press [LIST ON/OFF] to turn on or off the list of all available applications currently loaded (installed) in the analyzer. These are applications that you may have loaded using the [AUTO LOAD], [LOAD ALL], or [LOAD APPLICATN] softkeys.

[LOAD APPLICATN]

Press [LOAD APPLICATN] to load an application from the disc currently in the analyzer's active disc drive. Then specify the name of the particular application that you want loaded.

Here's what else you should know:

- The analyzer does not load applications that are already loaded.
- If an application specifies AUTOSTART, the analyzer will automatically start the application after loading it.
- Don't confuse programs that run in HP Instrument BASIC with applications. Although HP Instrument BASIC is itself an application, the programs that run in it are not – rather, they are loaded and saved like data tables and limit tables. For more information, see the HP Instrument Basic Getting Started Guide.

[LOAD ALL]

Press [LOAD ALL] to load all applications from the disc currently in the analyzer's active disc drive.

NOTE The analyzer does not load applications that are already loaded.

[AUTO LOAD ON/OFF]

Press [AUTO LOAD ON/OFF] to tell the analyzer whether or not to automatically load applications when you turn on the analyzer (power-up).

Here's what else you should know:

- During autoload, the analyzer loads only those applications that have the _LD suffix.
- If the analyzer is configured to be the system controller, it will first look for applications on the internal disc, and then look for applications on external disc drives.
- If the analyzer is not the system controller (in other words, configured to be addressable only), only applications on the internal disc will be loaded.

[RETURN]

Press [RETURN] to return to the previous menu.

[FILE UTILITIES]

Press [FILE UTILITIES] to call up a menu that lets you select a number of file management options. These include renaming, deleting, or copying files.

[DELETE FILE]

Press [DELETE FILE] to delete a file from the current mass storage device. Then specify the name of the file you want to delete.

[RENAME FILE]

Press [RENAME FILE] to rename a file. Then specify the new name.

[DELETE ALL FILES]

Press [DELETE ALL FILES] to delete all files from the current mass storage device. The analyzer will ask you if you really want to do this. Then specify by pressing [DO DELETE] or [CANCEL/RETURN].

NOTE If you want to change the current disc device, go back to the storage configuration menu. Alternatively, you can specify the disc device (for example, "INT:").

[PACK FILES]

Press [PACK FILES] to move all files to adjacent spaces on the disc. This applies only to those external disc drives that store data more efficiently when files are written to adjacent spaces on the disc.

[RENAME CATALOG]

Press [RENAME CATALOG] to specify a new volume name for a group of disc files. Then enter the new name.

[COPY DISC]

Press [COPY DISC] to copy the contents of one disc to another. If the source disc device is the same as the destination disc device (and the source disc is removable) then pressing [COPY DISC] will use the analyzer's memory as a buffer. The analyzer will ask you to swap source and destination discs (possibly several times) to complete the copy.

The copied disc is an image copy, so it will be an exact duplicate of the original disc.

[SOURCE DISC]

Press [SOURCE DISC] to specify the disc that you want to copy *from*. Then use the alphanumeric keypad to enter the name of the source disc.

[DESTN DISC]

Press [DESTN DISC] to specify the disc that you want to copy *to*. Then use the alphanumeric keypad to enter the name of the destination disc.

[START COPY]

Press [START COPY] to start the operation that copies one disc to another.

[COPY FILE]

Press [COPY FILE] to call up a menu that lets you copy one file to another.

[SOURCE FILENAME]

Press [SOURCE FILENAME] to specify the name of the source file you want copied. Then enter the name of the file.

You can use a volume specifier when entering the name of the source file. For example, 'INT:myconfig' would indicate a file named 'myconfig' located on the analyzer's internal disc.

Here are the device specifiers:

- INT – for an internal disc
- EXT – for an external disc
- RAM – for a RAM disc

[DESTN FILENAME]

Press [DESTN FILENAME] to specify the name of the destination file of the copied file. Then enter the name of the file.

You can use a volume specifier when entering the name of the destination file. For example, 'INT:myconfig' would indicate a file named 'myconfig' located on the analyzer's internal disc.

Here are the device specifiers:

- INT – for an internal disc
- EXT – for an external disc
- RAM – for a non-volatile RAM disc

[START COPY]

Press [START COPY] to start a copy operation. The analyzer will use the source and destination filenames that you specified most recently.

NOTE If both the source and the destination filenames are the same, the analyzer will ask you to insert a separate disc for the source file and for the destination file.

[RETURN]

Press [RETURN] to return to the previous menu.

[STORAGE CONFIG]

Press [STORAGE CONFIG] to call up a menu that lets you select storage options.

[DISC FUNCTIONS]

Press [DISC FUNCTIONS] to call up a menu that lets you select various disc operations, such as disc formatting.

[RETURN]

Press [RETURN] to return to the previous menu.

[STORAGE CONFIG]

Press [STORAGE CONFIG] to call up a menu that lets you select storage options.

[INTERNAL RAM DISC]

Press [INTERNAL RAM DISC] to specify that you want the analyzer's RAM disc as the designated mass storage device.

[INTERNAL DISC]

Press [INTERNAL DISC] to specify that you want the analyzer's internal disc drive as the designated storage device.

[EXTERNAL DISC]

Press [EXTERNAL DISC] to specify that you want an external disc drive as the designated storage device.

[FORMAT ASCII/BIN]

Press [FORMAT ASCII/BIN] to select an ASCII or Binary output format for the analyzer.

[PERIPHERL ADDRESSES]

Press [PERIPHERL ADDRESSES] to call up a menu that lets you specify addresses for compatible peripheral devices.

[CATALOG ON/OFF]

Press [CATALOG ON/OFF] to turn on or off the catalog for the current mass storage device.

[RETURN]

Press [RETURN] to return to the previous menu.

[CATALOG ON/OFF]

Press [CATALOG ON/OFF] to turn on or off the catalog for the current mass storage device.

[DISC FUNCTIONS]

Press [DISC FUNCTIONS] to call up a menu that lets you select various disc operations.

[FORMAT OPTION]

Press [FORMAT OPTION] to specify the format (bytes per sector) for the external disc drive — this tells the analyzer to use the correct format when writing to an external disc drive (or other mass storage device). Use the numeric keypad to enter the number of bytes per sector — for example, 256 or 512.

[START FORMAT]

Press [START FORMAT] to start the format operation. The analyzer will ask for the name of the disc to format. Enter the name, then press [ENTER].

When formatting an external disc, you'll have to check the external disc drive to see if the format operation is complete. The analyzer does not indicate when formatting is completed for external disc drives.

[STORAGE CONFIG]

Press [STORAGE CONFIG] to call up a menu that lets you select storage options.

[DISC VOLUME]

Press [DISC VOLUME] to specify the volume number for an external disc. Then use the numeric keypad to enter the address. You can enter a value from 0 to 7.

[PLOTTER ADDRESS]

Press [PLOTTER ADDRESS] to specify the HP-IB address of an external plotter. Then use the numeric keypad to enter the address. You can enter an address from 0 to 30.

[PRINTER ADDRESS]

Press [PRINTER ADDRESS] to specify the HP-IB address of an external printer. Then use the numeric keypad to enter the address. You can enter an address from 0 to 30.

[HP-IB UTILITIES]

Press [HP-IB UTILITIES] to call up a menu that lets you select additional HP-IB display options. These display options let you view:

- HP-IB status indicators
- mnemonic echo for HP-IB commands
- HP-IB scroll

[STATUS ON/OFF]

Press [STATUS ON/OFF] to turn on or off the HP-IB status display. If you turn on the status display, the HP-IB status messages always appear on the analyzer screen.

The four HP-IB status indicators are: RMT, TLK, LTN, and SRQ.

[MNEMONIC OFF]

Press [MNEMONIC OFF] to turn off the HP-IB mnemonic echo or scrolling features.

[MNEMONIC ECHO]

Press [MNEMONIC ECHO] to turn on the HP-IB mnemonic echo. If mnemonic echo is on, the analyzer displays the HP-IB command string that corresponds to the key or group of keys that you just pressed. In addition, the analyzer also displays command strings received over the HP-IB.

NOTE The HP-IB mnemonic echo is useful when writing HP-IB programs (for remote operation), since it indicates HP-IB command strings that will mimic front- panel operation.

[HP-IB SCROLL]

Press [HP-IB SCROLL] to turn on the HP-IB scroll. If scroll is on, the analyzer displays the last few HP-IB command characters received. As the analyzer receives new HP-IB command characters, the characters are scrolled to the left and new characters added to the right.

Here's what else you should know:

- When the HP-IB scroll is on, the HP-IB handshake will slow down to make it easier to view the scrolled commands
- If the analyzer detects an error, the character that triggered the error appears in inverse video
- Carriage returns and linefeeds are also displayed

[RETURN]

Press [RETURN] to return to the previous menu.

[USER SRQ]

Press [USER SRQ] to call up a menu that lets you select a number of HP-IB SRQ (Service Request) options. Each option interrupts an external controller for user-defined events. To learn how to use these SRQ options, see the HP 35660A HP-IB Programming Reference.

[USER SRQ 0]

Press [USER SRQ 0] to select Service Request option 0. To learn how to use this option, see the HP 35660A HP-IB Programming Reference.

[USER SRQ 1]

Press [USER SRQ 1] to select Service Request option 1. To learn how to use this option, see the HP 35660A HP-IB Programming Reference.

[USER SRQ 2]

Press [USER SRQ 2] to select Service Request option 2. To learn how to use this option, see the HP 35660A HP-IB Programming Reference.

[USER SRQ 3]

Press [USER SRQ 3] to select Service Request option 3. To learn how to use this option, see the HP 35660A HP-IB Programming Reference.

[USER SRQ 4]

Press [USER SRQ 4] to select Service Request option 4. To learn how to use this option, see the HP 35660A HP-IB Programming Reference.

[USER SRQ 5]

Press [USER SRQ 5] to select Service Request option 5. To learn how to use this option, see the HP 35660A HP-IB Programming Reference.

[USER SRQ 6]

Press [USER SRQ 6] to select Service Request option 6. To learn how to use this option, see the HP 35660A HP-IB Programming Reference.

[USER SRQ 7]

Press [USER SRQ 7] to select Service Request option 7. To learn how to use this option, see the HP 35660A HP-IB Programming Reference.

[USER SRQ 8]

Press [USER SRQ 8] to select Service Request option 8. To learn how to use this option, see the HP 35660A HP-IB Programming Reference.

[USER SRQ 9]

Press [USER SRQ 9] to select Service Request option 9. To learn how to use this option, see the HP 35660A HP-IB Programming Reference.

< Plot/Print >

Press < Plot/Print > to call up a menu that lets you print or plot measurement results.

NOTE The analyzer must have control of the HP-IB bus to plot or print anything. Make sure you've set the analyzer to be the system controller. To do this, press < Local/HP-IB >, then press [SYSTEM CONTROLLR].

[PLOT SCREEN]

Press [PLOT SCREEN] to plot the entire analyzer screen, including markers. Softkeys, however, will not be plotted.

[ABORT PLOT]

Press [ABORT PLOT] to abort the current plot in progress.

NOTE When plotting, the analyzer does not respond to any key presses, except the [ABORT PLOT] softkey.

[PLOT TRACE]

Press [PLOT TRACE] to plot the active trace.

NOTE Grids and markers are not plotted. This lets you use paper with pre-printed grids.

[ABORT PLOT]

Press [ABORT PLOT] to abort the current plot in progress.

NOTE When plotting, the analyzer does not respond to any key presses, except the [ABORT PLOT] softkey.

[PLOT MARKER]

Press [PLOT MARKER] to plot the marker that's on the active trace (just the marker, not the trace). The marker's x- and y-values will be plotted near the marker as well.

[ABORT PLOT]

Press [ABORT PLOT] to abort the current plot in progress.

NOTE When plotting, the analyzer does not respond to any key presses, except the [ABORT PLOT] softkey.

[DEFINE PLT SPEED]

Press [DEFINE PLT SPEED] to call up a menu that lets you select the plotter speed. You can select a slow speed, a fast speed, or a user-defined speed.

[SLOW (5 cm/s)]

Press [SLOW (5 cm/s)] to specify that you want the plotter to operate at 5 cm per second.

[FAST (36 cm/s)]

Press [FAST (36 cm/s)] to specify that you want the plotter to operate at 36 cm per second.

[USER DEFINED]

Press [USER DEFINED] to use the user-defined speed. To specify this speed, use the [USER ENTRY] softkey.

[USER ENTRY]

Press [USER ENTRY] to specify the plotter speed for the user-defined setting. Use the numeric keypad to enter a the plot speed (in cm per second). Then press [RETURN].

The speed you specify here does not go into effect until you switch to user-defined speed (by pressing the [USER DEFINED] softkey).

[RETURN]

Press [RETURN] to return to the previous menu.

[DEFINE PLOT PENS]

Press [DEFINE PLOT PENS] to call up a menu that lets you select the plotter pens you want to use.

[DEFAULT PENS]

Press [DEFAULT PENS] to have the plotter use these default settings:

The default settings are:

- Trace A line type: SOLID
- Trace B line type: SOLID
- Alpha pen: 1
- Grid pen: 2
- Trace A pen: 3
- Trace B pen: 4
- User entry type A and B: SOLID

NOTE The default pen selection may vary, depending on the type of plotter and its particular configuration.

[TRACE A PEN NUM]

Press [TRACE A PEN NUM] to assign a specific pen to plot Trace A. Use the numeric keypad to specify the pen number, then press [ENTER].

[TRACE A LINE TYPE]

Press [TRACE A LINE TYPE] to call up a menu that lets you select the type of line drawn for Trace A.

[SOLID]

Press [SOLID] to specify a solid line for Trace A.

[DOTTED]

Press [DOTTED] to specify a dotted line for Trace A.

[DASHED]

Press [DASHED] to specify a dashed line for Trace A.

[USER DEFINED]

Press [USER DEFINED] to use the user-defined line type for Trace A. To specify this type, use the [USER TYPE ENTRY] softkey.

[USER TYPE ENTRY]

Press [USER TYPE ENTRY] to specify one of eight different line types for Trace A. Use the numeric keypad to select a value between 0 and 6, then press [ENTER]. You can also enter −4096; this is a solid line for some plotters.

NOTE Some plotters use a number from 0 to 6 to specify a particular line type. To learn more about these line types, see the operating manual for your particular plotter.

The line type you specify here does not go into effect until you switch to user-defined line type (by pressing the [USER DEFINED] softkey).

[RETURN]

Press [RETURN] to return to the previous menu.

[TRACE B PEN NUM]

Press [TRACE B PEN NUM] to assign a specific pen to plot Trace B. Use the numeric keypad to specify the pen number, then press [ENTER].

[TRACE B LINE TYPE]

Press [TRACE B LINE TYPE] to call up a menu that lets you select the type of line drawn for Trace B.

[SOLID]

Press [SOLID] to specify a solid line for Trace B.

[DOTTED]

Press [DOTTED] to specify a dotted line for Trace B.

[DASHED]

Press [DASHED] to specify a solid line for Trace B.

[USER DEFINED]

Press [USER DEFINED] to use the user-defined line type for Trace B. To specify this type, use the [USER TYPE ENTRY] softkey.

[USER TYPE ENTRY]

Press [USER TYPE ENTRY] to specify one of eight different line types for Trace B. Use the numeric keypad to select a value between 0 and 6, then press [ENTER]. You can also enter −4096; this is a solid line for some plotters.

NOTE Some plotters use a number from 0 to 6 to specify a particular line type. To learn more about these line types, see the operating manual for your particular plotter.

The line type you specify here does not go into effect until you switch to user-defined speed (by pressing the [USER DEFINED] softkey).

[RETURN]

Press [RETURN] to return to the previous menu.

[ALPHA PEN NUM]

Press [ALPHA PEN NUM] to assign a specific pen to draw the letters and numbers on the plot. Use the numeric keypad to specify the pen number, then press [ENTER].

[GRID PEN NUM]

Press [GRID PEN NUM] to assign a specific pen to draw the grid part of the plot. Use the numeric keypad to specify the pen number, then press [ENTER].

[RETURN]

[PRINT SCREEN]

Press [PRINT SCREEN] to print the entire analyzer screen, including markers. Softkeys, however, will not be printed.

NOTE Your printer must be an HP-IB printer (with standard HP graphics capability) to print the entire screen.

[ABORT PRINT]

Press [ABORT PRINT] to abort the current print in progress.

NOTE When printing, the analyzer does not respond to any key presses, except the [ABORT PRINT] softkey.

[PRINT ALPHA]

Press [PRINT ALPHA] to print an ASCII representation of the data on the current screen.

Here's what else you should know:

- If the display is alphanumeric (the data table, for example), the printer simply prints the alphanumeric values.
- For the standard measurement display, the printer prints only the alphanumeric information about the trace(s), not the trace(s) themselves.

[ABORT PRINT]

Press [ABORT PRINT] to abort the current print in progress.

NOTE When printing, the analyzer does not respond to any key presses, except the [ABORT PRINT] softkey.

[PERIPHERL ADDRESSES]

Press [PERIPHERL ADDRESSES] to call up a menu that lets you specify addresses for compatible peripheral devices.

< Special Fctn >

Press < Special Fctn > to call up a menu that lets you select special functions. These include:

- Calibration options
- Memory allocation
- Turning on the beeper
- Setting the clock and calendar
- Self-test functions

[SINGLE CAL]

Press [SINGLE CAL] to start the analyzer's calibration routine. This is the same calibration routine that occurs when you turn on the analyzer (and at periodic intervals, if you've turned on auto calibration).

Incidentally, during calibration, a small ac voltage (around 2 mV) appears at the source output connector.

[AUTO CAL ON/OFF]

Press [AUTO CAL ON/OFF] to turn auto calibration on or off.

Here's what else you should know:

- If you turn on auto calibration, the analyzer will periodically calibrate itself – automatically. The auto calibration routine occurs several times during the first hour of operation. After the first hour, the routine occurs at one-hour intervals.
- If you turn off auto calibration, the analyzer will not calibrate itself.
- When you turn on the analyzer, auto calibration is automatically turned on – even if you turned off auto calibration previously.
- During calibration, a small ac voltage (around 2 mV) appears at the source output connector.

[CAL OPTIONS]

Press [CAL OPTIONS] to call up a menu that lets you select a number of calibration options.

[CLEAR CAL CONSTANTS]

Press [CLEAR CAL CONSTANTS] to clear all calibration constants – until the analyzer calibrates again.

NOTE If you've turned off auto calibration, the calibration constants will remain cleared.

[CAL TRACE ON/OFF]

Press [CAL TRACE ON/OFF] to turn on or off the calibration trace display. If the calibration trace is on, the analyzer will display the calibration results (calibration traces) after each calibration.

[BEEPER ON/OFF]

Press [BEEPER ON/OFF] to turn on or off the analyzer's beeper. The beeper sounds when the analyzer displays an important message.

[TIME HHMMSS]

Press [TIME HHMMSS] to view the current time. If you want to change the time, use the numeric keypad to enter the new time, then press [ENTER].

[DATE MMDDYY]

Press [DATE MMDDYY] to view the current date. If you want to change the date, use the numeric keypad to enter the new date, then press [ENTER].

[FAULT LOG]

This key is intended for service personnel only.

[CLEAR FAULT LOG]

This key is intended for service personnel only.

[DESCRIBE ENTRY]

This key is intended for service personnel only.

[VERSION]

Press [VERSION] to find the revision date of the analyzer's current software.

[RETURN]

Press [RETURN] to exit the fault log and return to the previous display.

[MEMORY USAGE]

Press [MEMORY USAGE] to view the analyzer's current memory allocation. This display indicates the total memory available and the amount of memory actually used.

[SELF TEST]

Press [SELF TEST] to call up a menu that lets you start several self-test routines.

Although most service routines are designed for service personnel only, you should use both quick and long confidence tests to check the analyzer if you suspect that something is wrong. The results of these tests are stored in the test log. Any failures reported in the test log should be brought to the attention of your local Hewlett-Packard Sales/Service Office (or other qualified personnel).

[QUICK CONF TEST]

Press [QUICK CONF TEST] to run a quick confidence test. The analyzer performs a calibration check, and compares the results to the calibration specification limits.

Test results are stored in the test log. Any failures reported in the test log should be brought to the attention of your local Hewlett-Packard Sales/Service Office (or other qualified personnel).

For more information about the confidence test, see the analyzer's service manual. For additional help, contact your local Hewlett-Packard Sales/Service Office or other qualified personnel.

[LONG CONF TEST]

Press [LONG CONF TEST] to call up a menu that lets you start or stop the series of instrument self-tests.

Test results are stored in the test log. Any failures reported in the test log should be brought to the attention of your local Hewlett-Packard Sales/Service Office (or other qualified personnel).

For more information about these confidence tests, see the analyzer's service manual. For additional help, contact your local Hewlett-Packard Sales/Service Office or other qualified personnel.

[START]

This key is intended for service personnel only.

[ABORT RETURN]

This key stops any activity in progress, and returns you to the previous menu.

[TEST LOG]

Press [TEST LOG] to see the results of a self-test routines, calibration errors, or other hardware errors.

Any failures reported in the test log should be brought to the attention of your local Hewlett-Packard Sales/Service Office (or other qualified personnel).

[CLEAR TEST LOG]

Press [CLEAR TEST LOG] to delete the contents of the test log.

This does not remove the test log from the screen. To do that, press [TEST LOG OFF].

[TEST LOG OFF]

Press [TEST LOG OFF] to remove the test log from the analyzer's screen.

This does not delete the contents of the test log. To do that, press [CLEAR TEST LOG].

< 0 >

Press < 0 > to enter the number 0.

< 1 >

Press < 1 > to enter the number 1.

< 2 >

Press < 2 > to enter the number 2.

< 3 >
Press < 3 > to enter the number 3.

< 4 >
Press < 4 > to enter the number 4.

< 5 >
Press < 5 > to enter the number 5.

< 6 >
Press < 6 > to enter the number 6.

< 7 >
Press < 7 > to enter the number 7.

< 8 >
Press < 8 > to enter the number 8.

< 9 >
Press < 9 > to enter the number 9.

< . >
Press < . > to enter a decimal point.

The analyzer uses the (.) to separate integral and fractional portions of a number. This is important to remember if it's the custom in your country to use the comma (,) for this purpose.

< +/− >
Press < +/− > to enter a minus sign — press twice to enter a plus sign. This is similar to a "change sign" key on a handheld calculator.

< Marker Value >
Press < Marker Value > to enter the numeric value of the x-marker or the y-marker.

NOTE The exact value entered varies. If the analyzer needs the x-marker value, pressing < Marker Value > will enter the x-value. If the analyzer needs the y-marker value, pressing < Marker Value > will enter the y-value.

< Back Space >

Press < Back Space > to erase preceding numeric or alpha keypad entries, one at a time.

< entry up >

Press <⇧> to step through successively greater numeric values, or choices from a list of options. The <⇧> key is especially useful when in the < Scale > menu, since it lets you quickly position the waveform trace and change the vertical scaling.

< entry down >

Press <⇩> to step through successively lesser numeric values, or choices from a list of options. The <⇩> key is especially useful when in the < Scale > menu, since it lets you quickly position the waveform trace and change the vertical scaling.

[EXP]

Press [EXP] to specify that you want to enter an exponent value. Then use the numeric keypad to enter the exponent value.

NOTE If you try to enter an exponent without having entered a preceding integer value, the analyzer displays an error message.

[dBm REF IMPEDANCE]

< **Source** >

[SOURCE ON/OFF]
[LEVEL]
[RANDOM]
[PERIODIC CHIRP]
[FIXED SINE]
[SINE FREQ ENTRY]

< **Frequency** >

[SPAN]
[START]
[CENTER]
[ZERO START]
[FULL SPAN]
[STEP]
[RECORD LENGTH]

< **Average** >

[AVERAGE ON/OFF]
[NUMBER AVERAGES]
[RMS AVERAGE]
[RMS EXPO AVERAGE]
[VECTOR AVERAGE]
[VECT EXPO AVERAGE]
[CONTINUOS PEAK HOLD]
[FAST AVG ON/OFF]
[UPDATE RATE]
[OVERLAP%]

< **Window** >

[HANNING]
[FLAT TOP]
[UNIFORM]
[FORCE EXPO]
[FORCE CHANNEL 1]
[EXPO CHANNEL 1]
[FORCE CHANNEL 2]
[EXPO CHANNEL 2]

< Start >

< Pause >

< Trigger >

- [CONTINUOS TRIGGER]
- [EXTERNAL TRIGGER]
- [CHANNEL 1 TRIGGER]
- [CHANNEL 2 TRIGGER]
- [SOURCE TRIGGER]
- [HP-IB TRIGGER]
- [AUTOMATIC ARM]
- [MANUAL ARM]
- [TRIGGER SET UP]
  - [LEVEL]
  - [SLOPE POS/NEG]
  - [CHANNEL 1 DELAY]
  - [CHANNEL 2 DELAY]
  - [RETURN]
- [ARM]

Display Keys

< Active Trace >

< Format >

- [SINGLE]
- [UPPER/ LOWER]
- [FRONT/ BACK]
- [SETUP STATE]
- [TRCE GRID ON/OFF]
- [TRACE TITLE]
- [DATA LBL ON/OFF]
- [DISP BLNK ON/OFF]

< Meas Data >

- [SPECTRUM CHANNEL 1]
- [SPECTRUM CHANNEL 2]
- [PSD CHANNEL 1]
- [PSD CHANNEL 2]
- [TIME CHANNEL 1]
- [TIME CHANNEL 2]
- [FREQUENCY RESPONSE]
- [COHERENCE]
- [CROSS SPECTRUM]
- [MORE]
  - [FUNCTION (F1-F5)]
    - [FUNCTION F1]
    - [FUNCTION F2]
    - [FUNCTION F3]
    - [FUNCTION F4]
    - [FUNCTION F5]
    - [RETURN]
  - [CONSTANT (K1-K5)]
    - [CONSTANT K1]
    - [CONSTANT K2]
    - [CONSTANT K3]
    - [CONSTANT K4]
    - [CONSTANT K5]
    - [RETURN]

[DEFINE K4]
- [DEFINE K4 REAL PART]
- [DEFINE K4 IMAG PART]
- [DEFINE K4 MAGNITUDE]
- [DEFINE K4 PHASE]
- [RETURN]

[DEFINE K5]
- [DEFINE K5 REAL PART]
- [DEFINE K5 IMAG PART]
- [DEFINE K5 MAGNITUDE]
- [DEFINE K5 PHASE]
- [RETURN]

< Trace Type >

- [LINEAR MAGNITUDE]
- [LOG MAGNITUDE]
- [PHASE]
- [GROUP DELAY]
  - [APERT .5% OF SPAN]
  - [APERT 1% OF SPAN]
  - [APERT 2% OF SPAN]
  - [APERT 4% OF SPAN]
  - [APERT 8% OF SPAN]
  - [APERT 16% OF SPAN]
  - [RETURN]
- [REAL PART]
- [IMAGINARY PART]

< Scale >

- [AUTO SCALE]
- [TOP REFERENCE]
- [CENTER REFERENCE]
- [BOTTOM REFERENCE]
- [REF LEVEL TRACKING]
- [VERTICAL /DIV]
- [VERTICAL UNITS]
- [X-AXIS LIN/LOG]

Marker Keys

< **marker up** >

< **marker down** >

< **marker left** >

< **marker right** >

< **Fast** >

< **Marker** >
- [MARKER ON/OFF]
- [COUPLED ON/OFF]
- [X ENTRY]
- [OFFSET]
  - [OFFSET ON/OFF]
  - [OFFSET ZERO]
  - [REFERENCE X ENTRY]
  - [REFERENCE Y ENTRY]
  - [RETURN]
- [MARKER TO PEAK]
- [NXT RIGHT PEAK]
- [NXT LEFT PEAK]
- [MARKER TO MINIMUM]
- [PEAK TRK ON/OFF]
- [SEARCH]
  - [TARGET]
  - [LEFT]
  - [RIGHT]
  - [RETURN]

< **Marker Fctn** >

- [OFF]
- [HARMONIC]
  - [FNDMNTL FREQ]
  - [DEFINE NUM HARM]
  - [DIVIDE FNDMNTL]
  - [THD]
  - [HARM PWR]
  - [RESULTS ON/OFF]
  - [RETURN]
- [SIDEBAND]
  - [CARRIER FREQ]
  - [SIDEBAND INCREM]
  - [DEFINE NUM SDBND]
  - [RESULTS ON/OFF]
  - [RETURN]
- [BAND]
  - [DEFINE LEFT FREQ]
  - [DEFINE RGHT FREQ]
  - [DEFINE CENT FREQ]
  - [RESULTS ON/OFF]
  - [RETURN]
- [LIMIT]
  - [X-START]
  - [Y-START]
  - [X-STOP]
  - [Y-STOP]
  - [LIMIT UPPER/LOW]
  - [INSERT SEGMENT]
  - [DELETE]
  - [DELETE SEGMENT]
  - [DELETE ALL]
  - [RETURN]
- [OFFSET]
  - [Y OFFSET ON/OFF]
  - [Y OFFSET VALUE]
  - [X ADJUST ALL SEGS]
  - [Y ADJUST ALL SEGS]
  - [RETURN]

System Keys

< **Preset** >

< **User Defined** >

< **Help** >

< **Save** >
- [SAVE TRACE]
  - [INTO FILE 'TRACE1']
  - [INTO FILE 'TRACE2']
  - [INTO FILE 'TRACE3']
  - [INTO FILE 'TRACE4']
  - [INTO FILE 'TRACE5']
  - [INTO FILE 'TRACE6']
  - [INTO FILE 'TRACE7']
  - [INTO FILE 'TRACE8']
  - [DEFINE FILENAME]
  - [RETURN]
- [SAVE STATE]
  - [INTO FILE 'STATE1']
  - [INTO FILE 'STATE2']
  - [INTO FILE 'STATE3']
  - [INTO FILE 'STATE4']
  - [INTO FILE 'STATE5']
  - [INTO FILE 'STATE6']
  - [INTO FILE 'STATE7']
  - [INTO FILE 'STATE8']
  - [DEFINE FILENAME]
  - [RETURN]
- [SAVE MATH]
  - [INTO FILE 'MATH1']
  - [INTO FILE 'MATH2']
  - [INTO FILE 'MATH3']
  - [INTO FILE 'MATH4']
  - [INTO FILE 'MATH5']
  - [INTO FILE 'MATH6']
  - [INTO FILE 'MATH7']
  - [INTO FILE 'MATH8']

[DEFINE FILENAME]
[RETURN]
[SAVE MORE]
[SAVE LIMIT]
[SAVE DATA TABLE]
[RETURN]
[SAVE SYS CONFIG]
[DO SAVE]
[CANCEL/RETURN]
[FILE UTILITIES]
[RENAME FILE]
[DELETE FILE]
[DELETE ALL FILES]
[DO DELETE]
[PACK FILES]
[RENAME CATALOG]
[COPY DISC]
[SOURCE DISC]
[DESTN DISC]
[START COPY]
[RETURN]
[COPY FILE]
[SOURCE FILENAME]
[DESTN FILENAME]
[START COPY]
[RETURN]
[STORAGE CONFIG]
[INTERNAL RAM DISC]
[INTERNAL DISC]
[EXTERNAL DISC]
[FORMAT ASCII/BIN]
[PERIPHERL ADDRESSES]
[DISC ADDRESS]
[DISC UNIT]
[DISC VOLUME]
[PLOTTER ADDRESS]
[PRINTER ADDRESS]
[RETURN]

[CATALOG ON/OFF]
[RETURN]
[DISC FUNCTIONS]
[FORMAT OPTION]
[INTRLEAVE FACTOR]
[START FORMAT]
[STORAGE CONFIG]
[INTERNAL RAM DISC]
[INTERNAL DISC]
[EXTERNAL DISC]
[FORMAT ASCII/BIN]
[PERIPHERL ADDRESSES]
[DISC ADDRESS]
[DISC UNIT]
[DISC VOLUME]
[PLOTTER ADDRESS]
[PRINTER ADDRESS]
[RETURN]
[CATALOG ON/OFF]
[RETURN]
[CATALOG ON/OFF]
[RETURN]
[RETURN]
[STORAGE CONFIG]
[INTERNAL RAM DISC]
[INTERNAL DISC]
[EXTERNAL DISC]
[FORMAT ASCII/BIN]
[PERIPHERL ADDRESSES]
[DISC ADDRESS]
[DISC UNIT]
[DISC VOLUME]
[PLOTTER ADDRESS]
[PRINTER ADDRESS]
[RETURN]
[CATALOG ON/OFF]
[RETURN]

- [CATALOG ON/OFF]
- [DISC FUNCTIONS]
  - [FORMAT OPTION]
  - [INTRLEAVE FACTOR]
  - [START FORMAT]
  - [STORAGE CONFIG]
    - [INTERNAL RAM DISC]
    - [INTERNAL DISC]
    - [EXTERNAL DISC]
    - [FORMAT ASCII/BIN]
    - [PERIPHERL ADDRESSES]
      - [DISC ADDRESS]
      - [DISC UNIT]
      - [DISC VOLUME]
      - [PLOTTER ADDRESS]
      - [PRINTER ADDRESS]
      - [RETURN]
    - [CATALOG ON/OFF]
    - [RETURN]
  - [CATALOG ON/OFF]
  - [RETURN]

< Recall >

- [RECALL TRACE]
  - [RCL FROM 'TRACE1']
  - [RCL FROM 'TRACE2']
  - [RCL FROM 'TRACE3']
  - [RCL FROM 'TRACE4']
  - [RCL FROM 'TRACE5']
  - [RCL FROM 'TRACE6']
  - [RCL FROM 'TRACE7']
  - [RCL FROM 'TRACE8']
  - [DEFINE FILENAME]
  - [RETURN]

[RECALL STATE]
- [RCL FROM 'STATE1']
- [RCL FROM 'STATE2']
- [RCL FROM 'STATE3']
- [RCL FROM 'STATE4']
- [RCL FROM 'STATE5']
- [RCL FROM 'STATE6']
- [RCL FROM 'STATE7']
- [RCL FROM 'STATE8']
- [DEFINE FILENAME]
- [RETURN]

[RECALL MATH]
- [RCL FROM 'MATH1']
- [RCL FROM 'MATH2']
- [RCL FROM 'MATH3']
- [RCL FROM 'MATH4']
- [RCL FROM 'MATH5']
- [RCL FROM 'MATH6']
- [RCL FROM 'MATH7']
- [RCL FROM 'MATH8']
- [DEFINE FILENAME]
- [RETURN]

[RECALL MORE]
- [RECALL LIMIT]
- [RECALL DATA TABL]
- [RETURN]

[APPLICATN UTILITIES]
- [LIST ON/OFF]
- [LOAD APPLICATN]
- [LOAD ALL]
- [AUTO LOAD ON/OFF]
- [RETURN]

[FILE UTILITIES]

[STORAGE CONFIG]
- [INTERNAL RAM DISC]
- [INTERNAL DISC]
- [EXTERNAL DISC]
- [FORMAT ASCII/BIN]
- [PERIPHERL ADDRESSES]

[PRINTER ADDRESS]
[RETURN]
[HP-IB UTILITIES]
[STATUS ON/OFF]
[MNEMONIC OFF]
[MNEMONIC ECHO]
[HP-IB SCROLL]
[RETURN]
[USER SRQ]
[USER SRQ 0]
[USER SRQ 1]
[USER SRQ 2]
[USER SRQ 3]
[USER SRQ 4]
[USER SRQ 5]
[USER SRQ 6]
[USER SRQ 7]
[USER SRQ 8]
[USER SRQ 9]

< Plot/Print >

[PLOT SCREEN]
[ABORT PLOT]
[PLOT TRACE]
[ABORT PLOT]
[PLOT MARKER]
[ABORT PLOT]
[DEFINE PLT SPEED]
[SLOW (5 cm/s)]
[FAST (36 cm/s)]
[USER DEFINED]
[USER ENTRY]
[RETURN]
[DEFINE PLOT PENS]
[DEFAULT PENS]
[TRACE A PEN NUM]
[TRACE A LINE TYPE]

[SOLID]
[DOTTED]
[DASHED]
[USER DEFINED]
[USER TYPE ENTRY]
[RETURN]
[TRACE B PEN NUM]
[TRACE B LINE TYPE]
[SOLID]
[DOTTED]
[DASHED]
[USER DEFINED]
[USER TYPE ENTRY]
[RETURN]
[ALPHA PEN NUM]
[GRID PEN NUM]
[RETURN]
[PRINT SCREEN]
[ABORT PRINT]
[PRINT ALPHA]
[ABORT PRINT]
[PERIPHERL ADDRESSES]
[DISC ADDRESS]
[DISC UNIT]
[DISC VOLUME]
[PLOTTER ADDRESS]
[PRINTER ADDRESS]
[RETURN]

< Special Fctn >

[SINGLE CAL]
[AUTO CAL ON/OFF]
[CAL OPTIONS]
[CLEAR CAL CONSTANTS]
[CAL TRACE ON/OFF]
[RETURN]

[BEEPER ON/OFF]
[TIME HHMMSS]
[DATE MMDD[YY]]
    [FAULT LOG]
    [CLEAR FAULT LOG]
    [DESCRIBE ENTRY]
    [TOBI]
    [VERSION]
    [RETURN]
[MEMORY USAGE]
    [RETURN]
[SELF TEST]
    [QUICK CONF TEST]
    [LONG CONF TEST]
        [START]
        [ABORT RETURN]
    [FUNCTIONL TESTS]

Key Index <Hardkeys>

Key Index [Softkeys]

A

B

C

S

T

U

V

X

Y

Z

Page 3-39, 10. Input Impedance.
Step "8a Perform the following steps:" under < Input > should read as follows:

< Input >
[CHANNEL 1 RANGE] < 1 > [dBVrms]

Page 3-40. Step "10a. Perform the following steps for channel 2 measurment:" under < Input > should read as follows:

< Input >
[CHANNEL 2 RANGE] < 1 > [dBVrms]

Page 3-41. Step 12, change the following formulas:
Channel 1: 100 kHz

$$Cin = 15.92 \times 10^{-12} \sqrt{\frac{Vin^2}{Vc^2} - 1.210}$$

or

$$\frac{Vin}{Vc} \leq 6.377$$

Channel 2: 50 kHz

$$Cin = 31.83 \times 10^{-12} \sqrt{\frac{Vin^2}{Vc^2} - 1.210}$$

or

$$\frac{Vin}{Vc} \leq 3.329$$

Page 3-44, 11. Harmonic Distortion.
Step 4b Should read as follows:

b. Press the HP 356660A keys as follows:
< Average >
[AVERAGE ON/OFF]
< Marker >
[X ENTRY] (to Input Signal Frequency column in the table)

Page 3-47. 12. Intermodulation Distortion.
Change the following:

Step 2 Frequency Synthesizer
FROM: Amplitude (Chan B) .... 0.5 Vrm
TO: Amplitude (Chan B) 0.28Vrm

Step3. < Input >
FROM: [CHANNEL 1 RANGE] < −1 > [dBVrms]
TO: [CHANNEL 1 RANGE] < −11 > [dBVrms]

Page 3-48. Step 4c and 4e Should read as follows:

c. Adjust the amplitude of the synthesizer's channel A until "A Marker Y:" and "B Marker Y:" equals −17 ±0.100 dBVrms.

e. Adjust the amplitude of the synthesizer's channel B until "A Marker Y:" and "B Marker Y:" equals −17 ±0.100 dBVrms.

Page 3-70 . 18. Source Output Resistance.
Step 4 Should read as follows:

< Source >
[SOURCE ON/OFF]
[LEVEL] < 1 > [V]
[SINE FREQ ENTRY] < 1 > < 0 > [kHz]