HP 8510C
ON–SITE SERVICE
MANUAL

SERIAL NUMBERS

This manual applies directly to instruments with this serial prefix number or above: 3031A.

If your instrument has a lower serial prefix number, refer to the Instrument History chapter.

MANUAL PART NO. 08510–90282

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EDITION 2

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 Institute of Standards and Technology (NIST, formerly NBS), to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

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

BP24.2

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1. Service and Equipment Overview

INTRODUCTION

This On-Site Service Manual is a complete guide to test, repair, adjustment and installation of the HP 8510C network analyzer. It was written for qualified service personnel. Previous knowledge of a network analyzer system is assumed, but specific knowledge of the HP 8510 system is not required.

This manual addresses troubleshooting to the faulty board or assembly, not to the component level. When the faulty board or assembly has been isolated, contact your nearest HP office and order the new part. In most cases, an exchange assembly is available, which costs less than a new part. A list of HP offices is provided at the end of this manual.

Due to the assembly level repair strategy, schematics and individual component lists are not included in this documentation.

ORGANIZATION OF THIS ON-SITE SERVICE MANUAL

This manual is part of the documentation set included with the HP 8510C network analyzer. Refer to the "HP 8510C Documentation Map" for a graphic representation of all chapters, and the complete documentation set for the HP 8510C network analyzer. This map is located after the title page at the front of this manual.

Tabs are used to divide the major chapters and sections. A chapter is a major topic division within the manual. A section is a division of information within a chapter. The names of the colored tabs and an explanation of their contents are listed below.

Service and Equipment Overview (Chapter 1)

This is the chapter you are reading now. It provides a brief summary of the service information in this manual, and a list of the test equipment required. This chapter should be read before attempting any repairs.

Safety/Licensing (Chapter 2)

This chapter contains safety and licensing information required for the HP 8510C.

Theory of Operation (Chapter 3)

This section describes how the system operates, especially the phase lock circuitry. Read this section to learn how the HP 8510 system hardware and firmware operate.

Main Troubleshooting Procedure (Chapter 4)

Turn to this chapter first when troubleshooting a system. It consists of a main procedure that refers to other sections within chapter 4. The following fold-outs are located at the back of this chapter:

- HP 8510C System-Level Troubleshooting Block Diagram
- HP 85101C Display/Processor Overall Block Diagram
- HP 85102 IF/Detector Overall Block Diagram
- HP 8510C Phase Lock Block Diagram
- HP 85101C A8 Motherboard Wiring Diagram
- HP 85102 A25 Motherboard Wiring Diagram

The sections within chapter 4 are as follows:

1 - Self Test Failures
2 - Running Error Messages
4.3 - Unratioed Power Failures
4.4 - Power Supply Failures
4.5 - Performance Test Failures
4.6 - Software Failures
4.7 - Other Failures
4.8 - Service Program
4.9 - Error Terms

Replaceable Parts (Chapter 5)

This chapter contains part numbers for replaceable parts and assemblies, and instructions on how to order them.

Replacement Procedures (Chapter 6)

This section contains procedures for disassembling or re-assembling the HP 8510C after a part or assembly is replaced.

Adjustments (Chapter 7)

This chapter contains adjustment procedures.

Specifications and Performance Verification (Chapter 8)

This chapter describes the following:

Performance verification
Specifications
Software for specifications and performance verification
How to run the system specifications and uncertainty program
Measurement uncertainties
Traceability and kit recertification
Substitution of system components
Calibration cycle

Installation (Chapter 9)

This chapter describes the following:

Site preparation
Checking the shipment and unpacking the system
Configuring and connecting the system
Checking the system operation

Preventive Maintenance (Chapter 10)

This section has some simple procedures that should be followed in order to maintain the system.

DEFINITION OF AN HP 8510 SYSTEM

There are many varieties of systems using an HP 8510 network analyzer. In the strictest sense, a basic HP 8510 system consists of the following:

1 - HP 85101 Display/Processor
1 - HP 85102 IF/Detector
1 (or more) - Source(s)
1 (or more) - RF Test Set(s)

Peripherals, such as controllers, plotters, printers, disk drives, and millimeter devices, may be added to the basic system.

SERVICE TOOLS AVAILABLE

Special service tools used in the troubleshooting procedures can be ordered separately. These include extender boards, source emulator, test set emulator, cables, and so forth. The source emulator and test set emulator are used to verify operation of the other instruments in the system by substituting these service tools for the individual instruments they emulate.

TABLE OF SERVICE TEST EQUIPMENT

Table 1-1 lists the equipment required to verify, adjust, and troubleshoot the network analyzer. The table also notes the use and critical specifications of each item, and the recommended models.

In addition to the test equipment listed in Table 1-1, the following tools are also required:

- #1 and #2 Pozidriv screwdrivers
- Flat-blade screwdrivers - small, medium, and large
- 5/16 inch open-end wrench (for SMA connector nuts)
- 3/16 inch and 5/16 inch hex nut drivers
- Non-conductive and non-ferrous adjustment tool
- Needle-nose pliers
- Tweezers
- Anti-static work mat with wrist-strap
- T10 and T15 TORX drivers
- Miscellaneous cables, adapters, and so forth as listed in chapter 5, "Replaceable Parts"

Table 1-1. Service Test Equipment

Instrument Required	Critical Specifications	Recommended Model	Use
Oscilloscope	100 MHz, Dual Channel	HP 1740A	A,T
Oscilloscope Probes	10:1 Divider	HP 1004D	A,T
Calibration Kit*	3.5 mm	HP 85052B	P,T
	2.4 mm	HP 85056B	P,T
Verification Kit*	3.5 mm	HP 85053B	P,T
	2.4 mm	HP 85057B	P,T
Test Port Cables*	3.5 mm	HP 85131D	P,T
	2.4 mm	HP 85133D	P,T
Computer/Controller	Basic 5.0 or higher and	HP 9000 Series	A,P,T
	2.5 Mbytes RAM, and 3.0 for dual source systems	200 or 300	
Photometer		Tektronix J16	A
Photometer Probe		Tektronix J6503	A
Printer		2225A	P
Power Meter	100 kHz to 50 GHz	HP 436A opt. 002	P,T
	50 MHz to 50 GHz		
	1 uW to 100 mW		
Power Sensor	100 kHz to 50 GHz	HP 8487A	P,T
	50 MHz to 50 GHz		
	1 uW to 100 mW		
Digital Multimeter	General Purpose VOM	HP 3466A	A,T
	32 mV to 300V, AC/DC		
High Voltage Probe	1000:1 Divider	HP 34111A	A,T
Frequency Counter	45 MHz to 26.5 GHz	HP 5343A opt. 001	A,P,T
10 dB Attenuator	45 MHz to 26.5 GHz (3.5 mm)	HP 8493C	P
	45 MHz to 50 GHz (2.4 mm)	HP 33340D opt. 010	P
Power Splitter	45 MHz to 26.5 GHz (3.5 mm)	HP 11667B	A,P,T
	DC to 50 GHz (2.4 mm)	HP 11667C	A,P,T
Pulse Generator	35 nS to 1 second	HP 8013B	A
Function Generator	20 MHz ±1 Hz	HP 3325B	A
Dual Power Supply	Dual 0 to 15 Vdc	HP 6205C	A
Spectrum Analyzer	100 kHz to 26.5 GHz	HP 8566A	A
	HP-IB Controllable		
Degausser	200W input	Radio Shack 44-233	A

A - Adjustments
P - Performance Verification
T - Troubleshooting
*Other calibration kits, verification kits, and cables may be required depending upon the system configuration.

2. Safety/Licensing

HP 8510 SAFETY INFORMATION

In order to maintain safe operation of the HP 8510 system, read and follow the specific instructions in the Warnings, Cautions, and Notes found in the instruments and throughout this manual.

HAZARDOUS INSTRUMENT AREAS WITH POWER ON

Each instrument in the HP 8510 system has areas that contain lethal voltages when the instrument has AC power applied. Figure 2-1 shows each of the instruments and their hazardous areas.

WARNING

A shock hazard exists when the covers are removed. Also, the protective earth grounding on this equipment must be maintained to provide protection from electrical shock. Any service or adjustment performed with the covers removed should be performed by qualified service personnel only.

CAUTION

Turn off the line voltage before removing or replacing printed circuit boards. Damage to integrated circuits can occur if power is left on when printed circuit boards are removed or replaced. Whenever the HP 8510 system is serviced, an anti–static work station should be used to avoid damage incurred by static discharge into the static–sensitive circuits of the HP 8510 system.

SAFETY CONSIDERATIONS

GENERAL

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation. This product has been designed and tested in accordance with international standards.

SAFETY SYMBOLS

Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual (refer to Table of Contents)

Indicates hazardous voltages.

Indicates earth (ground) terminal.

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, 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. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met

SAFETY EARTH GROUND

This is a Safety Class I product (provided with a protective earthing terminal). An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power, cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and secured against any unintended operation.

BEFORE APPLYING POWER

Verify that the product is configured to match the available main power source per the input power configuration instructions provided in this manual.If this product is to be energized via an autotransformer make sure the common terminal is connected to the neutral (grounded side of the mains supply).

SERVICING

WARNING

Any servicing, adjustment, maintenance, or repair of this product must be performed only by qualified personnel.Adjustments described in this manual may be performed with power supplied to the product while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.Capacitors inside this product may still be charged even when disconnected from their power source.To avoid a fire hazard, only fuses with the required current rating and of the specified type (normal blow, time delay, etc.) are to be used for replacement.

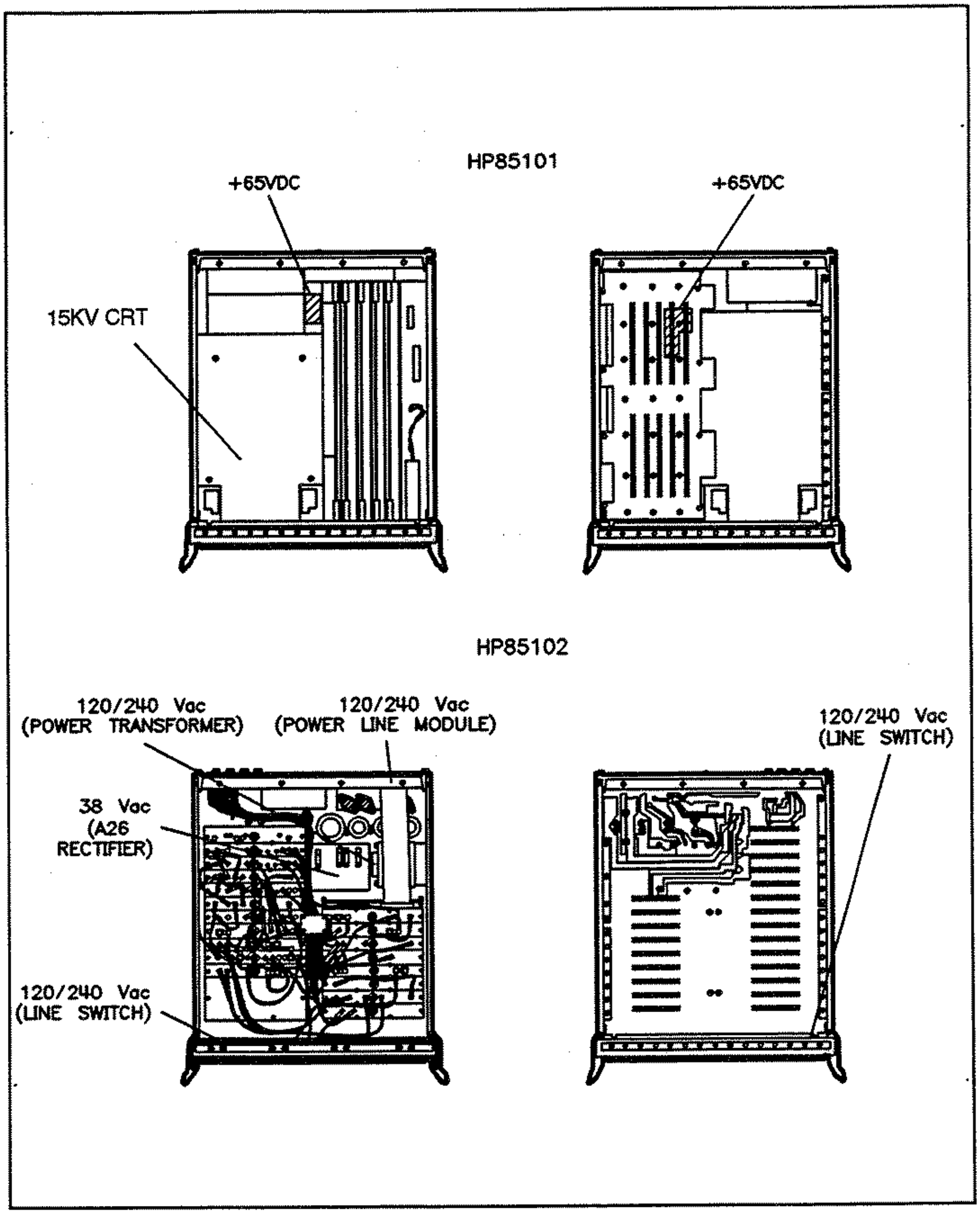


Figure 2-1. Location of Hazardous Voltages in HP 8510 Instruments (1 of 2)

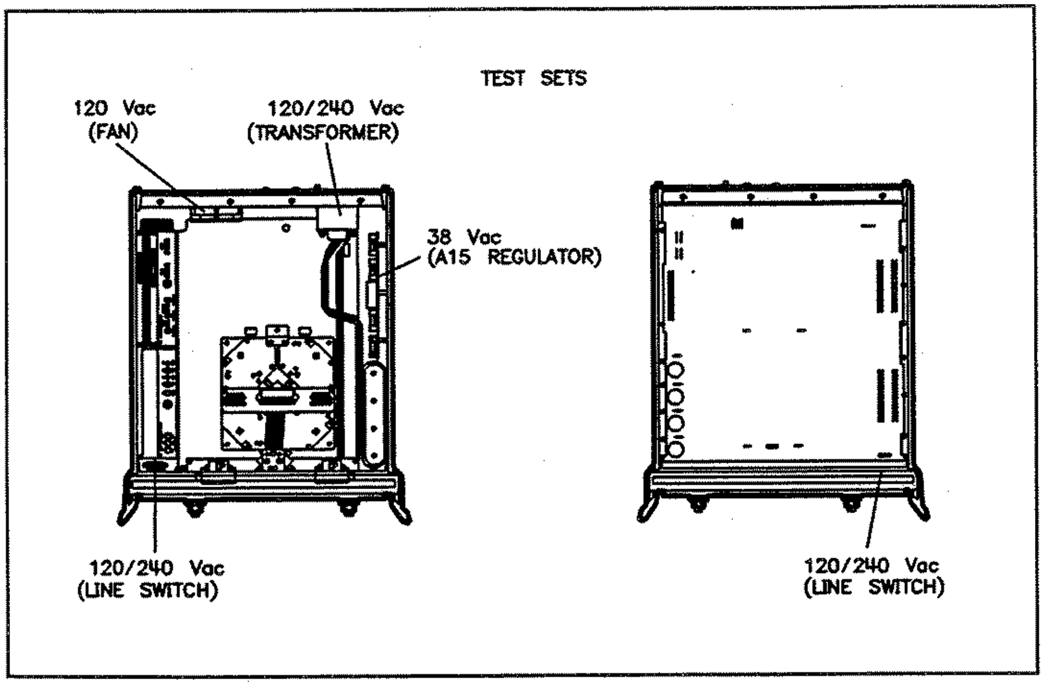


Figure 2-1. Location of Hazardous Voltages in HP 8510 Instruments (2 of 2)

COMPLIANCE WITH GERMAN FTZ EMISSIONS REQUIREMENTS

The HP 8510C Network Analyzer complies with German FTZ 526/527 Radiated Emissions and Conducted Emissions requirements.

This is to declare that the products listed below are in conformance with the German Regulation on Noise Declaration for Machines (Laermangabe nach der Maschinenlaermrerordnung —3. GSGV Deutschland).

Instruments with fan installed/Gerate mit engebautem Ventilator			
4195A	83642A	85102B/R	85309A
8350B	83650A	8511A/B	85106A–C
8620C	83651A	8512A	85108A
83601A/B	83420A	8513A	8702B
83602A	83421A	8514A/B	8703A
83621A	83422A	8515A	8719A
83622A	83423A	8516A	8720A–C
83624A	83424A	8517A	8722A
83630A	83425A	85105A	8753B/C
83631A	85101B/C	85110A	8757C/E
83640A			

Acoustic Noise Emission/Geraeuschemission	
LpA < 70 dB Operator position Normal operation per ISO 7779	LpA < 70 dB am Arbeitsplatz normaler Betrieb nach DIN 45635 t. 19

3. Theory of Operation

INTRODUCTION

This chapter describes the operation of the HP 8510 network analyzer system. "The Base System" describes one complete system in broad terms. This is the basis of all HP 8510 systems. Some systems are more specialized and complex, such as millimeter systems and MMIC systems. These will be explained in separate system manuals. However, disconnecting the specialized components of most HP 8510 systems will reduce them to the base system described here. Other parts of this chapter describe the individual instruments within the system in detail sufficient to aid troubleshooting. In this manual, sources and test sets are troubleshot to the instrument level. The IF/detector and display/processor are troubleshot to the assembly level. For additional source or test set information, refer to their manuals.

The final sections of this chapter describe a typical measurement sequence and explain the system phase-locked loop.

NOTE: In this chapter, "RF signal" and "RF signal path" refer to the main RF signal from the source. Depending on its place in the path, the "RF" may be RF, one of two IFs, or a digitized signal.

THE BASE SYSTEM

The HP 8510 network analyzer base system used in this example consists of a source, a test set, the HP 85102 IF/detector, and the HP 85101 display/processor instruments (see Figure 3-1).

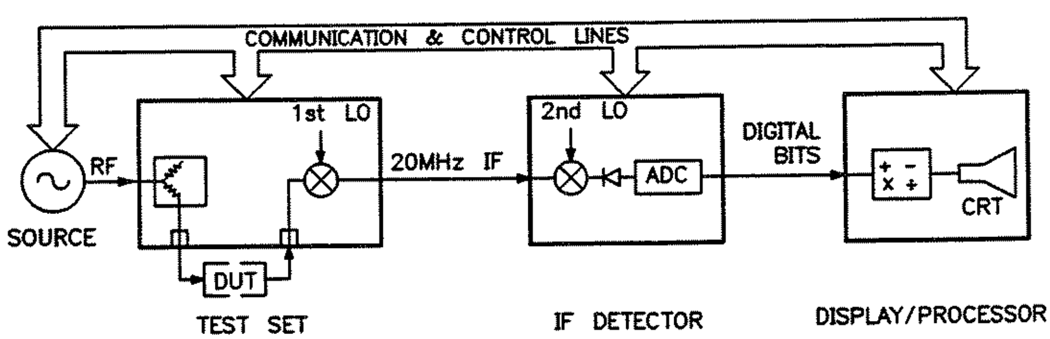


Figure 3-1. Forward Transmission Test Signal Path in HP 8510 Base System

The source produces RF signals that allow the network analyzer to examine DUTs (devices under test) with a signal applied.

The test set splits the source signal into a reference signal and a test signai. The test signal is transmitted through or reflected from the DUT and goes to the receiver for comparison to the reference signal. In Figure 3-1, only the transmitted signal path is shown. In the HP 8510 system, the test set also down-converts the source frequency (RF) to an IF of 20 MHz.

The IF/detector down-converts the 20 MHz IF signals from the test set to 100 kHz and then detects, processes, and digitizes them.

The display/processor compares the transmitted or reflected signal to the reference signal. It performs all of the math operations on the digitized signals and displays them. The display/processor also coordinates the actions of the system instruments. It is the system controller.

SOURCES

The system source provides an RF stimulus over the desired frequency range and power level as set by the HP 8510. Most sources cover their full frequency range in several bands because the individual oscillators are limited in frequency range. Low frequency and higher frequency oscillators are used alone and mixed to produce the entire frequency range. In the figure below, the source uses two oscillators for a frequency range of 10 MHz to 7.5 GHz. Oscillators with different frequency ranges and multipliers are also used to cover different frequency ranges.

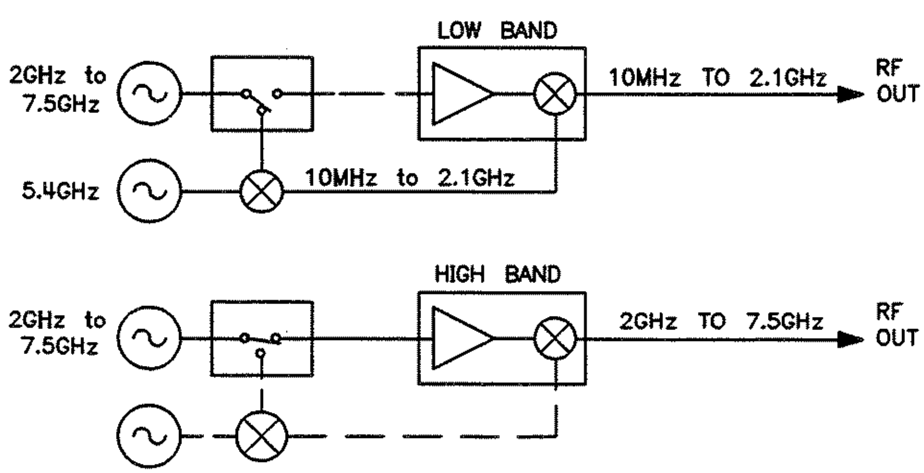


Figure 3-2. Source Covering Frequency Range in Two Bands

The source lets the HP 8510 know its frequency over digital interconnect lines. It starts and stops its frequency sweeps in response to commands from the HP 8510. As explained below, the system can use a synthesized sweeper, a sweep oscillator, or both as a source.

Synthesized Sweepers

Synthesized sweepers (or synthesizers) achieve frequency resolution to within a few hertz. Modern synthesizers are as fast as (or faster than) sweep oscillators in most circumstances. Older synthesizers tend to be slower but offer the same resolution.

A synthesizer can operate in step mode where it phase locks at each frequency point (for the number of points selected). At each point, it takes one or more measurements, depending upon the number of averages selected. It can also operate in ramp mode.

Sweep Oscillators

Sweep oscillators (or sweepers) like the HP 8350 are less frequency accurate than synthesizers. They operate in ramp mode only. A sweeper is fast but less accurate and sweeps through the frequency range as many times as the selected averaging factor.

TEST SETS

The standard test sets designed to work with the HP 8510 include the HP 8511, 8514, 8515, 8516, 8517. They differ in several respects: operating frequency range, dynamic range, front panel test port connectors, and internal RF path mechanics. An identification code in ROM or configuration switches within each test set allow the HP 8510 to recognize each type at power-up for proper operation.

Test sets have two main functions:

1. To separate the RF signal into reference and test signals.

2. To down-convert the RF signals to 20 MHz IF signals after separation.

Test sets separate the signals with couplers or triax bridges. During the RF to IF conversion, the test sets maintain the phase coherence of the measured signals so that they can be kept in ratioed pairs after calibration.

Most test sets for the HP 8510 are either sampler-based or mixer-based. A third type is the frequency converter.

Sampler-Based Test Sets

These test sets have samplers driven by a VTO. The VTO, acting like a second source or LO (local oscillator), enables the samplers to down-convert the RF signal to an IF signal according to this formula:

LO − RF = IF

Note that the LO frequency must vary as the RF varies to maintain a constant IF of 20 MHz. The VTO summing amp board provides the control voltages to tune the VTO to the correct LO frequency. The VTO usually operates at between 50 and 300 MHz. The LO frequency is a harmonic of the VTO. Should the VTO ever go out of range, the processor will generate an error message: VTO OVER-RANGE.

These test sets have a narrow IF bandwidth of approximately ±3 MHz.

Mixer-Based Test Sets

These test sets have mixers driven by two sources. The second source enables the mixers to down-convert the RF signal to an IF signal according to this formula:

LO − RF = IF

Note that the LO frequency must vary as the RF varies to maintain a constant IF of 20 MHz. These test sets have a wider IF bandwidth than sampler test sets.

HP 8511 Frequency Converter

The HP 8511 is a sampler-based test set without signal separation components (couplers or bridges). Its four front panel test ports connect directly to four samplers. So it is basically a four-channel frequency converter. Its assemblies are otherwise identical to the other test sets. The special applications of this test set are documented in its manual and HP application notes.

Test Set Control Path

The test set and the display/processor communicate over the HP 8510 system bus and the test set interface. The A4 HP-IB board is the control center of test set communications and logic. It contains an 8-bit microprocessor, an HP-IB chip, and an identification code (in ROM) to initialize and identify the test set to the display/processor. This code works in conjunction with configuration switches in the test set.

The A4 board also controls several assemblies within the test set via a separate data/address bus. The bus enables the A4 processor to do the following:

- Read the configuration switches
- Select the sampler(s) required to measure the desired signal
- Operate the front panel LEDs
- Program the switch/splitter and any programmable attenuators
- Monitor the test set temperature and notify the display/processor if it gets too hot.

Test Set Power-On Sequence

When power is applied to the test set, the A15 regulator board produces a power-on reset signal, PWON. PWON resets the control logic of the test set. When the power supply voltages are at their required levels, the PWON low-to-high signal transistion resets the processor, the HP-IB chip, and a data latch on the A3 summing amp board. Resetting the processor initiates a test set self-test program that checks the integrity of the ROM and RAM located on the A4 board. Resetting this data latch turns on all of the samplers in the test set.

The general effect of PWON is to put the test set in a default state at the time of power-on. This allows the test set to function even if the A4 HP-IB board is defective or if there is no communication between the HP 85101 and the test set.

Test Set Typical RF Path

The RF signal from the source enters the test set through the RF IN connector on the rear panel (see Figure 3-3). The RF is then applied to the switch/splitter: a combination of two power splitters and a solid state switch. This switch selects the power splitter to be used, and thereby selects the port that will receive incident RF power.

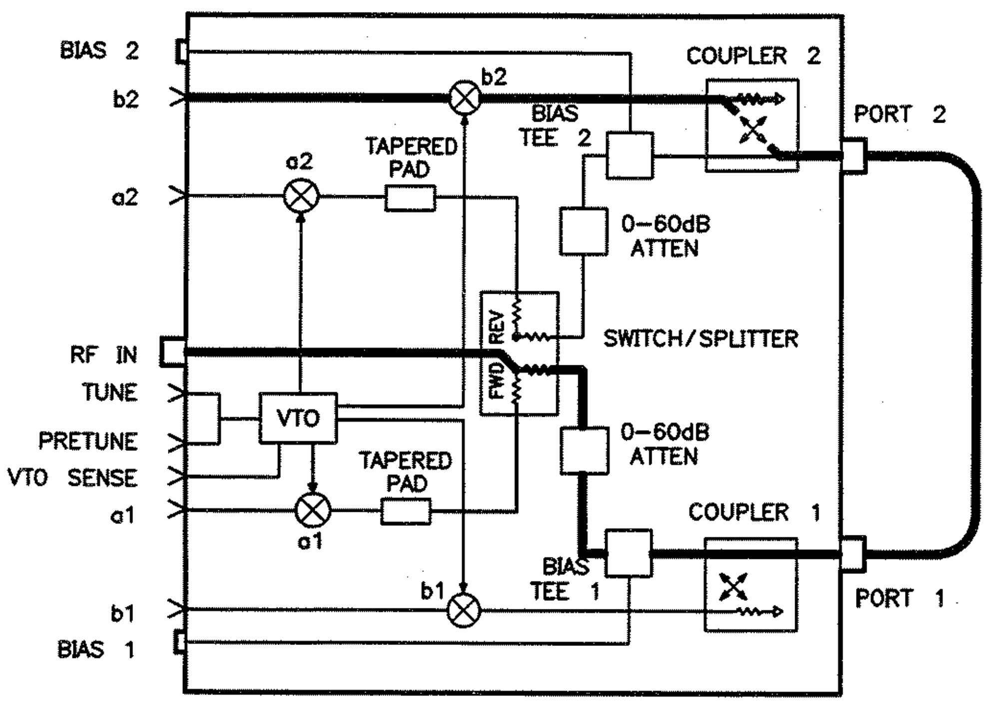


Figure 3-3. RF Signal Path Thru Sampler Test Set for Forward Transmission Measurement

For the forward transmission measurement S21 (b2/a1), the RF signal path is as follows:

The source RF signal is input to the test set and separated by the switch/splitter to produce the test signal and the reference signal. The test signal first passes through the DUT and port 2 coupler. It is then applied to the b2 sampler for down-conversion to 20 MHz before being sent to the HP 85102 IF/Detector. The reference signal is simultaneously applied to sampler a1, where it is down-converted to a 20 MHz IF and also sent to the HP 85102.

In the case of an S11 forward reflection measurement (b1/a1), the main difference from the S21 path operation is that the test signal is reflected from port 1 and coupled to the b1 sampler. There it is down-converted to the 20 MHz IF and sent to the HP 85102.

S12 reverse transmission RF paths (b1/a2) and S22 reverse reflection RF paths (b2/a2) are similar to the transmission and reflection paths explained above. The differences are that the switch/splitter is switched to the reverse path position and that the a2 sampler is used in the reference signal path.

A similar process occurs during reverse measurements, when RF power is applied to port 2 of the test set.

The LO signal generated by the VTO/driver is phase locked to the source so that the desired VTO harmonic is 20 MHz greater than the source frequency. The phase-locked loop process is described in the "System Phase Lock Operation" section of this chapter.

HP 85102 IF/DETECTOR

The IF/detector is the first half of the HP 8510 network analyzer. It performs a second down-conversion of the signals, detects them, and digitizes and multiplexes them for input to the display/processor. It also functions as part of the phase-locked loop. For the most part, it is controlled by the display/processor.

The assemblies of the IF/detector can be classified in four categories: signal path, control, phase-locked loop, and miscellaneous.

Signal Path Assemblies

The signal path assemblies down-convert, detect, digitize and multiplex the signals.

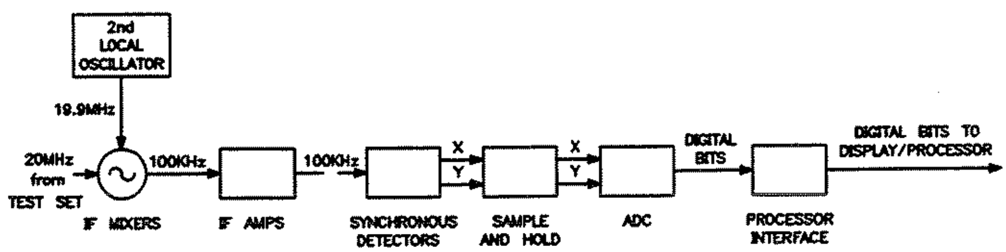


Figure 3-4. Signal Path Assemblies of IF/Detector

IF Mixers (A9, A11, A13, A14) buffer, filter and mix the 20 MHz signals (with the 19.9 MHz LO signal) down to 100 kHz. The assemblies are electrically and mechanically identical.

19.9 MHz Local Oscillator (A8) assembly provides the LO signals for the IF mixer assemblies.

Test and Reference IF Amplifiers (A10, A12) autorange and amplify the signals to allow the detectors to operate in their optimal range. The assemblies are electrically and mechanically identical.

Test and Reference Synchronous Detectors (A5, A7) detect the X and Y pairs (test and reference) that have been mixed down to 100 kHz IF. The assemblies are electrically and mechanically identical.

Sample and Hold (A17) assembly multiplexes the X and Y pairs from the synchronous detectors.

Analog-to-Digital Converter (A18) assembly converts the X and Y pairs from the analog IF waveform to digital bits.

Processor Interface (A24) assembly transmits the digital bits to the display/processor and enables the IF/detector and display/processor to communicate.

Control Assemblies

The control assemblies control the functioning and timing of the system and enable communication within the system. The phase lock assemblies are described later.

Front Panel and Front Panel Interface (A1) assembly enables the user to control the HP 8510, displays the status of power (on/off) and the active channel (1 or 2).

ADC Control (A19) provides the control for the A17 sample and hold assembly and the A18 analog-to-digital converter. It is controlled by the display/processor and works in conjunction with the A20 sweep ADC assembly.

Sweep ADC (A20) assembly triggers the sample and hold assembly to take data at the proper frequency intervals. Note that as the HP 8510 system sweeps, the intervals are determined by the display/processor.

Clock (A6) assembly provides four reference, timing, and calibration signals:

- Reference IF signals for the main phase-locked loop
- Timing signals for the synchronous detectors
- Timing signals for the 19.9 MHz local oscillator
- The 100 kHz calibration signal for the IF

Phase Lock Assemblies

IF Counter (A21) assembly counts the 20 MHz IF signal and checks for the power level and valid frequency count for both pretune and main lock.

Pretune Phase Lock (A22) assembly lets the system initiate a pretune phase lock based on the start frequency input to the display/processor. It also counts the VTO fundamental frequency.

Main Phase Lock (A23) assembly is used during pretune and as part of the main phase-locked loop.

Miscellaneous Assemblies

Motherboard (A25) assembly interconnects all of the other assemblies.

Regulator (A15) assembly provides four regulated DC voltages:

+15V —15V +5V —5V

Rectifier (A26) assembly rectifies line voltage (AC) to DC for the IF/detector.

HP 85101 DISPLAY/PROCESSOR

The HP 85101 display/processor is the system controller, data processor, and display unit for the HP 8510 system. It consists of the processor, EEPROM non-volatile memory, the display, and I/O ports.

The HP 85101 controls the HP 85102 IF/detector via a dedicated interface bus. It controls the test set and source via one dedicated HP-IB port (8510 SYSTEM BUS) and interfaces with an external controller, printer, or plotter via a second HP-IB port. In addition, the display/processor can control printers and plotters via two RS-232 ports.

Processor Assemblies

Processor Assembly (A5) performs all system control and computation functions. This assembly contains:

- The main processor, or CPU (a 68020, 32 bit microprocessor)
- A separate math coprocessor
- The main processor memory (RAM, 2 Mbyte)
- The system ROM
- LEDs to indicate self test (and subtest) results

Memory Board (A6) consists of 24 EEPROMS arranged in 12 banks. The main program resides in this non-volatile memory. The board has room for an additional eight EEPROMS to allow for future expansion.

Display Assemblies

Graphics Processor (A4) provides an interface between the processor and display assemblies. The CPU converts the formatted data to graphics commands and writes it to the graphics processor. The graphics processor converts the data to obtain the necessary video signals and sends the signals to the display. It also produces RGB output signals which are sent to the rear panel for use by optional external monitors. The assembly receives two power supply voltages: +5V (for processing) and +65V (not used but passed on to the display).

Display (A11) is a 7.5 inch raster scan color CRT with associated drive circuitry. Automatic degaussing is performed when the instrument is turned on to minimize the magnetization of the CRT. It receives these inputs from the display processor:

- +65V power supply
- Digital TTL horizontal and vertical synch signals
- RGB (red, green, and blue) video signals
- Background and intensity signals

Input/Output Assemblies

Disc Drive Assembly (A2) is a 1.44 Mbyte, double-sided disc drive. It can use standard or high-density 3.5 inch discs.

I/O Assembly (A7) is the main interface for the system. The main processor data, address, and control buses are routed throughout the HP 85101 via the motherboard and this assembly. It enables various parts of the system to communicate by supporting these components:

- Real-time clock[1]
- The disc drive[1]
- Two RS 232D ports[1]
- Two HP-IB ports
- The HP 85101 interrupt system
- The HP 85102 interface
- The front panel interface
- The RPG counters

NOTE: 1) The RS 232 port in conjunction with 0.5 Mbyte DRAM on the processor assembly permit spooling data to printers and plotters. 2) RS 232 ports shares only a small part of the 0.5 Mbyte DRAM; 400K DRAM for port 1, and 100K DRAM for port 2.

Power Supply

The power supply is a switching power supply. Its functions are distributed between the preregulator, post-regulator, and display assemblies.

Preregulator (A10) steps down and rectifies the line voltage. It provides a fully regulated +5V digital supply, and several preregulated voltages that go to the A8 post-regulator assembly for additional regulation. Figure 3-5 is a simplified block diagram of the power supply group.

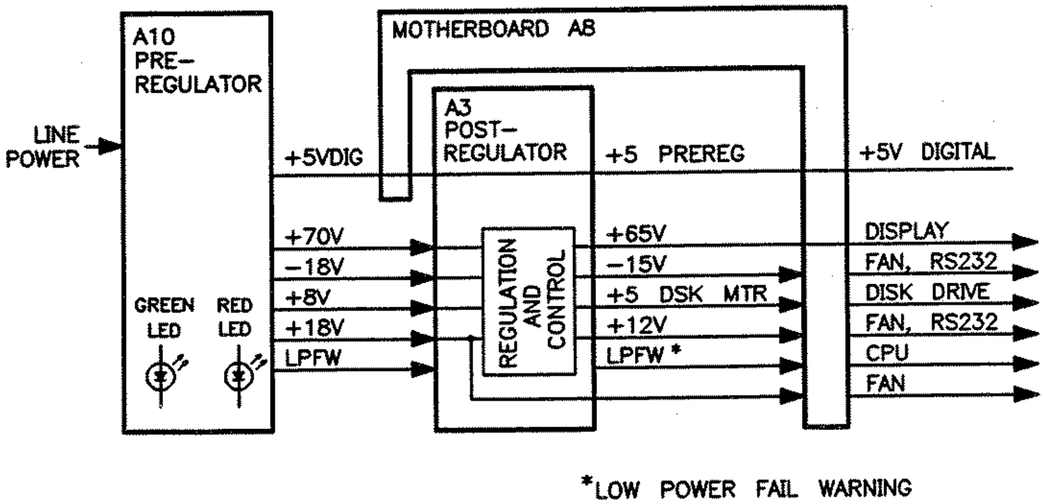


Figure 3-5. Power Supply Functional Group, Simplified Block Diagram

The preregulator assembly includes the line power module, a 60 kHz switching preregulator, and overvoltage protection for the +5V digital supply. It provides LEDs, visible from the rear of the instrument, to indicate circuit status.

Line Power Module includes the line power switch, voltage selector switch, and main fuse. The voltage selector switch adapts the instrument to local line voltages of approximately 115V or 230V. The main fuse protects the input side of the preregulator against drawing too much line current.

Preregulated Voltages are converted from line voltage by the switching preregulator. The regulated +5V digital supply goes directly to the motherboard. The following partially regulated voltages are routed to the post-regulator for final regulation:

+70 —18V +8V +18V

Regulated +5V Digital Supply is regulated by the control loop in the preregulator. It goes directly to the motherboard, and from there to all assemblies requiring a digital supply. A +5V sense line returns from the motherboard to the preregulator.

In order for the preregulator to function, the +5VD supply must be loaded by one or more assemblies, and the +5V sense line must be working. If not, the other preregulated voltages will be incorrect. However, this condition will not cause damage as all circuits are over- and under-voltage protected.

Shutdown Indications: the Green LED is on in normal operation. It is off when line power is not connected, not turned on, or set too low, or if the line fuse has blown.

The Red LED is off in normal operation. It lights to indicate a +5V supply fault or power transformer circuitry fault such as an undervoltage, overvoltage, overcurrent, or overtemperature condition.

Post-Regulator (A3) filters and regulates the DC voltages received from the preregulator. It provides fusing and shutdown circuitry for individual voltage supplies. It distributes regulated constant voltages to individual assemblies throughout the instrument. Five green LEDs provide status indications for the individual voltage supplies:

- +65V (for the display)
- —15V (for the fan and [dropped to —12V] for RS 232 ports)
- +5 PREREG (digital supply, also called +5V DIG)
- +12V (variable for the fan and fixed for RS 232 ports)
- +5 DSK MTR (for the disc drive motor)

The post-regulator consists of these circuits (among others):

- Shutdown circuit
- Variable fan speed circuit
- Low power circuit.

Shutdown Circuit is triggered by overcurrent, overvoltage, undervoltage, or overtemperature. It protects the instrument by causing the regulated voltage supplies to be shut down. The voltages that are not shut down are the +5V DIG digital supply from the preregulator and the fan supplies. If a fault occurs in any of the post-regulated voltages except +65V, all but the +65V and +5V DIG shut down.

The shutdown circuit can be disabled momentarily for troubleshooting purposes. But do so quickly and carefully or components may be damaged.

Variable Fan Speed Circuit and an air flow detector provide fan power as needed. Fan power is derived directly from the +18V and —18V supplies from the preregulator. The fan is fused only with the line fuse so that it will continue to provide airflow and cooling when the instrument is otherwise disabled. If overheating occurs, the main instrument supplies are shut down and the fan runs at full speed. Full speed is normal at initial power-up.

Low Power Fail Warning Circuit (LPFW) detects low power and shuts down the CPU gracefully.

Voltage Indicators: the Five Green LEDs along the top edge of the post-regulator assembly are on in normal operation, to indicate the correct voltage is present in each supply. If they are off or flashing, refer to the "Troubleshooting" chapter to trace the cause of the problem.

Display Power is routed through the motherboard to the graphics processor assembly and then to the CRT.

HP 8510 TYPICAL SYSTEM MEASUREMENT SEQUENCE

1. The HP 8510 display/processor sets the source and test set VTO start frequencies.
2. The system achieves phase lock as explained in "System Phase Lock Operation" (next).
3. The source begins one of two basic types of frequency sweep:
   - Step sweep mode: the system phase locks at each frequency point. This mode is accurate, relatively fast for current synthesizers, and relatively slow for older models.
   - Ramp sweep mode: the system phase locks at the start of each band crossing. This sweeper mode is fast but less accurate.
4. The test set separates RF power from the source into test and reference signals. The test signal is applied to the DUT and transmitted through or reflected from it.
5. The test set down-converts the RF signals (test and reference) into separate 20 MHz IF frequencies.
6. The IF/detector down-converts the 20 MHz signals to 100 kHz. It autoranges IF gain steps to maintain the IF signals at optimum levels for detection over a wide dynamic range.
7. The IF/detector applies each IF signal to a synchronous detector which generates DC voltages proportional to the magnitude and phase of each input signal. The synchronous detectors use digital techniques to develop outputs equal to the real (X) and imaginary (Y) parts of the signal.
8. The IF/detector digitizes the X and Y sample pairs.
9. The display/processor reads the sample pairs, processes them, and displays them on the CRT.

SYSTEM PHASE LOCK OPERATION

Components of the phase lock system are in each of the HP 8510 system instruments: the source, the test set, the IF/detector, and the display/processor. Therefore, a malfunction or bad connection in any of the instruments can cause a phase lock problem and generate a running error message.

Running error messages indicate that a fault was detected at a particular step in the phase lock sequence, not at a particular physical location. Running error messages allow the system to keep running. Until cleared, the messages remain on display even if the problem has ended.

Four main assemblies constitute the phase lock system:

- Pretune assembly (in the IF/detector)
- VTO summing amp assembly (in the test set)
- IF counter assembly (in the IF/detector)
- Main phase lock assembly (in the IF/detector)

Additionally the display/processor memory and processor assemblies are involved in controlling and monitoring the phase lock system. And the IF/detector IF mixer assemblies are part of the main phase-locked loop (but they are less important in determining loop operation).

The HP 8510 uses two separate phase-locked loops: a pretune phase-locked loop and a main phase-locked loop. The pretune phase-locked loop is a narrow bandwidth, synthesized, high accuracy loop. The main phase-locked loop locks to 20 MHz and has enough bandwidth to track the fast sweeping ramp.

Pretune Phase Lock Sequence

A pretune phase lock sequence precedes the beginning of every sweep and each band crossing. Its main purpose is to generate an LO frequency about 20 MHz higher than the RF. To do this the processor computes the start frequency and all other necessary programming information. That information includes digital information for a DAC which drives the VTO, the appropriate harmonic number of the VTO, and a divide-by-N number.

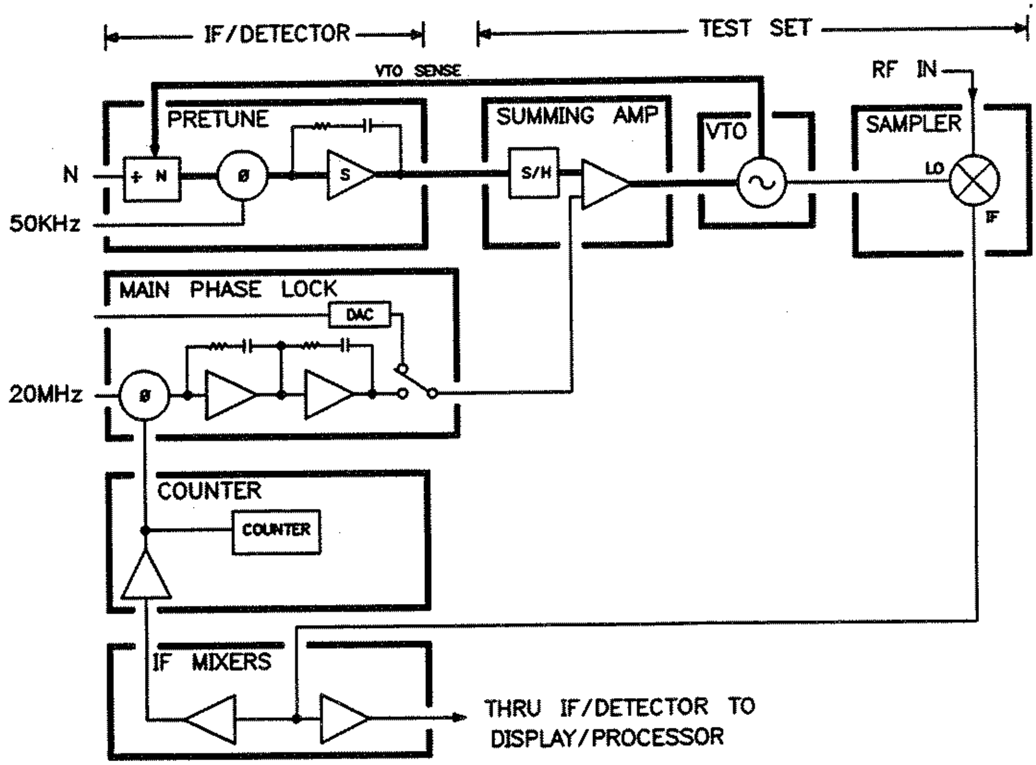


Figure 3-6. Simplified Pretune Phase-Locked Loop

As shown above, during pretune, the pretune assembly tunes the VTO by putting the S/H (sample-and-hold circuit) into the track-always mode. In this mode, the main phase-locked loop is switched away from the phase detector to a DAC. The processor chooses a VTO frequency such that a resulting VTO harmonic comb frequency is 20 MHz above the RF of the source. The VTO summing amp assembly in the test set sums the pretune voltage and main lock voltage to tune the VTO to the desired frequency.

To confirm that the VTO frequency is correct, the pretune board divides it by N and compares it to a 50 kHz reference signal. If the frequency is not correct, the VTO is retuned with an error voltage. When the pretune frequency is correct, a comparator on the pretune board detects lock. In turn the processor reads a bit from the comparator. If the pretune circuit is unable to generate the correct VTO frequency, the processor displays this running error message:

```
PRETUNE FAILURE
```

For example, if the start frequency entered on the front panel is 1.8 GHz, the processor calculates the LO frequency required to produce a 20 MHz IF (1.8 GHz + 20 MHz = 1.82 GHz). Since 1.82 GHz is beyond the frequency range of the VTO, the actual LO frequency is a harmonic of the VTO, in this case the ninth harmonic. And the VTO frequency is about 202.2 MHz (1.82 GHz / 9).

In summary, the pretune phase lock sequence tunes the VTO to a fundamental sampling rate and locks the pretune loop, based on the N number chosen by the processor.

Pretune IF Count Sequence

This sequence consists of two or three steps: an IF count, an IF search routine when needed, and a check step.

Pretune IF Count is less a count than a check. It determines whether a comb frequency is near the RF input frequency. The IF counter of the IF/detector checks the presence and frequency of the IF. The processor selects the active IF sampler (a_1 or a_2) with the PIN switch on the IF counter board.

The HP 8510 pretune synthesizer is accurate enough to pretune the comb frequency to within ±5 MHz of the desired LO frequency. Ideally this creates an IF at 20 MHz (±5 MHz), the IF counter detects that the IF is strong enough to lock to, and then the IF counter counts the IF to within 10 kHz resolution.

If the IF is not approximately 10 MHz to 30 MHz, or if the IF counter has over-ranged, or if the IF is too weak to lock to, the processor ignores the count and begins the IF search routine.

IF Search Routine is a series of ever-widening steps of approximately 10 MHz that attempts to find the IF. After several attempts, if a valid count is found, the check step is performed. If the check step is successful, the main phase lock is released. If the check step is not successful, the search continues for two more sequences.

The IF may not be counted at the default location for several reasons. It could be out of range or too weak. Source linearity (including band-cross locations) and sweep point quantization errors on the sweep ADC board are the two major sources of error in the location of the IF. Bandpass filtering on the sampler preamps in the test set limits the available search window to about 20 MHz (±10 MHz). The filter is down about 15 dB at the edges.

Check Step Sequence algorithm determines (1) whether the IF is a product of the RF and (2) whether the IF is the correct sideband of the desired harmonic.

The algorithm initiates a second pretune to move the IF towards 20 MHz by approximately 5 MHz. If the comb frequency is on the high side (the correct side), the IF decreases. The processor begins the main phase lock sequence (described below).

If the comb line is on the low side (the wrong side), the IF increases. When the wrong sideband is detected, the processor pretunes the IF 40 MHz higher. Then it repeats the check step.

For example, assume the first count is 23 MHz. If the comb frequency is on the high side, the check step count is 18 MHz (it has moved toward — and through — 20 MHz). If the comb frequency is on the low side of the RF, the check step count is 28 MHz (it has moved away from 20 MHz).

In summary, if the IF is not detected, if the check step fails, or if the IF is not found after the IF search routine, the processor displays this error message:

```
NO IF FOUND
```

Main Phase Lock Sequence

After a successful pretune sequence, the processor switches from pretune to main phase lock. During the switch, timing is very important. Any drift in source frequency, decrease in power, or fluctuation in the pretune loop could prevent phase lock.

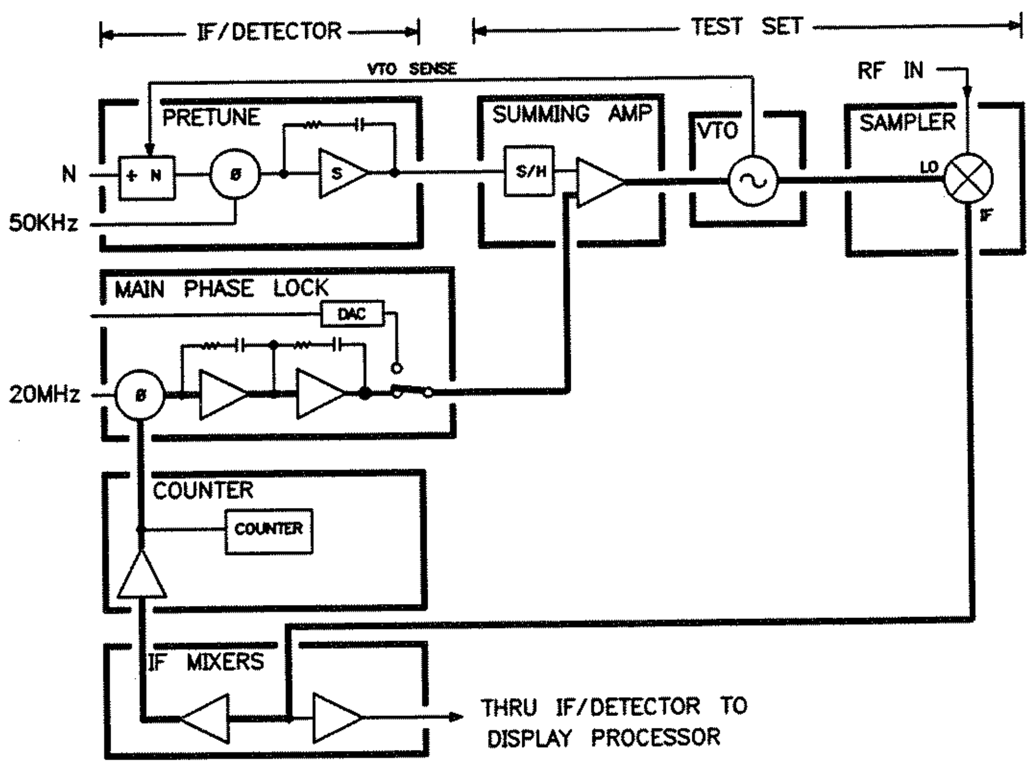


Figure 3-7. Simplified Main Phase Lock Loop

As shown above, the S/H on the test set VTO summing amp holds the pretune voltage and VTO frequency constant. The main phase lock tracks the error signal of the phase detector to acquire the IF (about 20 MHz). Then it locks the IF to the 20 MHz reference signal. Once the IF is locked on 20 MHz, the processor begins the sweep. The phase-locked loop remains locked while holding the IF at a zero phase error (for the ramp output of the main phase lock board). If the loop cannot lock, the processor displays this error message:

```
PHASE LOCK FAILURE
```

Monitoring Phase Lock

While making the measurement sweep, the processor monitors the IF count and power. If phase lock is lost during the sweep, the processor displays this error message:

```
PHASE LOCK LOST
```

The system attempts to lock one more time during the sweep. Lock may be recovered or not. If lock is not recovered, the loop stays unlocked until the next bandcrossing. In any case, the error message is displayed.

Phase lock problems of this nature may be caused by the main phase lock board (A23), or a power hole in the reference channel.

Monitoring the VTO

If the VTO is driven near the end of its tested range but maintains lock, the processor displays this error message:

```
VTO OVER-RANGE
```

In essence, the system (especially the VTO) is operating near its limits. The system is still functioning properly, but it may become unreliable. Often this condition indicates the source should be calibrated to the HP 8510 through its trim sweep adjustment (refer to the HP 8510 Operating and Programming manual).

Phase Lock Learn Mode

This mode enables the system, especially a sweeper-based system, to sweep quickly and accurately after the first sweep. In this context, the first sweep means the first sweep at a new start or stop frequency or new sweep speed. The first sweep takes longer than subsequent sweeps for two reasons:

1. Prior to the first sweep, the processor determines band-crossing frequencies based on default or calculated values. This determination takes some time.

2. At the end of the first sweep, the processor recalculates the band-crossing frequencies based on where it found the IF.

Recall that the sweep linearity of sweepers (like the HP 8350 and its associated plug-in) is approximately ±50 MHz. This wide range almost invariably forces the HP 8510 to enter an IF search routine. The frequency inaccuracy of the sweeper displaces the IF and forces the search.

For example, assume a start frequency of 500 MHz. The HP 8510 pretunes the VTO to produce an LO of 520 MHz (20 MHz above the RF). And it expects to find the IF at 20 MHz (required for phase lock). But if the sweeper RF is actually 478 MHz, the IF would be 42 MHz (not 20 MHz as calculated). The HP 8510 would not find the IF initially. But after retuning the LO to 498 MHz, it would find the required 20 MHz IF.

	LO (VTO)	RF (Sweeper)	IF (LO - RF)
Calculated	520	500	**20**
Actual	520	478	**42**
Required	498	478	**20**

Finally, and here's where the learning takes place, the processor learns (remembers) the required LO frequency for an IF of 20 MHz (and phase lock). It then uses that value on subsequent sweeps. It sweeps faster because it need not recalculate pretune frequencies or search for the IF. The process is the same for the start frequency and all of the band crossings. The process is used after the system has maintained phase lock through all of the band crossings of the complete sweep.

PHASE LOCK CYCLE SUMMARY (INCLUDING RUNNING ERROR MESSAGES)

The phase lock cycle occurs at every start frequency, at every band crossing, and at every point in step mode as follows:

Pretune Phase Lock Sequence pretunes a harmonic to the source frequency +20 MHz, locks the frequency, and checks for proper lock. If unsuccessful: PRETUNE FAILURE.

Pretune IF Count Sequence counts the IF, searches for it if unsuccessful, and checks the harmonic and sideband following a valid count. If unsuccessful: NO IF FOUND.

Main Phase Lock Sequence holds the pretune frequency, locks the main phase-locked loop, and checks for a 20 MHz IF. If unsuccessful: PHASE LOCK FAILURE.

If phase lock is lost during a sweep: PHASE LOCK LOST.

If the VTO reaches the end of its range before band crossing: VTO OVER-RANGE.

4. Main Troubleshooting Procedure

INTRODUCTION

This "Main Troubleshooting Procedure" provides a systematic series of checks to follow if the HP 8510 system appears to be faulty. If you follow these checks in the sequence given here, it will help you to isolate the cause of a problem in the least possible time. The checks in this main section are relatively brief: wherever a problem is indicated, you will be referred to more detailed information in the following sections. The service flowchart on the right-hand pages is an abbreviated version of the detailed procedure on the facing left-hand pages. It is provided as a quick summary to be used by people who are already familiar with HP 8510 troubleshooting.

Also included at the end of this procedure are the following diagrams for reference in troubleshooting:

- HP 8510C System-Level Troubleshooting Block Diagram
- HP 85101C Display/Processor Overall Block Diagram
- HP 85102 IF/Detector Overall Block Diagram
- HP 8510C Phase Lock Block Diagram
- HP 85101C A8 Motherboard Wiring Diagram
- HP 85102 A25 Motherboard Wiring Diagram

This manual provides troubleshooting information for the system and the HP 8510 network analyzer. You may also need to refer to the service manuals for the test set and the source.

TROUBLESHOOTING OUTLINE

WARNING

Death or injury can result from voltages inside the instrument when it is connected to AC line power. Only qualified personnel who are aware of the hazards involved should perform service on this instrument when its covers are removed.

CAUTION

Turn off the line voltage before removing or replacing assemblies, to avoid damage to the instrument. Use an antistatic work station to avoid damage from static discharge.

The troubleshooting strategy uses several different processes. This main procedure explains the appropriate times when each of these troubleshooting processes should be used.

1. Control, configuration, and cabling pre-operational checks. These can quickly identify many failures.

2. Specific procedures for certain obvious failures. When the nature of a failure is obvious, the procedure goes immediately to symptom-related troubleshooting steps.

3. Internal diagnostics. The service program checks various circuits in the network analyzer.

4. Hardware service tools. Test devices emulate the test set and source, to determine if the problem is in the analzyer.

WHAT'S WRONG

First consider four questions before any other troubleshooting is attempted. These questions quickly focus the direction troubleshooting should take. The questions are:

- Are there any self-test failures?
- Are there any running error messages?
- Is there an unratioed power failure?
- Is there any other obvious failure type?

These problems are briefly explained below. Before you continue with the individual troubleshooting for each of these problems, go to the "Control, Configuration, and Cabling Pre-Operational Checks." These checks can quickly correct up to 70% of failures.

Self-Test Failures

The network analyzer performs a series of self-tests each time it is powered up. If the analyzer passes all the tests, it loads and runs the operating system program.

A self-test failure is indicated on the CRT by one of the 14 self-test messages listed at the right side of the HP 8510C System-Level Troubleshooting Block Diagram. If one of these messages appears, go to "Control, Configuration, and Cabling Pre-Operational Checks," then if necessary to section 4.1, "Self-Test Failures."

ABBREVIATED HP 8510C SYSTEM SERVICE FLOWCHART
(See opposite page for detailed procedure)

WHAT'S WRONG?

Consider these questions before troubleshooting:

1. Are there any:
   self-test failures?
   running error messages (beeping)?
   raw channel (unratioed) power problems?

2. Is there an obvious failure? If so, go to next page.

↓

Self-Test Failures

If a self-test failure message appears, refer to "Control, Configuration, and Cabling Pre-Operational Checks." If necessary, see section 4.1, "Self-Test Failures." Otherwise, go to next page.

↓

Running Error Messages

Running error messages are the messages numbered 15 or higher listed on the right side of the HP 8510C System-Level Troubleshooting Block Diagram. They occur if the CPU detects an error during normal operation. When an error is detected and a running error message is displayed, the system usually continues to make measurements. Before troubleshooting a running error message, be sure it is consistent and repeatable. Press [ENTRY OFF] to remove the message from the screen, then press **MEASUREMENT** [RESTART] to initiate another sweep. Many times, a message such as PHASE LOCK LOST is only a momentary loss of lock that can be corrected on the next sweep. If the message disappears, there is no real problem. If the message repeats, go to "Control, Configuration, and Cabling Pre-Operational Checks," then if necessary to section 4.2, "Running Error Messages."

Unratioed Power Failures

A standard analyzer measurement is a ratio of two signals. For troubleshooting purposes, the frequency response of one signal only is checked in an unratioed absolute power mode through each of the signal paths. Observed problems can then be isolated to the components in the faulty signal path.

Go to "Control, Configuration, and Cabling Pre-Operational Checks," then follow the procedures in section 4.3, "Unratioed Power Failures."

Other Obvious Failure Types

Sometimes the nature of a failure may be obvious to a trained HP 8510 repair person, and you can go straight to the troubleshooting section for that type of failure. Obvious failure types (in addition to self-test failures, running errors, and unratioed power failures) are power supply failures, performance test failures, and software failures. (These failures may or may not seem obvious. It is not important to be able to recognize them: the total troubleshooting sequence will isolate them.)

Power Supply Failures. If the analyzer appears dead, or the CRT is dark, or the fan is not operating properly, or the front panel LEDs are either not functioning or all remain lit, go to "Control, Configuration, and Cabling Pre-Operational Checks," then to section 4.4, "Power Supply Failures."

Performance Test Failures. If you have performed the verification procedures in chapter 8, "Specifications and Performance Verification," and any part of the tests resulted in a failure, go to "Control, Configuration, and Cabling Pre-Operational Checks, then to section 4.5, "Performance Test Failures."

Software Failures. If you have trouble running the operating system, or if there are problems controlling the system over HP-IB, go to "Control, Configuration, and Cabling Pre-Operational Checks," then to section 4.6, "Software Failures."

ABBREVIATED HP 8510C SYSTEM SERVICE FLOWCHART (cont.)
(See opposite page for detailed procedure)

Running Error Messages

If a running error appears, press **[ENTRY OFF]** MEASUREMENT **[RESTART]**. If the message repeats, refer to "Control, Configuration, and Cabling Pre-Operational Checks." If necessary, see section 4.2, "Running Error Messages."

Unratioed Power Failures

If you suspect an unratioed power failure, refer to "Control, Configuration, and Cabling Pre-Operational Checks." If necessary, see section 4.3, "Unratioed Power Failures."

Other Obvious Failure Types

With each of the following failures, refer to "Control, Configuration, and Cabling Pre-Operational Checks" before going to the section that troubleshoots the failure.

Power Supply Failures

See section 4.4, "Power Supply Failures."

Performance Test Failures

See Chapter 8, "Specifications and Performance Verification."

Software Failures

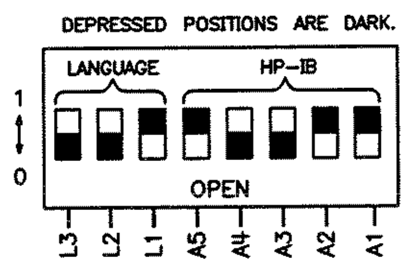
See section 4.6, "Software Failures."

CONTROL, CONFIGURATION, AND CABLING PRE-OPERATIONAL CHECKS

Refer to: HP 8510C System-Level Block Diagram at the end of this section
System Connections diagram, Figure 4-1.

Front and Rear Panel Checks

- Switch off power to all instruments. Switch on, in this sequence, the source, test set, HP 85102, (also HP 85101 if an early version with power switch).
- If the display is not clear, try to improve it with the intensity control.
- Source front panel: switch settings are of no concern, except for the line power switch, because the source is under analyzer control.
- Make sure the power line modules on all instruments are set to the appropriate local line voltage.
- Check the HP-IB addresses of all instruments.
- If the source is an HP 8360, make sure the language switch is set to 001 as shown:



- If the source is an HP 8340/8341, make sure the rear panel FREQUENCY STANDARD switch is set to INTERNAL.

Cabling Checks

- Make sure the system cables are connected as shown in Figure 4-1, "System Connections."
- Make sure the test set rear panel reference port extension cables are in place. See chapter 9, "Installation," for an explanation of these cables.
- Make sure the IF/DISPLAY cable AND the HP-IB cable are connected between the HP 85101 and 85102.

- Make sure the source RF output cable is connected to the test set.
- If the source is an HP 8360, REMOVE the SWEEP OUT/IN connections from the HP 8360 and HP 85102. Replace with TRIGGER IN/OUT.
- Disconnect the bias port BNCs and all other BNC cables (except SWEEP OUT/IN or TRIGGER IN/OUT) for now. Exception: if the test set is an HP 8516, leave the SOURCE CONTROL cable connected between the source and the test set to double the 20 GHz source signal.

ABBREVIATED HP 8510C SYSTEM SERVICE FLOWCHART (cont.)

(See opposite page for detailed procedure)

↓

CONTROL, CONFIGURATION AND CABLING PRE-OPERATIONAL CHECKS

Front and Rear Panel Checks

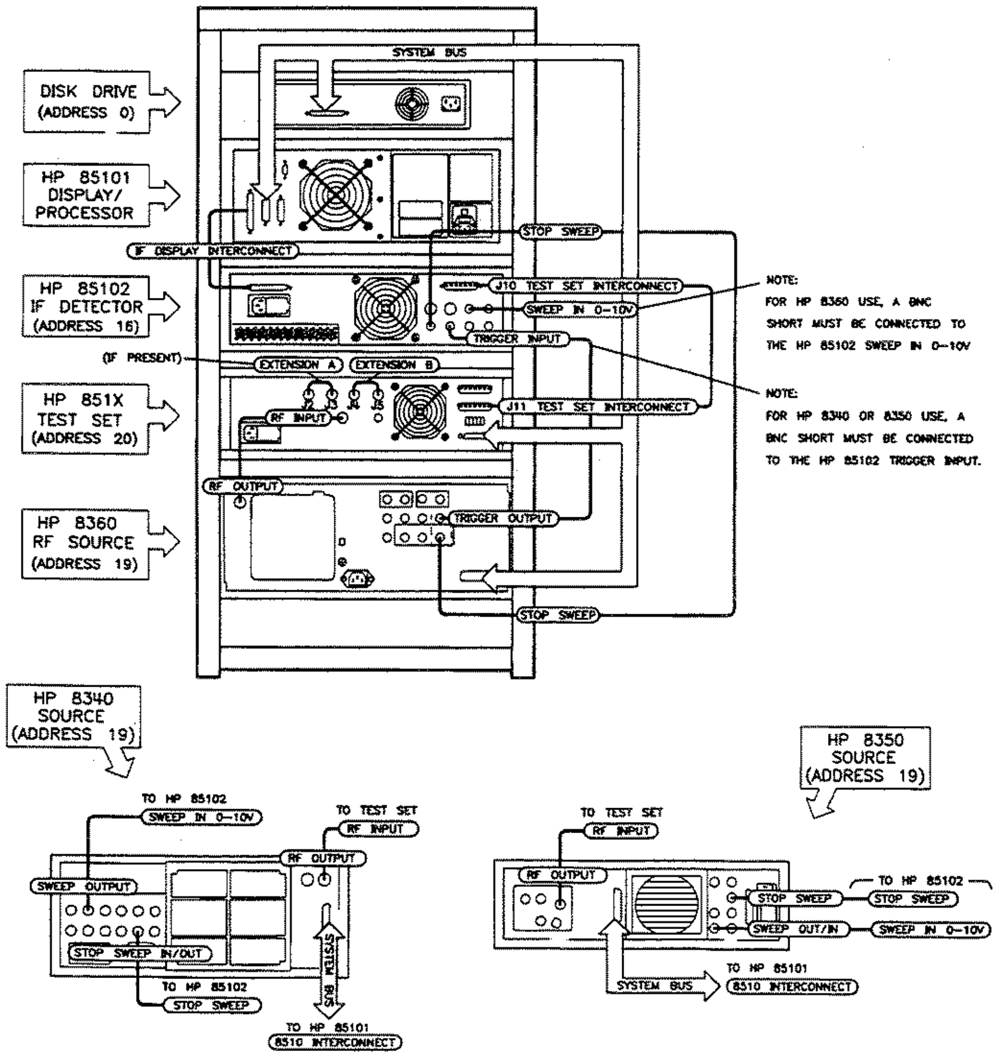
Instrument power-on sequence: source, test set, HP 85102, HP 85101.
Check power line modules for local lline voltage.
Check HP-IB addresses of all instruments.
For HP 8360, set language switch to 001.
For HP 8340/41, set FREQUENCY STANDARD switch to INTERNAL.

↓

Cabling Checks

Connect cables as shown in Figure 4-1, "System Connections." Check all connections carefully.

↓



NOTES:

1. Power cables must be connected to HP 85101, HP 85102, test set, source, and any peripherals.

2. Connect the reference port extension cables as shown in Figure 9-7. (Not applicable for HP 85110, 8516, 8517.)

3. For systems without controllers, connect any peripherals to the 8510 interconnect on the HP 85101. For systems with controllers, connect any peripherals and the controller to the HP-IB connector on the HP 85101.

4. An HP 8340 or HP 8360 requires a source interconnect cable connection when the test set used is an HP 8516.

Figure 4-1. System Connections

ABBREVIATED HP 8510C SYSTEM SERVICE FLOWCHART (cont.)
(See opposite page for detailed procedure)

Refer to Figure 4-1.

Firmware Revisions

- Check the HP 8510 operating system firmware revision. It must be C.06.00 or higher. On the analyzer, press SYSTEM ***[MORE] [SERVICE FUNCTIONS] [SOFTWARE REVISION]***.

Table 4-1. HP 8360 Upgrade Summary

HP 8510C Requires Rev. C.06.00 to C.07.XX			
HP Model	**Serial Prefix**	**Required for Test Port Flatness Correction[4] or Receiver Cal[6]**	**Required for Quick Step[5]**
83630A 83650A 83651A	All	No modification required[1]	
83621A 83631A	<3103A	HP 83601A upgrade kit[2, 5]	
	3103A	08360-60167 firmware kit[5]	
	3104A to 3111A	08360-60201 firmware kit[5]	
	≥ 3112A	No modification requred[1]	
83620A	≤ 3103A	08360-60167 firmware kit[4]	note 3
83622A	3104A to 3111A	08360-60201 firmware kit[4]	note 3
83624A 83640A 83642A	≥ 3112A	No modification required[1]	note 3

1. Fully compatible at time of shipment
2. Includes installation
3. Quick Step cannot be retrofitted to these models
4. HP 8360 series requires firmware ≥ 23 Oct. 90
5. HP 8360 series requires firmware ≥ 06 Mar. 91
6. Receiver Cal requires HP 8510C Rev. C.07.00 or greater

ABBREVIATED HP 8510C SYSTEM SERVICE FLOWCHART (cont.)

(See opposite page for detailed procedure)

Firmware Revisions, Operation, Internal Switches

Check that HP 8510C firmware is C.07.00 or higher. Check Tables 4-1 and 4-2 for the full functionality and compatibility of source firmware.

Table 4-2. Source Compatibility

Instrument[1]	Firmware Revision Number (or Higher)	Modification Kit
HP 8360 series synthesized sweeper	all[2]	unnecessary[2]
HP 8340A synthesized sweeper	all	unnecessary
HP 8340B synthesized sweeper	all	unnecessary
HP 8341A synthesized sweeper	all	unnecessary
HP 8341B synthesized sweeper	all	unnecessary
HP 8350A sweep oscillator	6	08350-60100[3]
HP 8350B sweep oscillator	6	08350-60101
HP 83522A RF plug-in	6	83525-60074
HP 83525A/B RF plug-in	6	83525-60074
HP 83540A/B RF plug-in	6	83525-60074
HP 83545A RF plug-in	6	83525-60074
HP 83550A RF plug-in	6	83550-60041
HP 83570A RF plug-in	6	83525-60074
HP 83572A RF plug-in	6	83572-60074
HP 83590A RF plug-in	7	83590-60074
HP 83592A RF plug-in	7	83592-60074
HP 83592B RF plug-in	7	83592-60100
HP 83592C RF plug-in	7	83592-60102
HP 83594A RF plug-in	7	83594-60074
HP 83595A RF plug-in	7	83595-60074
HP 83595C RF plug-in	7	83595-60104
HP 83596A RF plug-in	7	83596-60002
HP 83597A RF plug-in	7	83597-60021
HP 8360-series synthesizer	all	unnecessary
HP 8620 sweep oscillator	cannot be used	
HP 86200-series RF Plug-ins	cannot be used	

1. The sources listed above are the only compatible sources as of December 1990. Consult your HP customer engineer for additional information. To check the firmware revision on your HP 8360, press **[SHIFT] [49]**. The revision appears in the FREQUENCY/TIME window. To check the firmware revision on your HP 83500 series RF plug-in, press **[SHIFT] [99]**. The revision appears in the POWER window. The firmware revision for all synthesized sweepers appears when the instrument power is switched.

2. To take advantage of the quick step and test port power flatness correction features, some HP 8360-series synthesized sweepers must be upgraded. See Table 4-1 for a summary of upgrade kits required.

3. Converts HP 8350A to HP 8510 compatibility

- Switch off power. Switch on the source, the test set, then the analyzer. Check that each instrument preset condition is correct. Then check the system preset condition by pressing Instrument State [RECALL] ***[MORE] [FACTORY PRESET]***. The resulting analyzer display should be similar to Figure 4-2.

ABBREVIATED HP 8510C SYSTEM SERVICE FLOWCHART (cont.)
(See opposite page for detailed procedure)

Firmware Revisions, Operation, Internal Switches (continued)

Remove power, then apply power to the source, test set, and the analyzer. Check the preset condition of each instrument. Check the system factory preset condition (see Figure 4-2).

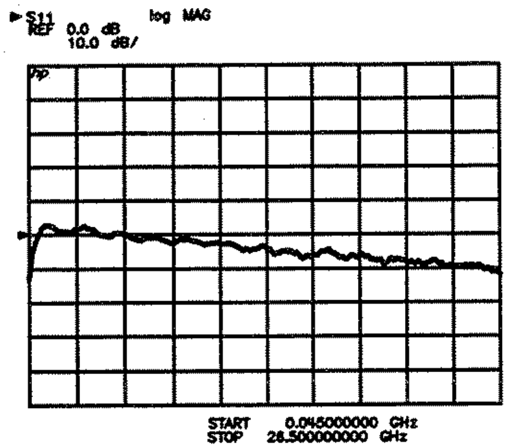


Figure 4-2. System Factory Preset State

- Remove the HP 85101C top cover. Remove the A5 CPU board and make sure the free run switch A5S1 is set to all zeroes. See Figure 4-3.

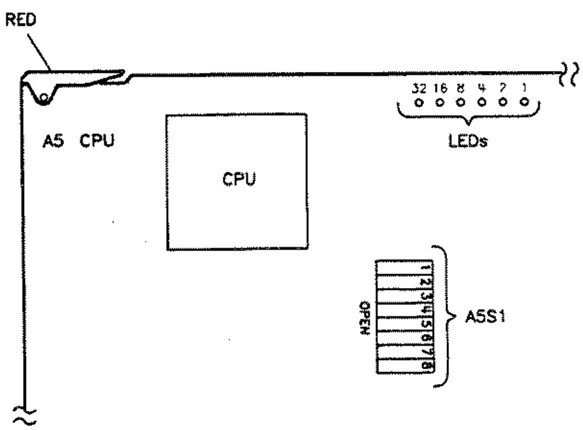


Figure 4-3. Location of Switch A5S1

- Remove the test set top cover. Check the setting of configuration switch A3S1. The correct settings are shown at the left side of the HP 8510C System-Level Troubleshooting Block Diagram at the end of this procedure.
- If the source is an HP 8350, check the setting of configuration switch A3S1. The correct settings are shown at the left side of the HP 8510C System-Level Troubleshooting Block Diagram at the end of this procedure.

If you have completed the control, configuration, and cabling checks, and you still have a self-test failure, running error message, unratioed power failure, or other obvious failure type, go to the appropriate troubleshooting section. Otherwise, continue with "No Obvious Failure Type."

ABBREVIATED HP 8510C SYSTEM SERVICE FLOWCHART (cont.)
(See opposite page for detailed procedure)

Firmware Revisions, Operation, Internal Switches (continued)

Remove the top covers.

HP 85101 A5 CPU board free run switch: all zeroes.
Test set A3S1 configuration switch: see troubleshooting block diagram.
HP 8350 A3S1 configuration switch: see troubleshooting block diagram

Make sure you have completed the control, configuration, and cabling checks.

If there is still a self-test failure, running error message, unratioed power failure, or other obvious failure type then go to the appropriate troubleshooting section. If not, continue to "No Obvious Failure Type," over.

NO OBVIOUS FAILURE TYPE

Verify the HP 85101C Display/Processor

The best approach to troubleshooting an HP 8510C when you are not aware of any obvious failure type is to verify that the HP 85101C Display/Processor is working properly. When its operation is verified, it will act as your diagnostic controller.

Reduce the analyzer system to its basic structure. Disconnect all peripherals such as printer, plotter, controller, and all their cables. The core system remaining should consist only of:

HP 8510 network analyzer

Test set

Source

The system should be connected as shown in Figure 4-1.

If the HP 85101 Display/Processor passed the self-tests at power-up without displaying self-test failure messages 1 to 14, it is already verified to a 70% confidence level. The following tests will verify it to a 95% confidence level.

Refer to section 4.8, "Service Program," and run all the tests in the "HP 85101 Display/Processor Service Program Menu."

If a service program test fails, follow the instructions in the "Service Program" section.

If all the tests pass, the problem is almost certainly in one of the remaining instruments: the HP 85102 IF/Detector, the source, or the test set (or their interfaces).

Verify the HP 85102B IF/Detector

Next, run the all the HP 85102 IF/Detector tests in the service program. This verifies the IF/Detector to an 80% confidence level.

ABBREVIATED HP 8510C SYSTEM SERVICE FLOWCHART (cont.)
(See opposite page for detailed procedure)

↓

NO OBVIOUS FAILURE TYPE

Verify the HP 85101C Display /Processor

Disconnect all peripherals and their cables. Leave only the network analyzer, test set and source connected.

Run all the service program tests in the "HP 85101 Display/Processor Service Program Menu."

If all the service programs pass, the problem is almost certainly in the HP 85102 IF/Detector, the source, or the test set (or interfaces).

↓

Verify the HP 85102B IF/Detector

Run all the HP 85102 IF/Detector tests in the service program.

↓

HARDWARE EMULATOR TOOLS

Now that you know with a high degree of confidence that both halves of the network analyzer are working, the next step is to check the test set and the source. Special service tools are available that emulate a test set and a source: the part numbers are provided in chapter 5, "Replaceable Parts."

Test Set Emulator

This is a service adapter that substitutes for the test set, by connecting the 20 MHz IF signal from the HP 85102 back into the amplifier of the HP 85102. The total effect on the analyzer system is similar to connecting a good test set in a normal configuration. This can determine if a fault is in the test set or the HP 85102. Refer to section 4.3, "Unratioed Power Failures," for the procedure.

If this test indicates that the HP 85102 IF/Detector is not the problem, its confidence level is now increased from 80% to 95%.

Source Emulator

This is a 60 MHz bandpass filter, which is used to pass the third harmonic of the HP 85102B output signal to the test set to emulate a signal from an external source. (Actually, almost any source that has a 60 MHz signal or higher can be used.)

Refer to section 4.7, "Other Failures," for a procedure that uses the source emulator/tripler to determine whether or not the problem is in the source.

Also available is an HP 8360 front panel emulator kit. This is an overlay that can be placed over the front panel keys of the HP 85102 IF/Detector. The HP 85102 keys can then be used to run the built-in service diagnostics of the HP 8360, according to the key codes on the overlay. Press [SERVICE] ***[FULL SELF TEST]*** to access the procedure.

OTHER TESTS FOR THE SOURCE

For additional assurance that the source is working, you can run the operator's check procedure in the source manual.

If the procedures in this HP 8510 service manual indicate a fault in the source, refer to the troubleshooting procedures in the service manual for that particular source.

ABBREVIATED HP 8510C SYSTEM SERVICE FLOWCHART (cont.)
(See opposite page for detailed procedure)

HARDWARE EMULATOR TOOLS

If all the previous tests pass, there is a high level of confidence that the HP 85101C and 85102 are working properly.

Test Set Emulator

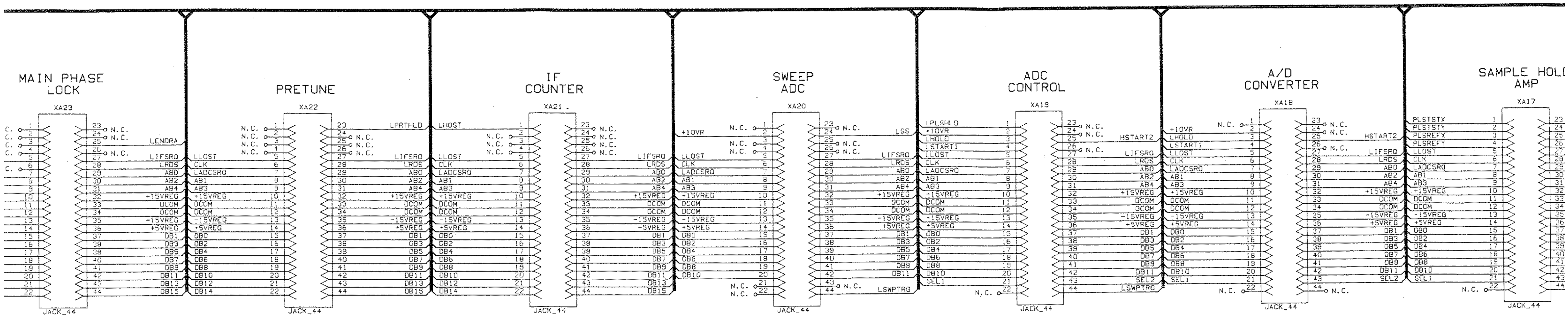
Substitute the service adapter for the test set. Follow the procedure in section 4.3, "Unratioed Power Failures," to verify that the test set is working.

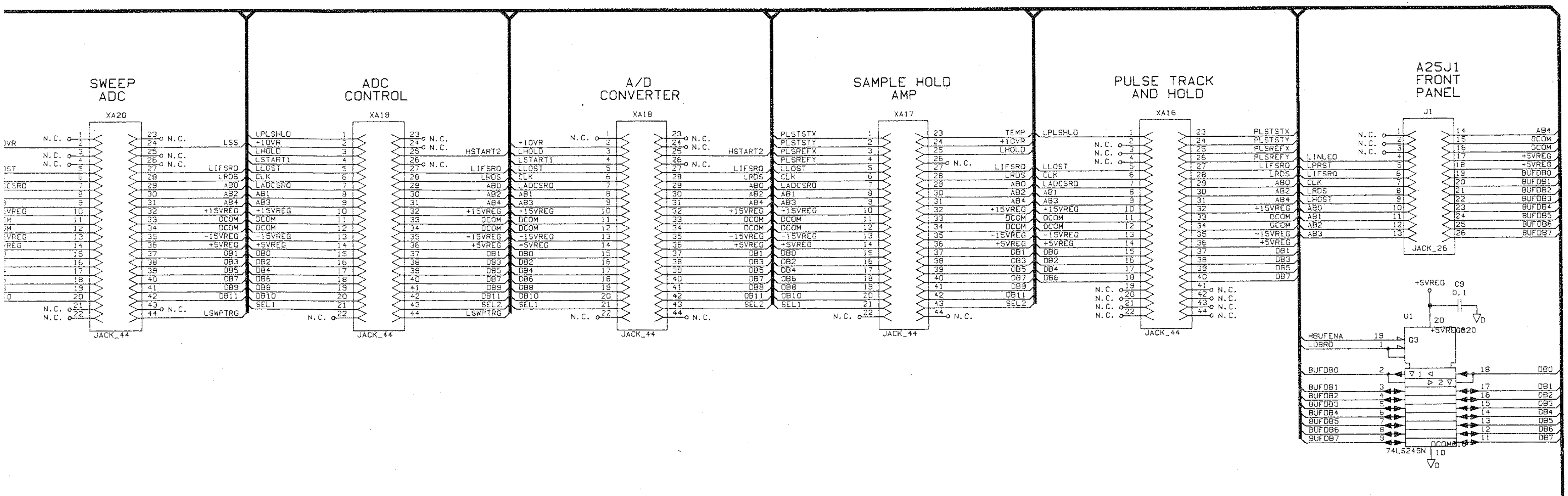
Source Emulator

Apply 60 MHz from the HP 85102 to the test set, using the source emulator. Follow the procedure in section 4.7, "Other Failures." For HP 8360 source, use the front panel emulator over the HP 85102 keys.

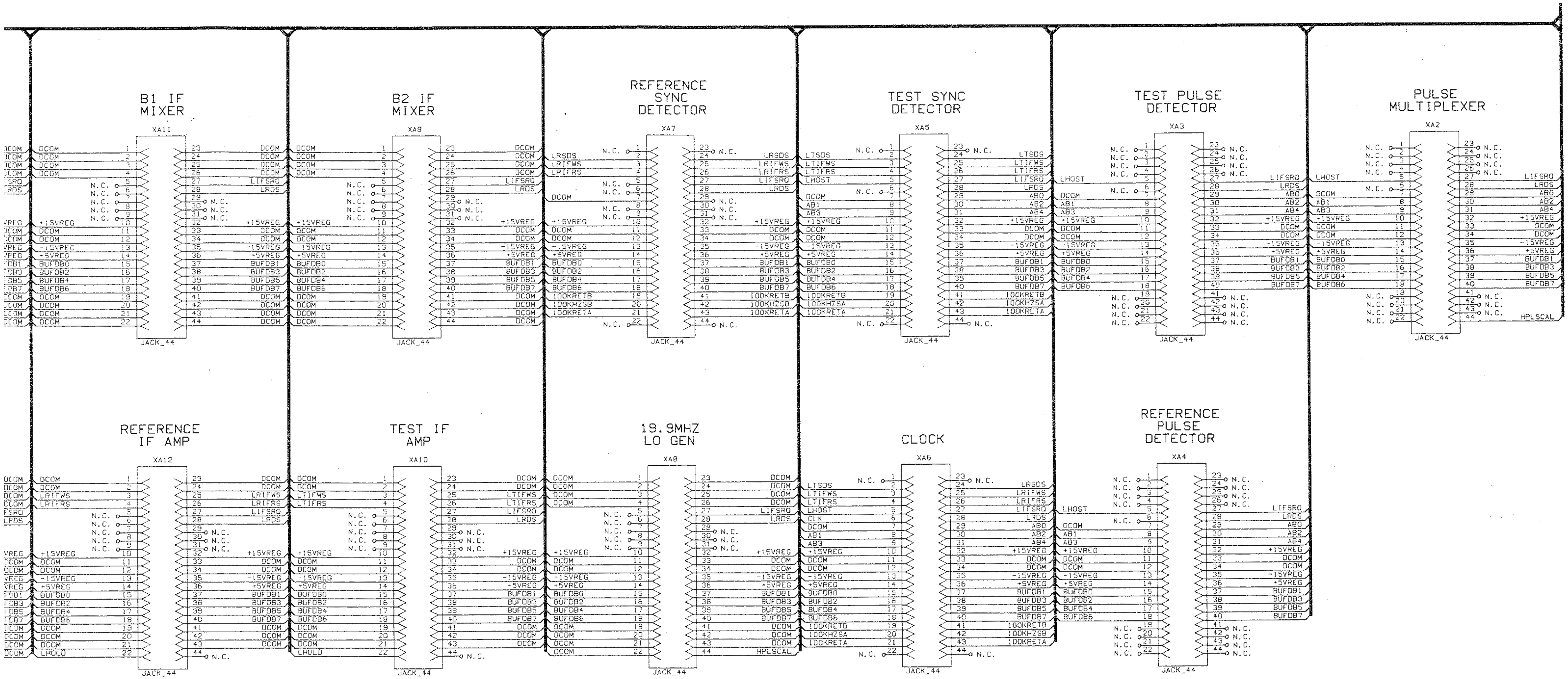
OTHER TESTS FOR THE SOURCE

If a source failure is indicated, run the source operator's check procedure in the source manual.

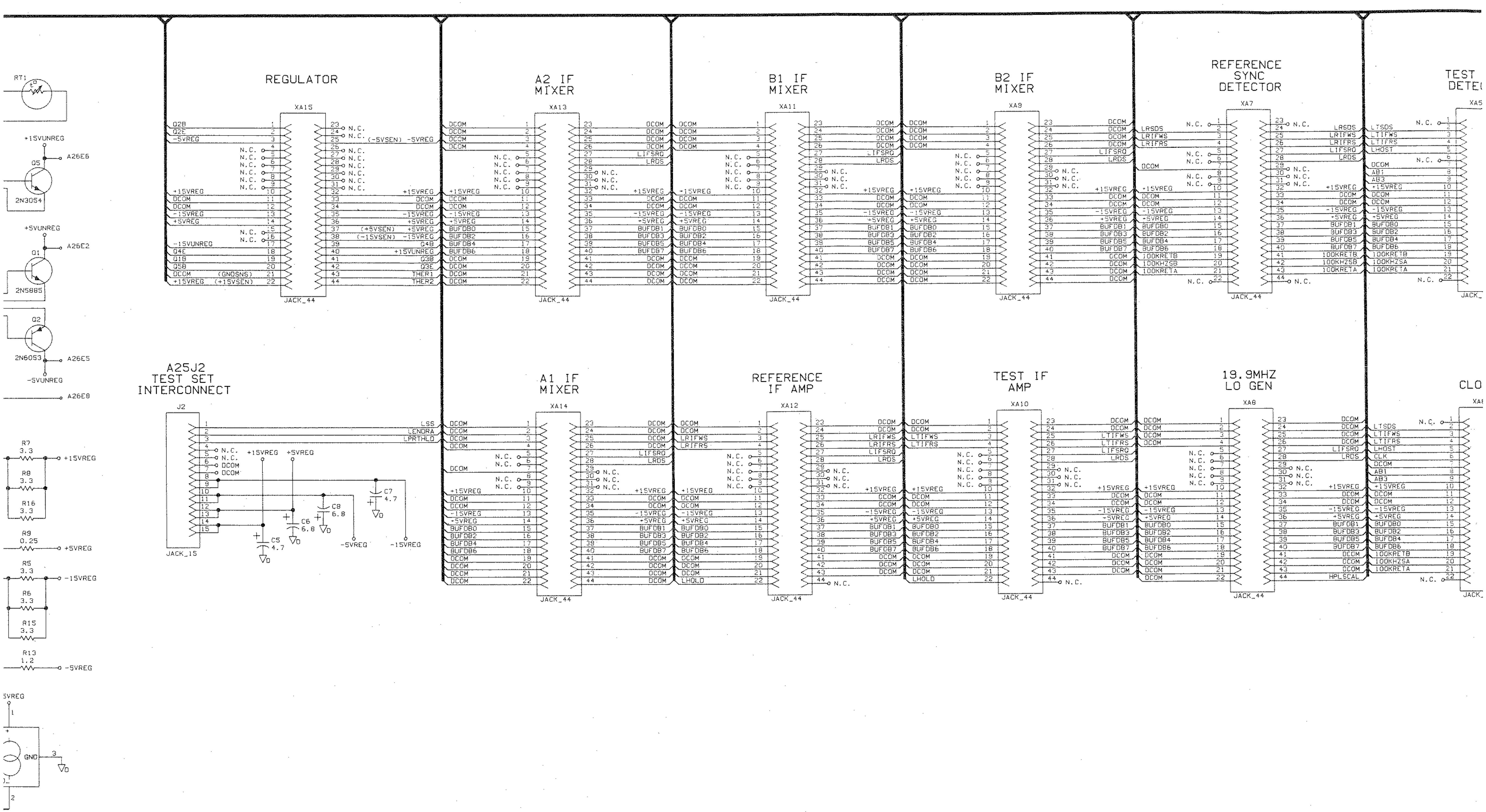

MAIN PHASE LOCK
XA23
PRETUNE
XA22
IF COUNTER
XA21
SWEEP ADC
XA20
ADC CONTROL
XA19
A/D CONVERTER
XA18
SAMPLE HOLD AMP
XA17
JACK_44

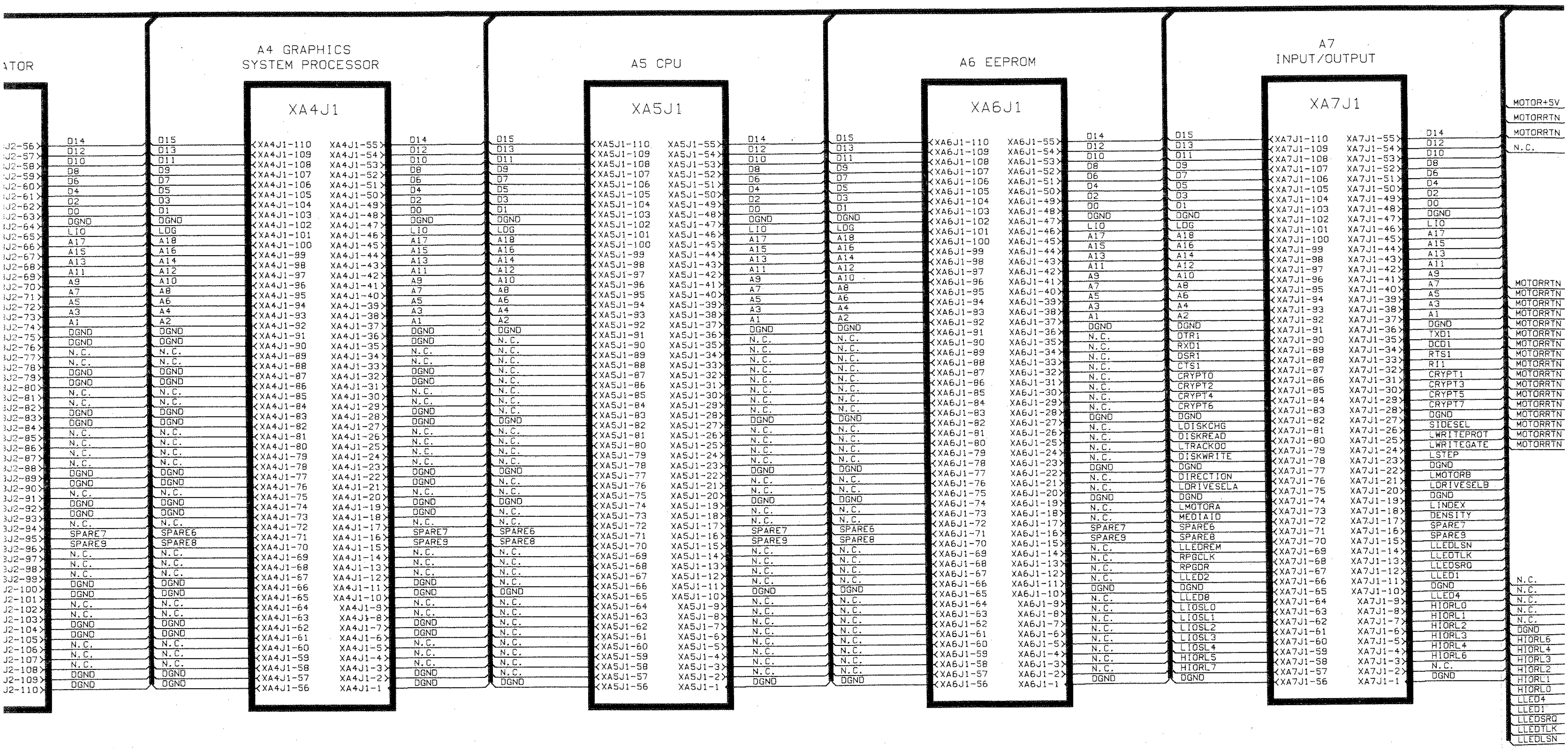


HP 85102C A8 Motherboard Wiring Diagram (2 of 2)

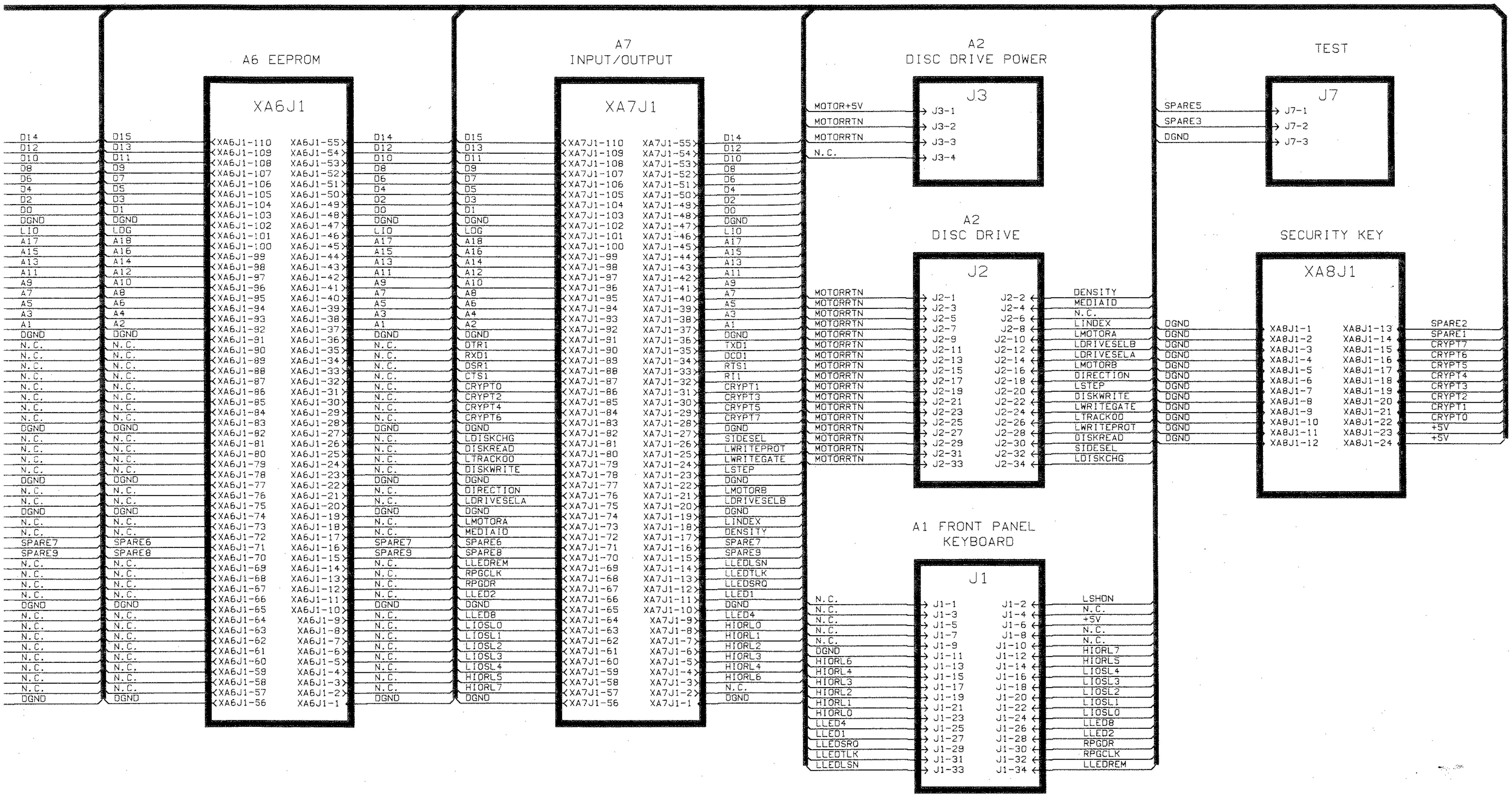


HP 85102C A8 Motherboard Wiring Diagram (1 of 2)

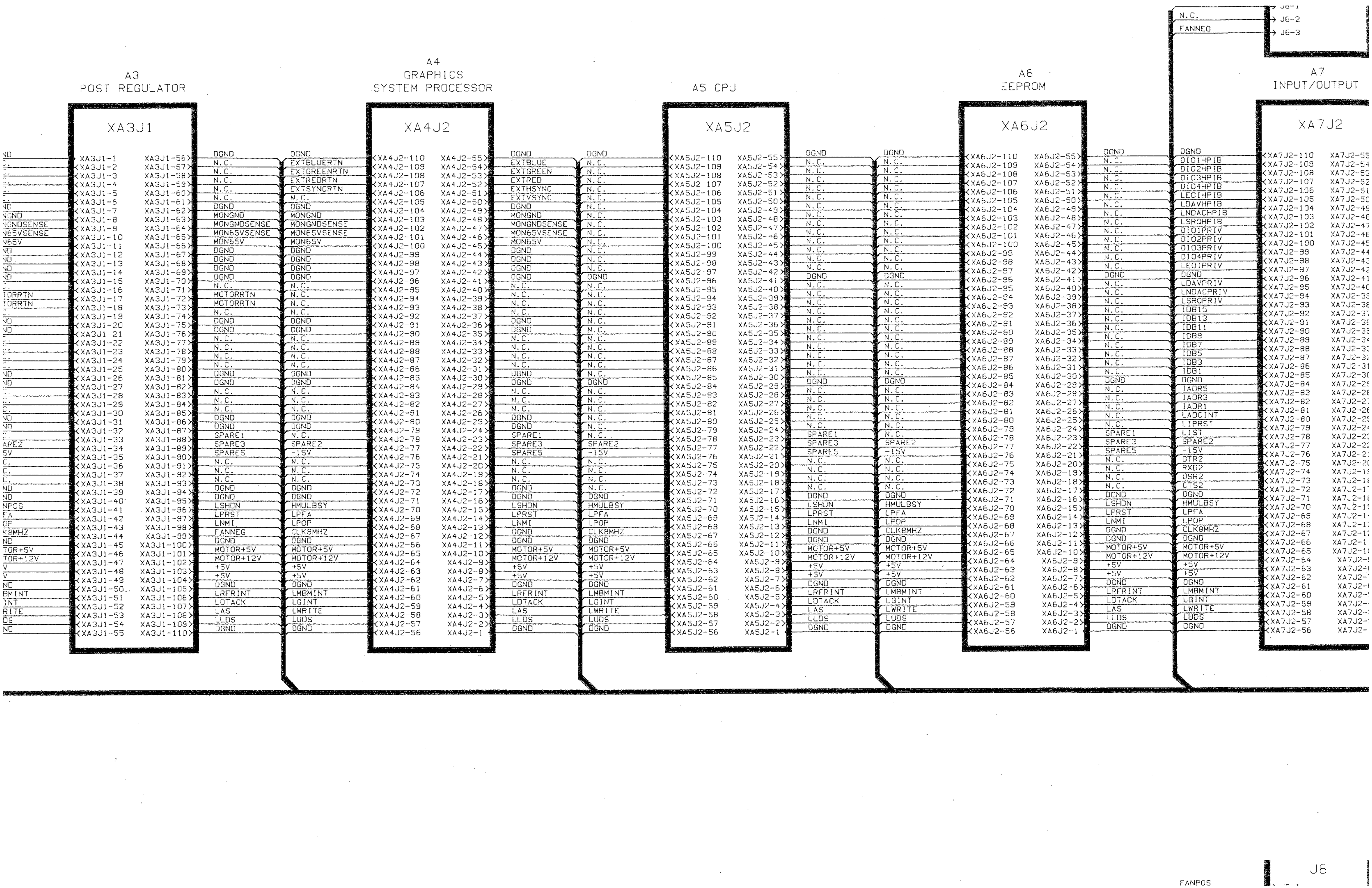

REGULATOR
XA15
A2 IF MIXER
XA13
B1 IF MIXER
XA11
B2 IF MIXER
XA9
REFERENCE SYNC DETECTOR
XA7
TEST DETE
XA5
A25J2 TEST SET INTERCONNECT
J2
JACK_15
A1 IF MIXER
XA14
REFERENCE IF AMP
XA12
TEST IF AMP
XA10
19.9MHZ LO GEN
XA8
CLO
JACK_44
RT1
Q5
2N3054
Q1
2N5885
Q2
2N6053
+15VUNREG
+5VUNREG
-5VUNREG
A26E6
A26E2
A26E5
A26E8
R7 3.3
R8 3.3
R16 3.3
R9 0.25
R5 3.3
R6 3.3
R15 3.3
R13 1.2
C5 4.7
C6 6.8
C7 4.7
C8 6.8
+15VREG
+5VREG
-15VREG
-5VREG
GND

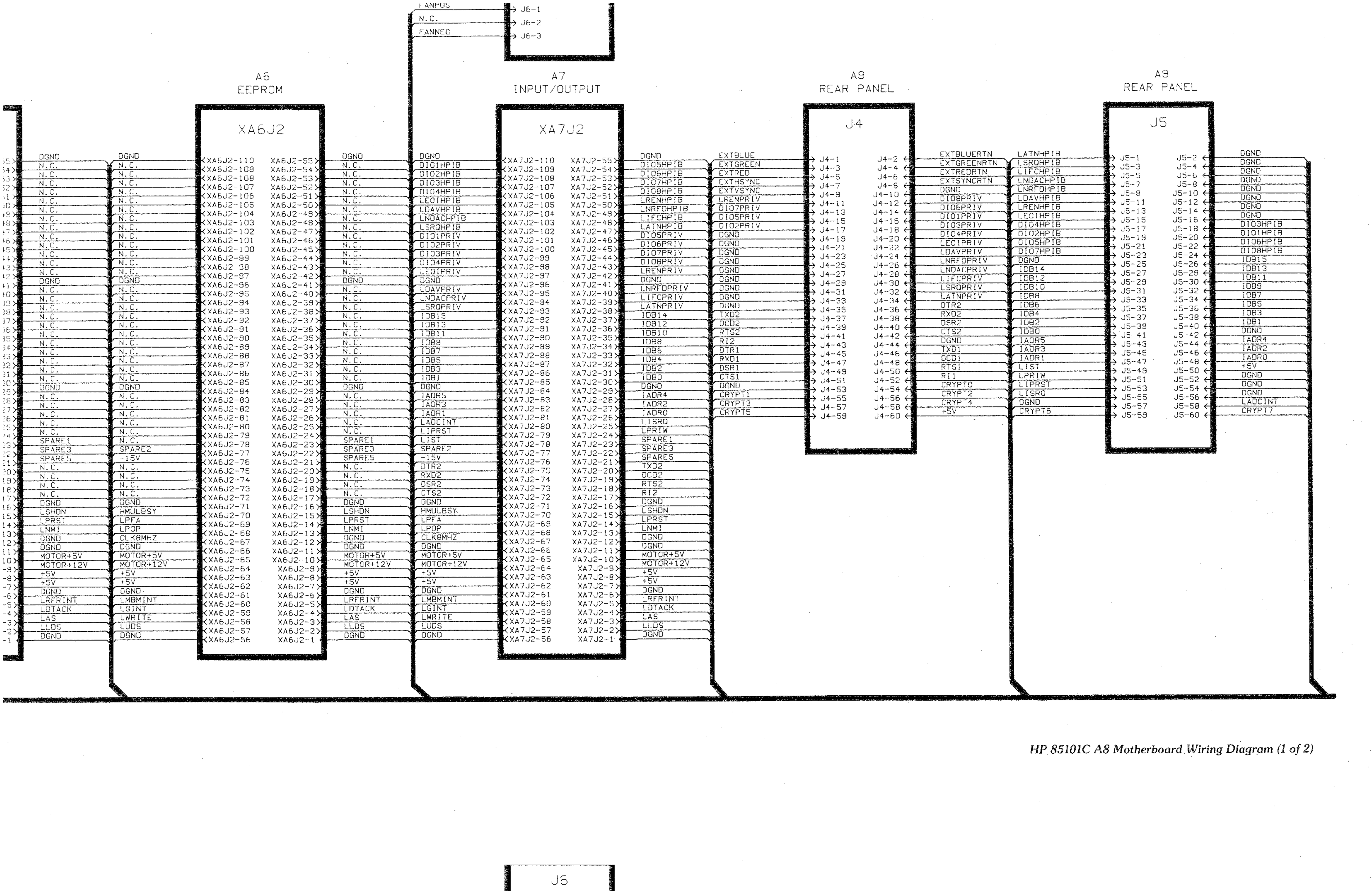


A4 GRAPHICS
SYSTEM PROCESSOR
XA4J1
A5 CPU
XA5J1
A6 EEPROM
XA6J1
A7
INPUT/OUTPUT
XA7J1
MOTOR+5V
MOTORRTN
MOTORRTN
N.C.



HP 85101C A8 Motherboard Wiring Diagram (2 of 2)


A3
POST REGULATOR
XA3J1
A4
GRAPHICS
SYSTEM PROCESSOR
XA4J2
A5 CPU
XA5J2
A6
EEPROM
XA6J2
A7
INPUT/OUTPUT
XA7J2
N.C.
FANNEG
J6-2
J6-3
J6
FANPOS



HP 85101C A8 Motherboard Wiring Diagram (1 of 2)

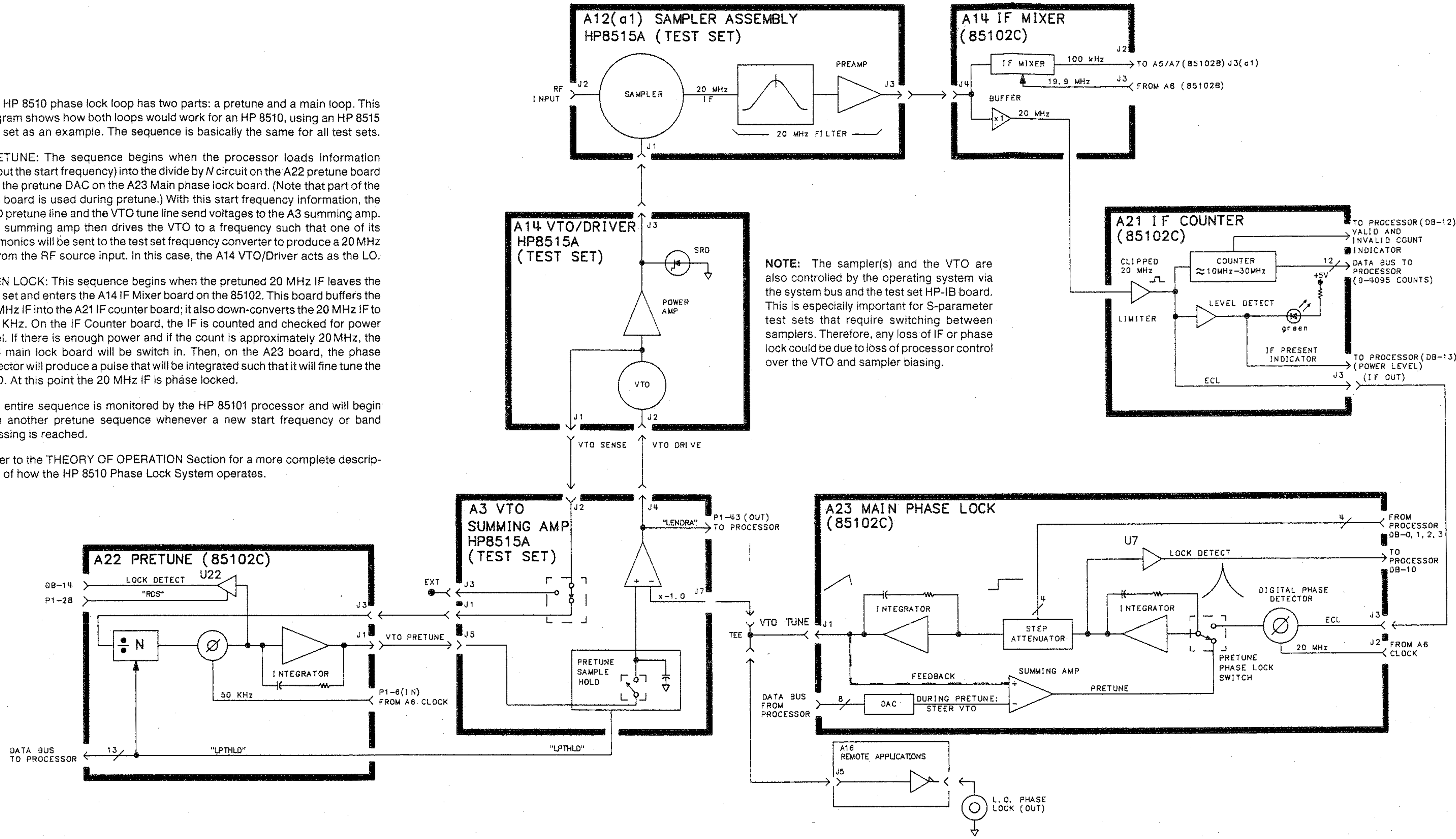
The HP 8510 phase lock loop has two parts: a pretune and a main loop. This diagram shows how both loops would work for an HP 8510, using an HP 8515 test set as an example. The sequence is basically the same for all test sets.

PRETUNE: The sequence begins when the processor loads information (about the start frequency) into the divide by *N* circuit on the A22 pretune board and the pretune DAC on the A23 Main phase lock board. (Note that part of the A23 board is used during pretune.) With this start frequency information, the VTO pretune line and the VTO tune line send voltages to the A3 summing amp. The summing amp then drives the VTO to a frequency such that one of its harmonics will be sent to the test set frequency converter to produce a 20 MHz IF from the RF source input. In this case, the A14 VTO/Driver acts as the LO.

MAIN LOCK: This sequence begins when the pretuned 20 MHz IF leaves the test set and enters the A14 IF Mixer board on the 85102. This board buffers the 20 MHz IF into the A21 IF counter board; it also down-converts the 20 MHz IF to 100 KHz. On the IF Counter board, the IF is counted and checked for power level. If there is enough power and if the count is approximately 20 MHz, the A23 main lock board will be switch in. Then, on the A23 board, the phase detector will produce a pulse that will be integrated such that it will fine tune the VTO. At this point the 20 MHz IF is phase locked.

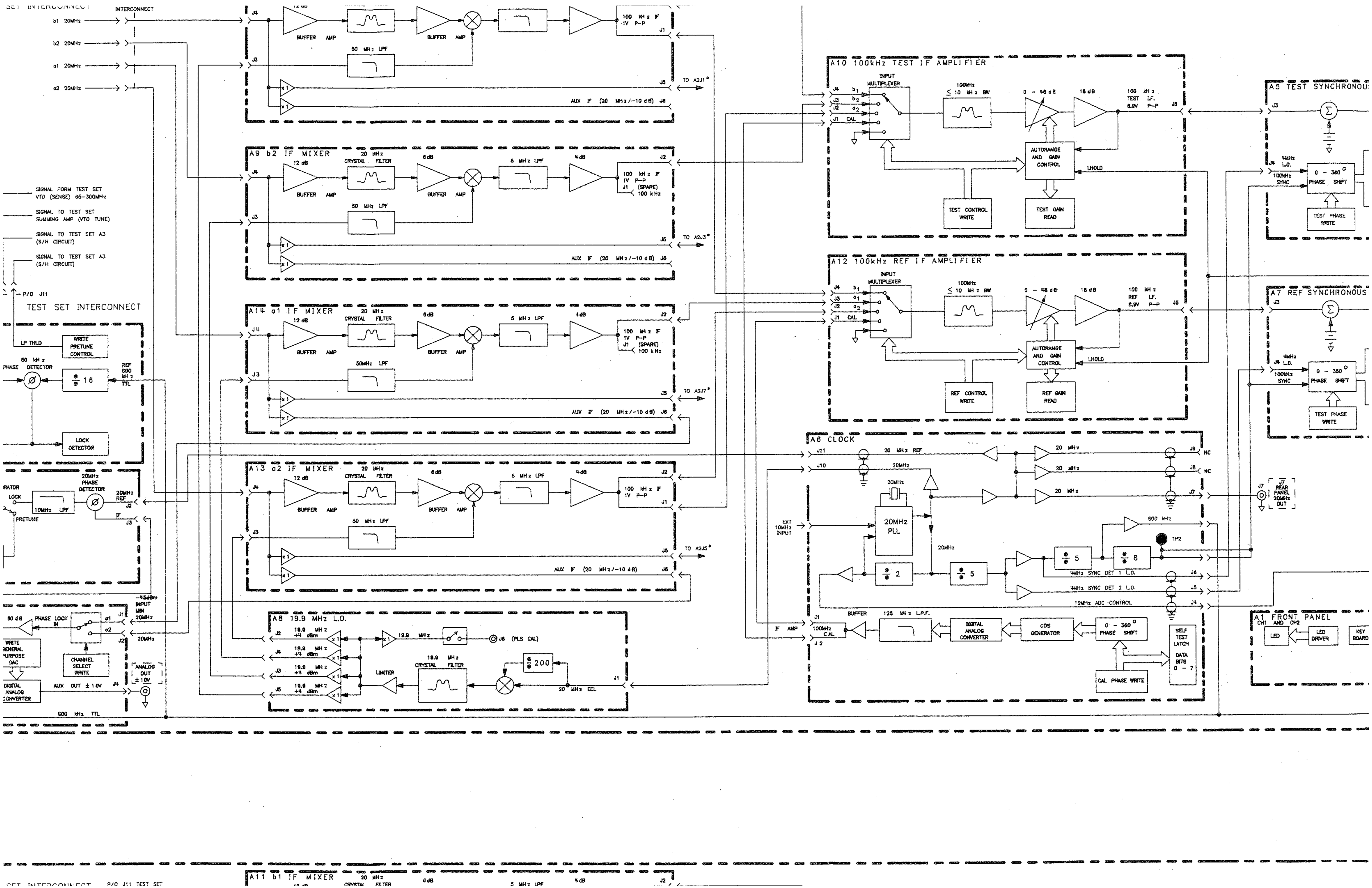
The entire sequence is monitored by the HP 85101 processor and will begin with another pretune sequence whenever a new start frequency or band crossing is reached.

Refer to the THEORY OF OPERATION Section for a more complete description of how the HP 8510 Phase Lock System operates.

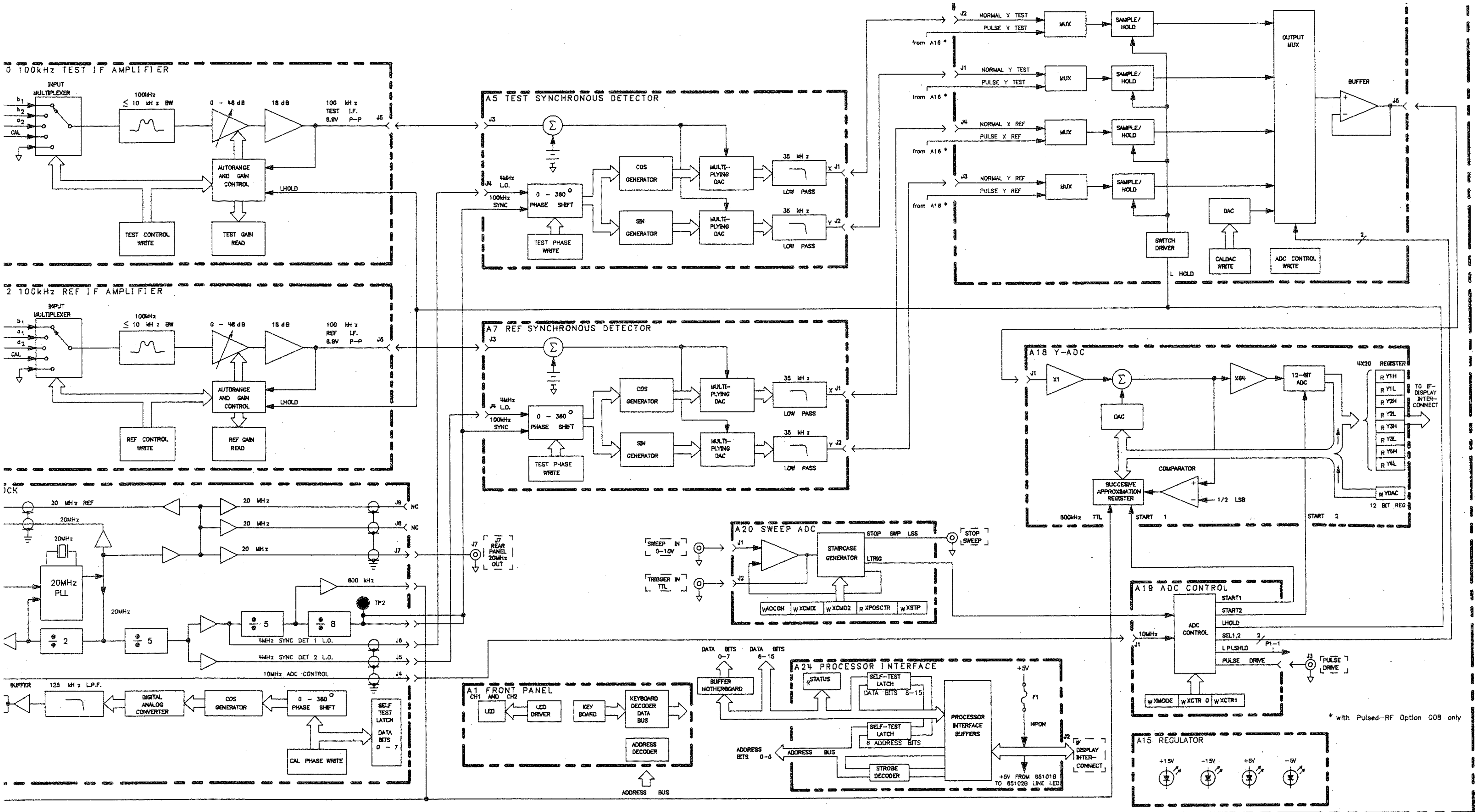


NOTE: The sampler(s) and the VTO are also controlled by the operating system via the system bus and the test set HP-IB board. This is especially important for S-parameter test sets that require switching between samplers. Therefore, any loss of IF or phase lock could be due to loss of processor control over the VTO and sampler biasing.

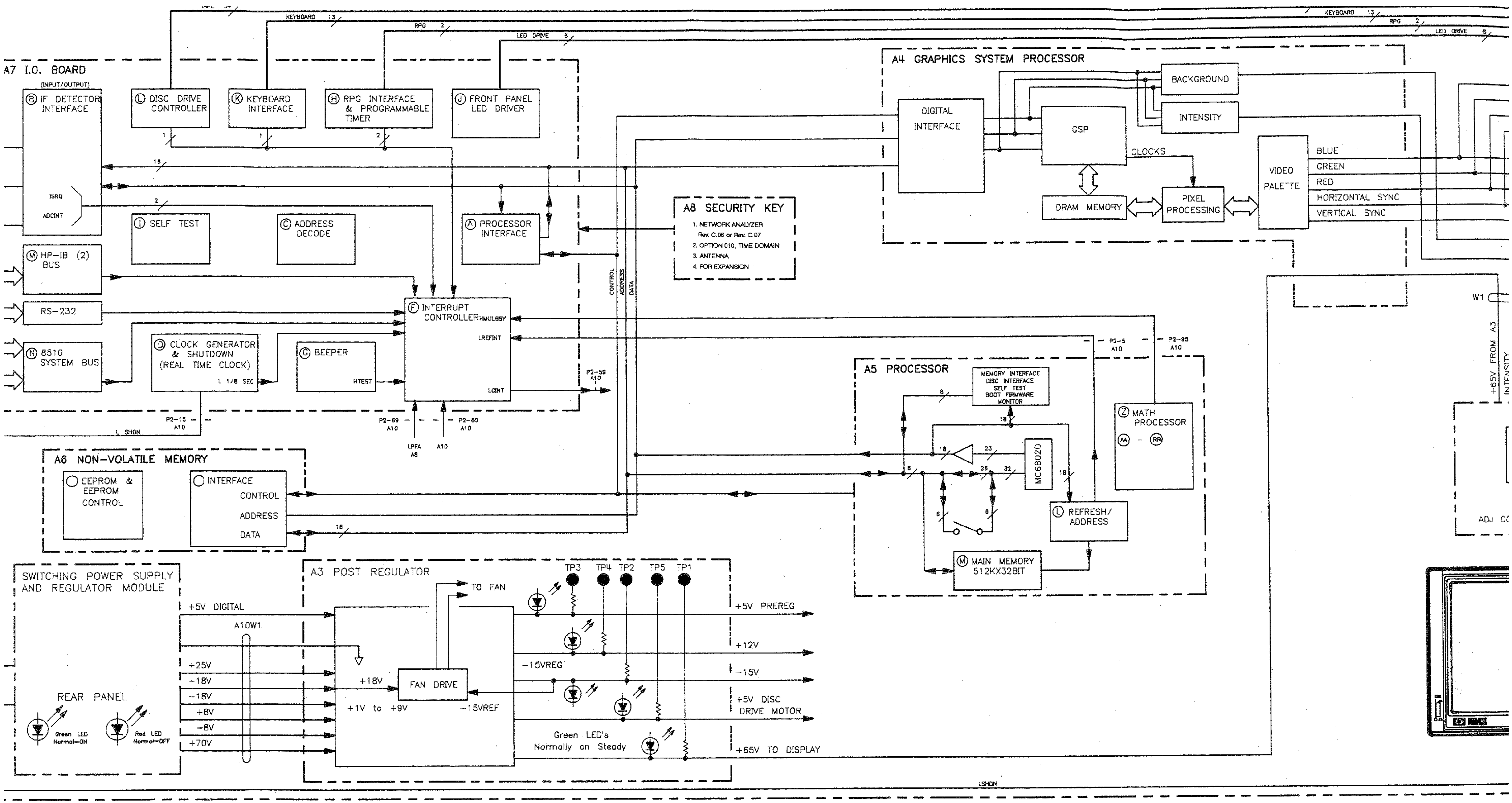
HP 8510C Phase Lock Block Diagram

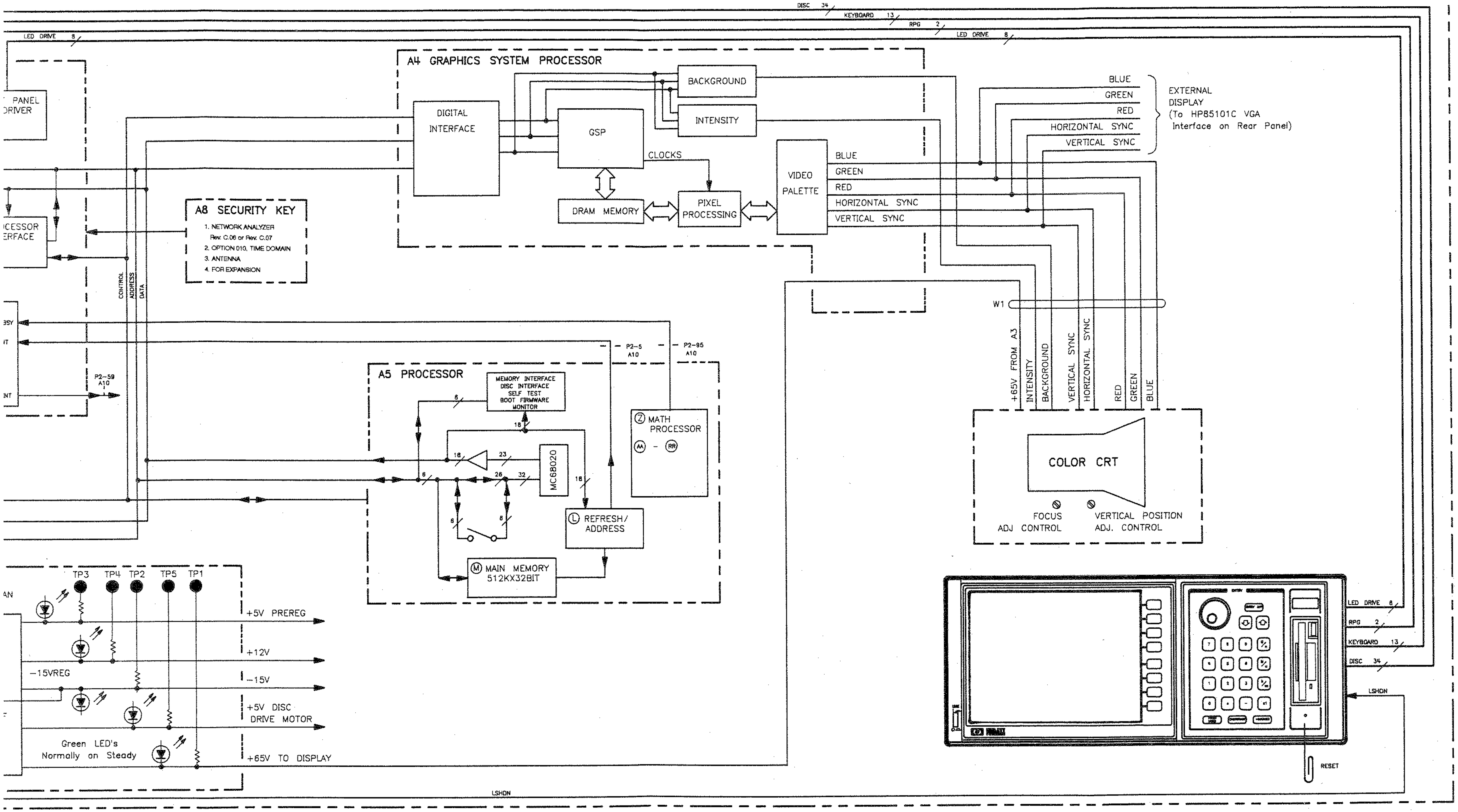


TEST SET INTERCONNECT
SIGNAL FORM TEST SET VTO (SENSE) 65-300MHz
SIGNAL TO TEST SET SUMMING AMP (VTO TUNE)
SIGNAL TO TEST SET A3 (S/H CIRCUIT)
P/O J11
A9 b2 IF MIXER
A14 a1 IF MIXER
A13 a2 IF MIXER
A8 19.9 MHz L.O.
A11 b1 IF MIXER
A10 100kHz TEST IF AMPLIFIER
A12 100kHz REF IF AMPLIFIER
A6 CLOCK
A5 TEST SYNCHRONOUS
A7 REF SYNCHRONOUS
A1 FRONT PANEL
BUFFER AMP
CRYSTAL FILTER
50 MHz LPF
5 MHz LPF
AUX IF (20 MHz/-10 dB)
INPUT MULTIPLEXER
AUTORANGE AND GAIN CONTROL
TEST CONTROL WRITE
TEST GAIN READ
REF CONTROL WRITE
REF GAIN READ
TEST PHASE WRITE
20MHz PLL
4MHz SYNC DET 1 L.O.
4MHz SYNC DET 2 L.O.
10MHz ADC CONTROL
125 kHz L.P.F.
DIGITAL ANALOG CONVERTER
COS GENERATOR
0 - 360° PHASE SHIFT
CAL PHASE WRITE
SELF TEST LATCH DATA BITS 0 - 7
LED DRIVER
KEY BOARD
PHASE LOCK IN
CHANNEL SELECT WRITE
WRITE GENERAL PURPOSE DAC
DIGITAL ANALOG CONVERTER
AUX OUT ±1.0V
ANALOG OUT ±10V
800 kHz TTL
LOCK DETECTOR
WRITE PRETUNE CONTROL
50 kHz PHASE DETECTOR
20MHz PHASE DETECTOR
10MHz LPF
EXT 10MHz INPUT
J7 REAR PANEL 20MHz OUT



HP 85102C IF/Detector Overall Block Diagram

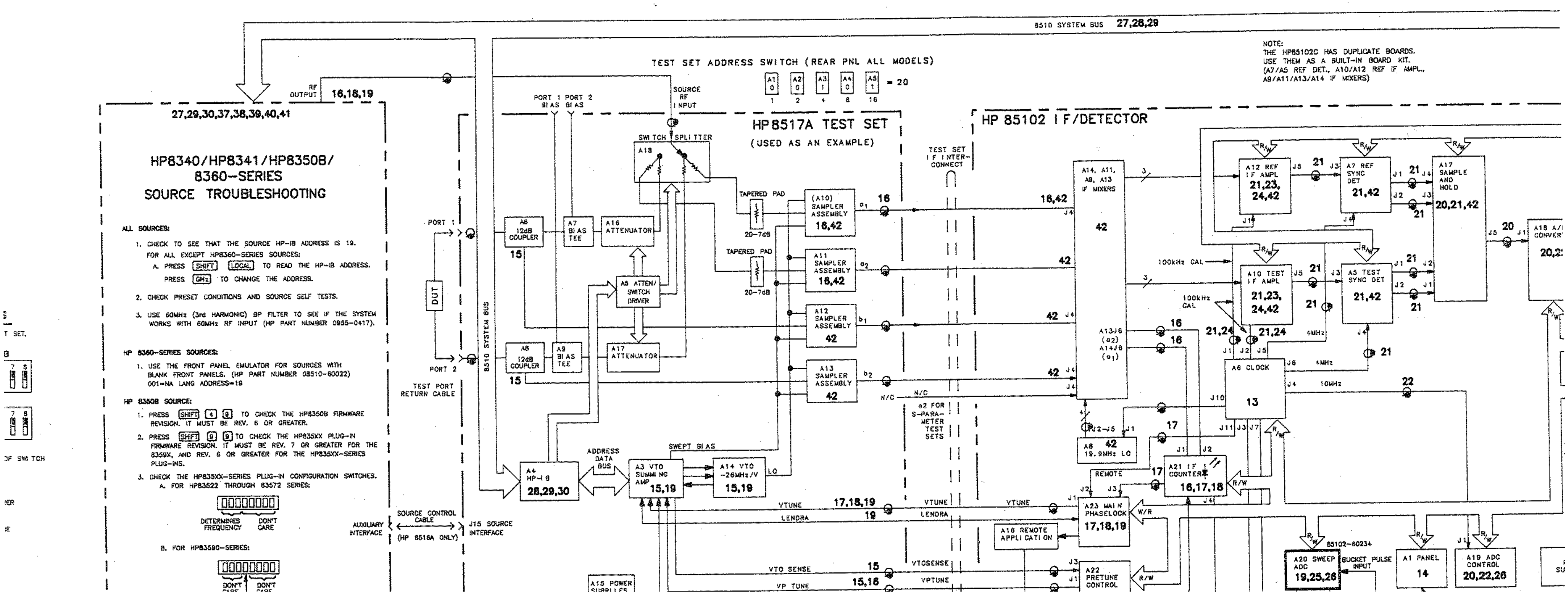

A7 I.O. BOARD
(INPUT/OUTPUT)
B IF DETECTOR INTERFACE
ISRQ
ADCINT
L DISC DRIVE CONTROLLER
K KEYBOARD INTERFACE
H RPG INTERFACE & PROGRAMMABLE TIMER
J FRONT PANEL LED DRIVER
KEYBOARD 13
RPG 2
LED DRIVE 8
I SELF TEST
C ADDRESS DECODE
A PROCESSOR INTERFACE
M HP-IB (2) BUS
RS-232
N 8510 SYSTEM BUS
D CLOCK GENERATOR & SHUTDOWN (REAL TIME CLOCK)
L 1/8 SEC
G BEEPER
HTEST
F INTERRUPT CONTROLLER
HMULBSY
LREFINT
LGINT
P2-59 A10
P2-15 A10
L SHDN
P2-69 A10
P2-60 A10
LPFA A8
A10
CONTROL
ADDRESS
DATA
A8 SECURITY KEY
1. NETWORK ANALYZER Rev. C.06 or Rev. C.07
2. OPTION 010, TIME DOMAIN
3. ANTENNA
4. FOR EXPANSION
A4 GRAPHICS SYSTEM PROCESSOR
DIGITAL INTERFACE
GSP
BACKGROUND
INTENSITY
CLOCKS
DRAM MEMORY
PIXEL PROCESSING
VIDEO PALETTE
BLUE
GREEN
RED
HORIZONTAL SYNC
VERTICAL SYNC
W1
+65V FROM A3
INTENSITY
ADJ CC
A6 NON-VOLATILE MEMORY
EEPROM & EEPROM CONTROL
INTERFACE
CONTROL
ADDRESS
DATA
A5 PROCESSOR
MEMORY INTERFACE
DISC INTERFACE
SELF TEST
BOOT FIRMWARE
MONITOR
MC68020
Z MATH PROCESSOR
AA - RR
L REFRESH/ ADDRESS
M MAIN MEMORY 512KX32BIT
P2-5 A10
P2-95 A10
SWITCHING POWER SUPPLY AND REGULATOR MODULE
REAR PANEL
Green LED Normal=ON
Red LED Normal=OFF
+5V DIGITAL
A10W1
+25V
+18V
-18V
+8V
-8V
+70V
A3 POST REGULATOR
TO FAN
+18V
FAN DRIVE
+1V to +9V
-15VREF
-15VREG
TP3
TP4
TP2
TP5
TP1
Green LED's Normally on Steady
+5V PREREG
+12V
-15V
+5V DISC DRIVE MOTOR
+65V TO DISPLAY
LSHDN



HP 85101C Display/Processor Overall Block Diagram

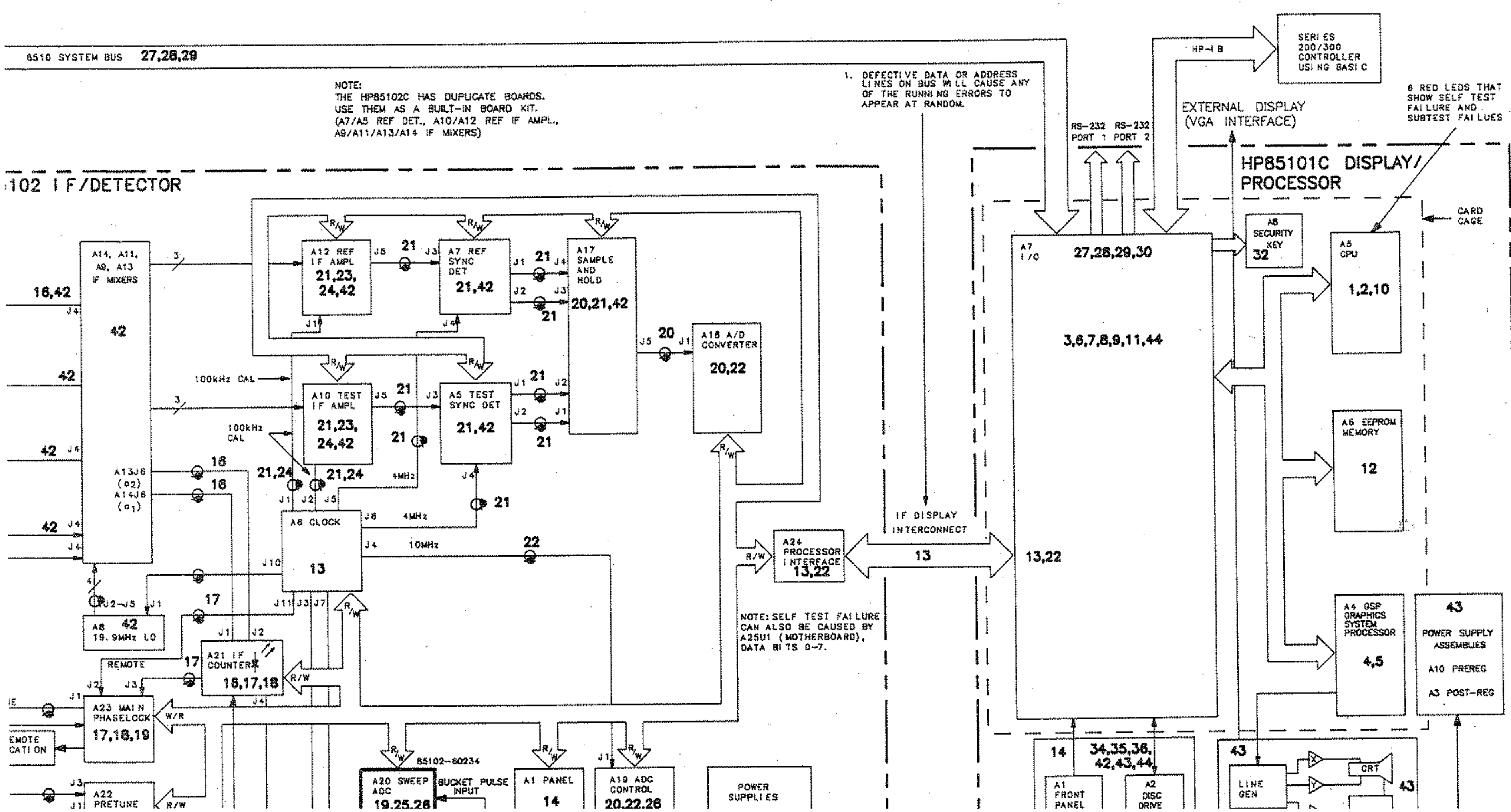
HP8510 SYSTEM LEVEL TROUBLESHOOTING BLOCK DIAGRAM

SELF-TEST (1-14), RUNNING ERROR MESSAGES (15-41), UNRATIOED POWER TEST (42), LEDS, HP-IB ADDRESSES AND CONFIGURATION



EM LEVEL TROUBLESHOOTING BLOCK DIAGRAM

OED POWER TEST (42), LEDS, HP-IB ADDRESSES AND CONFIGURATION SWITCH SETTINGS



SELF TESTS

1. A5 PROCESSOR EPROM (self test and service program PROM using checksum)
2. A5 PROCESSOR RAM (test processor memory using data complement technique)
3. A7 DATA BUS TEST (test I/O data bus)
4. A4 DISPLAY PROCESSOR
5. A4 DISPLAY RAM
6. A7 TIMER/CLOCK/RS-232
7. A7 PUBLIC HP-IB (read-write test of HP-IB register)
8. A7 SYSTEM BUS (read/write test of system bus register)
9. INTERRUPT SYSTEM (test interrupts)
10. A5 MULTIPLIER (performs a complex multiply)
11. A7 DISC CONTROLLER
12. A6 NON-VOLATILE MEMORY TEST (read/write test)
13. IF DETECTOR DATA (read/write test data and address lines)
14. KEYBOARD (read HP 85101C keyboard for a stuck key)

RUNNING ERROR MESSAGES

15. FAILED PRETUNE/LOST PRETUNE
16. NO IF FOUND
17. PHASE LOCK FAILURE
18. PHASE LOCK LOST
19. VTO OVER-RANGE
20. ADC CAL FAILED
21. IF CAL FAILED – REFERENCE
    IF CAL FAILED – TEST
    IF CAL FAILED – BOTH (channels)
22. ADC NOT RESPONDING
23. IF OVERLOAD
24. AUTORANGE CAL FAILED
25. SOURCE SWEEP SYNC ERROR
26. SWEEP TIME TOO FAST
27. SOURCE (HP-IB) SYNTAX ERROR
28. TEST SET (HP-IB) SYNTAX ERROR
29. SYSTEM BUS ADDRESS ERROR
30. SYSTEM BUS SRQ ERROR
31. UNABLE TO LOCK TO EXT 10 MHz REF
32. ERROR: SYSTEM KEY NOT INSTALLED
    CAUTION: OPTIONAL FUNCTION : NOT INSTALLED
    CAUTION: TIME DOMAIN KEY NOT INSTALLED
33. DISC HARDWARE PROBLEM
34. DISC COMMUNICATION ERROR
35. INITIALIZATION FAILED
36. DISC MEDIA WEARING OUT – REPLACE SOON

HP 8360-SERIES SOURCES RUNNING ERROR MESSAGES

37. FAILURE – FAULT INDICATOR ON
38. FAILURE – RF UNLOCKED
39. FAILURE – OVERMODULATION
40. FAILURE – SELF TEST FAILURE
41. INVALID SETUP – CHECK SYSTEM BUS CONFIGURATION (associated with incorrect power level flatness correction only)

OTHER TROUBLESHOOTING HINTS

42. Perform the unratioed power test for a1, a2, b1, and b2. Refer to 'Unratioed Power Failures' in the On-Site Service Manual.
43. The A11 display must be working in order for a normal display to be on the CRT.
44. If self test 11 passes, try to initialize a blank disc to further test the A2 disc drive.

4.1. Self Test Failures

INTRODUCTION

The HP 8510 self test sequence is a series of fourteen individual diagnostic tests that constitute the major part of the test menu. The test menu also contains four system commands, three disk commands, and two service commands. This section explains all of these tests and commands beginning with the self tests.

The self tests sequentially test most of the buses and circuits of the Display/Processor and a few circuits of the IF/Detector. The self test sequence is initiated automatically at power-up but can also be run manually. If the HP 8510 passes all of the tests in the sequence, it loads and runs the operating system program.

HOW TO USE THIS SECTION

How you use this section depends on your situation. These are the major topics:

Self Test and Other Failures describes what happens prior to and during the self test sequence. It gives an example of a failed self test, describes the power-up self test sequence, and explains what subtests are.

How to Identify a Self Test Failure tells how to spot a self test and subtest failure.

How to Troubleshoot a Self Test Failure explains how to troubleshoot the HP 8510 when a self test fails.

How to Access the Test Menu and Run a Self Test tells how to access and run one or all of the self tests.

Self Test Failures and Troubleshooting lists all of the self tests, shows the most likely causes of failures (with percentages), and offers additional troubleshooting hints.

System, Disc, and Service Commands explains how to access and use these commands.

How to Reload the Operating System explains how to do this from memory and disc.

SELF TEST AND OTHER FAILURES

Before or during self tests, the instrument may detect other failures. These are known as instrument errors and default test 15. The next paragraphs and "What To Do If the R-L-T-S-8-4-2-1 LEDs Stay Lit (Default Test 15)" explain these conditions.

What To Do If an Instrument Error Occurs

An instrument error may occur at power-up before the self test sequence runs or as it runs. If this happens, one of the following messages is displayed on the CRT:

- Abort
- Break
- Instruction Error
- Address Error
- Processor Error

An example of a processor error message is displayed below.

```
PROCESSOR ERROR

The processor encountered an error
from which it could not recover.

Technical Details:

Address executed or next instruction was PC = 000 009C
Status register at that time was SR = 2700
Top of memory stack after the error:
0002 FFAG 2700 0000 009C FFF1 423C 016C 0002

Reason for the error was:
Vector offset = 0010
Processor illegal instruction error
```

If any of the five messages above are displayed, reload the operating system (explained at the end of this section).

NOTE: Do not use the memory operations menu softkeys: ***[GO]***, ***[SHOW]***, ***[WRITE]***, ***[CSHOW]***, and ***[CWRITE]*** Hewlett-Packard recommends that only qualified Hewlett-Packard service personnel use these selections.

If reloading the operating system does not eliminate instrument errors, contact your HP customer engineer.

What To Do If the R-L-T-S-8-4-2-1 LEDs Stay Lit (Default Test 15)

Default test 15 is the condition when all eight of the front panel Display/Processor LEDs (R-L-T-S-8-4-2-1) stay lit.This condition occurs at the beginning of the self tests sequence. If it persists, it probably means that the sequence could not start or the processor was unable to clear the front panel LEDs.

If this condition occurs, check the numbered items below using the information on the power supply test points located in the "Power Supply Failures" section. Or refer to the test points on the HP 85101 block diagram in the "Main Troubleshooting Procedure" chapter.

1. Check the +5V power supply at the post-regulator. Refer to the "Power Supply Failures" section for information on power supply test points.

2. Confirm that the A4 GSP assembly is properly seated.

3. Confirm that the A5 CPU assembly is properly seated.

4. Check that all A5S1 switches (see Figure 2-3) are closed.

5. Check these pins of the A5 assembly:

Pin	Reading	Line
P2-13	>+2.5V	LHMF
P2-45	<+0.7V	HMULBSY
P2-59	>+2.5V	LGINT (low general interrupt masked)
P2-68	>+2.5V	LPOP (low power on pulse, from post-regulator)

6. Remove these assemblies: A7 I/O board, A6 EEPROM board, A4 graphics system processor board. Disconnect the IF/Detector interconnect cable and the HP-IB cable from Display/Processor rear panel. Verify that default error 15 is still present. If so, the trouble is isolated to the A5 CPU board assembly.

Self Test Sequence

The sequence starts testing with the processor-ROM circuit (the kernel) in the Display/Processor and then tests: RAM, the data bus, various input/output registers, math processor, IF/Detector interface, and the Display/Processor keyboard. Some of the tests are not completely exhaustive, but they do give an indication that these circuits are functional.

When no failures occur, the self test sequence runs as described below.

1. Press and hold the [TEST] button located on the front panel of the Display/Processor. The button is recessed about 1/2 inch. Use an adjustment tool or paper clip to reach it.

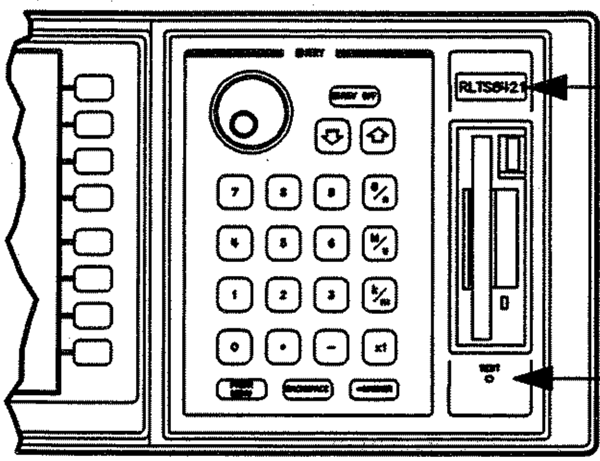


Figure 2-1. Location of Display/Processor LEDs and Test Button

The eight LEDs (shown above) all light. This indicates that the +5 volt supply in the Display/ Processor is operating properly.

NOTE: The events of the next seven steps happen quickly (about 15 seconds). If you do not observe each event, do not be concerned.

2. Release the [TEST] button. All of the LEDs go out to signal the beginning of the self test.
3. The four numbered LEDs (1, 2, 4, 8) briefly flash. They indicate the number of the current test.
4. TESTING appears on the CRT.
5. The disk drive LED blinks.
6. LOADING OPERATING SYSTEM appears on the CRT. The system has completed the self test sequence. It is now loading the operating system software from non-volatile memory into RAM, using a program in the self test ROM.
7. SYSTEM INITIALIZATION IN PROGRESS

RECALLING INSTRUMENT STATE appears on the CRT. The self test ROM has turned over control to the program stored in RAM. The initialization process continues.

8. INST STATE RECALLED appears on the CRT with a graticule (grid) and measurement trace (see Figure 2-2). The measurement/operating system software is now running.

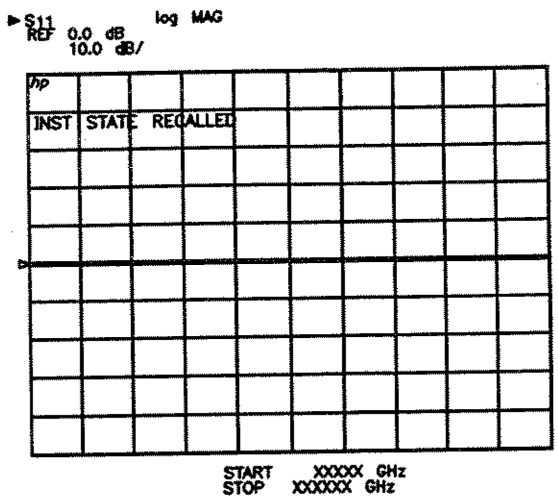


Figure 2-2. Typical Power-Up Display

The type of display that you see depends on the contents of instrument state 8. This power-up state is factory set to an S_{11} log-mag display over a typical default frequency range of 2 GHz to 18 GHz. However, instrument state 8 can be changed. Therefore, your display may appear different.

Subtests

Subtests are the building blocks of most self tests. Subtests further isolate a self test failure by revealing which part of the self test failed. In many cases they reveal which bit, data line, or address line has failed. This information can help to further verify that a particular board is faulty.

In most repair situations, subtest information is not required or useful because of HP's assembly level repair strategy for this instrument.

If you want to simulate this type of failure to see an example of a failure message, press [9] and keep it pressed in. Then press [TEST]. Keep the entry key (9) pressed in until the failure message appears.

HOW TO IDENTIFY A SELF TEST FAILURE

Self test failures are displayed three ways:

- By the CRT
- By the front panel LEDs
- By the CPU board LEDs.

When the CRT is operating properly, it displays self test failure information as shown above. In such instances, read the "most likely causes for failure" and troubleshoot accordingly. To rerun the self test sequence (or a single self test) to verify the fault, refer to "How to Access the Test Menu and Run a Self Test."

How to Identify a Self Test Failure When the CRT is not Working

When the CRT does not indicate a self test failure but you suspect a failure, observe the front panel LEDs. They may or may not indicate the failed self test.

If all of the front panel LEDs are lit, refer to "What To Do If the R-L-T-S-8-4-2-1 LEDs Stay Lit (Default Test 15)," above. (This is not a self test failure but default test 15 condition.)

If some combination of the 8-4-2-1 LEDs stays lit (and none of the R-L-T-S LEDs are lit), the binary sum of the numbers indicates the failed self test. Continue with "Self Test Failures and Troubleshooting," below.

If some combination of the 8-4-2-1 LEDs stays lit (and only one, two, or three of the R-L-T-S LEDs are lit), the binary sum of the numbers indicates the failed subtest. To see what self test failed, continue with the next paragraph.

How to Identify a Self Test Failure with the CPU Board LEDs

When neither the CRT nor the front panel LEDs indicate a self test failure but you suspect a failure, check the A5 CPU board as explained below.

1. Turn off the Display/Processor. Remove its top cover and locate the A5 board. It has red pull levers and six LEDs near its upper edge. The LEDs are labeled 32 16 8 4 2 1.

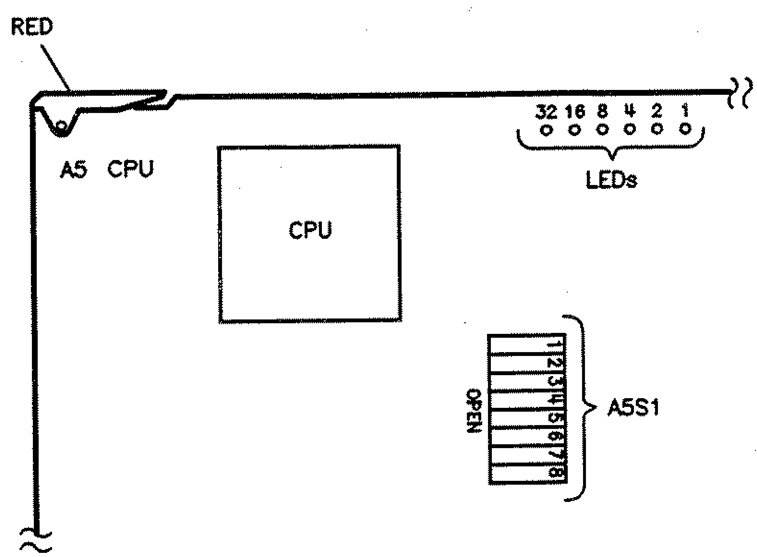


Figure 2-3. Diagnostic LEDs and Switch A5S1 on A5 CPU Board

2. At power-up, all six LEDs light for approximately two seconds. If a self test fails, the LEDs corresponding to the failed test will light for two seconds. Then the LEDs that correspond to the subtest number light and stay on. Self test 1 does not display a subtest number. Self test 15 is not coded.

Turn on the instrument and note the first LED pattern. It is the self test number in binary format.

Note the second LED pattern. It is the subtest number in binary format.

3. Either refer to Table 4.1-1 in "Self Test Failures and Troubleshooting" to identify and troubleshoot the problem, or rerun the test to confirm it.

HOW TO TROUBLESHOOT A SELF TEST FAILURE

If a self test failure message is visible on the CRT, troubleshoot the instrument based on the most likely causes for the failure. If the most likely causes for failure are not displayed, or for additional troubleshooting suggestions, refer to the appropriate self test paragraph (below).

HOW TO ACCESS THE TEST MENU AND RUN A SELF TEST

To run a self test, you must first access the test menu. Then you can run the self test in one of three diagnostic modes:

- Run one test repeatedly
- Run the self test sequence once and stop (in case of a failure) or go on to run the main program (normal operation)
- Run the self test sequence in a repeating (and failure logging) loop.

How to Access the Test Menu

If the operating system is running properly, press the [SYSTEM] key. Then press ***[MORE] [SERVICE FUNCTIONS [SERVICE MENU]***. The self test selections should appear with other selections.

If the instrument is off, press and hold in any key and turn on the instrument. When the keyboard self test failure message appears, release the key. Press [=MARKER] to enter the test menu.

With the instrument on, press and hold in any key. Then press and release the recessed [TEST] button. When the keyboard self test failure message appears, release the entry key. Press to enter the test menu.

Unless you entered the menu with the [SYSTEM] key, test 14 (binary 8 4 2) should be indicated on the front panel LEDs of the Display/Processor. If a fault occurred before test 14, the self test sequence has stopped and the LEDs indicate the test that failed. Press [=MARKER] to enter the test menu.

How to Run a Single Self Test Repeatedly

NOTE: This mode is not recommended for field use. It is typically used at the factory.

Use this repeating mode with external test equipment to trace waveforms and signals through circuits in question and detect intermittent failures. Note that if an error is found, the front panel LEDs do not clear until you rerun the entire self test sequence (even if the fault has cleared).

Access the test menu and enter the number of the self test with the entry keys. Then press [=MARKER]. The test repeats continuously unless a processor error halts it.

To exit the loop, press any entry key.

How to Run the Self Test Sequence Once

Press the recessed [TEST] button to run the self test sequence once.

Alternatively, access the test menu and enter number 17 (rerun self test) with the entry keys. Then press [=MARKER].

How to Run the Self Test Sequence Repeatedly

Access the test menu and enter number 18 (repeat test loop) with the entry keys. Then press [=MARKER]. Test 18 runs the entire self test continuously. It displays the number of times the sequence has passed, failed, and which test and subtest (if any) last failed.

In order to avoid wearing out EEPROM memory cells, the EEPROM write test routine is only performed for the first 20 cycles of a repeat loop. This applies only to the self test selections 12 (nonvolatile memory test) and 18 (repeat test loop).

How to Exit Self Test

Press the recessed [TEST] button to exit any self test.

SELF TEST FAILURES AND TROUBLESHOOTING

This part lists each of the 14 self tests and suggests troubleshooting techniques in the event of a failure. The conditions listed under "Most Likely Causes of Failure" are a duplicate of information displayed on the CRT.

Self Test Menu

The self test part of the test menu appears below. The LED pattern represents the binary code which appears on the front panel and A5 CPU board as explained earlier.

Table 2–1. Self Test Menu and LED Pattern

No.	Name of Test	LED Pattern					
		32	16	8	4	2	1
1	A5 Processor EPROM			no code			
2	A5 Processor RAM	.	.	.	.	O	.
3	A7 Data Bus	.	.	.	.	O	O
4	A4 Display Processor	.	.	.	O	.	.
5	A4 Display Ram	.	.	.	O	.	O
6	A7 Timer/Clock/RS-232	.	.	.	O	O	.
7	A7 Public HP-IB	.	.	.	O	O	O
8	A7 System Bus	.	.	O	.	.	.
9	Interrupt System	.	.	O	.	.	O
10	A5 Multiplier	.	.	O	.	O	.
11	A7 disk Controller	.	.	O	.	O	O
12	A6 Nonvolatile Memory	.	.	O	O	.	.
13	IF/Detector Data	.	.	O	O	.	O
14	Keyboard (performed after test 2)	.	.	O	O	O	O

Symbology of above Table "." = LED off, "O"=LED on

The following paragraphs list the most likely cause of failure for each test. The percentage in parentheses is the probability that a particular item is at fault. The percentages may not always total 100%. One percent (1%) means very low probability.

Supplemental troubleshooting help is provided by these features:

- Additional troubleshooting hints (part of each test description)
- System level troubleshooting block diagram (in the "Main Troubleshooting Procedure" chapter)
- The service program menu of the firmware and the "Service Program" section of this manual

Test 1: A5 Processor EPROM

Most likely cause of failure:

- A5 EPROM failure (60%)
- A5 processor board failure (40%)
- A8 motherboard trace/connector failure (1%)
- A4/A6/A7 trace problem (1%)

Additional troubleshooting hints:

- Check the seating of the A5 board.
- In the main Service Functions menu, press [2] [2] [=MARKER] to enter the HP 8510 Service Program menu. Select HP 85101 Display/Processor Service Program and run the CPU Board Tests (A5).

Test 2: A5 Processor RAM

Most likely cause of failure:

- A5 RAM failure (80%)
- A5 processor board failure (20%)
- A8 motherboard trace/connector failure (1%)
- A4/A6/A7 trace problem (1%)

Additional troubleshooting hints:

- Remove A4, A6, and A7 from the instrument and rerun self test 2. If the failure clears, suspect one of the boards removed.
- In the main Service Functions menu, press [2] [2] [=MARKER] to enter the HP 8510 Service Program menu. Select HP 85101 Display/Processor Service Program and run the CPU Board Tests (A5).

Test 3: A7 Data Bus

Most likely cause of failure:

- A7 I/O board failure (80%)
- A5 processor board failure (20%)
- A8 motherboard trace/connector failure (1%)
- A4/A6/A7 trace problem (1%)

Additional troubleshooting hints:

- Minimize the system: remove the A6 EEPROM board and A4 graphic signal processor board. Re-run test 3. If removing A6 or A4 appears to fix the problem, suspect A4, A6, and A7. The interrupt circuits on A7 may be faulty but only appear faulty with A6 and A4 installed.
- In the main Service Functions menu, press [2] [2] [=MARKER] to enter HP 8510 Service Program menu. Select HP 85101 Display/Processor Service Program and run the I/O Board and Front Panel Tests (A1, A2, A7).

Test 4: A4 Display Processor

Most likely cause of failure:

- A4 graphics signal processor board failure (90%)
- A5 processor board failure (10%)
- A8 motherboard trace/connector failure (1%)

Additional troubleshooting hints:

- In the main service functions menu, press [2] [2] [=MARKER] to enter the HP 8510 service program menu. Select HP 85101 Display/Processor service program and run display board and CRT tests (A4, A11).

Test 5: A4 Display RAM

Most likely cause of failure:

- A4 graphics signal processor board failure (90%)
- A4/A6/A7 trace problem (5%)
- HP 85102 motherboard or connector or cable failure (5%)

Additional troubleshooting hints:

- In the main service functions menu, press [2] [2] [=MARKER] to enter the HP 8510 service program menu. Select HP 85101 Display/Processor service program and run display board and CRT tests (A4, A11).

Test 6: A7 Timer/Clock/RS-232

Most likely cause of failure:

- A7 I/O board failure (90%)

Additional troubleshooting hints:

- In the main Service Functions menu, press [2] [2] [=MARKER] to enter HP 8510 Service Program menu. Select HP 85101 Display/Processor Service Program and run the I/O Board and Front Panel Tests (A1, A2, A7).

Test 7: A7 Public HP-IB

Most likely cause of failure:

- A7 I/O board failure (90%)
- A5 CPU board failure (10%)
- A8 motherboard trace/connection failure (1%)

Additional troubleshooting hints:

- Minimize the system: remove A6 and all HP-IB cables. Rerun self test number 7. If it does not pass, check the control lines.
- In the main Service Functions menu, press [2] [2] [=MARKER] to enter HP 8510 Service Program menu. Select HP 85101 Display/Processor Service Program and run the I/O Board and Front Panel Tests (A1, A2, A7).

Test 8: A7 System Bus

Most likely cause of failure:

- A7 I/O board failure (80%)
- A5 CPU board (20%)
- A8 motherboard (1%)

Additional troubleshooting hints:

- Minimize the system: remove A6 and all HP-IB cables. Rerun self test number 8. If it does not pass, check the control lines.
- In the main Service Functions menu, press [2] [2] [=MARKER] to enter HP 8510 Service Program menu. Select HP 85101 Display/Processor Service Program and run the I/O Board and Front Panel Tests (A1, A2, A7).

Test 9: A9 Interrupt System

Most likely cause of failure:

- A7 I/O board failure (90%)
- A5 processor board failure (10%)
- A8 motherboard trace/connector failure (1%)

Additional troubleshooting hints:

- In the main Service Functions menu, press [2] [2] [=MARKER] to enter the HP 8510 Service Program menu. Select HP 85101 Display/Processor Service Program and run the CPU Board Tests (A5).

Test 10: A5 Multiplier

Most likely cause of failure:

- A5 processor board failure (100%)

Additional troubleshooting hints:

- In the main Service Functions menu,press [2] [2] [=MARKER] to enter the HP 8510 Service Program menu. Select HP 85101 Display/Processor Service Program and run the CPU Board Tests (A5).

Test 11: A7 Disc Controller

Most likely cause of failure:

- A7 I/O board failure (50%)
- A1A1 disk drive (50%)

Additional troubleshooting hints:

- Check the power supply to the disk drive. If out of tolerance, check the supplies on the power supply board.
- In the main Service Functions menu, press [2] [2] [=MARKER] to enter HP 8510 Service Program menu. Select HP 85101 Display/Processor Service Program and run the I/O Board and Front Panel Tests (A1, A2, A7).

TEST 12: A6 NON-VOLATILE MEMORY

Most likely cause of failure:

- A6 nonvolatile memory board failure (70%)
- Nonvolatile memory not initialized (30%)

Additional troubleshooting hints:

- Make sure the A6 board is properly seated.
- In the main Service Functions menu,press [2] [2] [=MARKER] to enter the HP8510 Service Program menu. Select HP 85101 Display/Processor Service Program and run the Non-Volatile Memory Board Tests (A6).

Test 13: IF/Detector Data

Most likely cause of failure:

- HP 85102 interconnect cable missing or damaged (50%)
- HP 85102 A24 failure (20%)
- HP 85101 A7 I/O board failure (20%)
- HP 85102 A6 failure (10%)
- HP 85102 motherboard or connector or cable failure (1%)
- HP 85101 A8 motherboard or connector failure (1%)

Additional troubleshooting hints:

- In the test menu, press [2] [2] [=MARKER] to enter the service program. Select 85101 Display/Processor and run the CPU board (A5) tests and the I/O front panel boards tests.
- To troubleshoot the IF/Detector, refer to the HP 85102 IF/Detector tests part of the "Service Program" section.

TEST 14: KEYBOARD TEST

Most likely cause of failure:

- HP 85101 keyboard key was held down during power-up (80%)
- A7 I/O board failure (10%)
- A1 keyboard failure (10%)
- Keyboard connecting cable missing or damaged (1%)
- HP 85101 A8 motherboard or connector failure (1%)

Additional troubleshooting hints:

- In the main Service Functions menu, press [2] [2] [=MARKER] to enter the HP 8510 Service Program menu. Select HP 85101 Display/Processor Service Program and then select the I/O Board and Front Panel Tests (A1, A2, A7). Run the Keyboard and LEDs Test (A1, A7).

Self Test 14 Selected from Menu

To manually verify the complete operation of each key on the Display/Processor and IF/Detector, select test 14. As you press each key, the CRT should display a different hex code. To exit this test, press the recessed [TEST] button.

SYSTEM, DISC, AND SERVICE COMMANDS

System Command 15: Run Main Program

The processor runs the self test sequence but disregards (does not stop for or report) any failures. Then it loads the operating system from memory to RAM and begins program execution.

System Command 16: Memory Operations

CAUTION

You can destroy the operating Qystem in memory with this selection.

Hewlett-Packard recommends that you do not use this selection unless assisted by a qualified Hewlett-Packard customer engineer. This routine allows direct access to individual memory locations. Thus you can observe or change data. If you destroy the operating system in memory, reload the operating system with disk command 19 (below).

System Command 17: Rerun Self Test

The processor runs the self test sequence once but stops if there are any failures. If there are no failures, it loads the operating system and begins program execution.

System Command 18: Repeat Test Loop

The processor runs the self test sequence continuously. The CRT displays the number of times the sequence has passed (run without failure) and failed. This selection is a powerful mode for troubleshooting intermittent failures.

Press the recessed [TEST] button to exit this menu.

Disc Command 19: Load Program Disc

Use this selection to load or reload the operating system. Slide the operating system disk into the disk drive. In the test menu, press [2] [2] [=MARKER]. In about a minute, the operating system should be loaded and running. If the memory board has not been initialized, refer to the "Non-Volatile Memory Board" part of the "Service Program" section.

Disc Command 20: Record Program Disc

Use this selection to record a backup copy of the operating system on an initialized (see below) blank disk.

Disc Command 21: Initialize Disc

Use this selection to initialize a disk prior to recording the operating system on it. You can use a disk that has been recorded on before or not, but it should be double-sided and of good quality.

Slide the disk into the disk drive. In the test menu, press [2] [2] [=MARKER]. In about a minute, the operating system should be recorded.

Service Command 22: Run Service Program

Refer to the "Service Program" section to use this selection.

Service Command 23: Diagnose a Failure

This selection displays the failure message for a self test and subtest of your choice. Use it to read failure messages when the CRT goes blank but is not faulty. Refer to "How to Identify Self Test Failures when the CRT Is Not Working" toward the beginning of this section. Obtain the self test and subtest numbers as directed.

Press [SYSTEM] ***[MORE] [TEST MENU]*** to enter the test menu. Then press [2] [3] [=MARKER] to display the "diagnose a failure" screen. Enter the self test and subtest numbers obtained above and press [=MARKER]. The CRT should display the appropriate failure messages.

HOW TO RELOAD THE OPERATING SYSTEM

You can reload the operating system from RAM or from the disk.

To reload from RAM, press the recessed [TEST] button. This re-initializes the system, reruns the self tests sequence, and (if no failures occur) displays the power-up instrument state number 8.

If the operating system does not reload properly from RAM, you can reload it from disk. But do so only as a last resort. Use disk command 19, "Load program disc," as directed above. Select the softkey labeled PG_8510C, not the key labeled PG_8360FPE.

If it does not solve the problem, contact an HP customer engineer for assistance.

4.2. Running Error Messages

RUNNING ERROR MESSAGES AS BUILT-IN DIAGNOSTICS

Running error messages appear on the HP 8510C CRT whenever the HP 85101C CPU detects an error during normal operation. As a built-in diagnostic test, the CPU is constantly monitoring the overall system operation, especially that of the phaselock between the HP 85102 IF Detector, the test set and the source. Internal firmware routines are constantly checking power levels, phase relationships, frequency changes, operator commands, and so forth.

A message is displayed on the CRT whenever the CPU detects a fault. In other words, running error messages inform you of any detected faults while the system is running.

When an error is detected and a running error message is displayed, the system will usually continue running (making measurements). At this time the system has already passed the power-on self test diagnostics. Therefore, it is unlikely that a running error message indicates a problem in the HP 85101C Display/Processor unless the CPU has failed.

Whenever you get a running error message, be sure it is a consistent and repeatable error. Press the [ENTRY OFF] key to remove the message from the CRT and then press the **MEASUREMENT** [RESTART] key to take another sweep. Many times, an error message like PHASELOCK LOST is only an intermittent loss of phase lock that can be corrected on the next sweep. If the message is gone, then there is no real problem. However, if the error message repeats, find that message in this section and note the possible causes and troubleshooting suggestions.

DIFFERENT TYPES OF RUNNING ERROR MESSAGES

The four types of HP 8510C error messages are:

- Cautions
- Prompts
- Tells
- Errors

These four types are described below. Only those error messages which are related to *service* and *repair* are documented in this section. Refer to the Keyword Dictionary for an explanation of caution and tell messages. Messages such as those following are not documented in this section because they are not related to service and are mostly self-explanatory.

- FILE NOT FOUND (caution type)
- POSITION SLIDE THEN PRESS KEY TO MEASURE (prompt type)
- RECALLING CAL SET (tell type)
- INSUFFICIENT MEMORY (error type)

ERROR MESSAGE CHARACTERISTICS

The general characteristics of each type of error message are described in the following paragraphs.

Caution Type Messages

These messages are preceded with the word *CAUTION* and are accompanied by a beeping tone. They usually indicate a problem with the HP 85102 IF Detector, test set, source, or disk drive. They are the main subject of this section because they are related to hardware failures more than the other types of messages. Except for those caution messages that are concerned with the disk or disk drive, most of these messages relate to the hardware phaselock system.

For example, if you disconnect the RF source power from the test set, the message *CAUTION: NO IF FOUND* will be displayed. Immediately, the CPU has determined that there is insufficient IF power and reports the error on the CRT. However, because the CPU uses the information supplied by the HP 85102 A21 IF counter assembly, it is possible that this board (A21) is faulty and not the IF signal. Therefore, be careful in your interpretation of these error messages. Remember, the message indicates that a problem has been detected on a certain assembly, but the message does *not* always indicate where the actual problem is located.

Prompt Type Messages

Prompts are displayed whenever the CPU wants you to act during the normal running of the instrument. These messages do not indicate a failure. For example, if you have just finished calibrating the system and you do not have enough room to store the calibration, the prompt *NO SPACE FOR NEW CAL; DELETE A CAL SET* will be displayed. Here, the CPU knows that you have previously saved calibrations in all of the available cal sets. It is prompting you to delete one or more cal sets so that you can store the one you have just finished.

Tell Type Messages

Tell messages are displayed whenever the CPU is telling you what it is doing or has done. This type of message does not indicate a failure or a problem unless the message is unrelated to a key you thought you pressed. For example, if you want to save the current state of the HP 8510C for any reason, you would press the INSTRUMENT STATE [SAVE] key on the HP 85102. The CPU would immediately recognize your command and tell you that it is obeying by displaying the message: *SAVING INST STATE*.

Error Type Messages

These messages are displayed whenever the system cannot continue running because of a programming error. Error messages are not related to CAUTION messages. For example, if you have programmed the HP 8510C to perform a function requiring moving data to its internal memory and it does not have enough room to store the data, the message *INSUFFICIENT MEMORY* will be displayed on the CRT.

THINGS TO REMEMBER ABOUT RUNNING ERROR MESSAGES

- They may be caused by either an internal problem or an operator error.
- In many cases, they will not stop the measurement sweep.
- They can be intermittent or permanent and, in the case of cautions, the message indicates where the failure is detected and not always where the problem exists.
- They may be caused by an HP 85101C CPU failure or error, not necessarily by the cause indicated in the message. However, this type of failure is rare.
- They remain on the CRT until you clear the message by correcting the problem, pressing [ENTRY OFF] and **MEASUREMENT** [RESTART].

CATEGORIES OF CAUTION RUNNING ERROR MESSAGES

The following four types of CAUTION running error messages are used for service and troubleshooting:

Phase Lock Running Error Messages

NOTE: Refer to the chapter 3, "Theory of Operation," for a detailed description of how these phase lock error messages are generated.

- PRETUNE FAILURE
- PRETUNE LOST FAILURE
- NO IF FOUND
- PHASE LOCK FAILURE
- PHASE LOCK LOST
- VTO OVER RANGE

IF/Detector ADC Running Error Messages

- ADC NOT RESPONDING
- ADC CAL FAILED
- IF CAL FAILED
- IF OVERLOAD
- AUTORANGE CAL FAILED

Source Sweep Running Error Messages

- SOURCE SWEEP SYNC ERROR
- SWEEP TIME TOO FAST

HP-IB Running Error Messages

- SOURCE SYNTAX ERROR
- SYSTEM BUS ADDRESS ERROR
- TEST SET SYNTAX ERROR

RUNNING ERROR MESSAGE TROUBLESHOOTING

System Level Troubleshooting Block Diagram

Use the system-level troubleshooting block diagram, located in chapter 4, "Main Troubleshooting Procedure," as a reference guide for troubleshooting running error messages. Read "How to Read This Block Diagram" to the left of the block diagram. The running error messages are listed on the right, and have numbers associated with each message that cross-reference locations on the block diagram.

Helpful Troubleshooting Hints

Before troubleshooting a caution running error message, first do the following:

- Make sure that the line power applied to all instruments is correct. Check all connections. Refer to chapter 9, "Installation," if necessary.

- Make sure the source RF power and frequency are correct, as some phase lock errors are caused by these being improperly set.
- Be sure that the test set is properly down-converting the RF source input signal to 20 MHz. Refer to section 4.3, "Unratioed Power Failures," to verify test set operation.
- Always press the [ENTRY OFF] and **MEASUREMENT** [RESTART] keys several times after an error message is displayed. This will allow you to obtain the best indication of the true failure.

This is necessary because a running error message may be the result of the CPU executing a firmware instruction at the time of failure. Therefore, the displayed error message is indicating a related failure - not the actual failure. It is indicating a failure at the wrong place or wrong assembly. The error message that continually repeats is the running error message you want to troubleshoot.

- Make sure the system is powered-up in the proper order, to avoid a possible phase lock error. The instrument power-on sequence is:

In systems with controllers, switch on power to the controller last, the HP 85101C next to last.

In systems without controllers, switch on power to the HP 85101C last.

- Always disconnect all unnecessary peripheral instruments and non-terminated HP-IB cables from the system when troubleshooting.
- If the HP 85102 top cover has been removed, check the cables on the boards. Remove the instrument top cover (use a pozidrive screwdriver) and check that all snap-on cables are connected properly to the boards. Each cable is labeled with a **J** (jack) number that corresponds to the **J** input on the board cover.

ALPHABETICAL LIST OF CAUTION RUNNING ERROR MESSAGES

Troubleshooting suggestions and probable causes of failure are given with the following list of messages.

Always press the [ENTRY OFF] and **MEASUREMENT** [RESTART] keys to see if the error message repeats. If it does not repeat, it is probably NOT a true error, but rather an intermittent failure. If it does repeat, locate the error message below and follow the troubleshooting suggestions.

ADC Cal Failed

The HP 85102 A18 A/D converter assembly is calibrated by the ADC of the A17 sample/hold board. The HP 85101C CPU detects incorrect values of the measured bits and displays this message.

Possible cause of failure:

- HP 85102 A18 ADC board
- HP 85102 A17 sample and hold board
- HP 85102 A19 ADC control board

Troubleshooting:

- Run the HP 85102 service program tests in the Run All mode.
- Run the HP 85102 service program tests 1 (A19), 3 (A18), and 4 (A17).
- If the Service Program found no fault with any assembly, refer to section 4.7, "Other Failures" and run the 20 Hz Sine Wave Test.

ADC Not Responding

The HP 85102 A18 ADC board is not sending an expected interrupt service request to the HP 85101C CPU. This message is the highest priority interrupt in the HP 8510C.

Probable cause of failure:

- HP 85102 A18 ADC
- HP 85102 A19 ADC control
- HP 85102 A24 CPU interface
- HP 85101C interrupt problem
- IF Display interconnect cable

Troubleshooting:

- Run HP 85102 service program tests in the Run All mode
- Run HP 85102 service program tests 1 (A19) and 3 (A18)
- Run HP 85101C service program tests (I/O board tests)
- If the service program found no fault with any assembly, refer to section 4.7, "Other Failures" and run the 20 Hz Sine Wave Test.

Autorange Cal Failed

The CPU tries to calibrate the switchable gain amplifiers (0 dB, 12 dB, 24 dB, 36 dB, and 48 dB gain steps) on the HP 85102 IF amplifier boards (A10 and A12). If the measured values exceed the normal error limits, this message is displayed.

Probable cause of error:

- HP 85102 A10 or A12 IF amplifier

Troubleshooting:

- Run HP 85102 service program tests in the Run All mode.
- Run HP 85102 service program test 5 (A10/A12).

Caution: Optional Function Not Installed

This message occurs if the A8 security key assembly in the HP 85101C is removed.

Probable cause of failure:

- Missing HP 85101C A8 security key

Disc Communication Error

This message occurs when an external disk drive loses communication with the HP 85101C A7 I/O board assembly.

Probable causes of failure:

- Missing or bad HP-IB cable between the HP 85101C and the external disk drive
- HP 85101C A7 I/O board

Disc Hardware Problem

This message occurs when attempting access to an external disk drive, and indicates a hardware-type problem with the drive. This message does not indicate a failure with the HP 8510C internal disk drive.

Probable causes of failure:

- Hardware failure in the external disk drive

Disc Read Or Write Error

This message indicates an internal disk drive communication failure.

Probable causes of failure:

- Bad media disk
- HP 85101C A7 I/O board
- HP 85101C internal disk drive

Disc Media Wearing Out - Replace Soon

This indicates that further use of the disk may cause loss of data. The external drive counts the number of disk revolutions and records that number on the disk. When a certain number of revolutions has occurred, the disk drive causes this caution error message to appear. The message is not prompted by a measure of a disk's magnetic properties, and is meant only to advise the user of a potential disk media failure.

Most probable cause of failure:

- Disk media in an external disk drive is old

Failure - Check System Bus Configuration

This message refers to a failure of the HP 8360-series source. This is an indication of incorrect power level flatness (correction only). Refer to the source service manual for complete troubleshooting information.

Failure - Fault Indicator On

This message refers to a failure of the HP 8360-series source. Refer to the source service manual for complete troubleshooting information.

Failure - Overmodulation

This message refers to a failure of the HP 8360-series source. It appears when the RF output of the source is being overmodulated. Refer to the source service manual for complete troubleshooting information.

Failure - RF Unlocked

This message refers to a failure of the HP 8360-series source. Refer to the source service manual for complete troubleshooting information.

Failure - Self Test Failure

This message refers to a failure of the HP 8360-series source. It indicates a failure of the source CPU, CPU power supply, or a phaselock unlocked condition. Refer to the source service manual for complete troubleshooting information.

IF Cal Failed

The HP 85102 A6 clock board provides a 100 kHz calibration signal to IF amplifiers A10 and A12. The HP 85101C CPU uses this signal to calibrate the HP 85102 IF amplifiers. If the calibration error exceeds a certain limit, the CPU displays this message on the CRT.

Probable cause of failure:

- HP 85102 100 kHz cal signal from A6 clock
- HP 85102 A10 or A12 IF amplifier
- HP 85102 A5 or A7 synchronous detector
- HP 85102 A17 sample/hold
- 4 MHz from the HP 85102 A6 clock assembly to the A7 and A5 sync detector assemblies.

Troubleshooting:

- Run HP 85102 service program tests in the Run All mode.
- Run HP 85102 service program tests 4 (A17), 5 (A10/A12), and 6 (A5/A7).
- Both the test and reference channels may appear faulty, even though only one channel may have a problem. Swap the A5 and A7 boards, and also the A10 and A12 boards as they are the same. This way, you can try to determine if one or both of these matched boards are faulty.
- If the service program found no fault with any assembly, refer to section 4.7, "Other Failures" and run the 20 Hz Sine Wave Test.

Further troubleshooting:

When the IF Cal Failed running error message is displayed, the HP 85102 A17 or A5/A7 boards may be faulty. Also, the A6, A5/A7, and A10/A12 could be faulty because they are also part of the IF section. The following tests will help you determine which of these board assemblies is faulty.

If there are spikes on the trace greater than 20 dB at bandcross points (2.4 GHz, 13.5 GHz, and 20.0 GHz), suspect a failure of the A17 board.

Press **INSTRUMENT STATE** [RECALL] ***[MORE] [FACTORY PRESET]*** and look for the spikes explained above. If the error message appears and/or spikes appear at those points, follow the steps below:

1. Run the HP 85102 service program tests in the Run All mode.
2. If the Sync Detector test fails, the following message will appear on the CRT:

```
                    Failed
             ***SYNC DETECTOR TEST ***
Sample and hold line has no output. Check sample and hold (A17).
      Check output amplifier on sync detector board (A7).
```

If this message appears as is or if it indicates the A5 board instead of A7, continue with the steps below. If another test failed with another message, refer to the information in section 4.8, "Service Program" for that test. If no tests fail, do not continue with this test.

3. Run the HP 85102 Service Program test 4, cal DAC test (A17) and the CRT should display: *Passed*. If it does not indicate *Passed*, you should suspect the A17 cal DAC assembly and not the A5 or A7 boards.

4. To determine which board is defective (sync detector A5 and A7 or Cal Dac A17), reverse the inputs to A17 as follows:

   - Swap cables J1 and J3
   - Swap cables J2 and J4

   This exchange of cables means that the A5 or A7 board inputs to A17 are exchanged. Remember that the A5 and A7 boards are electrically and mechanically the same.

5. Run HP 85102 service program test 6, Synchronous Detector Test (A5, A7). If the CRT prompt indicates the same sync detector board (A5 or A7) that was in the first failure message, it means that the A17 board is defective. If the CRT prompt indicates that the other snyc detector board is the problem, it means that the first sync detector is defective.

IF Overload (or O)

The O is displayed on the left side of the CRT.

Both error messages indicate that the HP 85102 IF amplifier (A10 or A12) is overloaded. The CPU detects the overload condition from a status bit on the A10 or A12 IF boards. The **O** on the left side of the CRT is usually an intermittent failure that can disappear during a measurement sweep.

Do not be overly concerned with this type of error. O can appear if you are measuring a device with a sharp change in response (typically greater than 24 dB). This is normal and happens because the HP 85102 A10/A12 IF amp autoranging cannot respond fast enough to a step in RF power greater than 24 dB at adjacent data points. It is sometimes possible to eliminate the **O** by doing one of the following:

- Slow down the sweep time
- Change ramp sweep to step sweep mode
- Change the number of points
- Change the frequency span

Probable cause of failure:

- Operator error. The HP 8510C may be operated in manual mode with the source power too high (samplers are receiving excessive RF power).
- There is no 20 dB pad on the thru cable for an R/T test set (HP 8512).
- IF gain is too high. Access the IF gain test and control by pressing **AUXILIARY MENUS** [SYSTEM] ***[MORE] [SERVICE FUNCTIONS] [IF GAIN]***.

Troubleshooting:

- Run HP 85102 service program tests in the Run All mode.

Initialization Failed

This message occurs when a disk will not initialize in the HP 85101C disk drive.

Most probable failure:

- HP 85101C disk drive
- disk media

No IF Found

This error is detected by the level detector and the HP 85102 A21 IF counter board. This is done using an algorithm in the HP 85101C math CPU to calculate the IF frequency. The A21 counter and the CPU check if the IF is within range and has enough power. If not, the CPU initiates a search mode that attempts to relocate the test set VTO harmonic to re-establish the 20 MHz IF. This message is displayed if the IF is not found, or is not within range.

Probable cause of failure:

- RF source signal may be absent, low in power, or at an incorrect frequency
- HP 85102 A21 IF counter board
- Test set samplers. Be sure that the test set A3 summing amplifier assembly has not biased the samplers off. Measure the voltage on the *sampler control* pin to each sampler to verify TTL levels. 0 volts turns the sampler ON and approximately 3 volts or greater turns it OFF. You can press the S-parameter front panel keys to toggle the samplers.
- Defective cable in the IF signal path
- Test set component failure: A weak VTO, bad power amplifier, step recovery diode, or 4-way power splitter in the VTO
- HP 85101C A5 math CPU
- HP 85102 stop sweep cable not connected
- Occasionally, the HP 85102 A20 sweep ADC can cause this error, accompanied by a Source Sweep Sync error message.

Troubleshooting:

- Check the RF source to test set cable
- Run the HP 85102 service program in the Run All mode
- Run HP 85101C service program test 1 (CPU A5), and the HP 85102 tests 2 (A20) and A (A21)
- Perform the unratioed power test in section 4.3, "Unratioed Power Failures," to see if the samplers are working
- Check the Test Set-IF interconnect cable.

If the test set is an HP 8514A or 8515A, compare the S11 and S22 traces. If one looks bad and the other looks good, the HP 85102 and HP 85101C are probably working. Therefore, suspect a problem with the test set or the IF-test set interconnect cable. If both S11 and S22 look bad, first suspect a problem with the HP 85102 or the source.

NOTE: This check does not work for HP 8512A and 8513A test sets. However, you can compare the a1 and b1 channels for unratioed power levels. Refer to section 4.3, "Unratioed Power Failures."

Optional Function Not Installed

This message is prompted by attempting to use an option that has not been installed in the HP 8510C.

Most probable failure:

- Attempted use of an option that has not been installed (time domain or pulse, for example)

Phase Lock Failure

Because pretune is accomplished and the IF is detected by the time you see this message, it usually means that the A22 pretune, samplers, A14 VTO, and A21 IF counter are functioning. When a phase lock failure occurs only after a successful pretune, and the main phase lock is switched in, and is detected by the 20 MHz IF counter and HP 85101C math CPU.

Probable cause of failure:

- HP 85102 A23 main phase lock assembly

- HP 85102 20 MHz reference signal from A6 clock assembly
- HP 85102 A21 IF counter assembly
- LPRTHLD line to test set A3 summing amplifier (from HP 85102 A22)
- Weak or noisy VTO in the test set. If you have an intermittent error message, see if the error message appears as you gently torque the VTO heat sink. If it does, the VTO assembly has a problem. Also, check the screws around the frequency converter (samplers) and VTO to be sure they are tight.

Troubleshooting:

- Run HP 85102 service program tests in the Run All mode
- Run HP 85102 service program tests 8 (A22), 9 (A23), and A (A21)
- Check the A6 clock board (20 MHz signal). Refer to section 4.7, "Other Failures."

Phase Lock Lost

This error message indicates that the HP 8510C was phase locked but lost lock. Loss of phase lock is detected by the HP 85102 A21 20 MHz IF counter and the HP 85101C A5 CPU after pretune. Also, this error message is often intermittent. Be sure to press the [ENTRY OFF] and **MEASUREMENT** [RESTART] keys to verify that this is a repeatable message.

If this error message occurs when the HP 8430/41 source is in the RAMP mode, but not in the STEP mode, the problem is most likely the source or the HP 85102 A20 sweep ADC assembly. If so, be sure to check the A20 board with the service program diagnostics.

Probable cause of failure:

- Power holes or frequency error in the source
- HP 85102 A21 IF counter
- HP 85102 A22 pretune phase lock assembly
- HP 85102 A23 main phase lock
- Test set A3 VTO summing amplifier assembly
- Faulty or intermittent VTO assembly with <15 dB power loss

Troubleshooting:

- Run HP 85102 service program tests in the Run All mode.
- Run HP 85102 service program tests 8 (A22), 9 (A23), and A (A21).
- Check the unratioed power level of test set signal path a1
- Check all rear panel connections.

Pretune Failure
Pretune Lost Failure

The lock detector on the HP 85102 A22 pretune control assembly indicates that the pretune cycle has not occurred. The pretune cycle changes the VTO output to a frequency where one of its harmonics mixes with the RF to produce the 20 MHz IF.

The power from the VTO sense line must drop about 15 dB (to 18 dBm) before a VTO failure message occurs. This condition could cause the VTO frequency to be noisy and low in power.

Probable cause of failure:

- Test set power turned off
- Overheated or bad test set VTO
- HP 85102 A23 main phase lock board
- IF detector/test set interconnect cable
- HP 85102 A22 pretune assembly
- Test set A3 VTO summing amplifier
- LPRTHLD line to test set A3 summing amplifier (from HP 85102 A22 pretune assembly)

Troubleshooting:

- Run HP 85102 service program tests in the Run All mode
- Run HP 85102 service program tests 8 (A22) and 9 (A23)
- Check test set line power and fuses
- Check Test Set-IF interconnect cable
- Refer to section 4.3, "Unratioed Power Failures," to check operation of the test set

Pulse Cal Failure On Test/Reference Channel(s) Or Both Channels

This error message reports a failure detected in the pulsed-RF circuitry.

Probable cause of failure:

- HP 85102 A6 clock board (for both channels only)
- HP 85102 A2 multiplexer board
- HP 85102 A3 and A4 test and reference channel detector boards
- HP 85102 A16 sample and hold board

Source HP-IB Syntax Error

The source does not respond to a known good HP-IB command.

Probable cause of failure:

- Source HP-IB assembly
- HP 85101C A7 I/O assembly (HP-IB portion)
- HP-IB cable between the source and HP 85101C

Troubleshooting:

- Run HP 85101C service program test 2 (A7 I/O tests)

Source Sweep Sync Error

The HP 8510C is not synchronized with the source. Specifically, the HP 85102 A20 sweep ADC is not properly tracking the 0 to 10 volt ramp from the source.

Probable cause of failure:

- HP 85102 A20 sweep ADC
- Stop sweep or sweep output cables not connected
- Defective source

Troubleshooting:

- Run HP 85102 service program tests in the Run All mode
- Run HP 85102 service program test 2 (A20)
- Check all cabling. Refer to chapter 9, "Installation," particularly noting the stop sweep and sweep in/out connections
- Refer to section 4.3, "Unratioed Power Failures," to check source operation.
- Use the trim sweep procedure in the Operating and Programming Manual to adjust the sweep ADC gain DAC

Sweep Time Too Fast

Too many sweep triggers or too rapid sweep triggers were sent from the HP 85102 A20 sweep ADC assembly. The HP 85102 A19 ADC control assembly sends a status bit indicating it did not have time to complete an A to D conversion before receiving the next sweep trigger.

Probable cause of error:

- HP 85102 A19 ADC control assembly
- HP 85102 A20 sweep ADC assembly
- Source sweep speed set too fast, especially in local operation

Troubleshooting:

- Run HP 85102 service program tests in the Run All mode
- Run HP 85102 service program tests 1 (A19) and 2 (A20)
- If the service program found no fault with any assembly, refer to section 4.7, "Other Failures," and run the 20 Hz Sine Wave Test.
- Refer to section 4.3, "Unrationed Power Failures," to check source operation

System Bus Address Error

This message is displayed if the address of any HP 8510C system instrument is wrong or not recognized by the HP 85101C CPU.

Probable cause of failure:

- The source (19), test set (20), or plotter is at the wrong HP-IB address, or their line power is off
- HP-IB cable is not connected
- HP-IB cable or connector is faulty
- HP 85101C A7 I/O assembly (HP-IB portion)
- Test set A4 HP-IB assembly

Troubleshooting:

- Run the HP 85101C service program test 2 (A7)
- Run the service program HP-IB test for the test set A4 board
- Check the cabling and the addresses on all instruments
- Check the HP 8510C addresses. Press **AUXILIARY MENUS** [SYSTEM] ***[HP-IB ADDRESSES]***

System Bus SRQ Error

The HP 8510C system bus SRQ line is stuck and is not responding.

Probable cause of failure:

- Test set A4 HP-IB assembly
- Source HP-IB assembly
- HP 85101C A7 I/O assembly
- HP-IB circuitry of any peripheral on the bus
- Bad HP-IB cable or connector

Troubleshooting:

- Run HP 85101C service program test 2 (A7)
- Run the service program test for the test set A4 HP-IB board
- Check all HP-IB cables and all addresses

Test Set HP-IB Syntax Error

The test set does not respond to a known good HP-IB command.

Probable cause of failure:

- Test set A4 HP-IB assembly
- HP 85101C A7 I/O assembly (HP-IB portion)
- HP-IB cable between the test set and the HP 85101C

Troubleshooting:

- Run HP 85101C service program test 2 (A7)
- Run the service program test for the test set A4 HP-IB board
- Check all cables

Unable To Lock To Ext 10 MHz Ref

The 10 MHz external input to the HP 85102 A6 clock assembly is more than +500 Hz off frequency. The level should be >0 dBm. If the external input is off frequency or is less than 0 dBm, the A6 assembly sets the LIFSRQ low, alerting the CPU to the unlocked condition.

This message is not applicable unless you are locking to an external source such as in an HP 8510C millimeter-wave system.

If this error message occurs when the external 10 MHz input is **not** used, the probable causes of failure are:

- A6 clock assembly erroneously sets LIFSRQ low
- The A6 clock LIFSRQ signal is pulled low along the way to the HP 85101C A5 CPU
- +5V input to the HP 85102 A6 clock is intermittent

Troubleshooting:

- Run HP 85102 service program tests in the Run All mode
- Check the 10 MHz input signal frequency and amplitude that you are applying to the rear panel of the HP 85102

VTO Over-Range

The VTO swept beyond its normal range. It is detected by the A3 VTO "end of range" detector on the test set A3 VTO summing amplifier.

If this error occurs **only** when the HP 8430/41 source is in ramp mode, the problem is probably either the source or the HP 85102 A20 sweep ADC assembly.

Probable cause of error:

- Test set VTO
- Test set A3 VTO summing amplifier
- HP 85102 A23 main phase lock
- HP 85102 A20 sweep ADC
- Source is off frequency
- VTUNE line to test set A3 summing amplifier (from HP 85102 A23 main phase lock assembly)
- HP 85102 0-10V swept input BNC cable is not connected

Troubleshooting:

- Run the HP 85102 service program tests in the Run All mode
- Run HP 85102 service program tests 2 (A20) and 9 (A23)
- Check the source, especially the 0 to 10 volt ramp linearity
- Check the test set VTO and A3 summing amp boards. Refer to section 4.3, "Unratioed Power Failures."

4.3. Unratioed Power Failures

INTRODUCTION

This section checks test set RF functionality to isolate the problem to either the test set or the rest of the system. If the test set is at fault, this section helps to further isolate the faulty assembly within the test set.

The following test sets are covered in this section:

- HP 8514B
- HP 8514B Option 002/003
- HP 8515A
- HP 8516A
- HP 8516A Option 002/003
- HP 8517B Option 002, 004, and 007

The procedure in this section is divided into two parts.

First, the service adapter is connected to the HP 85102 IF/Detector to simulate basic operation of the test set. If the HP 85102 is operating correctly, then the test set is re-connected and the IF responses of the six RF signal paths are checked to verify test set operation. Knowing which test set assemblies are common to the RF signal paths of known IF signal responses is a powerful troubleshooting tool.

Second, you will check the output power levels of each test set sampler/mixer assembly and its associated IF amplifier alone. This is done by comparing the power levels and shape of the frequency response trace with traces supplied in this section. As each of the six RF signal paths are checked, you will record the results in a table. The most probable cause of failure is listed according to which RF signal path or paths are incorrect.

DEFINITION OF TERMS

The following terms are explained in greater detail in the "Operating and Programming Manual" included with the HP 8510C documentation.

User 1, 2, 3, and 4

These are user-defined parameters and allow measurement of unratioed power at the first frequency converter inputs for each of the reference and test signal paths. Therefore, the displayed frequency response of a user parameter is the combined test set sampler IF output response of 1) the source RF signal and 2) the test set VTO local oscillator signal.

The paths are initially defined as follows, and will be redefined during this procedure:

User 1 a1
User 2 b2
User 3 a2
User 4 b1

RF Signal Paths

There are only four user parameters. However, in this procedure you will redefine parameters to display the IF frequency responses from six possible RF signal paths in the test set.

Table 2–1 shows the relationship between the RF signal path, path definition, and redefined user parameter as used in this procedure.

Table 2–1. RF Signal Paths and User Parameters

RF Path	Redefined User Parameter	Path Description
1	User 1	a1
2	User 3	a2
3	User 4	b1 - Reflection
4	User 2	b2 - Reflection
5	User 4	b1 - Thru
6	User 2	b2 - Thru

Ratioed And Unratioed Responses

A normal power level display for the HP 8510C is a ratio of two frequency responses; in the case of S11, the ratio is b1/a1. The network analyzer automatically supplies power to and provides phase lock for one or more predefined ports to perform the selected measurement.

Ratioed measurements provide useful data but they can mask certain problems. For example, when measuring an S-parameter at a specific power level a faulty RF input connector on the test set creates a 20 dB power hole. In this case, the power hole might be invisible because the S-parameter measurement ratios out the frequency response error.

This is why troubleshooting system problems in a ratioed measurement mode can be deceptive. The solution is to look at the IF signal responses of the six RF paths singly in order to check them in an unratioed mode.

TROUBLESHOOTING WITH THE SERVICE ADAPTER

The service adapter substitutes for a test set, by connecting the 20 MHz IF signal from the HP 85102 back into the amplifier of the HP 85102. This is done to determine if a fault is in the test set or the HP 85102. This procedure does not check phase lock circuitry.

NOTE: Ignore any phase lock error messages that may appear during this procedure.

1. Disconnect the test set from J1 Test Set Interconnect on the HP 85102. Connect the service adapter as shown in Figure 2-1. The service adapter is not supplied with each HP 8510C; refer to chapter 5, "Replaceable Parts," to order this servicing tool.

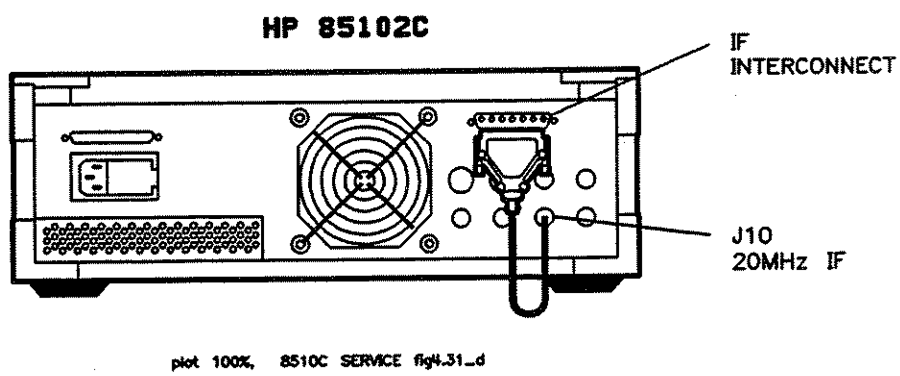


Figure 2-1. Service Adapter Connections

2. Press the following keys: **INSTRUMENT STATE** [RECALL] ***[MORE] [FACTORY PRESET]*** [MARKER] **STIMULUS** [MENU] ***[STEP]*** **PARAMETER** [MENU].

3. Examine each user parameter (IF response) by pressing the corresponding softkey to observe the unratioed power level of User 1 through User 4. The traces should be flat lines, quite close to each other, as indicated by the marker value (typically about —28 dB ±5 dB).

Service Adapter Conclusions

If One or More Signal Paths Are Incorrect. The problem is most likely with the HP 85102. Stop this procedure and return to chapter 4, "Main Troubleshooting Procedure," for further troubleshooting of the HP 85102.

If All Signal Paths are Correct. The HP 85102 is working properly. The problem is most likely with the source or the test set. Perform the following procedure to verify operation of the test set.

TEST SET UNRATIOED POWER TROUBLESHOOTING

Use this procedure with the following test sets:

- HP 8514B
- HP 8514B Option 002/003
- HP 8515A
- HP 8516A
- HP 8516A Option 002/003
- HP 8517B, Option 002, 004, 007

Option 002 deletes the programmable step attenuators and the dc bias tees. Option 003 "reverses" the port 2 coupler to provide high forward dynamic range.

Figure 2-2 shows a simplified diagram of RF signal paths tested in the unratioed power level tests.

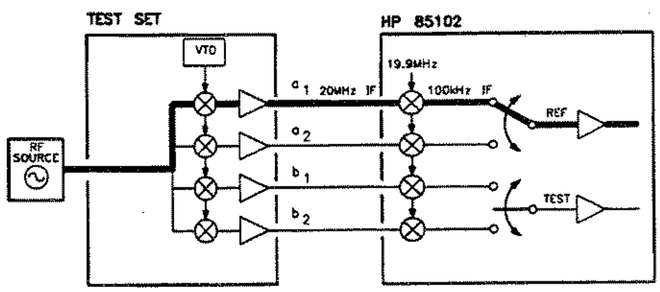


Figure 2-2. Simplified Signal Path of Unratioed Power Test

Troubleshooting Foldouts

The following foldout diagrams correspond to different test sets: one each for the HP 8514B, 8515A, 8516A, and 8517B, and options 002/003 where appropriate. Each foldout shows all the signal paths and corresponding typical traces, as well as the troubleshooting procedure. Locate the foldout that corresponds with your test set and follow the troubleshooting procedure.

ɘck RF Paths 1, 2, 3, and 4

ɘse paths are:

Path 1 = User 1 = a1
Path 2 = User 3 = a2
Path 3 = User 4 = b1 Reflected
Path 4 = User 2 = b2 Reflected

Do a factory preset of the analyzer and put the source into step mode. On the network analyzer press **INSTRUMENT STATE** RECALL ***[MORE] [FACTORY PRESET]*** **STIMULUS** MENU ***[STEP]***.

To examine the four sampler IF signals it is necessary to redefine what port and sampler the analyzer uses for phaselock.

Press **PARAMETER** MENU ***[User 3 a2] [REDEFINE PARAMETER] [DRIVE] [Port 2] [PHASE LOCK] [a2] [REDEFINE DONE]*** to redefine a2.

Press ***[User 2 b2] [REDEFINE PARAMETER] [DRIVE] [Port 2] [PHASE LOCK] [a2] [REDEFINE DONE]*** to redefine b2.

Connect an open (or short) to port 1 and port 2. This reflects power back to the b1 and b2 samplers through the coupler.

Find the test set RF paths and example frequency response traces on this foldout. Press ***[User 1 a1] [User 2 b2] [User 3 a2]*** and ***[User 4 b1]***. Each trace should be similar to the example traces on this foldout (typically within ±5 dB).

Record the results for paths 1 through 4 (User 1 through User 4) in Table 4.3-3.

ɘck RF Paths 5 and 6

ɘse paths are:

Path 5 = User 4 = b1 Thru
Path 6 = User 2 = b2 Thru

Connect a cable between port 1 and port 2.

Press **PARAMETER** MENU ***[User 4 b1] [REDEFINE PARAMETER] [DRIVE] [Port 2] [PHASE LOCK] [a2] [REDEFINE DONE]*** to observe the b1 power level trace through path 5, illustrated on this foldout. The trace should be similar to the example trace (typically within ±5 dB). Record the result for path 5 (good or bad) under the RF path diagram..

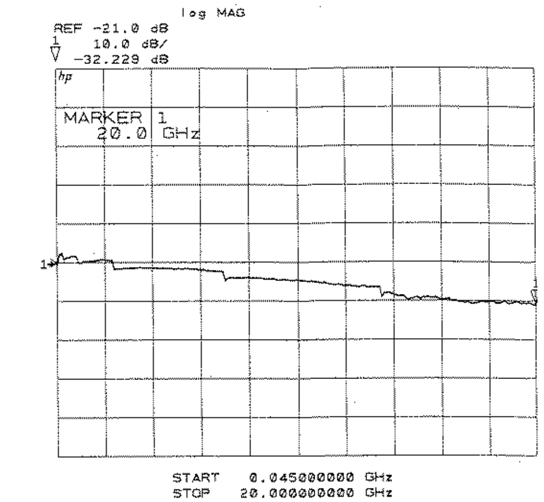
Press **PARAMETER** MENU ***[User 2 b2] [REDEFINE PARAMETER] [DRIVE] [Port 1] [PHASE LOCK] [a1] [REDEFINE DONE]*** to observe the b2 power level trace through path 6, illustrated on this foldout. The trace should be similar to the example trace (typically within ±5 dB). Record the result for path 6 (good or bad) under the RF path diagram.

Try to match the observed results recorded under the RF path diagrams with the results listed in the table of most probable failures, below. Out of 32 possible variations, the table lists the variations that result from 12 of the most *probable* failures.

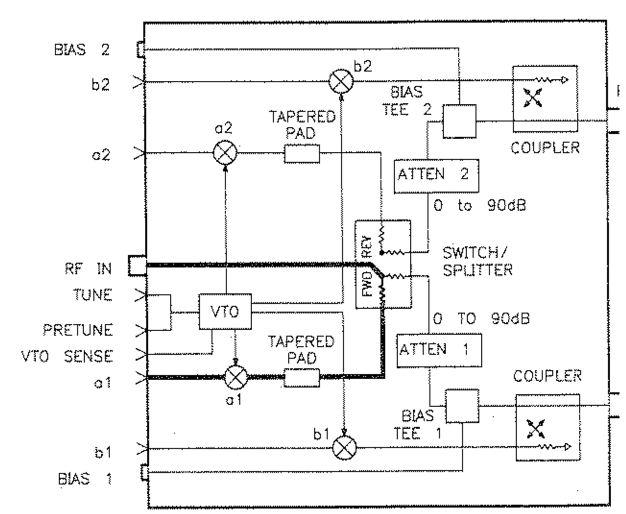
- If the observed results match a group of results in the table, investigate the most probable cause given in the table.
- If all the paths are good, then the test set is probably working properly. Return to the "Main Troubleshooting Procedure" to continue troubleshooting the system.
- If the observed results do not match any of those given in the table, re-evaluate and possibly re-measure your observed data. If the data is valid, troubleshoot using the RF path diagram(s) given in this foldout for the "bad" signal traces.

Path						Most Probable Failure
1 a1	2 a2	3 b1 refl.	4 b2 refl.	5 b1 thru	6 b2 thru	
-	-	-	-	-	-	Test set is not the problem
B	B	B	B	B	B	Source, source cable, VTO, cables from rear panel to switch splitter
-	B	-	B	B	-	Switch splitter
B	-	B	-	-	B	Switch splitter
-	-	B	-	B	-	b_1 sampler
B	-	-	-	-	-	a_1 sampler
-	B	-	-	-	-	a_2 sampler
-	-	-	B	-	B	b_2 sampler
-	-	B	-	B	B	Port 1 connector or directional coupler
-	-	B	-	-	B	Attenuator 1, bias tee 1
-	-	-	B	B	-	Attenuator 2, bias tee 2
-	-	-	B	B	B	Port 2 connector or directional coupler

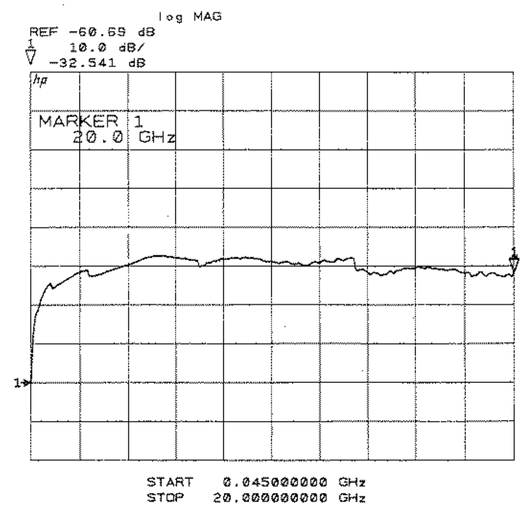
B = Bad
- = Good



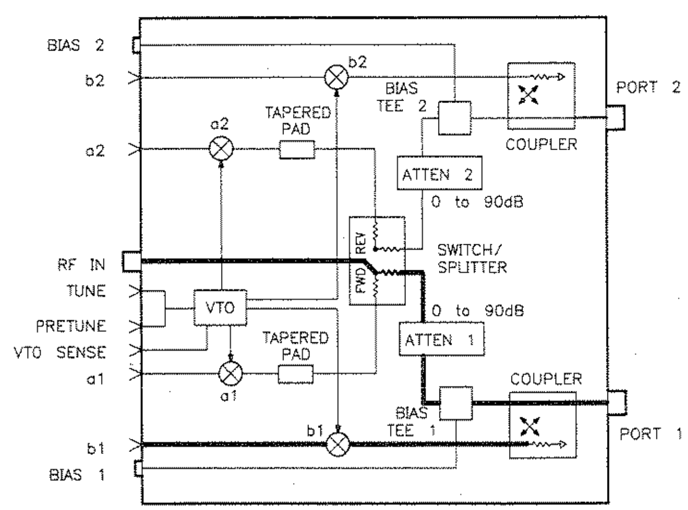
PATH 1 – a1



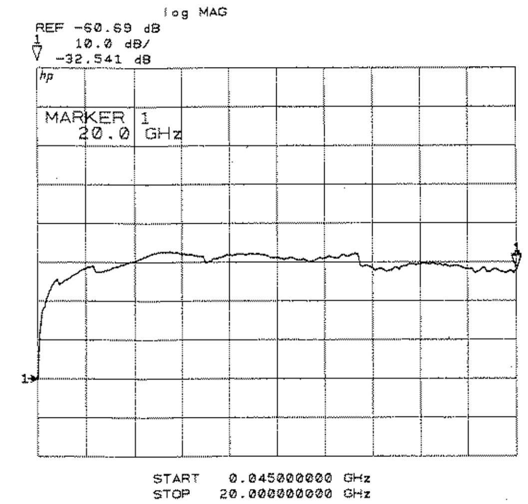
Good/Bad ______________



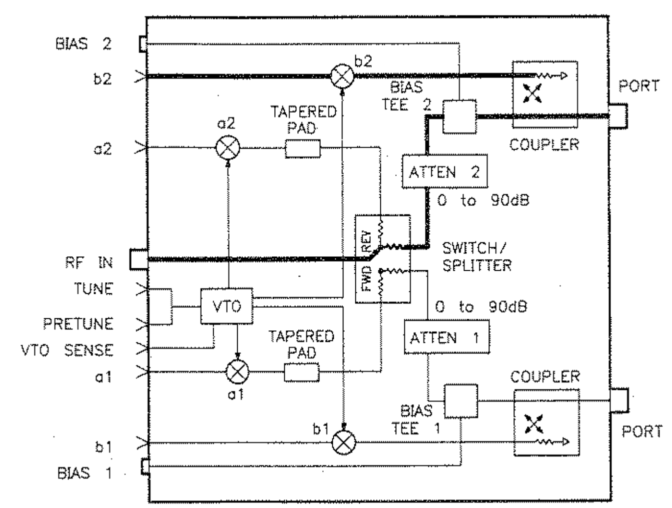
PATH 3 – b1 Reflected



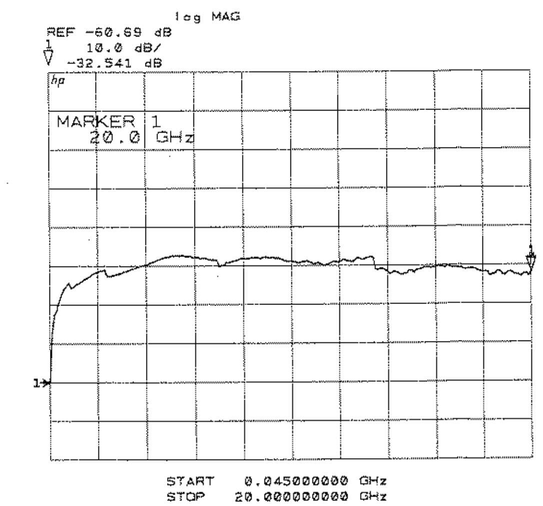
Good/Bad ____________



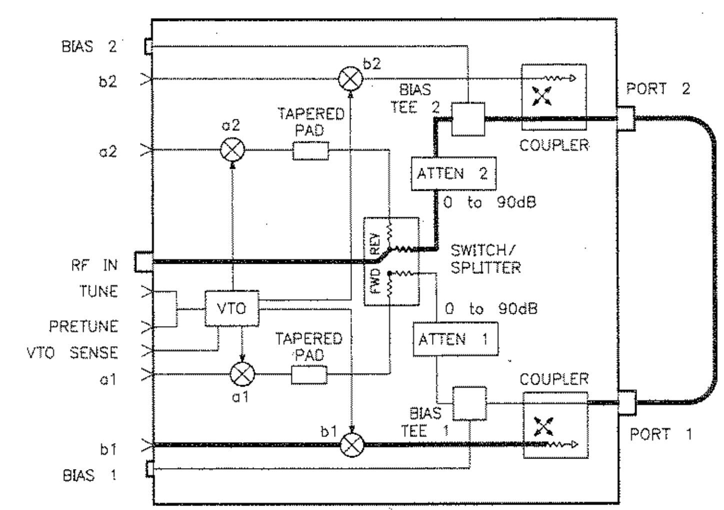
PATH 4 – b2 Reflected



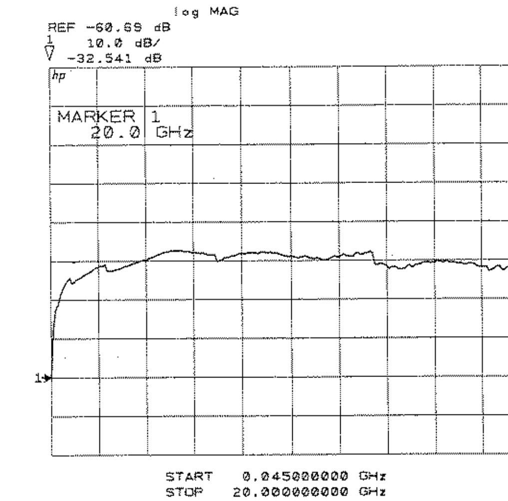
Good/Bad ____________



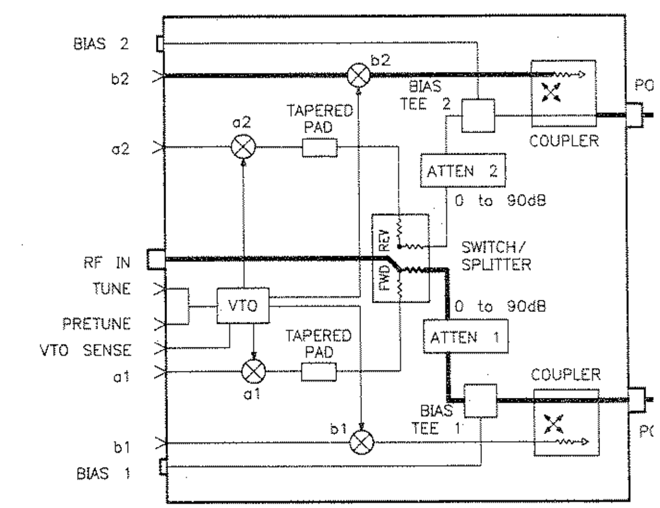
PATH 5 – b1 Thru



Good/Bad ____________



PATH 6 – b2 Thru



Good/Bad ____________

Figure 4.3–3. HP 8514B RF Flow Diagrams and Typical

Unratioed Power Failures

HP 8514B (STANDARD)

ɔource into step mode. On the network analyz-
ꓤE] [FACTORY PRESET] STIMULUS [MENU]

ɔessary to redefine what port and sampler the

ꓤEDEFINE PARAMETER] [DRIVE] [Port 2]
ɔdefine a2.
[DRIVE] [Port 2] [PHASE LOCK] [a2] [REDE-

2. This reflects power back to the b1 and b2

ɹency response traces on this foldout. Press
er 4 b1]. Each trace should be similar to the
±5 dB.

1 through User 4) in Table 4.3-3.

ꓤEDEFINE PARAMETER] [DRIVE] [Port 2]
serve the b1 power level trace through path 5,
ɜ similar to the example trace (typically within
ɔad) under the RF path diagram..

ꓤEDEFINE PARAMETER] [DRIVE] [Port 1]
serve the b2 power level trace through path 6,
ɜ similar to the example trace (typically within
ɔad) under the RF path diagram.

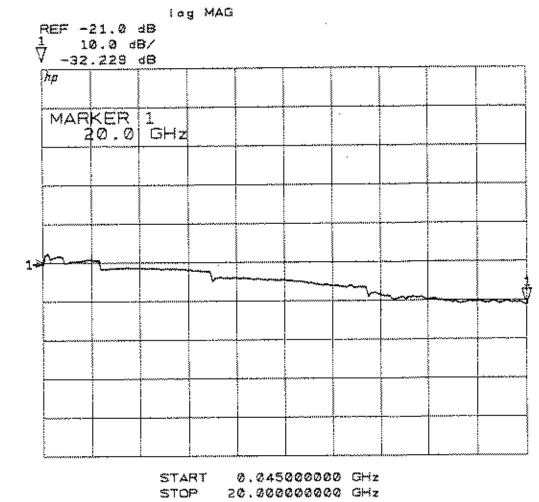
Find the Faulty Assembly

Try to match the observed results recorded under the RF path diagrams with the results listed in the table of most probable failures, below. Out of 32 possible variations, the table lists the variations that result from 12 of the most *probable* failures.

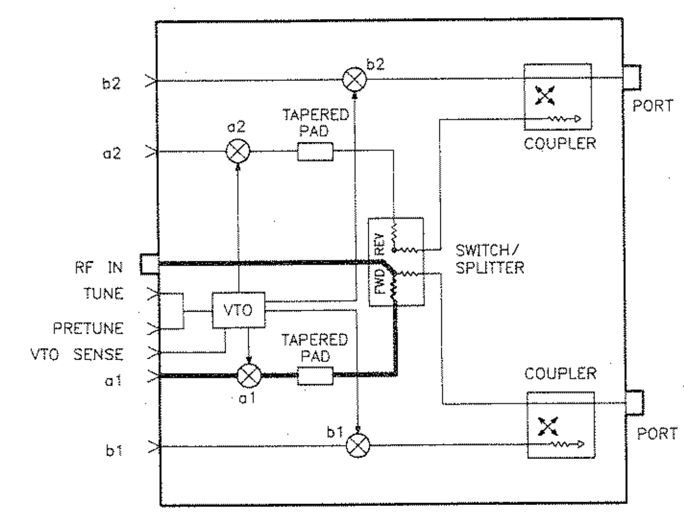
- If the observed results match a group of results in the table, investigate the most probable cause given in the table.
- If all the paths are good, then the test set is probably working properly. Return to the "Main Troubleshooting Procedure" to continue troubleshooting the system.
- If the observed results do not match any of those given in the table, re-evaluate and possibly re-measure your observed data. If the data is valid, troubleshoot using the RF path diagram(s) given in this foldout for the "bad" signal traces.

Path						Most Probable Failure
1 a1	2 a2	3 b1 refl.	4 b2 refl.	5 b1 thru	6 b2 thru	
-	-	-	-	-	-	Test set is not the problem
B	B	B	B	B	B	Source, source cable, VTO, cables from rear panel to switch splitter
-	B	-	B	B	-	Switch splitter
B	-	B	-	-	B	Switch splitter
-	-	B	-	B	-	b_1 sampler
B	-	-	-	-	-	a_1 sampler
-	B	-	-	-	-	a_2 sampler
-	-	-	B	-	B	b_2 sampler
-	-	B	-	B	B	Port 1 connector or directional coupler
-	-	-	B	B	B	Port 2 connector or directional coupler

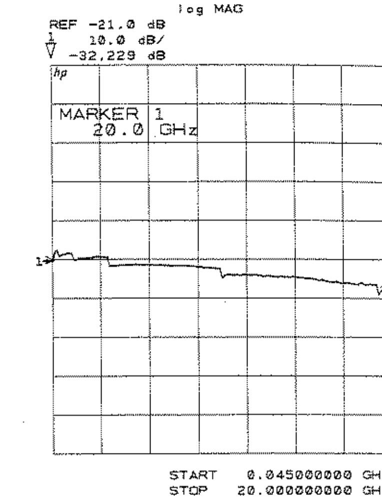
B = Bad
- = Good



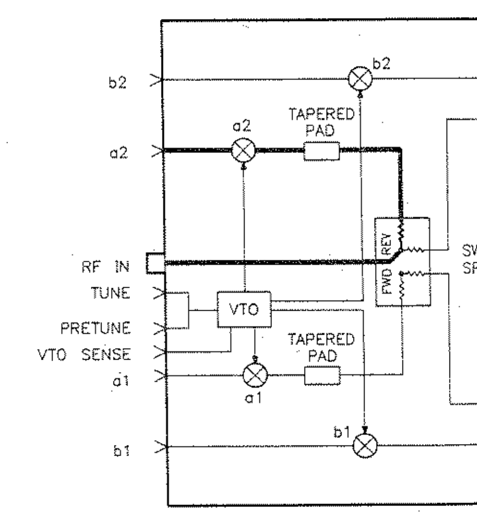
PATH 1 — a1



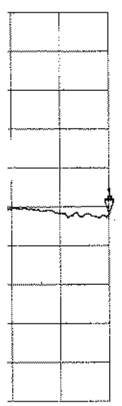
Good/Bad ____________



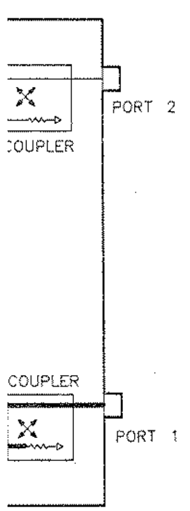
PATH 2 — a2



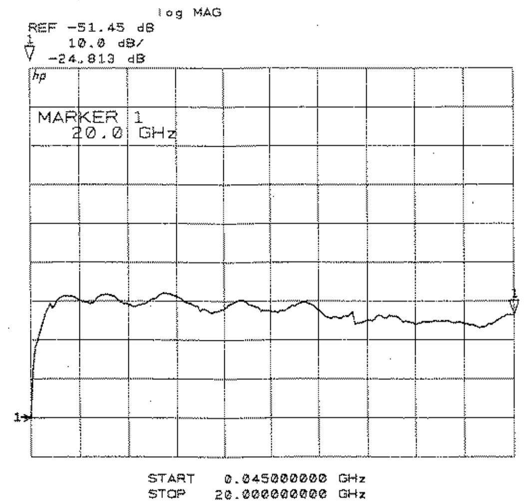
Good/Bad ____________



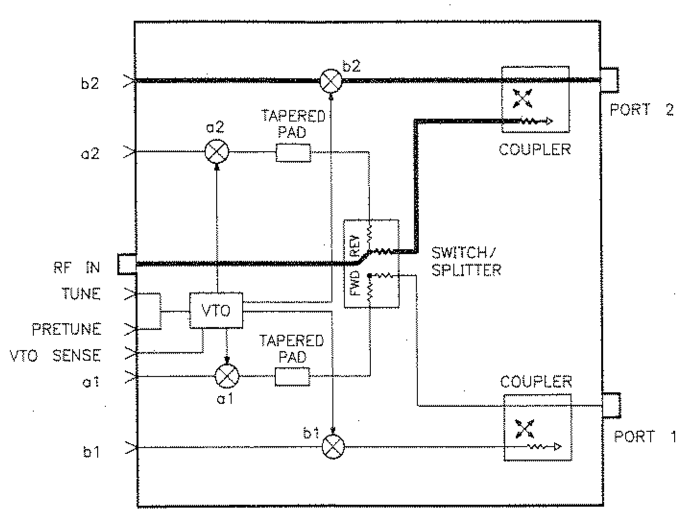
:ted



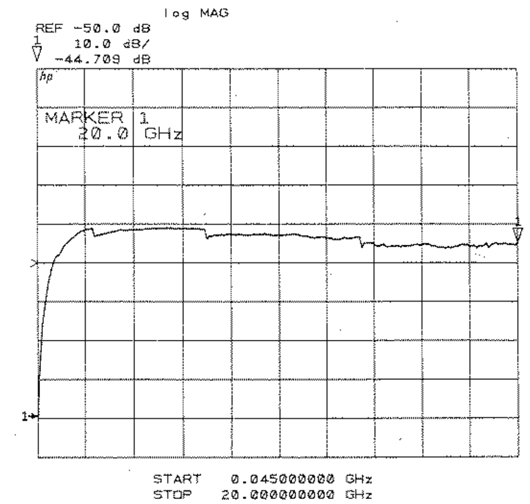
_



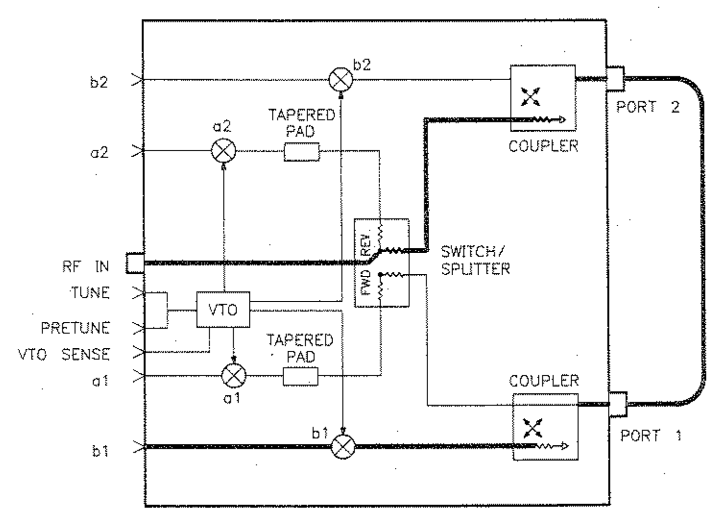
PATH 4 – b2 Reflected



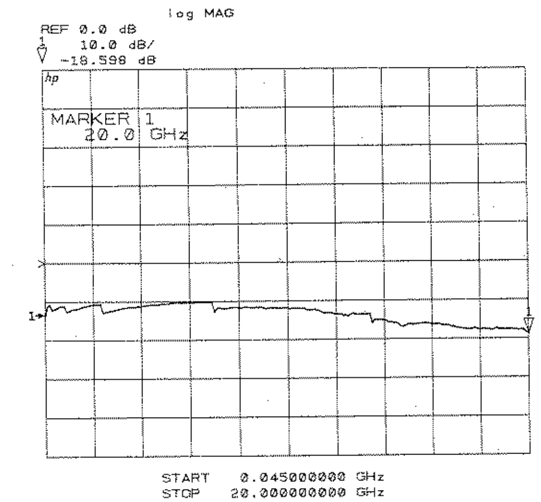
Good/Bad ______________



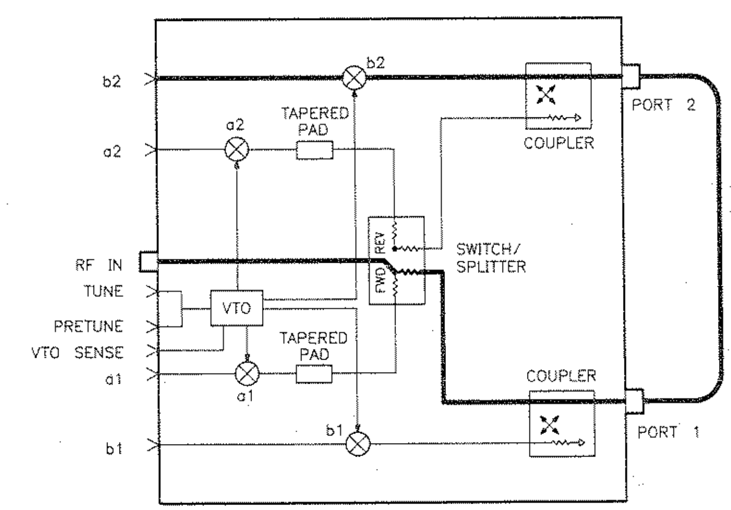
PATH 5 – b1 Thru



Good/Bad ______________



PATH 6 – b2 Thru



Good/Bad ______________

Figure 4.3–4. HP 8514B Option 002/003 RF Flow Diagrams and Typical Traces

mode. On the network analyz-
PRESET] **STIMULUS** MENU

ine what port and sampler the

?AMETER] [DRIVE] [Port 2]

] [PHASE LOCK] [a2] [REDE-

power back to the b1 and b2

› traces on this foldout. Press
trace should be similar to the

›r 4) in Table 4.3-3.

RAMETER] [DRIVE] [Port 2]
›wer level trace through path 5,
example trace (typically within
RF path diagram..

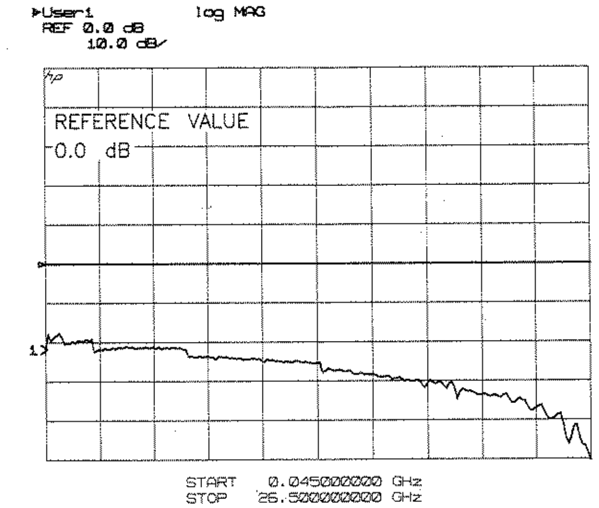
RAMETER] [DRIVE] [Port 1]
›wer level trace through path 6,
example trace (typically within
RF path diagram.

Try to match the observed results recorded under the RF path diagrams with the results listed in the table of most probable failures, below. Out of 32 possible variations, the table lists the variations that result from 12 of the most *probable* failures.

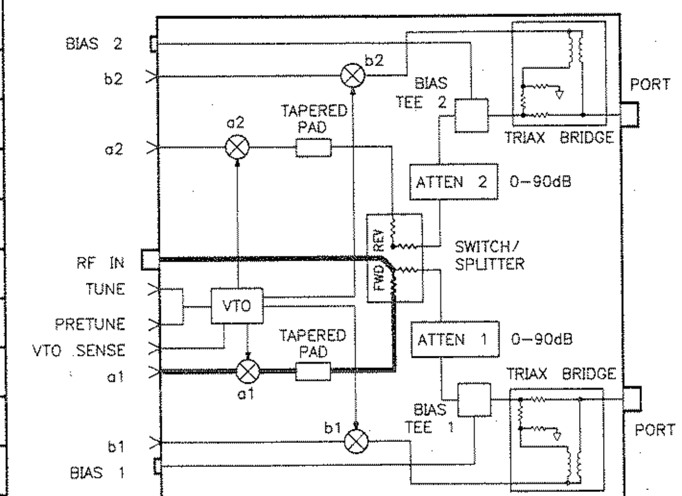
- If the observed results match a group of results in the table, investigate the most probable cause given in the table.
- If all the paths are good, then the test set is probably working properly. Return to the "Main Troubleshooting Procedure" to continue troubleshooting the system.
- If the observed results do not match any of those given in the table, re-evaluate and possibly re-measure your observed data. If the data is valid, troubleshoot using the RF path diagram(s) given in this foldout for the "bad" signal traces.

Path						Most Probable Failure
1 a1	2 a2	3 b1 refl.	4 b2 refl.	5 b1 thru	6 b2 thru	
-	-	-	-	-	-	Test set is not the problem
B	B	B	B	B	B	Source, source cable, VTO, cables from rear panel to switch splitter
-	B	-	B	B	-	Switch splitter
B	-	B	-	-	B	Switch splitter
-	-	B	-	B	-	b_1 sampler
B	-	-	-	-	-	a_1 sampler
-	B	-	-	-	-	a_2 sampler
-	-	-	B	-	B	b_2 sampler
--	-	B	-	B	B	Port 1 connector or triax bridge
-	-	B	-	-	B	Attenuator 1, bias tee 1
-	-	-	B	B	-	Attenuator 2, bias tee 2
-	-	-	B	B	B	Port 2 connector or triax bridge

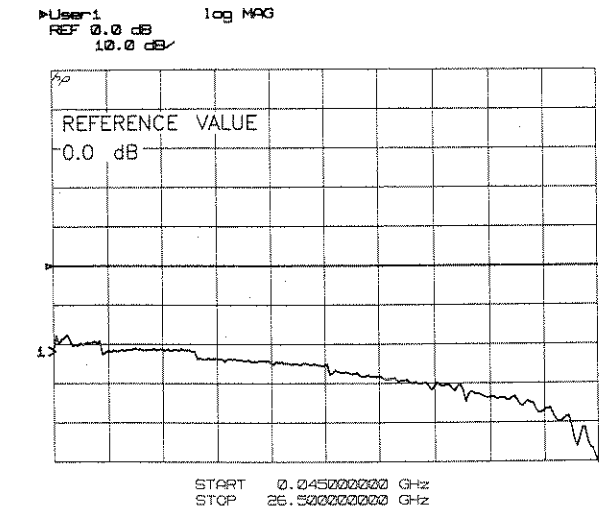
B = Bad
- = Good



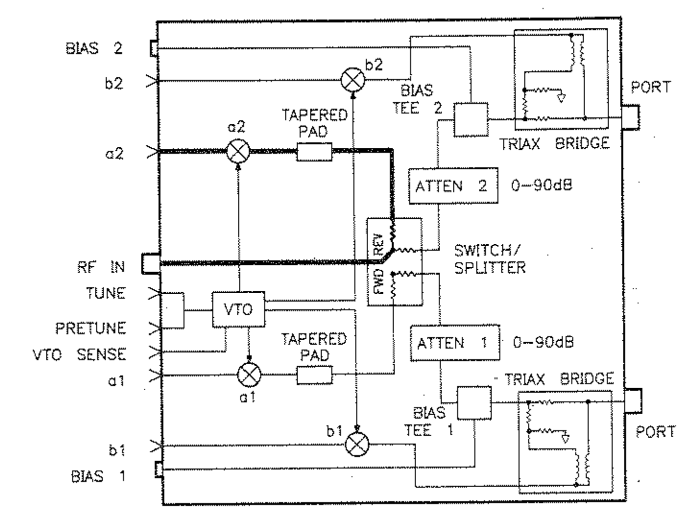
PATH 1 — a1



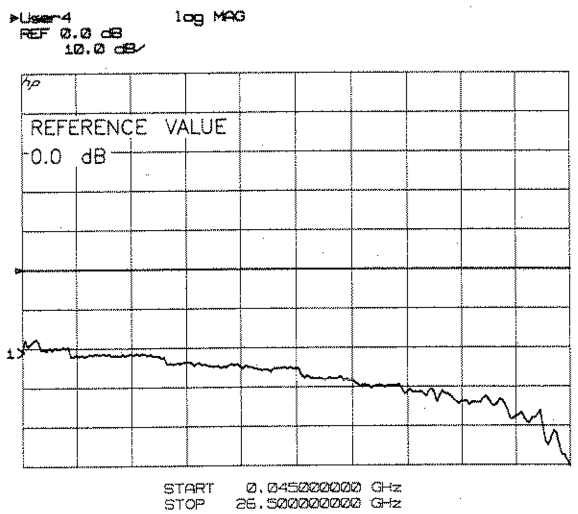
Good/Bad ________



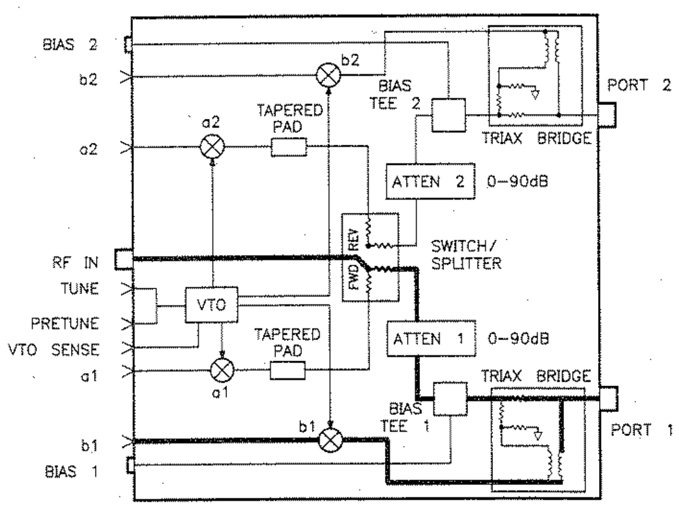
PATH 2 — a2



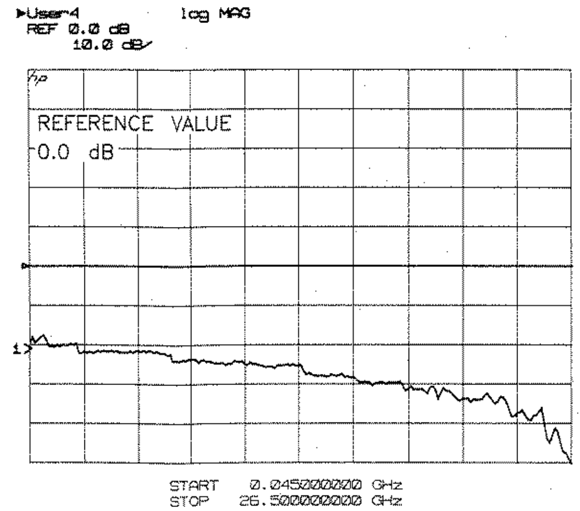
Good/Bad ________



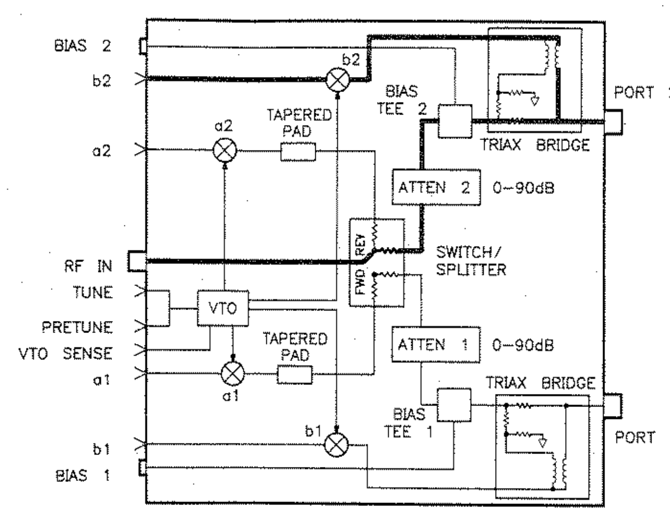
PATH 3 – b1 Reflected



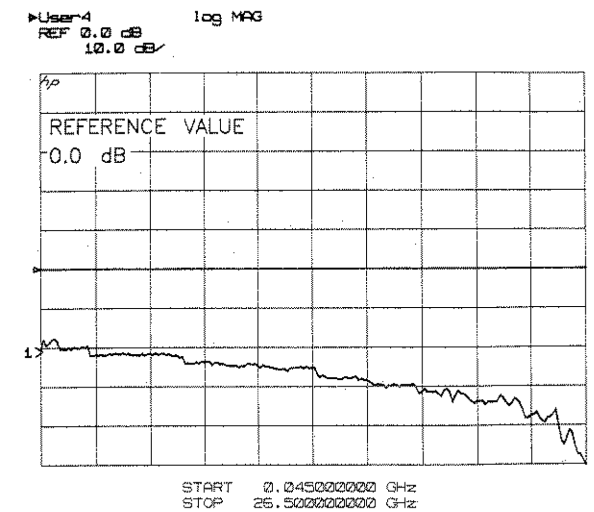
Good/Bad ______________



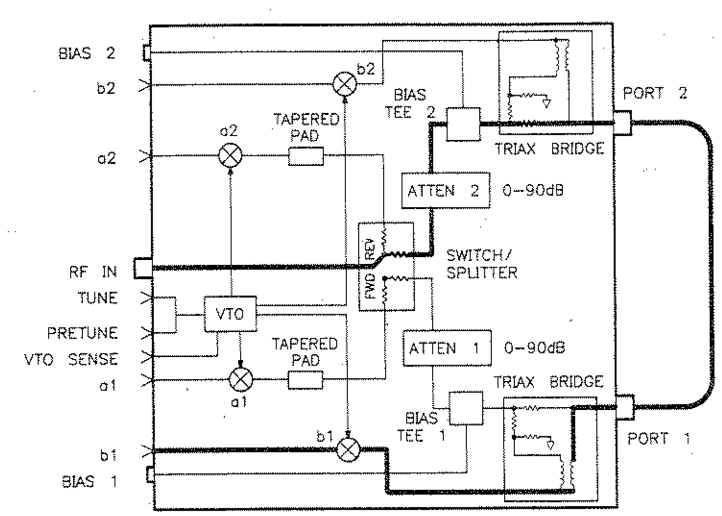
PATH 4 – b2 Reflected



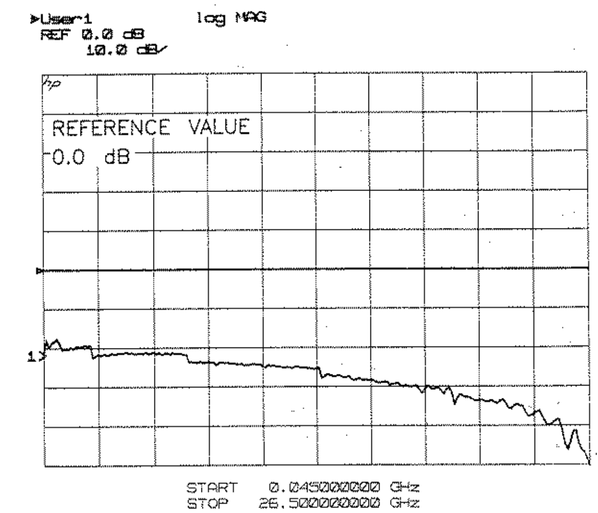
Good/Bad ______________



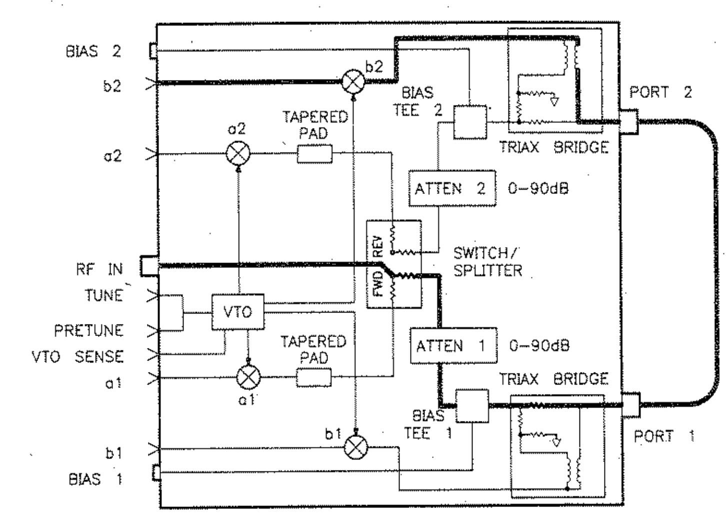
PATH 5 – b1 Thru



Good/Bad ______________



PATH 6 – b2 Thru



Good/Bad ______________

Figure 4.3–5. HP 8515A RF Flow Diagrams and Typical Traces

e source into step mode. On the network analyz-
ORE] [FACTORY PRESET] STIMULUS [MENU]

iecessary to redefine what port and sampler the

[REDEFINE PARAMETER] [DRIVE] [Port 2]
redefine a2.

] [DRIVE] [Port 2] [PHASE LOCK] [a2] [REDE-

rt 2. This reflects power back to the b1 and b2

quency response traces on this foldout. Press
Jser 4 b1]. Each trace should be similar to the
iin ±5 dB.

ser 1 through User 4) in Table 4.3-3.

[REDEFINE PARAMETER] [DRIVE] [Port 2]
observe the b1 power level trace through path 5,
be similar to the example trace (typically within
or bad) under the RF path diagram..

[REDEFINE PARAMETER] [DRIVE] [Port 1]
observe the b2 power level trace through path 6,
be similar to the example trace (typically within
or bad) under the RF path diagram.

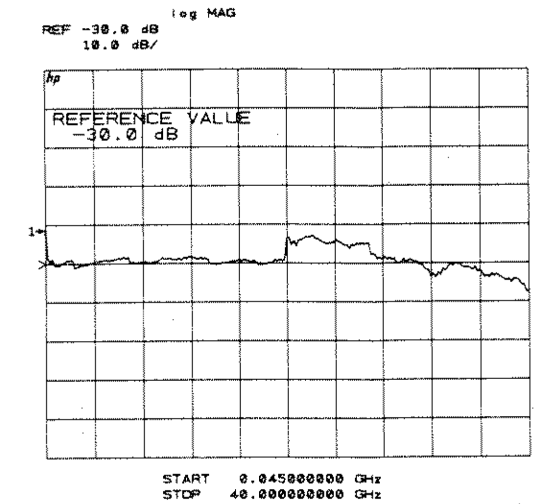
Find the Faulty Assembly

Try to match the observed results recorded under the RF path diagrams with the results listed in the table of most probable failures, below. Out of 32 possible variations, the table lists the variations that result from 12 of the most *probable* failures.

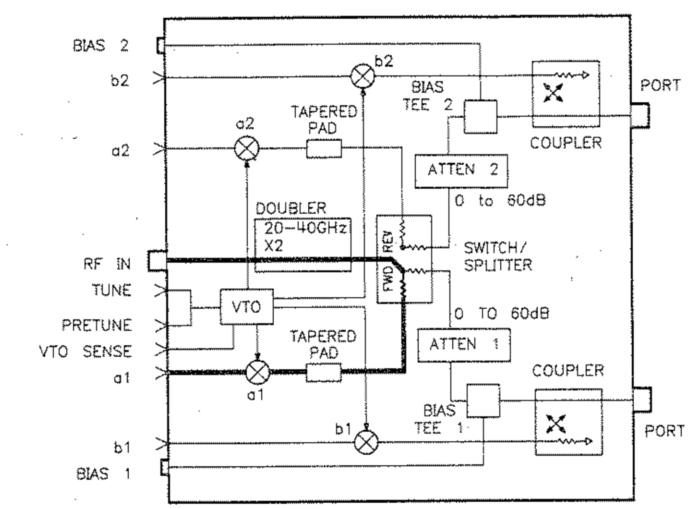
- If the observed results match a group of results in the table, investigate the most probable cause given in the table.
- If all the paths are good, then the test set is probably working properly. Return to the "Main Troubleshooting Procedure" to continue troubleshooting the system.
- If the observed results do not match any of those given in the table, re-evaluate and possibly re-measure your observed data. If the data is valid, troubleshoot using the RF path diagram(s) given in this foldout for the "bad" signal traces.

Path						Most Probable Failure
1 a1	2 a2	3 b1 refl.	4 b2 refl.	5 b1 thru	6 b2 thru	
-	-	-	-	-	-	Test set is not the problem
B	B	B	B	B	B	Source, source cable, VTO, doubler, cables from rear panel to switch splitter
-	B	-	B	B	-	Switch splitter
B	-	B	-	-	B	Switch splitter
-	-	B	-	B	-	b_1 sampler
B	-	-	-	-	-	a_1 sampler
-	B	-	-	-	-	a_2 sampler
-	-	-	B	-	B	b_2 sampler
-	-	B	-	B	B	Port 1 connector or directional coupler
-	-	B	-	-	B	Attenuator 1, bias tee 1
-	-	-	B	B	-	Attenuator 2, bias tee 2
-	-	-	B	B	B	Port 2 connector or directional coupler

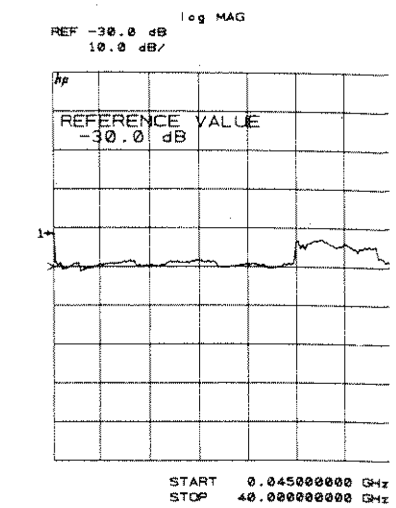
B = Bad
- = Good



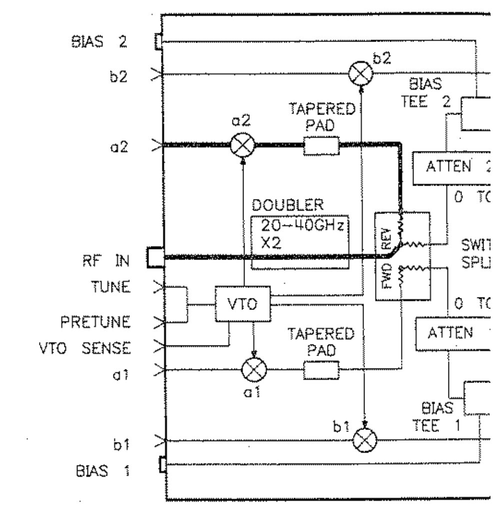
PATH 1 – a1



Good/Bad ________

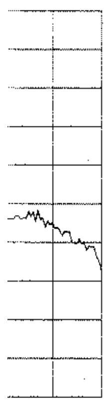


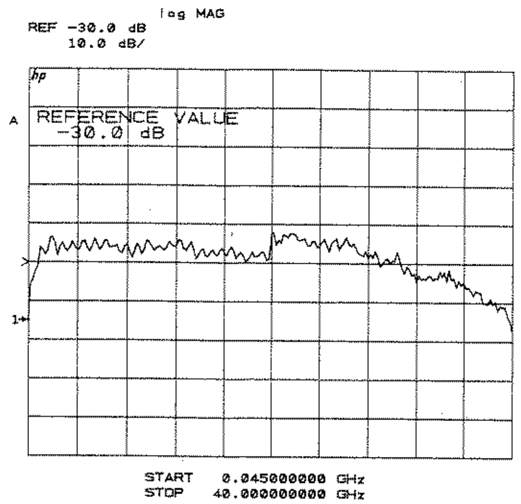
PATH 2 – a2

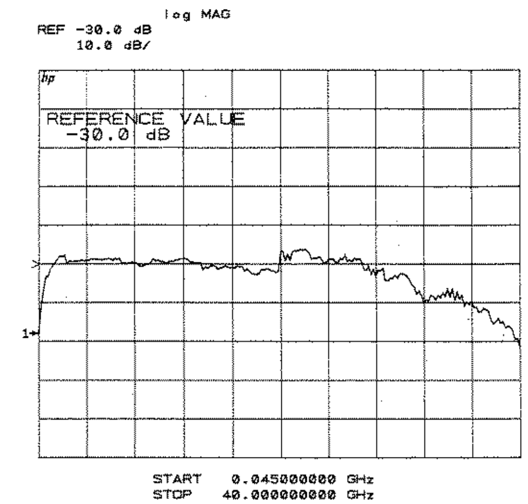


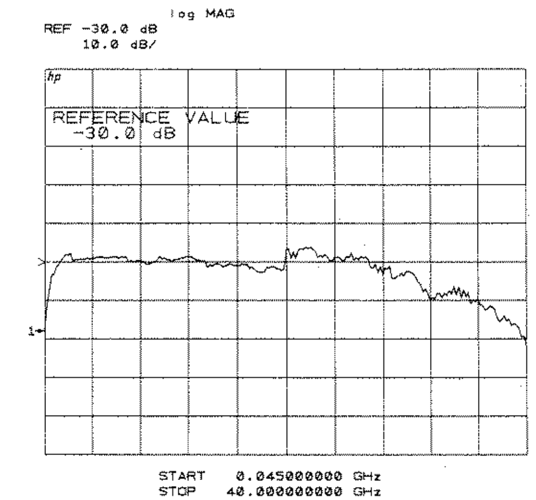
Good/Bad ________

Find the Faulty Assembly







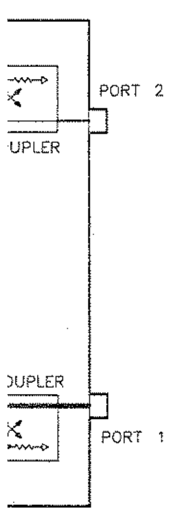


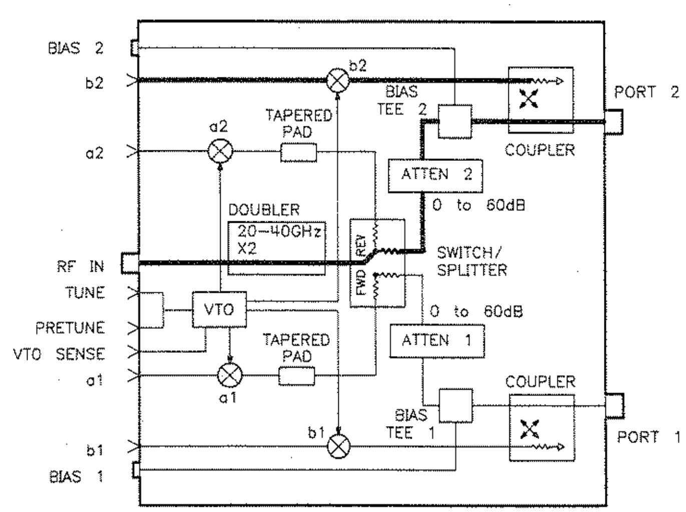
:d

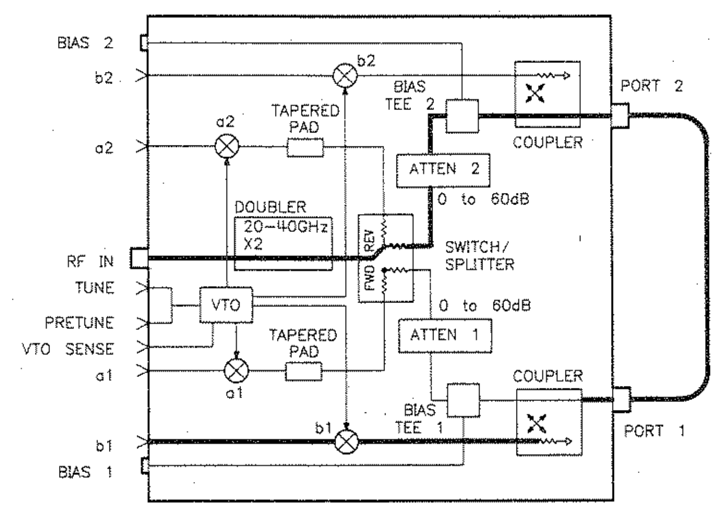
PATH 4 – b2 Reflected

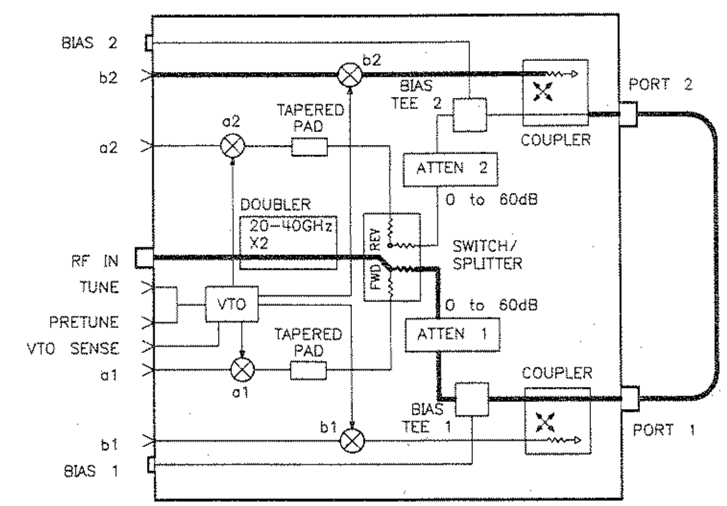
PATH 5 – b1 Thru

PATH 6 – b2 Thru









Good/Bad ____________

Good/Bad ____________

Good/Bad ____________

Figure 4.3–6. HP 8516A RF Flow Diagrams and Typical Traces

Unratioed Power Failures

node. On the network analyz-
PRESET] STIMULUS MENU

ne what port and sampler the

AMETER] [DRIVE] [Port 2]

[PHASE LOCK] [a2] [REDE-

power back to the b1 and b2

traces on this foldout. Press
race should be similar to the

4) in Table 4.3-3.

AMETER] [DRIVE] [Port 2]
ver level trace through path 5,
xample trace (typically within
IF path diagram..

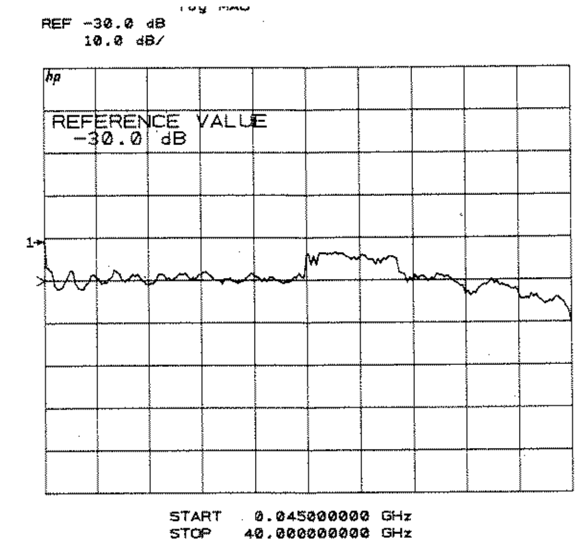
AMETER] [DRIVE] [Port 1]
ver level trace through path 6,
xample trace (typically within
IF path diagram.

Try to match the observed results recorded under the RF path diagrams with the results listed in the table of most probable failures, below. Out of 32 possible variations, the table lists the variations that result from 12 of the most *probable* failures.

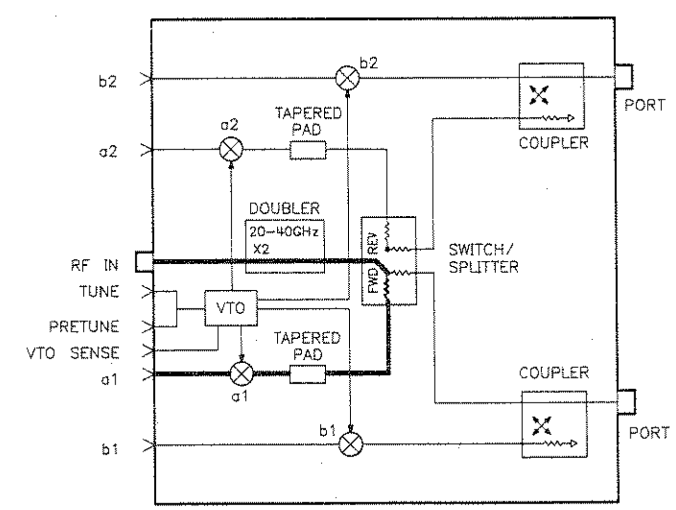
- If the observed results match a group of results in the table, investigate the most probable cause given in the table.
- If all the paths are good, then the test set is probably working properly. Return to the "Main Troubleshooting Procedure" to continue troubleshooting the system.
- If the observed results do not match any of those given in the table, re-evaluate and possibly re-measure your observed data. If the data is valid, troubleshoot using the RF path diagram(s) given in this foldout for the "bad" signal traces.

Path						Most Probable Failure
1 a1	2 a2	3 b1 refl.	4 b2 refl.	5 b1 thru	6 b2 thru	
-	-	-	-	-	-	Test set is not the problem
B	B	B	B	B	B	Source, source cable, VTO, doubler, cables from rear panel to switch splitter
-	B	-	B	B	-	Switch splitter
B	-	B	-	-	B	Switch splitter
-	-	B	-	B	-	b_1 sampler
B	-	-	-	-	-	a_1 sampler
-	B	-	-	-	-	a_2 sampler
-	-	-	B	-	B	b_2 sampler
-	-	B	-	B	B	Port 1 connector or directional coupler
-	-	-	B	B	B	Port 2 connector or directional coupler

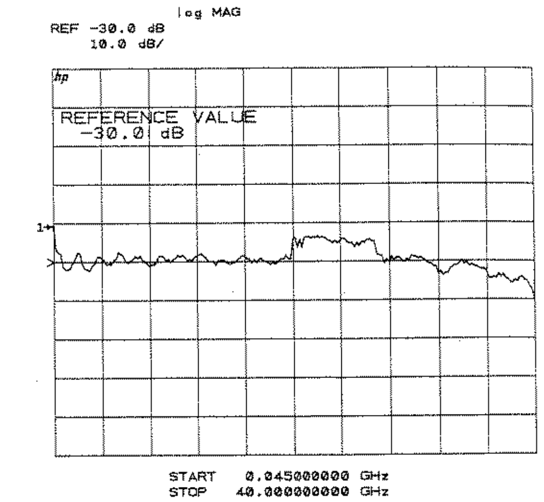
B = Bad
- = Good



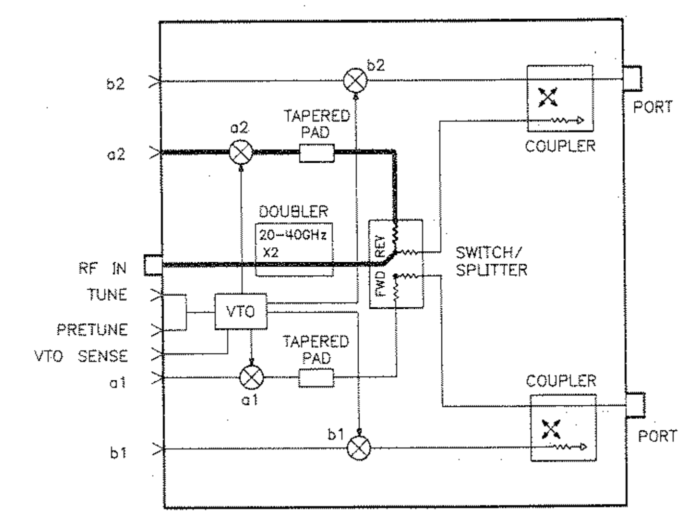
PATH 1 — a1



Good/Bad ________

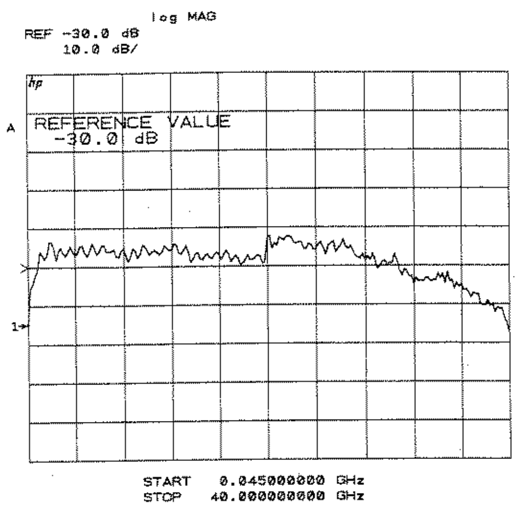


PATH 2 — a2

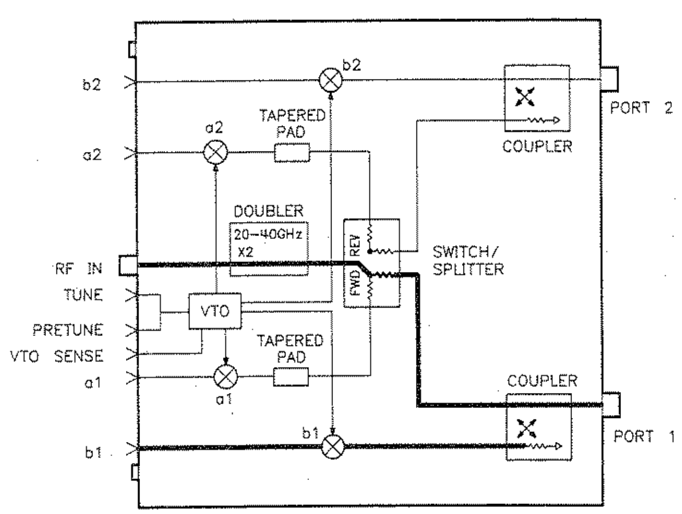


Good/Bad ________

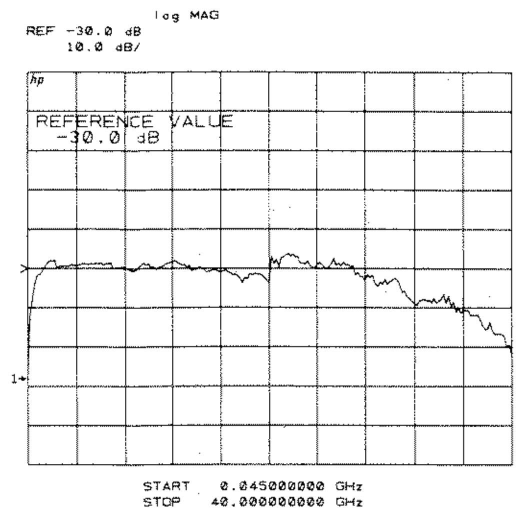
Find the Faulty Assembly



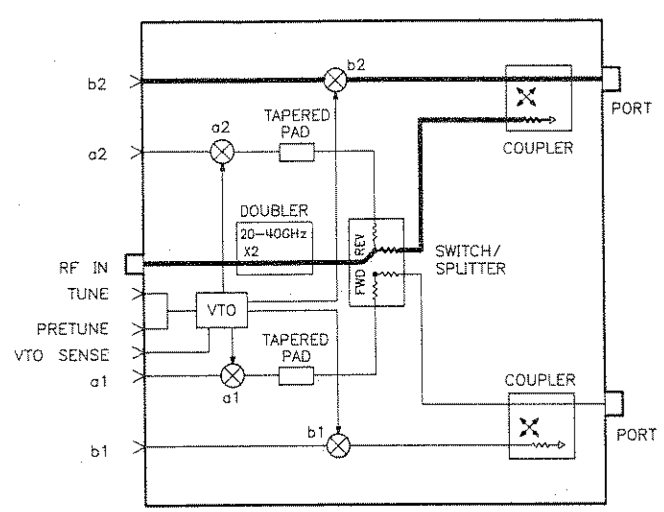
PATH 3 – b1 Reflected



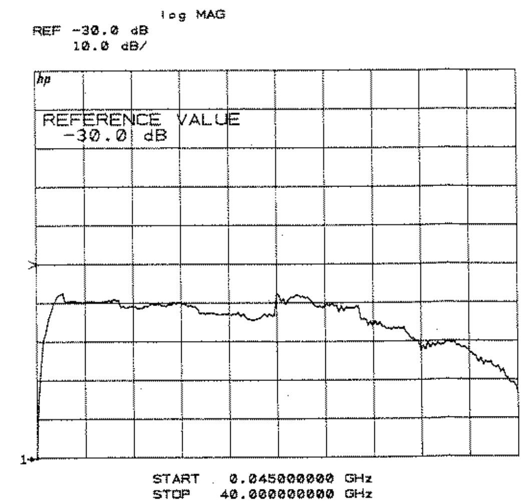
Good/Bad ________



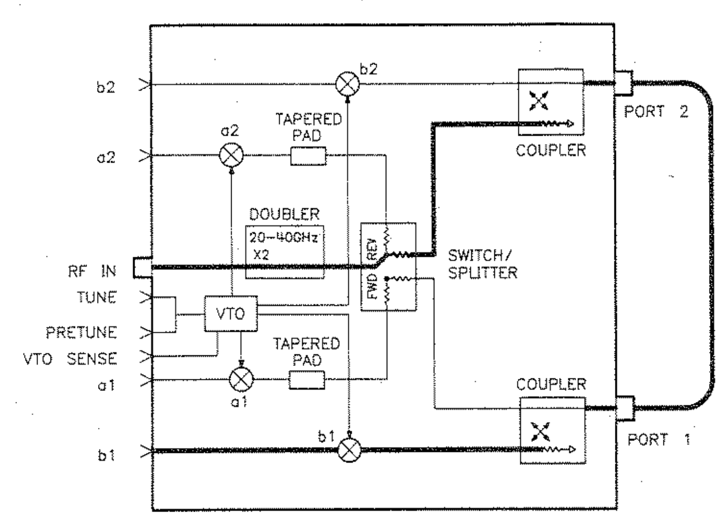
PATH 4 – b2 Reflected



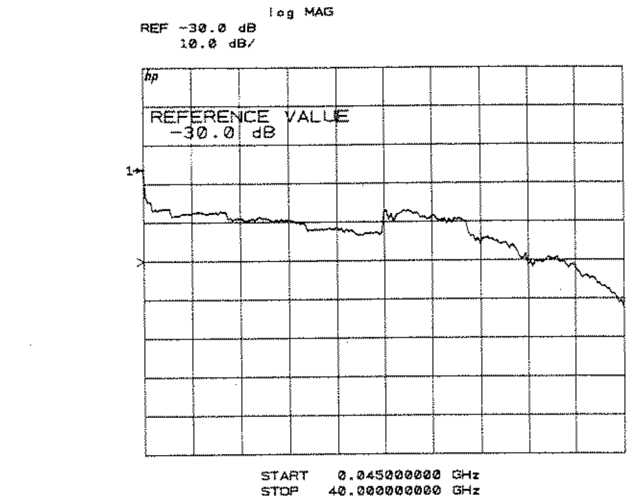
Good/Bad ________



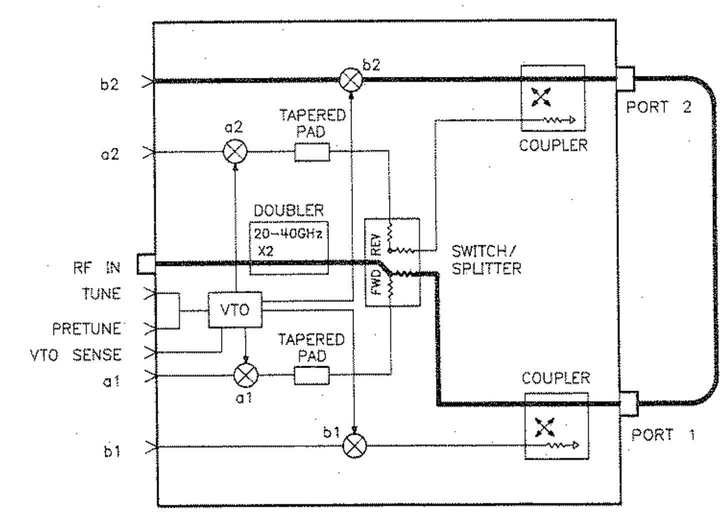
PATH 5 – b1 Thru



Good/Bad ________



PATH 6 – b2 Thru



Good/Bad ________

Figure 4.3–7. HP 8516A Option 002/003 RF Flow Diagrams and Typical Traces

the source into step mode. On the network analyz-
MORE] [FACTORY PRESET] STIMULUS [MENU]

; necessary to redefine what port and sampler the

2] *[REDEFINE PARAMETER] [DRIVE] [Port 2]*
to redefine a2.

ER] [DRIVE] [Port 2] [PHASE LOCK] [a2] [REDE-*

port 2. This reflects power back to the b1 and b2

frequency response traces on this foldout. Press *[User 4 b1]*. Each trace should be similar to the
ithin ±5 dB.

User 1 through User 4) in Table 4.3-3.

2.

1] *[REDEFINE PARAMETER] [DRIVE] [Port 2]*
o observe the b1 power level trace through path 5,
d be similar to the example trace (typically within
d or bad) under the RF path diagram..

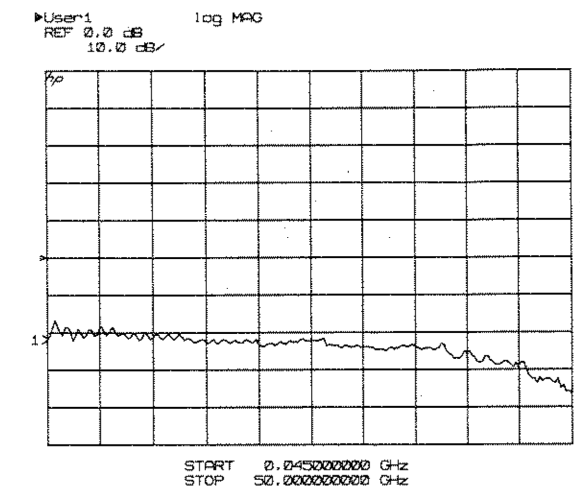
2] *[REDEFINE PARAMETER] [DRIVE] [Port 1]*
o observe the b2 power level trace through path 6,
d be similar to the example trace (typically within
d or bad) under the RF path diagram.

Try to match the observed results recorded under the RF path diagrams with the results listed in the table of most probable failures, below. Out of 32 possible variations, the table lists the variations that result from 12 of the most *probable* failures.

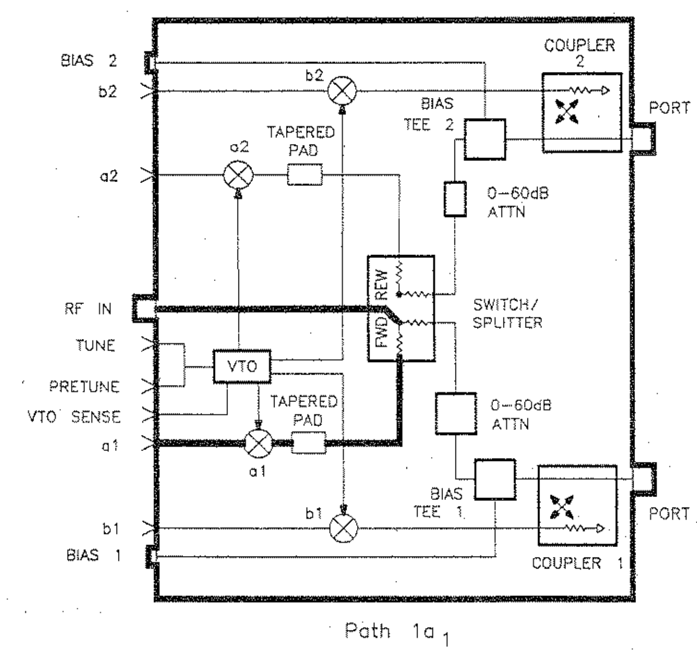
- If the observed results match a group of results in the table, investigate the most probable cause given in the table.
- If all the paths are good, then the test set is probably working properly. Return to the "Main Troubleshooting Procedure" to continue troubleshooting the system.
- If the observed results do not match any of those given in the table, re-evaluate and possibly re-measure your observed data. If the data is valid, troubleshoot using the RF path diagram(s) given in this foldout for the "bad" signal traces.

Path						Most Probable Failure
1 a1	2 a2	3 b1 refl.	4 b2 refl.	5 b1 thru	6 b2 thru	
-	-	-	-	-	-	Test set is not the problem
B	B	B	B	B	B	Source, source cable, VTO, cables from rear panel to switch splitter
-	B	-	B	B	-	Switch splitter
B	-	B	-	-	B	Switch splitter
-	-	B	-	B	-	b_1 sampler
B	-	-	-	-	-	a_1 sampler
-	B	-	-	-	-	a_2 sampler
-	-	-	B	-	B	b_2 sampler
-	-	B	-	B	B	Port 1 connector or directional coupler
-	-	B	-	-	B	Attenuator 1, bias tee 1
-	-	-	B	B	-	Attenuator 2, bias tee 2
-	-	-	B	B	B	Port 2 connector or directional coupler

B = Bad
- = Good

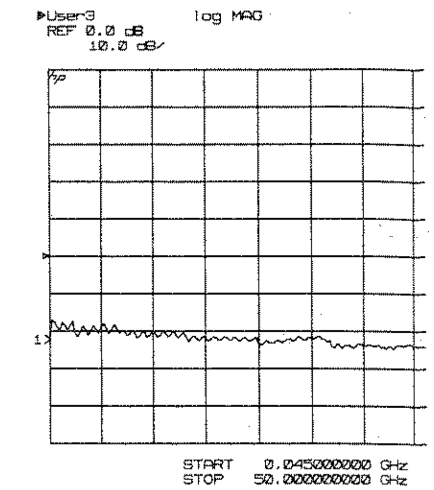


PATH 1 – a1

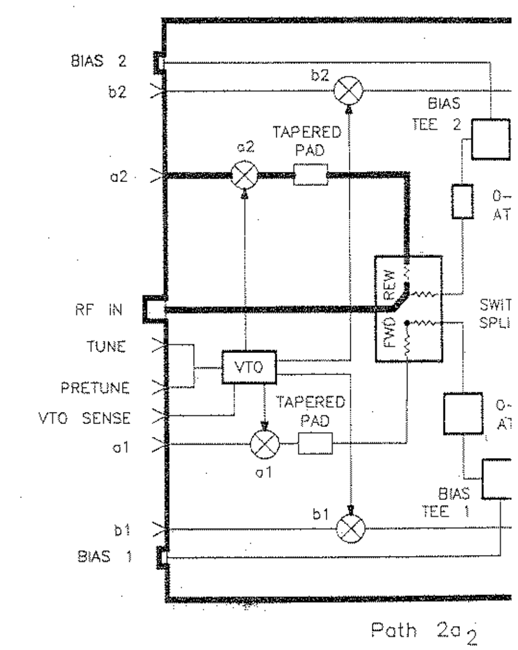


Path 1a1

Good/Bad ________

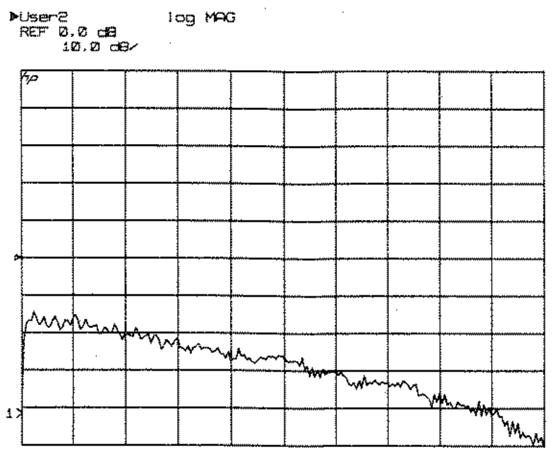


PATH 2 – a2

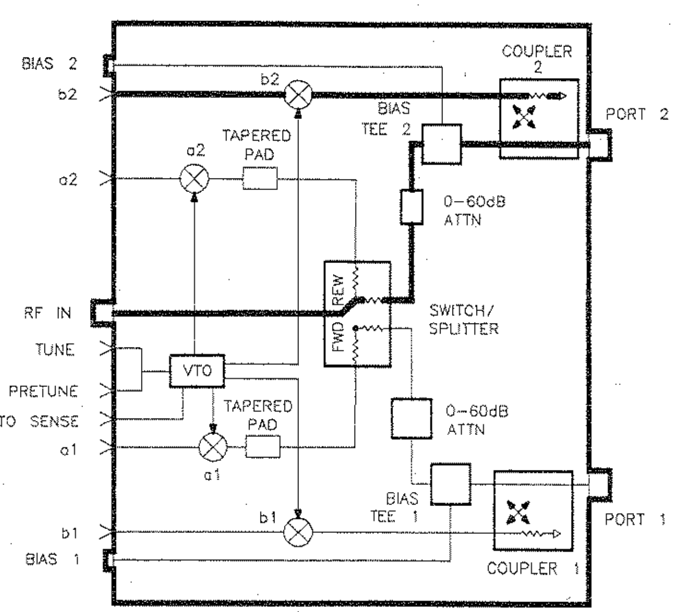


Path 2a2

Good/Bad ________

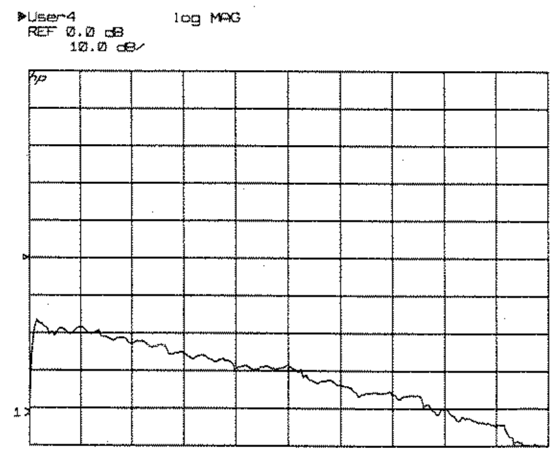


PATH 4 – b2 Reflected

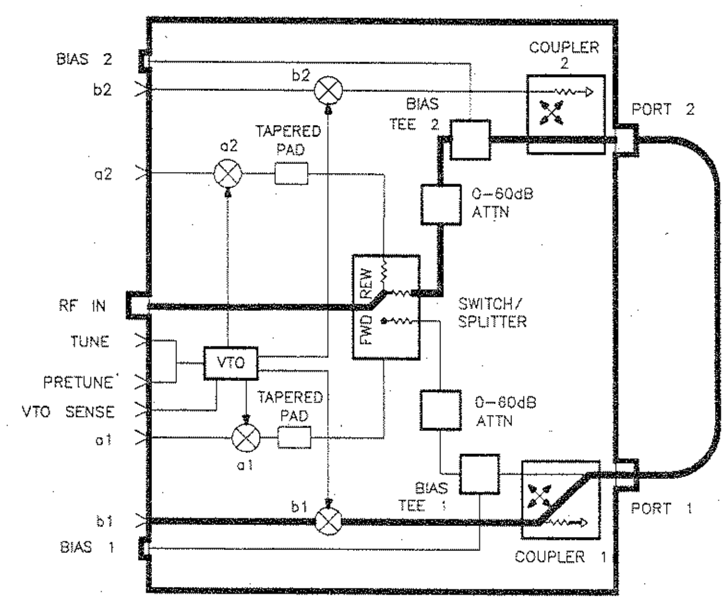


Path 4b$_2$

Good/Bad ____________

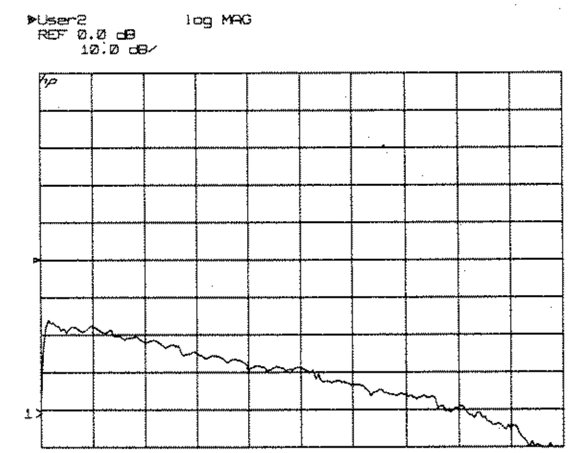


PATH 5 – b1 Thru

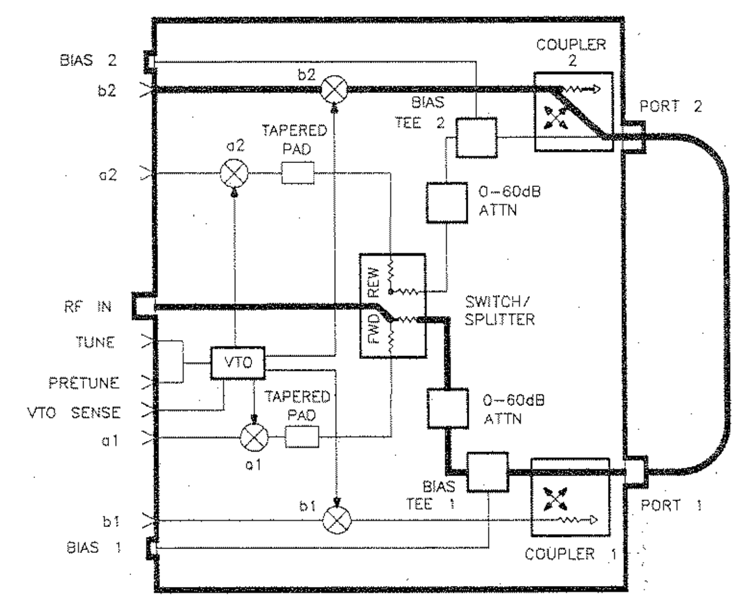


Path 5b$_1$

Good/Bad ____________



PATH 6 – b2 Thru



Path 6b$_2$

Good/Bad ____________

Figure 4.3–8. HP 8517 RF Flow Diagrams and Typical Traces

Unratioed Power Failures

ɔurce into step mode. On the network analyz-
E] [FACTORY PRESET] STIMULUS MENU

essary to redefine what port and sampler the

EDEFINE PARAMETER] [DRIVE] [Port 2]
ɟefine a2.

DRIVE] [Port 2] [PHASE LOCK] [a2] [REDE-

2. This reflects power back to the b1 and b2

ency response traces on this foldout. Press
r 4 b1]. Each trace should be similar to the
± 5 dB.

1 through User 4) in Table 4.3-3.

REDEFINE PARAMETER] [DRIVE] [Port 2]
erve the b1 power level trace through path 5,
similar to the example trace (typically within
ad) under the RF path diagram..

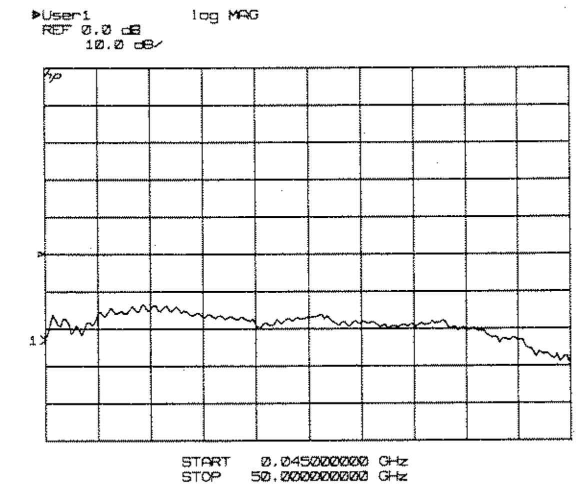
REDEFINE PARAMETER] [DRIVE] [Port 1]
erve the b2 power level trace through path 6,
similar to the example trace (typically within
ad) under the RF path diagram.

Try to match the observed results recorded under the RF path diagrams with the results listed in the table of most probable failures, below. Out of 32 possible variations, the table lists the variations that result from 12 of the most *probable* failures.

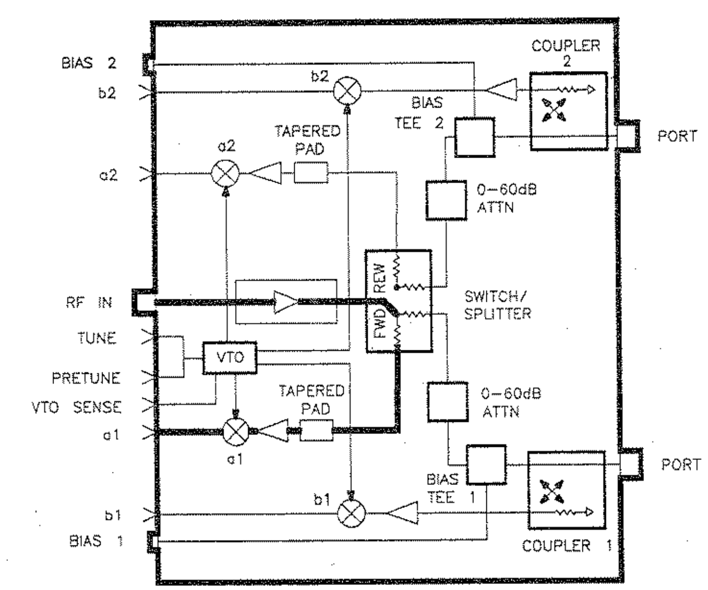
- If the observed results match a group of results in the table, investigate the most probable cause given in the table.
- If all the paths are good, then the test set is probably working properly. Return to the "Main Troubleshooting Procedure" to continue troubleshooting the system.
- If the observed results do not match any of those given in the table, re-evaluate and possibly re-measure your observed data. If the data is valid, troubleshoot using the RF path diagram(s) given in this foldout for the "bad" signal traces.

Path						Most Probable Failure
1 a1	2 a2	3 b1 refl.	4 b2 refl.	5 b1 thru	6 b2 thru	
–	–	–	–	–	–	Test set is not the problem
B	B	B	B	B	B	Source, source cable, VTO, cables from rear panel to switch splitter or input amplifier.
–	B	–	B	B	–	Switch splitter
B	–	B	–	–	B	Switch splitter
–	–	B	–	B	–	b_1 sampler, b_1 buffer amplifier
B	–	–	–	–	–	a_1 sampler, a_1 buffer amplifier
–	B	–	–	–	–	a_2 sampler, a_2 buffer amplifier
–	–	–	B	–	B	b_2 sampler, b_2 buffer amplifier
–	–	B	–	B	B	Port 1 connector or directional coupler
–	–	B	–	–	B	Attenuator 1, bias tee 1
–	–	–	B	B	–	Attenuator 2, bias tee 2
–	–	–	B	B	B	Port 2 connector or directional coupler

B = Bad
– = Good

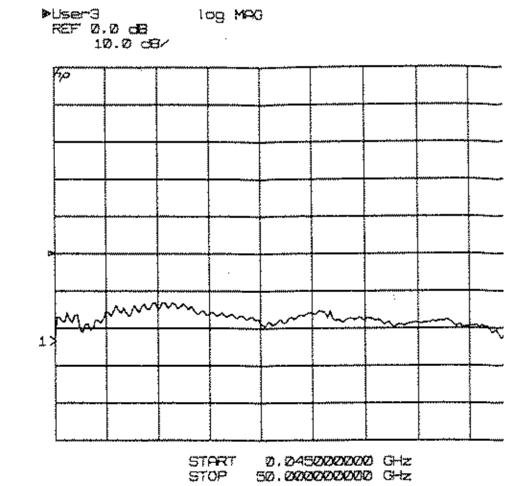


PATH 1 — a1

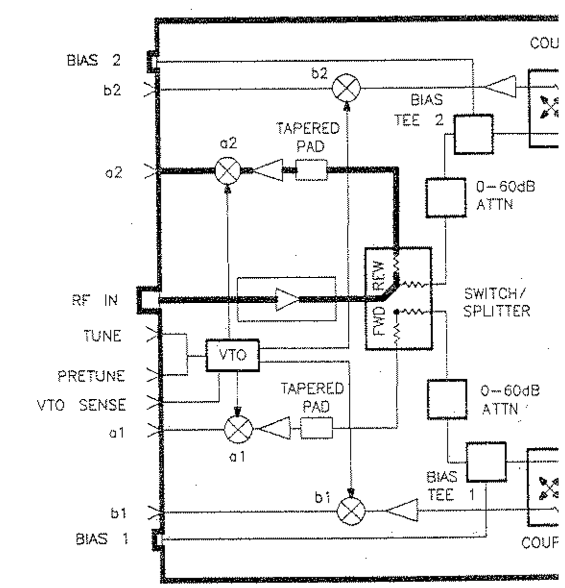


Path $1a_1$,Opt 007

Good/Bad ______



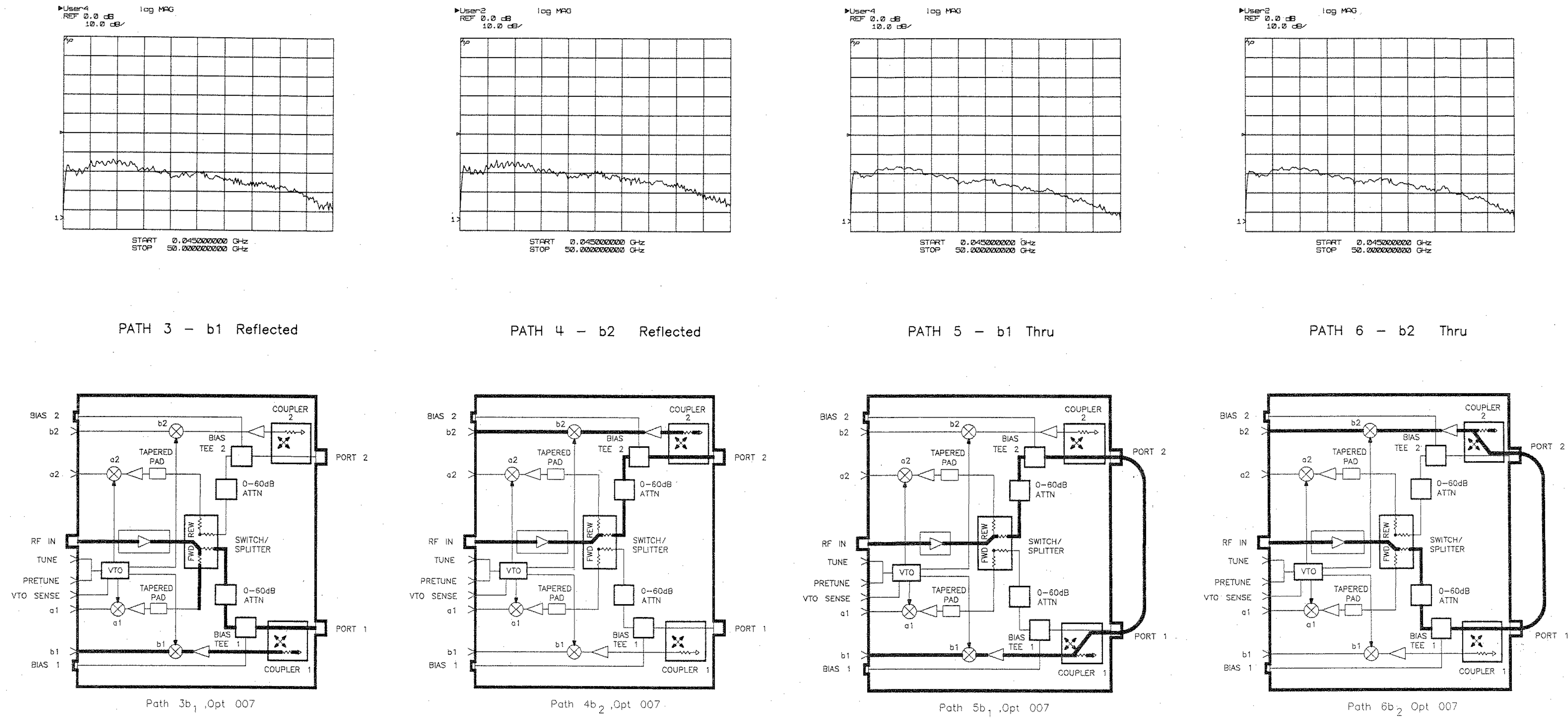
PATH 2 — a2



Path $2a_2$,Opt 007

Good/Bad ______

Find the Faulty Assembly



Good/Bad ______________ Good/Bad ______________ Good/Bad ______________ Good/Bad ______________

Figure 4.3–9. HP 8517B Option 007 RF Flow Diagrams and Typic

Unratioed Power Failures

4.4. Power Supply Failures

INTRODUCTION

NOTE: Use these procedures only if you were directed to this section from chapter 4, "Main Troubleshooting Procedure," and you believe the problem is in the HP 85101C or 85102 power supply.

This section consists of procedures to troubleshoot the HP 85101 Display/Processor and 85102 IF/Detector power supplies to the assembly level. The procedures are designed to let you identify the bad assembly in either the HP 85101 or 85102 power supply in the shortest possible time.

The HP 85101C and 85102 supplies provide DC voltages to their own units independently. It is assumed that you know which unit has the suspected bad supply. If they are both suspected bad, begin by troubleshooting the HP 85101C power supply.

HP 85101C Power Supplies Summary

Included are a short power supply troubleshooting summary (Table 4.4–1) and a longer, in-depth procedure. The summary is provided for troubleshooters who are familiar with the HP 85101C power supply circuitry. The in-depth procedure is provided for troubleshooters having minimum familiarity with the operation of the HP 8510C power supplies.

Refer to Figure 4.4-1. The HP 85101 Display/Processor power supply consists of the following assemblies:

A10 preregulator assembly

A3 post-regulator board assembly

All assemblies are related to A10 and A3 since power is supplied to each assembly. Therefore, a failure of any assembly can affect the power supply.

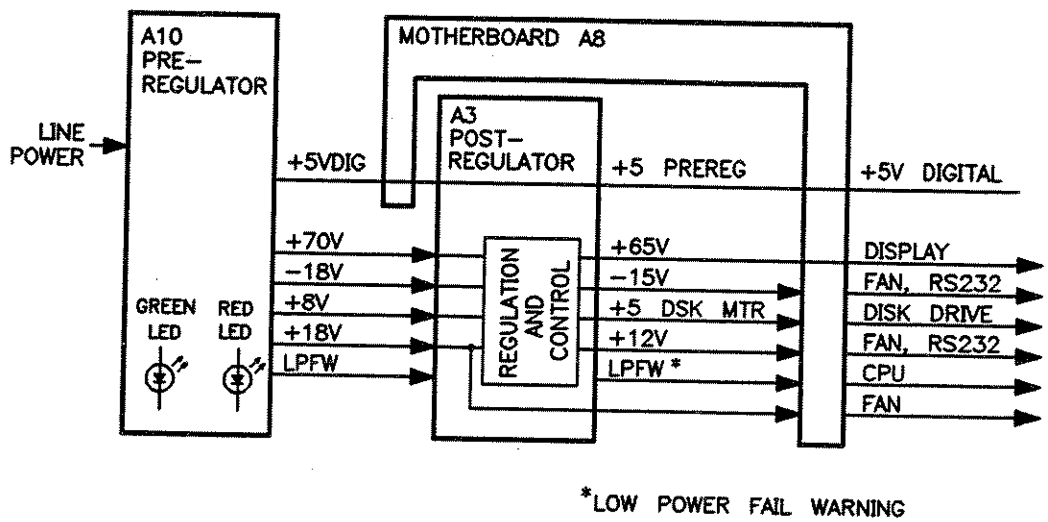


Figure 4.4-1. HP 85101C Power Supply Simplified Block Diagram

Refer to the "HP 85101C Power Supplies Detailed Block Diagram" at the end of this section to see signal paths and specific connector pin numbers.

HP 85102 Power Supplies Summary

The HP 85102 power supply consists of:

- A power transformer with two center-tapped secondary windings
- A separate bridge rectifier for each secondary winding
- Four regulators that supply —5V, —15V, +5V, and +15V
- Filtered but unregulated supply voltages of —5V, —15V, +5V, and +15V
- Fuses, test points, and LEDs for all regulated supplies

The HP 85102 power supply troubleshooting procedure is located in this section after the HP 85101C power supply troubleshooting procedure.

Table 4.4–1. Power Supply Troubleshooting Summary (1 of 2)

This summary gives an overview of the power supply troubleshooting procedure. Troubleshooters who are already familiar with troubleshooting the power supply may save time by following this summary instead of reading the entire procedure. Headings in this summary match the headings in the procedure, except for instructional text in italics.

HP 85101C DISPLAY/PROCESSOR
CHECK THE GREEN AND RED LEDs ON THE A10 PREREGULATOR
CHECK THE GREEN LEDs ON THE A3 POST-REGULATOR
MEASURE VOLTAGES ON THE A3 POST-REGULATOR
DETERMINE WHY THE GREEN LED ON A10 IS NOT ON STEADILY

Check the Line Voltage, Selector Switch, and Fuse

DETERMINE WHY THE RED LED ON A10 IS ON OR FLASHING

Disconnect A10W1

Check the A10 Preregulator and Related Assemblies

Measure Voltages on A10W1 and at A3J1

Remove Assemblies

Remove A8 Motherboard Connector Cables

Check the Operating Temperature

Inspect the A8 Motherboard

DETERMINE WHY THE GREEN LEDS ON A3 ARE NOT ALL ON

Remove the A3 Post-Regulator from its Motherboard Connector, Maintain A10W1 Cable Connection

Check the A3 Fuses and Voltages

Remove More Assemblies

Disconnect Display Power Cable

Inspect Motherboard

FAN TROUBLESHOOTING

Fan Speeds

Check the Fan Voltages

INTERMITTENT PROBLEMS

Replace the A5 CPU board assembly.

If the problem continues, replace the A10 preregulator assembly

Table 4.4–1. Power Supply Troubleshooting Summary (2 of 2)

HP 85102B IF/DETECTOR

CHECK THE GREEN AND RED LEDs ON THE A15 REGULATOR

Four green LEDs should be on, one red LED off.

If not, cycle power and measure the test points.

CHECK THE +5V TEST POINTS ON A24 INTERFACE

Remove assemblies and check 5V LED on A15

CHECK THE LEDs AND OUTPUT VOLTAGES OF A26 RECTIFIER

Four green LEDs should be on.

Measure at fuses: ±22V and ±11Vdc

Check line voltage selector

CHECK CONNECTOR P1

Unplug A26

HP 85101C DISPLAY/PROCESSOR

Disconnect the HP 85101/85102 interconnect cable at the HP 85101C Display/Processor rear panel.

- If an error message appears on the display, refer to "Power Supply Error Messages" near the end of this section.
- If the fan is not working, refer to "Fan Troubleshooting" near the end of this section.

CHECK THE GREEN AND RED LEDS ON THE A10 PREREGULATOR

Turn on the HP 85101C Display/Processor and look at the rear panel of the analyzer. Check the two power supply diagnostic LEDs on the A10 preregulator casting by looking through the holes located to the left of the line voltage selector switch (see Figure 4.4-2). Normally, the bottom (green) LED is on and the top (red) LED is off.

- If these LEDs are normal, then A10 is 95% verified. Continue this procedure at "Check the Green LEDs on the A3 Post-Regulator."
- If the red LED is on or flashing, then refer to "Determine Why the Red LED on A10 Is On or Flashing" in this section.

- If the green LED is not on steadily, then the line voltage is missing or is insufficient to power the HP 85101C. Continue this procedure at "Determine Why the Green LED on A10 Is Not On Steadily."

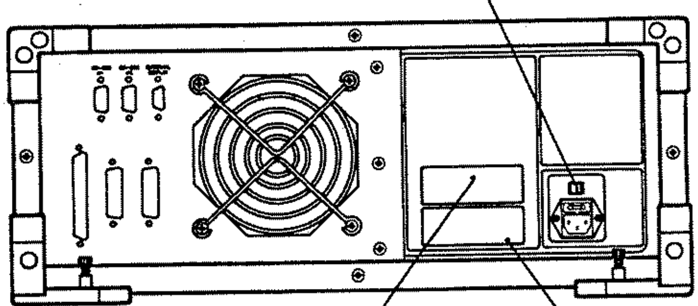


Figure 4.4-2. Location of A10 Preregulator Diagnostic LEDs

CHECK THE GREEN LEDS ON THE A3 POST-REGULATOR

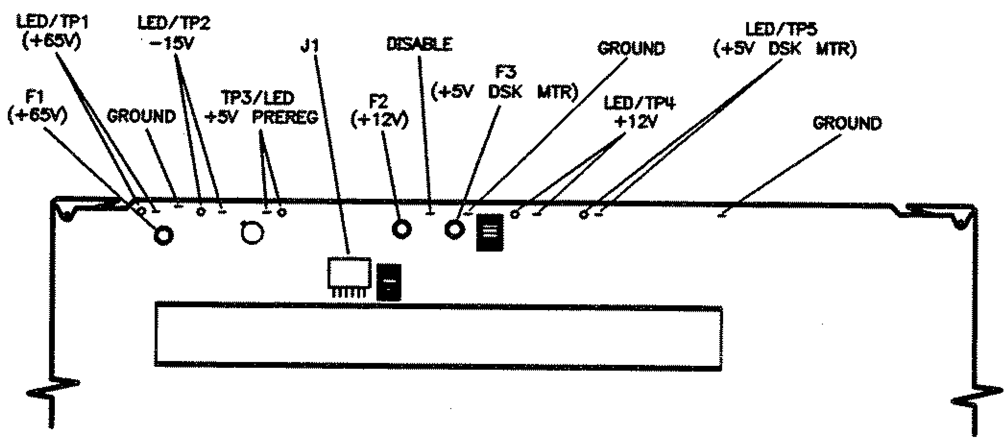
Turn off the HP 85101C. Remove the HP 85101C Display/Processor top cover and make sure that all board assemblies are firmly seated in their connectors. Turn the HP 85101C on. Locate the A3 post-regulator assembly and check to see if the five green LEDs on the top edge of this assembly are on. Refer to Figure 4.4-3 for locations of these LEDs.

- If any LED on the A3 post-regulator is off or flashing, refer to "Determine Why the Green LEDs on A3 Are Not All On" later in this procedure.
- If all of the green LEDs on the top edge of A3 are on, there is a 95% confidence level that the power supply is verified. To confirm the last 5% uncertainty, continue this procedure with the next paragraph.

MEASURE VOLTAGES ON THE A3 POST-REGULATOR

Refer to Figure 4.4-3 and measure the DC voltages on the A3 post-regulator test points. This figure lists the voltages and their limits.

- If the voltages are within their limits, the HP 85101C power supply is 100% verified.
- If the voltages are not within their limits, replace the A3 post-regulator.



Test Point	Supply	Range
1	+65V	+64.6 to +65.4
2	—15V	—13.6 to —15.0
3	+5V Prereg	+4.9 to +5.3
Disable	Disable	N/A
4	+12V	+11.4 to 12.6
5	+5V DSK MTR	+4.7 to +5.3

Figure 4.4-3. A3 Post-Regulator LEDs and Test Point Voltages

DETERMINE WHY THE GREEN LED ON A10 IS NOT ON STEADILY

If the green LED is not on steadily, the line voltage is missing or is not enough to power the HP 85101C. Continue this procedure with the next paragraph.

Check the Line Voltage, Selector Switch, and Fuse

Check the main power line cord, line selector switch setting, line fuse, and actual line voltage to see that they are all correct.

Figure 4.4-2 (earlier in this procedure) shows the location of the line voltage selector switch. Use a small flat-bladed screwdriver to select the correct switch position. Figure 4.4-4 shows how to remove the line fuse, using a small flat-bladed screwdriver to pry out the fuseholder. The line fuse is rated for 250V at 3 amperes for operation at all line voltages. A spare fuse is provided in a plastic "drawer" in the line fuseholder as shown in the figure. The line fuse HP part number is 2110-0655.

- If the A10 green LED is still not on steadily after verification of correct line voltage, replace the A10 preregulator.

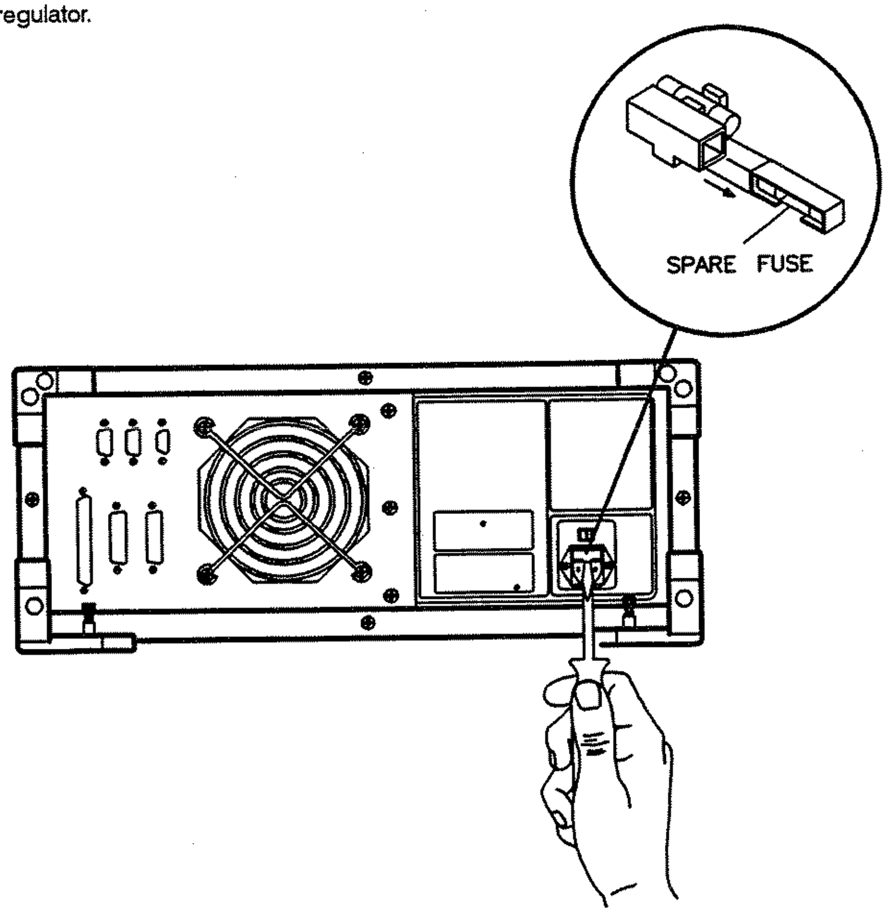


Figure 4.4-4. Removing the Line Fuse

DETERMINE WHY THE RED LED ON A10 IS ON OR FLASHING

If the red LED is on, the problem may be in the A10 preregulator, the A3 post-regulator, the +5V digital supply, or any of the assemblies obtaining power from the supplies. Continue with "Check the Line Voltage, Selector Switch and Fuse" and then continue this procedure with the next paragraph.

Disconnect A10W1

Refer to Figure 4.4-5. Turn off the HP 85101C and disconnect cable A10W1 from the A3 post-regulator. Turn on the HP 85101C.

- If the red LED goes out after removing A10W1, the +5V digital supply in A10 is verified. The problem is probably in the A3 post-regulator or one of the assemblies obtaining power from it. Refer to "Check the A10 Preregulator and Related Assemblies" to verify that the inputs to A3 and associated assemblies are correct.
- If the red LED is still on or flashing after removing A10W1, the problem is probably in the A10 preregulator or the +5V digital supply, or one of the assemblies obtaining power from it. Continue this procedure with the next paragraph.

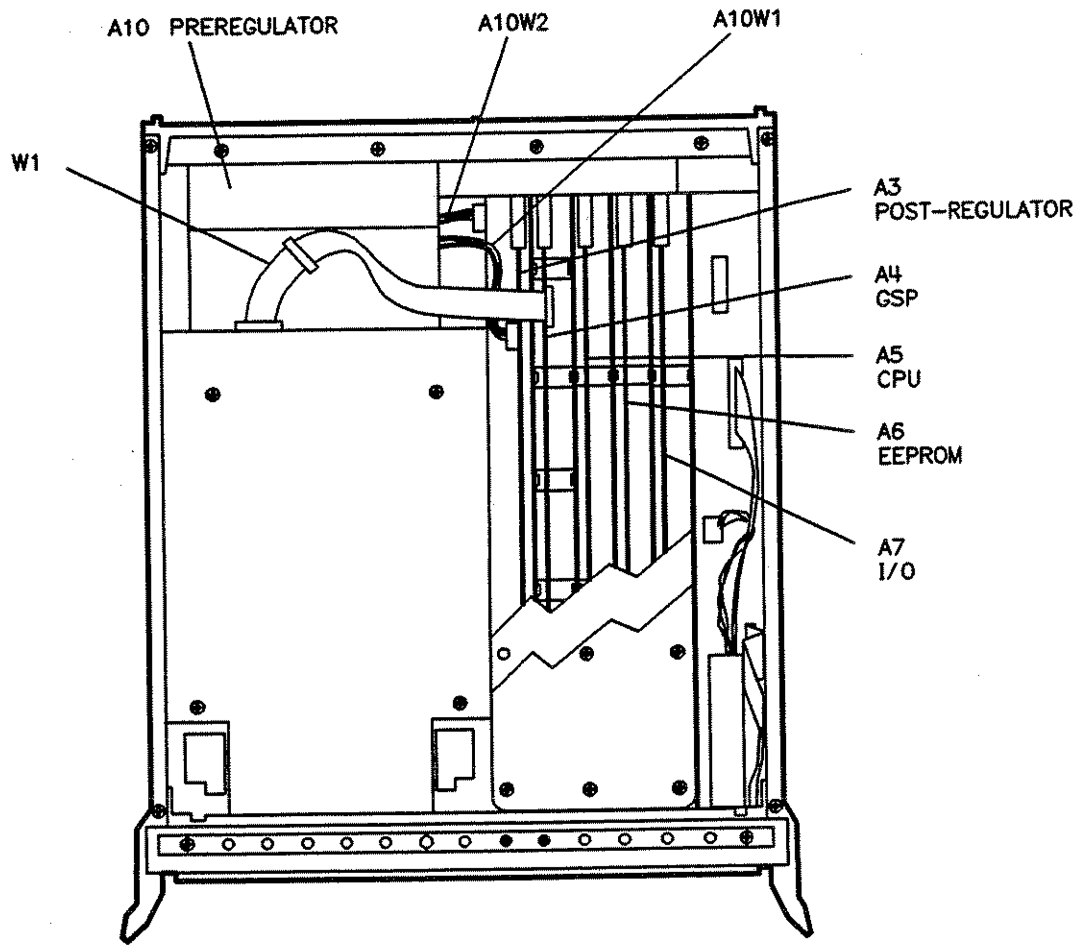


Figure 4.4-5. Location of HP 85101C Cables and Board Assemblies

Check the A10 Preregulator and Related Assemblies

The following paragraphs systematically check the assemblies to find the bad one.

Measure the Voltages on A10W1 and at A3J1. Turn off the HP 85101C and put the A3 post-regulator on an extender board. See Figure 4.4-3.

NOTE: The A3 post-regulator assembly has its own special extender board for troubleshooting, HP part number 85101-60236. The connector pin numbers are reversed from extenders for the other board assemblies.

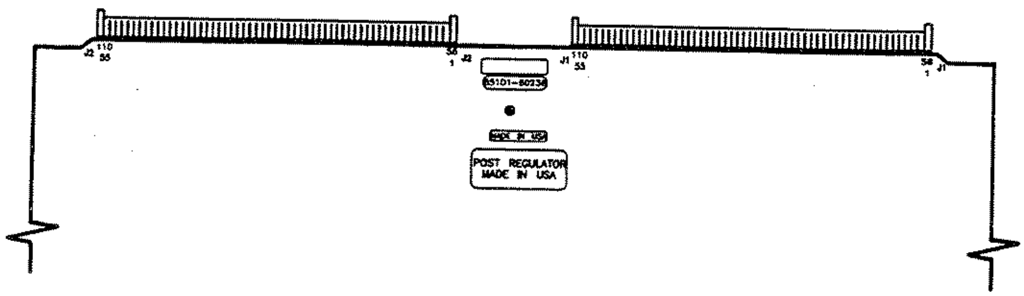


Figure 4.4-6. A3 Post-Regulator Extender Board

Ribbon cable W1 from the A11 display may remain disconnected from the A4 GSP board during this procedure. Disconnect A10 preregulator cable A10W1 from the A3J1 post-regulator connector.Turn on the HP 85101C and measure the voltages on the connector pins with a small probe. Compare the measured voltages with the voltages listed in Figure 4.4-7.

- If the voltages are not within tolerance, replace the A10 preregulator.
- If the voltages are within tolerance, the A10 preregulator is working properly. Continue with this procedure.

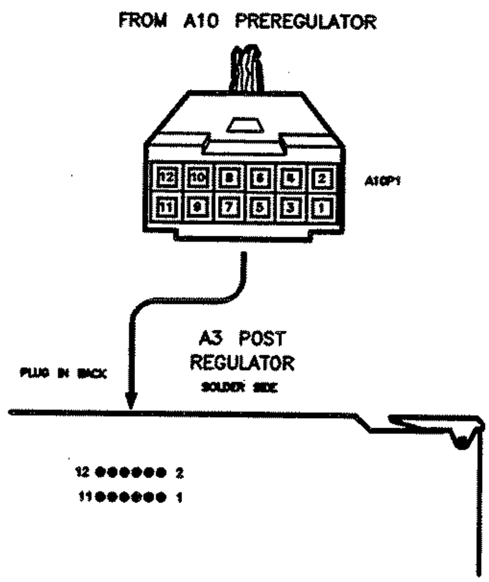
Turn off the HP 85101C and connect A10 preregulator cable A10W1 to the A3J1 post-regulator connector. Turn on the HP 85101C and measure the voltages on the pins of A3J1. Compare these voltages with the voltages listed in Figure 4.4-7.

- If the voltages are not within tolerance, either the A3 post-regulator or an assembly connected to it is loading down the A10 preregulator. Continue this procedure with "Remove Assemblies."
- If the voltages are within tolerance, it is likely that the A3 post-regulator is good and is being loaded down by an assembly connected to it. Continue this procedure with the next paragraph.

Remove Assemblies. Check power supply loading from the assemblies that are supplied by A10. Turn off the HP 85101C. Connect the A10W1 cable to the A3 post-regulator. Remove the following assemblies and then turn on the HP 85101C.

A4 GSP board
A5 CPU board
A6 EEPROM board
A7 I/O board
Disc drive power connector J3 on the A8 motherboard

- If the A10 red LED is still on, continue this procedure with "Remove A8 Motherboard Connector Cables".
- If the A10 red LED is off, disconnect line power from the HP 85101C. Plug the A4 GSP board assembly into the motherboard. If the LED lights, replace the A4 GSP assembly.
- Continue to plug in the rest of the assemblies until the red LED lights. Replace the assembly that causes the LED to light.



A10P1 Wire	Wire Color Code	A10P1 Voltages (Disconnected from A3J1)	A10P1 Voltages (Connected to A3J1)*	A10 Preregulator Mnemonic (Supply Block Diagram)
1	-	0 (N/C)	+68 to +100	+70V
2	3	+125 to +100	+68 to +100	+70V
3,4	92	+22.4 to +33.6	+17.0 to +33.6	+18V
5,6	97	—22.4 to —33.6	—17.0 to —33.6	—18V
7	-	0 (N/C)	+7.4 to +14	+8V
8	96	+9.4 to +14	+7.4 to +14	+8V
9,10	95	N/A	N/A	NONE
11	94	N/A	N/A	NONE
12	-	0 (N/C)	0 (N/C)	NONE

*The +5V digital supply must be loaded by one or more assemblies at all times, or the voltages shown here will be wrong. The +5V digital supply voltage connects from preregulator A10 to A8 motherboard connector A8J8.

Figure 4.4-7. A10P1 Plug Detail and Output Voltages

Remove A8 Motherboard Connector Cables. Turn off the HP 85101C. One at a time and in the order shown, remove the following cables from their motherboard connectors and turn the HP 85101C on until the red LED goes off. The cable and/or its supplied assembly that causes the red LED to go out when it is removed from its motherboard connector is bad.

A8J1 keyboard cable
A8J2 disc drive cable

- If the red LED is still on or flashing, continue this procedure with the next paragraph.

Check the Operating Temperature. The temperature-sensing circuitry inside the A10 preregulator may be disabling the supply. Make sure the operating environment ambient air temperature does not exceed +55 degrees C (+131 degrees F), and that the HP 85101C fan is operating.

- If the fan does not seem to be operating correctly, refer to "Fan Troubleshooting" at the end of this section.
- If there does not appear to be a temperature problem, it is likely that the A10 preregulator is bad.

Inspect the A8 Motherboard. If the red LED is still on after replacement or repair of the A10 preregulator, turn off the HP 85101C and inspect the A8 motherboard for solder bridges and other noticeable defects. Use an ohmmeter to check for shorts. In particular, check the following lines between the A10 preregulator and the A3 post-regulator:

- GNDDSENSE
- +5VDSENSE
- +5V DIG
- DGND

Refer to the A8 motherboard wiring diagram to troubleshoot these suspected power supply lines. The wiring diagram is supplied at the end of the "Main Troubleshooting Procedure" in Chapter 4.

DETERMINE WHY THE GREEN LEDS ON A3 ARE NOT ALL ON

The green LEDs along the top edge of the A3 post-regulator are normally on.

Flashing LEDs on A3 indicate that the shutdown circuitry on the A3 post-regulator is protecting power supplies from overcurrent conditions by repeatedly shutting them down. This may be caused by supply loading on A3 or on any other assembly in the HP 85101C.

Remove the A3 Post-Regulator from its Motherboard Connector, Maintain A10W1 Cable Connection

Turn off the HP 85101C. Remove post-regulator A3 from its motherboard connector but keep the A10-to-A3 cable (A10W1) connected to A3. Remove display power cable W1 (illustrated in Figure 4.4-5). Short to chassis ground any of the three common GND pins located on the top edge of the A3 postregulator. Turn the HP 85101C on.

- If any A3 post-regulator green LEDs other than +5V PREREG is still off or flashing, continue with this procedure.
- If all LEDs are now on steadily except for the +5V PREREG LED, the A10 preregulator and A3 post-regulator are working properly and the trouble is excessive loading somewhere after the motherboard connections at post-regulator A3. Continue this procedure with "Remove More Assemblies."

Check the A3 Fuses and Voltages

If any of LEDs for the following supplies are completely off, first check their fuses:

+65V
+12V
+5V DSK MTR

The fuses for these supplies are all located on the top edge of the A3 post-regulator board assembly. Their supply circuits, test points and current ratings are listed in Table 4.4−2. The part numbers of these fuses are in Chapter 5, "Replaceable Parts," under "HP 85101C Top Internal."

Table 4.4−2. A3 Post-Regulator Fuses

LED/Test Point	Fuse Designator	Fuse Rating	HP Part Number
TP1	A3F1	1.5A, 125V	2110-0333
TP4	A3F2	2A, 125V	2110-0425
TP5	A3F3	2A, 125V	2110-0425

If any A3 fuse burns out, replace it. If it burns out again when power is applied to the HP 85101C, A3 post-regulator or A10 preregulator is bad. Determine which of these assemblies has failed as follows:

Remove the A10W1 cable at post-regulator A3 and measure the voltages at A10W1P1 with a voltmeter having a small probe. Compare the measured voltages with those in Figure 4.4-7.

- If the voltages are within tolerance, replace post-regulator A3.
- If the voltages are not within tolerance, replace preregulator A10.

- If all A3 post-regulator green LEDs are now on, the A10 preregulator and A3 post-regulator are working properly and the trouble is excessive loading somewhere after the motherboard connections at A3. Continue this procedure with the next paragraph.

Remove More Assemblies

Install post-regulator A3. Remove the jumper from the GND pin on the top edge of post-regulator A3 and chassis ground. This jumper was connected earlier in this procedure. Remove the following assemblies and turn on the HP 85101C:

A4 GSP board
A5 CPU board
A6 EEPROM board
A7 I/O board
Disc Drive Power connector J3 on the A8 motherboard
A8J1 Keyboard cable
A8J2 disk drive cable

- If any of the A3 green LEDs are off or flashing, it is likely that the assemblies just removed are not causing the problem.
- If all A3 green LEDs are now on, turn off the HP 85101C.

Reinstall each assembly one at a time and turn on the HP 85101C after each is installed. The assembly that causes the A3 green LEDs to go off or flash is suspect. It is possible that this condition is caused by the A3 post-regulator supplying insufficient current. To check this, repeat the "Remove More Assemblies" step but replace the assemblies in a different order to change the loading. If the same assembly appears to be faulty, replace that assembly. If a different assembly appears faulty, post-regulator A3 is most likely bad (unless both of the other assemblies are bad).

Disconnect Display Power Cable

Turn off the HP 85101C and remove the display power cable W1 (illustrated in Figure 4.4-5). Turn on the HP 85101C.

- If all A3 green LEDs are now on, replace or repair the A11 display. The display manual part number is in chapter 5, "Replaceable Parts."
- If any of the A3 green LEDs are off or flashing, continue with the next paragraph.

Inspect Motherboard

Inspect the A8 motherboard for solder bridges and shorted traces.

FAN TROUBLESHOOTING

Fan Speeds

The fan speed is continuously variable depending upon temperature. It is normal for the fan to be at high speed when the instrument is just turned on, and then change to low speed when the instrument has cooled.

Check the Fan Voltages

If the fan is dead, refer to the "HP 85101C Power Supply Detailed Block Diagram" at the end of this section. The fan is driven by the +18V and —18V supplies coming from the A10 preregulator. Neither of these supplies is fused. The —18V supply is regulated on A3, and remains constant at approximately —15 volts. It connects to the fan via the A8 motherboard.

The +18V supply changes the voltage to the fan, depending on airflow and temperature information. Its voltage ranges from approximately +1.0 volts to +14.7 volts, and it also connects to the fan via the A8 motherboard.

INTERMITTENT PROBLEMS

PRESET states that appear spontaneously (without pressing **INSTRUMENT STATE** [RECALL] ***[MORE] [FACTORY PRESET]***) typically signal a power supply or A5 CPU assembly problem. Replace the A5 CPU board assembly as it is the most likely failure. If the problem continues, replace the A10 preregulator assembly.

HP 85102B IF/DETECTOR

Anytime during this procedure, refer to Figure 4.4-11, "HP 85102 Power Supply Detailed Block Diagram," for an overview of the HP 85102B IF/Detector power supplies.

Disconnect the interconnect cable from the rear panel. Switch on the HP 85102B. Check to see that the amber LINE LED on the front panel is on (normal). If the front panel LED is off, it is likely there is a problem with the HP 85102 power supply; continue with this troubleshooting.

Exception: Some early models of HP 85102B derive the +5V power for the front panel LED from the HP 85101, and the line LED in these models will therefore not light when the HP 85101 and 85102 are not connected.

CHECK THE GREEN AND RED LEDS ON THE A15 REGULATOR

Partially slide back the top cover of the HP 85102. The A15 regulator is the board furthest back on the left side. Check the five LEDs on A15. Normally, the four green LEDs should be on and the red LED should be off. If so, the power supply is verified with 85% confidence. To increase the confidence level to 100%, go on to "Check the 5V Test Points on A24 Interface."

If the A15 red LED is on and one or more of the A15 green LEDs are off, one of the following conditions exists:

- A thermal shutdown has occurred
- The thermal protection circuit has failed
- The +15V or —15V supply has failed

Cycle power on the HP 85102 to see if the thermal protection circuit will reset. If the heat sink temperature becomes too great, the +15V supply is disabled. This causes the +15V SENSE line to go low and disable one or more of the other supplies (—5V, —15V, and +5V).

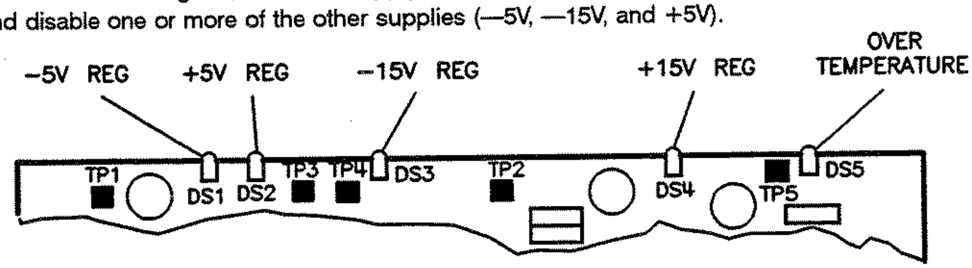


Figure 4.4-8. A15 LEDs and Test Points

If one or more of the green LEDs is still off, measure the voltages at the corresponding test points (see Figure 4.4-8). They should measure:

A15TP5	+15V
A15TP4	—15V
A15TP3	+5V*
A15TP1	—5V

*If the +5V regulator is indicated as the suspected fault, the +5V supply may be loaded down by another assembly. Continue to "Check the +5V Test Points on A24 Interface."

Otherwise, continue to "Check the LEDs and Output Voltages of A26 Rectifier."

CHECK THE +5V TEST POINTS ON A24 INTERFACE

Measure the voltage at test points A24TP5, TP8, and TP7 on the A24 processor interface board. They should all measure +5 Vdc ±25 mV with <10 mV p-p ripple. If so, the power supply is now verified with a confidence level increased to 100%.

If any of the test points does not measure +5 Vdc, the supply is probably being loaded down by another assembly. Switch off the instrument and try removing assemblies one at a time. (Switch on power after removing each, and switch off power again before removing the next.) Check the +5V LED on A15 after each assembly is removed. When removing a particular assembly causes the LED to light, that assembly is probably defective and should be replaced.

If removing assemblies does not cause the +5V LED to light, the fault is probably in the A15 regulator. Replace A15.

CHECK THE LEDS AND OUTPUT VOLTAGES OF A26 RECTIFIER

Check the four green LEDs on rectifier A26. They should all be on.

- If all the LEDs are off, check the power line module and P1 connector plug.
- If any one LED is out, check the continuity of the corresponding fuse. See Figure 4.4-9.
- If an LED is off but its fuse is good, A26 is bad: replace it.
- If you change a fuse and its LED is still out, go to "Check Connector P1" to check the continuity of P1 and the unloaded AC secondary voltages from transformer T1.

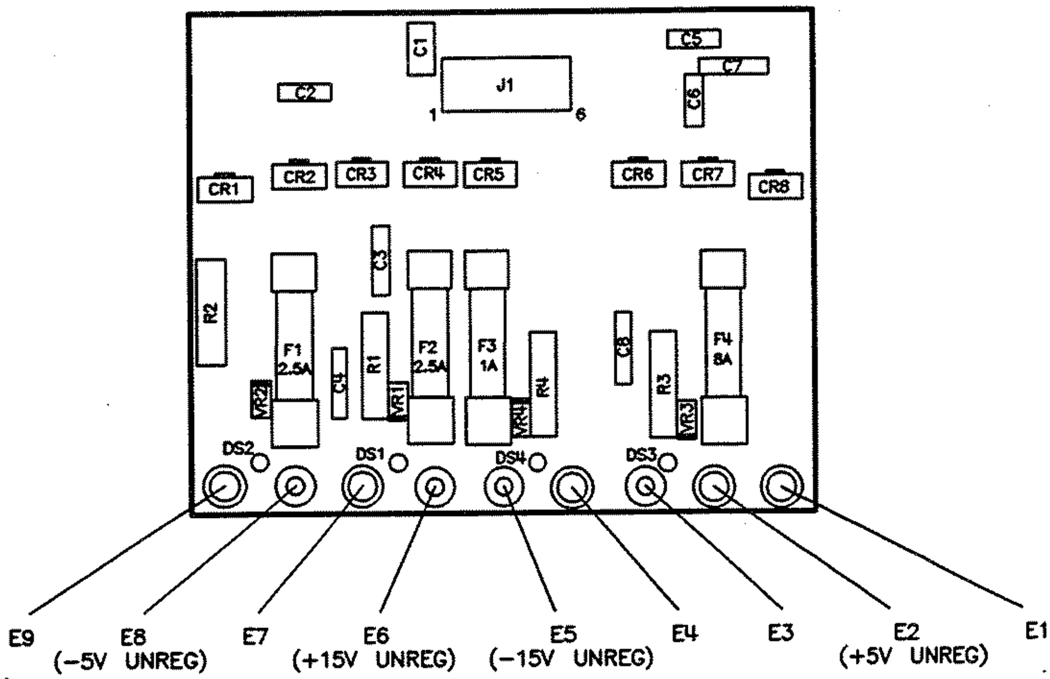


Figure 4.4-9. A26 Rectifier Fuse Locations

- If the LEDs are on, this means that voltages are present, but it does not necessarily mean they are at the correct values.

Next measure the four unregulated output voltages of the rectifier. Measure at either side of the fuses (see Figure 4.4-9). The voltages should measure approximately ±22 Vdc out of the 15V rectifier, and ±11 Vdc out of the 5V rectifier.

- If all the voltages are low, check the line voltage selector setting for the proper line voltage.
- If the A26 voltages are correct, but one or more A15 LEDs are off or the voltages on A15 are incorrect, the problem is in A15 or the interface between A26 and A15.
- If the voltages are present but not correct, continue with the next paragraph.

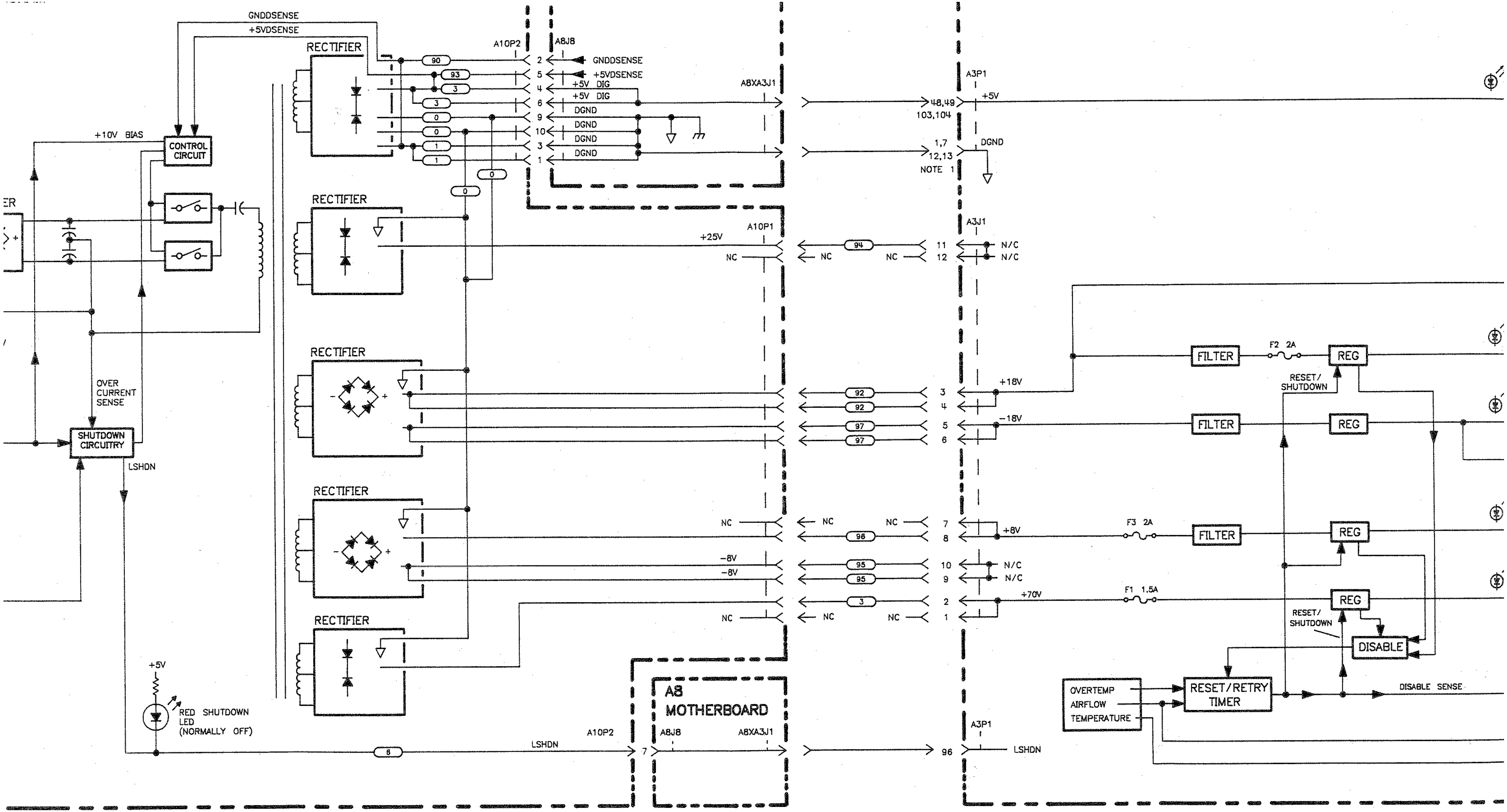
CHECK CONNECTOR P1

The line voltage may be loaded down by the A26 rectifier. Unplug A26 from P1. Refer to Table 4.4−3 and check the open end of P1 for unloaded AC secondary voltages from transformer T1.

Table 4.4−3. P1 AC RMS Voltages (Approximate)

Measure Between P1 Pins	Wire Color	AC Voltage (RMS Approx.)
1 2	Yellow Yellow	37V
1 4	Yellow Red	18.5V
2 4	Yellow Red	18.5V
3 6	Blue Blue	19.5V
3 5	Blue Grey	10V
6 5	Blue Grey	10V

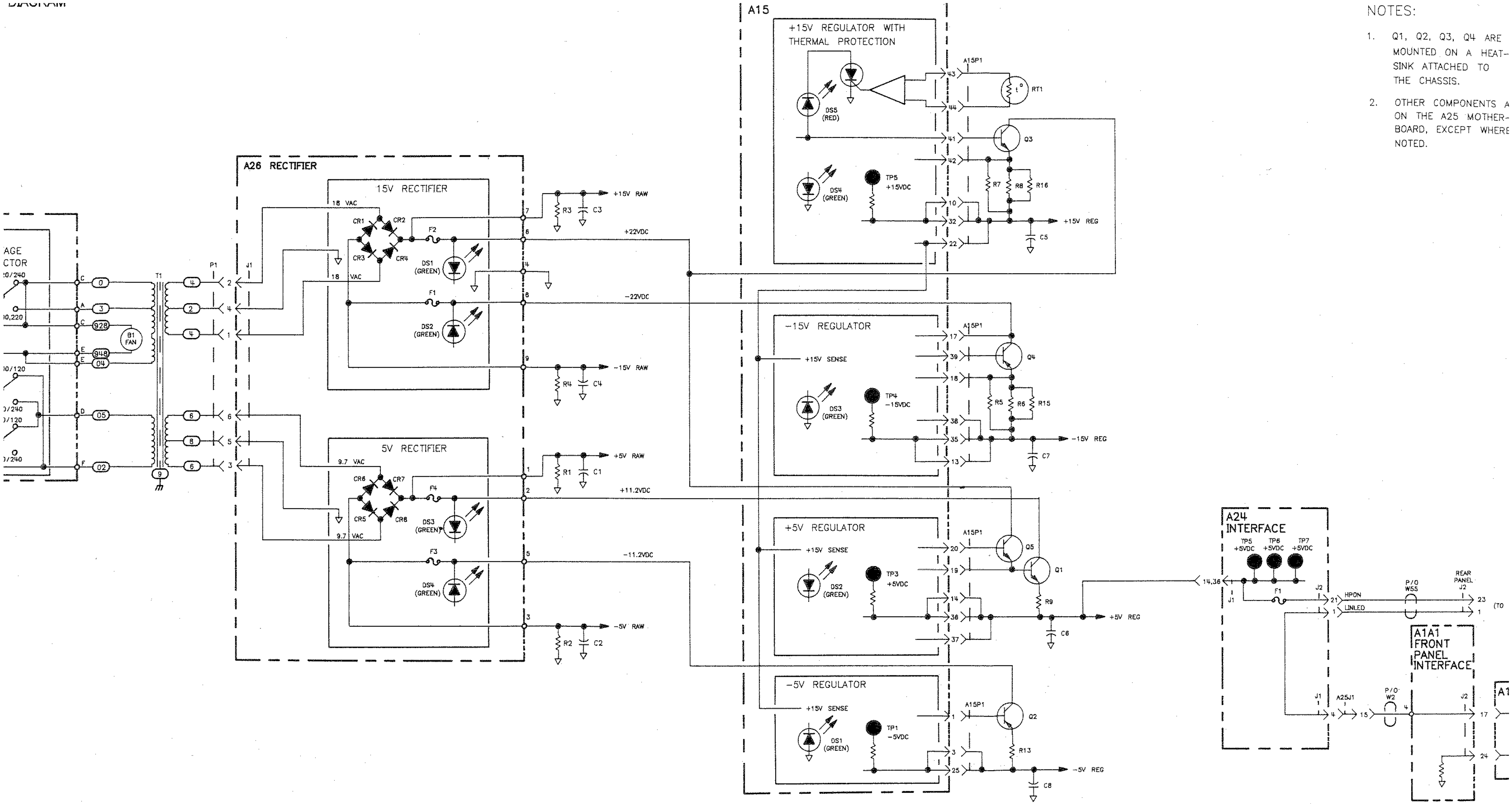
- If the voltages are approximately correct, replace A26.
- If the voltages are incorrect, the problem is in the power line module, transformer T1, or the connections.



AGRAM

A8 MOTHERBOARD

A3 POST-REGULATOR DETAILED BLOCK DIAGRAM



NOTES:

1. Q1, Q2, Q3, Q4 ARE MOUNTED ON A HEAT-SINK ATTACHED TO THE CHASSIS.
2. OTHER COMPONENTS A ON THE A25 MOTHER-BOARD, EXCEPT WHERE NOTED.

Figure 4.4-12 HP 85102C Power Supply Detailed Block Diagram

4.5. Performance Test Failures

INTRODUCTION

A performance test failure occurs whenever the performance verification data is not within specification limits. If you have performed the verification procedures in chapter 8, "Specifications and Performance Verification," and any part of the tests has resulted in a failure, follow the steps below.

PROCEDURE

1. The measurement calibration is the first thing to suspect. If the failure was in an S11 or S22 measurement, suspect the sliding load, open and/or short connection made during the calibration. If the failure was an S21 or S12 measurement, suspect the test port cable and connectors.

2. Check the calibration devices to be sure they are clean, properly gaged, and not worn out. If the device has a collet or slot, make sure it is not damaged. Make sure all pin depths are correct. The manuals for the various kits include the device specifications. Refer to the *Connector Care Manual* for information about making connections and caring for calibration devices.

3. Check the verification devices to be sure they are clean, properly gaged, and not worn out. If a test set connector is out of tolerance when gaged, it may be repaired or shimmed to bring it into tolerance: refer to the appropriate kit manual. (If a test set connector is shimmed or repaired, recalibrate before repeating the verification.)

4. Check the ambient temperature. System performance is specified at an ambient temperature of +23° ±3°C. Therefore the environmental temperature must remain in the range of +20°C to +26°C. Once calibrated, the environmental temperature must not vary more than ±1°C. The temperature of the devices is also important, because their electrical characteristics change with temperature. The devices should have been removed from their slots in the boxes and set on top of the foam to allow them to reach room temperature.

5. Check the standards data in the verification printout against the printed data that came with the verification kit. Make sure that the cal coefficients are the correct ones for your kit. For example, the HP 85052B calibration kit should be using a revision B.nnnn cal coefficient disk or tape. If they do not agree, contact your Hewlett–Packard customer engineer.

6. Perform the calibration and verification procedures again. Make sure all connections are good and properly torqued. (When you connect a device, you can gently tap on it with your finger to see if the CRT trace is stable. If not, reconnect the device and try again.)
7. If the procedure still fails and another calibration kit or verification kit is available, try substituting kits.
8. Use the verification program to print out the system error terms. If necessary, you will use this printout in step 10.
9. If the verification is still not successful, the problem is elsewhere in the system. Go to section 4.3, "Unratioed Power Failures," and perform the troubleshooting procedures in that section to see if the problem is in the test set.
10. If step 9 did not resolve the problem, refer to section 4.9, "Error Terms," and use the information there to analyze the error terms printout made in step 8.
11. If the verification still fails, go to chapter 4, "Main Troubleshooting Procedure," and follow the procedures there to check the system hardware.

4.6. Software Failures

INTRODUCTION

Use the information in this section if you are having problems running the operating system or the verification software, or controlling the system over HP-IB. Only use this section after going through the "Control, Configuration, and Cabling Pre-Operational Checks" in the "Main Troubleshooting Procedure."

This section explains how to resolve software and firmware failures, and provides a list of HP 8510 operating system revisions, beginning with revision A.01.00.

HOW TO RESOLVE SOFTWARE AND FIRMWARE FAILURES

The following procedure for the resolution of software and firmware failures is in two parts:

1. Make a list of programming codes or key-presses. Check the programming code descriptions with the documentation to verify that the intended operation is valid.

2. List all system components and the HP 8510C and source firmware revisions. Contact the nearest HP sales and service office for more help.

Part 1

List Programming Codes. If the HP 8510C system is manually controlled, make a list of HP 8510 key presses used to create the conditions that showed the problem. If you are using HP-IB to control the system, check your program and list the HP-IB programming codes being sent to the HP 8510 when the problem occurred. This list will be used in the following steps.

Check Programming Code Descriptions. Check the information on key press functions and/or mnemonics in the Keyword Dictionary. The entries in this document contain detailed descriptions of the manual operation and programmed operation of each function. Use the manual to verify how the commands should operate rather than assume they will operate in a certain way. Refer to the Operating and Programming Manual for tutorials about the functions being used.

If the actual behavior of a function is different than its documented, intended behavior, continue this procedure with "Part 2."

Part 2

List System Components and Firmware Revisions. Write down the following information prior to contacting HP in the next part of this procedure. The customer engineer (CE) will serve you better when this information is available:

- The exact system configuration including the model numbers of all system components in the system.
- The firmware revisions and serial numbers of the HP 8510C and the source(s) used. Check the HP 8510 revision by pressing AUXILIARY MENUS [SYSTEM] ***[MORE] [SERVICE FUNCTIONS] [SOFTWARE REVISION]***.
- The list of key presses or HP-IB programming codes used to create the conditions that showed the problem. This list was created in "List Programming Codes," earlier in this procedure.
- Any other details about the state of the system during failure that may be important to troubleshooting.

Contact HP. Contact your nearest HP sales and service office to discuss the problem with an HP customer engineer (CE). Your CE has access to a software tracking system that includes reports of known problems and their solutions or work-arounds. A list of HP sales and service offices is given at the end of this manual.

FIRMWARE REVISIONS

The following firmware revisions for the HP 8510A, 8510B, and 8510C are listed for historical purposes. Information about any later versions used with the HP 8510C will be published as they occur.

Table 4.6-1. HP 8510 Operating System History (1 of 2)

Revision Number	Analyzer[1]	HP Part Number	Significant Contribution
A.01.00	HP 8510A	85101-10001[2,3]	HP 8510A first release. Order A.02.00.
A.02.00	HP 8510A	85101-10001[2]	HP 11575A upgrade. Contains latest HP 8510A Operating System.
B.03.00	HP 8510B	See Note 3	HP 8510B first release. Major speed and feature enhancements.
B.03.11	HP 8510B	85101-80070	HP 11575B upgrade. Many improvements. New features for millimeter systems.
B.04.00	HP 8510B	85101-80078	HP 11575C upgrade. Requires two IC's. Adds many new features including HP 8516A operation. May require HP 8340/41 to be upgraded using HP 11875A kit.

Table 4.6-1. HP 8510 Operating System History (2 of 2)

Revision Number	Analyzer[1]	HP Part Number	Significant Contribution
B.05.00	HP 8510B	85101-80081[3]	Adds pulsed RF capability and improved external triggering. Included in both the HP 85111A and 11575D upgrade kits.
B.05.14	HP 8510B	85101-80111	This release allowed operation of the HP 83420 lightwave test set software. It also fixed anomalies found with dual channel cal, TRL cal, millimeter system TRL cal, and triggering in FASTCW mode. Included in both the HP 85111A and 11575E upgrades.
C.06.00	HP 8510C	85101-80098[3]	HP 8510C first release. Features include a color and 4-parameter display, 3.5-inch disc drive, and RS-232 interface. HP 83650/51 50 GHz compatibility.
B.06.00	HP 8510B	See Note 3	
C.06.30	HP 8510C	85101-80098	Released for DOS support and color paintjet support.
B.06.30	HP 8510B	85101-80102	Released for HP 8510B support of 50 GHz (HP 83650/51), HP 8517 and quickstep.
C.06.50	HP 8510C	85101-80113	HP 11595G Rev. C.06.00 to C.06.54
B.06.50	HP 8510B	85101-80109	HP 11575F Rev. B.03.00 to B.06.54
C.06.54	HP 8510C	85101-80113	HP 11575H Rev. C.06.30 to C.06.54
B.06.54	HP 8510B	85101-80109	HP 11575H Rev. B.06.30 to B.06.54
C.07.00	HP 8510C	85101-80116	Allows HP 8510C to work with HP 8517B option 007 and Power Domain Functions, Limit Lines, Dissimilar Connector Compensations, and Color Printer Compatibility features.

1. Replacements of HP 8510A or 8510B operating systems with time domain (option 010) must be ordered through an HP sales and service office. In this case, the HP 85101 serial number is required.
2. Revision A.01.00 is not orderable, even though it has the same part number as revision A.02.00. Revision A.02.00 is available.
3. Not recommended for replacement, may contain many bugs.

4.7. Other Failures

INTRODUCTION

This section presents additional tests that can be used for the small percentage of failulres that are not resolved by the other troubleshooting sections.

NOISY DISPLAY TRACE TEST

Whenever the noise on the trace is greater than 1 dB when you first turn the instrument ON, it means that the HP 85102 A18 ADC board may be faulty.

If the line power is cycled (off then on again), the noise may go away. If this occurs, there is probably a fault with the HP 85102 A18 ADC board although no apparent symptoms are present. Also, there may be no running error messages, no self test failures, and no service program test failures.

If the trace noise disappears when the power is cycled, replace the HP 85102 A18 ADC board.

20 Hz SINE WAVE TEST

This test checks the HP 85102 A17 sample and hold, HP 85102 A18 ADC, and the HP 85102 A19 ADC control board assemblies.

This procedure describes how to inject a signal into HP 85102 A17 J1, J2, J3, and J4 in order to test the A17 sample and hold capability for each of the four synchronous detector inputs. The procedure also tests the HP 85102 A18 ADC linearity and ability to do an analog-to-digital conversion. If this test passes, the HP 85102 A19 ADC control board is also functioning properly.

A signal generator is required that is capable of generating a 1.5V p-p sine wave at approximately 20 Hz.

Running error messages displayed when these boards fail are included below:

ADC Cal Failed
ADC Not Responding
IF Cal Failed
Sweep Time Too Fast

Procedure

1. Remove the HP 85102 IF/Detector top cover. Then remove all four snap-on RF cables from A17 J1, J2, J3, and J4.
2. Use an external signal generator to inject an approximate 1.5 V p-p 20 Hz sine wave into A17J1. You can also use 50 or 60 Hz if your signal generator is not capable of producing 20 Hz.
3. On the HP 8510, press **INSTRUMENT STATE** (RECALL) ***[MORE] [FACTORY PRESET]***. Set both start and stop frequencies to 500 MHz.
4. Set one of the A17 assembly multiplex inputs by pressing the following keys:

   PARAMETER (MENU), and then select the appropriate **USER 1-4** keys as follows, beginning with User 1:

   [USER 1 a1] softkey for A17J3 or J4

   [USER 2 b2] softkey for A17J1 or J2

   [USER 3 a2] softkey for A17J1 or J2

   [USER 4 b1] softkey for A17J1 or J2

   Press: **FORMAT** (MENU) and select one of the following:

   [REAL] softkey for A17J2 or J4

   [IMAGINARY] softkey for A17J1 or J3
5. Press: **STIMULUS** (MENU) ***[MORE] [SINGLE]***.
6. Press: **RESPONSE** (AUTO)
7. The HP 8510C CRT should display two cycles of the 20 Hz sine wave.
8. Repeat steps 4 through 7 of the procedure for each of the A17 inputs J2, J3, and J4.

   If the CRT does not display two cycles per 20 Hz, then suspect the HP 85102 A17, A18, or A19 boards. Perform all of the possible tests for these boards to isolate the failure.

SOURCE EMULATOR/TRIPLER TEST

This test uses a source emulator in place of the source to verify system operation when the source is suspected of having a fault. A 60 MHz signal is injected into the test set to emulate the source.

The "tripler" is a 60 MHz bandpass filter specially designed for the HP 8510. It operates by passing the third harmonic of the HP 85102 20 MHz output signal to the test set. However, almost any source that has a 60 MHz signal can be used. The 60 MHz bandpass filter is listed in chapter 5, "Replaceable Parts."

Procedure

1. Connect the 60 MHz bandpass filter to the HP 85102 20 MHz out BNC connector. Then connect a flexible RF cable from the filter to the test set rear panel RF input connector. Press **INSTRUMENT STATE** (RECALL) ***[MORE] [FACTORY PRESET]***. After the system has done a factory preset, change the source HP-IB address to 31. Press **AUXILIARY MENUS** (SYSTEM) ***[HP-IB ADDRESSES] [SOURCE #1]***. Then press (31) (x1).

2. Press **INSTRUMENT STATE** (RECALL) ***[MORE] [FACTORY PRESET]*** **MENUS** (MARKER) **STIMULUS** (CENTER) (60) (M/u) **STIMULUS** (SPAN) (100) (k/m) **STIMULUS** (MENU) ***[STEP]*** to set the displayed frequency to 60 MHz.

3. Press **PARAMETER** (MENU) ***[USER 1 a1]*** **RESPONSE** ***[SCALE]*** (20) (x1) to observe the channel a1 trace.

The CRT should display a trace at the marker value of approximately 50 dB. This power level is typical for the output of the 20 MHz out signal after filtering with the bandpass filter. If a power level within this range is displayed, it means that this RF path is working in the system and that the source could be faulty. Refer to section 4.3, "Unratioed Power Failures," to further check the RF paths.

Check the remaining user parameters (RF paths). The results should be the same for each one. Remember that these user parameters are the output power levels for the incident, reflected, and transmitted signal paths from the test set frequency converter.

4. Press **PARAMETER** (MENU) ***[USER 2 b2] [REDEFINE PARAMETER] [DRIVE] [PORT 2] [SCALE]*** (20) (x1) to observe the user b2 parameter.

5. Press **PARAMETER** (MENU) ***[USER 3 a2] [REDEFINE PARAMETER] [DRIVE] [PORT 2] [SCALE]*** (20) (x1) to observe the user a2 parameter.

6. Press **PARAMETER** (MENU) ***[USER 4 b1]*** **RESPONSE** ***[SCALE]*** (20) (x1) to observe the user b1 parameter.

If all the user parameters (RF paths) look good, the source is probably faulty. If they all look bad or if any one looks bad, the test set is faulty (probably the VTO or a sampler). Refer to section 4.3, "Unratioed Power Failures," to further check the RF paths in the test set.

4.8. Service Program

INTRODUCTION

The diagnostic tests and commands contained in the HP 8510 service program give a relatively fast and complete check of the HP 8510 system. When your HP 8510 system appears to have a failure, you can use this program along with other procedures to check the instrument board assemblies. The service program tests do not completely check all board assemblies, but are designed to exercise the most vulnerable parts of each board. If all tests pass, there is a 90% confidence level that all board assemblies tested are good.

After you familiarize yourself with this program, you can refer to the menu map included in this section. It is a map of all service program tests and the assemblies checked by each test.

Run the service program to:

- Identify/verify a failed assembly after a self test failure.
- Identify/verify a failed assembly after a running error message.
- Check board assemblies whenever a board assembly problem is suspected.
- Verify repair of a replaced board assembly.

TOOLS REQUIRED

The following items are required to run all parts of the service program:

- HP 85102 emulator board assembly
- HP 8510 service adapter
- Two BNC cablesThe HP 85102 emulator board assembly and the HP 8510 service adapter are available individually. Refer to Chapter 5, "Replaceable Parts," for HP part numbers and ordering information.

RUNNING THE HP 8510 SERVICE PROGRAM

To run the service program, press the following keys on the HP 8510:

AUXILIARY MENUS (SYSTEM) ***[MORE]***
[SERVICE FUNCTIONS] [TEST MENU]
(22) (=MARKER)

Refer to the menu map included in this section. It shows all service program tests and assemblies tested.

HOW TO INTERPRET SERVICE PROGRAM TEST RESULTS

The service program tests do not completely check all board assemblies, but are designed to exercise the most vulnerable parts of each board. If all tests pass, there is a 90% confidence level that all board assemblies tested are good.

If service program tests indicate a failure in a board assembly, there is a 75% probability that the board assembly indicated is bad. First make sure there are are no fundamental problems such as an improperly-seated board, and so forth.

If the HP 8510C has failed and the service program tests pass, then check to see that there are no fundamental problems such as wrong cable connections, error mesages due to improperly-seated boards, or "extra" HP-IB cables attached to the analyzer but not to anything else.

HP 8510 SERVICE PROGRAM MENU MAP

This defines the service program menu. From this map, you can access separate menus for testing the HP 85101C, 85102, or the test set. Figure 4.8-1, "HP 8510C Service Program Menu," is located at the end of this section.

HP 85101 DISPLAY/PROCESSOR SERVICE PROGRAM MENU

From this menu access four different menus associated with HP 85101C troubleshooting. You can enter this menu by pressing (1) (=MARKER). Use it to select the specific menu that you want. The four categories correspond to the four boards in the card cage - instructions for removing and replacing boards in it are given in the section titled ASSEMBLY/DISASSEMBLY. Note that the boards tested in each menu are shown in parenthesis below.

NOTE: If you disconnect the HP 85101 Display/Processor from all of the other instruments, you can verify its stand-alone operation. Disconnect all HP-IB cables and all other cables so that only the line voltage cord remains. Turn on the HP 85101C by pressing the line switch on the left edge of the HP 85101C.

HP 85101 CPU BOARD TESTS (A5)

This menu tests the functions of the CPU board, the address bus, and the data bus. The tests marked with an asterisk are intended for factory use only.

DRAM Refresh Test . . 1

Tests the dynamic RAM refresh controller. The interrupt system is turned on and is delayed by 8 ms before checking that a refresh interrupt occurred.

Read/Write/Shift Accumulator Test . . 2

Tests the math processor on the A5 CPU. Press (0) and (=MARKER) to run this test automatically. Data is written into the accumulators, shifted, and then read back and checked for proper results. A manual version of this test is for factory use only.

Multiplier Test . . 3

Tests the math processor by doing multiplication in the registers. Run this test in auto mode to find any failures in the multiplier. A manual version of this test is for factory use only.

Complex Multiply Test . . 4

This is the same test as self test 10 except for one difference. If there is an error, it displays the expected and received data rather than just the fact that it is faulty due to an error.

Circle Test (Exercises Multiplier) . . 5

This sets up a data pattern to the multiplier bus in order to troubleshoot the multiplier circuits. This test was designed for factory troubleshooting only.

Signature Analysis - Multiplier . . 6

Signature analysis is intended for factory use only. This test generates a pattern that can be used to check math processor signatures on the A5 CPU.

Signature Analysis - Address Bus . . 7

Signature analysis is intended for factory use only. This test provides a stimulus for checking signatures on the address bus.

Signature Analysis - (Data Bus) . . 8

Signature analysis is intended for factory use only. Provides a stimulus for checking signatures on the Display Generator data bus.

HP 85101 I/O BOARD AND FRONT PANEL TESTS (A1, A2, A7)

The A7 I/O board is located in the card cage. The A1 front panel board includes the keyboard, and A2 is the disk drive assembly. These assemblies work together to perform front panel commands and disk media transfer operations.

Disc Controller Bus Test (A7) . . 1

This test reads and writes to registers on the A7 I/O that control the disk drive.

Disc Write/Read Test (A2, A7) . . 2

This tests the status of the disk drive, adjusts to high or low density disks, and then writes and reads to one sector of the disk on each side. It writes again in another location, then reads back everything and verifies. If there is no disk in the drive, or if it is write-protected, then the status will be displayed and the test halted.

Timer Test (A7) . . 3

This tests all three sections of the programmable timer. It is set up with a known value and then read back to see that it has counted down.

Serial I/O Test (A7) . . 4

A special interconnect electronic tool is required to perform this test. This tool is not available to the field. This tests the bi-directional communication of the serial I/O ports on the rear panel of the HP 85101C. Data flow is from RS-232 Port 1 to RS-232 Port 2, and then the data is sent back to RS-232 Port 1.

Timer Clock Peripheral (TCP) Tests (A7) . . 5

This is a combination of seven tests that check out and set the TCP chip for beeper and time/date functions.

CPU to HP-IB Test (A7) . . 6

This routine creates a test pattern, then initializes the HP-IB chip to cause an internal echo of the data. The resulting data is compared to the original, and error messages are generated. The above sequence is repeated for each port. Nothing should be connected to the rear panel during this test.

Bidirectional HP-IB Test (A7) . . 7

Tests the ability of the HP-IB chips to communicate with each other in both directions (to and from). The CRT message will prompt you to connect the HP-IB to the SYSTEM bus. Use the HP-IB cable that would normally connect the test set to the HP 85101C, and make the connection from the system bus to the HP-IB on the rear panel of the HP 85101C. Then run the test. If the test fails, the A7 board, the cable connection, or the cable may be faulty.

Static Interrupt System Test (A7) . . 8

This routine exercises the CPU interrupt system on the A7 I/O board. This is a "static" test of the interrupt system; it is a simple means of detecting major system problems.

RPG Test (A1, A7) . . 9

Tests the RPG (rotary pulse generator) knob and front panel interface to that knob. Run the test and verify that the displayed RPG count is 00 Hex. Turn the knob counterclockwise and verify that the count increases. Then turn the knob clockwise and verify that the count decreases. You can go either way because the count wraps around from 00 Hex to FF Hex.

Keyboards and LEDs Test (A1, A7) . . A (G/n)

Tests the front panel keys and LEDs and their interface to the A7 I/O board. Run the test and first check that the HP 85101C front panel LEDs (RLTS 1248) are flashing on and off. If they are not, the A1 or A7 board is faulty. However, if they are flashing, continue the test by pressing the key that is displayed on the CRT. After each key is displayed, press that same key on the front panel.

HP 85102 Interface Test (A7) . . B (M/u)

This test verifies that the HP 85101C can communicate with the HP 85102. It requires the HP 85102 emulator (listed in chapter 5, "Replaceable Parts"). This emulates or takes the place of the HP 85102 IF/Detector. The emulator can be connected in two different ways:

1. Connect the male end directly to the IF-Display interconnect on the back of the HP 85101C.
2. Connect the IF-Display interconnect cable to the IF-Display interconnect, and then connect the female end to the other end of the cable. Using it this way, you can determine if there is any problem with the IF-Display interconnect cable.

Dynamic Interrupt System Test (A7) . . C (k/m)

This test is used in the factory only and is not intended for use in the field. It requires a different HP 85102 electronic emulator board.

Security Keys Interface Test (A7) . . D (X1)

This test is used in the factory only and is not intended for use in the field. A special electronic tool is required.

Watchdog Timer Test (A7) . . E (+/-)

Tests the ability of the CPU watchdog timer to reset the processor. Running this test will also reset the HP 8510C as if you pressed the recessed front panel TEST button. It will be necessary for you to enter the service program again if you run this test.

HP 85101 DISPLAY BOARD AND CRT TESTS (A4, A11)

GSP Address Decoder Stimulus Loop . . 1

This test strobes the interface address lines between the CPU and the graphics system processor (GSP) for oscilloscope troubleshooting. A scope trigger is provided by HTEST on the A7 I/O board. LED 1 is lit to indicate this test is active to help the troubleshooter who may not have a functioning display. The scope pattern is not clear except to those familiar with the patterns of good working units.

GSP Data Line Stimulus Loop . . 2

This test sends a continuous loop of "walking 1s" to the CPU-GSP interface data lines for scope troubleshooting. LED 2 is lit to indicate an active test. A scope trigger is provided by HTEST on the A7 I/O board.

Ramp Background DAC Loop . . 3

A continuous negative-going staircase pattern should be seen at TP4 on the A4 GSP board. A scope trigger is provided by HTEST on the A7 I/O board. This signal is generated by applying a digital ramp to the background DAC. LEDs 1 and 2 are lit to indicate that the test is active.

Ramp Intensity DAC Loop . . 4

A continuous negative-going staircase pattern should be seen at TP5 on the A4 GSP board. A scope trigger is provided by HTEST on the A7 I/O board. This signal is generated by applying a digital ramp to the intensity DAC. LED 4 is lit to indicate that the test is active.

Calibrate Background and Intensity . . 5

A password is required to run this test. It also requires a special digital photometer with probe and a light occluder. A three-step grayscale is used to set background where all three steps are just visible. Intensity is then set. All settings and the date are then stored. For a complete procedure, refer to chapter 7, "Adjustments."

Recall Background and Intensity Calibration . . 6

This recalls the calibration that is stored in nonvolatile memory and loads the appropriate DACs with the data.

Screen Test Patterns . . 7

This test provides 15 screen patterns for use in evaluating and adjusting the display. With these patterns, the following display qualities can be evaluated:

color purity
grayscale
focus
astigmatism
geometric distortion
convergence

Use the up/down keys, RPG knob, or the numeric keypad to select different patterns. To exit this test, press (=MARKER).

Softkey Label Alignment Pattern . . 8

This is a screen test pattern used to vertically align the display to the softkey positions.

HP 85101 NON-VOLATILE MEMORY BOARD (A6) TESTS

CAUTION

These tests require initialization of the EEPROMs on the A6 EEPROM board. This procedure erases parts of the operating system. The operating system MUST be reloaded after these tests are completed. Do not run these tests unless you are sure they are required for service, and unless you can reload your operating system from disk, when finished.

Password Entry

When the A6 EEPROM board test menu is selected from the HP 85101 Display/Processor service program menu, a message is displayed that requires a password to allow access to these tests. The password is 8515.

The purpose of the password is to ensure that these destructive tests are not run by accident.

Initialize Memory Board . . 1

This routine is used to initialize a new or repaired A6 EEPROM board prior to loading the operating system. It must be done at least once to an A6 board or the assembly will not function. This test should not be used for any other reason because it will erase the operating system code in that area of memory. It takes approximately five seconds to complete.

When the test is run, the message "Board Initialization in Progress..." will be displayed. When the EEPROMs have been initialized, the message "Initialization Completed" will be displayed.

After the test, it may be necessary to recalibrate the display and the beeper frequencies.

Complete Memory Board Unformatted Write/Read Test . . 2

This test checks the ability of non-volatile memory (EEPROMs) to correctly store data. This test takes approximately two minutes to complete.

The test writes to and reads from each EEPROM and reports where the first error occurred by giving the memory bank position, including upper (most significant) or lower (least significant) byte in the bank.

The subtest number that failed is reported. Normally, a good memory will report subtest 0.

Press (=MARKER) to re-initialize memory and return to the main menu of the nonvolatile memory board tests.

Complete Memory Board Formatted Write/Read Test . . 3

This test prompts the user for a hexadecimal bit pattern to write into and read from memory. Then it prompts for the start and stop page numbers. Normally, you would start at page 0000 and stop on the last available page in memory. These page numbers depend on how many EEPROMs are loaded in the A6 EEPROM board. Running test 8 will show how many pages are in your A6 EEPOM board, provided the board successfully initialized.

In the HP 85101C there is error-correction firmware that can cover up defects in EEPROM in this test. The usefulness of this test may therefore be limited and may best be used to check the error-correction capabilities. Use "Write Unformatted Data to Selected Memory Locations" to perform pattern writes in an uncorrected mode. This will destroy initialization and hardware calibration data.

Read/Verify Test 3 Data Again . . 4

This test re-verifies the data stored in memory from the prior test. It reports the first failed page. As explained in the previous test, error-correction is on the test and will not reliably show EEPROM failures.

Write Unformatted Data to Selected Memory Locations . . 5

The board must be re-initialized after this procedure. This test allows the user to input the size of the memory to write to, and the location and pattern. It reports problems with the write if any, and prompts to allow looping writes. The test reads the pattern back, and reports all locations where a pattern mismatch exists. There is no formatting, and hardware cal data may be lost. Also, repeated looping writes to EEPROM will reduce memory life span.

Read/Verify Test 5 Data Again . . 6

This test re-verifies the data stored in memory from the previous test. It displays any errors exactly as the previous test would display them. This re-verification is useful for detecting the type of EEPROM failure where memory is lost after a lapse of time.

Read Locations Where Hardware Cal Data Is Stored . . 7

This lists the data stored in formatted pages 1 and 2 of the A6 EEPROM board, and the data stored in page 1 of the timer clock peripheral RAM on the A7 I/O board. The date for the background and intensity DAC cal is also stored.

Show Non-Volatile Memory Parameters . . 8

This uses the EEPROM driver firmware to find out how it has calculated certain memory parameters. The A6 EEPROM board must be initialized for the driver to have the information. It returns the value for number of formatted pages and the present position of the memory pointer.

Reset Memory to Default Hardware Cal Data . . 9

This is meant for use by the factory only. This test requires the user to enter a password. It initializes memory and then loads pages 1 and 2 with the hardware default cal data. This should be done only as a last resort when all memory is lost.

HP 85102 IF-DETECTOR SERVICE PROGRAM MENU

This is the primary HP 85102 menu. It allows you to select any of the tests for the IF/Detector.

NOTE: Read the following instructions before using the HP 85102 diagnostics.

HARDWARE

These tests require that the source, test set, and all peripherals be disconnected from the system. In place of the source and test set, connect the HP 85102 test adapter. Refer to chapter 5, "Replaceable Parts," for the HP part number of this tool.

Connect the adapter, using a BNC cable, from the 20 MHz output on the rear panel of the HP 85102 to the IF-Display interconnect, also on the rear panel of the HP 85102. This test adapter takes a fixed 20 MHz IF reference signal from the HP 85102 and uses it in place of the 20 MHz IF from the test set. The test set down-converts the source RF to a 20 MHz IF. To verify the 20 MHz output, use an oscilloscope terminated in 50 ohms and you should see an approximate 0.7 volt p-p square wave signal with rounded corners. Or, if the scope is not terminated in 50 ohms, the 20 MHz signal is a distorted signal (like a sine-wave with a large third harmonic) of about 1.8 volts p-p.

Also connect a separate BNC cable from the ANALOG ±10V to the SWEEP IN 0-10V, both located on the rear of the HP 85102. This connection will provide a trigger input to the sweep ADC in the HP 85102.

HP 85102 PROMPT MESSAGE

A message will appear on the CRT, prompting you to make the connections explained in the paragraph titled "Hardware" above. Be sure you make these connections, or the diagnostics will not report valid results.

After making the connections, press (=MARKER) to get to the HP 85102 IF/Detector service program menu. Remember to reconnect the proper system cables after you are finished. Refer to chapter 9, "Installation," if necessary.

ORDER OF TESTING

These tests must be run in a specific order because of the relationship between the boards in the HP 85102. There is a specific signal flow that corresponds to the arrangement of the boards in this instrument. Therefore, it is recommended that you use the Run All mode first whenever you suspect a problem or replace a board in this instrument. This Run All mode will run all the tests in a specific order. Later, you can run the tests individually. Also, the Run All or any individual tests can be looped repeatedly to look for intermittent errors.

Again, because of the interdependence of the boards, it is possible to fail a specific test although the real failure is due to a problem on a different board. This is because the other board provided a faulty signal to the board that appeared to fail. The following sequence is recommended to minimize the chance of erroneous test failures. When running the tests separately, run them in the order below:

1. ADC control test (A19).
2. Sweep ADC (A20), ADC (A18), and 100 kHz IF amplifiers (A10, A12).
3. Cal DAC (A17), Mixers (A9, A11, A13, A14), synchronous detectors (A5, A7), and all others.

ADC Control Test (A19) . . 1

Tests the ability of the A18 ADC board to execute a complete set of conversions and generate an ADC interrupt request. This test verifies that the processor can trigger the ADC state machine on the A19 ADC control board. It also verifies that the state machine on A19 sequences properly and that a conversion is actually completed by the closely related A18 ADC board. Also, it verifies that the A19 repeat and delay counters are working properly.

Other causes of failure on this test may be:

- A faulty A6 clock board
- A faulty 10 MHz input to the A19 ADC control board
- A faulty 800 kHz signal in to the A18 ADC board

Sweep ADC Test (A20) . . 2

This test checks the following items on the A20 sweep ADC board:

- pulse generator
- trigger generator
- sweep counter
- input buffer
- sweep crossing detector
- staircase generator

It also tests the analog output DAC programmability of the A21 IF counter board. The A6 clock board must be working properly for this test to pass.

ADC Test (A18) . . 3

This test verifies that the board can be operated in calibration mode. It also verifies proper operation of the offset current source, 12-bit ADC, and all data RAMS. Failure messages may indicate which data bits are faulty. These types of messages are only useful for factory repair technicians.

Other causes of failure of this test may be:

- The multiplexer of the A17 sample and hold board is injecting a signal into the A18 ADC board. If it does fail, remove the W24 cable that connects A17 sample and hold to A18 ADC. If it passes after that, the A17 sample and hold board is probably faulty.

Cal DAC Test (A17) . . 4

This test verifies that the CAL DAC on the A17 sample and hold board can properly calibrate the eight-bit DAC on the A18 ADC board. The ADC test should be run prior to this test. Additionally, the running error message "ADC CAL FAILED" can be the result of a faulty A17 sample and hold board.

Other causes of failure of this test may be:

- A faulty A18 ADC board, primarily the 10 volt reference.

100 kHz IF Amplifier Test (A10, A12) . . 5

This test verifies the ability of the test and reference amplifier boards (A10 and A12, respectively) to pass and amplify the 100 kHz IF signals.

Other causes of failure of this test may be:

- Faulty A24 processor interface board
- Faulty 100 kHz IF address decoder on the A6 clock board
- Faulty 100 kHz Cal signal on the A6 clock board
- If both boards (A10, A12) fail, the A6 clock is probably faulty

Synchronous Detector Test (A5, A7) . . 6

This test verifies that both A5 and A7 synchronous detector boards are working properly. It is also used to detect failures with the A17 sample and hold board circuitry. However, you must run the ADC test (A18) and 100 kHz IF amp test (A10, A12) before running this test. If those tests pass, then you can run this test and have confidence in the results.

Other causes of failure of this test may be:

- Faulty A18 ADC and/or A19 ADC control board
- Faulty A10 or A12 IF amplifiers
- Faulty A6 clock board

20 MHz Mixer Test (A9, A11, A13, A14) . . 7

This test verifies the ability of the A9, A11, A13, and A14 mixer boards to down-convert the 20 MHz IF signals to 100 kHz. This test is a good example of the use of the 20 MHz output of the HP 85102. Before running this test, be sure that the 100 kHz IF amplifier test (A10, A12) has passed.

Other causes of failure of this test may be:

- Faulty A10/A12 IF amplifier boards
- Faulty 20 MHz signal from the A6 clock board
- Faulty 19.9 MHz signal from the A8 LO generator

Pretune Phase Lock Test (A22) . . 8

This test verifies the ability of the A22 pretune control board to count the 20 MHz signal on the VTO sense line. The test also verifies that the phase detector on the A22 pretune control is working. Refer to chapter 3, "Theory Of Operation," for more information on how the phase lock system operates.

Main Phase Lock Test (A23) . . 9

This test verifies the operation of the attenuator switches, lock indicator, search/offset DAC, and mode switch. Refer to chapter 3, "Theory Of Operation," for more information on how the phase lock system operates.

IF Counter Test (A21) . . A (G/n)

This test verifies the operation of the following circuits on the A21 IF counter:

- Reference channel select switch
- Counter circuit
- Gate generator
- Amplifier limiter

Other causes of failure of this test may be:

- A13 and/or A14 mixer boards that provide the 20 MHz signals to the A21 IF counter

Run All The Above Tests . . B (M/u)

HP 85102 Front Panel Test . . C (k/m)

This test allows you to check each front panel key. You press the key and the test verifies its operation. This test is not done in the Run All The Tests selection.

TEST SET HP-IB PROGRAM MENU

The tests on this menu verify the ability of the A4 HP-IB board in the test set to execute certain commands. Also, these tests verify operation of the A5 attenuator/switch driver board for S-parameter test sets only. These tests can be run with the test set connected to the entire system and also with the test set only connected to the HP 85101C. For more troubleshooting information about the test set, refer to section 4.3, "Unratioed Power Failures."

Preset Test Set . . 1

This test initializes the test set to its own preset state:

- 0 dB attenuation
- Power to port 1
- S11 display
- Active light on port 1

The test set must be at HP-IB address 720 or just 20 on the switches. If this test fails, the failure message will remain on the CRT even if you run any other test or if you run this test again and it passes. To clear the failure message from the CRT, exit this menu and return.

Switch Active Light . . 2

This test toggles the front panel active light when the (=MARKER) key is pressed. This test verifies that the light is working properly.

Switch Port 1,2 Lights . . 3

This test switches the two front panel LEDs on an S-parameter test set to display all four possible states: 00, 01, 10, 11. This test verifies that the A5 board can switch power between the ports - separately and together. Also, the test set A5 attenuator/switch driver board has two LEDs that should also light as you press the (=MARKER) key to toggle the power to all four states.

Activate Port 1,2 Attenuator . . 4

This test alternately activates/deactivates port 1 and 2 attenuators. This test is used together with the following test to verify that the attenuators in the S-parameter test set are functioning.

Increment Active Attenuator . . 5

This tests the test set attenuator of the activated port (selected by test 4 above) by incrementing attenuation in 10 dB steps (0 to 90 dB). You may be able to hear the relays clicking as the values are changed. The value of the sum of the ON green LEDs on the A5 attenuator/switch driver board should equal the number indicated on the CRT.

Select New HP-IB Address . . 6

This test changes the address that the HP 85101C will seek when performing future test set HP-IB commands. Remember, it does not change the address of the actual test set DIP switches. If you use this routine to change the HP 8510C test set address, remember to change the switches on the test set to match the changes you make.

IF THE TEST DOES NOT VERIFY OR ISOLATE THE FAILURE

If after running these service program tests, you suspect a single board, use the Run All mode first and then run the single board test afterward. If running the test does not verify the failure, refer to section 4.7, "Other Failures." That section contains additional information about some of the tests in this program. For example, if you have a running error message, and you are referred to this section to run a test, but it passes, check section 4.7, "Other Failures," to see if there is any further testing you can do.

FAILURE AFTER REPAIR

If a failure is detected after a board is replaced, the failure may be the result of a board that is indirectly related to the failed board. If this happens, you should check the following boards: A15 power supply, A6 clock board, and the A24 processor interface. Those boards affect all other boards and, if they are faulty, they can cause most other boards to fail a test. Be sure to check those boards if a replaced board still fails a test.

STEM MENU

PULSE CONFIG · EDIT SRC. · /TIME TIONS · YSTEM CLOCK · POWER /ELING · OUT ON | OFF · RVICE TIONS

SERVICE FUNCTIONS MENU

SERVICE MENU
SYSTEM BUS 'LOCAL' | 'REMOTE'
IF GAIN
PEEK/POKE LOCATION
PEEK | POKE
SOFTWARE REVISION

MAIN SERVICE FUNCTIONS MENU

LOOPING SELF TESTS

1 A5 PROCESSOR EPROM
2 A5 PROCESSOR RAM
3 A7 DATA BUS
4 A4 DISPLAY PROCESSOR
5 A4 DISPLAY RAM
6 A7 TIMER/CLOCK/RS-232
7 A7 PUBLIC HP-IB
8 A7 SYSTEM BUS
9 INTERRUPT SYSTEM
10 A5 MULTIPLIER
11 A7 DISC CONTROLLER
12 A6 NON-VOLATILE MEMORY
13 IF DETECTOR DATA
14 KEYBOARD

SYSTEM COMMANDS

15 RUN MAIN PROGRAM
16 MEMORY OPERATIONS
17 RERUN SELF TEST
18 REPEAT TEST LOOP

DISC COMMANDS

19 LOAD PROGRAM DISC
20 RECORD PROGRAM DISC
21 INITIALIZE DISC

SERVICE COMMANDS

22 RUN SERVICE PROGRAM
23 DIAGNOSE A FAILURE

ENTER SELECTION, THEN PRESS =MARKER

HP 8510 SERVICE PROGRAM MENU

HP 85101 DISPLAY/PROCESSOR SERVICE PROGRAM	1
HP 85102 IF/DETECTOR SERVICE PROGRAM	2 **(See next page)**
TEST SET HP-IB SERVICE PROGRAM	3 **(See next page)**
RETURN TO MAIN SERVICE FUNCTIONS MENU	F (see note 1)

NOTES: (1) Hex digits A thru F are assigned to [G/n], [M/u], [k/m], [X1], [+/-], and [.] respectively.

(2) To make a selection, type the number indicated, then press =MARKER.

(3) The default value on data entry is zero.

HP 85101 DISPLAY/PROCESSOR SERVICE PROGRAM MENU

CPU BOARD TESTS (A5)	1
I/O BOARD AND FRONT PANEL TESTS (A1, A2, A7)	2
DISPLAY BOARD AND CRT TESTS (A4, A11)	3
NON-VOLATILE MEMORY BOARD TESTS (A6)	4
RETURN TO HP 8510 SERVICE PROGRAM MENU	F [.]

CPU BOARD TESTS (A5)

DRAM REFRESH TEST	1
READ/WRITE/SHIFT ACCUMULATOR TEST	2
MULTIPLIER TEST	3
COMPLEX MULTIPLY TEST	4
CIRCLE TEST (EXERCISES MULTIPLIER)	5
*SIGNATURE ANALYSIS – MULTIPLIER	6
*SIGNATURE ANALYSIS – ADDRESS BUS	7
*SIGNATURE ANALYSIS – DATA BUS	8
RETURN TO HP 85101 SERVICE PROGRAM MENU	F [.]

* – For factory use only.

TO RETURN TO THIS MENU AFTER COMPLETING A TEST, PRESS THE =MARKER KEY

HP 85101 I/O BOARD AND FRONT PANEL TESTS (A1, A2, A7)

DISC CONTROLLER BUS TEST (A7)	1
DISC WRITE/READ TEST (A2, A7)	2
TIMER TEST (A7)	3
SERIAL I/O TEST (A7)	4
TIMER CLOCK PERIPHERAL (TCP) TESTS (A7)	5
CPU TO HP-IB TEST (A7)	6
BIDIRECTIONAL HP-IB TEST (A7)	7
STATIC INTERRUPT SYSTEM TEST (A7)	8
RPG TEST (A1, A7)	9
KEYBOARD AND LEDS TEST (A1, A7)	A [G/n]
HP 85102 INTERFACE TEST (A7)	B [M/u]
*DYNAMIC INTERRUPT SYSTEM TEST (A7)	C [k/m]
*SECURITY KEYS INTERFACE TEST (A7)	D [X1]
WATCHDOG TIMER TEST (A7)	E [+/-]
RETURN TO HP 85101 SERVICE PROGRAM MENU	F [.]

* – For factory use only.

TO RETURN TO THIS MENU AFTER COMPLETING A TEST, PRESS THE =MARKER KEY

HP 85101 DISPLAY BOARD AND CRT TESTS (A4, A11)

GSP ADDRESS DECODER STIMULUS LOOP	1
GSP DATA LINE STIMULUS LOOP	2
RAMP BACKGROUND DAC LOOP	3
RAMP INTENSITY DAC LOOP	4
CALIBRATE BACKGROUND AND INTENSITY	5
RECALL BACKGROUND AND INTENSITY CALIBRATION	6
SCREEN TEST PATTERNS	7
SOFTKEY LABEL ALIGNMENT PATTERN	8
RETURN TO HP 85101 SERVICE PROGRAM MENU	F [.]

TO RETURN TO THIS MENU AFTER COMPLETING A TEST, PRESS THE =MARKER KEY

CAUTION: The following tests will erase non-volatile memory. To access these tests, enter the password, then press =MARKER. To exit, just press =MARKER.

(Refer to the Service Manual for the password)

HP 85101 NON-VOLATILE MEMORY BOARD (A6) TESTS

INITIALIZE MEMORY BOARD	1
COMPLETE MEMORY BOARD UNFORMATTED WRITE/READ TEST	2
COMPLETE MEMORY BOARD FORMATTED WRITE/READ TEST	3
READ/VERIFY TEST 3 DATA AGAIN	4
WRITE UNFORMATTED DATA TO SELECTED MEMORY LOCATIONS	5
READ/VERIFY TEST 5 DATA AGAIN	6
READ LOCATIONS WHERE HARDWARE CAL DATA IS STORED	7
SHOW NON-VOLATILE MEMORY PARAMETERS	8
*RESET MEMORY TO DEFAULT HARDWARE CAL DATA	9
RETURN TO HP 85101 SERVICE PROGRAM MENU	F [.]

* – For factory use only.

TO RETURN TO THIS MENU AFTER COMPLETING A TEST, PRESS THE =MARKER KEY

ENTRY AREA HEX KEYS

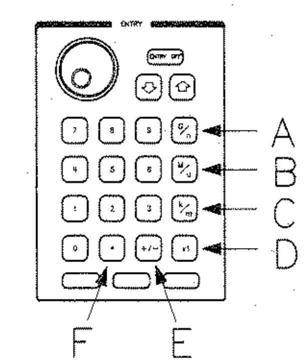


Figure 4.8-1 HP 8510C Service Program Menu (1 of 2)

HP 85101

PASSWORD ENTRY

HP 8510 SERVICE PROGRAM MENU

HP 85101 DISPLAY/PROCESSOR SERVICE PROGRAM	1 **(See prev. page)**
HP 85102 IF/DETECTOR SERVICE PROGRAM	2
TEST SET HP-IB SERVICE PROGRAM	3
RETURN TO MAIN SERVICE FUNCTIONS MENU	F (see note 1)

NOTES: (1) Hex digits A thru F are assigned to [G/n], [M/u], [k/m], [X1], [+/-], and [.] respectively.

(2) To make a selection, type the number indicated, then press =MARKER.

(3) The default value on data entry is zero.

TEST SET HP-IB PROGRAM MENU

PRESET TEST SET	1
SWITCH ACTIVE LIGHT	2
*SWITCH PORT 1,2 LIGHTS	3
*ACTIVATE PORT 1,2 ATTENUATOR	4
*INCREMENT ACTIVE ATTENUATOR	5
SELECT NEW HP-IB ADDRESS	6
RETURN TO HP 8510 SERVICE PROGRAM MENU	F [.]

* - For test sets with appropriate feature.

NOTES: (1) To repeat a function, press =MARKER.
(2) The default Test Set HP-IB address is 20.

On the HP 85102 rear panel, connect '20MHz OUT' to 'J1 TEST SET INTERCONNECT' using the service adapter and a BNC cable. Also, connect 'ANALOG +-10V' to 'SWEEP IN 0-10V' using another BNC cable. Failure to do so will result in false error messages.

PRESS =MARKER TO CONTINUE . . .

HP 85102 IF/DETECTOR SERVICE PROGRAM MENU

ADC CONTROL TEST (A19)	1
SWEEP ADC TEST (A20)	2
ADC TEST (A18)	3
CAL DAC TEST (A17)	4
100 kHz IF AMPLIFIER TEST (A10, A12)	5
SYNCHRONOUS DETECTOR TEST (A5, A7)	6
20 MHz MIXER TEST (A9, A11, A13, A14)	7
PRETUNE PHASE LOCK TEST (A22)	8
MAIN PHASE LOCK TEST (A23)	9
IF COUNTER TEST (A21)	A [G/n]
RUN ALL THE ABOVE TESTS	B [M/u]
HP 85102 FRONT PANEL TEST	C [k/m]
RETURN TO HP 8510 SERVICE PROGRAM MENU	F [.]

NOTE: Always check cables leading to and from boards with suspected problems.

Figure 4.8-1 HP 8510C Service Program Menu (2 of 2)

4.9. Error Terms

INTRODUCTION

Error terms are factors used for error correction, or accuracy enhancement, in the analyzer system when correction is turned on. Error terms are numbers generated and stored in internal arrays during a measurement calibration. They are also known as *E-terms* or measurement calibration coefficients. Descriptions of the individual error terms are provided at the end of this section.

Error terms can also serve a diagnostic purpose. Specific parts of the analyzer system and accessories contibute to the values of the error terms. Since we know this correlation and we know what typical error terms look like, we can examine error terms to monitor system performance or to identify faulty components in the system.

Error terms are created by measuring well-defined calibration devices over the frequency range of interest and comparing the measured data with the ideal model for the devices. Neglecting drift and random errors (such as noise), the differences represent systematic (repeatable) errors of the network analyzer system. The resulting measurement calibration coefficients are good representations of some raw error sources of the system.

Use the procedures in this section to generate and examine error terms. This information can be useful in two ways:

Preventive Maintenance. A stable, repeatable system should generate repeatable error terms over long time intervals, for example six months. Make a hardcopy record (print or plot) of the error terms, then periodically compare current error terms with the record. A sudden shift in error terms reflects a sudden shift in systematic errors or a degradation of cal standards, and may indicate the need for further troubleshooting. A long-term trend usually reflects drift, connector or cable wear, or gradual degradation of calibration devices, indicating the need for further investigation and preventive maintenance. Note that the system may still conform to specifications. The cure is often as simple as cleaning and gaging connectors and cal standards or inspecting cables.

Troubleshooting. If a subtle failure or minor performance problem is suspected, the magnitude of the error terms should be compared against values generated previously with the same system and calibration kit. This comparison will produce the most precise view of the problem.

Consider the following while troubleshooting:

These procedures are especially good for determining if a calibration is bad or the test set is faulty.

All parts of the network analyzer system, including cables and calibration devices, can contribute to systematic errors and impact the error terms.

Connectors must be clean, gaged, and within specification for error term analysis to be meaningful.

Avoid unnecessary bending and flexing of the cables following measurement calibration, to minimize cable instability errors.

Use good connection techniques during the measurement calibration. The connector interface must be repeatable. Refer to the *Microwave Connector Care Manual* for information on connection techniques and on cleaning and gaging connectors.

Use error term analysis to troubleshoot minor, subtle performance problems. Refer to chapter 4, "Main Troubleshooting Procedure," if a blatant failure or gross measurement error is evident.

It is often worthwhile to perform the procedure twice (using two separate measurement calibrations) to establish the degree of repeatability. If the results do not seem repeatable, check all connectors and cables.

The errors displayed on the CRT by the verification program may be greater than the specified total uncertainty errors that you print out using the specifications program. This can be due to bad connections during calibration or verification; or to devices, cables, or rear panel test set extension links that are faulty (dirty or damaged). In addition, defective calibration devices can be the cause of degraded error term data, just as careless calibration methods can.

MEASUREMENT CALIBRATION

Always perform a measurement calibration before doing the error term inspection. If the system includes an S-parameter test set, do a full 2-port calibration. For systems with a reflection/transmission test set, do a one-path 2-port calibration.

ERROR TERMS INSPECTION PROCEDURE

This procedure uses the specifications software to display and print out the system error terms. It compares the raw error terms to the printout of the specifications, to show whether any E-terms are out of specification.

Equipment

- HP 200 or 300 series controller (except HP 9826) with 2 megabytes of available memory after loading HP BASIC
- Specifications/verification software
- Calibration kit
- Compatible printer

Procedure

1. Set up the system with the controller connected to the HP 8510 over HP-IB.
2. Refer to chapter 8, "Specifications and Performance Verification," for instructions on running the specifications/verification software.
3. Within the specifications/verification program, use the controller softkeys to select the configuration of your system.
4. Select the system specs menu, then test port errors (correction off) to view the forward direction E-terms. Print out the E-terms.
5. Select the reverse direction E-terms, and print them out.
6. Perform the appropriate measurement calibration (2-port for a system with an S-parameter test set, one-path 2-port for a transmission/reflection test set).
7. Select the verifiction program with the VERIFY SYSTEM selection. Select DISPLAY ETERM to display the error terms.
8. On the printouts you made in steps 4 and 5, find the column of raw error terms. Use these raw error term figures to compare to the displayed E-terms.
9. Select each E-term and compare the CRT trace to the raw specifications in the corresponding printouts. Use the HP 8510 marker to read the trace values.

If the trace values are close to or better than the specified values, this is a normal situation.

If the trace value is significantly worse than the specified value, first suspect the calibration. Recalibrate, and display the E-terms again. If this does not solve the problem, the fault is in the cables or calibration devices, the test set, or the source. Try substituting cables and calibration devices. If the problem still exists after another recalibration, refer to section 4.3, "Unratioed Power Failures."

NOTE: If you cannot solve the problem, save the results of this entire procedure, and contact an HP customer engineer.

ERROR TERM DESCRIPTIONS

The following paragraphs describe the individual error terms, the devices used to characterize them in a measurement calibration, and the measurements they affect; and explain how they relate to faults in the system.

Directivity (Edf and Edr)

These are the uncorrected forward and reverse directivity errors of the system (mainly of the test set). These terms vary with frequency, but values that are worse than the specifications may indicate an error or mechanical malfunction in the test set or in the devices used for the reflection calibration. The calibration device used to characterize the directivity error term is usually a load. This may be a lowband fixed load for frequencies below 2 GHz, a broadband fixed load, a sliding load for frequencies above 2 GHz, or it may be an offset load for higher frequencies. The measurements most affected by directivity errors are low-reflection measurements: high-reflection measurements may appear normal.

Source Match (Esf and Esr)

These are the forward and reverse uncorrected source match terms of the driven port. The source match, in this case, is determined primarily by the match of the test set power splitter and the main line coupler or bridge. In some test sets, the match of the bias tees and step attenuators is also included. The calibration devices used to characterize source match are the short and the shielded open, or offset short for millimeter-wave devices. A bad connection of either of these during the calibration procedure can cause bad source match E-term data. The measurements most affected by source match errors are high-reflection measurements, and transmission measurements of highly reflective DUTs. Poor source match, when associated with poor directivity, is probably an indication of a defective coupler or bridge in the test set. Poor source match alone may be caused by a mismatch in the test set, the test set port connector, the cable between the RF source and the test set, or the RF source itself. Try inserting a 3 dB or 6 dB pad between the RF source cable and the test set rear panel to see if this improves the source match error. If it does, the problem is most likely the cable or the RF source.

Reflection Tracking (Erf and Err)

Tracking is the difference between the frequency response of the reference channel and the frequency response of the test channel. Large variations in the reflection tracking E-terms may indicate a problem in the reference or test signal path in the test set, or bad connections during the measurement calibration procedure. The calibration devices used to characterize the reflection tracking error terms are the short (or offset short) and the shielded open. All reflection measurements (of both high and low reflection devices) are affected by the reflection tracking errors.

Isolation (Crosstalk) (Exf and Exr)

These are the uncorrected forward and reverse isolation error terms that represent the leakage between the test port paths. The isolation error coefficients are characterized when fixed loads are connected to both test ports in the calibration procedure. Any signal that appears in the test channel is coupled from the reference channel. The crosstalk term should be very small. It affects both reflection and transmission measurements, primarily when the test channel signal is at a very low level, especially transmission measurements where the insertion loss of the DUT is large (for example >40 dB attenuation).

Load Match (Elf and Elr)

These are the forward and reverse uncorrected load match errors, a measure of the impedance match of the output port of a two-port device, including the match of test port cables. Load match error terms are characterized by measuring the responses of a thru connection during the calibration procedure (S11 for all test sets plus S22 for S-parameter test sets). Large variations in the forward or reverse load match error terms may indicate a bad thru cable or, if a reflection/transmission test set is used, a bad system attenuator. The measurements most affected by load match errors are all transmission measurements, and reflection measurements of a two-port device with low insertion loss (for example an airline).

Transmission Tracking (Etf and Etr)

Tracking is the difference between the frequency response of the reference channel and the frequency response of the test channel. Large variations in the transmission tracking E-terms may indicate a problem in the reference or test signal path in the test set, or bad connections during the measurement calibration procedure. Transmission tracking error terms are characterized from the transmission measurements of a thru connection in the measurement calibration procedure. All transmission measurements are affected by transmission tracking errors.

NOTES:

1. The TRL (thru-reflection-line) calibration method uses a thru connection, an airline, and a short or open to obtain all twelve error terms. No individual TRL device is identified with any single error term using this method.

2. Be extremely cautious when interpreting the results of E-term displays compared with specification printouts. A system failure is indicated only if the error is significantly worse than the specification.

3. The values listed for reflection tracking and transmission tracking refer only to the ripple of the frequency response. However, the reflection and transmission tracking E-terms include both the tracking E-term (ripple) and the frequency response rolloff. It is difficult to determine what part of the E-term ripple is independent of the rolloff. Therefore, the reflection and transmission tracking E-terms may not be as useful as the other values.

5. Replaceable Parts

INTRODUCTION

This section contains information about ordering replaceable parts for the HP 85101C (bottom box) and the HP 85102C (top box). Table 5-1 contains reference designations, abbreviations, multipliers, and manufacturers' codes used in the parts list. Table 5-2 lists the software and documentation for use with the HP 8510C. Figure 5-2 illustrates the service tools available for use with the analyzer, together with a listing of their part numbers. The remainder of this section consists of illustrations and corresponding parts lists of the major assemblies, cables, and other hardware in the HP 85101C and HP 85102B/C Parts tables for individual test sets and sources are in their respective manuals.

EXCHANGE ASSEMBLIES

Some of the major assemblies can be replaced on a rebuilt exchange (R-E) basis. Exchange, factory-repaired and tested assemblies are available only on a trade-in basis; the defective assemblies must be returned for credit, within 30 days. For this reason, assemblies required for spare parts stock must be ordered by the new assembly part number. Figure 5-1 explains the rebuilt module exchange procedure. R-E assembly part numbers are listed in the parts lists below the part numbers for the corresponding new assemblies.

ORDERING INFORMATION

To order a part listed in the replaceable parts tables, quote the Hewlett-Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard office.

Use this fast, efficient, economical method to keep your Hewlett-Packard instrument in service.

1. Locate defective assembly using troubleshooting procedures and service sheets in this manual.
2. Is a replacement assembly on hand?

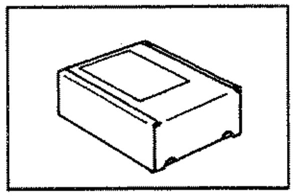
YES:

- Install the replacement assembly. Keep the defective assembly for return to HP.
- Order rebuilt-exchange assembly from HP. Refer to the replaceable parts section for part numbers.
- Put rebuilt-exchange assembly in spares stock.
- Return defective assembly to HP.

NO:

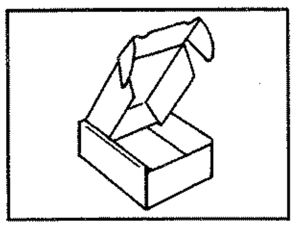
- Order rebuilt exchange assembly from HP. Refer to the replaceable parts section for part numbers.
- Swap replacement assembly and defective assembly.
- Return defective assembly to HP.

A.



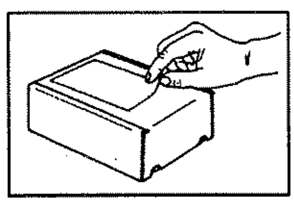
Rebuilt-exchange assemblies are shipped individually in boxes like this. In addition to the circuit assembly, the box contains:
Exchange assembly failure report
Return address label

B.



Open box carefully - it will be used to return defective assembly to HP. Complete failure report. Place it and defective assembly in box. Be sure to remove enclosed return address label.

C.



Seal box with tape. Inside U.S.A.*, stick preprinted return address label over label already on box, and return box to HP. Outside U.S.A., do not use address label; instead address box to the nearest HP office.

*HP pays postage on boxes mailed in U.S.A.

Figure 5-1. Module Exchange Program

Table 5-1. Reference Designations, Abbreviations, Multipliers and Manufacturer's Code List (1 of 3)

REFERENCE DESIGNATORS

A .... Assembly
B .... Fan, Motor
C .... Capacitor
E .. Miscellaneous Electrical Part
F .... Fuse
FL .... Filter
J .... Electrical Connector (Stationary Portion), Jack
MP .... Miscellaneous Mechanical Part
Q .... Silicon Controlled Rectifier (SCR), Transistor, Triode, Thyristor
R .... Resistor
T .... Transformer
U .... Integrated Circuit Microcircuit
W .... Cable, Transmission Path, Wire
X .... Crystal Unit (Piezoelectric, Quartz)

ABBREVIATIONS

A

AD .... Analog to Digital
ADC . Analog to Digital Converter
ADPT .... Adapter
AL .... Aluminum
AMP .... Amplifier
APC .... Amphenol Precision Connector
ASSY .... Assembly
AWG ..... American Wire Gauge
AY .... Assembly

B

B .... Band
BD .... Board
BLK .... Black
BNC .... Type of connector
BP .... Bandpass
BSC .... Basic
BSHG .... Bushing

C

C .... Capacitance
CA .... Cable
CBL .... Cable
CER .... Ceramic
CHAM .... Chamfer
CKT .... Circuit
CNDCT .... Conductor
CNTR .... Counter
CONN .... Connector
CONT .... Control, Controller
CONVTR .... Converter
CPU .... Central Processing Unit
CVR .... Cover

D

DARL .... Darlington Pair
DBL .... Double
DEG .... Degrees
DET .... Detector
DIP ...... Dual In–Line Package

E

EEPROM . Electronically Erasable Programmable Read Only Memory
EMU .... Emulator
EXT .... External, Extension

F

F .... Female
FEM .... Female
FL .... Flat
FLG .... Flange
FLTR .... Filter
FM .... Film
FRNT .... Front
FRT .... Front
FT ..... Current Gain Bandwidth
FXD .... Fixed

G

GROM .... Grommet
GRV .... Grooved

H

HD .... Head
HEX .... Hexagonal
HLD .... Hold
HNDL .... Handle
HT .... Heat

I

IC .... Integrated Circuit
ID ... Identifying, Inside Diameter
IF ...... Intermediate Frequency
IN .... Inch
INTL .... Internal
I/O .... Input/Output

J

JKT .... Jacket

K

KB .... Keyboard

L

L .... Left
LBL .... Label
LFT .... Left
LG .... Long
LK .... Lock
LKWR .... Lock Washer
LO .... Local Oscillator

M

M .... Male, Metric
MACH .... Machined
MFR .... Manufacturer
MISC .... Miscellaneous
MM .... Millimeter
MO .... Metal Oxide
MTG .... Mounting
MTLC .... Metallic
MXR .... Mixer

N

NO .... Number
NPN . Negative, Positive, Negative (Transistor)
NYL .... Nylon

O

OD .... Outside Diameter

Table 5-1. Reference Designations, Abbreviations, Multipliers and Manufacturer's Code List (2 of 3)

P

PAN .... Panel
PAN–HD .... Pan Head
PC .... Printed Circuit
PD Pad, Palladium, Pitch Diamter, Power Dissipation
PERF .... Perforated
PKG .... Package
PL Phase Lock, Plain, Plate, Plug
PNP .. Positive, Negative, Positive (Transistor)
POLYU .... Polyurethane
POZI .... Pozidrive
PROC .... Processor
PVC .... Polyvinyl Chloride
PW .... Power Wirewound
PWR .... Power

R

R .... Right
REF .... Reference
RF .... Radio Frequency
RFI Radio Frequency Interference
RGB .... Red, Green, Blue
RND .... Round
RPG .... Rotary Pulse Generator
RR .... Rear
RT .... Right

S

SCE .... Source
SCR ... Screw, Silicon Controlled Rectifier
SER .... Serial
SGL .... Single
SHFT .... Shaft
SI .... Silicon
SK .... Sink
SKT .... Skirt, Socket
SLDR .... Solder
SMB .... Subminiature type B (Snap–on connector)
SMPL .... Sample
SPCL .... Special
STR .... Strapped, Strip
SUBMIN .... Subminiature
SW .... Switch
SWP .... Sweep
SYNC .... Synchronous
SYS .... System

T

T .... Thickness, Teeth
TA .... Tantalum
TC .... Thermoplastic
THD .... Thread
THK .... Thick
THKNS .... Thickness
THRM .... Thermal
TNG .... Tongue
TPG .... Tapping
TTL .. Transistor Transistor Logic
TX .... Torx

U

UL Underwriters' Laboratories, Inc
....
UNCT .... Undercut

V

V .... Volt
VGA .... Video Graphics Adapter

W

W .... Watt, Width
WD .... Width

X

XDCR .... Transducer
XSTR .... Transistor

Table 5-1. Reference Designations, Abbreviations, Multipliers, and Manufacturer's Code List (3 of 3)

MULTIPLIERS

Abbreviation	Prefix	Multiple	Abbreviation	Prefix	Multiple	Abbreviation	Prefix	Multiple
T	tera	10^{12}	da	deka	10	n	nano	10^{-9}
G	giga	10^{9}	d	deci	10^{-1}	p	pico	10^{-_2}
M	mega	10^{6}	c	centi	10^{-3}	f	femto	10^{-15}
k	kilo	10^{3}	m	milli	10^{-3}	a	atto	10^{-16}
			μ	micro	10^{-6}			

MANUFACTURER'S CODE LIST

Mfr. No.	Manufacturer Name	Address		Zip Code
00000	ANY SATISFACTORY SUPPLIER			
00853	SANGAMO ELEC CO S CAROLINA DIV	PICKENS	SC	29671
01295	TEXAS INSTR INC SEMICON CMPNT DIV	DALLAS	TX	75222
24355	ANALOG DEVICES INC	NORWOOD	MA	02062
28480	HEWLETT−PACKARD CO CORPORATE HQ	PALO ALTO	CA	94304
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS	MA	01247
75402	TRW INC PHILADELPHIA DIV	PHILADELPHIA	PA	19108
91637	DALE ELECTRONICS	COLUMBUS	NE	68601

Table 5-2. Software, Documentation and Accessories

HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
		SOFTWARE		
85101-80116	1	Operating System Firmware C.07.00, Rev. 7	28480	85101-80116
85101-80113	1	Operating System Firmware C.06.54, Rev. 6.54	28480	85101-80113
85101−80109	1	Operating System Firmware C.06.00 or lower	28480	85101−80098
08510−10033	1	Test Set Specifications and Performance Tests Disk. **Note** − These tests are used for all test sets except the HP 8511A.	28480	08510−10033
08510−10024	1	HP 85102 and Test Sets Adjustment Software	28480	08510−10024
08510−10034	1	Master Calibration Disk	28480	08510−10034
08510−10036	1	Citifile Disk	28480	08510−10036
		DOCUMENTATION		
08510−90275	1	HP 8510C Operating and Service Manual Set	28480	08510−90275
		Includes the following separately available manuals:		
08510−90281	1	Operating and Programming Manual	28480	08510−90281
08510−90280	1	Keyword Dictionary	28480	08510−90280
08510−90282	1	On−Site Service Manual	28480	08510−90282
08510−90283	1	Test Sets and Accessories Binder	28480	08510−90283
		ACCESSORIES		
6010−1146		Dove Grey touch−up paint for front panel frame and painted portions of front handles	28480	6010−1146
6010−1147		French Grey touch−up paint for side, top, and bottom covers	28480	6010−1147
6010−1148		Parchment Grey touch−up paint for rack mount flanges, rack support shelves and front panels.	28480	6010−1148

Ref Desig2	HP Part Number	Description	Mfr Code	Mfr Part Number
1	08510-20001	CABLE RF – TEST 1	28480	08510-20001
2	08510-20002	CABLE RF – TEST	28480	08510-20002
3	08517-20019	CABLE FLEX SOURCE, 50 GHZ	28480	08517-20019
4	08513-60009	CABLE FLEX SOURCE 26.5	28480	08513-60009
5	5061-1022	CABLE ASSEMBLY	28480	5061-1022
6	5062-7230	CABLE ASSEMBLY BNC – SNAP	28480	5062-7230
7	0955-0417	FILTER, BP 60 MHZ, BNC – SOURCE EMULATOR	28480	0955-0417
8	5086-7408	POWER SPLITTER	28480	5086-7408
9	1250-0780	ADAPTER M TYPE-N F BNC	28480	1250-0780
10	1250-1236	ADAPTER F BNC F SMB	28480	1250-1236
11	1250-1200	ADAPTER F BNC M SMA	28480	1250-1200
12	1250-0669	ADAPTER M SMB M SMB	28480	1250-0669
13	1250-2330	ADAPTER M 3.5 MM M 2.4 MM*	28480	1250-2330
14	1250-1391	ADAPTER TEE MFM SMB	28480	1250-1391
15	8710-0630	ALIGNMENT TOOL .08 SCDR	28480	8710-0630
16	1400-0088	ALLIGATOR CLIP	28480	1400-0088
17	1490-0025	TEST PROBE	28480	1490-0025
18	85101-60209	BOARD ASSY – HP 85102 EMULATOR	28480	85101-60209
19	85101-60236	HP 85101 POST-REGULATOR EXTENDER BOARD	28480	85101-60236
20	85101-60237	HP 85101 STANDARD EXTENDER BOARD	28480	85101-60237
21	85101-60210	SERVICE ADAPTER – TEST SET EMULATOR	28480	85101-60210
22	85102-60030	BOARD ASSEMBLY – SERVICE EXTENDER	28480	85102-60030
27	8493C OPT 010	APC 3.5 10DB PAD	28480	8493C OPT 010
	2110-0001	FUSE 1A 250V HP 85102 A26F3*	28480	2110-0001
	2110-0002	FUSE 2A 250V HP 85102 F1 LINE FUSE*	28480	2110-0002
	2110-0012	FUSE .51 250V HP 85102 A24F1*	28480	2110-0012
	2110-0083	FUSE 2.5A 250V HP 85102 A26F1, A26F2*	28480	2110-0083
	2110-0333	FUSE 1.5A 125V – HP 85101C A3F1*	28480	2110-0333
	2110-0342	FUSE 8A 250V – HP 85102 A26F4*	28480	2110-0342
	2110-0425	FUSE 2A 125V – HP 85101C A3F2, A3F3*	28480	2110-0425
	2110-0655	FUSE 3.15A 250V – HP 85101C LINE FUSE*	28480	2110-0655
	9300-1367	WRIST STRAP, ANTI-STATIC, ADJUSTABLE (DOES NOT INCLUDE CORD)*	28480	9300-1367
	9300-0980	GROUNDING CORD, 5 FEET LONG (USE WITH WRIST STRAP)*	28480	9300-0980
	9300-0797	ANTI-STATIC EQUIPMENT MAT (4 FT. X 2 FT.)*	28480	9300-0797
23	08511-60016	HP 8511B SERVICE TOOLS KIT	28480	08511-60016
		THE FOLLOWING HP 8511B SERVICE TOOLS MAY BE ORDERED AS A KIT (HP PART NUMBER 08511-60016), OR ORDERED SEPARATELY:		
24	08511-20025	RF TEST CABLE (TWO SUPPLIED IN KIT)	28480	08511-20025
25	08511-20031	RF CABLE SOURCE, 2 FT LG	28480	08511-20031
26	11667C	50 GHZ POWER SPLITTER	28480	11667C
28	3334OD #006	FIXED ATTENUATOR, 6 DB (TWO SUPPLIED IN KIT)	28480	3334OD #006
29	3334OD #020	FIXED ATTENUATOR, 20 DB	28480	3334OD #020
30	85138B	FIXED LOAD, 50 OHM F 2.4 MM	28480	85138B
31	85138A	FIXED LOAD, 50 OHM M 2.4 MM	28480	85138A
32	1250-2188	ADAPTER F 2.4MM F 2.4MM	28480	1250-2188
33	08510-60022	8510/8360 FRONT PANEL EMULATOR KIT	28480	08510-60022
		THE FOLLOWING ITEMS ARE INCLUDED IN THE 8510/8360 FRONT PANEL EMULATOR KIT AND ARE AVAILABLE SEPARATELY:		
34	08510-90268	INSTALLATION NOTE	28480	08510-90268
35	85101-80097	8510/8360 FRONT PANEL EMULATOR TAPE	28480	85105-80097
36	85102-80115	PANEL OVERLAY	28480	85102-80115
		*NOT ILLUSTRATED		

Figure 5-2. Available Service Tools (1 of 3)

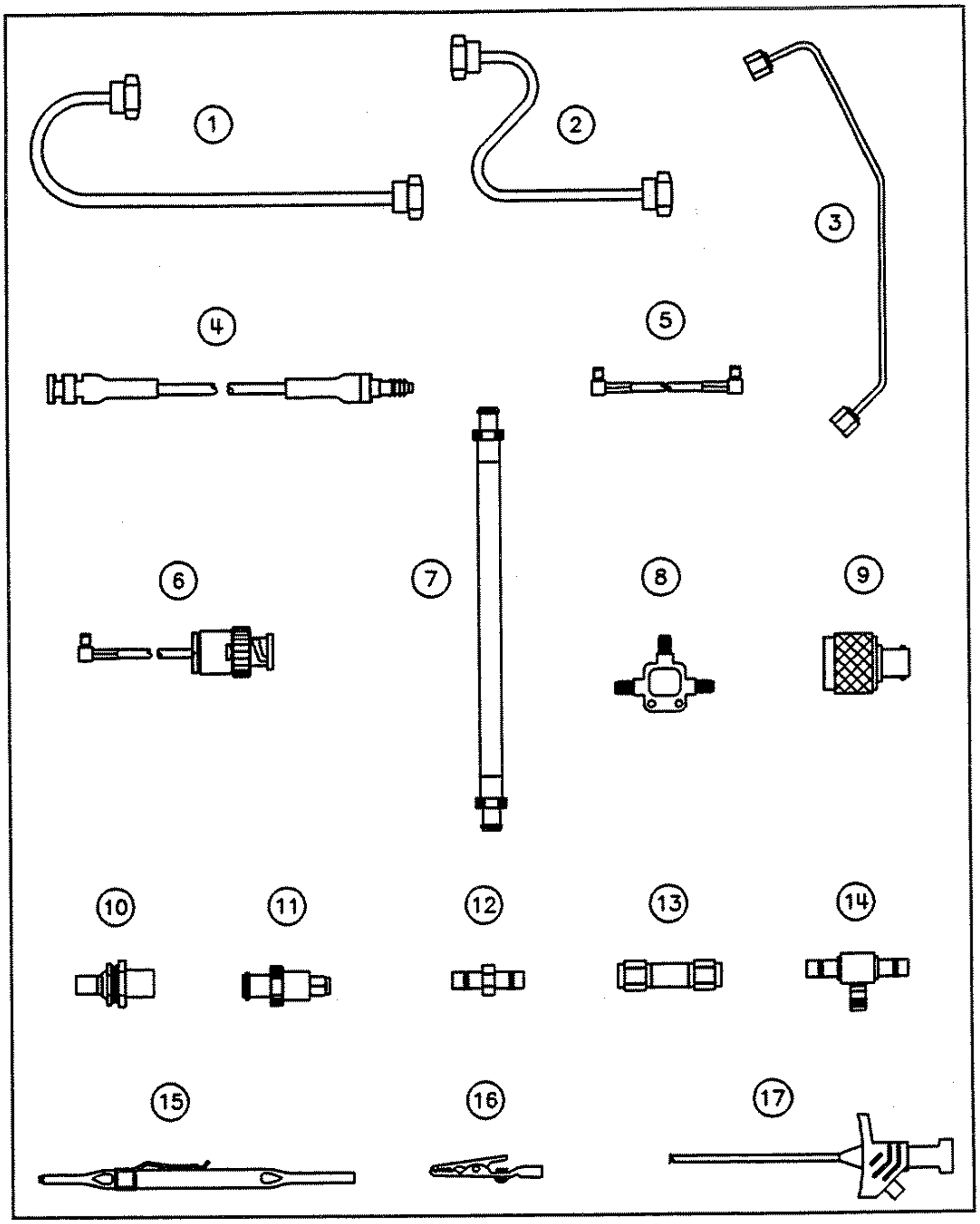


Figure 5-2. Available Service Tools (2 of 3)

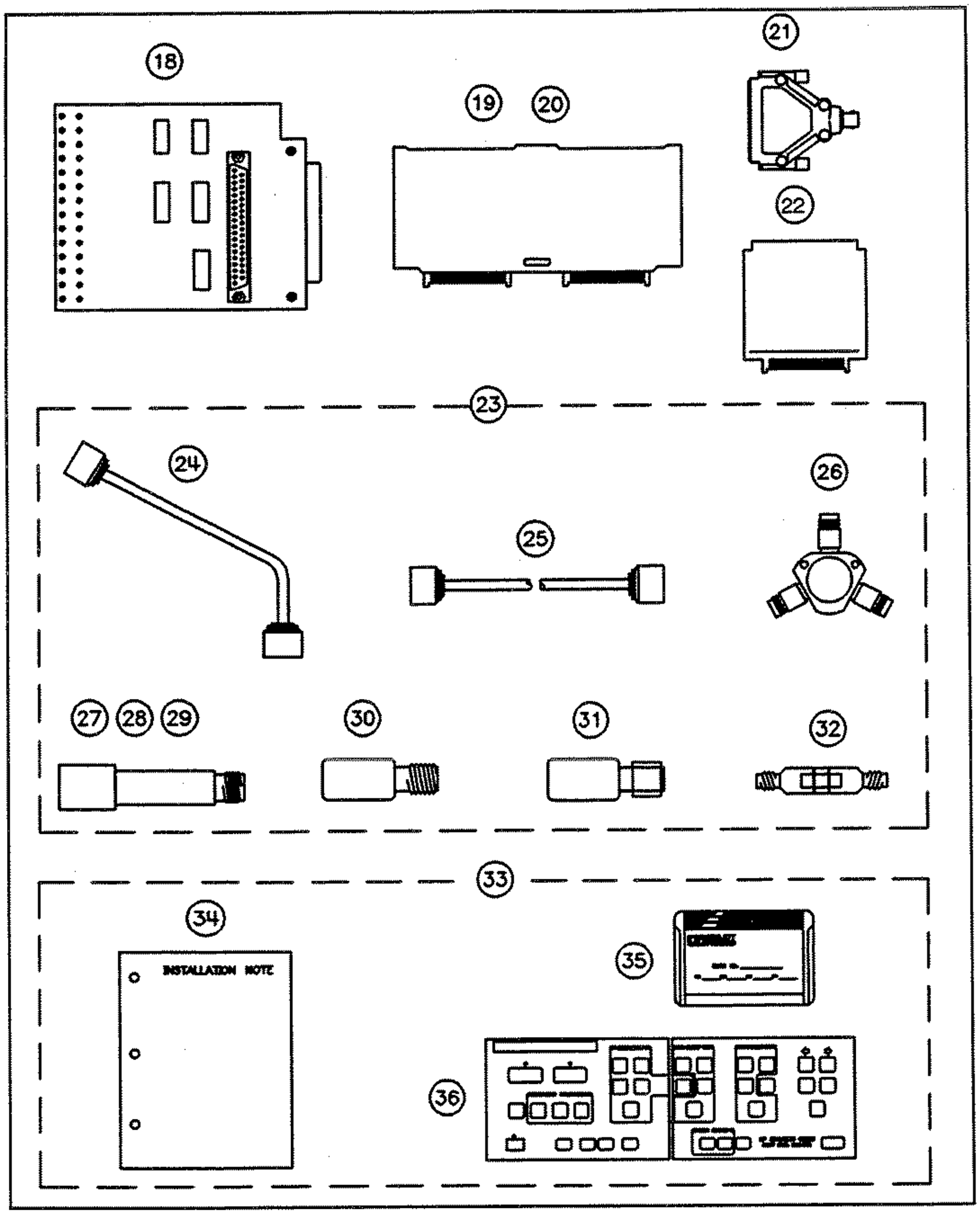


Figure 5-2. Available Service Tools (3 of 3)

Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	85101–60249	1	FRONT PANEL WITH KEYBOARD ASSEMBLY	28480	85101–60249
A2	0950–2075	1	DISC DRIVE	28480	0950–2075
A3	85101–60244	1	POST–REGULATOR BOARD ASSEMBLY (NEW)	28480	85101–60244
A3	85101–69244		POST–REGULATOR BOARD ASSEMBLY (R–E)	28480	85101–69244
A3F1	2110–0333	1	FUSE 1.5A 125V NTD	28480	2110–0333
A3F2	2110–0425	1	FUSE 2A 125V NTD .25 X .27	28480	2110–0425
A3F3	2110–0425	1	FUSE 2A 125V NTD .25 X .27	28480	2110–0425
A4	85101–60243	1	GRAPHICS SYSTEM PROCESSOR ASSEMBLY (NEW)	28480	85101–60243
A4	85101–69243		GRAPHICS SYSTEM PROCESSOR ASSEMBLY (R–E)	28480	85101–69243
A5	85101–60245	1	CPU BOARD ASSEMBLY	28480	85101–60245
A5	85101–69245		CPU BOARD ASSEMBLY (R–E)	28480	85101–69245
A6	85101–60238	1	EEPROM BOARD ASSEMBLY (NEW)	28480	85101–60238
A6	85101–69238		EEPROM BOARD ASSEMBLY (R–E)	28480	85101–69238
A7	85101–60240	1	INPUT/OUTPUT BOARD ASSEMBLY (NEW)	28480	85101–60240
A7	85101–69240		INPUT/OUTPUT BOARD ASSEMBLY (R–E)	28480	85101–69240
A8	85101–60263	1	SECURITY KEY BOARD ASSEMBLY (NEW) (NO IC SUPPLIED)	28480	85101–60263
A8IC1	85101–69269		SECURITY KEY IC, HP 8501C STANDARD (REBUILT–EX-CHANGE ONLY)	28480	85101–69269
A8IC2	85101–69268		SECURITY KEY IC, HP 8510C TIME DOMAIN (REBUILT–EXCHANGE ONLY)	28480	85101–69268
	85101-80114		SECURITY KEY IC, HP 8510C REVISION 7.0 FIRMWARE	28480	85101-80114
	85101-86114		SECURITY KEY IC, HP 8510C REVISION 7.0 FIRMWARE	28480	85101-86114
A9	85101–60246	1	REAR PANEL WITH BOARD ASSEMBLY	28480	85101–60246
A10	08753–60098	1	PREREGULATOR ASSEMBLY (NEW)	28480	08753–60098
A10	08753–69098		PREREGULATOR ASSEMBLY (R–E)	28480	08753–69098
A10F1	2110–0655	1	FUSE 3.15A 250V	28480	2110–0655
A11	2090–0210	1	DISPLAY ASSEMBLY (NEW)	28480	2090–0210
A11	5180–8484		DISPLAY ASSEMBLY (R–E)	28480	5180–8484
W1	85101–60257	1	RIBBON CABLE ASSEMBLY	28480	85101–60257
W2	85101–60254	1	RIBBON CABLE – DISK DRIVE	28480	85101–60254
W3	85101–60259	1	CABLE ASSEMBLY, DISK DRIVE POWER	28480	85101–60259
1	0515–2086	5	MACH SCREW M4.0 7MM TX	28480	0515–2086
2	0515–0377	4	MACH SCREW M3.5 10MM TX	28480	0515–0377
3	85101–40014	11	PC BOARD SPACER	28480	85101–40014
4	85101–20055	1	RFI GASKET, TOP	28480	85101–20055
5	0515–0372	21	MACH SCREW M3.0 8MM PN TX	28480	0515–0372
6	85101–00051	1	CARD CAGE COVER	28480	85101–00051
7	0515–1400	2	MACH SCREW M3.5 8MM FLP TXP	28480	0515–1400
8	0515–0433	4	MACH SCREW M4.0 8MM TX	28480	0515–0433

Figure 5-3. HP 85101C Top Internal (1 of 2)

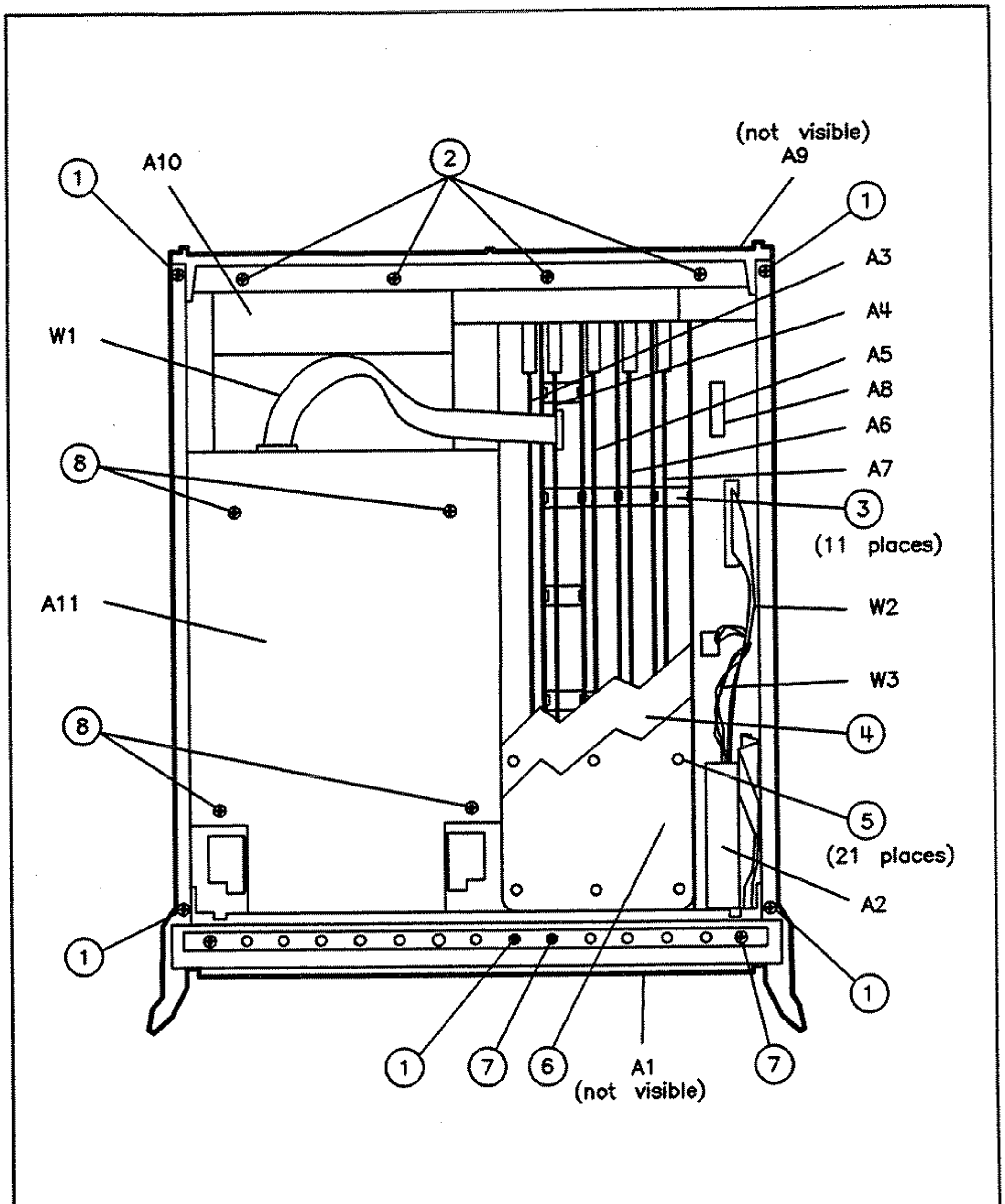
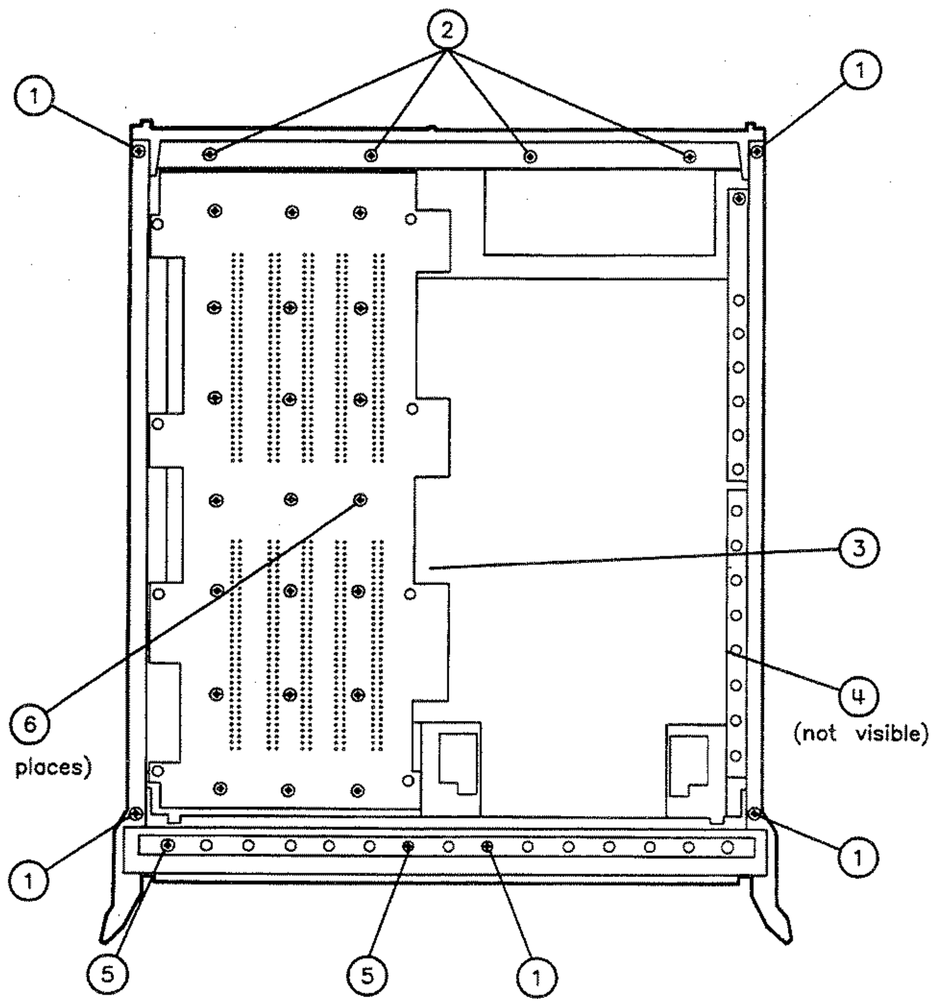
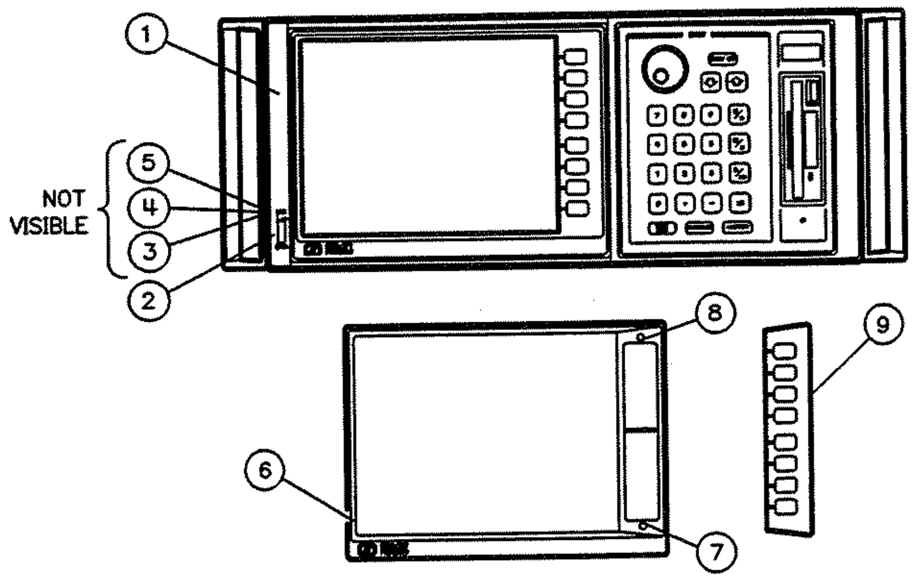


Figure 5-3. HP 85101C Top Internal (2 of 2)



Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
1	0515-2086	5	MACH SCREW M4.0 7MM TX	28480	0515-2086
2	0515-0377	4	MACH SCREW M3.5 10MM TX	28480	0515-0377
3	85101-60267	1	MOTHERBD/CARD CAGE ASSY (INCLUDES FRAME CORNER STRUTS)	28480	85101-6026 7
4	5180-8500	1	MYLAR DISPLAY INSULATOR	28480	5180-8500
5	0515-1400	2	MACH SCREW M3.5 8MM FLP TX	28480	0515-1400
6	0515-0372	21	MACH SCREW M3.0 8MM PN TX	28480	0515-0372

Figure 5-4. HP 85101C Bottom Internal



Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
1	85101-40011	1	BEZEL SUPPORT	28480	85101-4001 1
2	08757-40005	1	LINE SWITCH BUTTON	28480	08757-4000 5
3	1460-1573	1	SPRING-EXTENSION .138-IN-OD	28480	1460-1573
4	08753-00048	1	LINE SWITCH ACTUATOR	28480	08753-0004 8
5	08753-00036	1	SWITCH INSULATOR	28480	08753-0003 6
6	5062-7208	1	SUBASSEMBLY, BEZEL	28480	5062-7208
7	0515-1402	2	SCREW MACH M3.5 .68MM PN TX	28480	0515-1402
8	3050-1192	2	WASHER-FL MTLC 3.5MM 3.8MMID	28480	3050-1192
9	08757-40012	1	SOFT KEYS COVER	28480	08757-4001 2

Figure 5-5. HP 85101C Front Panel External

Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
1	85101-20050	1	FRONT BEZEL	28480	85101-20050
2	85101-00044	1	SUB PANEL	28480	85101-00044
3	0515-1946	6	MACH SCREW M3.0 6MM TX	28480	0515-1946
4	85101-80084	1	FRONT DRESS PANEL	28480	85101-80084
5	7121-4611	1	LABEL – MADE IN USA	28480	7121-4611
6	0510-1148	3	PUSH ON RETAINER	28480	0510-1148
7	85101-60239	1	KEYBOARD ASSEMBLY	28480	85101-60239
8	85101-20053	1	AIR DAM	28480	85101-20053
9	3050-0105	8	WASHER FLAT .125 ID	28480	3050-0105
10	0515-0430	8	MACH SCREW M3.0 6MM TX	28480	0515-0430
11	85101-60234	1	ROTARY PULSE GENERATOR (RPG)	28480	85101-60234
12	2190-0016	2	WASHER LK INTL T3/8 IN .377ID	28480	2190-0016
13	2950-0043	2	NUT HEX DBLCHAM 3/8-32-THD .094IN THK	00000	ORDER BY DES
14	3050-0180	1	TEFLON WASHER	28480	3050-0180
15	0370-3033	1	KNOB BASE 250 JG	28480	0370-3033

Figure 5-6. HP 85101C Front Panel Internal (1 of 2)

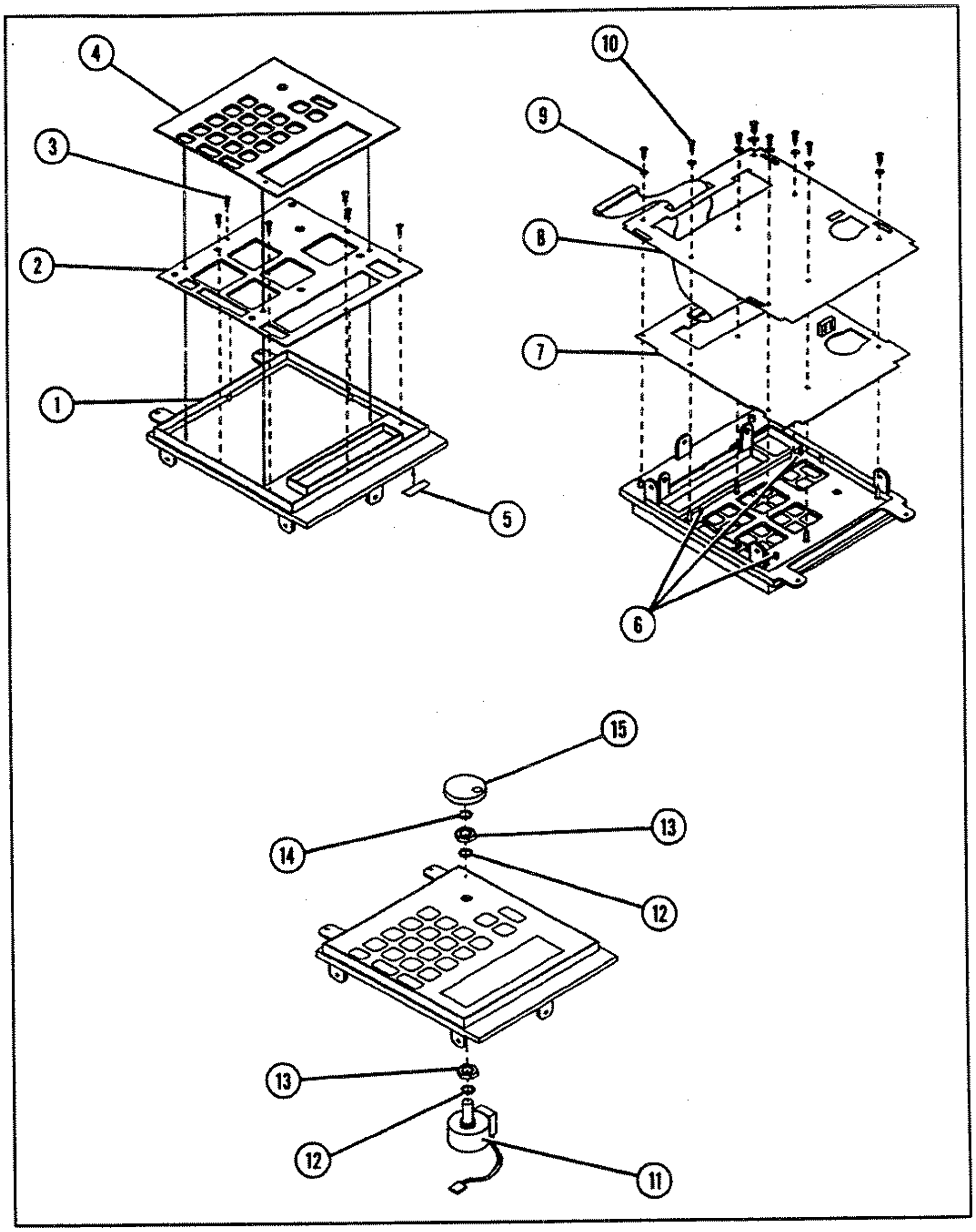


Figure 5-6. HP 85101C Front Panel Internal (2 of 2)

Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
1	5041−8821	2	STANDOFF − REAR PANEL	28480	5041−8821
2	0515−0372	3	MACH SCREW M3.0 8MM PN TX	28480	0515−0372
3	0515−1232	2	MACH SCREW M3.5 8MM PN PD	28480	0515−1232
4	0515−0892	2	MACH SCREW M3.5 12MM PN PD	28480	0515−0892
5	5021−8537	1	LOCKING FOOT, RIGHT	28480	5021−8537
6	5021−8539	1	LOCKING FOOT, LEFT	28480	5041−8539
7	85101−60241	1	REAR PANEL BOARD ASSEMBLY	28480	85101−60241
8	2190−0586	4	WASHER LK, HLCL 4.0MM	28480	2190−0586
9	0380−0643	4	STANDOFF HEX .255IN.LG 6−32	28480	0380−0643
10	2190−0584	8	WASHER, LK M3.0 NOM	28480	2190−0584
11	1251−7812	8	CONNECTOR, JACKSCREW	28480	1251−7812
12	85101−00045	1	REAR PANEL	28480	85101−00045
13	7121−4611	1	LABEL, MADE IN USA	28480	7121−4611
14	3050−1192	4	WASHER FL M3.5 NOM	28480	3050−1192
15	3160−0281	1	FINGER GUARD	28480	3160−0281
16	0515−0379	4	MACH SCREW M3.5 16MM PN TX	28480	0515−0379
17	08415−60036	1	FAN − TUBE AXIAL	28480	08415−60036

Figure 5-7. HP 85101C Rear Panel (1 of 2)

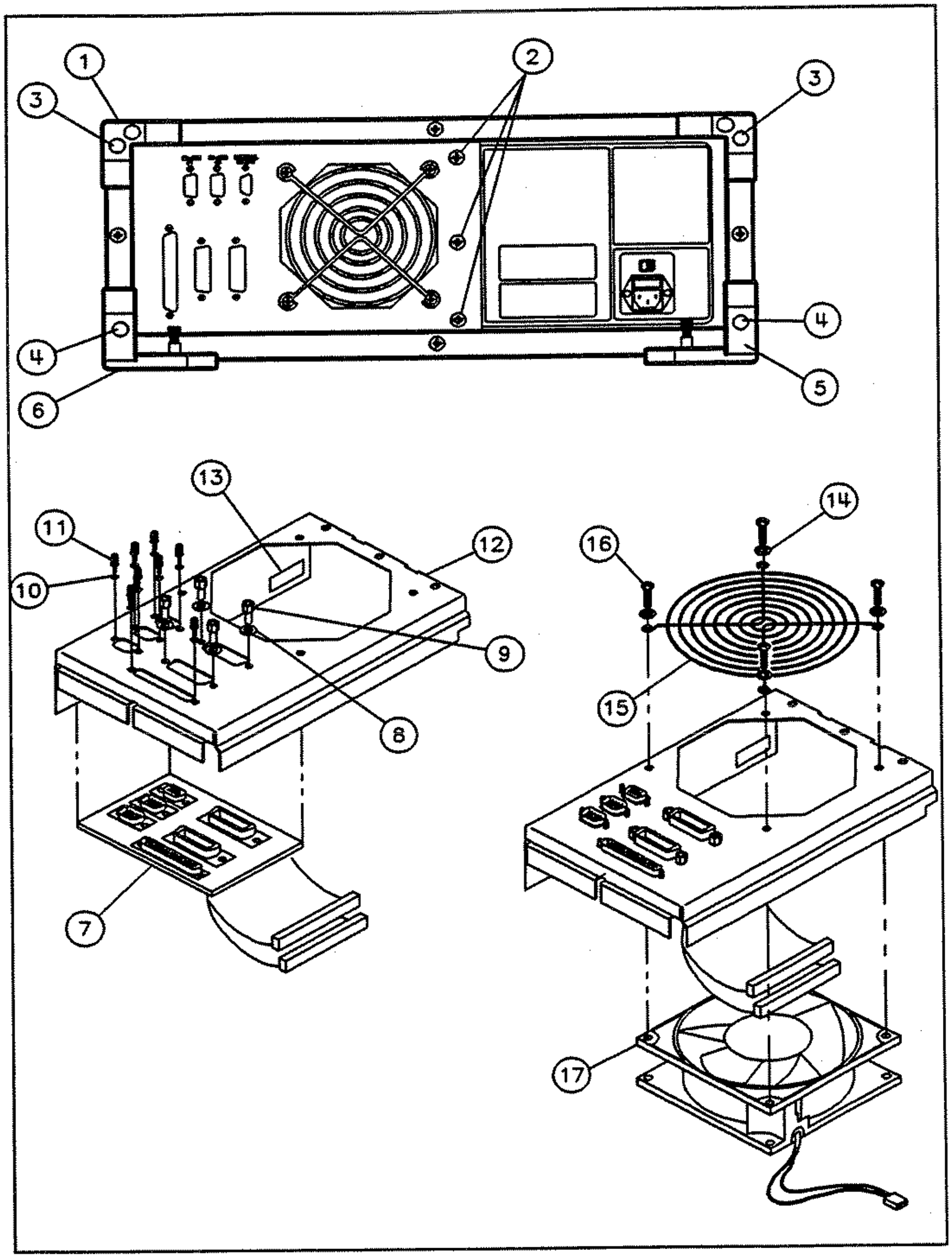
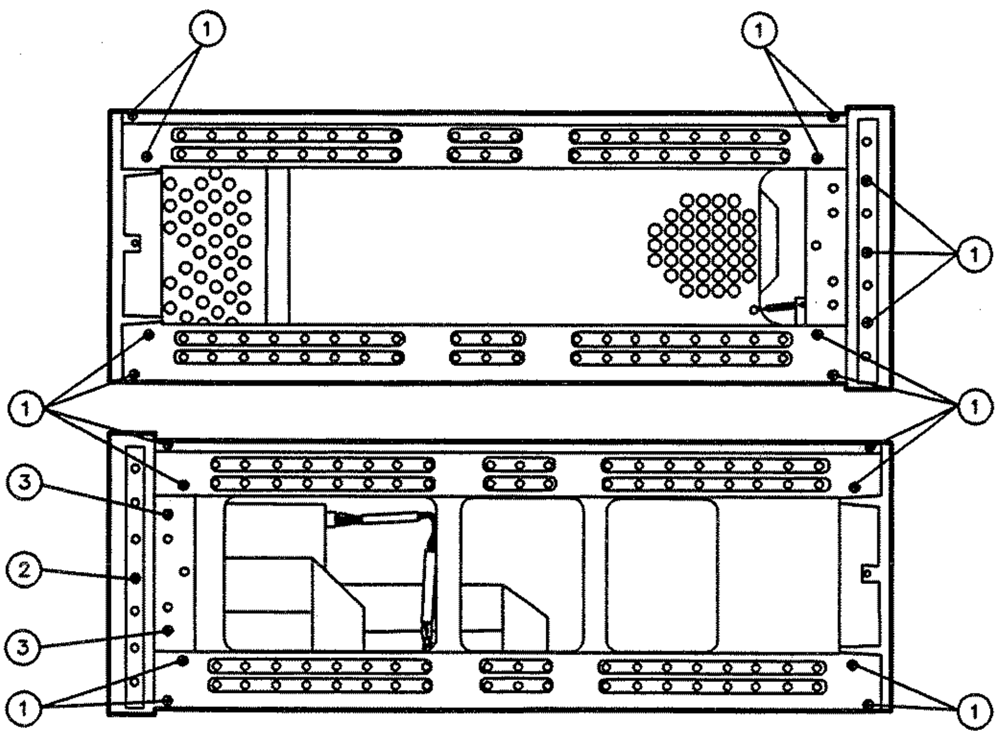


Figure 5-7. HP 85101C Rear Panel (2 of 2)



Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
1	0515-2086	19	MACH SCREW M4.0 7MM TX	28480	0515-2086
2	0515-1400	1	MACH SCREW M3.5 8MM TX	28480	0515-1400
3	0515-0458	2	MACH SCREW M3.5 8MM TX	28480	0515-0458

Figure 5-8. HP 85101C Left and Right Sides

Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
1	5062-3735	2	TOP AND BOTTOM COVER	28480	5062-3735
2	5021-5837	4	CORNER STRUT*	28480	5021-5837
3	5041-8802	1	TRIM STRIP	28480	5041-8802
4	5062-3817	1	COVER, SIDE -- PERFORATED	28480	5062-3817
5	5021-8405	1	FRONT FRAME	28480	5021-8405
6	5062-3800	2	HANDLE ASSEMBLY	28480	5062-3800
7	0515-0896	8	MACH SCREW M4.0 10MM FL PD	28480	0515-0896
8	5021-8497	2	TRIM, FRONT HANDLE	28480	5021-8497
9	5041-8821	1	STRAP HANDLE CAP, FRONT	28480	5041-8821
10	0515-1132	2	MACH SCREW M5.0 10MM FL PD	28480	0515-1132
11	5041-8820	1	STRAP HANDLE CAP, REAR	28480	5041-8820
12	5062-3704	1	STRAP HANDLE	28480	5062-3704
13	5062-3842	1	COVER, SIDE -- HANDLE	28480	5062-3842
14	5061-5806	1	REAR FRAME	28480	5061-5806
15	0515-2086	16	MACH SCREW M4.0 7MM FLP TX	28480	0515-2086
			***NOTE:** corner struts are part of motherbd/card cage assy. (HP part number 85101-60267)		

Figure 5-9. HP 85101C Cabinet Parts (1 of 2)

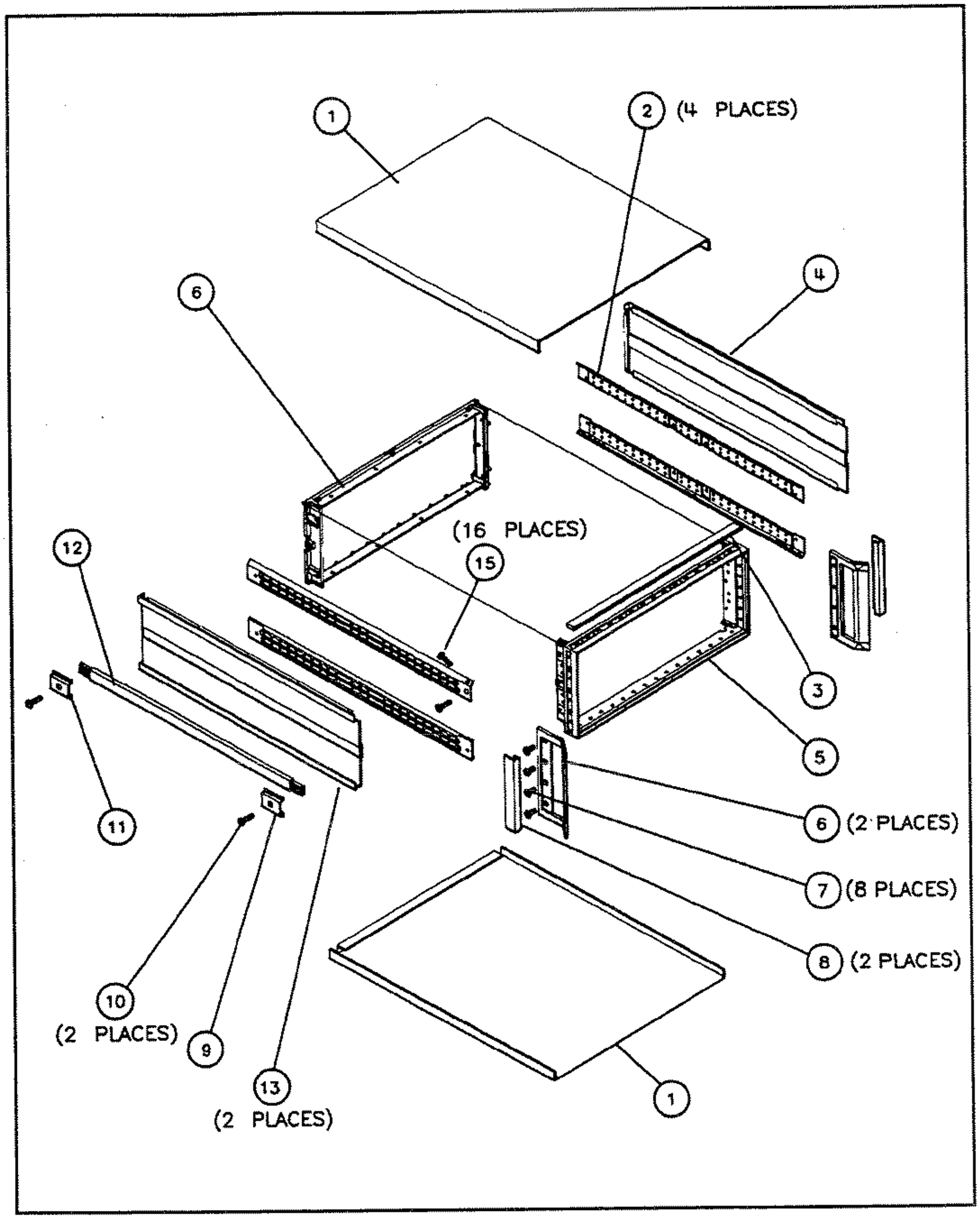
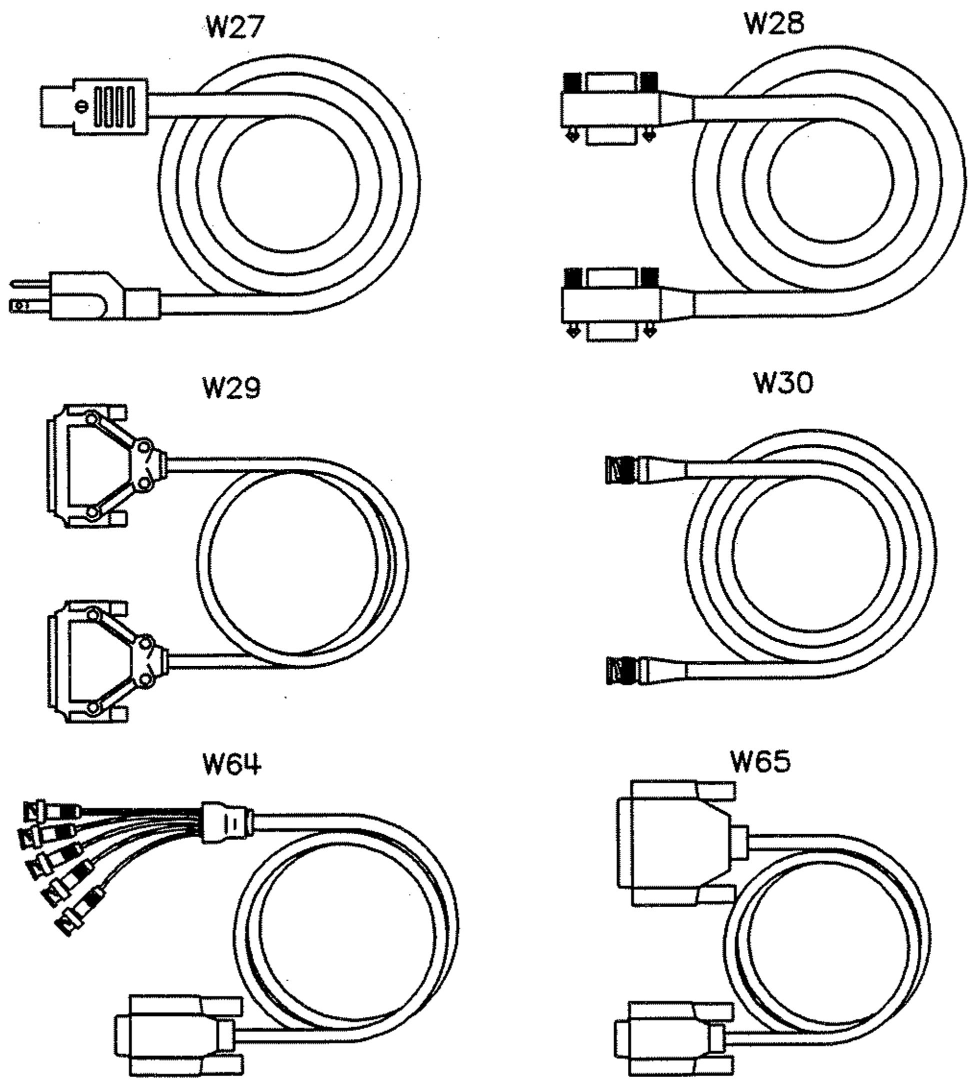


Figure 5-9. HP 85101C Cabinet Parts (2 of 2)



Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
W27	8120-1348	2	CABLE ASSY 18 AWG 3-CNDCT BLK-JKT	28480	8120-1348
W28	8120-3445	1	HP-IB CABLE 1 METER	28480	8120-3445
W29	08510-60101	1	CBL AY IF DISPLY	28480	08510-6010 1
W30	8120-2582	2	CBL AY BNC 1 METER	28480	8120-2582
W64	D1191A	1	CABLE ASSEMBLY VGA/RGB	28480	D1191A
W65	24542G	2	CABLE, SERIAL RS-232	28480	245425

Figure 5-10. HP 8510C Cable Assemblies

Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2			NOT ASSIGNED		
A3			NOT ASSIGNED		
A4			NOT ASSIGNED		
A5	85102-60203	1	BOARD ASSY, TEST SYNCHRONOUS DET. (NEW)	28480	85102-60203
A5	85102-69203		BOARD ASSY, TEST SYNCHRONOUS DET. (R-E)	28480	85102-69203
A6	85102-60006	1	BOARD ASSEMBLY, CLOCK (NEW)	28480	85102-60006
A6	85102-69006		BOARD ASSEMBLY, CLOCK (R-E)	28480	85102-69006
A7	85102-60203	1	BOARD ASSY, REF SYNCHRONOUS DET (NEW)	28480	85102-60203
A7	85102-69203		BOARD ASSY, REF SYNCHRONOUS DET (R-E)		
A8	85102-60008	1	BOARD ASSEMBLY, 19.9 MHZ L.O. (NEW)	28480	85102-60008
A8	85102-69008		BOARD ASSEMBLY, 19.9 MHZ L.O. (R-E)	28480	85102-69008
A9	85102-60206	1	BOARD ASSEMBLY, B2 IF MIXER (NEW)	28480	85102-60206
A9	85102-69206		BOARD ASSEMBLY, B2 IF MIXER (R-E)	28480	85102-69206
A10	85102-60010	1	BOARD ASSEMBLY, TEST IF AMPLIFIER (NEW)	28480	85102-60010
A10	85102-69010		BOARD ASSEMBLY, TEST IF AMPLIFIER (R-E)	28480	85102-69010
A11	85102-60206	1	BOARD ASSEMBLY, B1 IF MIXER (NEW)		
			(SAME AS A9; USE PREFIX A11).	28480	85102-60206
A11	85102-69206		BOARD ASSEMBLY, B1 IF MIXER (R-E)		
			(SAME AS A9; USE PREFIX A11).	28480	85102-69206
A12	85102-60010	1	BOARD ASSEMBLY, REF IF AMPLIFIER (NEW)		
			(SAME AS A10; USE PREFIX A12).	28480	85102-60010
A12	85102-69010		BOARD ASSEMBLY, REF IF AMPLIFIER (R-E)		
			(SAME AS A10; USE PREFIX A12).	28480	85102-69010
A13	85102-60206	1	BOARD ASSEMBLY, A2 IF MIXER (NEW)		
			(SAME AS A9; USE PREFIX A13).	28480	85102-60206
A13	85102-69206		BOARD ASSEMBLY, A2 IF MIXER (R-E)		
			(SAME AS A9; USE PREFIX A13).	28480	85102-69206
A14	85102-60206	1	BOARD ASSEMBLY, A1 IF MIXER (NEW)		
			(SAME AS A9; USE PREFIX A14).	28480	85102-60206
A14	85102-69206		BOARD ASSEMBLY, A1 IF MIXER (R-E)		
			(SAME AS A9; USE PREFIX A14).	28480	85102-69206
A15	85102-60015	1	BOARD ASSEMBLY, REGULATOR (NEW)	28480	85102-60015
A15	85102-69015		BOARD ASSEMBLY, REGULATOR (R-E)	28480	85102-69015
A16	85102-60235	1	REMOTE APPLICATIONS BOARD (NEW)	28480	85102-60235
A16	85102-69235		REMOTE APPLICATIONS BOARD (R-E)	28480	85102-69235
A17	85102-60212	1	BOARD ASSEMBLY, SAMPLE AND HOLD (NEW)	28480	85102-60212
A17	85102-69212		BOARD ASSEMBLY, SAMPLE AND HOLD (R-E)	28480	85102-69212
A18	85102-60208	1	BOARD ASSEMBLY, A/D CONVERTER (NEW)	28480	85102-60208
A18	85102-69208		BOARD ASSEMBLY, A/D CONVERTER (R-E)	28480	85102-69208
A19	85102-60019	1	BOARD ASSEMBLY, ADC CONTROL (NEW)	28480	85102-60019
A19	85102-69019		BOARD ASSEMBLY, ADC CONTROL (R-E)	28480	85102-69019
A20	85102-60234	1	BOARD ASSEMBLY, SWEEP ADC (NEW)	28480	85102-60234
A20	85102-69234		BOARD ASSEMBLY, SWEEP ADC (R-E)	28480	85102-69234
A21	85102-60021	1	BOARD ASSEMBLY, IF COUNTER (NEW)	28480	85102-60021
A21	85102-69021		BOARD ASSEMBLY, IF COUNTER (R-E)	28480	85102-69021
A22	85102-60204	1	BOARD ASSEMBLY, PRETUNE CONTROL (NEW)	28480	85102-60204
A22	85102-69204		BOARD ASSEMBLY, PRETUNE CONTROL (R-E)	28480	85102-69204
A23	85102-60227	1	BOARD ASSEMBLY, MAIN PHASE LOCK (NEW)	28480	85102-60227
A23	85102-69227		BOARD ASSEMBLY, MAIN PHASE LOCK (R-E)	28480	85102-69227
A24	85102-60024	1	BOARD ASSY, PROCESSOR INTERFACE (NEW)	28480	85102-60024
A24	85102-69024		BOARD ASSY, PROCESSOR INTERFACE (R-E)	28480	85102-69024
A26	85102-60026	1	BOARD ASSEMBLY, RECTIFIER (NEW)	28480	85102-60026
A26	85102-69026		BOARD ASSEMBLY, RECTIFIER (R-E)	28480	85102-69026

Figure 5-11. HP 85102 Board Location (1 of 2)

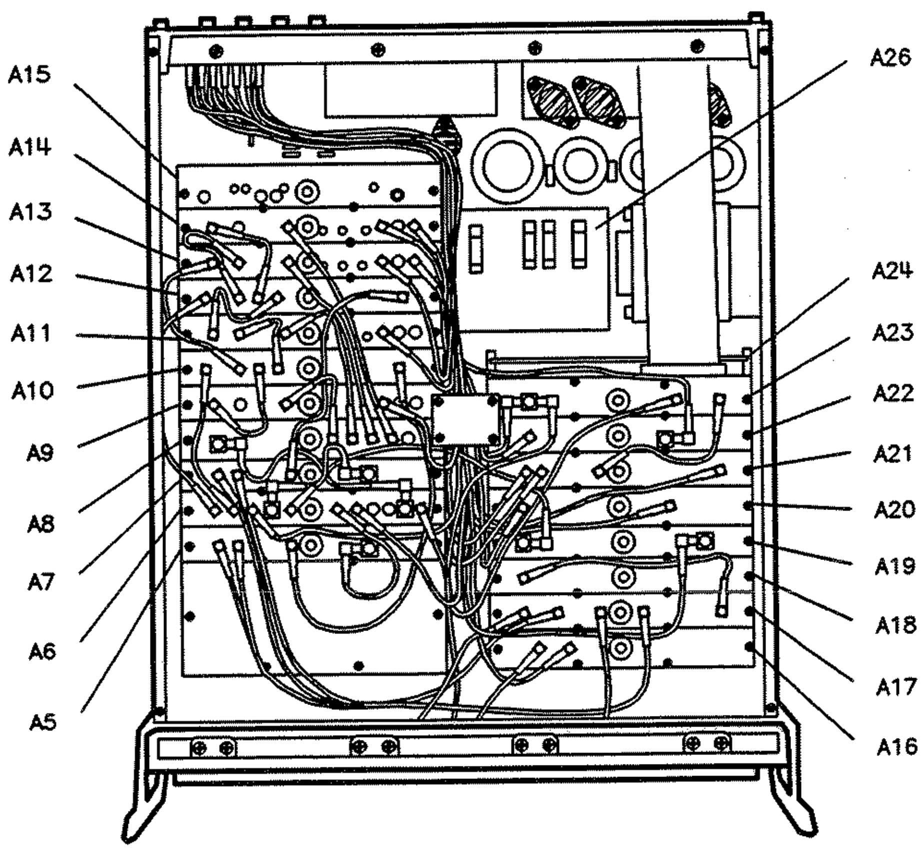


Figure 5-11. HP 85102 Board Location (2 of 2)

Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
B1	85102-20056	1	FAN ASSEMBLY	28480	85102-20056
E7	0340-0596	4	INSULATOR-XSTR THRM-CNDCT	28480	0340-0596
E8	0340-0596		INSULATOR-XSTR THRM-CNDCT	28480	0340-0596
E9	0340-0596		INSULATOR-XSTR THRM-CNDCT	28480	0340-0596
E10	0340-0596		INSULATOR-XSTR THRM-CNDCT	28480	0340-0596
J2	1250-1391	1	ADAPTOR TEE MFM SMB	28480	1250-1391
Q1	1854-0679	1	TRANSISTOR NPN 2N5885 SI TO-3 PD=200W	28480	1854-0679
Q2, Q4	1853-0351	2	TRANSISTOR PNP 2N6053 SI DARL TO-3	28480	1853-0351
Q3	1854-0611	1	TRANSISTOR NPN 2N6055 SI DARL TO-3	28480	1854-0611
W55	85102-60191	1	CABLE ASSEMBLY INTER CON	28480	85102-60191
1	2360-0193	5	SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	28480	2360-0193
2	1390-0104	1	FASTENER-SNAP-IN GROM PANEL THKNS	28480	1390-0104
3	1390-0281	1	FASTENER-SNAP-IN PLGR PANEL THKNS	28480	1390-0281
4	85102-20058	1	SAFETY COVER	28480	85102-20058
5	85102-20059	1	SAFETY COVER	28480	85102-20059
6	1205-0399	4	HEAT SINK SGL TO-3-CS	28480	1205-0399
7	2200-0113	8	SCREW-MACH 4-40 .625-IN-LG PAN-HD-POZI	00000	ORDER BY DESC.
8	2190-0017	4	WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
9	2510-0138	4	SCREW-MACH 8-32 3-IN-LG PAN-HD-POZI	00000	ORDER BY DESC.
10	3050-0005	4	WASHER-SHLDR NO. 6 .14-IN-ID .375-IN-OD	28480	3050-0005
11	3050-0139	4	WASHER-FL MTLC NO. 8 .172-IN-ID	28480	3050-0139
12	85102-20070	2	MOUNT TRANSFORMER	28480	85102-20070
14	08505-20133	1	ENCLOSURE CKT	28480	08505-20133
15	85102-00023	1	COVER-RF MAIN PHASE LOCK	28480	85102-00023
16	85102-00022	1	COVER-RF PRETUNE CONTROL	28480	85102-00022
17	85102-00021	1	COVER-RF IF COUNTER	28480	85102-00021
18	85102-00020	1	COVER-RF SWP A/D CONVERTER	28480	85102-00020
19	85102-00019	1	COVER-RF A/D CONVERTER	28480	85102-00019
20	85102-00018	1	COVER-A/D CONVERTER	28480	85102-00018
21	85102-00017	1	COVER-RF SAMPLE/HOLD	28480	85102-00017
22	85102-00053	1	COVER-RF REMOTE APPLICATIONS	28480	85102-00053
23	85102-20060	1	GASKET-RF COVER	28480	85102-20060
24	85102-00029	2	BRACKET	28480	85102-00029
25	85102-00028	1	BRACKET-WIREWAY	28480	85102-00028
26	2360-0115	36	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESC.
27	0624-0099	16	SCREW-TPG 4-40 .375-IN-LG PAN-HD-POZI	28480	0624-0099
28	85102-00037	1	CLIP	28480	85102-00037
29	0515-0887	8	SCREW-MACH 6-32 .188-IN-LG PAN-HD-POZI	00000	ORDER BY DESC.
30	2360-0333	10	SCREW-MACH 6-32 .25-IN-LG 100 DEG	28480	2360-0333
31	85102-20061	1	GASKET-RF COVER	28480	85102-20061
32	85102-00040	1	COVER-BLANK A2-3-4	28480	85102-00040
33	85102-00005	1	COVER-RF SYNCHRONOUS DETECTOR	28480	85102-00005
34	85102-00006	1	COVER A6 CLOCK	28480	85102-00006
35	85102-00008	1	COVER-RF 19.9 MHZ LO	28480	85102-00008
36	85102-00009	1	COVER-RF B2 IF MIXER	28480	85102-00009
37	85102-00010	1	COVER-TEST IF AMP	28480	85102-00010
38	85102-00011	1	COVER-RF B1 IF MIXER	28480	85102-00011
39	85102-00012	1	COVER-REF IF AMP	28480	85102-00012
40	85102-00013	1	COVER-RF A2 IF MIXER	28480	85102-00013
41	85102-00014	1	COVER-RFA1 IF MIXER	28480	85102-00014
42	08505-20163	1	ENCLOSURE CKT	28480	08505-20163
43	85102-00015	1	COVER-REGULATOR	28480	85102-00015

Figure 5-12. HP 85102 Top Internal (1 of 2)

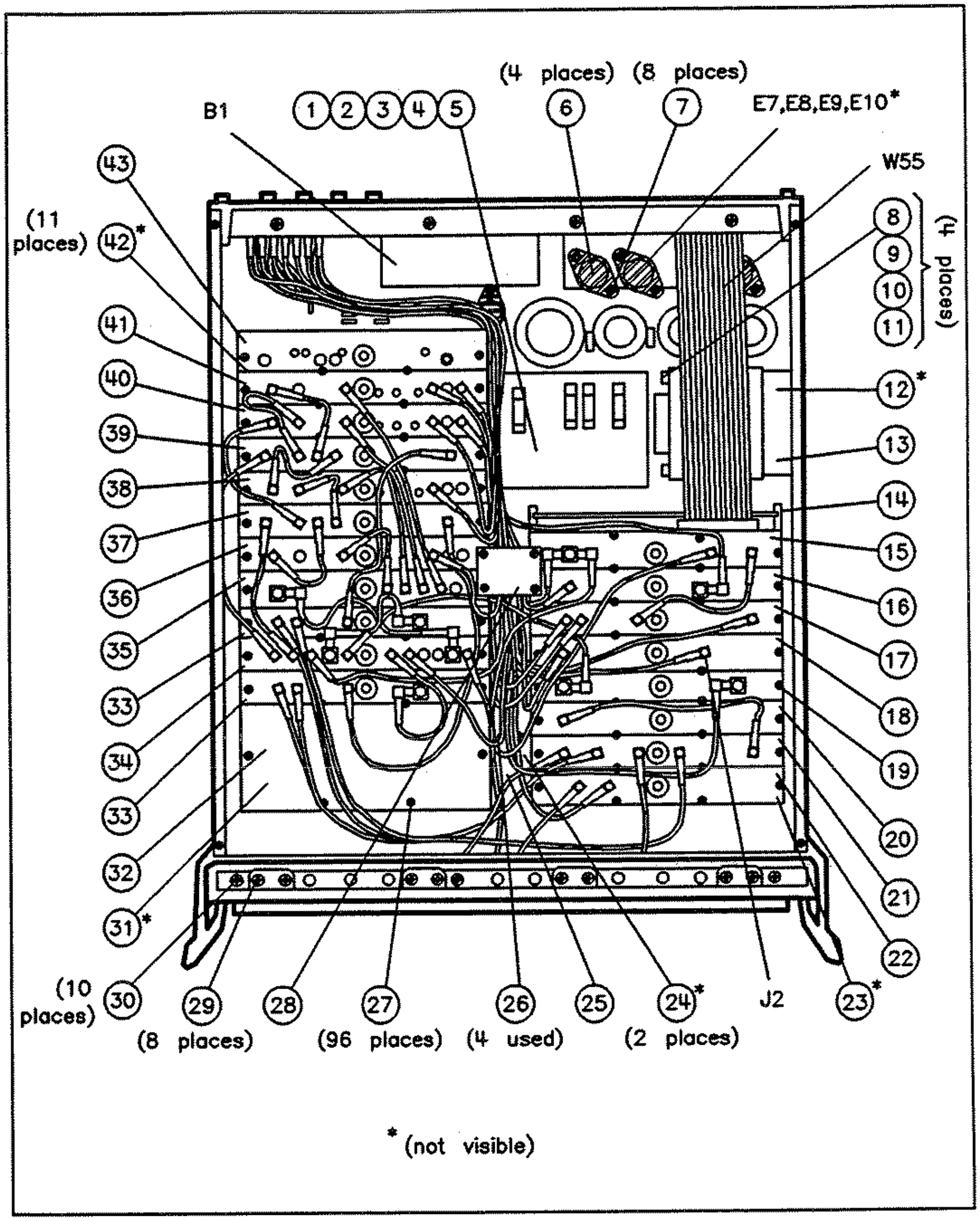


Figure 5-12. HP 85102 Top Internal (2 of 2)

Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
W1	85102-60131	1	CABLE ASSEMBLY A8J3-A11J3	28480	85102-60131
W2	85102-60132	1	CABLE ASSEMBLY A8J2-A9J3	28480	85102-60132
W3	85102-60133	1	CABLE ASSEMBLY A8J5-A14J3	28480	85102-60133
W4	85102-60134	1	CABLE ASSEMBLY A8J4-A13J3	28480	85102-60134
W5			NOT ASSIGNED		
W6	85102-60136	1	CABLE ASSEMBLY A6J6-A5J4	28480	85102-60136
W7	85102-60137	1	CABLE ASSEMBLY A6J5-A7J4	28480	85102-60137
W8	85102-60138	1	CABLE ASSEMBLY A11J2-A10J4	28480	85102-60138
W9	85102-60139	1	CABLE ASSEMBLY A9J1-A10J3	28480	85102-60139
W10	85102-60140	1	CABLE ASSEMBLY A13J1-A10J2	28480	85102-60140
W11	85102-60141	1	CABLE ASSEMBLY A6J2-A10J1	28480	85102-60141
W12	85102-60142	1	CABLE ASSEMBLY A11J1-A12J4	28480	85102-60142
W13	85102-60143	1	CABLE ASSEMBLY A14J1-A12J3	28480	85102-60143
W14	85102-60144	1	CABLE ASSEMBLY A13J2-A12J2	28480	85102-60144
W15	85102-60145	1	CABLE ASSEMBLY A6J1-A12J1	28480	85102-60145
W16	85102-60146	1	CABLE ASSEMBLY A6J11-A23J2	28480	85102-60146
W17	85102-60147	1	CABLE ASSEMBLY A21J3-A23J3	28480	85102-60147
W18	85102-60148	1	CABLE ASSEMBLY A14J6-A21J1	28480	85102-60148
W19	85102-60149	1	CABLE ASSEMBLY A6J7-J7	28480	85102-60149
W20	85102-60150	1	CABLE ASSEMBLY A10J5-A5J3	28480	85102-60150
W21	85102-60151	1	CABLE ASSEMBLY A5J1-A17J2	28480	85102-60151
W22	85102-60152	1	CABLE ASSEMBLY A5J2-A17J1	28480	85102-60152
W23	85102-60153	1	CABLE ASSEMBLY A12J5-A7J3	28480	85102-60153
W24	85102-60154	1	CABLE ASSEMBLY A7J1-A17J4	28480	85102-60154
W25	85102-60155	1	CABLE ASSEMBLY A7J2-A17J3	28480	85102-60155
W26	85102-60156	1	CABLE ASSEMBLY A17J5-A18J1	28480	85102-60156
W27	85102-60157	1	CABLE ASSEMBLY A19J2-J3	28480	85102-60157
W28	85102-60158	1	CABLE ASSEMBLY A20J1-J5	28480	85102-60158
W29	85102-60159	1	CABLE ASSEMBLY A21J4-J6	28480	85102-60159
W30	85102-60160	1	CABLE ASSEMBLY J1A2-A11J4	28480	85102-60160
W31	85102-60161	1	CABLE ASSEMBLY J1A3-A9J4	28480	85102-60161
W32	85102-60162	1	CABLE ASSEMBLY J1A4-A13J4	28480	85102-60162
W33	85102-60163	1	CABLE ASSEMBLY J1A5-A22J1	28480	85102-60163
W34	85102-60164	1	CABLE ASSEMBLY J1A6-A23J1	28480	85102-60164
W35	85102-60165	1	CABLE ASSEMBLY J1A7-A22J3	28480	85102-60165
W36	85102-60166	1	CABLE ASSEMBLY J1A1-A14J4	28480	85102-60166
W37	85102-60167	1	CABLE ASSEMBLY A13J6-A21J2	28480	85102-60167
W38	85102-60168	1	CABLE ASSEMBLY A6J3-J4	28480	85102-60168
W39	85102-60169	1	CABLE ASSEMBLY A6J4-A19J1	28480	85102-60169
W40	85102-60223	1	CABLE ASSEMBLY A16J2-REAR PANEL J9	28480	85102-60223
W41	85102-60224	1	CABLE ASSEMBLY A20J2-REAR PANEL J10	28480	85102-60224
W42	85102-60222	1	CABLE ASSEMBLY A16J1-A23J1	28480	85102-60222
W43			NOT ASSIGNED		
W44	85102-60174	1	CABLE ASSEMBLY A6J10-A8J1	28480	85102-60174

Figure 5-13. HP 85102 Cable Locations (1 of 2)

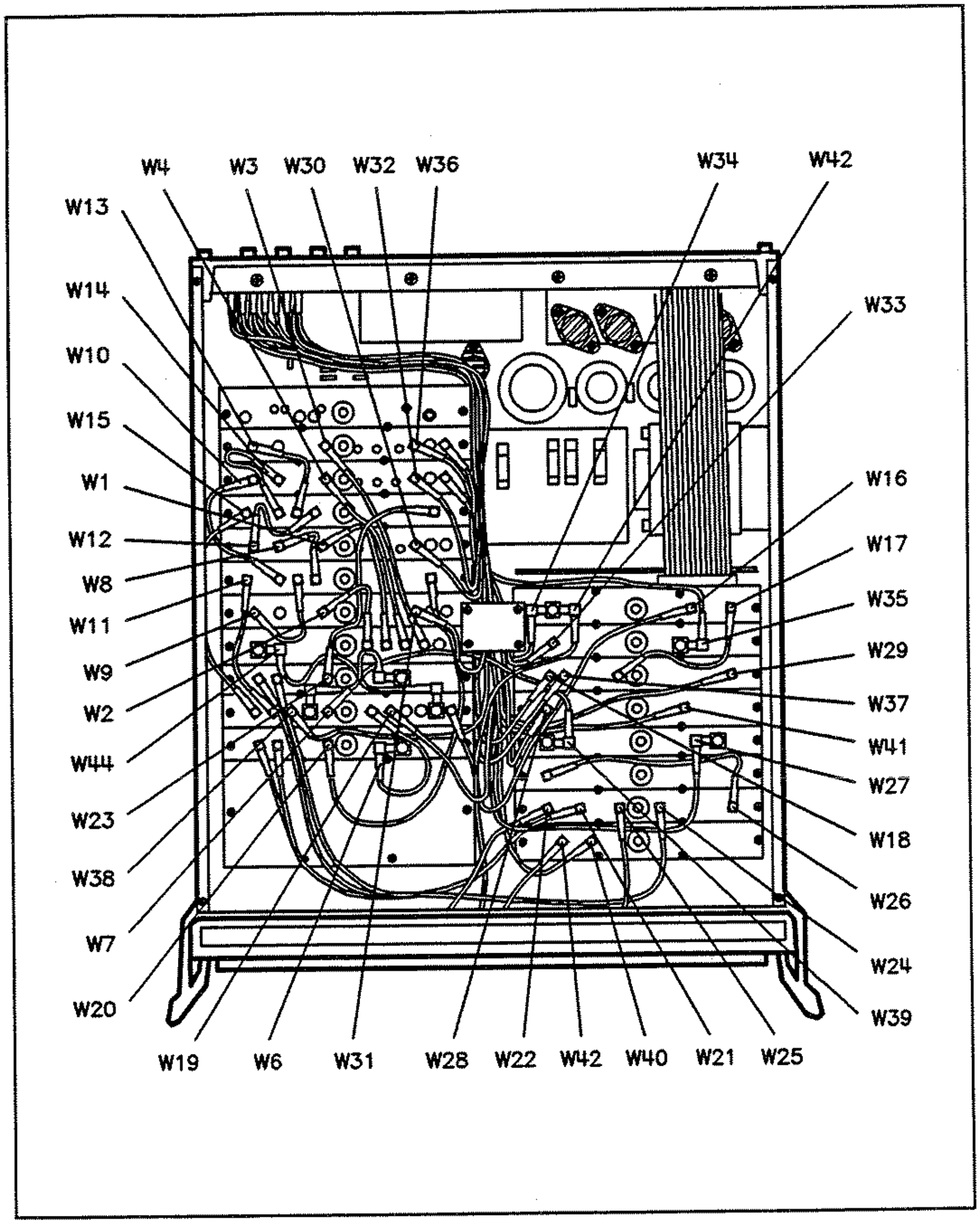
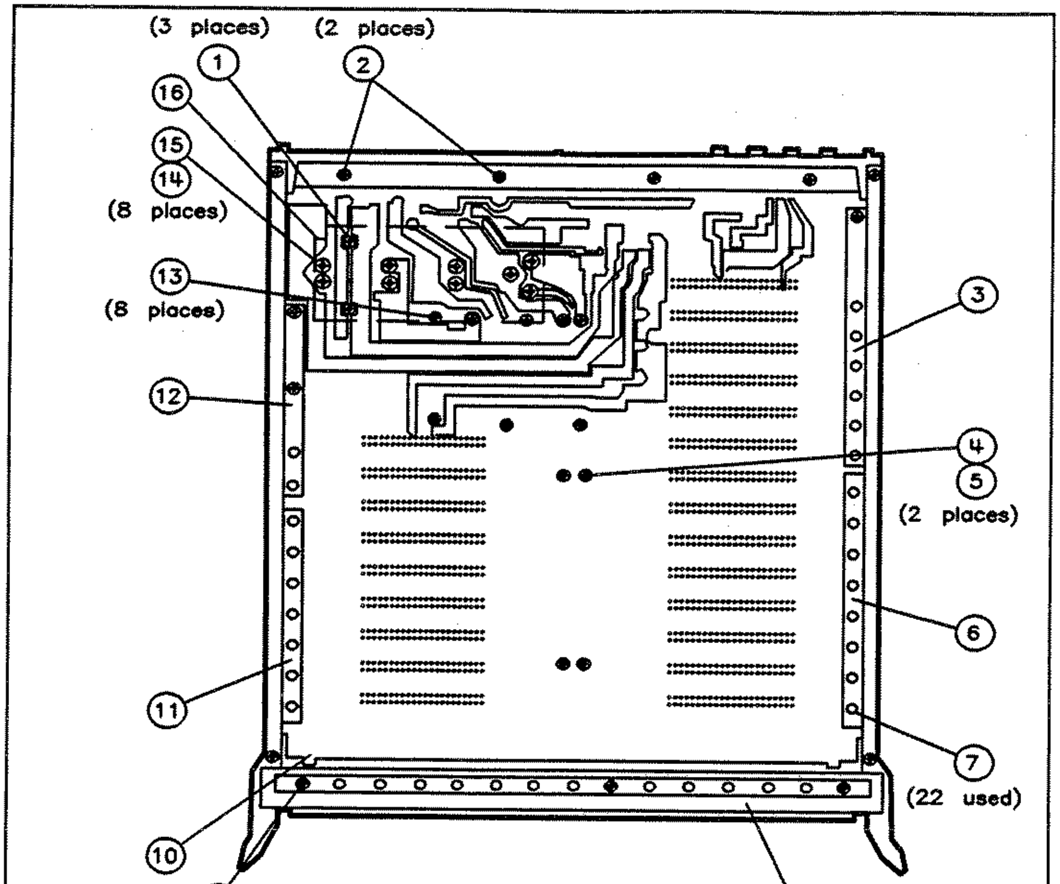
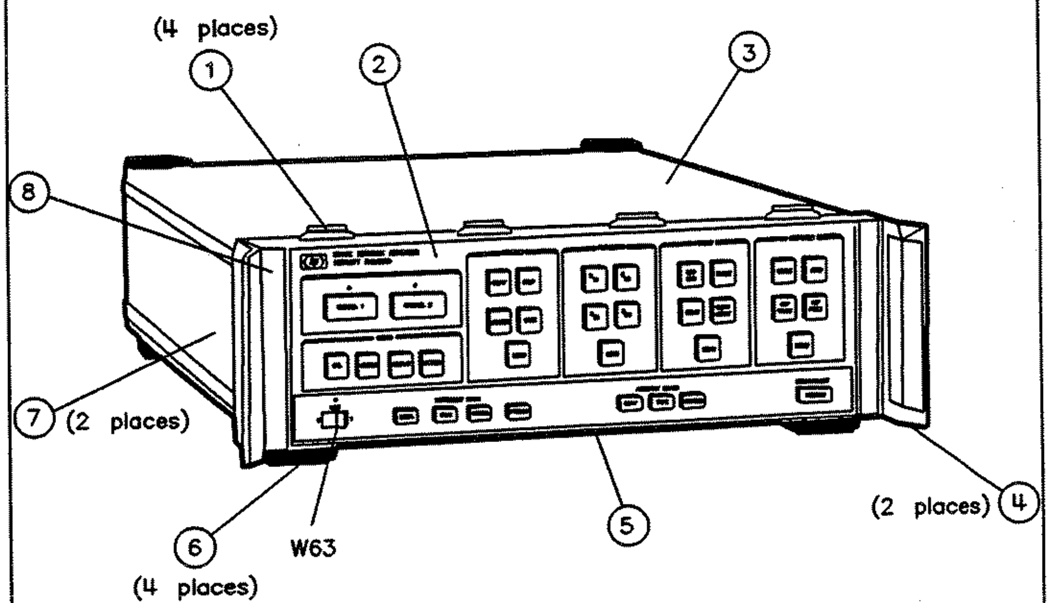


Figure 5-13. HP 85102 Cable Locations (2 of 2)



Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
1	2200-0165	3	SCREW-MACH 4-40 .25-IN-LG 82 DEG	00000	ORDER BY DESC.
2	2360-0117	2	SCREW-MACH 6-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESC.
3	85102-00036	1	BRACKET-L REAR	28480	85102-00036
4	2360-0202	2	SCREW-MACH 6-32 .625-IN-LG 100 DEG	00000	ORDER BY DESC.
5	0380-0018	2	SPACER-RND .25-IN-LG .194-IN-ID	28480	0380-0018
6	85102-00035	1	BRACKET-L FRONT	28480	85102-00035
7	0624-0100	26	SCREW-TPG 4-40 .5-IN-LG PAN-HD-POZI STL	28480	0624-0100
8	5021-8403	1	FRAME FRONT	28480	5021-8403
9	0624-0589	8	SCREW-TPG 4-40 .25-IN-LG UNCT 82 DEG	28480	0624-0589
10	0460-0778	1	TAPE INDL .75-IN-W .25-IN-T POLYU-FM	00000	ORDER BY DESC.
11	85102-00033	1	BRACKET-R FRONT	28480	85102-00033
12	85102-00034	1	BRACKET-R REAR	28480	85102-00034
13	2200-0105	8	SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESC.
14	2190-0011	8	WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0011
15	2680-0129	8	SCREW-MACH 10-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESC.
16	85102-20053	1	COVER-SAFETY	28480	85102-20053

Figure 5-14. HP 85102 Bottom Internal

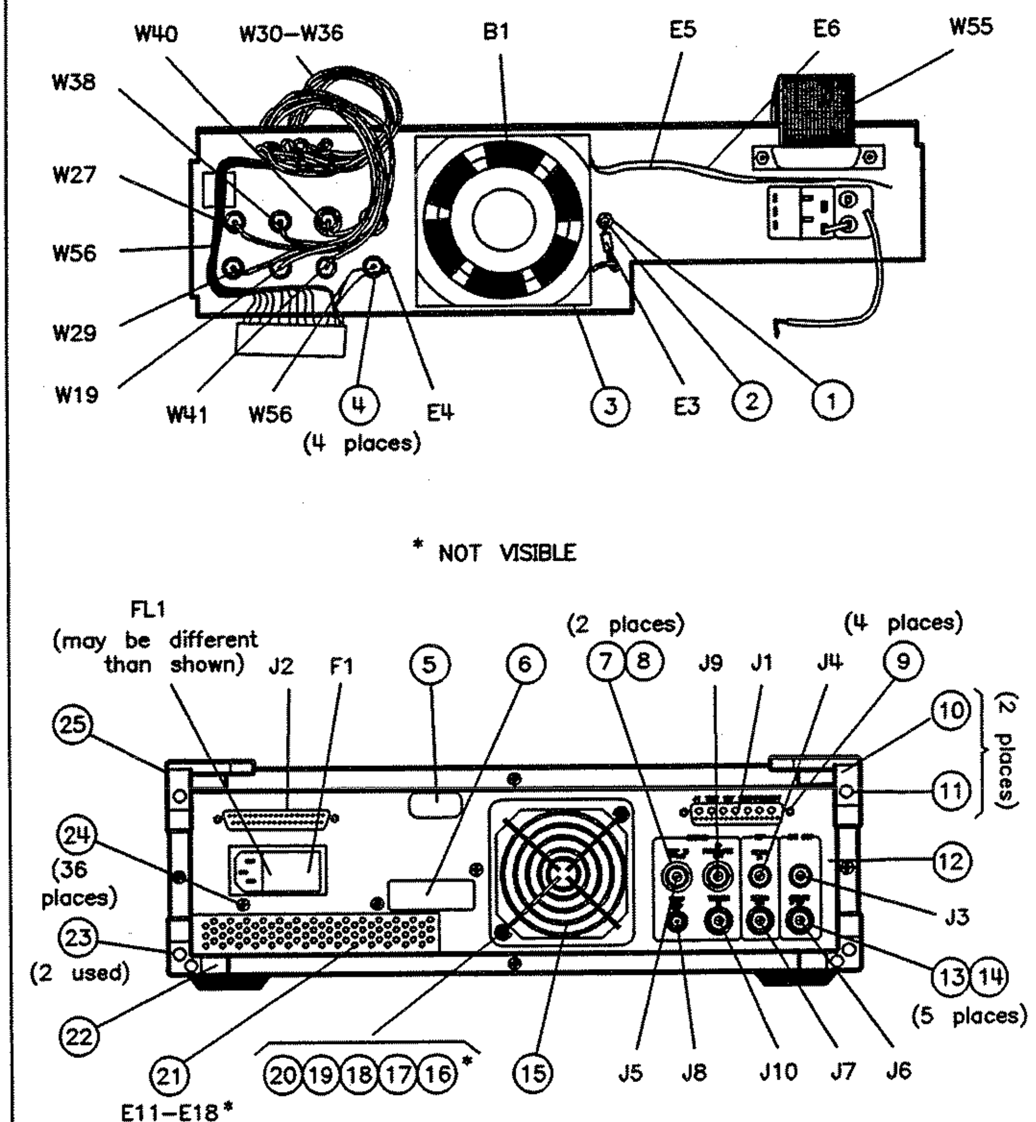


Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
1	1600-0367	4	VERTICAL LOCK (FRONT)	28480	1600-0367
2	85102-80116	1	DRESS PANEL	28480	85102-80116
3	5062-3735	1	COVER TOP 18"	28480	5062-3735
4	5062-3799	2	HANDLE ASSEMBLY FRONT	28480	5062-3799
5	85102-00043	1	BOTTOM COVER	28480	85102-00043
6	5041-8801	4	FOOT-BOTTOM	28480	5041-8801
7	5062-3757	2	COVER ASSEMBLY SIDE	28480	5062-3757
8	85102-20054	1	FRONT BEZEL MACH	28480	85102-20054
W63	85102-60193	1	CABLE ASSEMBLY LINE SWITCH	28480	85102-60193

Figure 5-15. HP 85102 Front

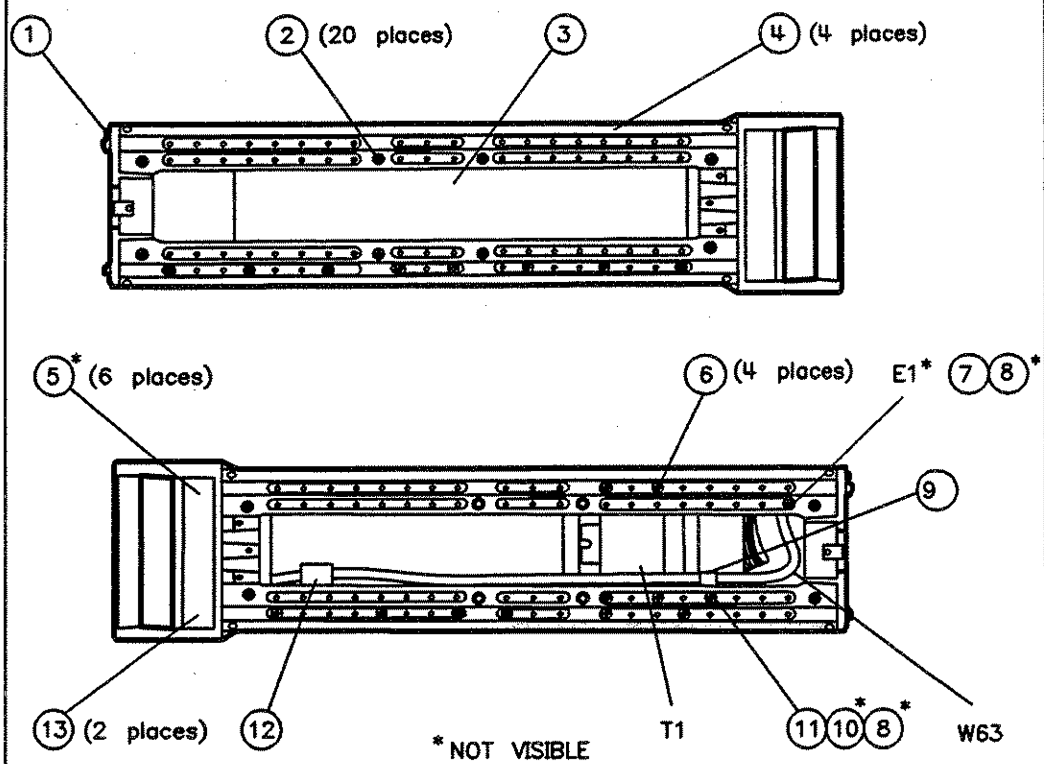
Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
B1	85102−20056	1	FAN ASSEMBLY	28480	85102−20056
E3	0360−0031		TERMINAL−CRIMP R−TNG #6 22−16−AWG RED	28480	0360−0031
E4	0360−1632	1	TERMINAL−SLDR LUG LK−MTG FOR−#3/8−SCR	28480	0360−1632
E5	0362−0227	2	CONNECTOR−SGL CONT SKT 1.14−MM−BSC−SZ	28480	0362−0227
E6	0362−0227		CONNECTOR−SGL CONT SKT 1.14−MM−BSC−SZ	28480	0362−0227
E11−18	1200−0147	8	INSULATOR−FLG−BSHG NYLON	28480	1200−0147
F1	2110−0002	1	FUSE 2A 250V NTD 1.25X.25 UL	75915	2110−0002
FL1	0960−0443	1	LINE MODULE−FILTERED	28480	0960−0443
J1	1251−2197	1	CONNECTOR R&P 24F	28480	1251−2197
J2	1250−1391	1	ADAPTOR TEE MFM SMB	28480	1250−1391
J4	1250−0870		CONNECTOR−RF BNC FEM SGL−HOLE−RR 50−OHM	28480	1250−0870
J5	1250−1091	1	CONNECTOR−RF BNC FEM SGL−HOLE−RR 50−OHM	28480	1250−1091
J6	1250−0870		CONNECTOR−RF BNC FEM SGL−HOLE−RR 50−OHM	28480	1250−0870
J7	1250−0870		CONNECTOR−RF BNC FEM SGL−HOLE−RR 50−OHM	28480	1250−0870
J8	1250−0083	1	CONNECTOR−RF BNC FEM SGL−HOLE−FR 50−OHM	28480	1250−0083
J9	1250−1091	1	CONNECTOR−RF BNC FEM SGL−HOLE−FR 50−OHM	28480	1250−1091
J10	1250−0870	1	CONNECTOR−RF BNC FEM SGL−HOLE−FR 50−OHM	28480	1250−0870
W19	85102−60149	1	CABLE ASSEMBLY A6J7−J7	28480	85102−60149
W27	85102−60157	1	CABLE ASSEMBLY A19J2−J3	28480	85102−60157
W29	85102−60159	1	CABLE ASSEMBLY A21J4−J6	28480	85102−60159
W30	85102−60160	1	CABLE ASSEMBLY J1A2−A11J4	28480	85102−60160
W31	85102−60161	1	CABLE ASSEMBLY J1A3−A9J4	28480	85102−60161
W32	85102−60162	1	CABLE ASSEMBLY J1A4−A13J4	28480	85102−60162
W33	85102−60163	1	CABLE ASSEMBLY J1A5−A22J1	28480	85102−60163
W34	85102−60164	1	CABLE ASSEMBLY J1A6−A23J1	28480	85102−60164
W35	85102−60165	1	CABLE ASSEMBLY J1A7−A22J3	28480	85102−60165
W36	85102−60166	1	CABLE ASSEMBLY J1A1−A14J4	28480	85102−60166
W38	85102−60168	1	CABLE ASSEMBLY A6J3−J4	28480	85102−60168
W40	85102−60223	1	CABLE ASSEMBLYA16J2−REAR PANEL J9	28480	85102−60223
W41	85102−60224	1	CABLE ASSEMBLY A20J2−REAR PANEL J10	28480	85102−60224
W55	85102−60191	1	CABLE ASSEMBLY DISPLAY INTERFACE	28480	85102−60191
W56	85102−60192	1	CABLE ASSEMBLY TEST SET INFERFACE	28480	85102−60192
1	2420−0001	3	NUT−HEX−W/LKWR 6−32−THD .109−IN−THK	00000	ORDER BY DESC.
2	2360−0193	5	SCREW−MACH 6−32 .25−IN−LG PAN−HD−POZI	28480	2360−0193
3	0400−0010	4	GROMMET−RND .25−IN−ID .375−IN−GRV−OD	28480	0400−0010
4	2950−0043	1	NUT−HEX−DBL−CHAM 3/8−32−THD .094−IN−THK	00000	ORDER BY DESC.
5	7121−2380	1	LABEL−SERIAL NUMBER	28480	7121−2380
6	7120−4835	1	LABEL−INFORMATION .75−IN−WD 2−IN−LG PPR	28480	7120−4835
7	3050−1094	1	WASHER−FL MTLC 1/2 IN .505−IN−ID	28480	3050−1094
8	00310−48801	2	SHOULDERED WASHER	28480	00310−48801
9	1251−2942	4	LOCK−SUBMIN D CONN	28480	1251−2942
10	5021−8540	1	LOCK FOOT L RT	28480	5021−8540
11	0515−1244	2	SCREW−MACH 6−32 .5−IN−LG PAN−HD−POZI	00000	ORDER BY DESC.
12	85102−00056	1	REAR PANEL	28480	85102−00056
13	0590−1251	5	NUT−SPCLY 15/32−32−THD .1−IN−THK .562−WD	00000	ORDER BY DESC.
14	2190−0102	5	WASHER−LK INTL T 15/32 IN .472−IN−ID	28480	2190−0102
15	3160−0300	1	FINGER GUARD	28480	3160−0300
16	0510−0110	3	NUT−CAP 6−32−THD .281−IN−THK .312−A/F	00000	ORDER BY DESC.
17	2190−0006	2	WASHER−LK HLCL NO. 6 .141−IN−ID	28480	2190−0006
18	2190−0007	4	WASHER−LK INTL T NO. 6 .141−IN−ID	28480	2190−0007
19	2360−0205	2	SCREW−MACH 6−32 .75−IN−LG PAN−HD−POZI	00000	ORDER BY DESC.
20	3050−0227	4	WASHER−FL MTLC NO. 6 .149−IN−ID	28480	3050−0227
21	85102−20057	1	HEAT SINK	28480	85102−20057
22	5040−7221	2	FOOT−REAR	28480	5040−7221
23	0515−1244	3	SCREW−MACH 6−32 .438−IN−LG PAN−HD−POZI	00000	ORDER BY DESC.
24	2360−0115	36	SCREW−MACH 6−32 .312−IN−LG PAN−HD−POZI	00000	ORDER BY DESC.
25	5021−8538	1	LOCK FOOT L LFT	28480	5021−8538
	08360-60026	1	BD ASSY - FP FLT BNC	28480	08360-60026

Figure 5-16. HP 85102 Rear (1 of 2)



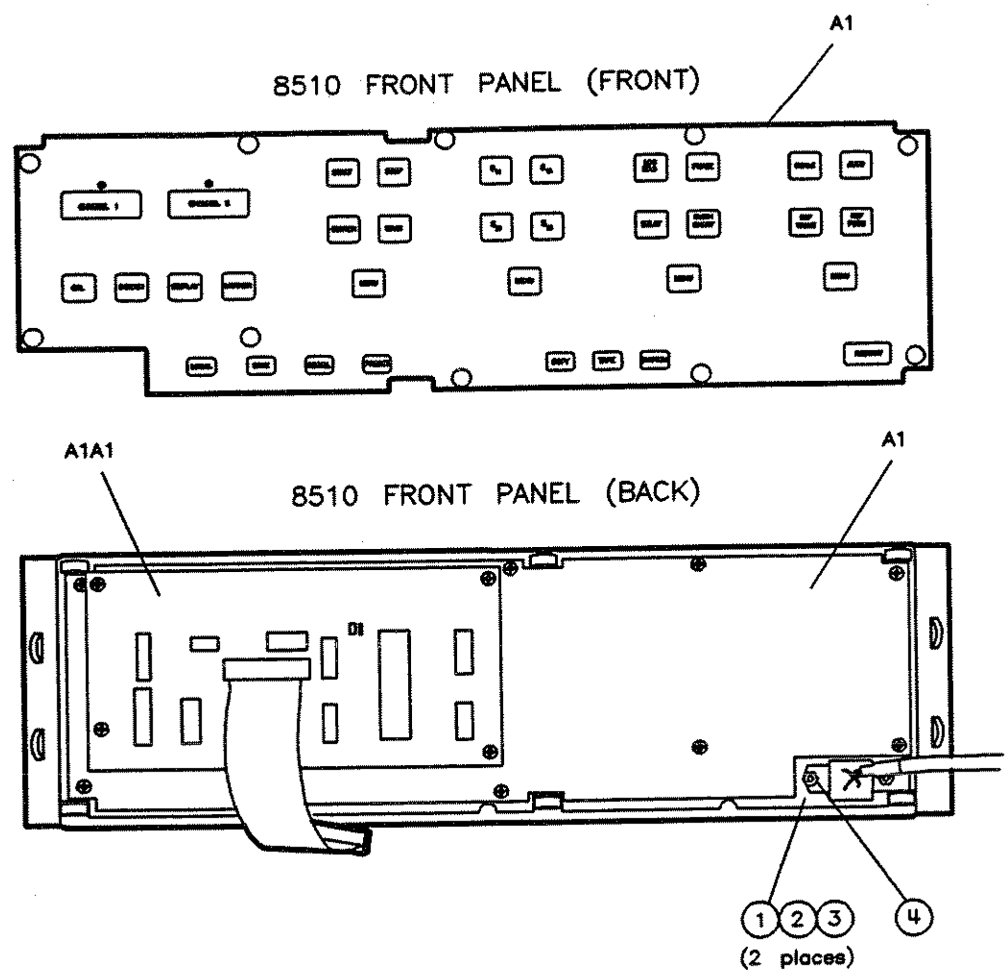
Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
	0590-0663	2	NUT-HEX 4-40	28480	0590-0663
	3050-0235	2	WASHER FLAT .117 IN-ID	28480	3050-0235
	3050-0011	2	WASHER FLAT .130 IN-ID	28480	3050-0011
	2200-0107	2	SCREW-MACH 440 .375 IN LG PAN-HD-POZI	28480	2200-0107

Figure 5-16. HP 85102 Rear (2 of 2)



Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
E1	0360−0009	1	TERMINAL−SLDR LUG PL−MTG FOR−#6−SCR	28480	0360−0009
T1	9100−4388	1	TRANSFORMER	28480	9100−4388
W63	85102−60193	1	CABLE ASSEMBLY LINE SWITCH	28480	85102−60193
1	5021−5804	1	FRAME REAR	28480	5021−5804
2	0515−1367	20	SCREW−MACH 8−32 .25−IN−LG 100 DEG	00000	ORDER BY DESC.
3	5001−8232	1	GUSSET SIDE	28480	5001−8232
4	5021−5837	4	STRUT CORNER 18"	28480	5021−5837
5	0515−0396	6	SCREW−MACH 8−32 .375−IN−LG 100 DEG	28480	0515−0396
6	2510−0049	4	SCREW−MACH 8−32 .5−IN−LG PAN−HD−POZI	00000	ORDER BY DESC.
7	2360−0115	36	SCREW−MACH 6−32 .312−IN−LG PAN−HD−POZI	00000	ORDER BY DESC.
8	2420−0001	3	NUT−HEX−W/LKWR 6−32−THD .109−IN−THK	00000	ORDER BY DESC.
9	1400−0017	1	CLAMP−CABLE .312−DIA .375−WD NYL	28480	1400−0017
10	3050−0227	4	WASHER−FL MTLC NO. 6 .149−IN−ID	28480	3050−0227
11	0515−1244	3	SCREW−MACH 6−32 .438−IN−LG PAN−HD−POZI	00000	ORDER BY DESC.
12	1400−0757	1	CLAMP−CABLE .25−DIA 1−WD PVC	28480	1400−0757
13	5020−8896	2	FRONT HANDLE TRIM	28480	5020−8896

Figure 5-17. HP 85102 Left and Right Internal



Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	85102–60001	1	BOARD ASSEMBLY, FRONT PANEL (NEW)	28480	85102–60001
A1	85102–69001		BOARD ASSEMBLY, FRONT PANEL (R–E)	28480	85102–69001
A1A1	85102–60029	1	BOARD ASSY, FRONT PANEL INTERFACE (NEW)	28480	85102–60029
A1A1	85102–69029		BOARD ASSY, FRONT PANEL INTERFACE (R–E)	28480	85102–69029
1	0380–0020	2	SPACER–RND .25–IN–LG .128–IN–ID	00000	ORDER BY DESC.
2	2190–0019	2	WASHER–LK HLCL NO. 4 .115–IN–ID	28480	2190–0019
3	2260–0001	2	NUT–HEX–DBL–CHAM 4–40–THD .094–IN–THK	28480	2260–0001
4	85102–60214	1	SUB PANEL	28480	85102–60214

Figure 5-18. HP 85102 Front Panel Board Assembly

Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
C1	0180–3017	1	CAPACITOR–FXD .045F+75–105VDC AL	28480	0180–3017
C2	0180–0453	1	CAPACITOR–FXD 8700UF+75–100VDC AL	28480	0180–0453
C3	0180–2671	2	CAPACITOR–FXD .012F+75–100VDC AL	00853	500123U030AC2A
C4	0180–2671		CAPACITOR–FXD .012F+75–100VDC AL	00853	500123U030AC2A
C5	0180–1731		CAPACITOR–FXD 4.7UF±100VDC TA	56289	150D475X9050B2
C6	0180–0116		CAPACITOR–FXD 6.8UF±105VDC TA	56289	150D685X9035B2
C7	0180–1731		CAPACITOR–FXD 4.7UF±100VDC TA	56289	150D475X9050B2
C8	0180–0116		CAPACITOR–FXD 6.8UF±105VDC TA	56289	150D685X9035B2
C9	0160–4084		CAPACITOR–FXD .1UF ±200VDC CER	28480	0160–4084
J1	1251–5800	1	CONNECTOR 26–PIN M POST TYPE	28480	1251–5800
J2	1251–3901	1	CONNECTOR 15–PIN M POST TYPE	28480	1251–3901
MP2	1251–5595		POLARIZING KEY–POST CONN	28480	1251–5595
MP4	0360–0124		CONNECTOR–SGL CONT PIN .04–IN–BSC–SZ RND	28480	0360–0124
MP5	0360–0124		CONNECTOR–SGL CONT PIN .04–IN–BSC–SZ RND	28480	0360–0124
MP7	2200–0105	2	SCREW–MACH 4–40 .312–IN–LG PAN–HD–POZI	00000	ORDER BY DESC.
MP8	2200–0105		SCREW–MACH 4–40 .312–IN–LG PAN–HD–POZI	00000	ORDER BY DESC.
MP9	1205–0421	1	HT SK TO66	28480	1205–0421
MP10	2420–0001	2	NUT HEX 6–32	28480	2420–0001
MP11	0570–0111	2	SCREW MACHINE 6–32	28480	0570–0111
Q5	1854–0072	1	TRANSISTOR NPN 2N3054 SI TO–66 PD=25W	28480	1854–0072
R1	0764–0016	2	RESISTOR 1K 5W MO TC=0±200	28480	0764–0016
R2	0764–0016		RESISTOR 1K 5W MO TC=0±200	28480	0764–0016
R3	0764–0015	2	RESISTOR 560 5W MO TC=0±200	28480	0764–0015
R4	0764–0015		RESISTOR 560 5W MO TC=0±200	28480	0764–0015
R5	0811–1672	6	RESISTOR 3.3 5W PW TC=0±400	75042	BWH2–3R3–J
R6	0811–1672		RESISTOR 3.3 5W PW TC=0±400	75042	BWH2–3R3–J
R7	0811–1672		RESISTOR 3.3 5W PW TC=0±400	75042	BWH2–3R3–J
R8	0811–1672		RESISTOR 3.3 5W PW TC=0±400	75042	BWH2–3R3–J
R9	0811–2048	1	RESISTOR .25 15W PW TC=0±90	91637	RH25–T2–1/4–F
R13	0811–1667	1	RESISTOR 1.2 5W PW TC=0±400	75042	BWH2–1R2–J
R15	0811–1672		RESISTOR 3.3 5W PW TC=0±400	75042	BWH2–3R3–J
R16	0811–1672		RESISTOR 3.3 5W PW TC=0±400	75042	BWH2–3R3–J
RT1	0837–0126	1	THERMISTOR DISC 1K–OHM TC=–4.4–DEG	28480	0837–0126
U1	1820–2075		IC MISC TTL LS	01295	SN74LS245N
U2	1826–0661		IC TEMP XDCR TO–52 PKG	24355	AD590KH
W1–2	8151–0013	2	WIRE 22 1X22	28480	8151–0013
X1	1200–0639	1	SOCKET–IC 20–CONT DIP DIP–SLDR	28480	1200–0639
XA2–XA24	1251–7882	23	CONNECTOR–PC EDGE 2–ROWS	28480	1251–7882

Figure 5-19. HP 85102 Motherboard (1 of 4)

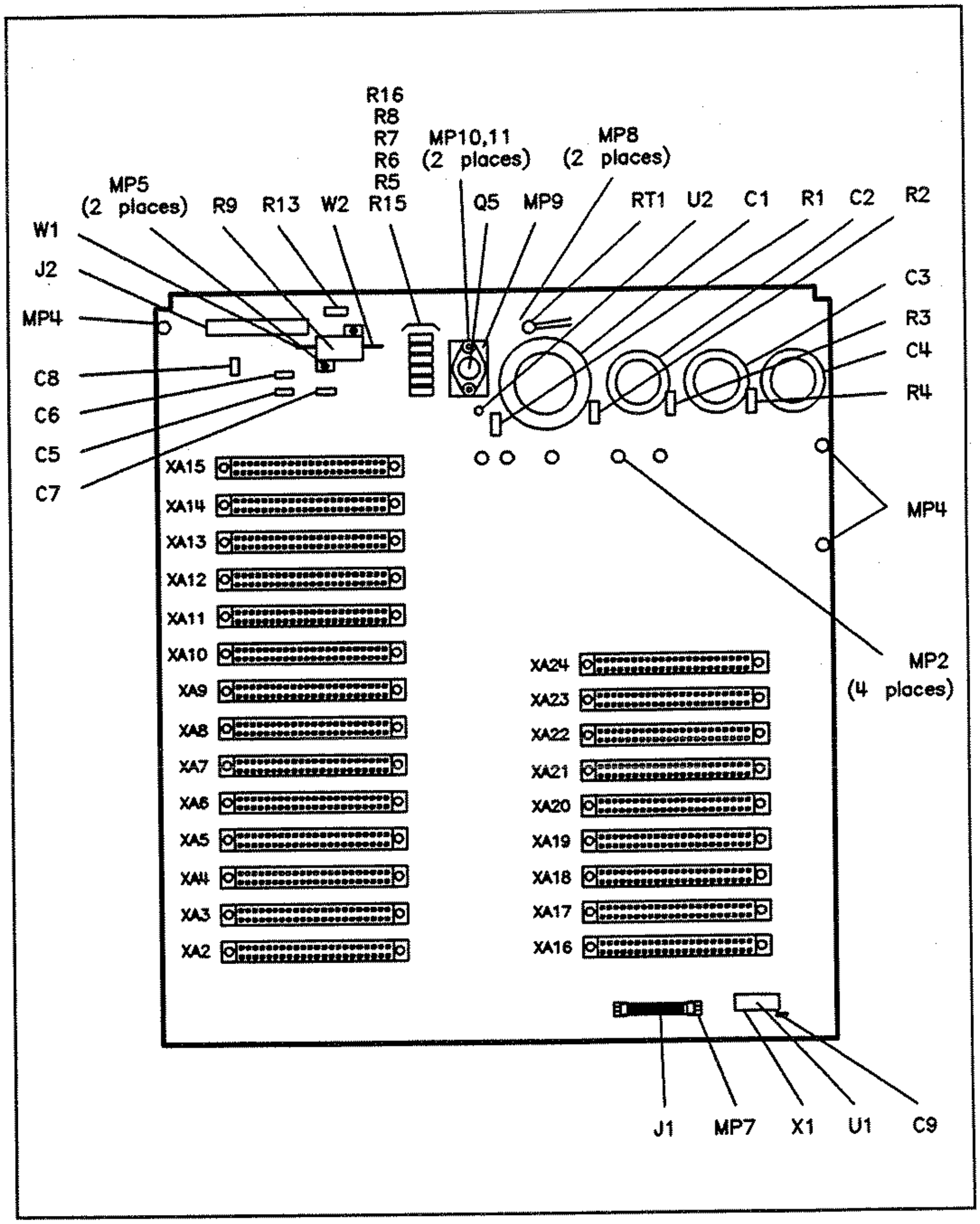


Figure 5-19. HP 85102 Motherboard (2 of 4)

Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A25	85102-60229	1	BOARD ASSEMBLY, MOTHER	28480	85102-60229
			THE FOLLOWING PARTS ARE NOT SUPPLIED WHEN A25 IS ORDERED:		
			A25C1, A25C2, A25C3, A25C4, A25Q1, A25Q2, A25Q3, A25Q4		
MP3	0360-0124	4	CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
MP6	0360-0124		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124

Figure 5-19. HP 85102 Motherboard (3 of 4)

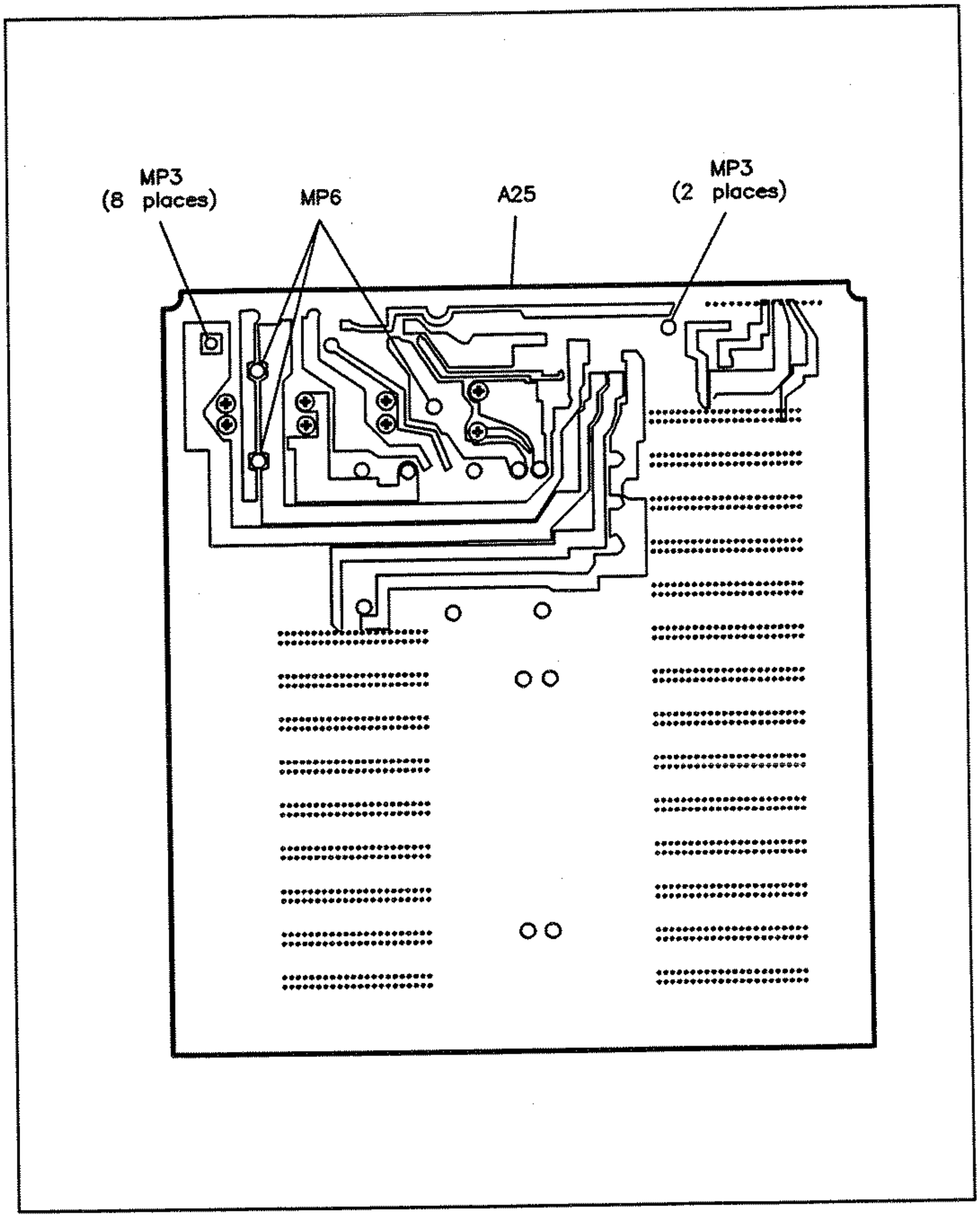


Figure 5-19. HP 85102 Motherboard (4 of 4)

Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
1	5062−3735	1	COVER TOP 18"	28480	5062−3735
2	5062−3757	2	COVER ASSEMBLY SIDE	28280	5062−3757
3	0624−0589	8	SCREW−TPG 4−40 .25−IN−LG UNCT 82 DEG	28480	0624−0589
4	5021−8403	1	FRAME FRONT	28480	5021−8403
5	5041−8801	4	FOOT−BOTTOM	28480	5041−8801
6	85102−00061	1	BOTTOM COVER	28480	85102−0006 1
7	5062−3799	2	HANDLE ASSEMBLY FRONT	28480	5062−3799
8	0515−0396	6	SCREW−MACH 8−32 .375−IN−LG 100 DEG	28480	0515−0396
9	5021−8496	2	TRIM FRONT HANDLE	28480	5021−8496
10	5041−8821	2	FOOT−REAR	28480	5041−8821
11	5001−8232	1	GUSSET SIDE	28480	5001−8232
12	5021−5837	4	STRUT CORNER 18"	28480	5021−5837
13	5021−5804	1	FRAME REAR	28480	5021−5804

Figure 5-20. HP 85102 Cabinet Parts (1 of 2)

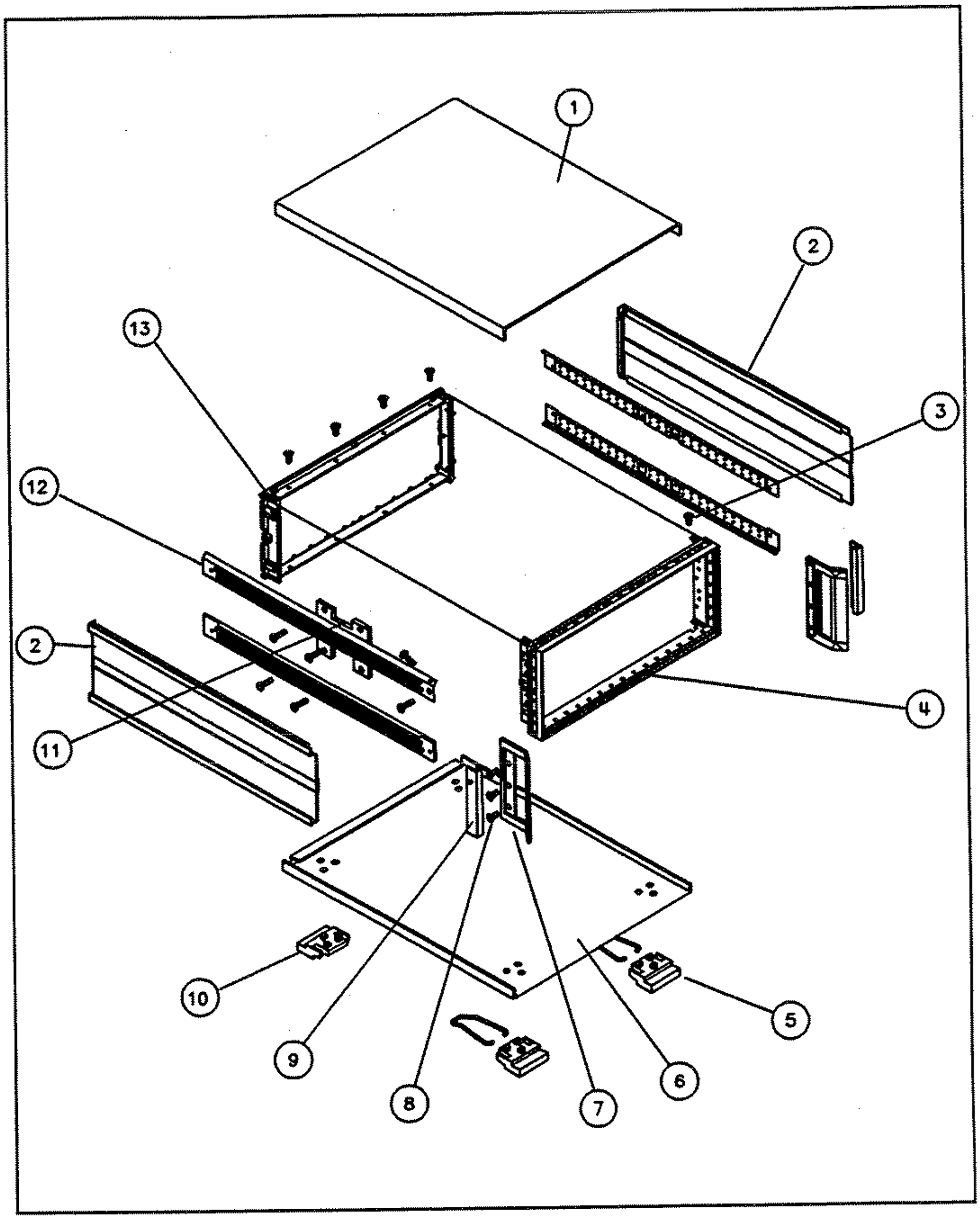


Figure 5-20. HP 85102 Cabinet Parts (2 of 2)

6. Replacement Procedures

INTRODUCTION

This chapter contains procedures for removing and replacing the following assemblies:

HP 85101C

- Front panel (A1)
- Rotary pulse generator (RPG)
- Disk drive (A2)
- Display (A11)
- Rear panel (A9)
- Preregulator (A10)
- Motherboard / card cage assembly

HP 85102B

- Front panel
- Rectifier board (A26)
- Power supply capacitors (C1, C2, C3 and C4)
- Rear panel

Table 6-1 provides Hewlett-Packard part numbers for the tools required in these procedures.

ADJUSTMENTS AND PERFORMANCE TESTS

When an assembly is replaced, adjustments may be necessary to assure the analyzer meets its specifications. Refer to Table 6-2, Related Adjustment Procedures, to identify the adjustment(s) required after replacing an assembly. In addition to any necessary adjustments, performance verification should be done if any assembly is replaced.

WARNING

The AC line voltage inside the instrument can, if contacted, produce fatal electrical shock. DISCONNECT BOTH AC POWER CORDS FOR ALL DISASSEMBLY PROCEDURES! With the AC power cables connected to the instrument, the AC line voltage is present on the terminals of the line power modules on the rear panels, and the LINE power switch, whether the switch is ON or OFF. Be aware that capacitors inside the instrument may remain charged even though the instrument has been disconnected from its AC power source.

Table 6-1. Disassembly Tools

Tool	HP Part Number
Large Pozidrive	8710-0900
Small Pozidrive	8710-0899
Torx driver T-10	8710-1623
Torx driver T-15	8710-1622
Nut driver 1/4 in.	8720-0002
Nut driver 7/16 in.	8720-0006
Allen wrench No. 6 (1/16 in.)	5020-0289
Small flat blade screwdriver	8730-0008
Needlenose pliers	8710-0595
Conductive Loctite	0470-0573
Insulated clip leads	N/A

HP 85101 REPLACEMENT PROCEDURES

ATTENTION
Static Sensitive

Handle only at Static Safe Work Stations

This product contains static-sensitive components. When handling these components or assemblies, work on an anti-static surface and use a static grounding wrist strap.

A1 FRONT PANEL REPLACEMENT

TOOLS REQUIRED

Large Pozidrive screwdriver
Very small flat blade screwdriver
T-10 Torx screwdriver

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 6-1.

To Disassemble

1. Disconnect the power cords and remove the top and right side covers.
2. Remove the bezel's softkey cover (item 1) by sliding your fingernail under the left edge, near the top or bottom of the cover. Pry the softkey cover away from the bezel. If you use another tool, take care not to scratch the glass.
3. Remove the two screws and washers (item 2) exposed by the previous step. Remove the bezel (item 3) from the frame.
4. Remove the trim strip from the top edge of the front frame by prying under it with a flat screwdriver.
5. Remove five screws: two from the top edge of the frame, two from the bottom edge of the frame and one from the side edge of the frame (item 4).
6. Disconnect the two ribbon cables from the motherboard by pressing down and out on the connector locks. Disconnect the disc drive power cable from the motherboard. The front panel is now free of the instrument.

To Reassemble

7. To install a front panel, reverse the preceding steps. Torque all screws to 113 N-cm (10 in-lb).

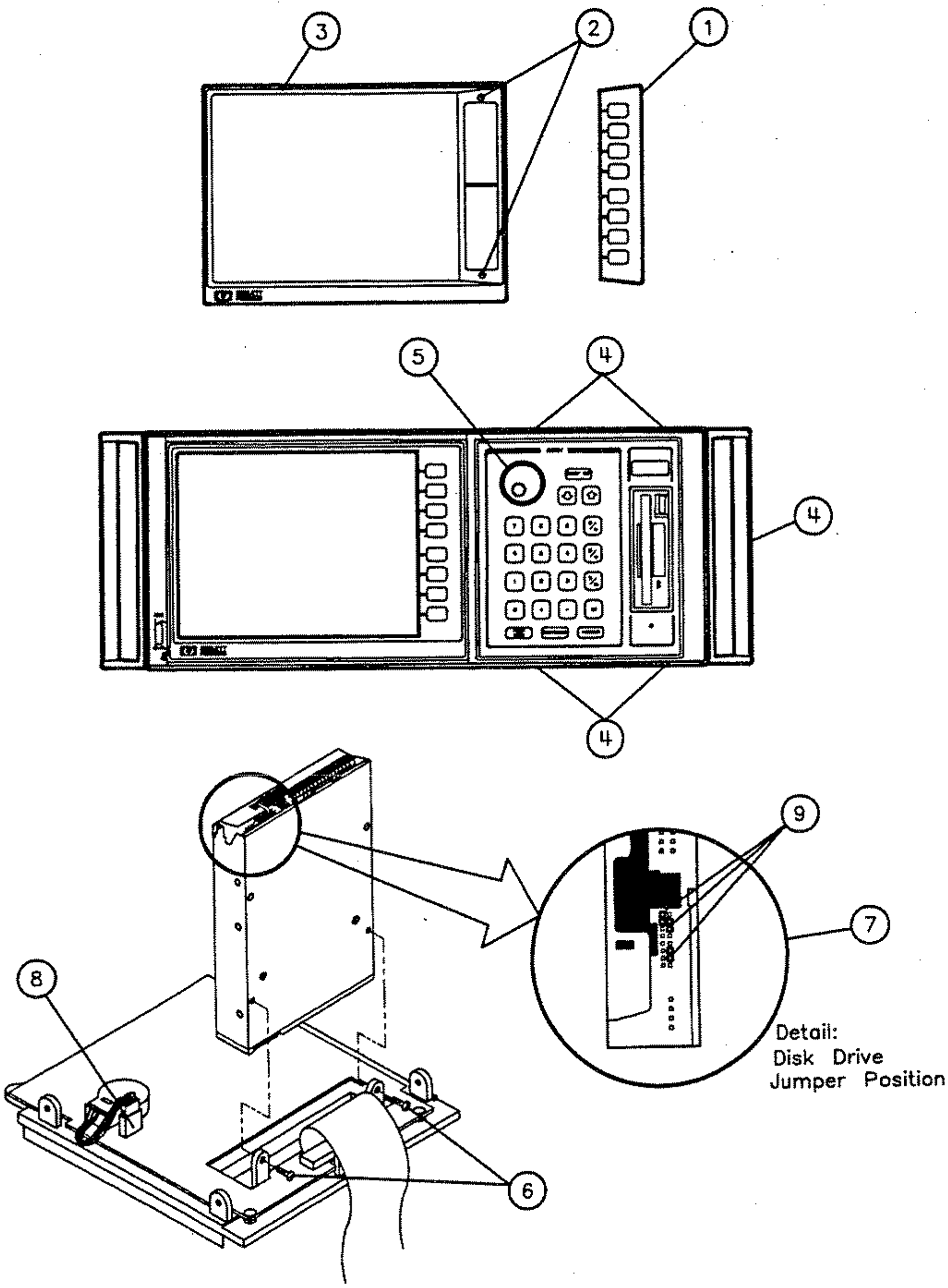


Figure 6-1

ROTARY PULSE GENERATOR (RPG) REPLACEMENT

TOOLS REQUIRED

Large Pozidrive screwdriver
Very small flat blade screwdriver
7/16 in. open-end wrench or nut driver
No. 6 Allen wrench (1/16 in.)
T-10 Torx screwdriver

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 6-1.

To Disassemble

1. Perform the front panel (A1) disassembly procedure.

2. Using a 1/16 in. Allen wrench, loosen the screws in the RPG knob (item 5). Pull the knob off the RPG shaft.

3. Remove the teflon sleeve, nut and washer from the RPG shaft.

4. Disconnect the cable from the A1J2 RPG connection (item 8) and remove the RPG from the front panel assembly.

To Reassemble

5. Reverse steps 2 through 4. Perform step 7 of front panel (A1) replacement procedure.

DISK DRIVE (A2) REPLACEMENT

TOOLS REQUIRED

Large Pozidrive screwdriver
Very small flat blade screwdriver
T-10 Torx screwdriver
Needlenose pliers

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 6-1.

To Disassemble

1. Perform the front panel (A1) disassembly procedure.
2. Remove the two screws holding the disc drive to the front panel (item 6).
3. Remove the disc drive from the front panel assembly.

To Reassemble

4. Reverse steps 2 and 3. Torque the two screws in step 2 to 79 N-cm (7 in-lb). Perform step 7 of front panel (A1) replacement procedure.

NOTE: If a new disc drive is being installed, verify the jumper positions (item 7) before installing. If necessary, use needlenose pliers to move the jumpers (item 9) to their correct positions.

DISPLAY REPLACEMENT (A11)

TOOLS REQUIRED

Large Pozidrive screwdriver
Small Pozidrive screwdriver
Small flat blade screwdriver
T-10 Torx screwdriver
T-15 Torx screwdriver

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 6-1.

To Disassemble

1. Disconnect the power cords and remove the top cover.

2. Remove the bezel's softkey cover (item 1) by sliding your fingernail under the left edge near the top or bottom of the cover. Pry the softkey cover away from the bezel. If you use another tool, take care not to scratch the glass.

3. Remove the two screws and washers (item 2) exposed by the previous step. The bezel is now free from the frame. Remove the bezel (item 3) and the gasket behind it.

Refer to Figure 6-2 for the rest of this procedure.

4. Remove the four screws (item 1) from the top of the display.

5. Remove the display cable grounding clip (item 2) from the display unit.

6. Remove 21 screws (item 7) from the card cage cover.

7. Remove the card cage cover (item 8), the RFI gasket (item 6) and the PC board spacers (item 5).

8. Disconnect the display power cable assembly (item 3) from the display processor board.

9. Gently slide the display forward and out of the steel display enclosure.

10. Disconnect the display power cable assembly (item 3) from the display rear panel.

To Reassemble

11. Remove the display power cable assembly shipped with the new display unit.

12. Install the display power cable assembly (item 3) used in the HP 85101C to the new display unit.

13. To install a new display unit, reverse the preceding steps. When replacing the four screws in step 4, first hand-tighten them, then torque to 237 N-cm (21 in-lb). Torque all other screws to 113 N-cm (10 in-lb).

NOTE: Before installing a new display, remove the four screws from the rear panel of the new display assembly. Slide off the one-piece bottom and rear cover of the new display and discard.

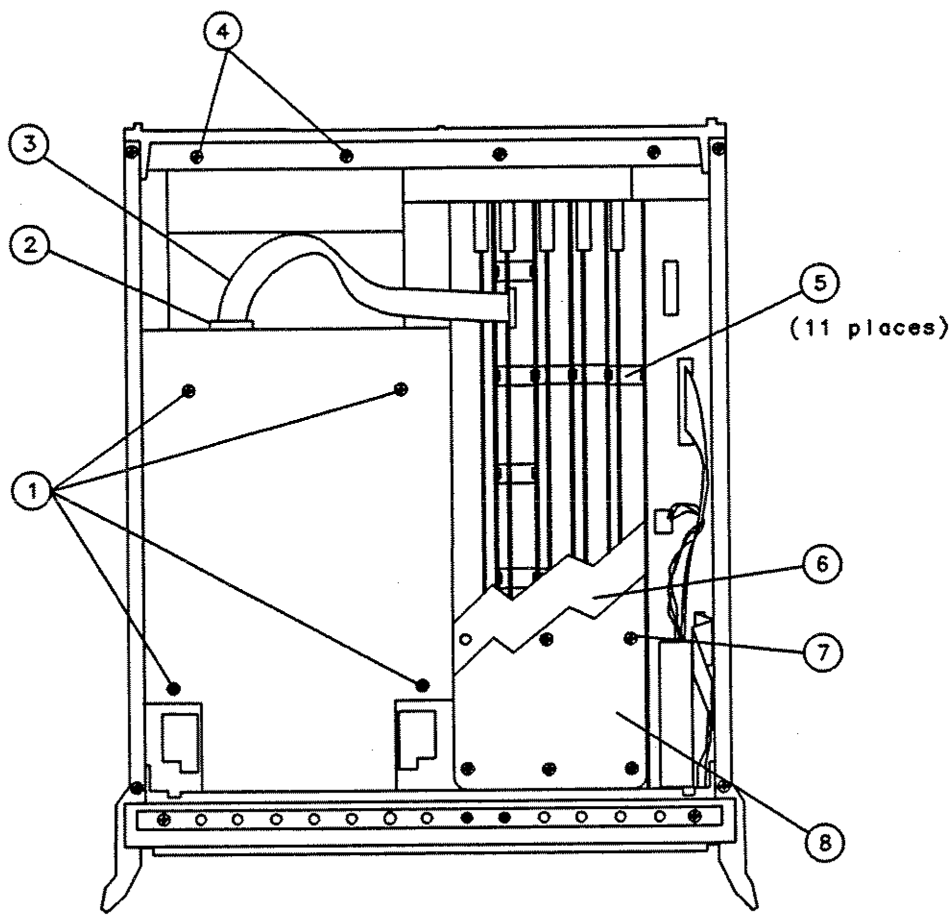


Figure 6-2

REAR PANEL (A9) REPLACEMENT

TOOLS REQUIRED

Large Pozidrive screwdriver
T-10 Torx screwdriver

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 6-3.

To Disassemble

1. Disconnect the power cords and remove the top and bottom covers.

2. Remove seven screws: two from the top edge of the frame and two from the bottom edge of the frame (item 1); and three from the middle of the rear panel of the instrument (item 2).

3. Slide the rear panel partway out to access the ribbon cable connections to the motherboard.

4. Remove the ribbon cables from the motherboard and slide the rear panel out.

To Reassemble

5. Reverse the preceding steps. Torque frame screws (item 1) to 113 N-cm (10 in-lb). Torque rear panel screws (item 2) to 79 N-cm (7 in-lb).

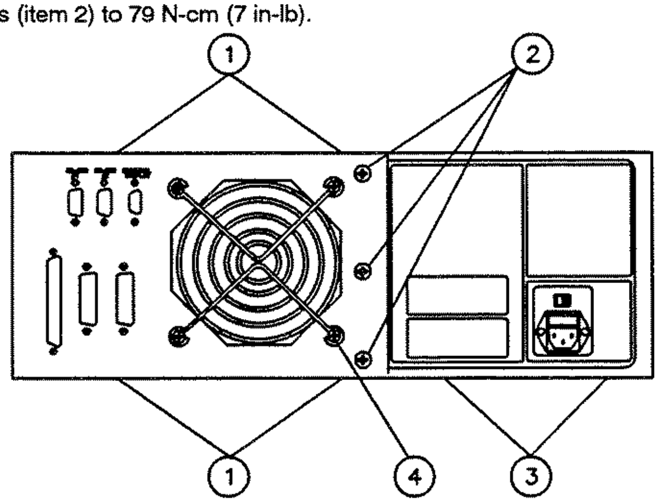


Figure 6-3

PREREGULATOR (A10) REPLACEMENT

TOOLS

T-10 Torx screwdriver
Large Pozidrive screwdriver

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 6-2.

TO DISASSEMBLE

1. Perform the rear panel disassembly procedure.
2. Remove the 21 screws (item 7) from the card cage cover. Remove the card cage cover (item 8), the RFI gasket (item 6), and the PC board spacers (item 5).
3. Disconnect the preregulator ribbon cable from the A3 post-regulator board.
4. Remove the four screws in the rear frame; two on the top and two on the bottom (item 4).
5. Pull the preregulator assembly away from the frame. Disconnect the cable harness assembly at the J8 preregulator connection on the motherboard.

To Reassemble

6. To install a new preregulator, reverse steps 2 through 5. Torque all screws to 113 N-cm (10 in-lb). Perform step 5 of rear panel replacement procedure.

MOTHERBOARD / CARD CAGE ASSEMBLY REPLACEMENT

TOOLS REQUIRED

Large Pozidrive screwdriver
Small Pozidrive screwdriver
Very small flat blade screwdriver
T-10 Torx screwdriver
T-15 Torx screwdriver

PROCEDURE

To Disassemble

1. Disconnect the power cords and remove all handles and covers.

2. Perform the front panel (A1) disassembly procedure.

3. Perform the display (A11) disassembly procedure.

4. Perform the rear panel (A9) disassembly procedure.

5. Perform the preregulator (A10) disassembly procedure.

6. Remove all PC boards from the instrument.

7. Remove all screws from the frame of the instrument. The front and rear frame are now free from the motherboard / card cage assembly.

To Reassemble

8. Reverse the preceding steps, torquing screws to 113 N-cm (10 in-lb).

HP 85102B REPLACEMENT PROCEDURES

ATTENTION
Static Sensitive

Handle only at Static Safe
Work Stations

This product contains static-sensitive components. When handling these components or assemblies, work on an anti-static surface and use a static grounding wrist strap.

FRONT PANEL REPLACEMENT

TOOLS REQUIRED

Large Pozidrive screwdriver
Small Pozidrive screwdriver

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 6-4.

To Disassemble

1. Disconnect the power cords.
2. Remove the instrument handles. Screws are located under the plastic covers.
3. Remove the three screws from the bottom edge of the frame (item 1).
4. Remove seven screws: three from the top edge of the frame (item 2), and two each from each side edge of the frame (item 3).
5. Disconnect the ribbon cable from the front panel interface board and the wires from the transformer. The front panel is now free of the instrument.

To Reassemble

6. Reverse the above procedure to install the front panel. Torque all frame screws to 113 N-cm (10 in-lb). Torque the handle screws to 237 N-cm (21 in-lb).

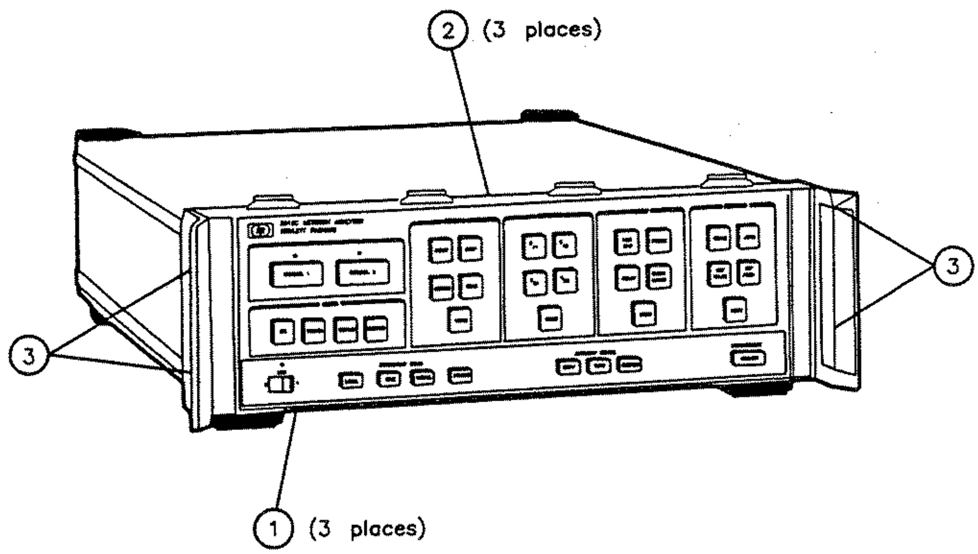


Figure 6-4

RECTIFIER BOARD REPLACEMENT

TOOLS REQUIRED

Large Pozidrive screwdriver
Small Pozidrive screwdriver
Small flat blade screwdriver
1/4 in. nut driver
Insulated clip leads (2)

WARNING

Even with the power cords disconnected, dangerous voltages may be present on the capacitors in the instrument. Perform the the follwing procedure to DISCHARGE THE POWER SUPPLY CAPACITORS BEFORE PERFORMING THE DISASSEMBLY PROCEDURE.

CAPACITOR DISCHARGE PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 6-5.

1. Disconnect the power cords and remove top and bottom covers.

2. On the bottom of the instrument, remove three screws (item 2) from the plastic safety cover. Carefully remove the cover taking care not to touch capacitor terminals (eight large Pozidrive screws) (item 3).

3. Connect the chassis of the instrument to earth ground.

4. Discharge the capacitors one-by-one by attaching one end of an insulated clip lead to the chassis and the other end of the clip lead to the capacitor terminal (large Pozidrive screws) (item 3). **Do this to every capacitor terminal.**

To Disassemble

Refer to Figure 6-6 for this portion of the procedure.

1. From the top side of the rectifier board, remove the two clear plastic safety covers. Pull the top one off using the black handle. Remove the four plastic screws to remove the lower cover.

2. Disconnect the wire harness from the rectifier board.

3. Using a 1/4 in. nut driver, remove the eight hex nuts from the rectifier board (item 1).

Refer to Figure 6-5 for the rest of this procedure.

4. Turn the instrument over. Remove the eight rectifier board screws (item 1) from the motherboard. The rectifier board can now be removed from the instrument.

To Reassemble

5. Reverse steps 1 through 4. Hand-tighten the plastic screws in step 1. Torque all other screws to 79 N-cm (7 in-lb).

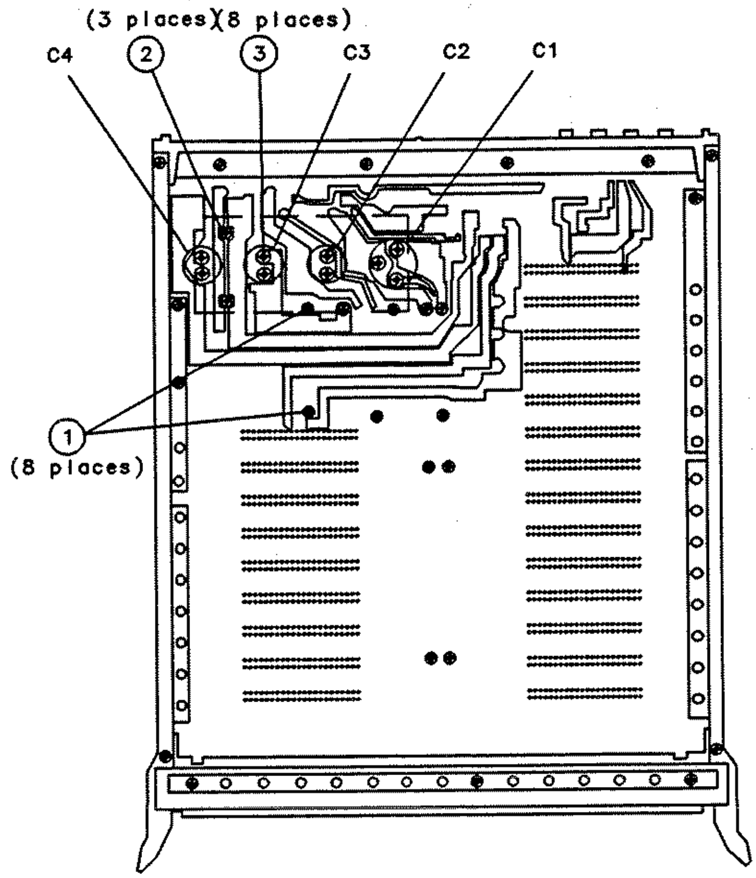


Figure 6-5

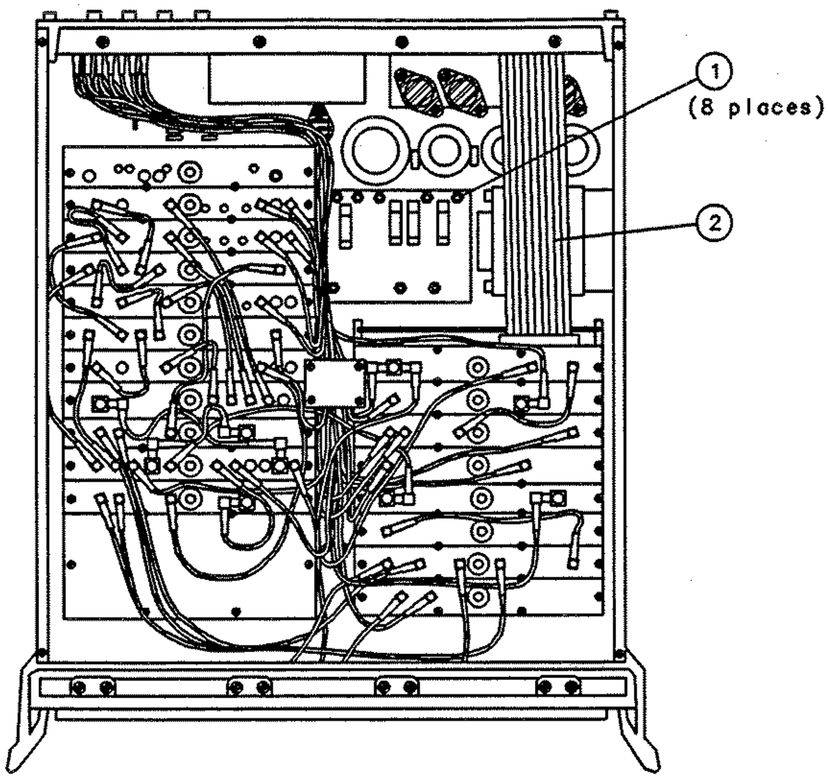


Figure 6-6

POWER SUPPLY CAPACITORS REPLACEMENT (C1, C2, C3 AND C4)

TOOLS REQUIRED

Large Pozidrive screwdriver
Insulated clip leads (2)

WARNING

Even with the power cords disconnected, dangerous voltages may be present on the capacitors in the instrument. Perform the the follwing procedure to DISCHARGE THE POWER SUPPLY CAPACITORS BEFORE PERFORMING THE DISASSEMBLY PROCEDURE.

CAPACITOR DISCHARGE PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 6-5.

1. Disconnect the power cords and remove top and bottom covers.

2. On the bottom of the instrument, remove the three screws (item 2) from the plastic safety cover. Carefully remove the cover taking care not to touch capacitor terminals (eight large Pozidrive screws) (item 3).

3. Connect the chassis of the instrument to earth ground.

4. Discharge the capacitors one-by-one by attaching one end of an insulated clip lead to the chassis and the other end of the clip lead to the capacitor terminal (large Pozidrive screws) (item 3). **Do this to every capacitor terminal.**

To Disassemble

The items in parentheses refer to the corresponding item numbers in Figure 6-5.

5. Remove the two screws (item 3) of the desired capacitor and remove the capacitor.

To Reassemble

6. To install a new capacitor, apply one drop of conductive Loctite to each capacitor screw hole and install the capacitor. Torque the capacitor screws to 237 N-cm (21 in-lb). Torque the plastic-shield screws to 79 N-cm (7 in-lb).

NOTE: It is important to observe polarity when installing a capacitor. There is a plug in the bottom of the capacitor that can be seen through a hole in the motherboard if the capacitor is installed correctly.

REAR PANEL REPLACEMENT

TOOLS REQUIRED

Large Pozidrive screwdriver
Small Pozidrive screwdriver

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 6-7.

To Disassemble

1. Disconnect the power cords and remove all covers.
2. Remove two screws from the bottom edge of the frame (item 3), four screws from the top edge of the frame (item 2) and two screws from the rear panel (item 4).
3. Disconnect the seven orange and seven yellow SMB cables from the PC board covers (Reference Designators W19, W27, W28, W29, W30, W31, W32, W33, W34, W35, W36, W38, W40, and W41). (For additional information on location of specific cables, see Figure 5-13, HP 85102 Cable Locations in chapter 5 of this manual.)
4. Disconnect the ribbon cable from the A24 processor interface board. (See item 2, Figure 6-6.)
5. Disconnect the wire harness assembly from J2 on motherboard.
6. Remove two screws (item 1) from the left side frame and disconnect the ground wires.
7. Disconnect all wires from the transformer.
8. Remove the rear panel.

To Reassemble

9. Reverse the preceding steps. Torque screws to 113 N-cm (10 in-lb).

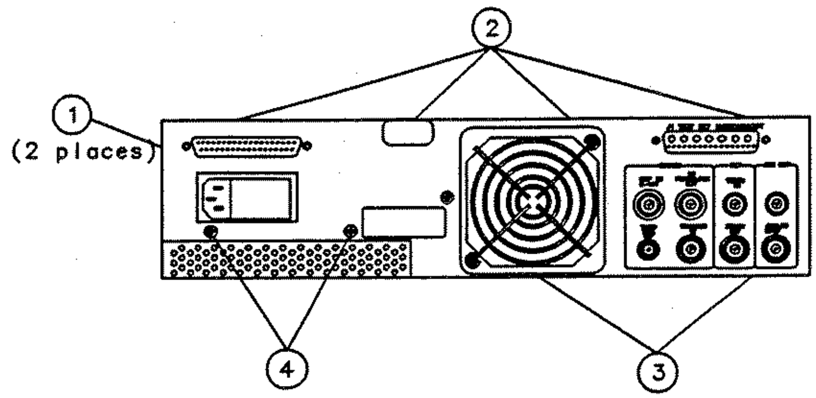


Figure 6-7

Table 6-2. Related Adjustment Procedures

Assembly Replaced or Repaired	Adjustment Procedure Number, If Replaced
HP 85101 Display/Processor	
A1 Front Panel	none
A2 Disk Drive	none
A3 Post-Regulator Board	none
A4 Graphic System Processor	1, 3
A5 CPU Board	1, 3
A6 EEPROM Board	1, 3
A7 Input/Output Board	none
A8 Not Assigned	
A9 Rear Panel	none
A10 Preregulator	none
A11, Display	1, 3
HP 85102 IF Detector	
A1 Front Panel	none
A1A1 Front Panel Interface	none
A2-A4 Not Assigned	
A5 Test Synchronous Detector	7
A6 Clock	8
A7 Reference Synchronous Detector	7
A8 19.9 MHz LO	none
A9 B2 IF Mixer	5
A10 Test IF Amplifier	6
A11 B1 IF Mixer	5
A12 Reference IF Amplifier	6
A13 A2 IF Mixer	5
A14 A1 IF Mixer	5
A15 Regulator	none
A16 Remote Applications	none
A17 Sample and Hold	none
A18 ADC	none
A19 ADC Control	none
A20 Sweep ADC	4
A21 IF Counter	none
A22 Pretune	none
A23 Main Phase Lock	none
A24 Interface	none
A25 Motherboard	none
A26 Rectifier	none

7. Adjustments

OVERVIEW

This chapter provides adjustment procedures for the HP 8510 network analyzer. These procedures should be used (1) after replacement of a part, or (2) when performance tests show that the specifications cannot be met. Table 7-1 lists the adjustment procedures by the order they appear in this chapter. Table 7-2 lists all adjustable components by reference designator, name, and the function adjusted. Table 7-3 lists adjustment procedures that interact between assemblies and lists the adjustment procedures that must be done when an assembly is replaced or repaired.

NOTE: Allow the analyzer system to warm up for one hour before making any adjustments.

The HP 85102 IF detector adjustments are semi-automated. Each adjustment procedure requires an HP 9000 series 200 or 300 controller connected to the HP 8510 bus (labeled "HP-IB" on the display/processor rear panel). The HP 8510 service adjustments software is also required.

The system source must be connected to the system bus to do the HP 85102 adjustments. A test set is not required. Yet, if a test set is not connected, the following cautions are displayed on the analyzer CRT: "CAUTION: SYSTEM BUS ADDRESS ERROR" and "CAUTION: VTO FAILURE." Both error messages may be safely ignored.

The HP 85102 IF detector adjustments are independent of one another. You only need to do the adjustment procedure associated with the module that has been replaced.

SAFETY CONSIDERATIONS

This instrument is designed according to international safety standards. However, this manual contains information, cautions, and warnings that must be followed to insure safe operation. Service and adjustments should be done only by qualified service personnel.

WARNING

Adjustments in this chapter are done with power supplied to the instrument and protective covers removed. There are voltages at many points in the instrument that can, if contacted, cause personal injury. Adjustments should be done only by trained service personnel.

Before removing or installing any assembly or printed circuit board in the HP 85101, remove the power cord from the rear panel.

Capacitors inside the instrument may still contain a charge, even if the instrument is disconnected from its source of supply. Use a non-metallic adjustment tool whenever possible.

EQUIPMENT REQUIRED

Table 7-4 lists the equipment required for the adjustment procedures. If the test equipment recommended is not available, other equipment may be used if the performance meets the critical specifications listed in the table. The test setup used for an adjustment procedure is shown on the CRT.

ADJUSTMENT TOOLS

For safety reasons, HP recommends that a non-metallic tuning tool is used for all adjustment procedures. Never try to force any adjustment control in the instrument. This is especially critical when tuning variable slug-tuned inductors and variable capacitors.

NOTE: Many adjustment procedures require the use of various miscellaneous tools and accessories. Adjustment procedures reference the tools and accessories.

RELATED ADJUSTMENTS

Table 7-3 lists any adjustments that interact with, or relate to, other adjustments. It is important that adjustments listed in Table 7-3 are done in the order shown to insure that the instrument meets its specifications.

RESEALING OF COMPONENTS

The steps to adjust a sealed component follow:

1. Remove the seal to adjust the component.

2. Reseal the component using a silicone rubber compound that does not contain acetic acid.

LOADING THE CONTROLLER BASIC LANGUAGE SYSTEM

Before loading the adjustments software, you must load a controller language system as follows:

Loading BASIC 2.0

1. With the controller power off, insert the HP 98611A BASIC 2.0 system disk into either the right or left disk drive. Switch the power on to the controller.

2. When BASIC is finished loading, remove the disk and insert the HP 98612A extended BASIC 2.1 disk into the same disk drive you used to load the BASIC system.

3. Type LOAD BIN "AP2_1", then press [RETURN] or [EXECUTE] or [EXEC].

Loading BASIC 3.0 or Higher

1. With the controller off, insert the HP 98613A BASIC 3.0 (or higher) system disk into either the right or left disk drive. Switch the power on to the controller.

2. When BASIC is finished loading, remove the disk. Insert the HP BASIC 3.0 (or higher) drivers disk or the language extensions and drivers disk into the same disk drive you used to load the BASIC system.

3. The following extension files must be loaded into the controller memory.

Drivers	Extensions
DISC	MAT, KBD
HPIB	IO, GRAPH

If you have any of the following system configurations, the following driver and/or extension files also must be loaded:

Configuration	Driver File	Extension File
SRM	DCOMM	SRM
HP 9885 disk drive	HP9885	
CS80 disk drive	CS80	
HP 9122 disk drive	CS80	

To load the files, type LOAD BIN "filename" for each driver filename (and each extension filename, if you have the double-sided language extensions and drivers disk), then press [RETURN] or [EXECUTE] or [EXEC].

4. When all the driver files are loaded, remove the disk.

If you have the double-sided language extensions and drivers disk, the procedure is complete.

If you do not have the double-sided language extensions and drivers disk, insert the BASIC 3.0 (or higher) language extensions disk into the same disk drive.

5. Type LOAD BIN "filename" for each extension filename, then press [RETURN] or [EXECUTE] or [EXEC].

Table 7-1. Adjustment Procedures

Title	Procedure Number	Assembly Adjusted
Vertical Position and Focus Adjustments (HP 85101)	1	A11
Display Degaussing (Demagnetizing) (HP 85101)	2	A11
Display Intensity Adjustments (HP 85101)	3	A11
Sweep ADC Gain Adjustment (HP 85102)	4	A20
IF Mixer Adjustment (HP 85102)	5	A9, A11, A13, A14
IF Amplifier Adjustment (HP 85102)	6	A10
Synchronous Detector Adjustment (HP 85102)	7	A5, A7
Clock Adjustment (HP 85102)	8	A6

Table 7-2. Adjustable Components in Alpha-Numeric Order (1 of 2)

Reference Designator	Adjustment Name	Adjustment Procedure Number	Adjustment Function
HP 85101 Display Processor			
A11	DISPLAY VERTICAL POSITION	1	Aligns softkey labels with softkeys
A11	DISPLAY FOCUS	1	Adjusts for optimum focus of display
A11	DISPLAY DEGAUSSING	2	Demagnetizes Display
A11	DISPLAY BACKGROUND INTENSITY	3	Sets "black level" of front panel intensity control of display background
A11	DISPLAY OPERATING DEFAULT INTENSITY	3	Sets maximum limit of front panel intensity control
HP 85102 IF Detector			
A5L4	X OUTPUT FILTERING	7	Minimizes higher order products from appearing at the X-component output
A5L5	X OUTPUT FILTERING	7	Minimizes higher order products from appearing at the X-component output
A5L6	Y OUTPUT FILTERING	7	Minimizes higher order products from appearing at the Y-component output
A5L7	Y OUTPUT FILTERING	7	Minimizes higher order products from appearing at the Y-component output
A6R51	CLOCK	8	Adjusts for a clock frequency of 20 MHz
A7L4	X OUTPUT FILTERING	7	Minimizes higher order products from appearing at the X-component output
A7L5	X OUTPUT FILTERING	7	Minimizes higher order products from appearing at the X-component output
A7L6	Y OUTPUT FILTERING	7	Minimizes higher order products from appearing at the Y-component output
A7L7	Y OUTPUT FILTERING	7	Minimizes higher order products from appearing at the Y-component output
A9C6	20MHZ XTAL FILTER	5	Adjusts for minimum bandpass ripple
A9C7	20MHZ XTAL FILTER	5	Adjusts for minimum bandpass ripple
A9C8	20MHZ XTAL FILTER	5	Adjusts for minimum bandpass ripple
A10L1	100KHZ TUNED FILTER	6	Tunes the filter to 100 kHz
A11C6	20MHZ XTAL FILTER	5	Adjusts for minimum bandpass ripple

Table 7-2. Adjustable Components in Alpha-Numeric Order (2 of 2)

Reference Designator	Adjustment Name	Adjustment Procedure Number	Adjustment Function
A11C7	20MHZ XTAL FILTER	5	Adjusts for minimum bandpass ripple
A11C8	20MHZ XTAL FILTER	5	Adjusts for minimum bandpass ripple
HP 85102 IF Detector (Cont'd)			
A12L1	100KHZ TUNED FILTER	6	Tunes the filter to 100 kHz
A13C6	20MHZ XTAL FILTER	5	Adjusts for minimum bandpass ripple
A13C7	20MHZ XTAL FILTER	5	Adjusts for minimum bandpass ripple
A13C8	20MHZ XTAL FILTER	5	Adjusts for minimum bandpass ripple
A14C6	20MHZ XTAL FILTER	5	Adjusts for minimum bandpass ripple
A14C7	20MHZ XTAL FILTER	5	Adjusts for minimum bandpass ripple
A14C8	20MHZ XTAL FILTER	5	Adjusts for minimum bandpass ripple
A20R26	SWEEP ADC GAIN	4	Compensates for component tolerances in the staircase generation circuit.

Table 7-3. Adjustment Interdependence between Assemblies

Assembly Replaced orRepaired	Adjustment Procedure Number, If Replaced
HP 85101 Display/Processor	
A1 Front Panel	none
A2 Disk Drive	none
A3 Post-Regulator Board	none
A4 Graphic System Processor	1, 3
A5 CPU Board	1, 3
A6 EEPROM Board	1, 3
A7 Input/Output Board	none
A8 Not Assigned	
A9 Rear Panel	none
A10 Preregulator	none
A11, Display	1, 3
HP 85102 IF Detector	
A1 Front Panel	none
A2-A4 Not Assigned	
A5 Test Synchronous Detector	7
A6 Clock	8
A7 Reference Synchronous Detector	7
A8 19.9 MHz LO	none
A9 B2 IF Mixer	5
A10 Test IF Amplifier	6
A11 B1 IF Mixer	5
A12 Reference IF Amplifier	6
A13 A2 IF Mixer	5
A14 A1 IF Mixer	5
A15 Regulator	none
A16 Remote Applications	none
A17 Sample and Hold	none
A18 ADC	none
A19 ADC Control	none
A20 Sweep ADC	4
A21 IF Counter	none
A22 Pretune	none
A23 Main Phase Lock	none
A24 Interface	none
A25 Motherboard	none
A26 Rectifier	none

Table 7-4. Test Equipment for HP 8510 Adjustments

Instrument	Recommended Model	Critical Specifications
Controller	HP 9000, 200, or 300 series	No substitute
Photometer	TEK J16 option 2	No Substitute
Photometer Probe	TEK J6503 option 2	No Substitute
Light Occluder	TEK 016-0305-00	No substitute
CRT Degmagnetizer or Bulk tape eraser	Radio Shack Model 44-233	
Spectrum Analyzer	8566 or 8568	100 kHz to 26.5 GHz HP-IB controlled
Frequency Counter	5343 Opt. 011	500 MHz to 26.5 GHz
Function Generator	3325A	Fast Sweep, less than 10 msec
RF Source	8360, 8340 or 8350 and 83595	500 MHz to 26.5 GHz, Plug-in Option 004 is recommended but not required

Procedure 1. Vertical Position and Focus Adjustments

No display adjustments, other than those in this manual, can be done in the field (this includes both customers and service centers). Any other adjustments to the display will void the warranty.

EQUIPMENT

screwdriver (non-conductive) flat head

DESCRIPTION AND PROCEDURE

There is one vertical position adjustment and one focus adjustment. In general, these adjustments should not be required.

Warm-up time: 30 minutes.

Vertical Adjustment

NOTE: The vertical position can be adversely affected by magnetic interference. Before adjusting the vertical position, be sure the analyzer is in a non-magnetic environment and the CRT is degaussed.

1. To access vertical position and focus adjustment controls, remove the side panel nearest the display.
2. Insert a narrow, non-conductive, flat head screwdriver (at least 2 inches long) into the vertical position hole.
3. Adjust the control until the softkey labels are aligned with the softkeys.

Focus Adjustment

NOTE: The CRT focus can be adversely affected by the CRT intensity set too high or by magnetic interference.

4. Use the same screwdriver used in step 3 to adjust the focus until the display has the best readability. Look for equal width of both the horizontal and vertical segments of the "H" character. Also check the focus in all four corners of the CRT.

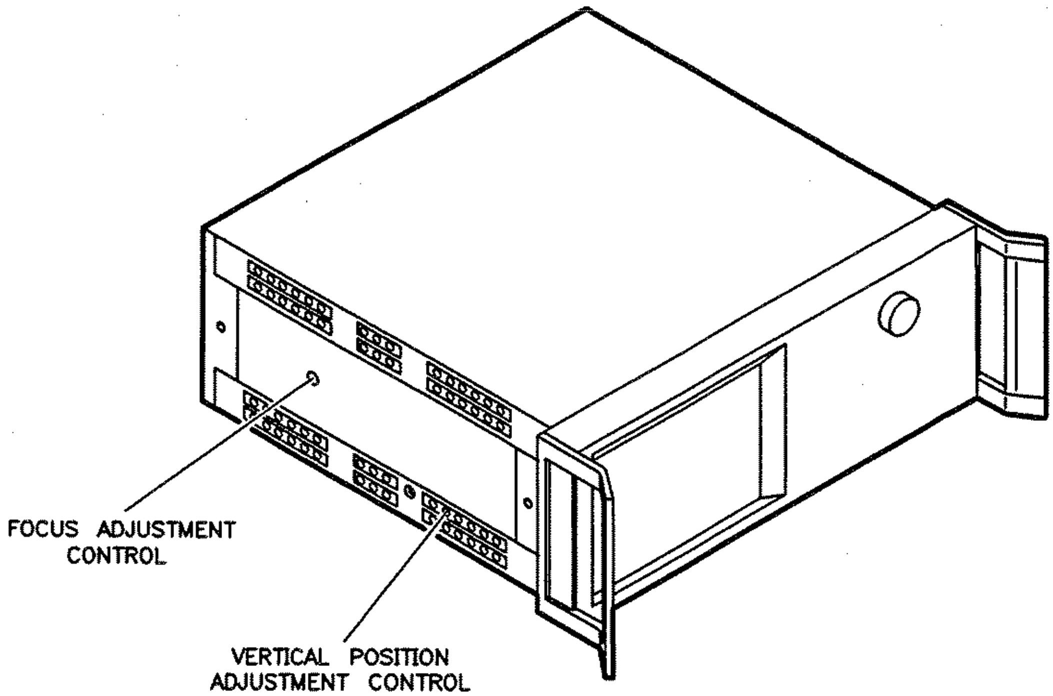


Figure 7-1. Vertical Position and Focus Adjustment Controls

Procedure 2. Display Degaussing (Demagnetizing)

EQUIPMENT

any CRT demagnetizer or
bulk tape eraser

DESCRIPTION AND PROCEDURE

As with all color monitors, the display is very susceptible to external magnetic fields. These fields can originate from many sources including metal frame tables and from the earth. The usual symptom is a discoloration or slight dimming of the display (usually near the top left corner of the CRT). In extreme cases, a total color shift may be observed; for example, a trace that was red may shift to green. This shift does not suggest a problem with the display; it is characteristic of color displays. If the display becomes magnetized, or if color purity is a problem, cycle the power several times. Leave the instrument off for at least 15 seconds before switching on the power. This will trigger the automatic degaussing circuit in the display. If this is insufficient to get color purity, a commercially available demagnetizer must be used (either a CRT demagnetizer or a bulk tape eraser can be used). Follow the manufacturer's instructions keeping in mind the following; it is imperative when demagnetizing the display that the degausser is not placed closer than 4 inches (10 cm) from the face of the CRT. Generally, degaussing is done with a slow rotary motion of the degausser, moving it in a circle of increasing radius while simultaneously moving away form the CRT. Figure 7-2 shows the motion for degaussing the display.

CAUTION

Applying an excessively strong magnetic field to the CRT face can permanently destroy the CRT.

Like most displays, the CRT can be sensitive to large magnetic fields generated from unshielded motors. In countries that use 50 Hz, some 10 Hz jitter may be observed. If this problem is observed, remove the device causing the magnetic field.

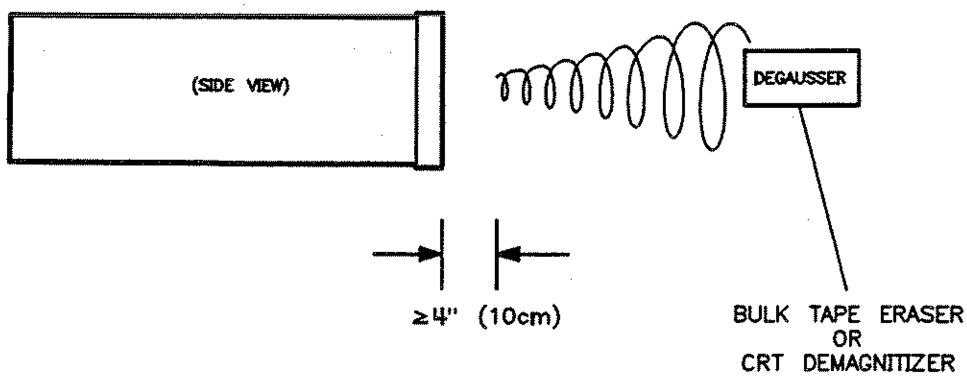


Figure 7-2. Motion for Degaussing the Display

Procedure 3. Display Intensity Adjustments

EQUIPMENT

photometer .... Tektronix J16
photometer probe .... Tektronix J6503
light occluder .... Tektronix 016-0305-00

DESCRIPTION AND PROCEDURE

There are two display intensity adjustments: background (black), and operating default. In general, these adjustments should not be required. Yet, when either the GSP, EEPROM, or display assembly is replaced, do a visual inspection of the display. If it appears to need adjustment, proceed with these adjustments.

NOTE: This procedure should be done with a photometer and only by qualified service personnel.

Warm-up time: 30 minutes.

Background Intensity (Black) Adjustment

1. Remove the top cover of the analyzer.
2. In a dimly lit room (or with the analyzer CRT shaded from bright lights), press:

   [PRESET] [SYSTEM]

   [MORE] (softkey 8)

   [SERVICE FUNCTIONS] (softkey 8)

   [TEST MENU] (softkey 1)

   [2] [2] [=MARKER]

   [1] [=MARKER]

   [3] [=MARKER]

   [5] [x1] [=MARKER]

   [8] [5] [1] [7] [=MARKER]

   [=MARKER]

3. Alternating vertical bars of three different intensities are shown on the CRT. Each bar has a number written below it (either 0, 1, or 2).

   Adjust the analyzer front panel knob until the vertical bar labeled "1" is just barely visible against the black border. Vertical bar "0" must not be visible (indistinguishable from the black border).

4. When the adjustment is complete, press [=MARKER].

Operating Default Intensity Adjustment

This adjustment sets the default level of the display intensity. The analyzer normally presets to the same intensity level that was last used. This level is stored in volatile memory. If you switch the power on and off, the memory is lost. Then the analyzer uses the default display intensity to ensure that the display is visible and eliminate concern that the display may not be functioning.

The level is set using a photometer that measures the output light.

5. To start the adjustment, press [=MARKER].

6. Set the photometer probe to NORMAL. Press [POWER] on the photometer to switch the power on and allow 30 minutes warm-up. Zero the photometer according to the manufacturer's instructions. The analyzer CRT should have an all white screen.

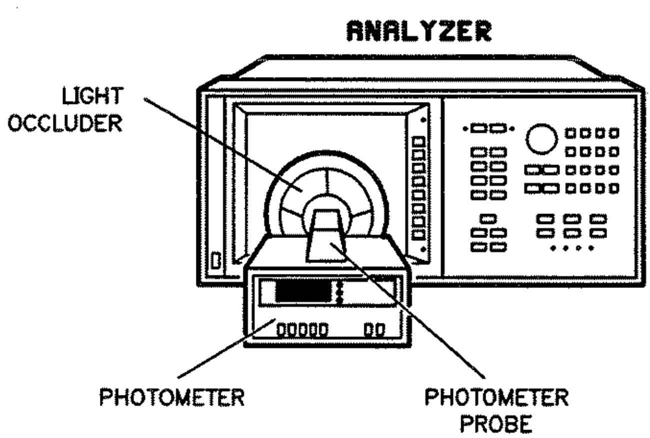


Figure 7-3. Maximum Intensity Adjustment Setup

7. Center the photometer on the analyzer CRT as shown in Figure 7-3. Adjust the analyzer front panel knob to the maximum (clockwise) position. If the photometer registers greater than 100 NITs, turn the front panel knob until a reading of no more than 100 NITs registers on the photometer.

   If the photometer does not register a reading of 100 NITs, the display is faulty. Refer to the "Troubleshooting" chapter.

NOTE: The intensity level is read without a display bezel installed. The glass filter transmits 60% of the display light, therefore 100 NITs would be 60 NITs with the bezel installed.

Procedure 4. Sweep ADC Gain Adjustment

WARNING

This procedure does not work with an HP 8360 Series source. You must use an HP 8340/41/A/B.

EQUIPMENT

12" snap-on cable assembly	5061-1022
F-M-M snap-on tee	1250-1391
HP 85102 adjustments software	08510-10024
Controller	HP 200, 300, or 9000 series

DESCRIPTION AND PROCEDURE

When the HP 8510 system is making a swept frequency measurement, it must sample the data at points equally spaced between the start and stop frequencies. The sweep analog-to-digital converter (ADC) controls when to trigger the sample-and-hold amplifiers so that the data will be taken at the correct frequencies. The A20 sweep ADC board generates a staircase waveform that tracks the sweep voltage from the source. The following procedure adjusts the sweep ADC gain to compensate for component tolerance in the staircase generation circuit.

1. After loading BASIC into the controller memory, insert the adjustments software disk into the controller disk drive. (Refer to the beginning of the chapter for a procedure on how to load BASIC.)

2. Type LOAD "ADJ_85102" [EXECUTE].

3. When the program is loaded, press [RUN].

4. Press the softkey that selects the sweep ADC adjustment.

5. Switch off the analyzer power. Configure the equipment as the controller display shows.

6. Switch on the analyzer power, but switch on the display/processor last to avoid system "lock-up."

7. When a graticule appears on the analyzer CRT, the instrument has finished initializing. Press ***[CONTINUE]*** on the controller.

8. The following prompt is displayed:

```
ADJUST GAIN (R26) FOR 300 ±0.03mUnits
```

9. Refer to Figure 7-4 for the location of A20R26. Adjust A20R26 so that the mUnit displayed on the analyzer CRT shows 300 ±0.3. (Refer to Figure 7-5.)

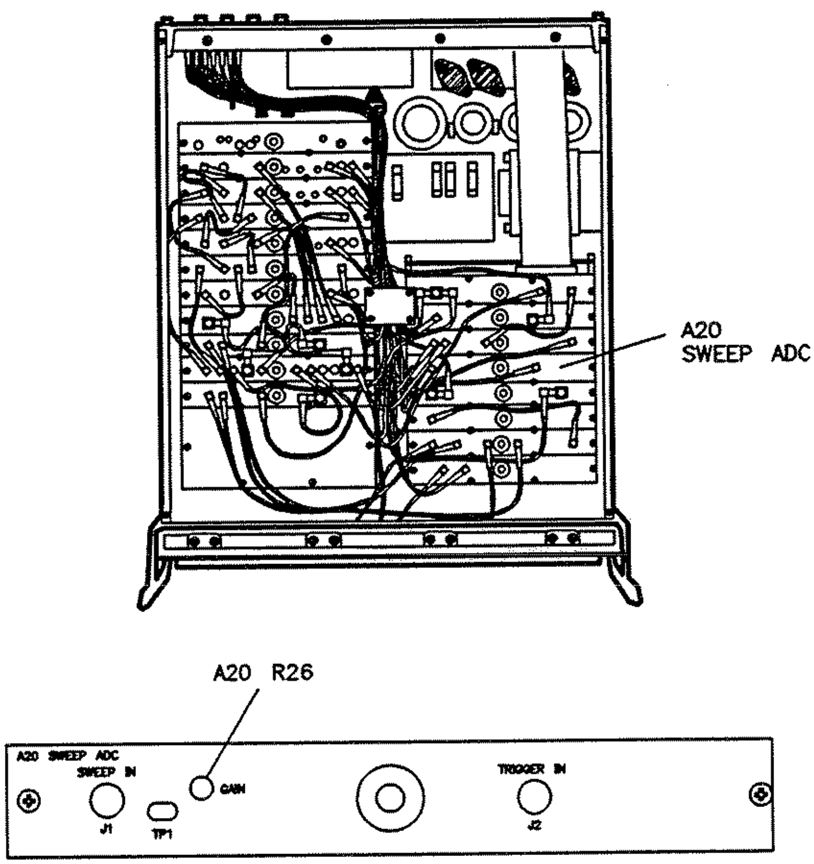


Figure 7-4. Location of Sweep ADC Gain Adjustment

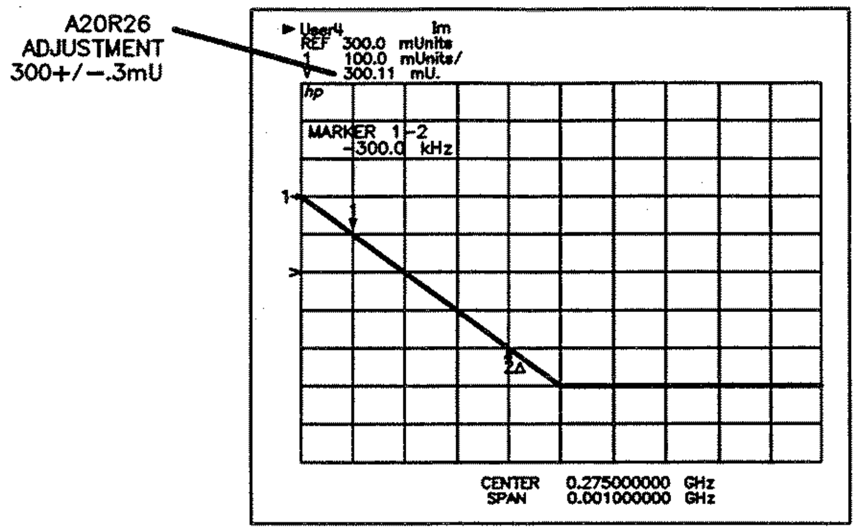


Figure 7-5. Display of Sweep ADC Gain Adjustment

10. When the adjustment is complete, press ***[CONTINUE]*** to return to the menu.

11. If you are unable to adjust A20R26 within the given specification, and the following prompt is displayed, refer to the troubleshooting chapter:

```
ADC CONTROL GAIN is beyond limit press CONTINUE
```

12. Switch off the analyzer power and return all the equipment to the original configuration. Be sure to reconnect all the HP 85102 cables in the original configuration.

Procedure 5. IF Mixer Adjustment

EQUIPMENT

spectrum analyzer	HP 8566 or 8568
function generator	HP 3325
(2) 4-ft BNC snap-on cable assembly	85680-60093
adapter, male N to female BNC	1250-0780
HP 85102 adjustments software	08510-10024
Controller	HP 200, 300, or 9000 series

DESCRIPTION AND PROCEDURE

The IF mixers convert the 20 MHz first IF signals from the test set to 100 kHz second IF signals, which go to the IF amplifiers. The 20 MHz IF signals are mixed with the 19.9 MHz signals from the 19.9 MHz LO board (A8). The 20 MHz IF signals are also buffered and sent to the IF counter (A21). All four IF mixers are identical. In the following procedure, the signal generator simulates the test set. The signal is fed into the mixer board while the output of the mixer is monitored on the spectrum analyzer. The following adjustments optimize the matching of the crystal filter to the IF thereby minimizing the test set noise appearing at the mixer output.

1. After loading BASIC into the controller memory, insert the adjustments software disk into the controller disk drive. (Refer to the beginning of the chapter for a procedure on how to load BASIC.)

2. Type `LOAD "ADJ 85102"` [EXECUTE]

3. When the program is loaded, press [RUN].

4. Press the softkey that selects the IF mixer adjustment.

5. The following prompt is displayed:

   `Model number of spectrum analyzer being used. Select a softkey.`

6. Press the appropriate softkey.

7. Switch off the analyzer power. Configure the equipment as the controller display shows. Make sure that the addresses of the test equipment match the addresses appearing on the controller CRT.

8. Switch on the analyzer power, but switch on the display/processor last to avoid system "lock-up."

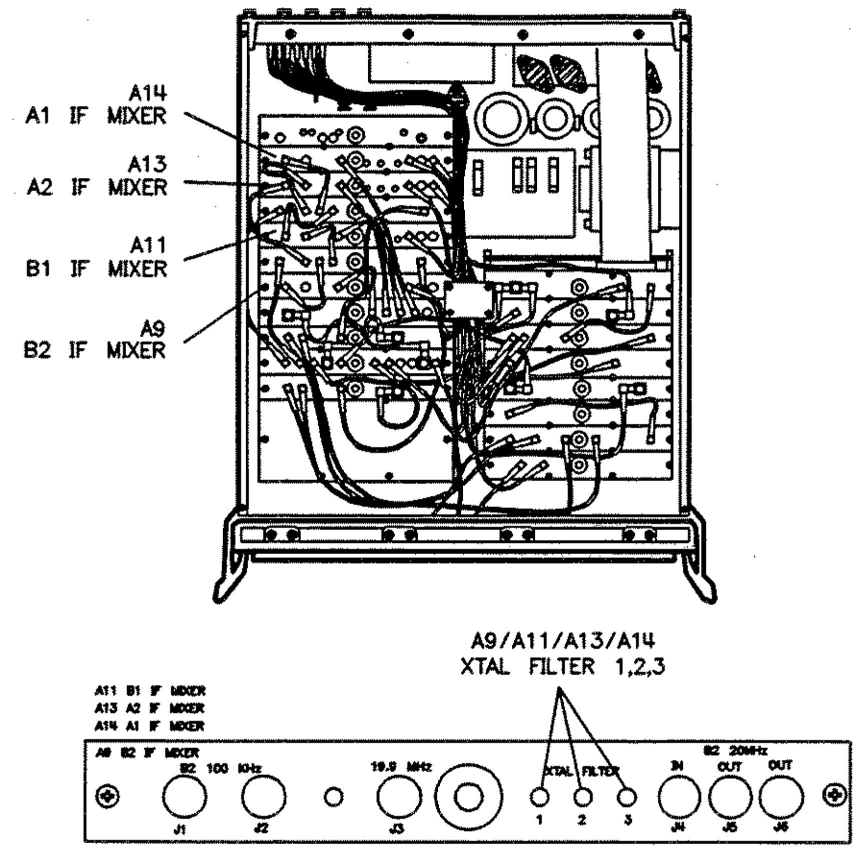


Figure 7-6. Location of the IF Mixer Adjustments

9. When a graticule appears on the analyzer CRT, the instrument has finished initializing. Press ***[CONTINUE]*** on the controller.

10. The following prompt is displayed:

```
ADJUST XTAL FILTER 1, 2 AND 3 FOR MINIMUM RIPPLE <1/2 dB (20 kHz BW)
```

11. Refer to Figure 7-6 for the location of the XTAL FILTER adjustments. To get the minimum ripple of the RF envelope seen on the spectrum analyzer, iterate XTAL FILTER adjustments 1, 2, and 3. Adjust for minimum ripple at 100 kHz ±10 kHz (see Figure 7-7).

12. If you are unable to adjust the XTAL FILTER within specification, or if the following prompt is displayed, check the equipment setup for configuration errors, or refer to the troubleshooting chapter.

```
100 kHz LEVEL TOO LOW (<-20 dBm)
```

13. When the adjustment is complete, press ***[CONTINUE]*** to return to the menu.

14. Switch off the analyzer power and return the equipment to the original configuration. Be sure to reconnect all the HP 85102 cables in the original configuration.

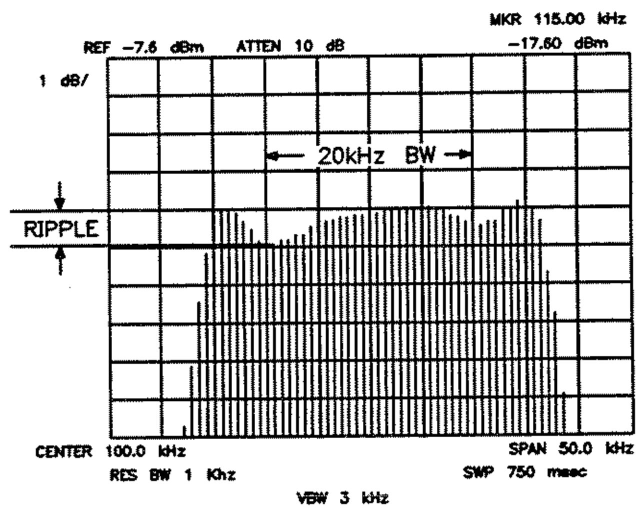


Figure 7-7. IF Mixer Adjustment Waveform

Procedure 6. IF Amplifier Adjustment

EQUIPMENT

service extender board	85102-60030
(2) adapter, snap-on M-M	1250-0669
(2) 12" snap-on cable assembly	5061-1022
HP 85102 adjustments software	08510-10024
Controller	HP 200, 300, or 9000 series

DESCRIPTION AND PROCEDURE

The 100 kHz IF amplifiers provide port selection, switchable IF gain, and autoranging for the 100 kHz IF signal. The 100 kHz IF mixer output is passed through a single-section bandpass filter. The following procedure peaks the A10 and A12 IF amplifiers by adjusting the circuit bandwidth to a center frequency of 100 kHz.

1. After loading BASIC into the controller memory, insert the adjustments software disk into the controller disk drive. (Refer to the beginning of the chapter for a procedure on how to load BASIC.)
2. Type `LOAD "ADJ 85102"` [EXECUTE]
3. When the program is loaded, press [RUN].
4. The following prompt is displayed:

   `Adjustment on which IF AMPL module? Select a softkey.`
5. Press the appropriate softkey.
6. Switch off the analyzer power. Remove the board (A10 or A12) from the HP 85102 and install it on an extender board. Reconnect the cables, as the controller CRT shows, using adapters and extra cables provided in the service kit. It is necessary only to reconnect the cables that are noted in the setup on the CRT.
7. Switch on the analyzer power, but switch on the display/processor last to avoid system "lock-up."
8. When a graticule appears on the analyzer CRT, the instrument has finished initializing. Press ***[CONTINUE]*** on the controller.

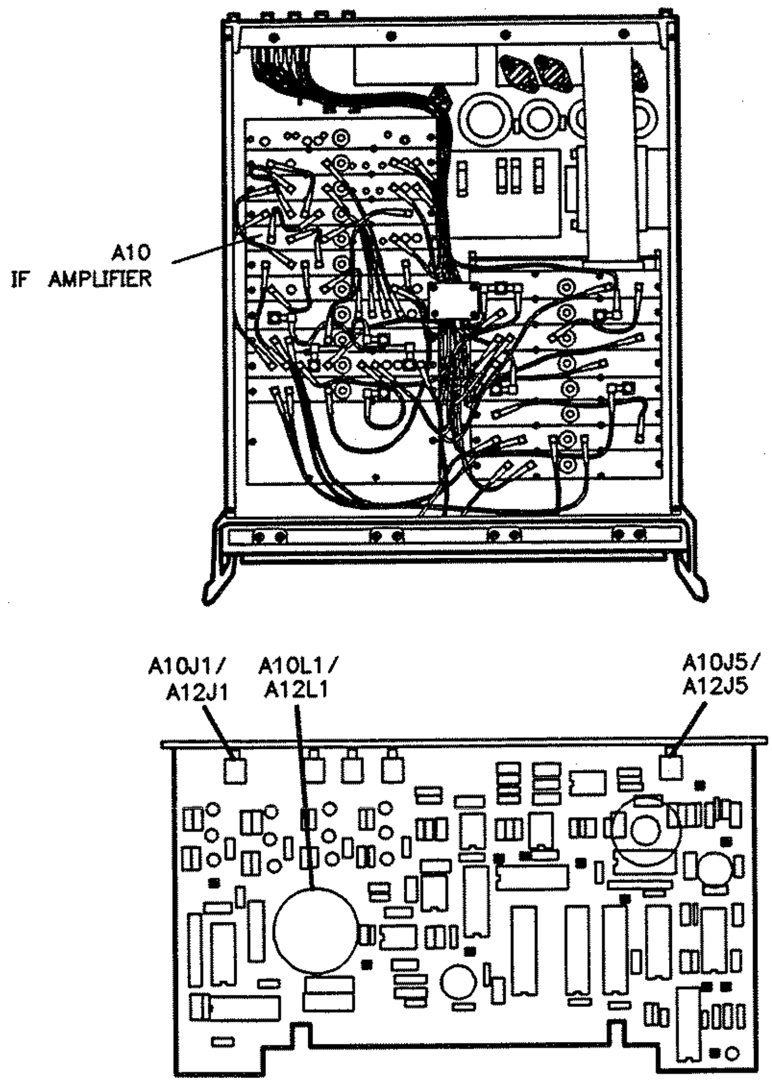


Figure 7-8. Location of IF Amplifier Adjustments

9. The following prompt is displayed:

```
>>>>>COARSE ADJUST<<<<<

ADJUST L1 TO PEAK TRACE ON 8510 CRT.
```

10. Refer to Figure 7-8 for the location of L1. Adjust L1 so that the horizontal line on the analyzer CRT is at its maximum vertical location.

11. Press ***[CONTINUE]***.

12. The following prompt is displayed:

```
>>>>>FINE ADJUST<<<<<

RE-ADJUST L1 TO PEAK TRACE ON 8510 CRT
```

(re-center trace with '=marker' key if necessary)

13. Repeat step 10. If necessary, press [=MARKER] on the analyzer to recenter the trace.

14. When the adjustment is complete, press ***[CONTINUE]*** on the controller to return to the menu.

15. If either of the following prompts is displayed, check the equipment setup for configuration errors, or refer to the troubleshooting chapter:

```
AMPLIFIER OUTPUT <-30 dBm TOO LOW. REPAIR BOARD OR TEST-SETUP.
```

or

```
AMPLIFIER OUTPUT >-20 dBm TOO HIGH. REPAIR BOARD OR TEST-SETUP.
```

16. Switch off the analyzer power and return the equipment to the original configuration. Be sure to tighten the screws when reinstalling the board into the mainframe; loose screws can cause crosstalk in the instrument. Also be sure to reconnect all the HP 85102 cables in the original configuration.

Procedure 7. Synchronous Detector Adjustment

EQUIPMENT

function generator	HP 3325A
service extender board	85102-60030
4 ft BNC snap-on cable assembly	85680-60093
(2) 12" snap-on cable assembly	5061-1022
(2) adapter, snap-on M-M	1250-0669
HP 85102 adjustments software	08510-10024
Controller	HP 200, 300, or 9000 series

DESCRIPTION AND PROCEDURE

The A5 and A7 synchronous detector assemblies provide two voltages that are equal to the real and imaginary components of the vector representing the input signal to the sample and hold assembly. The following procedure adjusts the two output filters of the synchronous detector to equalize the delay through them.

1. After loading BASIC into the controller memory, insert the adjustments software disk into the controller disk drive. (Refer to the beginning of the chapter for a procedure on how to load BASIC.)

2. Type `LOAD "ADJ 85102"` [EXECUTE]

3. When the program is loaded, press [RUN].

4. Press the softkey that selects the synchronous detector adjustment.

5. The following prompt is displayed:

   `Adjustment on which SYNC DET module? Select a softkey.`

6. Press the appropriate softkey.

7. Switch off the analyzer power. Remove the board (A5 or A7) from the HP 85102 and install it on the extender board. Reconnect the cables, as the controller CRT shows, using adapters and extra cables provided in the service kit. It is necessary only to reconnect the cables that are noted in the setup on the CRT.

8. Switch on the analyzer power, but switch on the display/processor last to avoid system "lock-up."

9. When a graticule appears on the analyzer CRT, the instrument has finished initializing. Press *[CONTINUE]* on the controller.

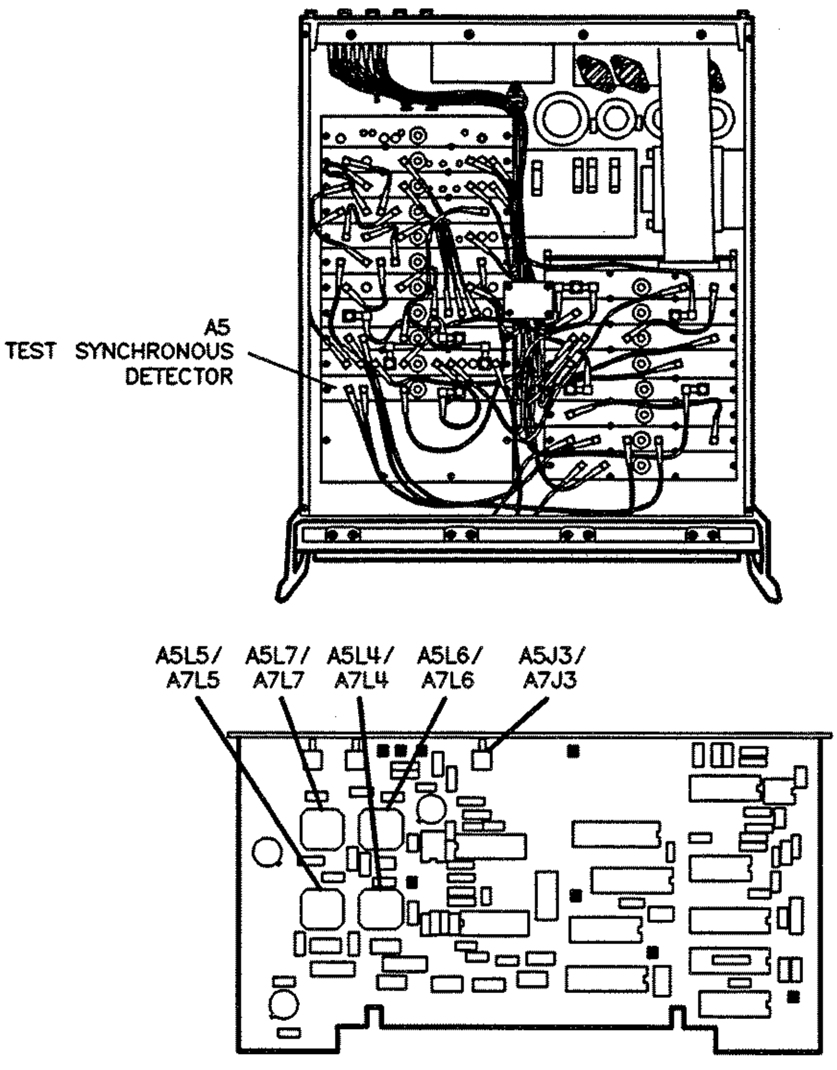


Figure 7-9. Location of Synchronous Detector Adjustments

10. The following prompt is displayed:

```
CENTER THE CORES IN L4 & L5.
USING THE 8510 DISPLAY, ADJUST L6 & L7 FOR MINIMUM RIPPLE
```

(minimize the high frequency ripple).

```
THEN ADJUST L4 & L5 TO FURTHER REDUCE RIPPLE
```

If the following prompt is displayed, check equipment setup for configuration errors, or refer to the troubleshooting chapter:

```
SIGNAL LEVEL IS TOO LOW
IT MEASURES XXX dB BUT SHOULD BE >-15 dB
CHECK SETUP OR REPAIR BOARD
```

11. Refer to Figure 7-9 for the location of L4 and L5. To center L4 and L5 adjustable inductors, rotate each inductor fully counterclockwise (until the core is as far out as it will go), then three turns clockwise.

CAUTION

Be careful not to rotate the inductors too far clockwise. Damage may occur to the inductors.

12. Refer to Figure 7-9 for the location of L6 and L7. Alternately adjust L6 and L7 to get the minimum ripple seen on the analyzer CRT (see Figure 7-10).

13. Alternately adjust L4 and L5 to minimize the ripple. Typically the ripple is less than 0.01 dB.

14. When the adjustment is complete, press ***[CONTINUE]*** to return to the menu.

15. Switch off the analyzer power and return the equipment to the original configuration. Be sure to tighten the screws when reinstalling the board into the mainframe: loose screws can cause crosstalk in the instrument. Also be sure to reconnect the HP 85102 cables in the original configuration.

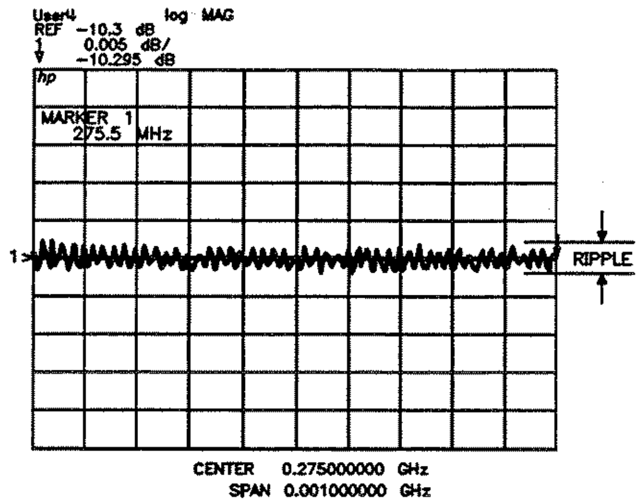


Figure 7-10. Synchronous Detector Adjustment Waveform

Procedure 8. Clock Adjustment

EQUIPMENT

frequency counter	HP 5343
4-ft BNC snap-on cable assembly	85680-60093
HP 85102 adjustments software	08510-10024
Controller	HP 200, 300, or 9000 series

DESCRIPTION AND PROCEDURE

The clock assembly generates the reference signals for the main phase-locked loop, the 19.9 MHz LO generator, and the YADC. It also provides timing and LO signals for the 100 kHz synchronous detectors, and a sinusoidal signal that is used to calibrate the 100 kHz IF system.

The 20 MHz LO oscillator is composed of an integrated circuit in a phase-locked loop whose VCO is crystal controlled to run at 20 MHz. By adjusting R51, the free-running frequency of the VCO can be fine tuned to 20.0 MHz. The following procedure adjusts the DC voltage input to the VCO, on the A6 clock board, to fine tune the free-running frequency to 20 MHz.

1. After loading BASIC into the controller memory, insert the adjustments software disk into the controller disk drive. (Refer to the beginning of the chapter for a procedure on how to load BASIC.)

2. Type `LOAD "ADJ 85102"` [EXECUTE]

3. When the program is loaded, press [RUN].

4. Press the softkey that selects the clock adjustment.

NOTE: For this procedure, the frequency counter input impedance switch may be set to either 50 ohms or 1M ohms.

5. Switch on the analyzer power, but switch on the display/processor last to avoid system "lock-up."

6. When a graticule appears on the analyzer CRT, the instrument has finished initializing. Press ***[CONTINUE]***.

7. The following prompt is displayed:

```
ADJUST R51 FOR 20 MHz ±50 Hz
```

8. Refer to Figure 7-11 for the location of A6R51. Adjust A6R51 for a frequency counter reading of 20 MHz ±50 Hz.

9. When the adjustment is complete, press ***[CONTINUE]*** to return to the menu.

10. If either of the following prompts is displayed, refer to the troubleshooting chapter:

```
20 MHz FREQUENCY COUNTS
LIMIT: 20 MHz ±50 Hz; Freq Delta <10 Hz
FIRST COUNT = XXXXXXXX
SECOND COUNT = XXXXXXXX
FREQUENCY IS OUT OF LIMIT
```

or

```
FREQUENCY UNSTABLE, COUNT 1-COUNT 2 TOO LARGE
```

11. Switch off the analyzer power and return the equipment to the original configuration. Be sure to reconnect the HP 85102 cables in the original configuration.

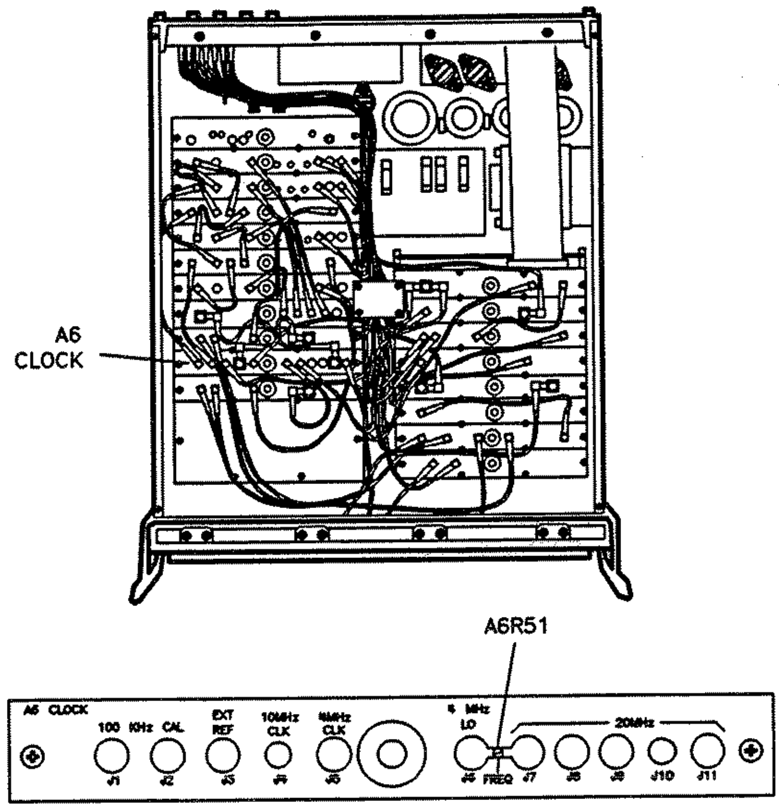


Figure 7-11. Location of Clock Adjustment

8. Performance Verification and Specifications

OVERVIEW

This chapter describes the following topics:

- System performance
- Performance verification
- Specifications
- Software for specifications and performance verification
- How to verify system performance
- Operational check procedures
- Frequency test procedures
- Total system uncertainty test procedure
- Measurement uncertainties
- Sources of measurement errors
- Measurement uncertainty equations
- Generation of system measurement uncertainties
- System error models
- Dynamic accuracy error model
- Measurement traceability
- Substitution of system components
- Calibration cycle

SYSTEM PERFORMANCE

The performance of a network analyzer system is attributable to the accuracy and stability of the entire system. The accuracy of the system is dependent on the measurement error correction. The error correction, also known as measurement calibration, is dominated by the quality of the calibration kit devices and the device models. The stability of the measurement calibration is dependent on the raw performance of each system component.

Individual System Components

The following characteristics and conditions of the system components affect the performance of the combined system configuration.

- Operating characteristics (source frequency accuracy, test set stability, test port cable stability, and connector type).
- User-selected operating conditions (analyzer measurement parameter (S11, S21, S12, S22), averaging, source sweep mode, sweep speed, and power).
- Condition and quality of the components.

Calibration Kit

The quality of the measurement calibration is dominated by the accuracy of the calibration kit device models and how closely the actual electrical performance of the device meets the model. Model limitations can be overcome by using a calibration method that requires a less precise device model. For example, a TRL (thru-reflection-line) calibration method requires less precise modelling of the devices than an open-short-load method. Measurement calibration errors occur when the expected, or modeled, electrical performance of the calibration standard deviates from the actual electrical performance of the standard. The calibration kit should be periodically recertified to ensure the actual electrical performance matches the model. Refer to the calibration kit manual for information on how to recertify your kit.

Measurement Process

The measurement process includes the measurement of calibration and test devices. This process encompasses connector care, the amount of flex on test port cables, the method of measurement calibration, the way you make connections (for both the measurement calibration and the DUT measurement), and connection repeatability. Connection quality is typically a small component of total system measurement error when connections are correctly made. However, poor connection quality can induce errors that significantly affect the accuracy of the measurement.

Measurement Errors

Measurement errors prevent measured data from being a true representation of the unknown test device. In all applications, measurement errors can influence the application goals.

Network analysis measurement errors can be separated into three types: systematic errors (those which are stable and repeatable), random errors (those which are random in nature and cannot be characterized and removed), and drift errors (those associated with temperature, humidity, pressure, or other factors related to time). Measurement errors that remain after measurement calibration are called residual measurement errors. See the "Measurement Calibration" chapter in the operating manual for a detailed description of the systematic errors corrected by measurement calibration.

The measurement errors of the system are explained in relationship to error model flowgraphs and uncertainty equations later in this chapter.

If measurement accuracy (measurement uncertainty) specifications were written for each possible HP 8510 system configuration and measurement condition, several thousand specifications would need to be generated. Therefore, the specifications/performance verification software calculates the total measurement uncertainty of different systems. This allows you to print out the specifications for your system configuration. Refer to "How to Run the System Specifications and Uncertainties Program" in this chapter to determine the system performance of your HP 8510 system. To verify this calculated system performance, refer to "How to Verify System Performance".

Systematic Errors. These errors result from imperfections in the calibration standards, connector standards and interface, interconnecting cables, and instrumentation. Measurement calibration can reduce systematic errors.

Random Errors. These non-repeatable errors are due to trace noise, noise floor, cable repeatability, and connector repeatability. They affect both transmission and reflection measurements. Measurement calibration does not correct random errors.

Drift Errors. These errors result from frequency drift and instrumentation drift. They affect both transmission and reflection measurements. Instrumentation drift is primarily temperature-related. Measurement calibration does not correct drift errors.

SYSTEM PERFORMANCE VERIFICATION

Performance verification is a process that verifies that the overall system is making measurements within the expected total measurement uncertainties. The entire system (hardware, calibration kit, and connections) is verified using the following procedures:

- Operational checks
- Frequency tests (HP 8340 and HP 8360 only)
- Total system uncertainty test
- Recommended process checks

Operational Checks Description

The first level of system performance verification is a series of recommended, but not required, functional checks. The assessment of the system operating environment and the functional operation of the system components help identify faulty equipment. The procedures check the environmental temperature and humidity, the typical power out of the analyzer measurement channels, the typical system dynamic range, and the connector dimensions (pin depths). Test port cable stability is also tested in a subset of the operational checks procedure.

The "Operational Checks Procedure" is located later in this chapter.

Frequency Tests Description

The second level of the system performance verification is for synthesized sources only. (The HP 8350 source frequency accuracy is tested during the total system uncertainty test procedure.) The source frequency accuracy is checked across the entire sweep range in both the swept and the CW sweep modes.

The "Frequency Tests Procedure" is located later in this chapter.

Total System Uncertainty Test Description

The procedure consists of calibrating the analyzer with a calibration kit, measuring a set of characterized devices, and comparing the resultant measured data to the data and uncertainty limits supplied with the verification kit. The device data provided with the verification kit has a traceable path to NIST. The total measurement uncertainty limits for the performance verification are the sum of the factory measurement uncertainties and the uncertainties associated with measuring the same devices on the system being verified. The difference between the factory-measured data and the verification-measured data must fall within the total uncertainty limits at all frequencies for the total system uncertainty test to pass. You can compare the factory system measurement uncertainty to your system measurement uncertainty in "Comparing System Measurement Uncertainties for the Performance Verification Devices" located later in this chapter.

The performance verification software calculates the total measurement uncertainty for each measurement, and determines if the system being verified meets that total uncertainty limit. The results of the performance verification can be immediately viewed and printed.

When an HP 8510 system passes this test it does not ensure the system meets all the performance specifications. However, it does show the system being verified measures the same devices with the the same results as a factory system that was verified in a "bottoms-up" approach.

The "Total System Uncertainty Test Procedure" is located later in this chapter.

Recommended Process Checks Description

To assure the continued correct operation of the analyzer system, the following process checks should be done periodically.

- Recertify your calibration kit at the interval stated in your calibration kit manual (or more often, depending on the amount of use).
- Review the "Microwave Connector Care Manual" to ensure that you are using correct connection techniques.
- Record the system raw error terms and compare them to periodically generated lists of the same raw error terms. By tracking the error terms, you can monitor when the system is beginning to drift, and use the data to help troubleshoot the system. Refer to the "Error Terms" section of the "Troubleshooting" chapter in this manual for information on how to generate a list of error terms.
- Periodically measure the same device (daily, for example) and compare the current results to the results previously measured. When the data begins to deviate greatly, refer to the "Troubleshooting" chapter in this manual.

SPECIFICATIONS

Specifications are the limiting values of the individual system errors that describe the system performance. This performance is different for each type of HP 8510 system configuration (depending on test set, source, connector type, calibration method, and cables). System specifications, for your system configuration, can be generated with the performance verification/specifications software. Except for the examples in this chapter, there are no system specifications in the manual. (Example printouts appear under the title "Interpreting the Specifications and Uncertainties Printouts".)

"Measurement Uncertainties" later in this chapter, explains the sources and types of measurement errors and how they relate to measurement uncertainties.

To generate system specifications, follow the "How to Load the Software" and "How to Run the System Specifications and Uncertainties Program" procedures in this chapter.

SOFTWARE FOR PERFORMANCE VERIFICATION AND SPECIFICATIONS

Both the performance verification and the specifications use the same software.

The program consists of a number of menus and forms that are selected by controller hardkeys and softkeys. The program softkeys are always labeled on the CRT and correspond to the menu selections you make. When you want to change an item or move to another selection, you can use the program softkeys or the controller arrow keys (up/down) or the ***[Next]*** and ***[Previous]*** keys.

NOTE: Using the BASIC [STOP] or [PAUSE] keyboard keys will not reset the program. Even pressing the keyboard BASIC [RESET] key will not reset the program's menus to their default settings. The program keeps data in the controller memory so that you can perform other computer tasks when paused in the middle of the program. You can then rerun the program without having to reload files.

The program database includes error models for hardware components of the system. The software only generates specifications and allows performance testing for system hardware that is included in the database. For example, specifications for systems using cables other than those available through HP cannot be generated because error models for them are not contained in the data. Refer to "Substitutions of System Components" located later in this chapter.

NOTE: Specifications for a system using an HP 8511 frequency converter test set can be generated using this software (refer to "Reference Information for Performance Verification and Specifications" in this chapter). However, the performance verification must be performed with HP 8511 performance verification software (shipped with HP 8511 frequency converters).

NOTE: For HP 8510 systems that have their own "system manual," refer to that manual for performance verification instructions.

EQUIPMENT REQUIRED

The table below shows the equipment required to do the system performance verification and to run the specifications/measurement uncertainties program.

Table 8-1. Equipment Required

System Performance Verification

- HP 8510C network analyzer
- HP source
- HP test set
- HP 200 or 300 series controller (except HP 9826) with 3 megabytes of available memory after loading HP BASIC (1 megabyte memory boards are available for all 200 and 300 series computers)
- or
  HP Vectra 386 with an HP 82300C BASIC language processor card
  or
  UNIX based workstation with Rocky Mountain BASIC (RMB)
- HP BASIC 5.0 or higher (uses approximately 0.6 megabytes of memory)
- Specifications/performance verification software
- HP calibration kit
- HP verification kit
- HP 5343 option 001 frequency counter
- Compatible printer or plotter
- Cables:
- test port cables (2)
  coax 3.5 mm (m-f)
- Adapters:
  2.4 mm (f) to 3.5 mm (f) (for 50 GHz system)
  3.5 mm (f) to BNC (m)

Specifications and Measurement Uncertainties

- 200 or 300 series controller (except 9826) with 2.5 megabytes of available memory before loading HP BASIC
  or
  HP Vectra 386 with an HP 82300C BASIC language processor card
  or
  UNIX based workstation with Rocky Mountain BASIC (RMB)
- HP BASIC 5.0 or higher (uses approximately 0.6 megabytes of memory)
- Specifications/performance verification software
- Compatible printer or plotter

It is NOT required to have the HP 8510 connected to a controller when generating specifications, or measurement uncertainties.

HOW TO LOAD THE SOFTWARE

There are many ways to load BASIC, therefore the example below is one common sequence. Refer to the manual of your computer for an exact procedure.

1. Insert the BASIC disc into the controller disc drive 0.

2. Cycle the power of the controller to activate the BASIC start up.

NOTE: You must have 3 megabytes of memory for the program to run. To check this, type `SYSTEM$("AVAILABLE MEMORY")` [RETURN].

3. After BASIC is loaded, the drive LED goes off and a "BASIC ready" prompt appears on the controller CRT. Remove the disc.

4. The following binary files must be loaded into the controller memory: *

   ERR
   CLOCK
   MAT
   I/O
   HP-IB

   To check which binary files are already loaded in the controller memory, type:

   `LIST BIN` [RETURN]

5. To load the binary files, insert the language extensions disc in the disc drive and type:

   `LOAD BIN "ERR"` [RETURN] `LOAD BIN "CLOCK"` [RETURN] `LOAD BIN "MAT"` [RETURN] `LOAD BIN "I/O"` [RETURN]

6. To load the HP-IB binary file, remove the language extensions disc and insert the drivers disc into the disc drive and type:

   `LOAD BIN "HPIB"`

Remove the drivers disc.

7. Type `MSI":,700,0"` [RETURN] on the controller to specify the system mass storage device (drive '0' of the disc drive).

***NOTE:** This procedure is used only with older revisions of BASIC (i.e. 3.0). BASIC 5.0 automatically loads these files.

NOTE: The mass storage device must be set to the correct location for the program to run smoothly.

8. Insert the program disk into the computer's disk drive.

9. Set the active drive. Type MSI and enter the mass storage specifier.

10. Type LOAD "SPECS_8510" and wait for the program to be installed.

11. Type RUN to start the program.

The initial screen displays the program revision and the data revision numbers. These numbers are also listed on the disk label. Refere to these numbers if you contact an HP Sales and Service Office about your software product.

12. Follow the instructions on the controller CRT to set the date and time. When the correct date and time are set, type [Y] at the prompt.

13. The hardware configuration menu is displayed with a highlighted field around the active selection. Use the ***[Next]*** and ***[Previous]*** keys to change the selection in the highlighted area. Use the cursor keys to move the highlighted box to each piece of hardware. Match the list of system hardware to your system configuration, and select the calibration technique.

NOTE: If the test set is an HP 8516, the source selection MUST be HP 834X016 or HP 8360X016. Older HP 8340 sources may require modification to work with the HP 8516.

NOTE: When generating specifications for HP 8511 systems, select no source, no cal kit, no cables, and no verification kit. See "Reference Information for Performance Verification and Specifications" later in this chapter.

14. To load the data files from the disc, press: ***[Done]***

15. The program presents the main menu. From here you can select one of four other menus:
    - System configuration
    - System specifications
    - System uncertainty
    - Verify system
    - A brief explanation of the menu choices follows:

[System Config] - This menu presents the choice of returning to the hardware configuration menu or entering the software configuration menu. The software configuration menu allows you to set the addresses of your HP 8510 and your printer/plotter, or select plotter trace pens.

[System Specs] - In this menu you can choose several types of tables and formats for a hard copy of both forward and reverse error terms.

[System Uncert] - This menu allows you to print or plot dynamic accuracy or total uncertainty for your system configuration.

[Verify System] - This menu allows you to verify system performance.

If you want to verify the performance of your system, follow the next procedure. If you want to generate system specifications, follow the procedure "How to Run the System Specifications and Uncertainties Program."

USING THE KEYBOARD OR MOUSE FOR PROGRAM CONTROL

Use of the keyboard or mouse is supported in the software program. The list below provides a brief overview of the different methods for controlling the cursor and modifying values. keyboard controls |

Cursor Keys	Use the cursor keys (arrow keys) to move the cursor up, down, left, and right.
[Done] or [SELECT]	Use either the softkey or the [SELECT] keyboard key to complete data entry. Always press the key to retain edited data.
[HOME]	Use the [HOME] key to page forward. Combine the [SHIFT] key with the [HOME] key to return to previous pages.
Mouse	Use the mouse to position the cursor on a specific character or field. Click the mouse select button to edit the data. You may find that using the mouse is less efficient than using the cursor keys. The sensitivity of the mouse makes it awkward to position.
[TAB]	Use the keyboard tab key to move from one data entry field to the next, or when columns are used, from one column to the next. Combine the [SHIFT] key with the [TAB] key for reverse-tabbing.

In Case of Difficulty

- Check that the mass storage device is specified (refer to step 7).
- Check that the BASIC revision is 3.0 or higher. 5.0 is preferred.
- Check that the controller has at least 3 megabytes of memory. Type `"SYSTEM$("AVAILABLE MEMORY")"` [RETURN].
- Check that all the required binary files are loaded in the controller memory (refer to step 4).
- If the program is still not running correctly, cycle the power of all the instruments.

HOW TO VERIFY SYSTEM PERFORMANCE

The system performance verification process is summarized below:

1. Operational checks
   a. Environment and device temperature check
   b. User parameters check (unratioed power)
   c. Inspect, clean, and gage connectors
   d. Cable check
   e. Dynamic range check

2. Frequency tests
   a. CW frequency accuracy test
   b. Swept frequency accuracy test

3. Total system uncertainty test
   a. The program sets the frequency range of the HP 8510 system to the corresponding frequency of the traceable verification devices.
   b. The program prompts you to perform a full 2-port measurement calibration.
   c. You measure the verification devices.
   d. The program compares the measured data with the traceable data and uncertainty limits supplied with the verification devices, and generates pass/fail results.

4. Defining a custom system in the software
   a. The first menu that appears in version A.03.01 software is the Hardware Configuration menu.
   b. From this menu, choose the model numbers of the hardware you are using.
   c. If you plan to make measurements with a custom test setup, choose model numbers from this menu that most closely matches the capability of the equipment you are using.
   d. To calibrate a custom system, new features in the software allow you to modify error-term parameters.
   e. You can store the error-term changes in tables, compute customized specifications from the new error terms, then use the tables for plots and system verification.
   f. If you plan to use hardware configuration values listed in the Hardware Configuration menu already, follow the "No" path in the flowchart, Figure 8-1. To create unique specifications for a custom system, fillow the "Yes" path in Figure 8-1.

NOTE: LIMITATION OF WARRANTY. Hewlett-Packard does not warrant the performance of systems that are customized by the user. That is, systems already customized at the factory as special systems are warranteed; however, if you customize the system at your facility, the performance warranty cannot be applied.

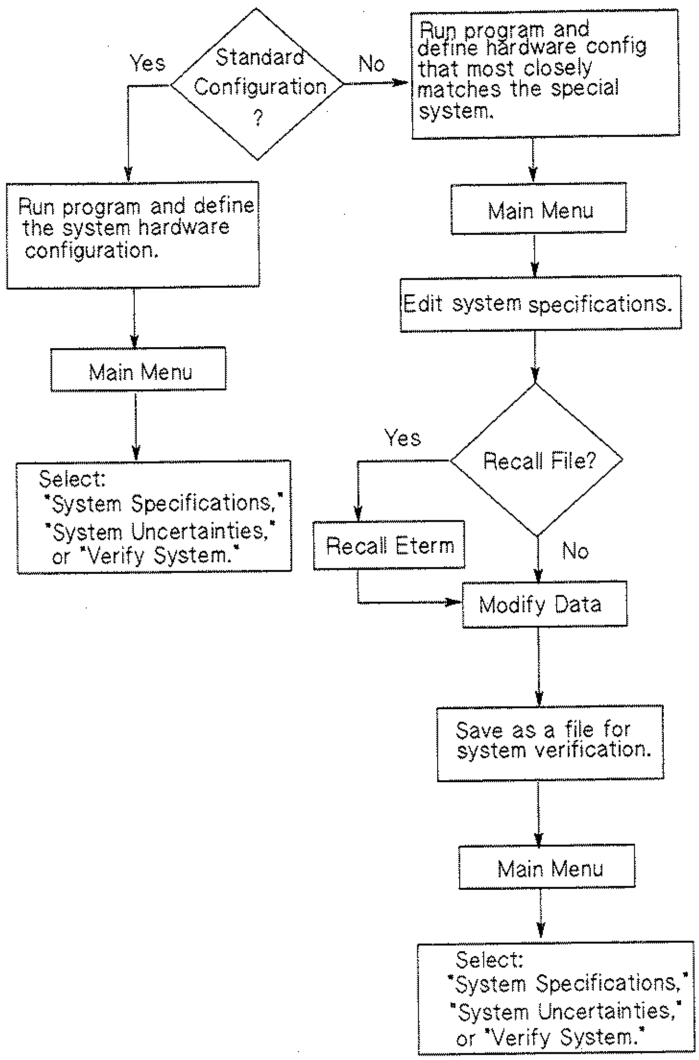


Figure 8-1. Flowchart for Selecting to Modify Specifications

Choosing to Edit Specifications

1. After installing the software program, press ***[Hardware Config]*** from the System Config menu.

- Select hardware models that most closely match the equipment you are using.
  - ☐ Exact model numbers may not match, but similar capabilities (frequency range, power range, and so forth) need to be matched as closely as possible.
  - ☐ Selections such as no source and no calibration kit are available if there are no similar models of equipment.
- After completing hardware configuration and model selection, press ***[Done]*** to save the information.

From the Main menu display, select ***[Edit Specs]*** .

By selecting ***[EDIT SYST SPECS]*** from the Main menu, you can modify error terms for your hardware configuration. You can use the modified data to compute custom uncertainties to use during performance verification. Refer to "Using the Error Term Table Editor" to learn how to edit specifications..

Using New Features

In addition to the ability to edit error terms and compute custom specifications you can save, recall, and label your customized information.

Using Markers on Uncertainty Plots

Markers automatically turn on when the uncertainty plot is displayed. The marker appears on the plot as a as vertical dashed line. To display the plot and use the marker function, refer to the steps below:

1. From the Main menu, press ***[Syst Uncert]*** .
2. From the plot options, choose the desired selections.
3. Press ***[Done]*** to display the graph.
4. To move the marker, use the left- or right-arrow keys.

NOTE: You can control the position of the marker with the mouse, however, it is not recommended. The mouse's sensitivity may make it too awkward to use.

5. Read the marker values along the bottom row of the display. The readings include the X-axis value, and marker readouts for each frequency range.
6. Use the ***[Marker (ON) OFF]*** key to turn markers on or off.
7. Use the ***[Mkr Sens]*** key to change the marker sensitivity. You can choose a marker sensitivity of 1, 3, or 10. The setting determines the distance the marker moves on the graticule each time you press the left- or right-arrow key.

Choosing User-Generated Error Terms

To select edited error terms for generating system specifications tables, refer to the steps below:

1. Press ***[System Specs]*** in the Main menu.
2. Choose User Parameters for Table Type:.
3. Use the softkeys within the menu to edit other selections as needed.
4. Press ***[Done]*** to display the specifications table.

Generating customized system uncertainty plots

To select edited error terms for generating system uncertainty data, refer to the steps below:

1. Press ***[System Uncert]*** in the Main menu.
2. For Compute Using:, select User Parameters.
3. Use the softkeys within the menu to edit other selections as needed.
4. Press ***[Done]*** to display uncertainty plots.

Using user-generated specifications in system verification

You can choose user-generated specifications for system verification. Refer to the steps below:

1. Press ***[Verify System]*** in the Main menu.
2. Press ***[Select Standard]*** .
3. Move the cursor to Verify Using: and select User Parameters.
4. Use the softkeys within the menu to edit other selections as needed.
5. Press ***[Done]*** to begin system verification.

Entering S-parameters of the DUT

You can edit the S-parameter values for your specific device under test. Refer to the steps below:

1. Press ***[System Uncert]*** in the Main menu.
2. Locate the S-parameter data fields in the middle of the display. Notice the default values of S11 = S22 = 0, and S21=S12.
3. To enter an S11 value, press ***[Previous]*** until the asterisk beside S11 (lin) blinks (indicating the data field is activated).

4. Use the keyboard to enter the new S11 (linear) value.
5. Move to the next data field and press ***[Next]*** or ***[Previous]*** as needed to edit the remaining S-parameter data fields and to enter the device length (in cm). *Notice that S11 and S22 are in linear units, while S21 and S12 are in dB.*
6. Press ***[Done]*** to display the DUT's system uncertainty.

Entering user labels or comments on plots

If desired, use the features in this software to enter your own titles or comments on plots. The label you enter appears on the 3rd or 4th line of the title at the top of the plot.

1. Press ***[System Uncert]*** in the Main menu.
2. Move to User Label 1 and press ***[Previous]*** until the asterisk in the data field blinks.
3. From the keyboard, enter the label or title you want to appear on the output.
4. If desired, repeat the above two steps to enter User Label 2.
5. Press ***[Done]*** when you are finished entering user labels to display the plot.

Entering user labels or comments system verification reports

If desired, use the features in this software to enter your own titles or comments on system verification reports. The comment you enter appears on the test record for the selected verification kit device.

1. Press ***[Verify System]*** in the Main menu.
2. Press ***[Select Standard]*** .
3. Move to the Comment selection at the bottom of the screen.
4. Press ***[Previous]*** until the asterisk in the data field blinks.
5. From the keyboard, enter a one-line comment that you want to appear on the system verification report.
6. If desired, repeat the above two steps to enter a second comment line.
7. Press ***[Done]*** when you are finished entering comments.

PERFORMING SYSTEM VERIFICATION

After configuring the system, decide whether you want to choose user generated specs or software defined uncertainties. Select ***[Verify System]*** in the Main menu. In this menu, you can start the HP 8510C system verification using either the defined system specifications or custom specifications calculated from edited error term values. To choose the desired specifications for system verification, follow the steps below:

1. Press ***[Select Standard]*** .
2. Go to Verify Using.
3. Select either Specifications for defined values or User Parameters to use the customized specifications.

For additional information on performing system verification, refer to the "Total System Uncertainty Test Procedure" later in this chapter.

CHANGING ERROR TERM VALUES

Before you start editing the error terms, determine the characteristics of the equipment in your system that are not already defined in the software. As an example, you may plan to use a calibration kit that is manufactured by a company other than HP. You need to determine the directivity of the load in this kit. You may want to use custom cables; if so, you need to know the loss factor. You also need to know which error terms to edit and what values to enter for the error terms changed.

Refer to Figure 8-18 and Figure 8-19 in this chapter. Review the error term labels and locations. You need to understand which error term gets modified with respect to the unique components within your system setup. In Figure 8-18, the device-under-test is identified with the labels S11, S21, S22, and S12 and is in the center of the graph. You can use the location of the device in this illustration to help you determine which error term to change.

In there are examples to help you understand how to change error terms for some typically used hardware modifications.

HANDLING CUSTOMIZED ERROR TERMS

The information you need to understand about customized error terms is explained in this section. The topics are listed below:

- Using the error term table editor
- Saving edited error term values
- Recalling a custom error term table file

USING THE ERROR TERM TABLE EDITOR

To display an error term table for editing, select ***[Edit Specs]*** in the Main menu.

NOTE: Refer to Figure 8-18 and Figure 8-19. Find the error term of interest on the figure. The figure can help you determine the relative, physical location of the error term in your system configuration.

Refer to the steps below to edit the values:

1. Locate the error term in the displayed table that represents the error term of the hardware change.

2. Use the mouse, arrow keys, or TAB key to position the cursor at the term that needs to be edited.

3. Use the number keys to enter the values.

4. Continue editing error terms until your system or device is defined.

5. Press ***[Done]*** when you have finished editing error terms.

6. At the prompt Re-compute effective terms from raw terms?, respond with Yes.

The function of the Edit Specs menu keys are described below:

[Undo Term] Use this key to restore all values of the currently highlighted error term to the value listed just prior to your most recent change. If you have changed an error term, then changed it again, but you want to restore the value to your first change, press ***[Undo Term]***. Use ***[Reset All]*** only if you want to use the software's predefined error terms.

[Undo All] Use this key to restore the values of all the error terms to the previous change. As with ***[Undo Term]***, this key changes all the error terms of the table to previously changed values. Use ***[Reset All]*** only if you want to use the software's predefined error terms.

[Reset Term] Use this key to restore the value of the currently highlighted error term to the software's predefined error term values.

[Save Eterms] Use this key to save the edited error term table under a file name you specify.

[Recall Eterms] Use this key to display a data field for you to enter the name of an error term table file to recall. You need to press ***[Next]*** or ***[Previous]*** until the asterisk flashes before entering a filename.

[Done] Use this key when you have finished editing the error term table. New uncertainties are computed based on the error terms.

[Prior Menu] Use this key to return to a previous menu.

SAVING EDITED ERROR TERM VALUES

Use the new features in the software to save your specific error terms in a user-parameters file. Use the following steps to save customized error terms.

The original data files are isolated from changes made to the error term tables for your specific system. As a result, you can choose to use standard error terms, or your customized values.

1. After editing error term tables, pres the ***[Done]*** key to save edited terms.

2. From the Main menu, press ***[Edit Specs] [Save Eterms]***.

3. Enter a file name and directory, if needed, for the new data in the space provided.

NOTE: To enter a file name, press ***[Next]*** or ***[Previous]*** until the blinking asterisk * appears beside the blank input field. The blinking asterisk indicates that you can edit the current field. The program allows you to choose a previously entered file name or type in a new one. Use the ***[Next]*** and ***[Previous]*** keys to select another file name.

RECALLING A CUSTOM ERROR TERM FILE

After saving the custom file to disk, you can recall it for use whenever the system you plan to use matches your current hardware configuration.

To recall a customized error term table file, use the steps below:

1. From the Main menu, press ***[Edit Specs] [Recall Eterms]*** .
2. Edit the file name and directory if necessary.
3. Press ***[Done]*** to retrieve the file.

At this point, the user can make any of the following choices:

- Edit more specifications.
- Return to the Main menu and choose ***[System Specs]*** , ***[System Uncertainty]*** , or ***[Verify System]***.

To use edited specifications, you need to select user parameters. The user parameters are available within the following menus:

- ☐ In the ***[System Specs]*** menu, for table type, choose User Parameters.
- ☐ In the ***[System Uncert]*** menu under Compute Using, select User Parameters.
- ☐ In the ***[Verify System]*** menu, press ***[Select Standard]*** , then select Verify Using: User Parameters.

USING THE NEW SOFTWARE: A TUTORIAL

The tutorial chapter is intended to help you get comfortable using new features in the software. The features allow you to create your own equipment specifications for a calibration test setup. Additional marker features simplify determining the results of these customized setups. Answers to the questions are provided in tables at the end.

- Selecting the hardware for an HP 8510SX system
- Examining error term tables, exercise 1
- Computing uncertainty curves, exercise 2
- Editing specifications, exercise 3
- Answers to tutorial questions

SELECTING THE HARDWARE FOR AN HP 8510SX SYSTEM

After loading the software (as directed in the section following the flowchart, Figure 8-1), the first selection menu that appears is the Hardware Configuration menu. For this tutorial, select the following equipment:

- HP 8510C network analyzer
- HP 8515A test set
- HP 83631A synthesized source
- HP 85052C 3.5 mm TRL cal kit (choose TRL calibration)
- HP 85131F 3.5 mm test port cable set
- HP 85053B 3.5 mm verification kit

EXAMINING ERROR TERM TABLES, EXERCISE 1

Select ***[System Specs]*** from the Main menu. Review the following descriptions to learn more about a few of the menu selections.

Output Table — You can look at the residual errors with correction on, the test port errors with correction off, the test set channel (B1, B2, A1, A2) errors with correction off, or All Tables.

Table Type — Choose Specification, Data Sheet, or User Parameter values.

Data sheet values are published in HP's technical literature. The values do not include effects due to cable stability or system drift errors.

Specification values are used during system verification.

User parameter values are tables which have been modified by the user with the ***[Edit Specs]*** function.

To examine the error terms tables, select All Tables. You see displayed both the effective (corrected) and raw (uncorrected) error terms. Refer to Table 8-2 at the end of this section for answers to the questions below:

1. Which effective error term would dominate when you measure the following?
   a. A very good 50Ω termination?
   b. A short circuit?
   c. An amplifier with 10 dB of gain?
   d. The isolation of a switch?
2. What is the raw directivity at 26.5 GHz?
   How does it compare to the data sheet?
3. What is the difference between "system" and "receiver" dynamic range?

COMPUTING UNCERTAINTY CURVES, EXERCISE 2

Select ***[System Uncert]*** from the Main menu. Review the following descriptions to learn more about a few of the menu selections.

Parameter	Select the appropriate s-parameter.
Format	Choose magnitude or phase.
Uncertainty Limit	Selection applies only to transmission measurements where: ■ The "Upper Limit" is 20×log (1 + error). ■ The "Lower Limit" is 20×log (1 - error). ■ The lower limit always produces the *larger* uncertainty value.
Compute	Choose from the worst-case uncertainty, RSS uncertainty, dynamic accuracy, dynamic range, or test-port power levels. ■ RSS uncertainties are calculated with the RSS of all systematic errors, but the 3-sigma values of random errors are still used for 99.7% certainty. ■ Dynamic accuracy shows the worst-case uncertainty due to IF residuals and detector inaccuracies,without the effects of noise, frequency response, directivity, port match, cross-talk, and connector repeatability.
Compute Using	The uncertainty may be computed using `Specification`, `Data Sheet`, or `User Parameter` (user modified) values.

The specific s-parameters and electrical length of the DUT can also be entered. This is important for determining the phase uncertainty of HP 8350B sweeper-based systems.

Look at the worst-case uncertainty curves (data sheet) for S11 and S21 magnitude and phase. Notice that you can generate read-out values on the display with the vertical "marker." Instructions about using the marker are in the section following Figure 8-1. Refer to Table 8-3 to for answers to the questions.

1. On the S11 magnitude uncertainty curve (at 26.5 GHz), do the following:
   - Estimate effective directivity
   - Compare the estimate with the data sheet value
2. On the S21 magnitude uncertainty curve (at 26.5 GHz), do the following:
   - Estimate system dynamic range
   - Compare the estimate with the data sheet value
3. Compare the S11 and S21 phase uncertainty curves

EDITING SPECIFICATIONS, EXERCISE 3

The exercises in this section present typical examples of customizing a test setup. Each exercise presents a task, followed with a related question. The answers to the questions are in tables located at the end of the chapter. You are referred to the specific table number for the exercise you are doing.

Each exercise presents a different aspect of changing error terms for customizing specifications. The exercises do not need to be completed in any particular order.

- ☐ Exercise 3a shows you how to modify error terms for a custom system.
- ☐ Exercise 3b shows you how to modify error terms for a custom test set.
- ☐ Exercise 3c shows you how to edit error terms for custom cables in a test setup.
- ☐ Exercise 3d shows you how to edit error terms to calculate uncertainties for measuring a non-ideal test device.

Select ***[Edit Specs]*** from the Main menu. This selection allows you to edit the system specifications tables. You can change power levels, averaging factors, or error terms. After you finish editing, the software prompts you to recompute the effective terms that are calculated by the program (crosstalk, noise on trace, noise floor, power ref, power max, and power min).

Review the modify/edit key descriptions of the menu selections in "Handling Customized Error Terms" in this section.

Using a Custom Calibration Kit, Exercise 3a

You have purchased a 3.5 mm broadband load calibration kit from another manufacturer. You want to use this kit on an HP 8510SX system to make reflection measurements at 26.5 GHz. The known return loss of a broadband load at 26.5 GHz is 35 dB. There is a +2° phase error on both the open and short terminations. These factors require that you change the following error terms to the values listed:

- Effective directivity of -35 dB
- Port match of -35 dB
- Reflection tracking of 0.024

HINT: In the hardware configuration menu, select the HP 85052D calibration kit and edit the effective terms. Remember to select User Parameters when generating the S11 magnitude uncertainty curve.

- *Task:* Generate an S11 magnitude uncertainty curve for this measurement.
- *Question:* How can you verify that the S11 magnitude uncertainty curve is correct? Answers are provided in Table 8-4.

Using a Special Test Set, Exercise 3b

You want to compute the S21 uncertainty at 26.5. GHz for a customized high-power measurement setup using the same HP 8511A. A block diagram of the setup is shown in Figure 8-2.

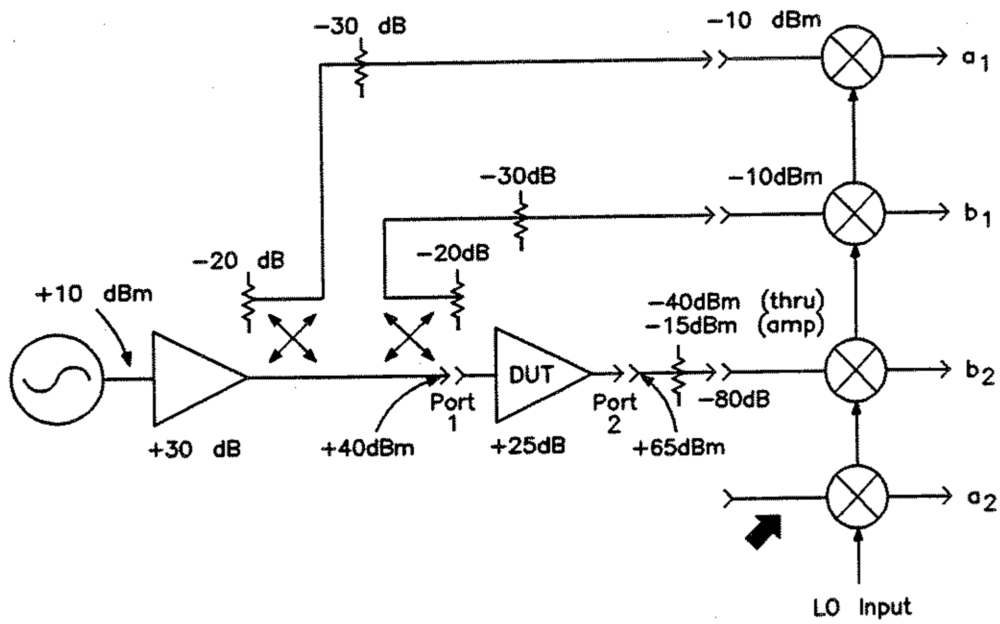


Figure 8-2. Equipment Setup Block Diagram

For the hardware configuration, choose the following:

- HP 8511A test set
- No source
- No calibration kit
- No cables
- No verification kit

Use the broad band-load calibration method. Assume the following:

- Effective directivity of -30 dB
- Reflection tracking of 0.011
- Source match of -25 dB
- Load match of -30 dB
- *Task:* Plot the S21 magnitude uncertainty upper-case uncertainty.
- *Question:* What is the difference between this result and the lower-case uncertainty? Refer to Table 8-6 for the answer.

HINT: Hint: Modify the effective terms and the raw-loss terms. Don't forget to select ***[User Parameters]*** when you start generating the S21 magnitude uncertainty curves.

Using Non-Standard Test Cables, Exercise C.

You are using a pair of non-standard 3.5 mm flexible cables. You want to approximate the measurement uncertainty for an HP 8510SX system over the system's entire frequency range. While you cannot guarantee the results, you can change certain error terms to provide satisfactory results.

- *Question:* Assuming you have specified No Cables in the Hardware Configuration menu, which error terms do you need to degrade to account for this cable? Refer to Table 8-7 for answers.

HINT: Hint: Consider how the cables impact your measurements.

The cable's known worst-case loss is 1.85 dB at 16 GHz and 0.25 dB at 45 MHz. You can determine the RF cable loss by assuming that, similar to HP cables, the total loss on these cables has a constant DC-loss component and an RF-loss component that varies with the square root of the frequency (in GHz).

The error term is "Loss/sqrt(F -ghz) port 1, 2 cable." Use the following formula to calculate the error term (*assuming $F_1 > F_2$*):

$$\frac{Loss1 - Loss2}{\sqrt{F_1(GHz)} - F_2(GHz)}$$

- *Question:* What is the value of this error term for the cables described above?
- *Question:* Which transmission and reflection tests do you perform to determine the stability of the non-standard cables? Refer to the *HP 8510C On-Site Service Manual* as needed.

While you are working on the system, you perform a 2-port calibration. Then, you connect the cables together and store the transmission measurement in memory. Next, you bend the connected cables by the same amount that the cables are bent during a measurement.

Looking at S21/M (data/memory), you find the cable's transmission magnitude repeatability to as indicated below:

- ☐ ±0.02 dB, for frequency range ending at 2 GHz
- ☐ ±0.03 dB, for frequency range ending at 8 GHz
- ☐ ±0.04 dB, for frequency range ending at 20 GHz
- ☐ ±0.06 dB, for frequency range ending at 26 GHz

The S21/M phase measurements showed ±0.1° around 0° at 1 GHz.

You find the cable's reflection magnitude stability, C_{rm}, to be the following values:

- ☐ -45 dB at 2 GHz
- ☐ -41 dB at 8 GHz
- ☐ -35 dB at 20 GHz
- ☐ -31 dB at 26 GHz

- *Question:* What are the new values for the following error terms? Refer to Table 8-8 to verify answers.

  Port 1: Ld1c, Lf1c, Crm1, Ctm1, Cpf1

  Port 2: Ld2c, Lf2c, Crm2, Ctm2, Cpf2

- *Task:* Knowing the information above, press ***[Edit Specs]*** . Enter the new values for the above error terms. Use the ***[Next]*** and ***[Tab]*** keys to edit values.

   a. Enter the error terms Lf1c, Lf2c, Cpf1, and Cpf2 as constants over the software's frequency breakpoints. At any frequency, you can calculate the actual total RF loss with the following equation (where $x = 1$ or 2, depending on the port used):

$$Ldxc + Lfxc \times \sqrt{(frequency\ in\ GHz)}$$

   b. Use the following equation to determine the phase stability:

$$Ctmx + Cpfx \times (frequency\ in\ GHz)$$

After allowing the software to recompute the uncertainties, look at the uncertainty curves. How do they compare with a system that uses HP 85131F cables?

HINT: Remember to select `User Parameters` when generating the uncertainty curves for the non-standard cables.

Using a Non-Ideal Test Device, Exercise D.

You want to determine the measurement uncertainties for a 20 dB fixed attenuator. You want to use this attenuator to make a measurement over the frequency range of 45 MHz to 26.5 GHz. The attenuator has a worst case SWR of 1.25. The device length is about 3 cm. Refer to Table 8-9 for the answers.

To determine the attenuator uncertainties, use the following 3.5 mm HP 8510 system:

☐ HP 8510C network analyzer
☐ HP 8515A test set
☐ HP 83631A synthesized source
☐ HP 85052B calibration kit (choose a sliding load calibration)
☐ HP 85131B/D cables
☐ HP 85053B verification kit

- *Task:* Generate the worst-case uncertainty specifications for an S21 magnitude measurement, using the lower limits.
- *Question:* What are the measurement uncertainties in each frequency range for the attenuator measurement?

ANSWERS TO TUTORIAL QUESTIONS

Exercise questions from the tutorials are repeated in the first column of the tables. Answers are stated in the column beside the question.

"Examining Error Term Tables" Answers

The answers to Examining Error Term Tables, exercises 1, 2, and 3 are in Table 8-2:

Table 8-2. Examining Error Term Tables Answers

Questions	Answers
1. Which effective error term would dominate when you measure the following:	The dominant error terms are:
a. For a good 50Ω termination?	The directivity term.
b. For a short circuit?	The source match term.
c. For an amplifier with 10 dB of gain?	The load match term.
d. For switch isolation?	The crosstalk term.
2. What is the raw directivity at 26.5 GHz?	The value should be about -27 dB.
How does this value compare with the data sheet value?	The raw directivity at 26.5 GHz on the data sheet is -27 dB.
3. What is the difference between "system" and "receiver" dynamic range?	Notice that in the first table (Residual Errors - Correction On), there are two values for effective dynamic range. One refers to the system dynamic range, while the other refers to the receiver dynamic range. These terms are defined below: a. System dynamic range = P__ref__ - P__min__ b. Receiver dynamic range = P__max__ - P__min__ *P_{ref} is the nominal or reference power at the test port.* *P_{min} is the minimum power that can be measured above the noise floor.* *P_{max} is the maximum power that can be applied to port 2 before 0.1 dB compression.*

"Computing Uncertainty Curves" Answers

The answers to Computing Uncertainty Curves, questions 1, 2, and 3 are in Table 8-3:

Table 8-3. Computing Uncertainty Curves Answers

Questions	Answers
1. On the S11 magnitude uncertainty curve (at 26.5 GHz), what is the estimated effective directivity?	The value is 0.004 linear, which is equivalent to -48 dB. To estimate the effective directivity, look for the uncertainty when S11 = 0 (a perfect load).
How does the estimated value compare with the data sheet value?	-48 dB is close to the data sheet value of 50 dB.
2. On the S21 magnitude uncertainty curve (at 26.5 GHz), what is the estimated system dynamic range?	The estimated value is around 68 dB or 70 dB, depending upon how you read the graph. To estimate the dynamic range, look on the S21 uncertainty curve. The curve shows S21 in dB from reference power. Find where the uncertainty becomes too large. Too large can be considered to be >6 dB uncertainty (estimated dynamic range about 68 dB), where the noise power equals the signal power, or >10 dB uncertainty, which is off the graph, corresponding to 70 dB dynamic range.
Does the value correspond with the data sheet?	The data sheet value of 74 dB corresponds with the estimated value.
3. Compare the S11 and S21 phase uncertainty curves with the data sheet. Why are they different?	The data sheet values for these curves do not include the effects of cable stability and system drift errors.

"Editing Specifications Examples" Answers

The answers to tutorial exercises 3a, 3b, 3c, and 3d. are provided in these tables.

Exercise 3a: Answers to Using a Custom Calibration Kit

Table 8-4. Tutorial Exercise 3a. Answers

Questions	Answers
How can you verify that the S11 magnitude uncertainty curve is correct?	At S11 = 0, the value for the 26.5 GHz curve should be about -35 dB, or 0.0178 linear, since that is the of return loss of the load.

Exercise 3b: Answers to Using A Special Test Set

The error terms that need to be modified for generating the S21 magnitude uncertainty curves are in Table 8-5 below:

Table 8-5. Error Terms to Modify for Generating Uncertainty Curves

Error Term	Value
Power of source	10 dB
Effective directivity	-30 dB
Effective reflection tracking	0.011 dB
Effective source match	-25 dB
Effective load match	-30 dB
Effective power ref (out) port 1	40 dBm
Loss/DC source to port 1	30 dB
Loss/DC port 1 to B1	-50 dB
Loss/DC port 2 to B2	-80 dB
Loss/DC source to A1	-50 dB

Table 8-6. Tutorial Exercise 3b. Answers

Error Term	Value
What is the difference between the S21 upper-case magnitude uncertainty and the lower-case uncertainty?	As expected, the lower-case uncertainty is larger than the upper-case uncertainty. The plots for both the upper- and lower-case uncertainty are shown in Figure 8-3 and Figure 8-4.

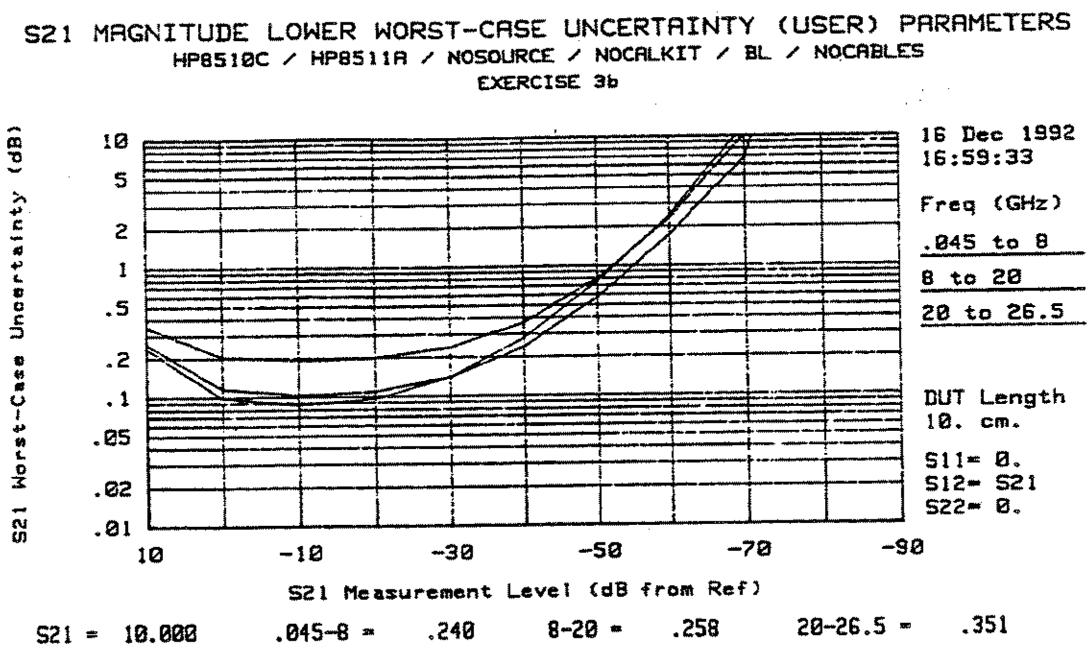


Figure 8-3. S21 Magnitude Upper-Case Uncertainty, User Parameters& for Special Test Set

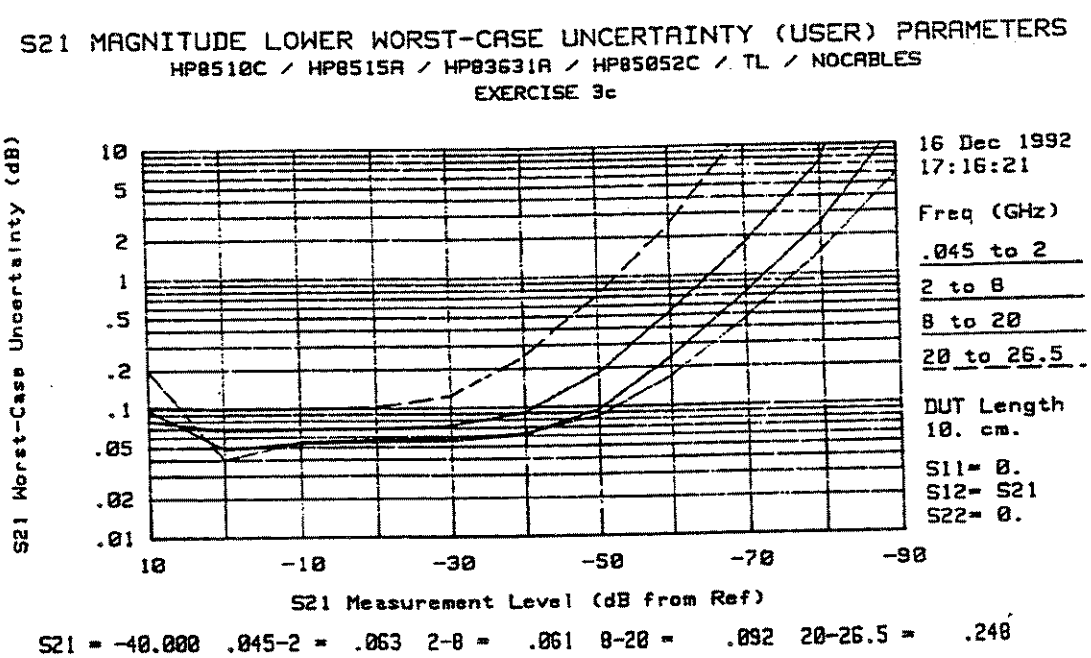


Figure 8-4. S21 Magnitude Lower-Case Uncertainty, User Parameters& for Special Test Set

Exercise 3c: Answers to Using Non-Standard Test Cables

Table 8-7. Tutorial Exercise 3c. Answers

Questions	Answers
Assuming you have specified No Cables in the Hardware Configuration menu, which error terms do you need to degrade to account for these cable?	Cable loss, DC and RF. Reflection and transmission repeatability.
What is the calculated worst-case loss of the custom cables?	0.4 dB should be the calculated loss error term result.
Which reflection and transmission test should you perform to determine the stability of the non-standard cables?	For transmission stability: Connect the cables together and measure S21. Look at S21/M, then bend the cables.
	For reflection stability: Connect the short to port 1 cable and measure S11. Look at S11/M, then bend the cables. Repeat the reflection measurement on port 2 cable and measure S22.

Table 8-8. Error Term Values Needed for This Custom Cable

Question	Port 1 ETerm	Port 2 ETerm	2.0 GHz	8.0 GHz	20 GHz	26.5 GHz
What are the new calculated values for port 1 and port 2 error terms?	Ld1c	Ld2c	-0.25 dB	-0.25 dB	-0.25 dB	-0.25 dB
	Lf1c	Lf2c	-0.40 dB	-0.40 dB	-0.40 dB	-0.40 dB
	Crm1	Crm2	-45.0 dB	-41.0 dB	-35.0 dB	-31.0 dB
	Ctm1	Ctm2	0.02 dB	0.03 dB	0.04 dB	0.06 dB
	Cpf1	Cpf2	0.10 dB	0.10 dB	0.10 dB	0.10 dB

Review the graph of the new error terms in the figures below. The uncertainties are higher for the system using non-standard cables than for the system using HP 85131F cables. See Figure 8-5 and Figure 8-6.

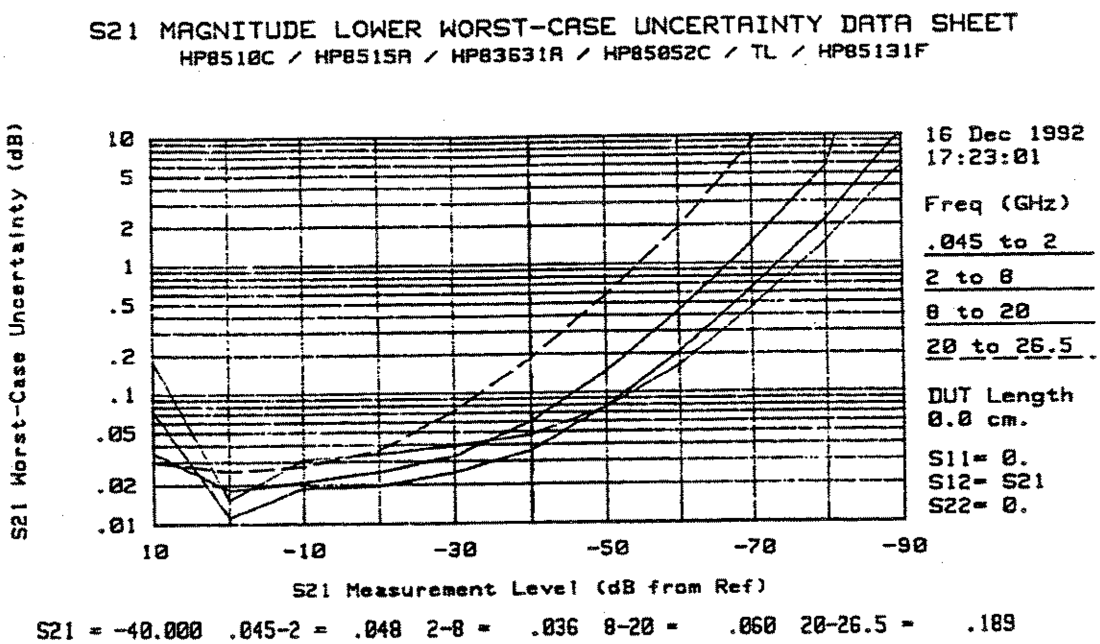


Figure 8-5. S21 Magnitude Uncertainty Using Custom Cables

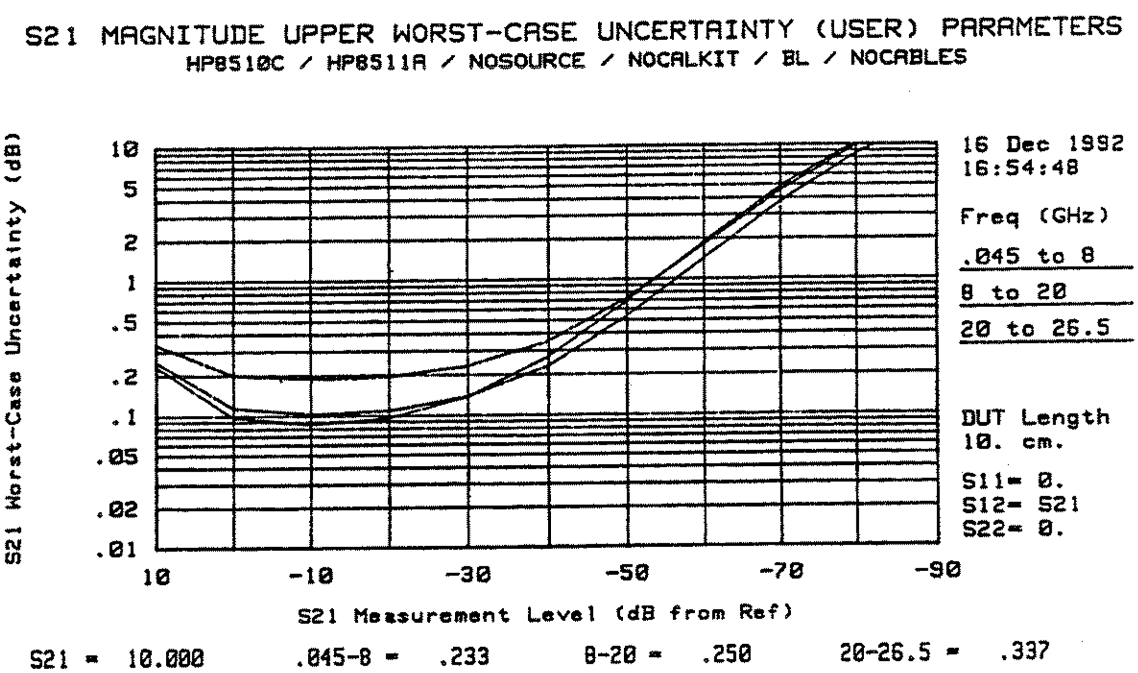


Figure 8-6. S21 Magnitude Uncertainty Using HP 85131F Cables

Exercise 3d: Answers to Using Non-Ideal Test Device

Table 8-9. Tutorial Exercise 3d. Answers

Questions	Answers
What are the measurement uncertainties for each frequency range in the attenuator measurement?	a. After setting up the hardware configuration for the non-ideal test device, go to the Main menu and press the ***[System Uncert]*** key. b. Select a plot for S21 magnitude, `Lower Limit, Worst-Case Uncertainty`, and `Computed Using = Specifications.` c. Notice that by default, the program assumes an "ideal" test device which has S21 = S12, with no reflection from either the input or output ports. d. Next, move to the space for entering S11 and press ***[Previous]*** until the asterisk blinks. Type in S11 = 0.11, the linear value (from SWR = 1.25). e. Go to S21, press ***[Previous]*** until the asterisk blinks. Type in -20 dB for S21. f. Go to S12, press ***[Previous]*** until the asterisk blinks. Type in S12 = -20 dB. g. Go to S22, press ***[Previous]*** until the asterisk blinks. Type in S22 = 0.11, the linear value. h. Enter the device length as 3 cm. i. Press ***[Done]*** to display the uncertainty plot. Use the marker to read the uncertainty values when S21 is -20 dB.
Using the marker, what are the uncertainty values when S21 is -20 dB for the different frequency ranges?	at 0.045 GHz to 2 GHz 0.065 dB uncertainty at 2.0 GHz to 8.0 GHz 0.077 dB uncertainty at 8.0 GHz to 20 GHz 0.111 dB uncertainty at 20 GHz to 26.5 GHz 0.129 dB uncertainty

OPERATIONAL CHECK PROCEDURES

The following operational checks are highly recommended, but not required. The assessment of the system operating environment and the functional operation of the system components help identify faulty equipment.

CAUTION

Use an antistatic work surface and wrist strap to lessen the chance of electrostatic discharge.

ENVIRONMENT AND DEVICE TEMPERATURE CHECK

1. Measure the temperature and humidity of the environment and write the values on the test record, located at the end of this chapter.

   The performance is specified at an ambient temperature of +23°C ±3°. Therefore, the environmental **TEMPERATURE MUST** remain in the range of +20°C to +26°C. Once the measurement calibration has been done, the ambient temperature must be held to ±1°C.

2. Open the calibration and verification kits and place all the devices on top of the foam so they will reach room temperature.

   TEMPERATURE OF THE DEVICES IS IMPORTANT because device dimensions (electrical characteristics) change with temperature.

3. Switch on the power to the system instruments. Switch on the controller last and the HP 85101 next to last. To achieve the maximum system stability, allow the system instruments to warm up for at least 1 hour before measurement calibration.

USER PARAMETERS CHECK (UNRATIOED POWER)

Refer to the "Unratioed Power Failures" section in the "Troubleshooting" chapter for a procedure to check that the system RF power level is correct.

NOTE: Check the user parameters with the source at different power levels and in the ramp and step modes.

INSPECT, CLEAN, AND GAGE CONNECTORS

CAUTION

SMA connectors can easily damage the verification devices. Always use adapters when verifying a system with SMA connectors.

1. Visually inspect all the connectors for any burrs, gold flakes, or places where the gold is worn.
2. Clean all the connectors with alcohol and foam-tipped swabs. Dry the connectors with dry foam-tipped swabs.
3. Gage all devices, cables, and test port connectors.

NOTE: The procedures for correct use of gages are in the calibration kit manuals.

CABLE CHECK

The following series of cable tests (return loss, insertion loss, magnitude stability, phase stability, and connector repeatability) can be done to check the stability of a test port cable. This check is recommended to avoid spending a considerable amount of time on the verification only to have a failure caused by the cables.

Return Loss of Cables

1. Press STIMULUS [MENU] *[STEP]*.
2. Perform an S11 1-port measurement calibration at test port 1. Use a lowband load and a sliding load for the loads portion of the calibration. (If your calibration kit is an economy grade, use the broadband load only.) If necessary, refer to the operating manual for a detailed measurement calibration procedure.

NOTE: If the fixed load in your calibration kit is labeled BROADBAND, you can use this load in the lowband portion of the measurement calibration.

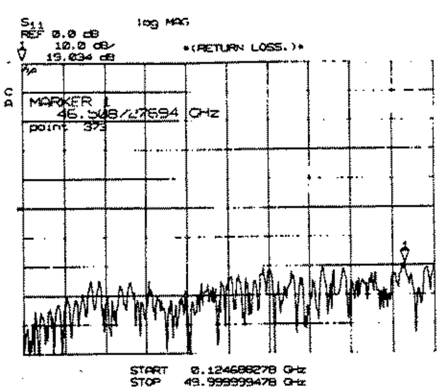
3. Connect the test port cable to PORT 1 and tighten to the specified torque for the connector type.
4. Connect a broadband termination to the end of the cable.
5. To measure S11 of the cable and load combination, press:

   PARAMETER [S11]

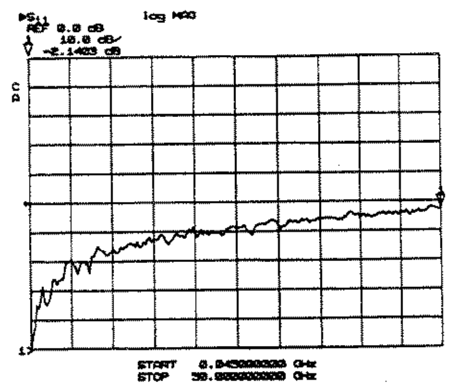
6. To measure the return loss over the entire specified band, press [MARKER], turn the front panel knob, and look for the worst case S11 measurement.

NOTE: The termination used at the cable end must be significantly higher in performance than the cable under test.

See Figure 8-7 for an example of a return loss measurement. Refer to the cable manual to see if the cable meets the return loss specification.



Good Cable



Bad Cable

Figure 8-7. Return Loss Measurement of Cables

Insertion Loss of Cables

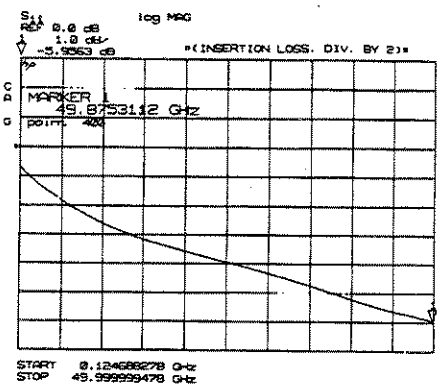
1. Replace the load with a short.

2. To measure the insertion loss of the cable over the entire specified band, press [MARKER], turn the front panel knob, and look for the worst case measurement.

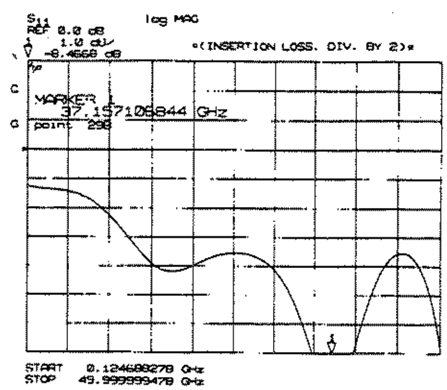
   Power holes >0.5 dB indicate a bad cable. See Figure 8-8 for example insertion loss measurements of a good and a bad cable. Refer to the cable manual to see if the cable you are measuring meets its insertion loss specification.

   In this S11 measurement, the displayed trace results from energy being propagated down the cable and reflected back from the short. Therefore, the correct insertion loss is approximately the measured value divided by 2 (one-way path loss of the cable).

NOTE: It is normal for the data trace to have a roll-off toward the high end of the frequency range.



Good Cable



Bad Cable

Figure 8-8. Insertion Loss Measurements of Cables

Magnitude and Phase Stability of Cables

1. To measure magnitude and phase stability, press the following keys on the analyzer:

   DISPLAY *[DUAL CHANNEL] [SPLIT]*
   CHANNEL 1 LOG MAG
   RESPONSE MENU *[AVERAGING ON]* 6 4 x1
   CHANNEL 2 PARAMETER S11 FORMAT PHASE
   RESPONSE MENU *[AVERAGING ON]* 6 4 x1

2. Connect a short at the end of the cable.

3. Hold the cable in a straight line, and press the following keys to normalize the displayed traces:

   CHANNEL 1 DISPLAY *[DATA→MEMORY 1] [MATH (/)]*
   CHANNEL 2 DISPLAY *[DATA→MEMORY 2] [MATH (/)]*

4. Make a gradual 90° bend in the middle of the cable.

NOTE: The specification in the cable manual is determined from a transmission measurement (not a reflection measurement) and using a particular radius of a bend.

5. To change the scale of the displayed traces, press:

   CHANNEL 1 RESPONSE SCALE STEP ⬇ (repeat arrow key)
   CHANNEL 2 RESPONSE SCALE STEP ⬇ (repeat arrow key)

6. To mark the end of the cable's specified range, place a marker on the highest specified frequency of the cable. Press:

   MARKER (enter the specified frequency) G/n

7. Place a marker on the largest deflection that goes above and below the reference line and is within the specified frequency range. See Figure 8-9 for example plots of this measurement. Press:

   MARKER *[MARKER 2]* (turn the front panel knob)

   In this S11 measurement, the displayed trace results from energy being propagated down the cable and reflected back from the short. Therefore, the measured deflection value must be divided in half to reach the correct value. Refer to the cable manual to see if the cable meets the magnitude and phase stability specifications.

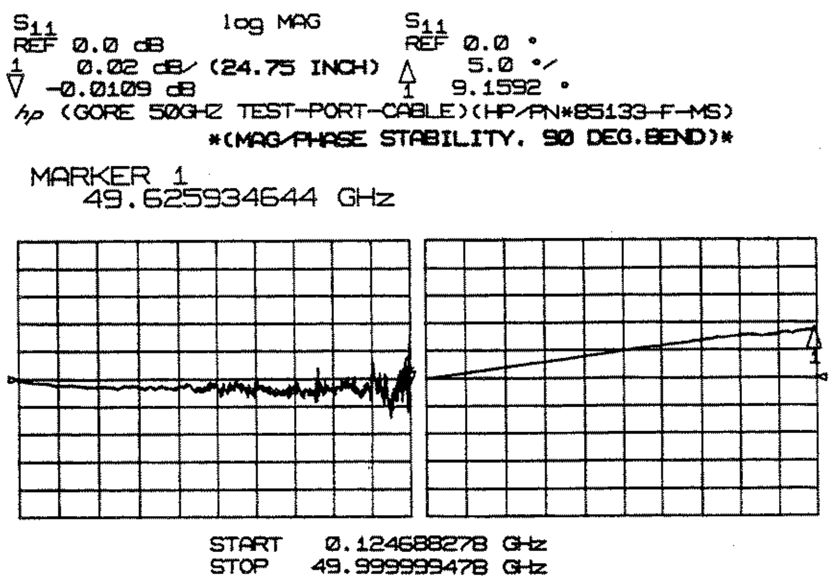


Figure 8-9. Cable Magnitude and Phase Stability

Cable Connector Repeatability

1. To measure the cable connector repeatability, connect a broadband termination at the end of the cable.

NOTE: The connector repeatability specification that the specifications/performance verification software computes is not related to this check. It is determined from the same connector type as the calibration kit devices.

2. Press the following keys on the analyzer:

   CHANNEL 1 DISPLAY *[SINGLE CHANNEL] [DATA]*
   RESPONSE MENU *[AVERAGING ON]* 1 2 8 x1

3. To normalize the data trace press:

   DISPLAY *[MORE] [MATH OPERATIONS] [MATH (-)]*
   DISPLAY *[DATA→MEMORY 1] [MATH (-)]*
   RESPONSE REF VALUE − 5 0 x1

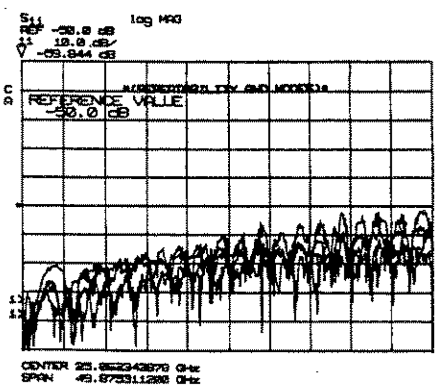
4. Disconnect and then reconnect the cable to the test port. Tighten the connection to the specified torque for the connector type.

5. To add the data trace of the reconnected cable to memory, press:

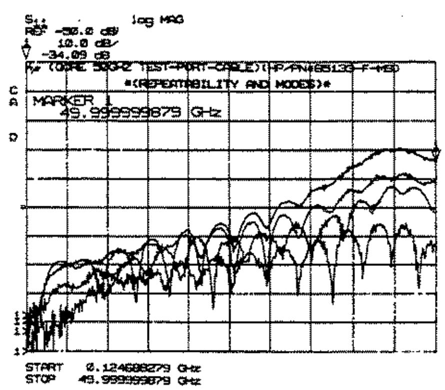
   DISPLAY *[DATA→MEMORY 1]*

6. Repeat steps 4 and 5 at least 3 times to look for modes. Modes appear when a harmonic of the source fundamental frequency is able to propagate through the cable or connector. Any mode that appears each time the cable is connected and reconnected will affect measurement integrity. Refer to the example plot in Figure 8-10.

NOTE: The connector repeatability measurement should be done at the test port as well as at the end of the test port cable.



Good Cable



Bad Cable

Figure 8-10. Connector Repeatability Examples

DYNAMIC RANGE CHECK

This check requires a full 2-port measurement calibration with isolation and 1024 averages. Since the total measurement uncertainty test also requires the same measurement calibration, this check should be done in the first portion of that test.

NOTE: Each system configuration has a different dynamic range specification. Use the effective dynamic range specifications (Ref-min Edrr2, Edrr1) that are found on the residual error (w/correction on) table generated from the specifications/performance verification software.

1. Terminate each test port with a broadband load (included in the calibration kit).

2. On the analyzer, press:

   FORMAT [LOG MAG]
   PARAMETER [S21]
   RESPONSE [MENU] ***[AVERAGING ON]***
   (for sweepers) [1] [2] [8] [x1]
   (for synthesizers) [1] [0] [2] [4] [x1]
   MEASUREMENT [RESTART]

   Allow at least one complete sweep (until the asterisk at the left side of the CRT disappears).

3. Compare the measured dynamic range to the specification on the generated table.

NOTE: Test sets with option 003 (reversed coupler) have a different specification for forward and reverse measurements. Measure the dynamic range in both S12 and S21 parameters.

FREQUENCY TEST PROCEDURES

The frequency tests are only for HP 8340/8360 sources. The HP 8350 source frequency accuracy is tested during the total system uncertainty test.

Source frequency accuracy is tested across the entire sweep range in both the swept and CW sweep modes.

NOTE: Allow at least one hour for the system instruments to warm up.

CW FREQUENCY ACCURACY TEST

The front panel emulation software, contained on the HP 8510 operating system disc, is required to do this test for an HP 83621/31/51. The analyzer keypad overlay is part of the front panel emulator kit.

1. Connect the equipment as shown in the figure below.

NOTE: If the source and test set operate below 500 MHz, connect the test set output to the 10 Hz-500 MHz BNC connector on the frequency counter. The input switch on the frequency counter must also be in the 10 Hz-500 MHz position.

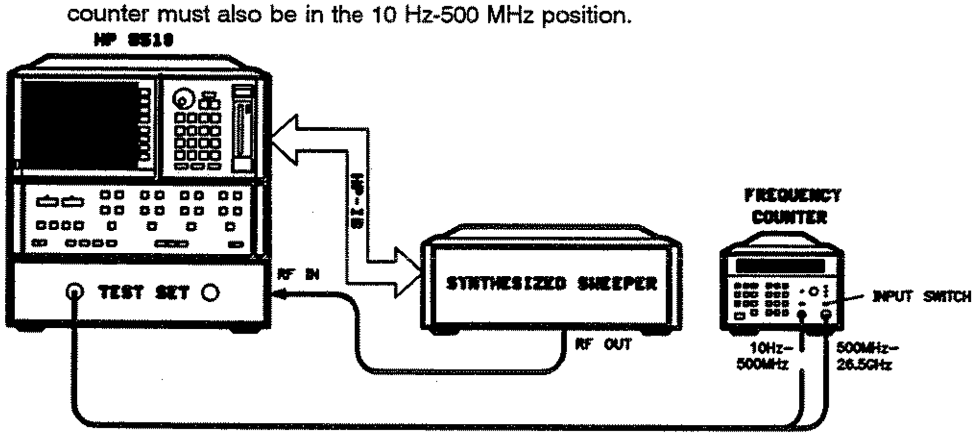


Figure 8-11. CW Frequency Accuracy Setup

2. To preset the instruments, press:

   INSTRUMENT STATE [RECALL] ***[MORE] [FACTORY PRESET]***

3. To set the frequency from the analyzer front panel, press:

   STIMULUS [CENTER] [MENU] ***[SINGLE POINT]*** and enter the start frequency of the source or test set, whichever is higher.

   Measure the frequency with the counter, and record this value on the test record located at the end of this chapter.

4. From the analyzer front panel, enter the stop frequency of the source or test set, whichever is lower. (For an HP 83640 or 83651, omit this step and follow the appropriate next step.)

NOTE: Make sure the test set output is connected to the 500 MHz-26.5 GHz input on the frequency counter. The input switch must also be set to the 500 MHz-26.5 GHz position.

Measure the frequency with the counter, and record the value on the test record located at the end of this chapter.

For the HP 83640:

5. From the analyzer front panel, enter [2] [6] [.] [5] [G/n] .

NOTE: Make sure the test set output is connected to the 500 MHz-26.5 GHz input on the frequency counter. The input switch must also be set to the 500 MHz-26.5 GHz position.

Measure the frequency with the counter, and record the value on the test record located at the end of this chapter.

6. In the HP 83640, an internal frequency doubler is used to generate frequencies of ≥ 20 GHz through 40 GHz. Since the highest frequency that the frequency counter can measure is 26.5 GHz, the doubler is disabled for the measurement at 40 GHz, providing an RF output of 20 GHz. This verifies a 40 GHz output except for the operation of the doubler. Since the doubler is engaged to produce the 26.5 GHz RF output, the operation of the doubler is verified in the 26.5 GHz measurement.

   On the synthesizer, press:

   [SERVICE] ***[MORE] [TOOLS MENU]***
   [MORE] [DISABLE DOUBLER] (asterisk on)
   [CW] [4] [0] [G/n]

   Measure the frequency with the counter and record the value on the test record located at the end of this chapter.

For the HP 83651:

5. From the analyzer front panel, enter [2] [6] [.] [5] [G/n] .

NOTE: Make sure the test set output is connected to the 500 MHz-26.5 GHz input on the frequency counter. The input switch must also be set to the 500 MHz-26.5 GHz position.

Measure the frequency with the counter, and record the value on the test record located at the end of this chapter.

6. Insert the HP 8510 operating disc into the analyzer disc drive to run the front panel emulation software.

   In the HP 83651, an internal frequency doubler is used to generate frequencies of ≥26.5 GHz through 50 GHz. Since the highest frequency that the frequency counter can measure is 26.5 GHz, the doubler is disabled for the measurement at 50 GHz, providing an RF output of 25 GHz. This verifies a 50 GHz output except for the operation of the doubler. Since the doubler is engaged to produce the 26.5 GHz RF output, the operation of the doubler is verified in the 26.5 GHz measurement.

7. On the analyzer, press:

   AUXILIARY MENUS [SYSTEM]
   [MORE] [SERVICE FUNCTIONS]
   [TEST MENU]
   [1] [9] (LOAD PROGRAM DISC) [=MARKER]
   [⇓] ***[LOAD FILE]***
   [2] (FRONT PANEL EMULATOR) [=MARKER]

8. Put the keypad overlay on the analyzer front panel. (The overlay is part of the front panel emulator kit.)

9. To set the stop frequency of the HP 83651, press the following keys on the analyzer.

   FREQUENCY [CW] [5] [0] [G/n]
   [SERVICE] [D4] (more) ***[k2]*** (Tools Menu)
   [k4] (more) ***[k4]*** (Disable Doubler) (asterisk on)

   Measure the frequency with the counter and record the value on the test record located at the end of this chapter.

10. Follow the instructions on the analyzer CRT to exit the front panel emulator software.

In Case of Difficulty

If the measured values do not meet the specifications listed on the test record, refer to the source manual for adjustment and troubleshooting instructions.

SWEPT FREQUENCY ACCURACY TEST

This check is helpful for systems that are primarily operated in ramp mode, and is optional. This procedure is not part of performance verification. Performance verification requires step-mode only.

The front panel emulation software, contained on the HP 8510 operating system disc, is required to do this test for an HP 83621/31/51. The analyzer keypad overlay is part of the front panel emulator kit.

1. Connect the equipment as shown in Figure 8-12.

NOTE: The HP 8514/8515 test sets must have the ports unbalanced. Connect long cables between the front panel ports and short cables between the back panel ports (or vice versa).

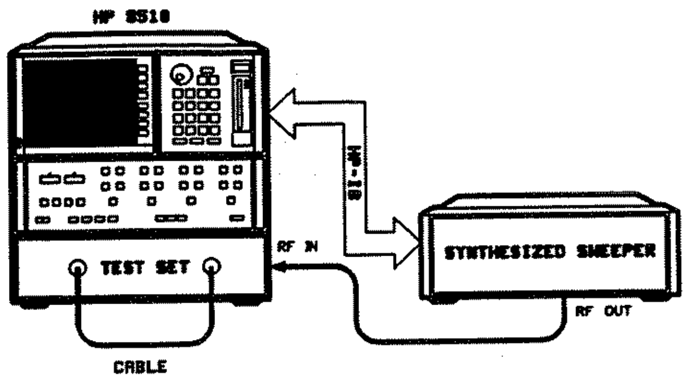


Figure 8-12. Swept Frequency Accuracy Setup

2. To preset the system instruments, press:

   INSTRUMENT STATE [RECALL] ***[MORE] [FACTORY PRESET]***

For HP 83621/31/51 Synthesizers:

3. Run the front panel emulation software. On the analyzer, press:

   AUXILIARY MENUS [SYSTEM]
   [MORE] [SERVICE FUNCTIONS]
   [TEST MENU]
   [1] [9] (LOAD PROGRAM DISC) [=MARKER]
   [⬇] ***[LOAD FILE]***
   [2] (FRONT PANEL EMULATOR) [=MARKER]

   Put the keypad overlay on the analyzer front panel. (The overlay is part of the front panel emulator kit.)

4. To initiate a synthesizer full user cal, that includes auto track and sweep span cal, press:

   [USER CAL] [k0] (Full Usr Cal) ***[k0]*** (proceed)

   The user cal takes a few minutes to complete.

NOTE: Auto track is not an adjustment; it must be done to ensure the source specifications are met. Hewlett-Packard recommends you do an auto track every time you do a measurement calibration.

5. Follow the instructions on the analyzer CRT to exit the front panel emulator software.

Continue with step 6.

For All Other HP 8360 Series Synthesizers:

3. To initiate an auto track, press the following keys on the synthesizer:

   [PRESET] [USER CAL] ***[FREQ CAL MENU]*** [ONCE].

4. To initiate a sweep span cal, press the following keys on the synthesizer:

   [PRESET] [USER CAL] [FREQ CAL MENU] *[Sweep Span Once]* [ONCE]

Continue with step 6.

For HP 8340/41 Series Synthesizers:

3. To initiate an auto track, press the following keys on the synthesizer:

   [PRESET] [SHIFT] [PEAK]

4. Continue with step 6.

For All Synthesizers:

6. Press the following keys on the analyzer:

   PARAMETER [S21] FORMAT [PHASE] STIMULUS [MENU] ***[STEP]***

   Allow at least one complete sweep (until the asterisk is gone).

7. To normalize the measurement, press:

   MENUS [DISPLAY] ***[DATA→MEMORY 2] [MATH (/)]***

8. To offset the center frequency by 5 MHz, press STIMULUS [CENTER] and increase the displayed value by 5 MHz. For example, for a 45 MHz to 50 GHz sweep, the center frequency should be changed from 25.0225 to 25.0275 GHz.

9. Press RESPONSE [SCALE] and use the front panel knob to adjust the scale factor so that the flat trace is shifted to the bottom or top graticule. (Where the trace variations are approximately halfway above and below the last graticule.)

10. Press STIMULUS [CENTER] and change the displayed frequency by 10 MHz. This places the trace on the opposite side of the CRT. The amount of the frequency shift now represents a vertical scaling of 1 MHz per division.

11. Press STIMULUS [CENTER] and return the frequency to the original setting. The phase measurement should return to 0°.

12. Press STIMULUS [MENU] ***[RAMP] [SWEEP TIME]*** [.] [5] [x1]. The display shows the difference between step and ramp sweep modes. An example of a full band measurement at 1 MHz per division is shown in the figure below.

13. Measure the trace variation with the 1 MHz per division scale. Record the results on the test record located at the end of this chapter.

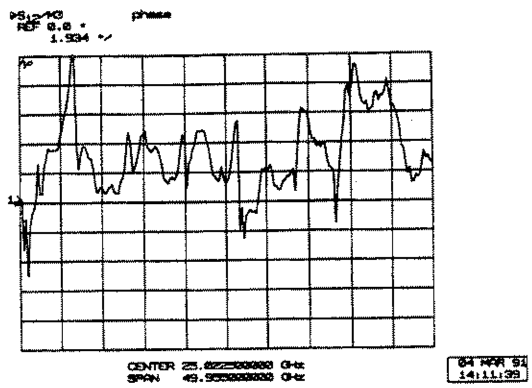


Figure 8-13. Typical Ramp Sweep Frequency Accuracy

For HP 8340/41 Series Synthesizers:

14. On the synthesizer, press CAL ***[MORE] [TRIM SWEEP]*** and adjust the front panel knob to position the highest frequency bandswitch transition point on the reference line. Refer to the figure below.

    Record the maximum trace variation on the test record located at the end of this chapter.

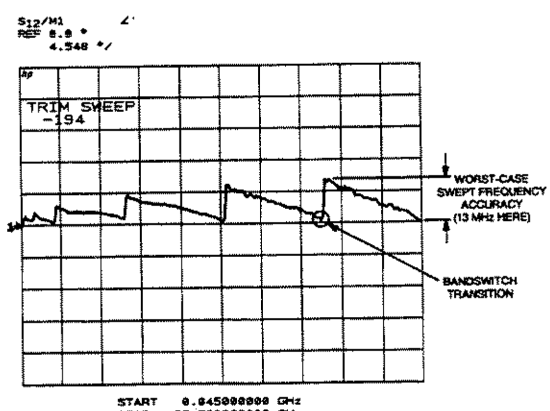


Figure 8-14. Typical Trace Variation for HP 8340/41 Swept Frequency Accuracy

In Case of Difficulty

If the measured values do not meet the specifications listed on the test record, refer to the source manual for adjustment and troubleshooting instructions.

TOTAL SYSTEM UNCERTAINTY TEST PROCEDURE

The figure below shows a menu map of the performance verification program. Step-by-step instructions follow.

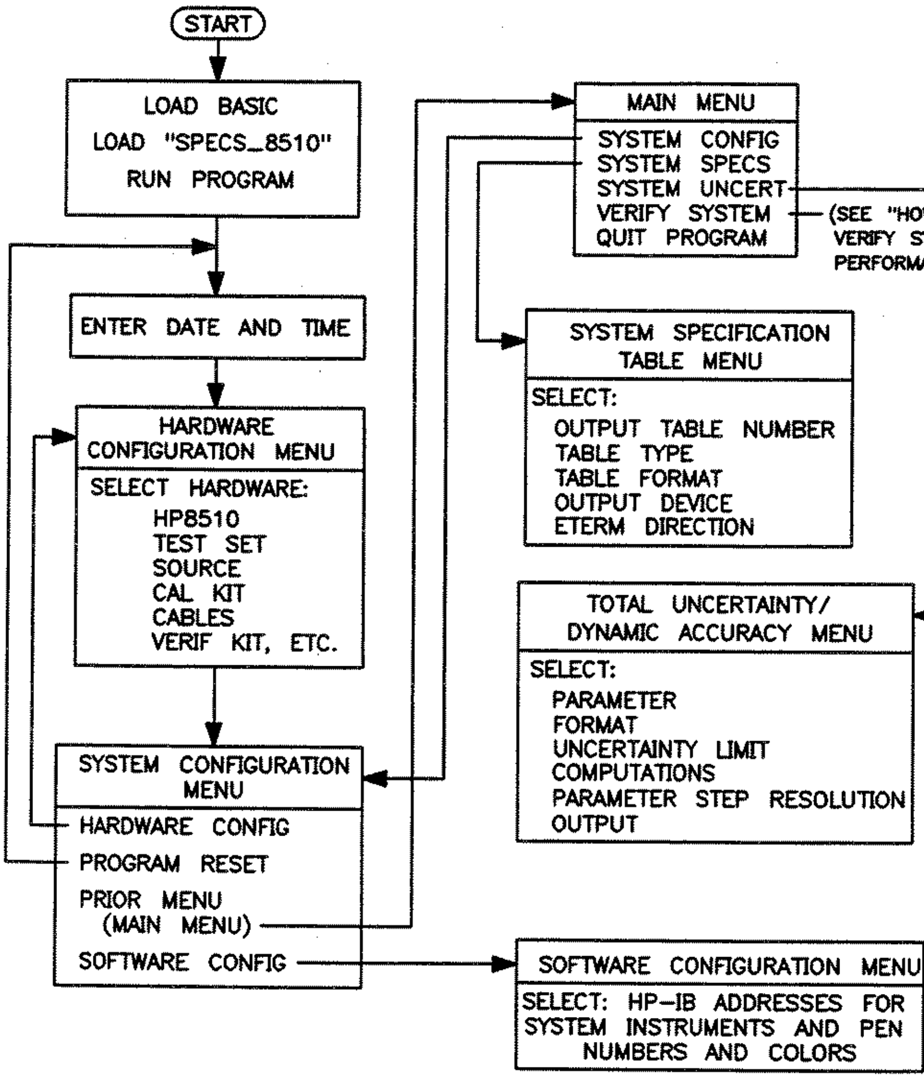


Figure 8-15. Performance Verification Program

1. Perform the "How to Load the Software" procedure earlier in this chapter.
2. To run the performance verification, press:

   [Verify System] [Serial Numbers].

3. Complete the list of system component and kit serial numbers. Also fill in the NIST test numbers from the verification kit. Press ***[DONE]*** when the list is complete.
4. To begin a measurement calibration, insert the calibration kit data disc into the analyzer disc drive, and press ***[System Cal]***.

If the list does not match your system, press ***[Prior Menu] [Prior Menu] [System Config]*** to return to the hardware configuration menu to correct the list. If the list does match your system, press ***[Resume]***.

5. Follow the cable connection instructions on the CRT and then press ***[Resume]***.

NOTE: Tighten all connections to the correct torque.

6. If your system operates at 45 MHz and your verification kit contains the device characterization data for 45 MHz, insert the verification kit data disc into the analyzer disc drive and press ***[Resume]***. After the 45 MHz data is loaded, press ***[Yes]***.

If your system does not operate at 45 MHz or if your verification kit does not contain device characterization data for 45 MHz, press ***[Bypass]***.

If you do not know if your verification kit disc has data for 45 MHz, the software will automatically detect whether or not the disc contains the data.

7. Insert the calibration kit data disc into the analyzer disc drive. Press ***[Resume]***.
8. Measure the environmental temperature and record the results on the test record at the end of this chapter.
9. After allowing a 1 hour warm up, perform a full 2-port measurement calibration by connecting the calibration devices and pressing the corresponding keys on the analyzer. **DO NOT HOLD THE CALIBRATION DEVICES** when the analyzer is measuring them. (Use a TRL calibration whenever possible. Otherwise, for the loads portion of the calibration, use the sliding and lowband loads or the broadband load for economy calibration kits.) Refer to the operating manual for a detailed measurement calibration procedure.

NOTE: If you are using a TRL measurement calibration technique, be extremely careful not to move the test port cables. Cable movement, between measurement calibration and verification, may introduce enough error to cause a verification failure. If the highest accuracy measurement calibration is desired, HP recommends that you place the cables in a fixture to prevent cable movement.

Save the measurement calibration in one of the analyzer registers. When the measurement calibration is completed and saved, press ***[Resume]***.

.If you have selected a performance verification for 45 MHz, perform a full 2-port measurement calibration at 45 MHz. (Use only the lowband load for the loads portion of the calibration). Save the measurement calibration in a different analyzer register. When the measurement calibration is completed and saved, press ***[Resume]***.

10. Press ***[Select Standard]*** and fill in the serial number for the verification standard listed.
11. Leave the number of averages at 1024 unless you changed it for the measurement calibration. The number of averages MUST be the same for the measurement calibration AND the verification device measurements.

12. Select the appropriate register(s) where you saved the measurement calibration(s).

13. Select the 45 MHz measurement if the system operates in that frequency range and the characterization data is available. Press ***[Done]***.

14. Insert the verification kit disc into the analyzer disc drive and press ***[Resume]***.

15. Measure the environmental temperature and record the results on the test record at the end of this chapter.

NOTE: For specified performance, the environmental **TEMPERATURE** at the time of verification **MUST BE WITHIN 1°C (1.8°F)** of the measurement calibration temperature.

16. Press ***[Measure Data]***.

17. If the measurement calibration sets and corresponding analyzer registers that appear on the CRT are not correct, return to the system calibration menu by pressing ***[Prior Menu] [Prior Menu]***.

    If the measurement calibration sets are valid, connect the verification device between the test port cables and press ***[Resume]***.

18. After the measurement is complete, view the results of each parameter measurement. Press:

    [S11] [S12] [S21] [S22].

19. Press ***[Print All]*** to create a hardcopy of the verification results.

20. If the system passes all the parameter measurements of the device, press ***[Select Standard]*** to select another verification device measurement.

If the system does not pass all the parameter measurements, refer to "If the System Fails Performance Verification" later in this chapter.

21. Use the cursor keys and the ***[Next]*** and ***[Previous]*** softkeys to select another verification standard and to change the device serial number. Press ***[Done] [Resume]***.

22. Repeat steps 16 through 21 until all the devices in the verification kit are measured.

    The system performance verification is complete. Refer to Examples 8–3 and 8–4 to interpret the printout of your measurement results.

COMPARING SYSTEM MEASUREMENT UNCERTAINTIES FOR THE PERFORMANCE VERIFICATION DEVICES

You can determine your system measurement uncertainty and compare it to the factory uncertainty for each frequency measurement of each verification device. The comparison calculation can be done by following the steps below.

1. Extract a factory measurement uncertainty value from the verification device data (contained in the verification kit or make a printout using the software).

2. Subtract the value in step 1 from the total measurement uncertainty value on the performance verification printout.

The example below shows where the equation values are located on the device data sheet and the verification printout. The example also shows how the equations can be arranged to make a table. A blank table is provided for you to write the comparison equations for your system.

HEWLETT-PACKARD DEVICE CHARACTERIZATION DATA SHEET FOR 8510
Date : 3 Jul 1990, Kit: 85057A, Serial No. 2803A00356
Item : 20 dB ATTENUATOR, 85057-60010, Serial No. 00649
Ambient conditions: 23 deg. C., Uncertainties for Factory Test System
PORT IDENTIFICATION : With the device label facing the user;
Port 1 (A) is on the left and Port 2 (B) is on the right

	S21				S12			
FREQ GHz	MAG db	UNC +/-	ANG deg	UNC +/-	MAG db	UNC +/-	ANG deg	UNC +/-
.045	-19.722	.140	-1.49	1.04	-19.742	.141	-1.09	1.14
1.000	-19.715	.043	-27.51	.42	-19.707	.044	-27.49	.49
2.000	-19.724	.043	-54.92	.46	-19.725	.045	-54.89	.55
4.000	-19.751	.043	-109.66	.50	-19.750	.046	-109.64	.59
8.000	-19.812	.071	140.86	.81	-19.813	.072	140.88	.88
10.000	-19.852	.072	86.23	.88	-19.857	.073	86.23	.94
12.000	-19.904	.070	31.62	.93	-19.902	.073	31.63	1.01
16.000	-20.018	.070	-77.59	1.06	-20.028	.073	-77.53	1.13
18.000	-20.087	.070	-132.07	1.12	-20.088	.072	-132.07	1.19
20.000	-20.159	.070	173.46	1.19	-20.160	.073	173.48	1.25
22.000	-20.237	.108	119.07	1.50	-20.240	.110	119.03	1.56
26.000	-20.408	.110	10.51	1.65	-20.411	.112	10.61	1.70
30.000	-20.575	.111	-97.58	1.78	-20.569	.114	-97.59	1.84
34.000	-20.737	.109	154.77	1.90	-20.737	.113	154.75	1.96
36.000	-20.820	.109	101.06	1.97	-20.804	.112	101.08	2.02
38.000	-20.884	.136	47.49	2.24	-20.856	.142	47.40	2.32
40.000	-20.918	.180	-5.89	2.60	-20.917	.193	-5.73	2.72

	S11				S22			
FREQ GHz	MAG lin	UNC +/-	ANG deg	UNC +/-	MAG lin	UNC +/-	ANG deg	UNC +/-
.045	.00476	.00484	174.44	180.00	.00180	.00506	-23.62	180.00
1.000	.00425	.00378	166.41	63.17	.00246	.00410	-60.92	180.00
2.000	.00370	.00378	145.19	180.00	.00291	.00409	-94.57	180.00
4.000	.00705	00378	107.29	32.67	.00240	.00559	152.85	180.00
8.000	.00915	.00759	15.01	56.28	.00747	.00922	61.76	180.00
10.000	.01207	.00760	-21.83	39.27	.01074	.00923	11.05	59.94
12.000	.01532	.00761	-56.81	30.08	.01322	.00923	-28.82	45.14
16.000	.01269	.00760	-133.19	37.11	.01188	.00923	96.31	52.00
18.000	.00936	.00759	164.95	54.49	.00332	.00920	-132.61	180.00
20.000	.00900	.00758	62.63	57.80	.00574	.00921	14.13	180.00
22.000	.01771	.00788	6.69	26.87	.01649	.01078	-6.31	42.11
26.000	.03423	.00797	-78.00	13.95	.03321	.01085	-82.85	20.55
30.000	.03759	.00797	-150.38	12.79	.03593	.01086	-149.69	19.28
34.000	.01749	.00786	137.40	27.32	.01810	.01080	133.53	38.48
36.000	.00621	.00781	70.85	180.00	.00923	.01077	99.48	180.00
38.000	.01084	.00802	-67.46	48.37	.00253	.01325	-18.23	180.00
40.000	.01603	.00814	-97.87	31.21	.00968	.01351	-68.02	180.00

* Note: Uncertainties for frequency data points below 500 Mhz do not apply when used with 8512 or 8514 test sets.

HP8510C PERFORMANCE VERIFICATION 13:52:75 10 Jan 1991

Verif Std: 20 dB Attenuator Ser #: 00649 Origin: 7/ 3/90
Verif Kit: HP85057A -- 2.4mm Ser #: 2803A00356 Origin: 7/ 3/90

Network Analyzer: HP8510C S/N: 3031A06614 2844A05410
Test Set: HP8517A S/N: 3032A00117
Source: HP83651A S/N: 3027A00113
Calibration Kit: HP85056D S/N: 3012A00117
Calibration Technique: BL
Test Port Cables: HP85133F

NSU Test Numbers: [illegible]

Comments:

	S11 MAGNITUDE (lin)				S11 PHASE (deg)			
Freq (GHz)	Factory Meas'd (A)	User Meas'd (B)	Diff Mag (A-B)	Total Uncert +/-	Factory Meas'd (A)	User Meas'd (B)	Diff Phase (A-B)	Total Uncert +/-
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NOTE: Total Uncert = Factory System Uncertainty + User System Uncertainty.

Legend: N -- Parameter Verification Not Required.

PASSED: S11 Verification Measurement of the 20 dB Attenuator.

Freq GHz	Total Uncertainty	—	Factory Uncertainty	=	System Measurement Uncertainty
0.045	0.01348	—	0.00484	=	0.00864
1.000	0.01242	—	0.00378	=	0.00864
2.000	0.01241	—	0.00378	=	0.00863

Example 8–1. Comparing Measurement Uncertainties

Freq GHz	Total Uncertainty	—	Factory Uncertainty	=	System Measurement Uncertainty

Example 8–2. Table for Comparing Measurement Uncertainties

Interpreting the Performance Verification Results

Two example printouts are used to explain the various columns.

```
HP8510B PERFORMANCE VERIFICATION                          10:11:47  10 Aug 1990   (1)
=================================================================================
(2) Verif Std: 20 dB Attenuator                  Ser #: 01371     Origin: 12/20/88
    Verif Kit: HP85053B -- 3.5mm                 Ser #: 00301     Origin: 12/20/88
=================================================================================
(3) Network Analyzer:          HP8510B          S/N:
    Test Set:                  HP8515A          S/N:
    Source:                    HP83631A         S/N:
    Calibration Kit:           HP85052D         S/N:
    Calibration Technique:     BL
    Test Port Cables:          HP85131B
=================================================================================
(4) NBS Test Numbers:  #:                       #:
                       #:                       #:
                       #:                       #:
                       #:                       #:
    Comments:
```

(5)

Freq (GHz)	S21 MAGNITUDE (dB) Factory Meas'd [A]	User Meas'd [B]	Diff Mag [A-B]	Total Uncert +/-	S21 PHASE (deg) Factory Meas'd [A]	User Meas'd [B]	Diff Phase [A-B]	Total Uncert +/-
1.500 (6)	-20.110	-20.105	-.005	.078	-60.84	-60.78	-.07	.85
2.000	-20.117	-20.111	-.006	.078	-81.09	-80.99	-.10	.94
3.000	-20.129	-20.120	-.001	.089	-121.57	-121.42	-.15	1.18
4.500	-20.155	-20.151	-.004	.090	177.81	178.00	-.19	1.45
6.000	-20.175 (7)	-20.171	-.003	.089	117.16	117.38	-.22	1.69
7.500	-20.203	-20.199	-.005	.087	56.56	56.87	-.30	1.94
8.000	-20.210	-20.202	-.008	.089	36.35	36.64	-.29	2.04
[illegible]	[illegible]	-20.231 (8)	.003	.148	-4.06	-3.71	-.35	2.61
10.500	-20.254	-20.262	.008	.148	-64.66	-64.29	-.37	2.86
12.000	-20.287	-20.282	-.006	.148	-125.19	-124.87	-.32	3.12
[illegible]	[illegible]	[illegible]	.002 (9)	.146	174.19	174.59	-.40	3.36
15.000	-20.347	-20.332	-.015	.147	113.64	114.13	-.49	3.62
16.500	-20.363	-20.346	-.017	.147	53.08	53.56	-.48	3.88
18.000	-20.378	-20.366	-.012	.146 (10)	-7.46	-6.96	-.50	4.12
19.500	-20.396	-20.389	-.008	.143	-67.99	-67.59	-.40	4.36
20.000	-20.394	-20.386	-.008	.142	-88.26	-87.94	-.31	4.43
21.000	-20.399	-20.407	.007	.246	-128.69	-128.30	-.39	5.31
22.500	20.339	-20.356	-.043	.256	170.58	170.93	-.35	5.63
24.000	-20.379	-20.323	-.057	.268	109.85	110.27	-.42	5.96
25.500	20.362	-20.275	-.087	.280	49.10	49.61	-.51	6.30
26.500	20.322	-20.319	-.003	.290	8.53	8.81	-.28	6.54

NOTE: Total Uncert = Factory System Uncertainty + User System Uncertainty.

(11) PASSED: S21 Verification Measurement of the 20 dB Attenuator.

NOTES:

1. Time and date of performance verification
2. Verification device and kit identification with the date of the latest kit certification
3. System components identification and calibration technique: broadband load (BL)
4. Verification kit test numbers that document the traceable path to a national standard
5. Measurement parameter: S21 magnitude and phase
6. Frequency of the data point
7. Results of magnitude measurement as measured at the factory
8. Results of magnitude measurement as measured in the performance verification
9. Difference between the factory and verification measurements (this must be less than the total uncertainty to pass)
10. Total measurement uncertainty which is the sum of the factory system uncertainty and the uncertainty of the system being verified
11. Result of the performance verification measurement

Example 8–3. Performance Verification (S21 Measurement)

```
HP8510B PERFORMANCE VERIFICATION                              10:11:47  10 Aug 1990
==================================================================================
Verif Std: 20 dB Attenuator                       Ser #: 01371     Origin: 12/20/88
Verif Kit: HP85053B -- 3.5mm                      Ser #: 00301     Origin: 12/20/88
==================================================================================
Network Analyzer:               HP8510B                  S/N:
Test Set:                       HP8515A                  S/N:
Source:                         HP83631A                 S/N:
Calibration Kit:                HP85052D                 S/N:
Calibration Technique:          BL
Test Port Cables:               HP85131B
==================================================================================
NBS Test Numbers:  #:                                    #:
                   #:                                    #:
                   #:                                    #:
                   #:                                    #:

Comments:
```

(1)

Freq [GHz]	S22 MAGNITUDE (lin) Factory Meas'd [A]	User Meas'd [B]	Diff Mag [A-B]	Total Uncert +/-	S22 PHASE (deg) Factory Meas'd [A]	User Meas'd [B]	Diff Phase [A-B]	Total Uncert +/-
1.500	.01317	.01115	.00202	.01234	91.87	98.59	-6.72 N	58.38
2.000	.01503	.01219	.00284	.01235	70.02	70.03	-.01 N	50.33
3.000	.01791	.01492	.00299	.01709	32.89	31.51	1.39 N	61.87
4.500	.02306	.01782	.00523	.01776	-5.84	-12.63	6.79 N	47.85
6.000	.02290	.01533	.00756	.01776	-47.38	-58.99	11.61 N	48.53
7.500	.02100	.01516	.00584	.01774	-89.14	-86.16	-2.98 N	53.75
8.000	.02056	.01220	.00836	.01774	-104.17	-105.72	1.55 N	55.16
9.000	.01887	.01441	.00446	.02124	-131.76	-108.12	-23.64 N	80.20
10.500	.01994	.02020	-.00026	.02125	-169.07	-139.57	-29.49 N	73.77
12.000	.02107	.02779	-.00672	.02125	163.47	-171.06	-25.47 N	68.65
13.500	.02398	.03423	-.01025	.02127	138.67	147.41	-8.74 N	58.77
15.000	.02981	.03684	-.00703	.02131	116.06	109.97	6.09 N	46.65
16.500	.03383	.03351	.00032	.02134	94.42	69.98	24.44 N	41.41
[illegible]	.03520	.02459	.01061	.02135	70.96	44.07	26.88 N	40.17
19.500	.03494	[illegible]	.02157 F	.02134	51.79	[illegible]	2.60 N	40.79
20.000	.03354	[illegible]	[illegible]	.02133	49.02	45.60	3.42 N	42.53
[illegible]	.03092	.01839	.01253	.03703	36.25	58.79	-22.54 N	180.00
22.500	.03244	.02986	.00258	.03787	26.45	35.22	-8.77 N	180.00
24.000	.03524	.03913	-.00390	.03792	6.22	-2.29	8.51 N	84.45
25.500	.03858	.03636	.00222	.03799	-23.62	-35.31	11.69 N	72.72
26.500	.03829	.04705	-.00876	.03802	-52.04	-87.63	35.58 N	73.81

(2) (3)

NOTE: Total Uncert = Factory System Uncertainty + User System Uncertainty.

(4) Legend: N -- Parameter Verification Not Required.
F -- Parameter Verification failed.

(5) FAILED: S22 Verification Measurement of the 20 dB Attenuator.

NOTES:

1 Measurement parameter: S22 magnitude and phase
2 Difference between the factory measurement and the verification measurement is more than the total uncertainty (the system failed verification)
3 Difference between the phase measured at the factory and the phase measured in the verification is not required for this measurement parameter (or for S11)
4 Definitions for any annotation that appears next to the measurement differences
5 Result of the performance verification measurement

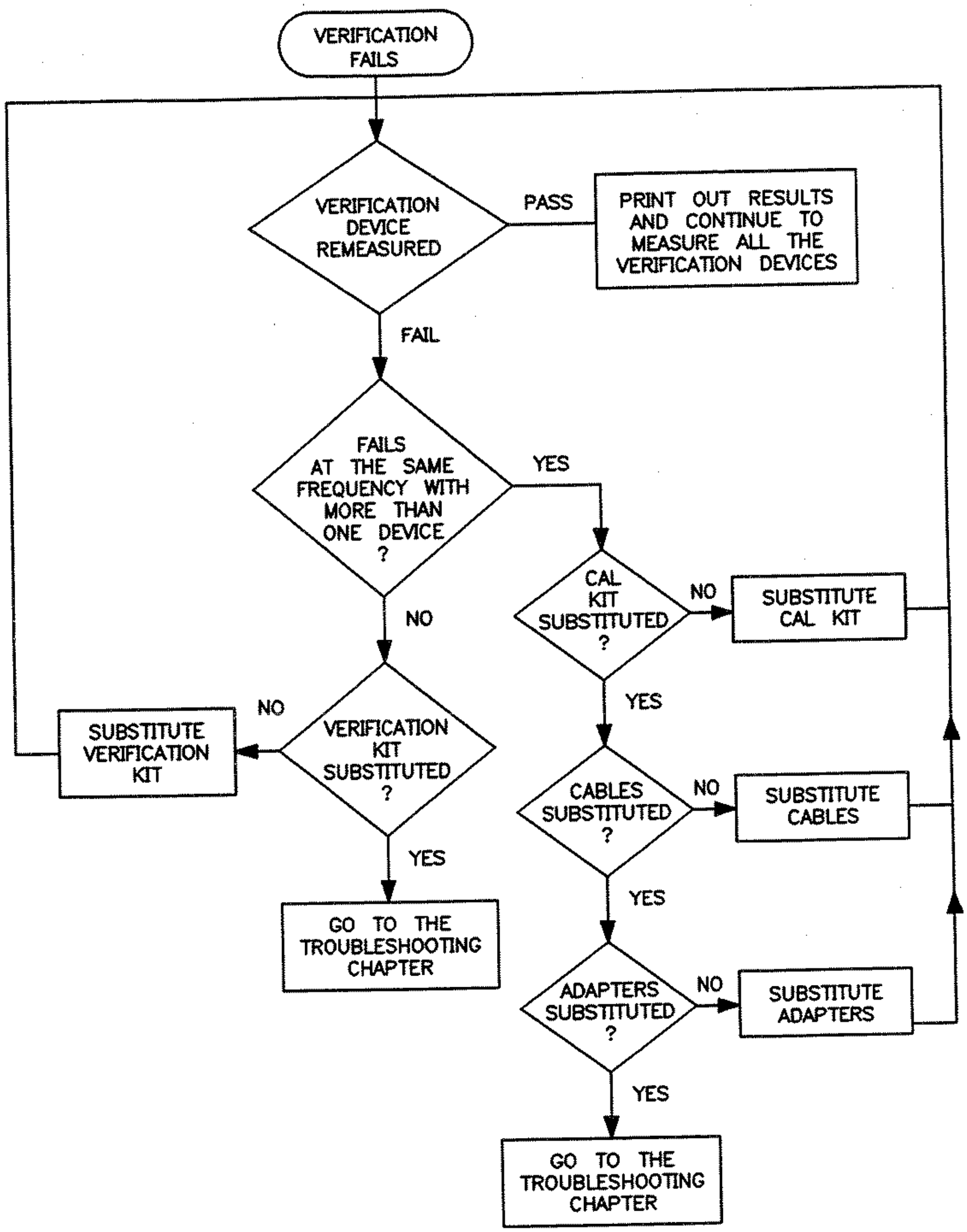
Example 8–4. Performance Verification (S22 Measurement)

If the System Fails Performance Verification

- Disconnect and reconnect the device that failed the verification. Then remeasure the device.

If the performance verification still fails:

- Continue to measure the rest of the verification devices and print out the results of all four measurement parameters.
- Print the error terms and examine them for anomalies near the failure frequencies. (Refer to "Error Terms" in the "Troubleshooting" chapter in this manual.)
- Make another measurement calibration and follow the flow chart on the following page.
- Verify that the data disk from the verification kit is for an HP 8510 and not for an HP 8720.


VERIFICATION FAILS
VERIFICATION DEVICE REMEASURED
PASS
PRINT OUT RESULTS AND CONTINUE TO MEASURE ALL THE VERIFICATION DEVICES
FAIL
FAILS AT THE SAME FREQUENCY WITH MORE THAN ONE DEVICE ?
YES
NO
CAL KIT SUBSTITUTED ?
NO
SUBSTITUTE CAL KIT
YES
VERIFICATION KIT SUBSTITUTED ?
NO
SUBSTITUTE VERIFICATION KIT
YES
GO TO THE TROUBLESHOOTING CHAPTER
CABLES SUBSTITUTED ?
NO
SUBSTITUTE CABLES
YES
ADAPTERS SUBSTITUTED ?
NO
SUBSTITUTE ADAPTERS
YES
GO TO THE TROUBLESHOOTING CHAPTER

HOW TO RUN THE SYSTEM SPECIFICATIONS AND UNCERTAINTIES PROGRAM

The figure below shows a menu map of the system specifications and uncertainties program. Step-by-step instructions follow.

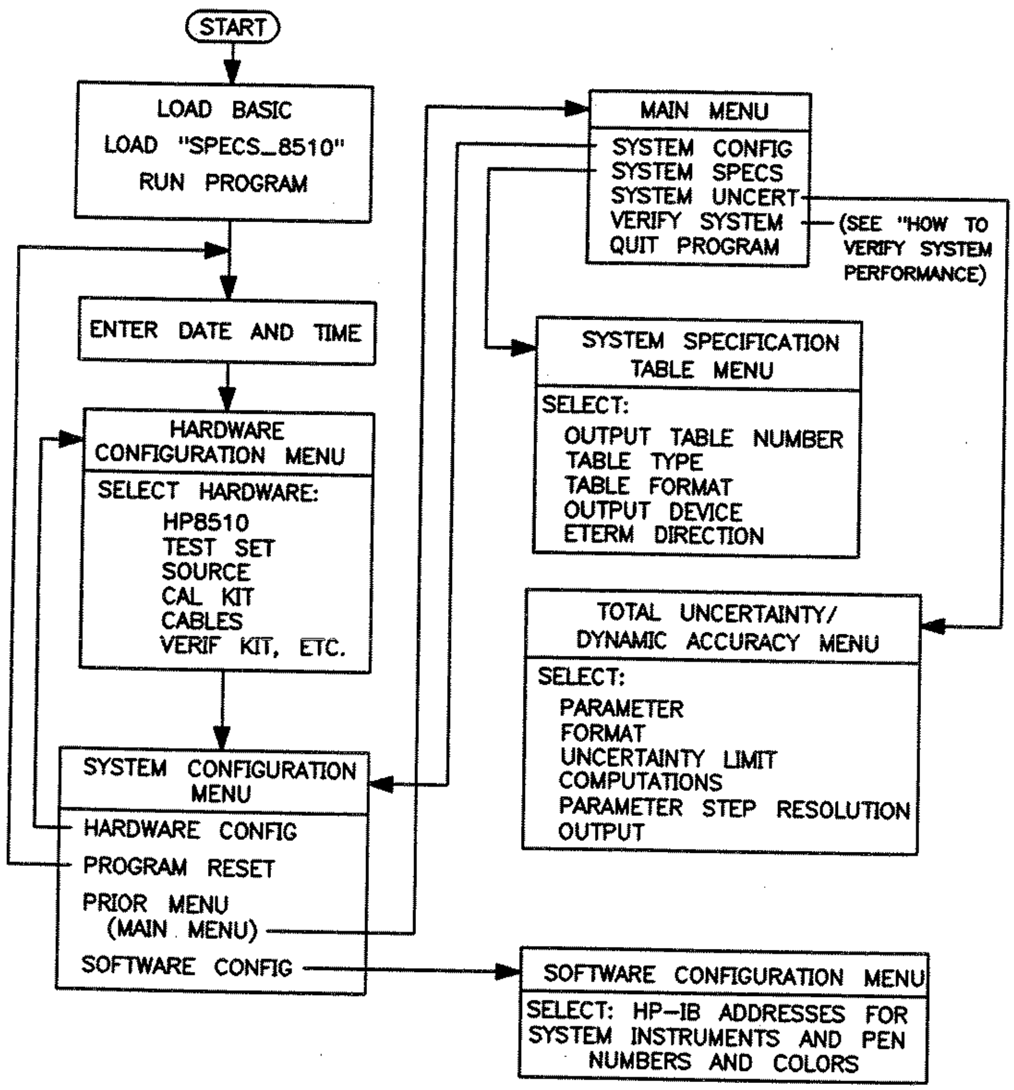


Figure 8-16. Menu Map of System Specifications and Uncertainties Program

1. Perform the "How to Load the Software" procedure located earlier in this chapter.

2. To specify which type of system specifications you want to generate, press:

   [System Specs]

The active (highlighted) window is used to choose the following:

- The table you want
- The type of table: data sheet or specifications
- The table format: linear or dB
- The output device: CRT or printer
- The Eterm direction: forward, reverse, or forward/reverse

The data sheet table is identical to the specifications table except that the cable stability errors and system drift errors are excluded. The tables can be generated in two different modes:

CORRECTION ON (after measurement calibration). These system specifications are values based upon residual errors after a measurement calibration (as specified in the configuration menu by the type of calibration and calibration kit used). These errors are the "effective" system errors.

CORRECTION OFF (uncalibrated). These system specifications are values based on the same system configuration but without a measurement calibration. These errors are the "raw" system errors.

3. Press the ***[Next]*** or ***[Previous]*** softkeys to change the selection in the window.

   For example, if you select ***[All Tables]***, ***[Specifications]***, ***[dB]***, and ***[CRT]*** and press the ***[Done]*** softkey, the controller CRT will quickly display or scroll through the system specifications (as explained in "Reference Information for Performance Verification and Specifications" later in this chapter). You can temporarily pause the printing that goes to the CRT by pressing any key on the keyboard. To continue printing again, press any key.

4. Make the selections you want and press the ***[Print]*** softkey to print them out.

5. Press ***[Prior Menu]*** to return to the main menu.

6. To print or plot dynamic accuracy or total uncertainty for the system configuration specified, press ***[System Uncert]***. These specifications are available as plots or tables, based on data sheet or system specification values with upper or lower limits (explained in "Reference Information for Performance Verification and Specifications" later in this chapter).

   Dynamic accuracy errors are a function of signal power level and are calculated and included as a component of the total uncertainty calculation. They can be described as follows: the down-converted RF signal passes through the HP 85102 IF detector, and is either attenuated or amplified in order to be further down-converted and processed for display. Because of this, the signal has some magnitude and phase inaccuracies that vary with signal levels. By plotting the dynamic accuracy specifications of your system, you can see how dynamic accuracy changes with power level.

Dynamic accuracy or total system uncertainty values (with correction ON) are calculated using equations derived from a flowgraph model of the measurement system. Therefore, total uncertainty can be described as a computation of all the residual errors that affect your measurement.

NOTE: Total measurement uncertainty is also highly dependent on the device being measured. For the purpose of the uncertainty plots, the following ideal device assumptions are made.

For S11 and S22 uncertainties, the device is a one-port device, therefore the value of S21 and S12 are $-\infty$ dB. The value of S11 or S22 is varied.

For S21 and S12 uncertainties, the device is a reciprocal two-port device with perfect input/output match, therefore S11 and S22 are ϕ (linear) and S21=S12. The value of S21 or S12 is varied. For phase uncertainty calculations, an arbitrary length (of 10 cm) is assumed. If your device is longer than 10 cm, your phase uncertainty will be greater than the value shown. Likewise, if your device length is shorter than 10 cm, your phase uncertainty will be less than the value shown.

For system performance verification, the S-parameters of the verification standards measured at the factory are used in the actual uncertainty calculations.

NOTE: At any time, you can return to the hardware configuration menu and change any of the items. For example, if you change calibration kits you can print out the specifications for the same system with the different calibration kit and compare the results.

7. Make the menu selections you want and press the ***[Done]*** softkey when finished. The same keys used in the system specs menu are used to select and toggle the selections in this menu.

The program computes the values and the controller beeps each time the values for a particular frequency band are completed.

The table or plot appears on the controller CRT with a softkey selection for sending the display to the printer or plotter.

NOTE: If you want to run the performance verification on your system, keep the program running and refer to "How to Run Verify System Performance" earlier in this chapter. If you want to exit the program, press the ***[Quit Program]*** key in the main menu.

The examples that follow are explanations of typical tables and plots generated by this program.

INTERPRETING THE SPECIFICATION AND UNCERTAINTIES PRINTOUTS

Example printouts are used to explain the various information included. Refer to the system error model later in this chapter for the association of the error terms with the system error flow graph.

```
(1)----- System Specifications -- Residual Errors (Correction ON)
===========================================================================
         Network Analyzer:           HP8510B -- Enhanced Model
(2)----- Test Set:                   HP8516A003 -- 2.4mm S-Parameter (45MHz-40GHz)
         Source:                     HP836X016 -- 836X & 8516 Synth. (10MHz-40GHz)      (6)
         Calibration Kit:            HP85056A -- 2.4mm Slotless Standard Grade
         Calibration Technique:      SL -- Sliding Load Cal
         Test Port Cables:           HP85133D -- pair short cables (2.4mm-2.4mm)
===========================================================================
                                         |Eterm |        Frequency (GHz) ------------(7)
         Description Of Error Term       |Symbl | .045-2    2-20     20-36    36-40
===========================================================================
(3)----- Power of Source            (dBm) |Ps    |  -3.15    -3.31    +4.77   +32.00
         Power Slope of Source/Freq-ghz (dB) |Pssf |    .28      .36      .13     -.63
         AVeraGing factor             (x1) |Avg   |   1024     1024     1024     1024
         Loss of Attenuator 1         (dB) |La1   |   0.00     0.00     0.00     0.00
         Loss of Attenuator 2         (dB) |La2   |   0.00     0.00     0.00     0.00
         Cable Flex Factor           (Lin) |Cff   | 1.0000   1.0000   1.0000   1.0000
         Drift in Room Temperature (deg C) |Drt   | 1.0000   1.0000   1.0000   1.0000
         ----------------------------------|------|-------------------------------
         Effective Fwd Directivity    (dB) |Efd   | -41.90   -41.90   -37.90   -37.90
         Effective Fwd Refl tracking (+/-dB) |Efr |  .0014    .0082    .0201    .0201
         Effective Fwd Source match   (dB) |Efs   | -41.40   -37.90   -33.00   -33.00
         Effective Fwd Crosstalk      (dB) |Efc   |-120.56  -111.95   -98.10   -86.91
(4)      Effective Fwd Trans tracking (+/-dB) |Eft |  .0453    .0569    .1352    .1381
         Effective Fwd Load match     (dB) |Efl   | -41.90   -41.90   -37.90   -37.90
         ----------------------------------|------|-------------------------------
         Effective Fwd Noise on Trace (+/-dB) |Efnt |  .0009    .0013    .0052    .0086
         Effective Fwd Noise Floor    (dB) |Efnf  | -99.31   -98.70   -77.15   -66.46
         ----------------------------------|------|-------------------------------
         Effective Power Ref (out) port1 (dBm) |Epr1 | -11.32  -13.26   -15.71   -25.61
         Effective Power maX (in) port2 (dBm) |Epx2 |  -5.88     +.28     -.31     +.48
(5)      Effective Power miN (in) port2 (dBm) |Epn2 |-110.59  -103.93   -92.83   -92.03
         ----------------------------------|------|-------------------------------
         Effective Dyn Rng (Ref-min) pt2 (dB) |Edrr2 |  99.28    90.67    77.12    66.42
         Effective Dyn Rng (maX-min) pt2 (dB) |Edrx2 | 104.72   104.22    92.52    92.51
===========================================================================
```

NOTES:

1 Table type: specifications of residual errors (error terms left after a measurement calibration).
2 The system instruments, calibration kit, and calibration technique (selected in the hardware configuration menu) that the specifications have been generated for.
3 Conditions of the system that the specifications are based on.
4 The systematic residual errors.
5 The typical reference power at port 1, maximum power at port 2, minimum power at port 2, and dynamic range
6 The symbol for the error terms, that is used in the system error model located later in this chapter.
7 The specifications are generated for each frequency band.

Example 8-5. Residual Errors

(1) System Specifications -- Test Port Errors (Correction OFF)

(2)

Network Analyzer:	HP8510B -- Enhanced Model
Test Set:	HP8516A003 -- 2.4mm S-Parameter (45MHz-40GHz)
Source:	HP836X016 -- 836X & 8516 Synth. (10MHz-40GHz)
Calibration Kit:	HP85056A -- 2.4mm Slotless Standard Grade
Calibration Technique:	SL -- Sliding Load Cal
Test Port Cables:	HP85133D -- pair short cables (2.4mm-2.4mm)

Description Of Error Term		:Eterm :Symbl	Frequency (GHz) .045-2	2-20	20-36	36-40
Drift Source Frequency	(+/-GHz)	:Dsf	0.000	0.000	0.000	0.000
(3) Raw Fwd Directivity	(dB)	:Rfd	-14.00	-7.00	-7.00	7.00
Raw Fwd Reflection tracking	(+/-dB)	:Rfr	27.0000	9.0000	11.0000	19.0000
Raw Fwd Source match	(dB)	:Rfs	-10.00	-10.00	-7.00	6.50
Raw Fwd Crosstalk	(dB)	:Rfc	-85.00	-85.00	-72.00	-65.00
Raw Fwd Transmission tracking	(+/-dB)	:Rft	19.0000	16.0000	12.0000	14.0000
Raw Fwd Load match	(dB)	:Rfl	-10.00	-10.00	-7.00	-7.00
low Freq Cutoff Source to port1	(GHz)	:Fcs1	0.000	0.000	0.000	0.000
(4) low Freq Slope Source to port1	(dB)	:Fss1	0.00	0.00	0.00	0.00
Loss/Dc Source to port1	(dB)	:Lds1	-7.61	-6.94	6.47	11.80
Loss/sqr(F-ghz) Source to port1	(dB)	:Lfs1	-1.24	-1.72	-4.71	-22.27
Drift Mag/deg-c Src to port1	(+/-dB)	:Dms1	0.0000	0.0000	0.0000	0.0000
Drift Ph/deg-c Src to port1	(+/-deg)	:Dps1	.1518	.1518	.1518	.1518
Drift Ph/deg-c/F-ghz Src-pt1	(+/-deg)	:Dpfs1	.0146	.0146	.0146	.0146
Connector Repeat Refl port1	(dB)	:Crr1	-75.00	-68.00	-62.00	-62.00
Connector Repeat Trans port1	(dB)	:Crt1	-75.00	-68.00	-62.00	-62.00
Connector Repeat Refl port2	(dB)	:Crr2	-75.00	-68.00	-62.00	-62.00
Connector Repeat Trans port2	(dB)	:Crt2	-75.00	-68.00	-62.00	-62.00
Loss/Dc port1 Cable	(dB)	:Ld1c	-.19	-.19	-.19	-.19
Loss/sqr(F-ghz) port1 Cable	(dB)	:Lf1c	-.54	-.54	-.54	.54
Cable Refl Mag stab port1	(dB)	:Crm1	-66.60	-54.00	-49.10	-44.50
Cable Trns Mag stab port1	(+/-dB)	:Ctm1	.0010	.0019	.0042	.0041
Cable Ph/F-ghz stab pt1	(+/-deg/GHz)	:Cpf1	.0235	.0121	.0118	.0123
Loss/Dc port2 Cable	(dB)	:Ld2c	-.19	-.19	.19	-.19
Loss/sqr(F-ghz) port2 Cable	(dB)	:Lf2c	-.54	-.54	-.54	-.54
Cable Refl Mag stab port2	(dB)	:Crm2	-66.60	-54.00	-49.10	-44.50
Cable Trns Mag stab port2	(+/-dB)	:Ctm2	.0010	.0019	.0042	.0041
Cable Ph/F-ghz stab pt2	(+/-deg/GHz)	:Cpf2	.0235	.0121	.0118	.0123

NOTES:

1 Table type: specifications of raw errors associated with the test ports.
2 The system instruments, calibration kit, and calibration technique (selected in the hardware configuration menu) that the specifications have been generated for.
3 The systematic error terms without measurement calibration including the drift, connector, and cable error terms.
4 The symbol for the error terms, that is used in the system error model located later in this chapter.

NOTE: Refer to the system error model later in this chapter for the association of the error terms with the system error flow graph.

Example 8-6. Raw Test Port Errors

```
(1) ——— System Specifications -- B1 Channel Errors (Correction OFF)
==============================================================================
    Network Analyzer:             HP8510B -- Enhanced Model
    Test Set:                     HP8516A003 -- 2.4mm S-Parameter (45MHz-40GHz)
    Source:                       HP836X016 -- 836X & 8516 Synth. (10MHz-40GHz)
(2) Calibration Kit:              HP85056A -- 2.4mm Slotless Standard Grade
    Calibration Technique:        SL -- Sliding Load Cal
    Test Port Cables:             HP85133D -- pair short cables (2.4mm-2.4mm)
==============================================================================
                                          :Eterm :          Frequency (GHz)
    Description Of Error Term             :Symbl : .045-2    2-20    20-36    36-40
==============================================================================
(3) low Freq Cutoff port1 to B1    (GHz) :Fclb1 :   .950    .950     .950     .950
    low Freq Slope port1 to B1      (dB) :Fslb1 :  -6.00   -6.00    -6.00    -6.00
    -------------------------------------:------:-------------------------------
    Drift Mag/deg-c port1 to B1   (+/-dB) :Dmtb1 :  .0403   .0403    .0403    .0403
    Drift Ph/deg-c port1 to B1   (+/-deg) :Dptb1 : 0.0000  0.0000   0.0000   0.0000
    Drift Ph/deg-c/F-ghz pt1-B1  (+/-deg) :Dpftb1: 0.0000  0.0000   0.0000   0.0000
    -------------------------------------:------:-------------------------------
(4) Loss/Dc port1 to convertor B1   (dB) :Ldlb1 : -14.71  -14.54   -14.59    47.25
    Loss/sqr(F-ghz) port1 to conv B1 (dB) :Lflb1 :   -.15    -.27     -.26   -10.57
    Loss/Dc conVertor to I.f. B1    (dB) :Ldvib1:  -4.03   -3.28   -11.50   -12.00
    Loss/Freq-ghz conV to I.f. B1   (dB) :Lfvib1:    .77    -.06     0.00     0.00
    -------------------------------------:------:-------------------------------
    Damage Level B1                (dBm) :Dlb1  : +17.00  +17.00   +17.00   +17.00
    Pwr at Conv for 0.1 db Comp B1 (dBm) :Pccb1 : -10.00  -10.00   -15.00   -15.00
    -------------------------------------:------:-------------------------------
    Raw rms Noise on Trace B1     (+/-dB) :Rntb1 :  .0070   .0090    .0360    .0360
    Raw rms Noise Floor B1 I.f.    (dBm) :Rnfbi1:-800.00 -800.00  -800.00  -800.00
    Raw rms Noise Floor B1 Conv    (dBm) :Rnfblc:-100.30 -101.20  -101.50  -102.00
    -------------------------------------:------:-------------------------------
    REsiduals of B1 I.f.           (dBm) :Rebli :-140.00 -140.00  -140.00  -140.00
    REsiduals of B1 Conv           (dBm) :Reblc :-800.00 -800.00  -800.00  -800.00
    Linearity of Xtal B1          (+/-dB) :Lxb1  :  .0030   .0030    .0030    .0030
    -------------------------------------:------:-------------------------------
    i.f. Gain Err1 -34>-46 dbm B1 (+/-dB) :Ge1b1 :  .0050   .0050    .0050    .0050
    i.f. Gain Err2 -46>-58 dbm B1 (+/-dB) :Ge2b1 :  .0100   .0100    .0100    .0100
    i.f. Gain Err3 -58>-70 dbm B1 (+/-dB) :Ge3b1 :  .0150   .0150    .0150    .0150
    i.f. Gain Err4 -70>-oo dbm B1 (+/-dB) :Ge4b1 :  .0250   .0250    .0250    .0250
    -------------------------------------:------:-------------------------------
    Mag error vs Phase shift B1   (+/-dB) :Mpb1  :  .0030   .0030    .0030    .0030
==============================================================================
```

NOTES:

1. Table type: specifications of raw errors associated with the B1 channel signal path
2. The system instruments, calibration kit, and calibration technique (selected in the hardware configuration menu) that the specifications have been generated for.
3. These specifications refer to the errors contributed by the test set from the test port, through the coupler, and into the sampler (down-converter). The tables show values that are already included in the calculations for system specifications. Their use is limited to inspecting the flowgraph error terms that exist between the coupler or bridge and the sampler.
4. The symbol for the error terms, that is used in the system error model located later in this chapter.

NOTE: Refer to the system error model later in this chapter for the association of the error terms with the system error flow graph.

Example 8-7. Raw B1 Channel Errors

(1) System Specifications -- B2 Channel Errors (Correction OFF)

(2)

Network Analyzer:	HP8510B -- Enhanced Model
Test Set:	HP8516A003 -- 2.4mm S-Parameter (45MHz-40GHz)
Source:	HP836X016 -- 836X & 8516 Synth. (10MHz-40GHz)
Calibration Kit:	HP85056A -- 2.4mm Slotless Standard Grade
Calibration Technique:	SL -- Sliding Load Cal
Test Port Cables:	HP85133D -- pair short cables (2.4mm-2.4mm)

Description Of Error Term		Eterm Symbl	Frequency (GHz) .045-2	2-20	20-36	36-40
(3) low Freq Cutoff port2 to B2	(GHz)	Fc2b2	0.000	0.000	0.000	0.000
low Freq Slope port2 to B2	(dB)	Fs2b2	0.00	0.00	0.00	0.00
Drift Mag/deg-c port2 to B2	(+/-dB)	Dm2b2	.0475	.0475	.0475	.0475
Drift Ph/deg-c port2 to B2	(+/-deg)	Dp2b2	0.0000	0.0000	0.0000	0.0000
Drift Ph/deg-c/F-ghz pt2-B2	(+/-deg)	Dpf2b2	0.0000	0.0000	0.0000	0.0000
(4) Loss/Dc port2 to convertor B2	(dB)	Ld2b2	-3.65	-3.42	2.79	.24
Loss/sqr(F-ghz) port2 to conv B2	(dB)	Lf2b2	-.79	-.95	-2.25	-1.32
Loss/Dc conVertor to I.f. B2	(dB)	Ldvib2	-4.03	-3.28	-11.50	-12.00
Loss/Freq-ghz conV to I.f. B2	(dB)	Lfvib2	.77	-.06	0.00	0.00
Damage Level B2	(dBm)	Dlb2	+13.00	+13.00	+13.00	+13.00
Pwr at Conv for 0.1 db Comp B2	(dBm)	Pccb2	-10.00	-10.00	-15.00	-15.00
Raw rms Noise on Trace B2	(+/-dB)	Rntb2	.0070	.0090	.0360	.0360
Raw rms Noise Floor B2 I.f.	(dBm)	Rnfb2i	-800.00	-800.00	-800.00	-800.00
Raw rms Noise Floor B2 Conv	(dBm)	Rnfb2c	-101.20	-101.20	-101.50	-102.00
REsiduals of B2 I.f.	(dBm)	Reb2i	-140.00	-140.00	-140.00	-140.00
REsiduals of B2 Conv	(dBm)	Reb2c	-800.00	-800.00	-800.00	-800.00
Linearity of Xtal B2	(+/-dB)	Lxb2	.0030	.0030	.0030	.0030
i.f. Gain Err1 -34>-46 dbm B2	(+/-dB)	Ge1b2	.0050	.0050	.0050	.0050
i.f. Gain Err2 -46>-58 dbm B2	(+/-dB)	Ge2b2	.0100	.0100	.0100	.0100
i.f. Gain Err3 -58>-70 dbm B2	(+/-dB)	Ge3b2	.0150	.0150	.0150	.0150
i.f. Gain Err4 -70>-oo dbm B2	(+/-dB)	Ge4b2	.0250	.0250	.0250	.0250
Mag error vs Phase shift B2	(+/-dB)	Mpb2	.0030	.0030	.0030	.0030

NOTES:

1 Table type: specifications of raw errors associated with the B2 channel signal path.

2 The system instruments, calibration kit, and calibration technique (selected in the hardware configuration menu) that the specifications have been generated for.

3 These specifications refer to the errors contributed by the test set from the test port, through the coupler, and into the sampler (down-converter). The tables show values that are already included in the calculations for system specifications. Their use is limited to inspecting the flowgraph error terms that exist between the coupler or bridge and the sampler.

4 The symbol for the error terms, that is used in the system error model located later in this chapter.

NOTE: Refer to the system error model later in this chapter for the association of the error terms with the system error flow graph.

Example 8-8. Raw B2 Channel Errors

```
(1)  System Specifications -- A1 Channel Errors (Correction OFF)
     ================================================================================
     Network Analyzer:          HP8510B -- Enhanced Model
     Test Set:                  HP8516A003 -- 2.4mm S-Parameter (45MHz-40GHz)
(2)  Source:                    HP836X016 -- 836X & 8516 Synth. (10MHz-40GHz)
     Calibration Kit:           HP85056A -- 2.4mm Slotless Standard Grade
     Calibration Technique:     SL -- Sliding Load Cal
     Test Port Cables:          HP85133D -- pair short cables (2.4mm-2.4mm)
     ================================================================================
                                           :Eterm :        Frequency (GHz)
     Description Of Error Term             :Symbl : .045-2    2-20    20-36   36-40
     ================================================================================
     low Freq Cutoff Source to A1    (GHz) :Fcsa1 :  0.000   0.000   0.000   0.000
(3)  low Freq Slope source to A1      (dB) :Fsse1 :   0.00    0.00    0.00    0.00
     --------------------------------------:------:----------------------------------
     Drift Mag/deg c Source to A1  (+/-dB) :Dmsa1 :  .0403   .0403   .0403   .0403
(4)  [illegible]                           :Dpsa1 :  .1518   .1518   .1518   .1518
     Drift Ph/deg-c/F-ghz Src-A1  (+/-deg) :Dpfsa1:  .0146   .0146   .0146   .0146
     --------------------------------------:------:----------------------------------
     Loss/Dc Source to A1             (dB) :Ldsa1 : -26.47  -25.87  -26.24   21.35
     Loss/sqr(F-ghz) Source to A1     (dB) :Lfsa1 :   -.48    -.90    -.82   -8.75
     Loss/Dc conVertor to I.f. A1     (dB) :Ldvia1:  -4.03   -3.28  -11.50  -12.00
     Loss Freq-ghz conV to I.f. A1    (dB) :Lfvia1:    .77    -.06    0.00    0.00
     --------------------------------------:------:----------------------------------
     Damage Level A1                 (dBm) :Dla1  : +20.00  +20.00  +20.00  +20.00
     Pwr at Conv for 0.1 db Comp A1  (dBm) :Pcca1 : -10.00  -10.00  -15.00  -15.00
     --------------------------------------:------:----------------------------------
     Raw rms Noise on Trace A1     (+/-dB) :Rnta1 :  .0070   .0090   .0360   .0360
     Raw rms Noise Floor A1 I.f.     (dBm) :Rnfai:-800.00 -800.00 -800.00 -800.00
     Raw rms Noise Floor A1 Conv     (dBm) :Rnfac:-101.20 -101.20 -101.50 -102.00
     --------------------------------------:------:----------------------------------
     REsiduals of A1 I.f.            (dBm) :Reai :-140.00 -140.00 -140.00 -140.00
     REsiduals of A1 Conv            (dBm) :Reac :-800.00 -800.00 -800.00 -800.00
     Linearity of Xtal A1          (+/-dB) :Lxa1  :  .0030   .0030   .0030   .0030
     --------------------------------------:------:----------------------------------
     I.f. Gain Err1 -34 -46 dbm A1 (+/-dB) :Ge1a1 :  .0050   .0050   .0050   .0050
     I.f. Gain Err2 -46 -58 dbm A1 (+/-dB) :Ge2a1 :  .0100   .0100   .0100   .0100
     I.f. Gain Err3 -58 -70 dbm A1 (+/-dB) :Ge3a1 :  .0150   .0150   .0150   .0150
     I.f. Gain Err4 -70 -oo dbm A1 (+/-dB) :Ge4a1 :  .0250   .0250   .0250   .0250
     --------------------------------------:------:----------------------------------
     Mag error vs Phase shift A1   (+/-dB) :Mpa1  :  .0030   .0030   .0030   .0030
     ================================================================================
```

NOTES:

1 Table type: specifications of raw errors associated with the A1 channel signal path.
2 The system instruments, calibration kit, and calibration technique (selected in the hardware configuration menu) that the specifications have been generated for.
3 These specifications refer to the errors contributed from the source to the A1 sampler signal path. The tables show values that are already included in the system specifications.
4 The symbol for the error terms, that is used in the system error model located later in this chapter.

NOTE: Refer to the system error model later in this chapter for the association of the error terms with the system error flow graph.

Example 8-9. Raw A1 Channel Errors

(1) System Specifications -- A2 Channel Errors (Correction OFF)

(2)

Network Analyzer:	HP8510B -- Enhanced Model
Test Set:	HP8516A003 -- 2.4mm S-Parameter (45MHz-40GHz)
Source:	HP836X016 -- 836X & 8516 Synth. (10MHz-40GHz)
Calibration Kit:	HP85056A -- 2.4mm Slotless Standard Grade
Calibration Technique:	SL -- Sliding Load Cal
Test Port Cables:	HP85133D -- pair short cables (2.4mm-2.4mm)

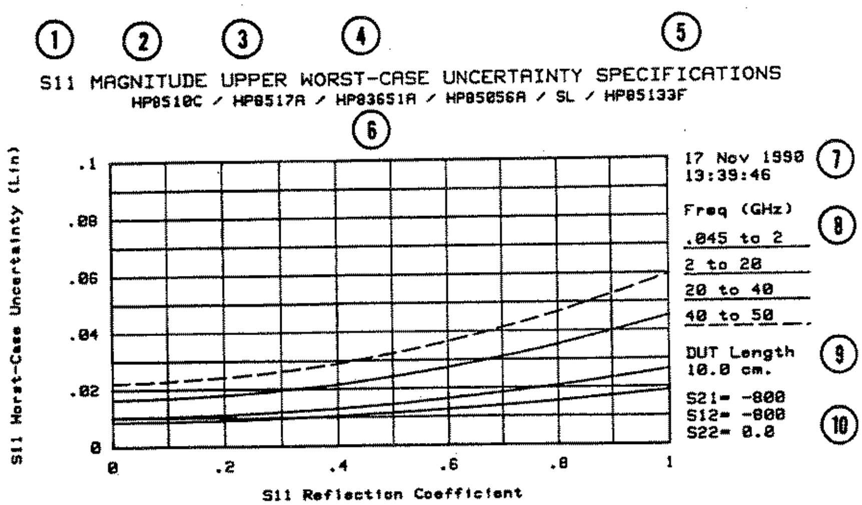
(3) (4)

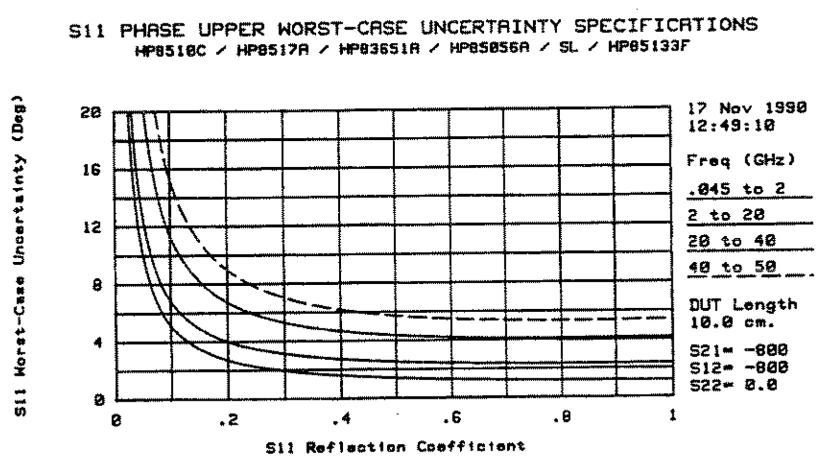
Description Of Error Term		Eterm Symbl	Frequency (GHz) .045-2	2-20	20-36	36-40
Low Freq Cutoff Source to A2	(GHz)	Fcsa2	0.000	0.000	0.000	0.000
Low Freq Slope source to A2	(dB)	Fssa2	0.00	0.00	0.00	0.00
Drift Mag/deg-c Source to A2	(+/-dB)	Dmsa2	.0475	.0475	.0475	.0475
Drift Ph/deg-c Source to A2	(+/-deg)	Dpsa2	0.0000	0.0000	0.0000	0.0000
Drift Ph/deg-c/f-ghz Src-A2	(+/-deg)	Dpfsa2	.0173	.0173	.0173	.0173
Loss/Dc Source to A2	(dB)	Ldsa2	-26.47	-25.66	-26.21	21.37
Loss-sqrt(f-ghz) Source to A2	(dB)	Lfsa2	-.49	-.92	-.84	-8.77
Loss/Dc converter to I.f. A2	(dB)	Ldvia2	-4.03	-3.28	-11.50	-12.00
Loss/Freq-ghz conV to I.f. A2	(dB)	Lfvia2	.77	-.06	0.00	0.00
Damage Level A2	(dBm)	Dla2	+20.00	+20.00	+20.00	+20.00
Pwr at Conv for 0.1 db Comp A2	(dBm)	Pcca2	-10.00	-10.00	-15.00	-15.00
Raw rms Noise on Trace A2	(+/-dB)	Rnta2	.0070	.0090	.0360	.0360
Raw rms Noise Floor A2 I.f.	(dBm)	Rnfa2i	-800.00	-800.00	-800.00	-800.00
Raw rms Noise Floor A2 Conv	(dBm)	Rnfa2c	-101.20	-101.20	-101.50	-102.00
REsiduals of A2 I.f.	(dBm)	Rea2i	140.00	140.00	-140.00	-140.00
REsiduals of A2 Conv	(dBm)	Rea2c	-800.00	-800.00	-800.00	-800.00
Linearity of Xtal A2	(+/-dB)	Lxa2	.0030	.0030	.0030	.0030
I.f. Gain Err1 34 -46 dbm A2	(+/-dB)	Ge1a2	.0050	.0050	.0050	.0050
I.f. Gain Err2 46 -58 dbm A2	(+/-dB)	Ge2a2	.0100	.0100	.0100	.0100
I.f. Gain Err3 -58 -70 dbm A2	(+/-dB)	Ge3a2	.0150	.0150	.0150	.0150
I.f. Gain Err4 -70 -oo dbm A2	(+/-dB)	Ge4a2	.0250	.0250	.0250	.0250
Mag error vs Phase shift A2	(+/-dB)	Mpa2	.0030	.0030	.0030	.0030

1 Table type: specifications of raw errors associated with the A2 channel signal path.
2 The system instruments, calibration kit, and calibration technique (selected in the hardware configuration menu) that the specifications have been generated for.
3 These specifications refer to the errors contributed from the source to the A2 sampler signal path. The tables show values that are already included in the system specifications.
4 The symbol for the error terms, that is used in the system error model located later in this chapter.

NOTE: Refer to the system error model later in this chapter for the association of the error terms with the system error flow graph.

Example 8-10. Raw A2 Channel Errors





NOTES:

1 Measurement parameter: S11.
2 Data format: magnitude (unitless measurements such as reflection coefficient magnitude or transmission coefficient magnitude) or phase (phase shift of data versus frequency).
3 Uncertainty limits: upper or lower (the limits only apply to transmission measurements).
4 Type of plot: worst-case uncertainties (This is a "field" "bottoms-up" uncertainty analysis of the HP 8510 being verified, using the worst case specifications of the HP 8510 system).
5 Table type: specifications or data sheet (data sheet is identical to the specifications table except that the cable stability errors and system drift errors are excluded).
6 System instruments: selected in the hardware configuration menu.
7 Time and date the plot was made.
8 Data trace patterns for each frequency band.
9 DUT length is assumed to be 10 cm (the DUT length for the data sheet values and for systems using sweepers is 0 cm).
10 For reflection plots (S11 or S22), the values of the other three S-parameters will be = 0 (linear). For transmission plots (S21 or S12), S11 and S22 = 0 (linear), and S21 = S12.

Example 8-11. S11 Uncertainty Specifications Plots

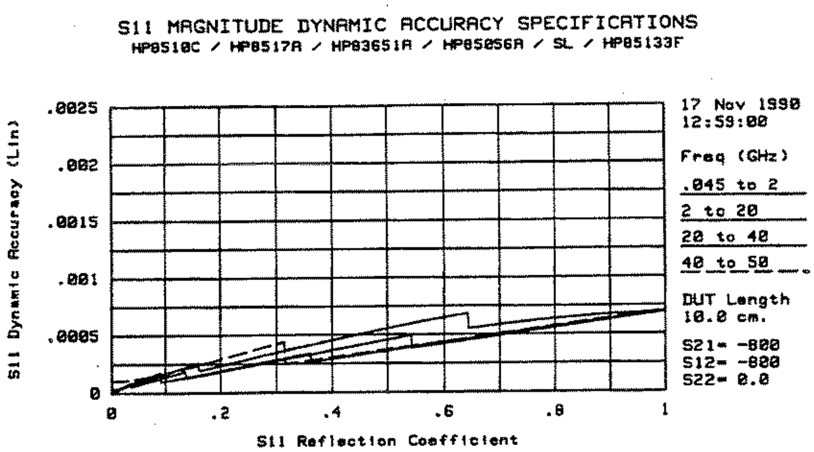
```
S11 UPPER WORST-CASE UNCERTAINTY SPECIFICATIONS
17 Nov 1990  13:13:58
S21= -800,  S12= -800,  S22= 0.0   Device Length= 10.0 cm.
Network Analyzer:          HP8510C -- Color Model
Test Set:                  HP8517A -- 2.4mm S-Parameter (45MHz-50GHz)
Source:                    HP83651A -- Synthesizer (45MHz-50.0GHz)
Calibration Kit:           HP85056A -- 2.4mm Slotless Standard Grade
Calibration Technique:     SL -- Sliding Load Cal
Test Port Cables:          HP85133F -- pair short cables (2.4mm-2.4mm)
```

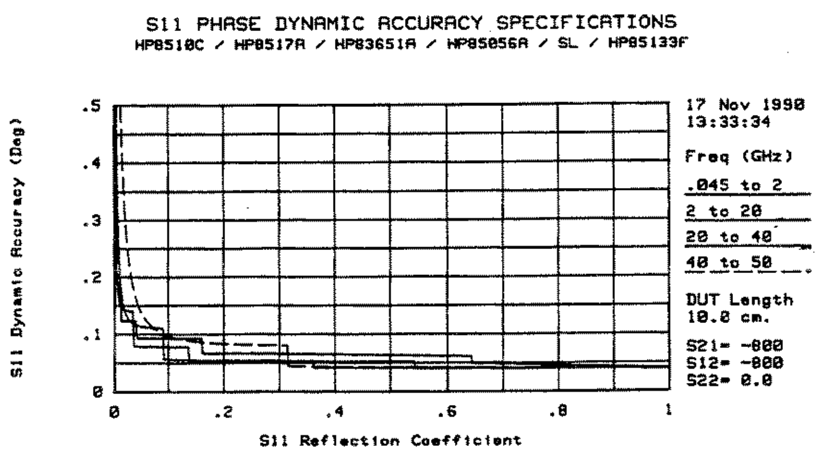
Refl (Lin)	.045-2 (Mag Lin)	.045-2 (Deg)	2-20 (Mag Lin)	2-20 (Deg)	20-40 (Mag Lin)	20-40 (Deg)	40-50 (Mag Lin)	40-50 (Deg)
0.000	.008554	180.000	.010070	180.000	.016344	180.000	.022174	180.000
.050	.008598	10.026	.010172	12.610	.016531	20.899	.022424	28.656
.100	.008709	5.113	.010354	6.812	.016851	11.292	.022848	15.216
.150	.008864	3.498	.010615	4.926	.017307	8.215	.023445	10.999
[illegible]	.009084	2.708	.010947	4.003	.017896	6.722	.024214	8.960
.250	.009357	2.245	.011361	3.468	.018620	5.858	.025156	7.781
.300	.009680	1.946	.011851	3.126	.019477	5.308	.026270	7.039
[illegible]	[illegible]	1.740	.012417	2.894	.020467	4.937	.027543	6.518
.400	.010468	1.592	.013057	2.730	.021582	4.676	.028996	6.161
.450	.010932	1.483	.013771	2.612	.022833	4.491	.030619	5.905
.500	.011441	1.400	.014558	2.526	.024215	4.350	.032411	5.720
.550	.011955	1.332	.015418	2.463	.025726	4.262	.034374	5.586
.600	.012549	1.284	.016348	2.417	.027368	4.195	.036505	5.490
.650	.013187	1.247	.017328	2.382	.029139	4.150	.038805	5.424
.700	.013869	1.219	.018399	2.360	.031039	4.121	.041274	5.382
.750	.014595	1.198	.019539	2.347	.033068	4.107	.043912	5.358
.800	.015364	1.183	.020749	2.340	.035226	4.103	.046718	5.349
.850	.016177	1.173	.022029	2.339	.037512	4.109	.049693	5.353
.900	.017034	1.167	.023378	2.342	.039926	4.122	.052836	5.367
.950	.017934	1.164	.024796	2.349	.042469	4.141	.056147	5.389
1.000	.018878	1.164	.026283	2.359	.045140	4.166	.059626	5.419

NOTES:

1. Measurement parameter: S11.
2. Uncertainty limits: upper or lower (the limits only apply to transmission measurements).
3. Type of plot: worst-case uncertainties (This is a "field" "bottoms-up" uncertainty analysis of the HP 8510 being verified, using the worst case specifications of the HP 8510 system).
4. Table type: specifications or data sheet (data sheet is identical to the specifications table except that the cable stability errors and system drift errors are excluded).
5. Time and date the plot was made.
6. For reflection plots (S11 or S22), the values of the other three S-parameters will be = 0 (linear). For transmission plots (S21 or S12), S11 and S22 = 0 (linear), and S21 = S12.
7. DUT length is assumed to be 10 cm airline (the DUT length for the data sheet values is 0 cm).
8. System instruments: selected in the hardware configuration menu.
9. Reflection coefficient (linear magnitude).
10. Magnitude uncertainty data for each frequency band (linear magnitude).
11. Phase uncertainty data for each frequency band (degrees).

Example 8-12. S11 Uncertainty Specifications Table





Example 8-13. S11 Dynamic Accuracy Specifications Plots

```
S11 DYNAMIC ACCURACY SPECIFICATIONS
17 Nov 1990  13:10:06
S21= 800.  S12= -800.  S22= 0.0   Device Length= 10.0 cm.

Network Analyzer:        HP8510C -- Color Model
Test Set:                HP8517A -- 2.4mm S-Parameter (45MHz-50GHz)
Source:                  HP83651A -- Synthesizer (45MHz-50.0GHz)
Calibration Kit:         HP85056A -- 2.4mm Slotless Standard Grade
Calibration Technique:   SL -- Sliding Load Cal
Test Port Cables:        HP85133F -- pair short cables (2.4mm-2.4mm)
```

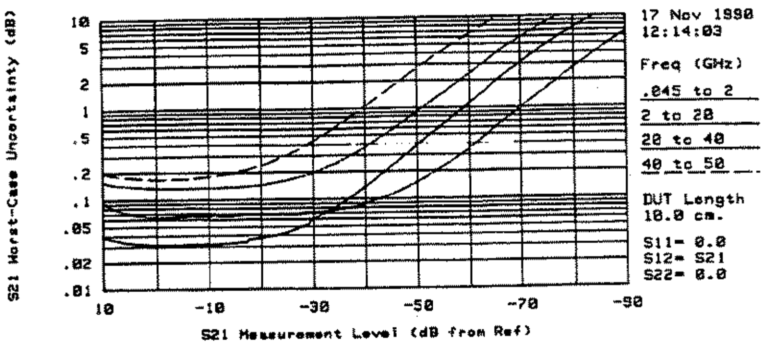
Refl	.045-2 (Mag Lin)	.045-2 (Deg)	2-20 (Mag Lin)	2-20 (Deg)	20-40 (Mag Lin)	20-40 (Deg)	40-50 (Mag Lin)	40-50 (Deg)
0.000	.000011	180.000	.000003	180.000	.000029	180.000	.000099	180.000
.050	.000069	.079	.000081	.093	.000099	.114	.000121	.139
.100	.000106	.072	.000162	.093	.000098	.056	.000169	.097
.150	.000137	.055	.000242	.093	.000143	.055	.000226	.087
.200	.000183	.052	.000274	.067	.000189	.054	.000291	.083
.250	.000223	.052	.000290	.067	.000235	.054	.000356	.082
.300	.000274	.052	.000346	.066	.000281	.054	.000422	.081
[illegible]	.000320	.052	.000401	.066	.000327	.054	.000269	.044
.400	.000365	.052	.000454	.065	.000290	.042	.000303	.043
.450	.000411	.052	.000505	.064	.000325	.041	.000336	.043
.500	.000456	.052	.000555	.064	.000360	.041	.000370	.042
[illegible]	[illegible]	.040	.000602	.063	.000395	.041	.000404	.042
.600	.000421	.040	.000647	.052	.000429	.041	.000438	.042
.650	.000455	.040	.000554	.049	.000464	.041	.000471	.042
.700	.000499	.040	.000503	.048	.000498	.041	.000505	.041
.750	.000523	.040	.000610	.047	.000531	.041	.000539	.041
.800	.000557	.040	.000632	.045	.000564	.040	.000573	.041
.850	.000591	.040	.000652	.044	.000597	.040	.000606	.041
.900	.000625	.040	.000670	.043	.000629	.040	.000639	.041
.950	.000658	.040	.000692	.041	.000661	.040	.000672	.041
1.000	.000691	.040	.000691	.040	.000692	.040	.000705	.040

NOTES:

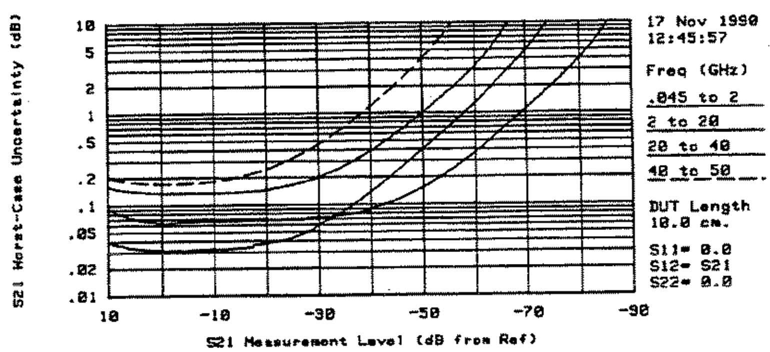
1 Measurement parameter: S11.
2 Type of plot: dynamic accuracy (overall magnitude detection accuracy as a function of levels for signals or arbitrary phase).
3 Table type: specifications or data sheet (data sheet is identical to the specifications table except that the cable stability errors and system drift errors are excluded).
4 Time and date the plot was made.
5 For reflection plots (S11 or S22), the values of the other three S-parameters will be = 0 (linear). For transmission plots (S21 or S12), S11 and S22 = 0 (linear), and S21 = S12.
6 DUT length is assumed to be 10 cm (the DUT length for the data sheet values is 0 cm).
7 System instruments: selected in the hardware configuration menu.
8 Reflection coeffecient (linear magnitude).
9 Magnitude uncertainty data for each frequency band (linear magnitude).
10 Phase data for each frequency band (degrees).

Example 8-14. S11 Dynamic Accuracy Specifications Table

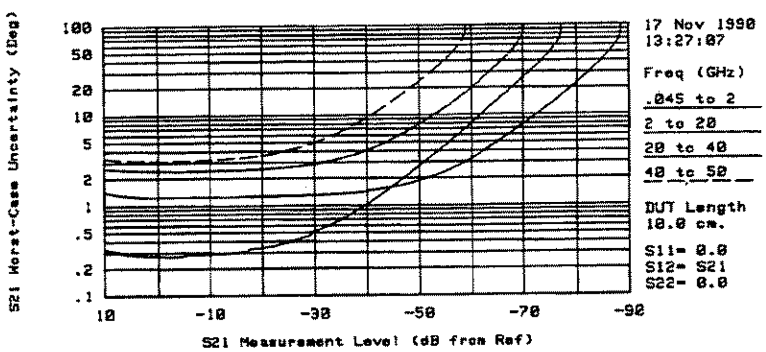
S21 MAGNITUDE UPPER WORST-CASE UNCERTAINTY SPECIFICATIONS
HP8510C / HP8517A / HP83651A / HP85056A / SL / HP85133F



S21 MAGNITUDE LOWER WORST-CASE UNCERTAINTY SPECIFICATIONS
HP8510C / HP8517A / HP83651A / HP85056A / SL / HP85133F



S21 PHASE UPPER WORST-CASE UNCERTAINTY SPECIFICATIONS
HP8510C / HP8517A / HP83651A / HP85056A / SL / HP85133F



Example 8-15. S21 Uncertainty Specifications Plots

S21 UPPER WORST-CASE UNCERTAINTY SPECIFICATIONS

17 Nov 1990 13:16:55

S11= 0.0, S12= S21, S22= 0.0 Device Length= 10.0 cm.

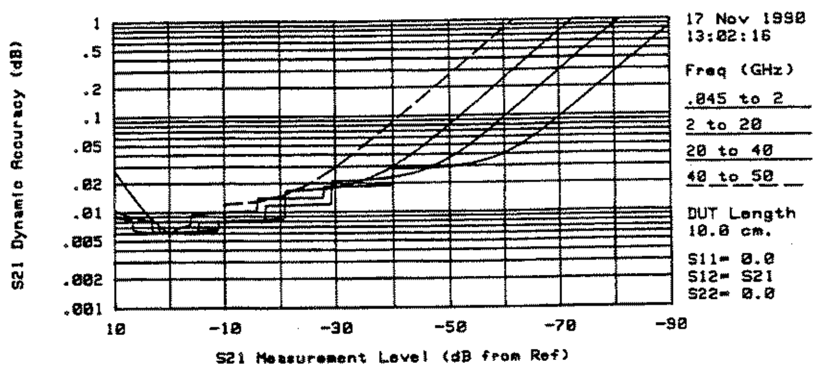
Network Analyzer:	HP8510C -- Color Model
Test Set:	HP8517A -- 2.4mm S-Parameter (45MHz-50GHz)
Source:	HP83651A -- Synthesizer (45MHz-50.0GHz)
Calibration Kit:	HP85056A -- 2.4mm Slotless Standard Grade
Calibration Technique:	SL -- Sliding Load Cal
Test Port Cables:	HP85133F -- pair short cables (2.4mm-2.4mm)

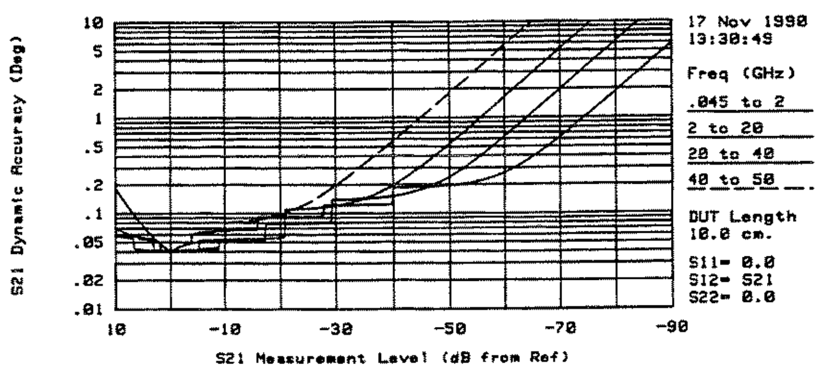
Level (dB)	.045-2 (Mag dB)	.045-2 (Deg)	2-20 (Mag dB)	2-20 (Deg)	20-40 (Mag dB)	20-40 (Deg)	40-50 (Mag dB)	40-50 (Deg)
10.0	.0386	.329	.0927	1.427	.1582	2.598	.2015	3.316
5.0	.0330	.286	.0702	1.278	.1395	2.473	.1752	3.141
0.0	.0314	.276	.0631	1.231	.1332	2.430	.1681	3.096
-5.0	.0312	.276	.0649	1.247	.1322	2.425	.1702	3.115
-10.0	.0322	.290	.0652	1.250	.1336	2.439	.1795	3.185
-15.0	.0331	.301	.0654	1.251	.1367	2.467	.2008	3.336
[illegible]	.0373	.342	.0676	1.275	.1447	2.531	.2399	3.607
-25.0	.0433	.391	.0681	1.281	.1640	2.670	.3115	4.098
-30.0	.0603	.515	.0724	1.319	.1972	2.900	.4390	4.979
-35.0	.0850	.693	.0753	1.351	.2588	3.322	.6620	6.551
-40.0	.1352	1.025	.0910	1.460	.3692	4.079	1.0454	9.357
-45.0	.2242	1.627	.1107	1.597	.5630	5.432	1.6882	14.398
-50.0	.3817	2.706	.1504	1.867	.8980	7.846	2.7258	23.641
-55.0	.6557	4.629	.2241	2.367	1.4639	12.171	4.3111	42.002
-60.0	1.1229	8.065	.3558	3.268	2.3873	20.035	6.5677	180.000
-65.0	1.8966	14.257	.5865	4.879	3.8203	35.129	9.5327	180.000
-70.0	3.1224	25.764	.9830	7.755	5.8995	78.081	13.1367	180.000
-75.0	4.9490	50.296	1.6466	12.921	8.6881	180.000	17.2405	180.000
-80.0	7.4735	180.000	2.7144	22.395	12.1421	180.000	21.6926	180.000
-85.0	10.6918	180.000	4.3394	41.268	16.1343	180.000	26.3687	180.000
-90.0	14.5019	180.000	6.6411	180.000	20.5116	180.000	31.1810	180.000

NOTES:

1 Measurement parameter: S21.
2 Uncertainty limits: upper or lower (the limits only apply to transmission measurements).
3 Type of plot: worst-case uncertainties (This is a "field" "bottoms-up" uncertainty analysis of the HP 8510 being verified, using the worst case specifications of the HP 8510 system).
4 Table type: specifications or data sheet (data sheet is identical to the specifications table except that the cable stability errors and system drift errors are excluded).
5 Time and date the plot was made.
6 For reflection plots (S11 or S22), the values of the other three S-parameters will be = 0 (linear). For transmission plots (S21 or S12), S11 and S22 = 0 (linear), and S21 = S12.
7 DUT length is assumed to be 10 cm (the DUT length for the data sheet values and systems using sweepers is 0 cm).
8 System instruments: selected in the hardware configuration menu.
9 Power level the specifications apply to (dB).
10 Magnitude uncertainty data for each frequency band (dB).
11 Phase uncertainty data for each frequency band (degree).

Example 8-16. S21 Uncertainty Specifications Table





Example 8-17. S21 Dynamic Accuracy Specifications Plots

```
S21 DYNAMIC ACCURACY SPECIFICATIONS
=====================================================================
17 Nov 1990  13:08:57
S11= 0.0,  S12= S21,  S22= 0.0   Device Length= 10.0 cm.
=====================================================================
Network Analyzer:           HP8510C -- Color Model
Test Set:                   HP8517A -- 2.4mm S-Parameter (45MHz-50GHz)
Source:                     HP83651A -- Synthesizer (45MHz-50.0GHz)
Calibration Kit:            HP85056A -- 2.4mm Slotless Standard Grade
Calibration Technique:      SL -- Sliding Load Cal
Test Port Cables:           HP85133F -- pair short cables (2.4mm-2.4mm)
=====================================================================
```

Level (dB)	.045-2 (Mag dB)	.045-2 (Deg)	2-20 (Mag dB)	2-20 (Deg)	20-40 (Mag dB)	20-40 (Deg)	40-50 (Mag dB)	40-50 (Deg)
10.0	.0090	.060	.0278	.184	.0106	.070	.0093	.061
5.0	.0063	.042	.0112	.074	.0085	.056	.0082	.054
0.0	.0060	.040	.0060	.040	.0060	.040	.0061	.040
-5.0	.0061	.040	.0095	.062	.0062	.041	.0064	.042
-10.0	.0079	.052	.0100	.066	.0081	.054	.0068	.045
-15.0	.0080	.053	.0102	.067	.0082	.054	.0128	.085
-20.0	.0118	.078	.0141	.093	.0085	.056	.0147	.097
-25.0	.0119	.079	.0141	.093	.0171	.113	.0195	.128
-30.0	.0212	.140	.0186	.123	.0183	.121	.0298	.197
-35.0	.0217	.143	.0187	.123	.0217	.143	.0500	.331
-40.0	.0230	.152	.0283	.187	.0300	.198	.0869	.576
[illegible]	[illegible]	.178	.0286	.189	.0473	.313	.1528	1.017
-50.0	.0365	.241	.0296	.196	.0804	.532	.2693	1.804
-55.0	.0569	.377	.0326	.215	.1402	.932	.4728	3.207
-60.0	.0961	.638	.0404	.267	.2464	1.649	.8235	5.707
-65.0	.1674	1.115	.0583	.386	.4326	2.927	1.4142	10.184
-70.0	.2939	1.972	.0942	.625	.7545	5.206	2.3746	18.325
-75.0	.5149	3.502	.1606	1.069	1.2990	9.283	3.8574	33.993
-80.0	.8951	6.231	.2793	1.872	2.1904	16.668	5.9954	83.828
-85.0	1.5326	11.127	.4874	3.309	3.5797	30.665	8.8432	180.000
-90.0	2.5624	20.068	.8463	5.874	5.6067	65.084	12.3482	180.000

1 Measurement parameter: S21.
2 Type of plot: dynamic accuracy (overall magnitude detection accuracy as a function of level for signals or arbitrary phase).
3 Table type: specifications or data sheet (data sheet is identical to the specifications table except that the cable stability errors and system drift errors are excluded).
4 Time and date the plot was made.
5 For reflection plots (S11 or S22), the values of the other three S-parameters will be = 0 (linear). For transmission plots (S21 or S12), S11 and S22 = 0 (linear), and S21 = S12.
6 DUT length is assumed to be 10 cm (the DUT length for the data sheet values is 0 cm).
7 System instruments: selected in the hardware configuration menu.
8 Power level the specifications apply to (dB).
9 Magnitude uncertainty data for each frequency band (dB).
10 Phase uncertainty data for each frequency band (degrees).

Example 8-18. S21 Dynamic Accuracy Specifications Table

MEASUREMENT UNCERTAINTIES

INTRODUCTION

In any measurement, certain measurement errors associated with the system add uncertainty to the measured results. This uncertainty defines how accurately a device under test (DUT) can be measured.

Network analysis measurement errors can be separated into two types: raw and residual. The raw error terms are the errors associated with the uncorrected system that are called systematic (repeatable), random (non-repeatable), and drift errors. The residual error terms are the errors that remain after a measurement calibration.

The error correction procedure, also called measurement calibration, measures a set of calibration devices with known characteristics. It uses the measurement results to effectively remove systematic errors, using the vector math capabilities of the analyzer. The residual systematic errors remain after error correction, primarily due to the limitations of how accurately the electrical characteristics of the calibration devices can be defined and determined. Also, the random (non-repeatable) and drift errors, cannot be corrected because they cannot be quantified and measured during the measurement calibration and device measurement. However, the effects of random errors can be reduced through averaging. Random errors, that occur during a measurement calibration, are part of the error correction and become systematic errors when the calibration is turned on. For this reason, it is best to use a large number of averages during measurement calibration to reduce to the effect of the random errors. The averaging may then be reduced for device measuremnet. The residual systematic errors along with the random and drift errors continue to affect measurements after error correction, adding an uncertainty to the measurement results. Therefore, measurement uncertainty is defined as the combination of the residual systematic (repeatable), random (non-repeatable), and drift errors in the measurement system after error correction.

Measurement uncertainties of any analyzer system are highly dependent on the characteristics of the device under test. The expected measurement uncertainty of your analyzer system, when measuring the verification kit devices, can be determined by using the performance verification software. The expected measurement uncertainty of ideal terminations and thrus may be determined by using the uncertainties portion of the software.

The following measurement uncertainty equations and system error models (flowgraphs) show the relationship of the systematic, random, and drift errors. These are useful for predicting overall measurement performance.

SOURCES OF MEASUREMENT ERRORS

Sources of Systematic Errors

The residual (after measurement calibration) systematic errors result from imperfections in the calibration standards, the connector interface, the interconnecting cables, and the instrumentation. All measurements are affected by dynamic accuracy and frequency error effects. For reflection measurements, the associated residual errors are effective directivity, effective source match, and effective reflection tracking. For transmission measurements, the additional residual errors are effective crosstalk, effective load match, and effective transmission tracking.

The listing below shows the abbreviations used for systematic errors that are in the error models and uncertainty equations.

- Efd, Erd = effective directivity
- Efs, Ers = effective source match
- Efr, Err = effective reflection tracking
- Efc, Erc = effective crosstalk
- Efl, Erl = effective load match
- Eft, Ert = effective transmission tracking
- Crm, Ctm = cable stability (deg./GHz)
- Ab1, Ab2 = dynamic accuracy
- F = frequency

The sources for dynamic accuracy error effects are from errors during self-calibration, gain compression in the microwave frequency converter (sampler) at high signal levels, errors generated in the synchronous detectors, localized non-linearities in the IF filter system, and from LO leakage into the IF signal paths.

Sources of Random Errors

The random error sources are noise, connector repeatability and dynamic accuracy. There are two types of noise in any measurement system: low level noise (noise floor) and high level noise (phase noise of the source).

Low level noise is the broadband noise floor of the receiver which can be reduced through averaging or by changing the IF bandwidth.

High level noise or jitter of the trace data is due to the noise floor and the phase noise of the LO source inside the test set.

Connector repeatability is the random variation encountered when connecting a pair of RF connectors. Variations in both reflection and transmission can be observed.

The listing below shows the abbreviations used for random errors in the error models and uncertainty equations.

- Rnt = raw noise on trace (rms)
- Rnf = raw noise on floor (rms)
- Crr1 = port 1 connector reflection repeatability error
- Crt1 = port 1 connector transmission repeatability error
- Crr2 = port 2 connector reflection repeatability error
- Crt2 = port 2 connector transmission repeatability error

Sources of Drift Errors

Drift has two categories: frequency drift of the signal source and instrumentation drift. Instrumentation drift affects the magnitude and phase of both reflection and transmission measurements.

The primary causes for instrumentation drift are the thermal expansion characteristics of the interconnecting cables within the test set and the conversion stability of the microwave frequency converter.

The list below shows the drift errors in the error models and uncertainty equations.

- Dmxbx, Dmsax = drift magnitude
- Dpxbx, Dpsax = drift phase
- Dpfxbx, Dpfsax = drift phase/f

Sources of Additional Measurement Errors

Two additional categories of measurement errors are connection techniques and contact surfaces.

The connection techniques category includes torque limits, flush setting of sliding load center conductors, and handling procedures for beadless airlines.

The contact surfaces category includes cleaning procedures, scratches, worn plating, and rough seating.

These types of errors are not accounted for in the uncertainty analysis.

MEASUREMENT UNCERTAINTY EQUATIONS

Any measurement result is the vector sum of the actual test device response plus all error terms. The precise effect of each error term depends on its magnitude and phase relationship to the actual test device response. When the phase of an error response is not known, phase is assumed to be worst case (—180 to +180 degrees). Random errors such as noise and connector repeatability are generally combined in a root-sum-of-the-squares (RSS) manner.

Due to the complexity of the calculations, the performance verification/specifications software calculates the system measurement uncertainty. The following equations are representative of the equations the performance verification/specifications software uses to generate the system measurement uncertainty plots and tables.

REFLECTION UNCERTAINTY EQUATIONS

Total Reflection Magnitude Uncertainty (Erm)

An analysis of the error model in Figure 8-18 yields an equation for the reflection magnitude uncertainty. The equation contains all of the first order terms and the significant second order terms. The terms under the radical are random in character and are combined on an RSS basis. The terms in the systematic error group are combined on a worst case basis. In all cases, the error terms and the S-parameters are treated as linear absolute magnitudes.

Reflection magnitude uncertainty (forward direction) = Erm =

$$\mathrm{Erm} = \mathrm{Systematic} + \sqrt{(\mathrm{Random})^2 + (\mathrm{Drift})^2}$$

$$\mathrm{Systematic} = \mathrm{Efd} + \mathrm{Efr}\ \mathrm{S11} + \mathrm{Efs}\ \mathrm{S11}^2 + \mathrm{S21}\ \mathrm{S12}\ \mathrm{Efl} + \mathrm{Ab1}\ \mathrm{S11}$$

$$\mathrm{Random} = \sqrt{(\mathrm{Cr})^2 + (\mathrm{Rr})^2 + (\mathrm{Nr})^2}$$

$$\mathrm{Cr} = \sqrt{(\mathrm{Crm1})^2 + (\mathrm{2Ctm1S11})^2 + (\mathrm{Crm1S11})^2 + (\mathrm{Crm2S21S12})^2}$$

$$\mathrm{Rr} = \sqrt{(\mathrm{Crr1} + \mathrm{2Crt1S11} + \mathrm{Crr1S11}^2)^2 + (\mathrm{Crr2S21S12})^2}$$

$$\mathrm{Nr} = \sqrt{(\mathrm{EfntS11})^2 + \mathrm{Efnf}^2}$$

$$\mathrm{Drift\ \&\ Stability} = \mathrm{Dm1b1}\ \mathrm{S11}$$

where

- Efnt = effective noise on trace
- Efnf = effective noise floor
- Crt1 = connector repeatability (transmission)
- Crr1 = connector repeatability (reflection)
- Ctm1 = cable 1 transmission magnitude stability
- Crm1 = cable 1 reflection magnitude stability
- Crm2 = cable 2 reflection magnitude stability
- Dms1 = drift magnitude °C source to port 1
- Efs = effective source match error
- Efr = effective reflection tracking error
- Efl = effective load match error
- Efd = effective directivity error
- Crr2 = Connector repeatability (reflection)

The detailed equation for each of the previous terms is derived from the signal flow model in Figure 8-18. Due to the complexity of combining these terms manually, the specifications/performance verification software calculates the terms for you. However, the software makes some ideal device assumptions:

- For S11 and S22 uncertainties the device is a one-port device, therefore the value of S21 and S12 are $-\infty$ dB. The value of S11 or S22 is varied.
- For S21 and S12 uncertainties, the device is a reciprocal two-port device with perfect input/output match, therefore S11 and S22 are ϕ (linear) and S21 = S12. The value of S21 or S12 is varied.

Reflection Phase Uncertainty (Erp)

Reflection phase uncertainty is determined from a comparison of the magnitude uncertainty with the test signal magnitude. The worst case phase angle is computed. This result is combined with the error terms related to thermal drift of the total system, port 1 cable stability, and phase dynamic accuracy.

$$Erp = \text{Arcsin}\,(Erm/S11) + 2Cpf1f + Dps1 + Dpfs1f$$

where

Cpf1 = cable phase/frequency port 1
Dps1 = drift phase/degree source to port 1
Dpfs1 = drift phase/degree/frequency source to port 1

TRANSMISSION UNCERTAINTY EQUATIONS

Transmission Magnitude Uncertainty (Etm)

An analysis of the error model in Figure 8-18 yields an equation for the transmission magnitude uncertainty. The equation contains all of the first order terms and some of the significant second order terms. The terms under the radical are random in character and are combined on an RSS basis. The terms in the systematic error group are combined on a worst case basis. In all cases, the error terms are treated as linear absolute magnitudes.

Transmission magnitude uncertainty (forward direction) = Etm =

$$\mathrm{Ert} + \mathrm{Systematic} + \sqrt{(\mathrm{Random})^2 + (\mathrm{Drift\ \&\ Stability})^2}$$

$$\mathrm{Systematic} = (\mathrm{Ef_t} + \mathrm{EfsS11} + \mathrm{EflS22} + \mathrm{EfsEflS21S12} + \mathrm{Ab2})\ \mathrm{S21}$$

$$\mathrm{Random} = \sqrt{(\mathrm{Ct})^2 + (\mathrm{Rt})^2 + (\mathrm{Nt})^2}$$

$$\mathrm{Ct} = \mathrm{S21}\sqrt{(\mathrm{Ctm1})^2 + (\mathrm{Ctm2})^2 + (\mathrm{Crm1S11})^2 + (\mathrm{Crm2S22})^2}$$

$$\mathrm{Rt} = \mathrm{S21}\sqrt{(\mathrm{Crt1})^2 + (\mathrm{Crt2})^2 + (\mathrm{Crr1S11})^2 + (\mathrm{Crr2S22})^2}$$

$$\mathrm{Nt} = \sqrt{(\mathrm{EfntS21})^2 + \mathrm{Efnf}^2}$$

$$\mathrm{Drift\ \&\ Stability} = \mathrm{Dm2b2S21}$$

where

Crt2 = Connector repeatability (transmission) port 2
Crr2 = Connector repeatability (reflection) port 2
Efnt = effective noise on trace
Efnf = effective noise floor
Crr1 = connector repeatability (relection)
Crt1 = connector repeatability (transmission)
Ctm1 = cable 1 transmission magnitude stability
Crm1 = cable 1 reflection magnitude stability
Ctm2 = cable 2 transmission magnitude stability
Crm2 = cable 2 reflection magnitude stability
Dms1 = drift magnitude °C source to port
Efs = effective source match error
Eft = effective transmission tracking error
Efl = effective load match error
Efc = effective crosstalk error

The detailed equation for each of the above terms is derived from the signal flow model in Figure 8-18. Due to the complexity of combining these terms manually, the performance verification/specifications software calculates the terms for you. However, the software makes some ideal device assumptions:

- For S11 and S22 uncertainties the device is a one-port device, therefore the value of S21 and S12 are $-\infty$ dB. The value of S11 or S22 is varied.
- For S21 and S12 uncertainties, the device is a reciprocal two-port device with perfect input/output match, therefore S11 and S22 are ϕ (linear) and S21 = S12. The value of S21 or S12 is varied.

Transmission Phase Uncertainty (Etp)

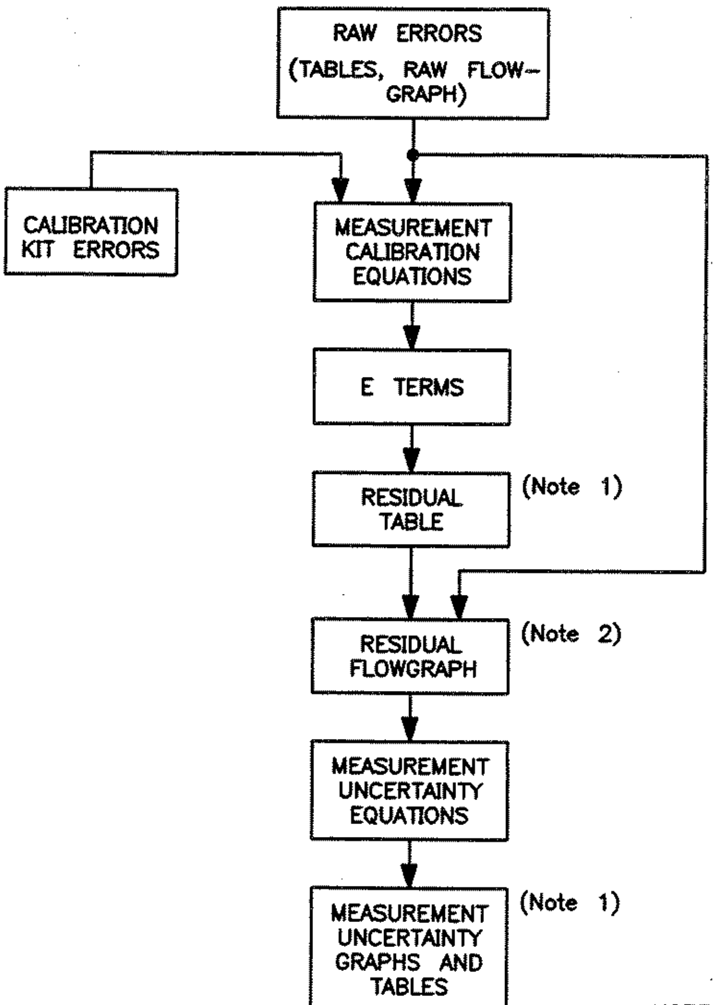
Transmission phase uncertainty is calculated from a comparison of the magnitude uncertainty with the test signal magnitude. The worst case phase angle is computed. This result is combined with the error terms related to phase dynamic accuracy, cable phase stability, and thermal drift of the total system.

$$Etp = \text{Arsin}(Ert/S21) + Cpf1f + Cpf2f + Dps1 + Dpfs1f$$

where

Cpf1 = Cable phase/frequency port 1
Cpf2 = Cable phase/frequency port 2
Dps1 = drift phase/degree source to port 1
Dpfs1 = drift phase/degree/frequency source to port 1

GENERATION OF SYSTEM MEASUREMENT UNCERTAINTIES



NOTES:

1. Program can print this out.
2. See Figure 8-13.

Figure 8-17. System Measurement Uncertainties Generation Process

The system raw errors are combined with the uncertainties of the calibration kit standards in a manner determined by the measurement calibration process. This results in a set of specifications for the residual error terms (effective directivity, tracking, source match, load match, crosstalk and dynamic range). The residual error terms are included in the corrected system flowgraph. The flow graph is then solved with measurement uncertainty equations, resulting in the measurement uncertainty and dynamic accuracy tables and plots. See Figure 8-17 for the graphic representation of this process.

NOTE Examples of generated system uncertainties and dynamic accuracy are located earlier in this chapter.

SYSTEM ERROR MODELS

The system error model flowgraphs, illustrated in the following pages, show the relationship of the various error sources in the forward and reverse directions. These flowgraphs can be used to analyze overall measurement performance. Use the lists of error terms in the following tables as a guide to the abbreviations in the error model flowgraphs. The additional information column helps clarify how the error terms are derived.

The system flowgraphs show the following:

- Error model of the uncorrected analyzer system (without measurement calibration, Figure 8-18).
- Error model of the corrected analyzer system (the residual errors remaining after measurement calibration, Figure 8-19).

Table 8-10. Residual Error Term Symbols

NOTE: In all of the terms below, f= the forward direction and r= the reverse direction.

Error Term	Eterm Symbol	Additional Information
Power of Source ‡	Ps	Condition
Averaging factor	Avg	Condition
Loss of Attenuator 1 ‡	La1	Condition
Loss of Attenuator 2 ‡	La2	Condition
Cable Flex Factor *	Cff	Condition
Drift in Room Temperature*	Drt	Condition
Effective Directivity *,†	Efd, Erd	Fac. Comp.
Effective Refl Tracking *,†	Efr, Err	Fac. Comp.
Effective Source match *,†	Efs, Ers	Fac. Comp.
Effective Crosstalk *	Efc, Erc	Fac. Comp.
Effective Trans Tracking *,†	Eft, Ert	Fac. Comp.
Effective Load Match *,†	Efl, Erl	Fac. Comp.
Effective Noise on Trace *	Efnt, Ernt	Fac. Comp.
Effective Noise Floor *	Efnf, Ernf	Fac. Comp.
Effective Power Ref (out) port1,2	Epr1, Epr2	Typical
Effective Power maX (in) port1,2	Epx2, Epx1	Typical
Effective Power miN (in) port1,2	Epn2, Epn1	Typical
Effective Dny Rng (Ref-min) pt1,2	Edrr1, Edrr2	Fac. Comp.
Effective Dny Rng (maX-min) pt1,2	Edrx1, Edrx2	Fac. Comp.

* Used in the corrected error model flowgraph to determine measurement uncertainty.

† Related to specifications of calibration kit devices and measurement calibration techniques.

‡ Used in the corrected error model flowgraph to determine dynamic accuracy.

Table 8-11. Test Port Error Term Symbols

Error Term	Eterm Symbol	Additional Information
Drift Source Frequency	Dsf	Typical
Raw Directivity	Rfd, Rrd	Factory
Raw Reflection Tracking	Rfr, Rrr	Typical
Raw Source Match	Rfs, Rrs	Factory
Raw Crosstalk	Rfc, Rrc	Factory
Raw Transmission Tracking	Rft, Rrt	Typical
Raw Load Match	Rfl, Rrl	Factory
Low Freq Cutoff Source to port 1,2 ‡	Fcs1, Fcs2	Fac. Comp.
Low Freq Slope Source to port 1,2 ‡	Fss1, Fss2	Fac. Comp.
Loss/DC Source to port 1,2 ‡	Lds1, Lds2	Typical
Loss/sqr(f-GHz) Source to port 1,2 ‡	Lfs1, Lfs2	Typical
Drift Mag/deg-c Src to port 1,2 *	Dms1, Dms2	Fac. Char.
Drift Ph/deg-c Src to port 1,2 *	Dps1, Dps2	Fac. Char.
Drift Ph/deg-c/F-GHz Src to port 1,2 *	Dpfs1, Dpfs2	Fac. Char.
Connector Repeat Refl port 1,2 *	Crr1, Crr2	Fac. Char.
Connector Repeat Trans port 1,2 *	Crt1, Crt2	Fac. Char.
Loss/DC port 1,2 Cable ‡	Ld1c, Ld2c	Cust. Site
Loss/sqr(F-GHz) port 1,2 Cable ‡	Lf1c, Lf2c	Cust. Site
Cable Refl Mag stab port 1,2 *	Crm1, Crm2	Fac. Char.
Cable Trans Mag stab port 1,2 *	Ctm1, Ctm2	Fac. Char.
Cable Ph/F-GHz stab port 1,2 *	Cpf1, Cpf2	Fac. Char.

* Used in the corrected error model flowgraph to determine measurement uncertainty.

‡ Used in the corrected error model flowgraph to determine dynamic accuracy.

Table 8-12. Channel Error Term Symbols

Error Term	Eterm Symbol	Additional Information
low Freq Cutoff port1,2 to b1, b2 ‡	Fc1b1, Fc2b2	Fac. Comp.
Source to a1, a2	Fcsa1, Fcsa2	
low Freq Slope port1,2 to b1, b2 ‡	Fs1b1, Fs2b2	Fac. Comp.
Source to a1, a2	Fssa1, Fssa2	
Drift Mag/deg-c port1,2 to b1, b2 *	Dm1b1, Dm2b2	Fac. Char.
Source to a1, a2	Dmsa1, Dmsa2	
Drift Ph/deg-c port1,2 to b1, b2 *	Dp1b1, Dp2b2	Fac. Char.
Source to a1, a2	Dpsa1, Dpsa2	
Drift Ph/deg-c/F-GHz pt1,2 to b1, b2 *	Dpf1b1, Dpf2b2	Fac. Char.
Source to a1, a2	Dpfsa1, Dpfsa2	
Loss/DC port1,2 to convertor b1, b2 ‡	Ld1b1, Ld1b2	Typical
Source to a1, a2	Ldsa1, Ldsa2	
Loss/sqr(F-GHz) port1,2 to conv. b1, b2 ‡	Lf1b1, Lf2b2	Typical
Source to a1, a2	Lfsa1, Lfsa2	
Loss/DC convertor to I.F. ‡	Ldvib1, Ldvib2	Typical
	Ldvia1, Ldvia2	
Loss/(F-GHz) conv. to I.F. ‡	Lfvib1, Lfvib2	Typical
	Lfvia1, Lfvia2	
Damage Level ‡	D1b1, D1b2	Fac. Char.
	D1a1, D1a2	
Power at conv. for 0.1 compress. ‡	Pccb1, Pccb2	Factory
	Pcca1, Pcca2	
Raw rms Noise on Trace	Rntb1, Rntb2	Factory
	Rnta1, Rnta2	
Raw rms I.F. Noise Floor	Rnfb1i, Rnfb2i	Factory
	Rnfa1i, Rnfa2i	
Residuals at I.F. ‡	Reb1i,Reb2i	Factory
	Rea1i, Rea2i	
Linearity of Xtal ‡	Lxb1,Lxb2	Factory
	Lxa1, Lxa2	
I.F. Gain Err1 −34>−46 dbm ‡	Ge1b1,Ge1b2	Factory
	Ge1a1, Ge1a2	
I.F. Gain Err2 −46>−58	Ge2b1,Ge2b2	Factory
	Ge2a1,Ge2a2	
I.F. Gain Err3 −58>−78 dbm	Ge3b1,Ge3b2	Factory
	Ge3a1,Ge3a2	
I.F. Gain Err4 −70>−∞ dbm	Ge4b1,Ge4b2	Factory
	Ge4a1,Ge4a2	
Mag Error vs Phase Shift B1, B2, A1, A2	Mpb1,Mpb2	Factory
	Mpa1,Mpa2	

* Used in the corrected error model flowgraph to determine measurement uncertainty.

‡ Used in the corrected error model flowgraph to determine dynamic accuracy.

Additional Information Definitions:

Cust. Site: Verified in the factory and verifiable at the customer's site using the performance verification software.

Factory: Verified in the factory on all units before shipment. Not tested at the customer's site.

Fac. Comp: Factory computed - verified in the factory by mathematical derivation using the measured performance of the system components and calibration standards. Not tested at the customer's site.

Fac. Char: Factory characterized parameter set by measuring a number of units. Verified in the factory by measurements on a random sampling. Not tested at the customer's site.

Typical: Non-warranted performance characteristics intended to provide information useful in applying the HP 8510 system. Typical characteristics are representative of most systems, though not necessarily tested in each system. Not tested at the customer's site.

Condition: A condition of the measurement or calculation.

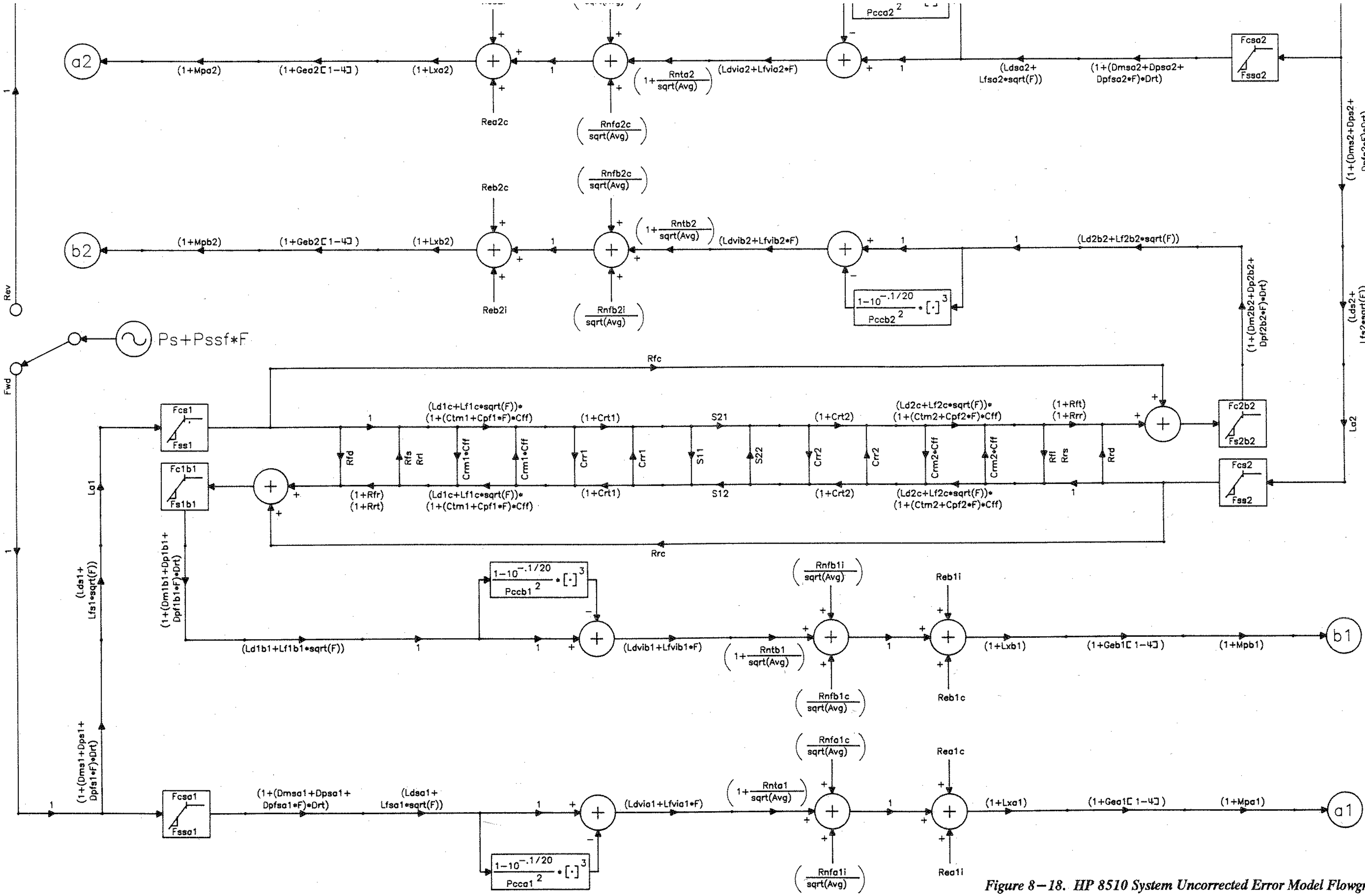


Figure 8−18. HP 8510 System Uncorrected Error Model Flowgraph

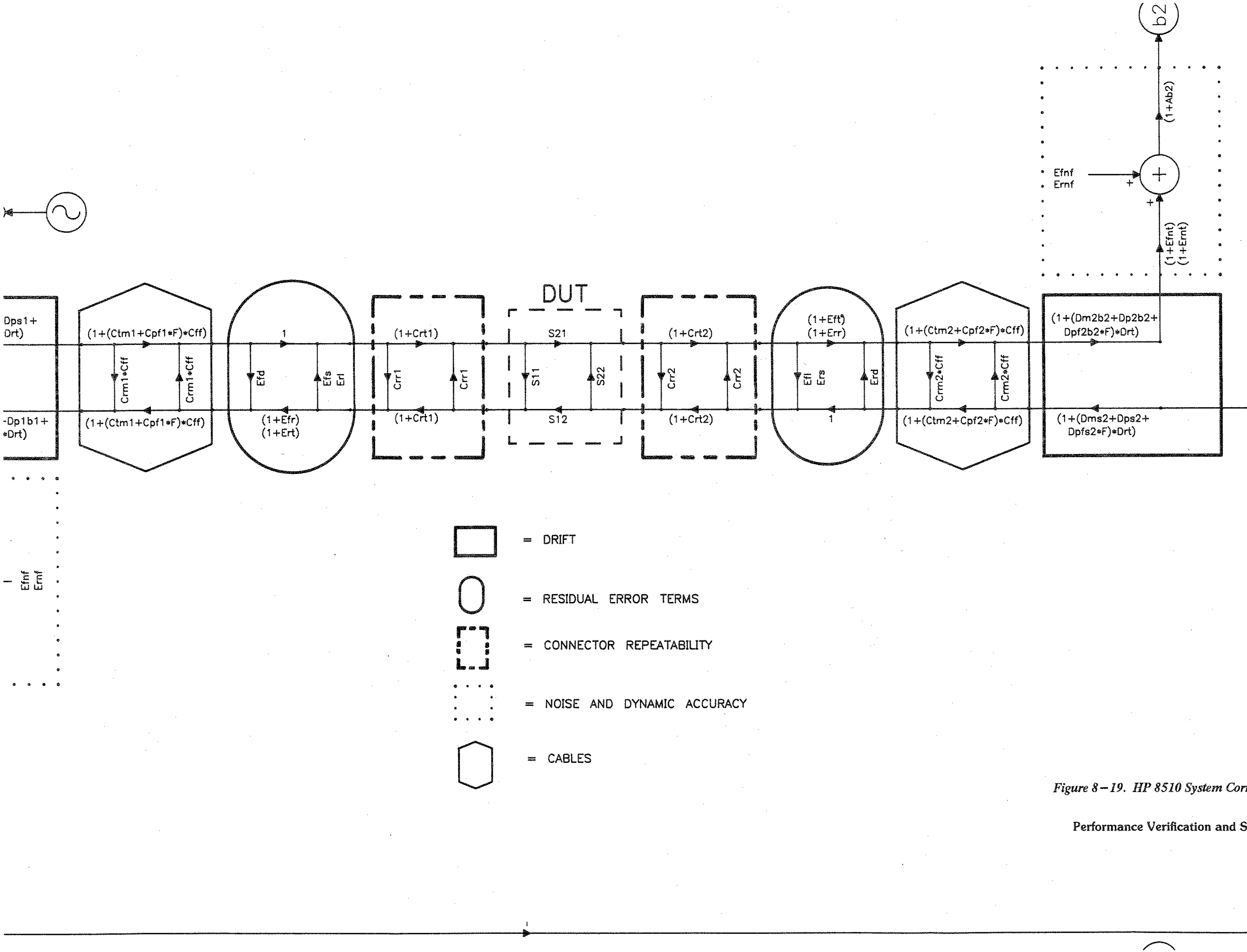
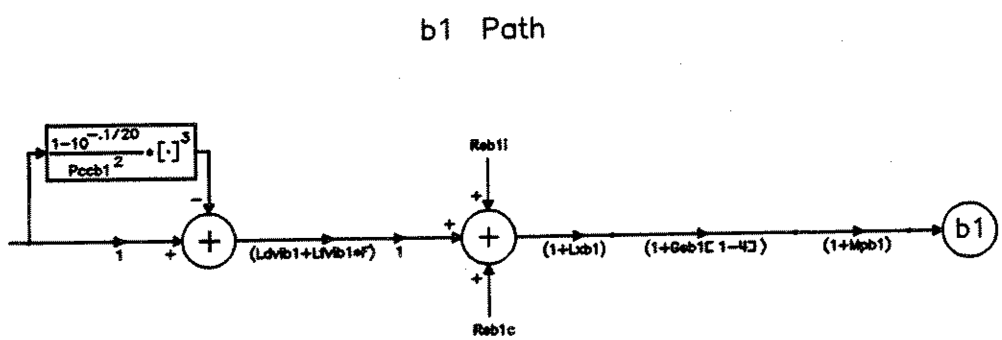


Figure 8-19. HP 8510 System Corrected Error Model Flowgraph

DYNAMIC ACCURACY ERROR MODEL

The dynamic accuracy value used in the system uncertainty equations is obtained from the following error model. Example plots of generated dynamic accuracy curves are located earlier in this chapter.



Geb1 = IF autorange gain error
Pccb1 = compression error
Mpb1 = error of magnitude versus phase shift
Lbx1 = crystal filter linearity error
Rebli,Reblc = IF residuals signal error
Ldvib1, Lfvib1 = Loss of converter

Where all the terms are expressed in linear format.

Dynamic Accuracy = A (which is used in the corrected error model flow graph to determine measurement uncertainty)

Figure 8-20. Dynamic Accuracy Error Model Flowgraph

MEASUREMENT TRACEABILITY

To establish a measurement traceability path to a national standard for a network analyzer system, the overall system performance is verified through the measurement of device characteristics that have a traceability path. This is accomplished by electrically measuring devices in an HP verification kit. Refer to "How to Verify System Performance" for the system performance verification procedure.

The measurement of the verification kit device characteristics has a traceable path because the factory system that characterizes the devices is calibrated and verified by measuring standards that have a traceable path to the National Institute of Standards Technology (NIST). This chain of measurements defines how the verification process brings NIST traceability to the HP 8510 system measurements. Therefore, when your analyzer system is verified through the performance of the "Total System Uncertainty" procedure, a measurement traceability path is established.

Figure 8-21 shows the traceability path for the calibration and verification standards.

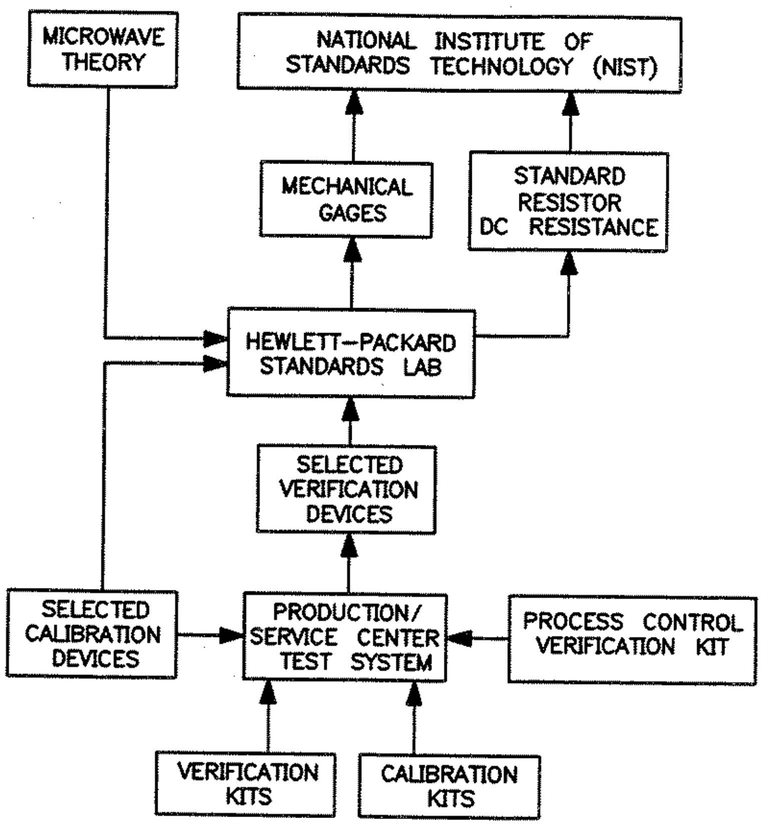


Figure 8-21. National Institute of Standards Technology Traceability Path for HP 8510 System Calibration and Verification Standards

SUBSTITUTION OF SYSTEM COMPONENTS

All Hewlett-Packard components that are specified for an HP 8510 system provide a top-quality system product that ensures good measurements. The performance verification can be performed with HP 8510 system components other than those manufactured by Hewlett-Packard. However, when the components used are not part of a specified HP 8510 system, the measurement integrity can be compromised.

Source Substitution

Sources other than those listed in the source compatibility table in the "Installation" chapter are not compatible with the HP 8510 system communication. Therefore, there can be no source substitutions for a system performance verification.

Cable Substitution

The test port cables specified for an HP 8510 system have been characterized for connector repeatability, magnitude and phase stability with flexing, return loss, insertion loss, and aging rate. Since the performance of test port cables is a very significant contributor to the system performance, substituting specified cables with cables that have not been carefully characterized will increase the uncertainty of your measurement verification. If a substitute cable is used that is of lesser quality than characterized in the verification program, the performance verification is no longer valid. Refer to the plots in the cable checks (earlier in this chapter) that show the difference in performance between good and bad cables. It is highly recommended to periodically check test port cables to determine if they are good.

If the system verification is performed with non-HP cables and fails but is then repeated with HP cables and passes, the non-HP cables are at fault. (It must be documented in the comments area of the performance verification printout that non-HP cables were used in the system.) The effects of the non-specified cables cannot be taken into account in the performance verification procedure without fully characterizing the cables and modifying the verification program to include this data. Contact an HP system engineer for more information.

Calibration Kit Substitution

The accuracy of the HP 8510 when used with any calibration kit is dependent on how well the kit standards are defined.

The measurement specifications for the HP 8510 system include measurement calibration with an HP calibration kit. Measurement calibrations made with user defined or modified calibration kits are not subject to the HP 8510 performance specifications, although a procedure similar to the standard verification procedure may be used. Contact an HP system engineer for more information.

CALIBRATION CYCLE

The recommended system calibration cycle is once every year. However, that does not extend past the test ports of the test set if non-HP cables are used (test port cables, test fixtures, adapters, etc.). The calibration cycle for the system is unknown with non-HP cables, and must be determined by the owner since the stability, repeatability, and aging rate characteristics of the test port cables are unknown. The user of the system should determine the calibration interval based on the amount of use and the degree of cable movement.

REFERENCE INFORMATION FOR PERFORMANCE VERIFICATION AND SPECIFICATIONS

The information listed in this section helps to correctly generate specifications, prepare the program for performance verification, and interpret any results.

HP 8510 System Specification Criteria (Assumptions)

The specifications for any system are valid only when certain conditions are met. HP assumes that the following criteria is met for all specifications.

1. SOURCES: Synthesizers are in step mode, not ramp mode. Sweepers are in ramp mode.
2. TEMPERATURE OF SYSTEM: Uncorrected = 0 to 55 degrees C. Corrected = 23 degrees ± 3 degrees at calibration. Also, ± 1 degree from calibration must be maintained for valid verification and for measurements within specified uncertainty limits.
3. REFLECTION/TRANSMISSION TEST SETS: Use a 10 dB attenuator for HP 8513 and a 20 dB attenuator for HP 8512 on the transmission thru path. These attenuators are available by ordering HP 8492A option 20 (20 dB, 7 mm) or HP 8493C option 10 (10 dB, 3.5 mm). Devices are connected directly to test port 1 for reflection measurements. For transmission measurements, the device is connected to test port 1, the attenuator is connected to the end of the device, and the cable is connected between the attenuator and port 2.
4. SYSTEM CONFIGURATIONS: Specifications apply to systems configured with hardware items available in the HP 8510 specifications database.
5. TEST SET PORTS, RF INPUT CONNECTORS, REFERENCE CHANNEL POWER: Characteristics for the test set ports, RF input connectors, and maximum and minimum reference channel power are defined in the test set manuals.

45 MHz Calibration and Verification

If the verification kit data disc has 45 MHz data, always use the fixed load for the loads portion of the 45 MHz calibration, and always select the lowband load from the menu.

–800 dB or 180 Degree Values

The program will not display a magnitude value less than —800 dB or a phase value greater than ±180 degrees (covers the full Smith chart). Therefore, whenever these values appear, it is likely that even greater values were calculated. For example, if a magnitude error is a negative number that is less than —800 dB (for example: —4,000 dB or minus infinity) it will appear as —800 dB.

Aborting Plots and Printouts with the *[ABORT]* Key

You can press this softkey whenever you want to stop plotting or printing a program selection. Use this key instead of turning off the peripheral or pressing the controller STOP or PAUSE key. Some printers and plotters will continue after ***[ABORT]*** is pressed because data is held in an internal buffer.

NOTE: If incorrect characters or traces appear on the printout, turn OFF the printer enhancement selection in the software configuration menu.

Adapters (Test Port)

When you use adapters on a test set, the program will calculate and include the adapter errors. The program compares the test set port connector type to the calibration kit and determines if an adapter is required for that configuration.

ATTENTION Messages...and "SCPP" Settings

When the program exercises the HP 8510 to determine if it and its peripherals are correctly addressed and responding, it will display a message if there is a problem. This message will tell you to check the HP-IB address. Check the software configuration menu addresses so that they correspond to the address switches set on the peripherals.

SCPP is an HP BASIC abbreviation for select code primary address. It is possible to have an HP 8510 address anywhere from 716 through 3130, depending upon your system address configuration.

BASIC 5.0 and HP-UX Systems (setting the time on your system)

If you are using BASIC 5.0 that is running from a hard disc shared with an HP-UX system, you may find that the time displayed by the program is incorrect because BASIC requires explicit information to set the correct time. Do not use the program to change the system clock. Instead, use the TIME-ZONE IS command to set the correct time and re-run the program. Refer to the *BASIC Language Reference* manual.

Calculated Error Terms

Some of the error terms that appear in the specifications are calculated by the program. They are not fixed values on the database. In both forward and reverse directions, they are:

- Effective Forward/Reverse Crosstalk
- Effective Forward/Reverse Noise on the Trace
- Effective Forward/Reverse Noise Floor
- Effective Power Ref (out) port 1, 2
- Effective Power max (in) port 2, 1
- Effective Power min (in) port 2, 1
- Effective Dynamic Range (Ref-min) port 2, port 1
- Effective Dynamic Range (max-min) port 2, port 1

Connections and Connector Maintenance

Always keep your connectors and cables in good working order by following the instructions in the respective manuals. As a general rule, clean all connections prior to calibration and verification with the recommended cleaning solution and lint-free swabs.

Controller CRT Displays and High-Resolution Monitors

Tabular data displays do not stop at the top of each page on the CRT. If the controller display memory is not capable of displaying the entire table, you can press any key to stop the scrolling table and then press any key to continue the display. You can also pause the program with the BASIC [PAUSE] or [STOP] key and then use the UP/DOWN arrow keys to scroll the display. Afterward, you can use the BASIC [CONTINUE] key to resume program operation (you may have to reset the BASIC softkeys to menu softkeys by pressing [USER] or [SHIFT] [USER], depending on your keyboard).

Limited Scrolling Capabilities on the Controller CRT

Some controllers do not have enough screen memory to allow you to scroll through a display of a table. This is especially true for high resolution monitors. HP recommends that you always print out the specifications.

Controller Keyboard Keys

The program is capable of responding to many of the BASIC operating system key presses, including [INSERT CHAR], [DELETE CHAR], [INSERT LINE], etc.

DUT Length (N cm) and Default S-Parameter Values

A default DUT length and the values of the other three S-parameters will always appear on uncertainty and dynamic accuracy plots. This length is based on a 10 cm airline. The DUT length for data sheet values is 0 cm.

For the reflection plots (S_{11} or S_{22}), the values of the other three S-parameters will be = 0 (linear). For transmission plots (S_{21} and S_{12}), S_{11} and S_{22} = 0 (linear), and $S_{21} = S_{12}$.

Explanation of the Wording on Tables

Origin = date the verification kit was certified
Factory = verification kit disc data
Field = uncertainty calculated by the program

HP 8510 mm-Wave Systems

Performance verification procedures for mm-wave systems, and the HP 85106 racked system, are provided with mm-wave products and documented in HP 8510 mm-wave system manuals.

HP 8511 Frequency Converter Test Sets

When generating specifications for systems using an HP 8511 frequency converter test set, specify the following in the hardware configuration menu:

- No source
- No test port cables
- No cal kit
- No verification kit

When no source is specified, a —20 dBm power level is assumed at the samplers during calibration.

When a source is chosen, the performance verification software assumes no loss between the source and samplers, thereby causing the software to show an "overload" on the samplers.

HP 8511 performance verification procedures and software are provided with the HP 8511 - they are not part of this program.

HP 8350B Sweep Oscillators as System Sources

Additional magnitude and phase errors are introduced into the system by these sweepers.

Frequency accuracy of HP 8350B/83592A (25±5 degrees C)					
BAND:	0	1	2	3	Full Band
Frequency range (GHz)	.01-2.4	2.4-7	7-13.5	13.5-20	.01-20
Frequency accuracy (MHz):					
Ramp sweep (typical)	±5	±6	±25	±30	±50
Ramp sweep (typical, using Trim Sweep)	±5	±6	±8	±10	±15

Magnitude Errors Due to Device Frequency Response

When measuring high frequency selective devices, HP 8350B frequency errors can cause additional magnitude uncertainty. As shown in the following filter measurement, frequency errors cause a shift in the measured data, resulting in a difference between the measured data and the actual data. Also, the measurement data shows increased noise due to the residual FM of the sweeper.

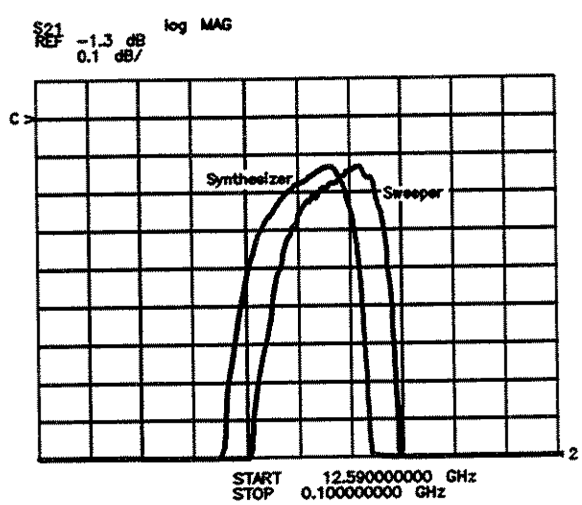


Figure 8-22

Measurement Calibration Method

Before verification, you must do a full two-port calibration for systems with S-parameter test sets and a one-path two-port calibration for systems with reflection/transmission test sets.

The calibration method selected in the program is based on the type of load you use: sliding load, offset load, broadband load, or TRL.

Phase Errors Due to Device Electrical Length

In measurements of devices with finite electrical length, the frequency accuracy of the sweeper causes additional uncertainty in phase measurements. The phase uncertainty DΘ is given by the following equation:

$\Delta\Theta = (-360/c)(F)(L)$

Where c is the propagation velocity in a vacuum (3×10^{10}cm/sec), ΔF is the frequency accuracy specification of the sweeper in ramp mode, and L is the length of the device under test. The following plot shows this uncertainty for the HP 8350B/83592A:

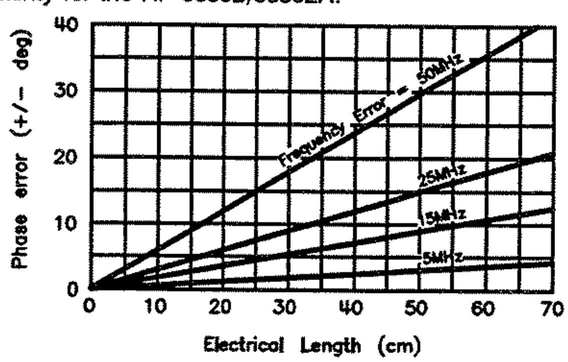


Figure 8-23

NIST Numbers

The National Institute of Standards Technology (NIST) measures HP standards and returns the results to HP with a test number and a date.

NIST numbers are supplied with the certificate of calibration that comes with your verification kit. The numbers are kept on record at Hewlett-Packard. They are used to document the traceable path of the measured kit data to NIST. Below is a typical set of numbers:

738/236940-86
738/234708-85
738/230170-83
731/237627-86
233661

NOTE: These numbers are supplied and authorized for use by NIST. They refer to device tests made by NIST. The 83, 85, and 86 numbers that appear after the dash (-) are the latest revision dates for each test. Contact HP if you have any further questions regarding these numbers.

Omit Isolation Measurement for HP 8350B Sources

If you are using an HP 8350B source, omit the isolation measurement in the measurement calibration sequence. The isolation measurement removes crosstalk, but requires a large number of averages since this type of error occurs below the noise floor. The software sets the HP 8350B to 128 averages which is not enough averages for a correct measurement of the crosstalk. Unless the number of averages is 1024 or more, the measurement creates a larger error than it is correcting for. If 1024 or more averages are taken, the measurement calibration process would take approximately 30 minutes. Also, the test sets do not introduce enough crosstalk that this error removal is critical.

Parameter Step Resolution (Software Configuration Menu)

The software configuration menu allows you to specify how many data points will be used to generate plot traces. This is called the parameter step resolution size. Using this feature you can increase or decrease the trace resolution on plots. Since the grid scale is always a fixed size, you can select tabular data to examine exact scale values.

Performance Verification Criteria

A complete performance verification requires that you measure all of the devices in your kit. Do not change any of the HP 8510 parameters or stimulus settings that the program uses for your system. The averaging factor should always be 1024 for synthesizers (for example, HP 8360/8340/8341) and 128 for sweepers (for example HP 8350B). For sweepers, the program always sets the HP 8510 sweep time to 500 milliseconds. Remember that sweep time does not apply to synthesizers because the system is in step mode.

The four devices are slightly different for each configuration. However, every kit has one of the following:

- 20 dB attenuator
- 40 or 50 dB attenuator
- Airline (length varies with kit type)
- 25 ohm mismatch airline (length varies with kit type)

NOTE: Systems with an HP 8350 as a source use a shorted airline instead of the 25 ohm mismatch airline. This is because of the sweeper's phase and magnitude errors (explained in "HP 8350B Sweep Oscillators as System Sources" in this reference section). Use the flush short from the calibration kit.

Plotters and Printers

The verification program requires that the printer be connected on the controller's HP-IB.

The plotter can be on either the HP 8510 system bus (default state in the software configuration menu) or the controller's HP-IB. When it is connected to the HP 8510 system bus, plots can be made from the HP 8510 CRT or from the controller CRT. However, the HP 8510 does not have to be connected to a controller to generate specifications. Therefore, without an HP 8510 connected and running, you would connect the plotter to the controller's HP-IB.

Plot Label Information

If you set the date and time when you first run the program, the correct date and time when the plot is made appears in the upper right corner of the plot.

Plots will also be labeled with the system hardware models. However, some of the sources will not have their correct A, B, or C labels. For example, HP 8340B sources will be labeled as HP 8340A. This is only on plots and does not mean that the program is faulty. The program must eliminate the slash (/) that occurs after hardware configuration labels such as HP 8340A/B.

Plotter Pens

The software configuration menu lists pen numbers (#) and colors. If your plotter has a pen wheel, the pen numbers correspond to the wheel numbers. Otherwise, plotters with only two pens use the first and second pens listed. The color relates to color monitors and the choice of pen colors is arbitrary. When the plotter is connected to the HP 8510 system bus, you can use the HP 8510 [COPY] key on the front panel to access its plotting capabilities for plotting HP 8510 CRT displays.

Plot Traces on the Controller CRT

Some traces may appear to be missing from program plots that show four frequency bands. Whenever three traces appear (instead of four), it is because the bands have the same values and are overlaid. This overlay cannot be distinguished on low resolution monitors or plotters. For example, the S11 magnitude uncertainty specifications for an HP 8510 using an HP 8340 source and an HP 8514 test set have the same uncertainty values for traces labeled 8 to 18 GHz and 18 to 20 GHz. Plot traces are designed for all controller/CRT combinations, but they appear best on high resolution color monitors.

When the program is calculating the values for plot traces, it beeps each time a trace is calculated. Therefore, if you hear four beeps, but only see three traces, that indicates that four traces were generated but one is overlaid on the other.

Program Modifications

It is **not** possible to modify this program. Contact an HP system engineer for more information. If you experience a problem with the program, contact HP with a description of the problem.

Ramp Mode Operation for Synthesizers

Ramp sweep is tested in "Frequency Tests" as part of the system performance verification. The performance verification software sets the synthesizer to a step mode for a system using a synthesizer as the source. Do not set the synthesizer to ramp sweep because the program will not correctly execute its commands in that mode. (However, the program will switch the source back to the step mode.)

Remote or Local Operation

The program automatically sets the HP 8510 to local (front panel) operation whenever it expects you to press any keys on the HP 8510. For example, this would happen when you are expected to make a measurement calibration. Remote operation occurs whenever the program is controlling the HP 8510 over the HP-IB bus.

System Hang-Ups or Other Problems

If the system or the controller will not respond during verification, press LOCAL and PRESET on the HP 8510, and re-run the program.

If a printer is connected to the system, cycle the power to all the instruments (including the printer).

Test Set Channel Signal Path Specifications: a1, b1, a2, b2

These specifications refer to the errors contributed by the test set from the test port, through the coupler, and onto the sampler (down-converter). The tables show values that are already included in the data sheet or system specifications. Their use is limited to inspecting the flowgraph error terms that exist between the coupler or bridge and the sampler.

Test Set Rear Panel Extension Links

The program will prompt you to use the long or short test set rear panel extension links, depending on the test set and the cables you have selected.

A rule-of-thumb for these extension links is:

- Reflection/transmission test sets use short links
- S-parameter test sets use long links

Trim Sweep Procedure

The HP 8510 trim sweep procedure is especially designed for use with HP 8350B, 8340, and 8341 sources (not necessary for HP 8360 in ramp mode). The procedure will improve the frequency accuracy of your system. It does this by aligning more closely the HP 8510 frequencies to those of the sweeper. Refer to "HP 8350B Sweep Oscillators as System Sources" in this reference section.

Uncertainty and Dynamic Accuracy Limits: Upper or Lower

The uncertainty and dynamic accuracy menu (in the uncertainty portion of the software) allows you to select lower or upper uncertainty limits. The limits only apply to transmission measurements. If you did select the upper limit for a reflection measurement, its value would be the same as the lower limit.

For transmission measurements, the limits are the worst case values that will add to or subtract from the measurement. These limits are derived from the equations:

Upper Limit = 20 log [1 Uij/Sij]

Lower Limit = 20 log [1 Uij/Sij]

Where U is the uncertainty and S is the measured S-parameter, and $_{ij}$ is a vector number.

Whenever $U_{ij}/S_{ij} = 1$, the worst case is be times the log of 2 (6 dB) for the upper limit, and 20 times the log of 0 (minus infinity) for the lower limit. This is due to vector numbers adding in phase and subtracting out of phase.

For example, if you were measuring a 60 dB band-stop filter, and the upper limit was 6 dB, you could add 6 dB to the measurement: —60 dB - 6 dB = —54 dB. And, if the lower limit was minus infinity, the measurement of the filter could be considered —54 dB or less.

PERFORMANCE TEST RECORD

The complete system performance verification record includes the printout from the performance verification software, this test record, and a certificate of calibration.

Use this sheet to record the results of the frequency tests. You may wish to copy this sheet to retain it as a master.

Performance Test Record

Test Facility ______________________ Report Number ______________________

______________________ ______________________

______________________ Date ______________________

______________________ Date of Last System Calibration ________

______________________ ______________________

Tested By ______________________ Customer ______________________

Text Equipment Used	Model Number	Trace Number	Cal Due Date
1. Frequency Counter	________	________	________

Ambient temperature ____________°C Relative Humidity______________________ %

Ambient temperature at measurement calibration______________________°C

Ambient temperature at performance veritication ______________________°C

Performance Test Record

Test Description	Minimum Specification	Results	Maximum Specification	Measurement Uncertainty
CW Frequency Accuracy				
Worst Case Value:				
45 MHz[2]	44.999955 MHz	______	45.000045 MHz	±10 Hz
2 GHz[3]	1.999998 GHz	______	2.000002 GHz	±10 Hz
20 GHz[4]	19.99998 GHz	______	20.00002 GHz	±4 kHz
26.5 GHz[5]	26.4999735 GHz	______	26.5000265 GHz	±5 kHz
40 GHz[6]	39.99996 GHz	______	40.00004 GHz	±5 kHz
50 GHz[7]	24.999975 GHz	______	25.000025 GHz	±5 kHz
Swept Frequency Accuracy				
Worst Case Value:				
Start Freq ______		______	0.1% of sweep (HP 8360)	±150 kHz
Stop Freq ______		______	1% of sweep (HP 8340/41)	
Worst Case Value:[4]				
Start Freq ______		______	0.1% of sweep (HP 8360)	±150 kHz
Stop Freq ______		______	1% of sweep (HP 8340/41)	

1. The measurement uncertainty is quoted for these performance tests using only the recommended models specified in Table 8-1 "Equipment Required". The measurement uncertainty quoted represents limits of ±3 times the equivalent standard deviation (3σ) and is intended to represent a 99% confidence level.
2. For all sources except HP 83622/24.
3. HP 83622/24 only.
4. HP 83620/21/22/23/24 and 8341 only.
5. HP 83631/40/51 and 8340 only.
6. HP 83640 only.
7. HP 83651 only.

9. System Installation

OVERVIEW

This chapter provides instructions for installing and interconnecting an HP 8510 system in either a cabinet or a bench–top configuration. System installation consists of the following steps:

1. Preparing the site
2. Checking the shipment and unpacking the system
3. Configuring and connecting the system
4. Checking the system operation

The basic system is defined as follows:

- HP 8510 (which consists of an HP 85101 display/processor and an HP 85102 IF detector)
- HP 851x test set
- Microwave source

(Peripherals, such as controllers, plotters, printers, disk drives, and millimeter devices, may be added to the basic system.)

OPTIONS

The following options are available for the HP 8510C:

Option Number	Description
1BN	MIL–STD certification
1BP	MIL–STD certification with data
008	Adds pulse capability
010	Adds time domain capability
908	Adds a rack flange mounting kit (without front handles)
910	Adds a duplicate manual set
913	Adds a rack flange mounting kit (with front handles)
W30	Extended service warranty, 2–year return–to–HP
W31	Extended service warranty, 2–year on–site

SCHEDULING INSTALLATION

If you have ordered on–site installation and verification, be sure that all system components have been delivered, unpacked, and collected at the installation site. Also be sure the site preparation is complete, as described in this chapter. Then contact the Hewlett–Packard customer engineer to schedule the installation and system verification.

Preparing the Site

ENVIRONMENTAL REQUIREMENTS

The environment must meet the conditions listed in the table below.

Table 9-1. Environmental Conditions

Temperature	
For operation	+5°C to +40°C (41°F to 104°F)
For measurement calibration	+20°C to +26°C (+68°F to +79°F)
For performance verification	±1°C (±1.8°F) of the measurement calibration temperature
For storage	—40°C to +65°C (—40°F to +158°F)
Humidity	
For operation	5% to 95% at +40°C or less (non−condensing)
For storage	5% to 95% at +65°C or less (non−condensing)
Pressure Altitude	
For operation	less than 4,600 meters (15,000 feet)
For storage	less than 4,600 meters (15,000 feet)

NOTE: Accuracy enhancement is dependent, in part, on a stable temperature environment. If your environmental temperature has a tendency to fluctuate more than ±1°C, periodically perform a system verification to ensure that the system has been correctly calibrated.

ATTENTION
Static Sensitive

Handle only at Static Safe
Work Stations

System Heating and Cooling

Install air conditioning and heating, if required.

Air conditioning requirements depend on the amount of heat produced by the instruments. Use the BTU/hour ratings from the table below to determine the total rating of your system. Each VA rating is multiplied by 3.4 to determine the BTU/hour rating of each instrument.

To convert the total BTU/hour figure to "tons," divide the total BTU/hour value by 12,000. A "ton" is the amount of heat required to melt a ton (907 kg) of ice in one hour.

Table 9-2. Maximum VA Ratings and BTU/Hour Ratings of HP Instruments

Instrument	Maximum VA Rating[1]	VA Subtotal	Maximum BTU/hour	BTU/hour Subtotal
Standard Equipment				
HP 85101 Display Processor	250		850	
HP 85102 IF Detector	210		714	
HP 8340 Synthesized Sweeper or	500		1,700	
HP 8360 Synthesized Sweeper or	400		1,360	
HP 8350 with Plug−In	375		1,275	
HP 851x RF Test Set	145		323	
Standard System Total				
Accessory Equipment				
HP 9000 Series 300	250		850	
19 inch CRT: HP 98751A, 98752A, 98753A, 98754A	420		1,430	
16 inch CRT: HP 98785A, 98789A	200		680	
Typical Hard Disk Drive	65		222	
HP LaserJet II	170 to 800		580 to 2,720	
HP PaintJet	20		68	
HP 7440A Plotter	100		340	
System Total				

1. Values are based on 120 Vac supplied to each instrument at 60 Hz

SPACE REQUIREMENTS

An area must be provided for the system instruments. The following table lists the space required for different configurations and includes the additional space for proper ventilation.

Table 9-3. System Space Requirements

	Height	Width	Depth
HP 85043 System Cabinet	124 cm	90 cm	95 cm
(without work surface)	(49 in)	(36 in)	(38 in)
Bench–Top System*	60 cm	45 cm	60 cm
(arranged as single stack)	(24 in)	(18 in)	(24 in)
(arranged as two stacks)	–	113 cm	60 cm
	–	(45 in)	(24 in)

*Refer to Figure 9-4 for examples of system configurations.

ELECTRICAL REQUIREMENTS

To determine the power requirements of a particular system, add the volt/amp ratings of the individual instruments. These ratings can be found on the rear panel of the instrument near the line module. The voltage and frequency information can also be found in the same general location.

Example HP 8510 System (includes test equipment and peripherals):

- Voltage: 90 to 127, 195 to 253 volts AC
- Power: 1100 VA maximum
- Frequency: 47.5 to 66 Hertz

NOTE: In addition to the power outlets required for operation of the HP 8510 system, three power line outlets should be provided for service equipment. A six–outlet strip (HP 92199A) with a continuous power rating of 1875 VA is available from Hewlett–Packard.

Electromagnetic Interference

HP 8510 conducted and radiated interference is in compliance with German Messempfaenger–Postverfuergung 526/527/1979 (Kennzeichnung Mit F–Nummer/Funkschutzzeichen).

NON–HP SYSTEM CABINET REQUIREMENTS

Using a non–HP system cabinet may result in measurement inaccuracy and reliability problems due to overheating. The following conditions must be met when a system is installed in a non–HP cabinet.

- Air temperature at the fan intake of each instrument must not exceed the ambient temperature specified for that instrument
- Minimum clearance for adequate cooling:

– 0.5 in. between stacked instruments

– 3.0 in. between instrument side and cabinet

– 6.0 in. between rear panel and instrument and cabinet

OTHER REQUIREMENTS

Install a telephone next to the system in case assistance is needed.

Checking the Shipment and Unpacking the System

CHECKING THE SHIPMENT

Ensure that all system components ordered have arrived by comparing the shipping forms to the original system purchase order.

Keep the shipping containers in one area and do not unpack them until all the instruments are delivered. As you unpack the system components, compare the serial numbers on the shipping forms to the serial numbers on the instruments.

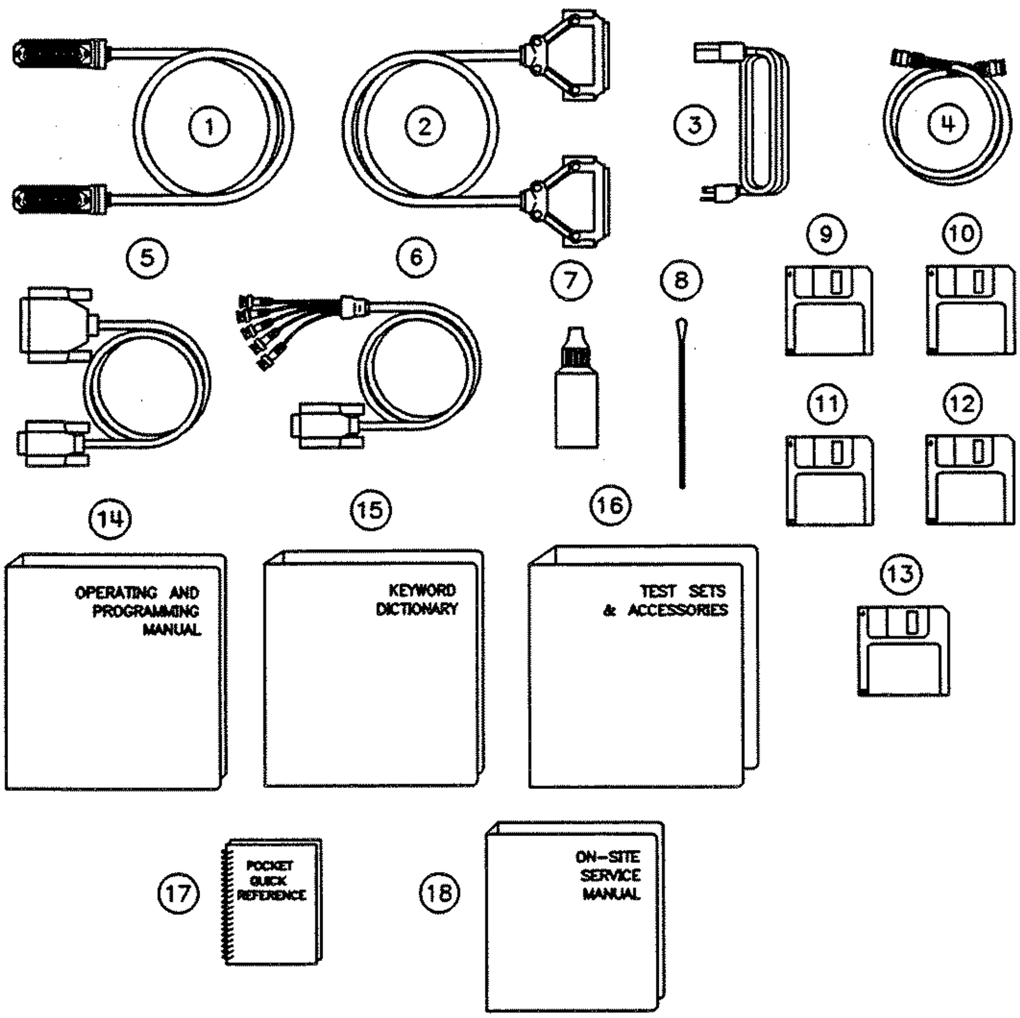
UNPACKING THE SYSTEM

If any container or instrument is damaged or incomplete, save the packing materials and notify both the carrier and Hewlett–Packard.

WARNING

Some of the instruments are heavy and can cause injury. Unpack them on the floor, and handle them carefully.

When you unpack the HP 8510, check that you have received the accessories illustrated in Figure 9-1.



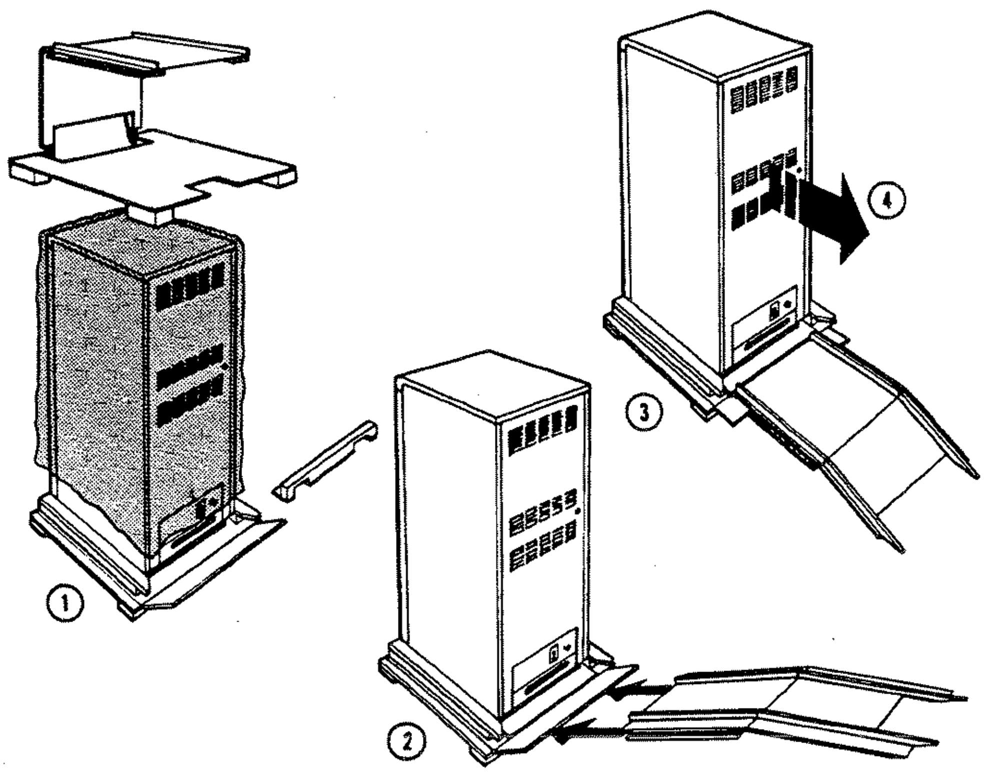
1. HP-IB Cable
2. IF Display Interconnect
3. Power Cables (2)
4. BNC Cables (2)
5. RS-232 Cable
6. VGA-Color Cable
7. Alcohol
8. Swabs
9. Operating System Disk
10. Master Calibration Data Disk
11. HP 85102 Adjustments Software
12. Operating and Programming Manual
13. Keyword Dictionary
14. Test Sets and Accessories Binder
15. Pocket Quick Reference
16. On-Site Service Manual

Figure 9-1. Accessories Supplied

Unpacking the System Cabinet

CAUTION

The cabinet packaging is designed for the system cabinet standing upright on a pallet. Do not store or install instruments in the cabinet when it is on its side or back. Major damage to the instruments and to the cabinet can occur.



1. Cut the wrapping bands on the crate. Snap off the retaining clips on the sides of the crate. Remove the cardboard cover.
2. Take out the ramp. The cardboard spacer below it can be discarded, as can the plastic foam around the cabinet.
3. Remove the wooden spacer at the lower end in back of the cabinet. Slide the ramp over the short rear panel at the bottom.

WARNING

At least two people are required to control the system cabinet in the next step. The loaded cabinet weighs approximately 600 pounds. DO NOT attempt to lift the cabinet. Do not allow anyone in front of the cabinet when it is being rolled down the ramp.

4. Have at least two people roll the cabinet down the ramp carefully. Hold back on the front edges of the cabinet with a person staninding on either side of it to avoid getting in the way of the heavy, rolling cabinet.

Figure 9-2. Unpacking the System Cabinet

Repacking

If it is necessary to ship any of the instruments in the HP 8510 system, pack each instrument separately in a double–wall cardboard carton made of 350–pound test material. Place enough shock–absorbing material around all sides of the instrument to prevent any movement inside the container. Containers and materials similar to those used for factory shipments are available through any Hewlett–Packard office.

If an instrument is being returned to Hewlett–Packard for service, please attach a tag indicating the nature of the problem and the person to contact for more information about the service required. Identify the instrument by model number and full serial number and list the other system instruments it is used with.

Configuring and Connecting the System

LINE VOLTAGE AND FUSES

Set the line voltage for each instrument according to the voltage of the AC power source. Typically, line voltage is set with a line voltage selector switch or a voltage selector card at the rear panel of the instrument.

CAUTION

Severe damage to the instruments can result if line voltage settings are incorrect when power is applied.

Use an autotransformer if the line voltage is not within the following voltage ranges: 90 to 127V, or 195 to 253V. Some of the instruments may have wider ranges as noted in their operating and service manuals.

WARNING

Death by electrocution is possible if both the common terminal of an autotransformer and the protective earth terminals of the HP 8510 system instruments are not connected to earth ground.

Verify the value of the line voltage fuses in all instruments of the system. The correct fuse values are listed on the rear panel of each instrument.

SOURCE COMPATIBILITY REQUIREMENTS

If you are installing a source that is not the newest version available, it must have the modification or firmware revision or both noted in the table below for HP 8510 compatibility.

Table 9-4. Source Compatibility and Modification Kits

Instrument	Firmware Revision Number (or Higher)	Modification Kit
HP 8360 series synthesized sweeper	all	unnecessary
HP 8340A synthesized sweeper	all	unnecessary
HP 8340B synthesized sweeper	all	unnecessary
HP 8341A synthesized sweeper	all	unnecessary
HP 8341B synthesized sweeper	all	unnecessary
HP 8350A sweep oscillator	6	08350−60100[1]
HP 8350B sweep oscillator	6	08350−60101
HP 83522A RF plug−in	6	83525−60074
HP 83525A/B RF plug−in	6	83525−60074
HP 83540A/B RF plug−in	6	83525−60074
HP 83545A RF plug−in	6	83525−60074
HP 83550A RF plug−in	6	83550−60041
HP 83570A RF plug−in	6	83525−60074
HP 83572A RF plug−in	6	83572−60074
HP 83590A RF plug−in	7	83590−60074
HP 83592A RF plug−in	7	83592−60074
HP 83592B RF plug−in	7	83592−60100
HP 83592C RF plug−in	7	83592−60102
HP 83594A RF plug−in	7	83594−60074
HP 83595A RF plug−in	7	83595−60074
HP 83595C RF plug−in	7	83595−60104
HP 83596A RF plug−in	7	83596−60002
HP 83597A RF plug−in	7	83597−60021
HP 8360−series synthesizer	all	unnecessary
HP 8620 sweep oscillator	cannot be used	
HP 86200−series RF Plug−ins	cannot be used	

1. Converts HP 8350A to HP 8510 compatibility

Note: The sources listed above are the only compatible sources as of December 1990. Consult your HP customer engineer for additional information.

To check the firmware revision on your HP 8350, press [SHIFT] [4] [9]. The revision appears in the FREQUENCY/TIME window.

To check the firmware revision on your HP 83500 series RF plug−in, press [SHIFT] [9] [9]. The revision appears in the POWER window.

The firmware revision for all synthesized sweepers appears when the instrument power is switched on.

CONFIGURING THE SYSTEM IN A CABINET

If your system will be used in a system cabinet follow the configuration instructions here. Otherwise, refer to "Configuring the System on a Bench–Top" later in this chapter.

Preconfigured Systems

If the system is shipped in the system cabinet, inspect for loosened connections and conclude the installation procedure with "Checking the System Operation" later in this chapter.

Systems that Are Not Preconfigured

Place the empty cabinet in the operating area. Then lower the feet at the bottom corners of the cabinet to prevent movement.

Remove the instrument feet and pull–out instruction card assemblies (if any).

Attach the rack–mount flanges with the instrument placed partly on the support shelves of the cabinet.

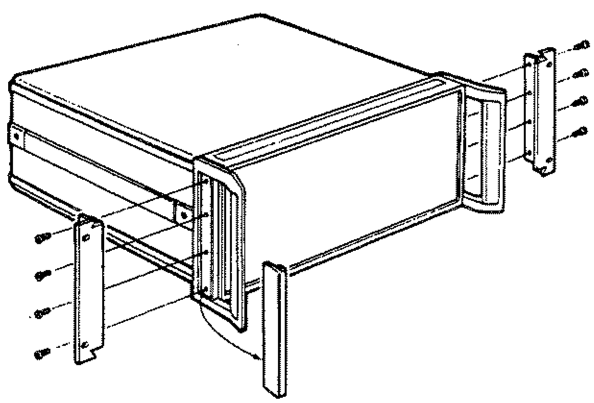


Figure 9-3. Attaching Flanges to Instruments With and Without Handles

Slide each instrument into the cabinet and secure it with the dress screws provided.

NOTE: Refer to Figure 9-5 for the recommended cabinet configuration.

CONFIGURING THE SYSTEM ON A BENCH–TOP

Set up instruments in one of the configurations in Figure 9-4. Different configurations are possible, including single stack and equal stack (2x2) styles.

WARNING

DO NOT REMOVE INSTRUMENT FEET on any of the system components. DAMAGE WILL OCCUR to the instruments if ventilation is restricted.

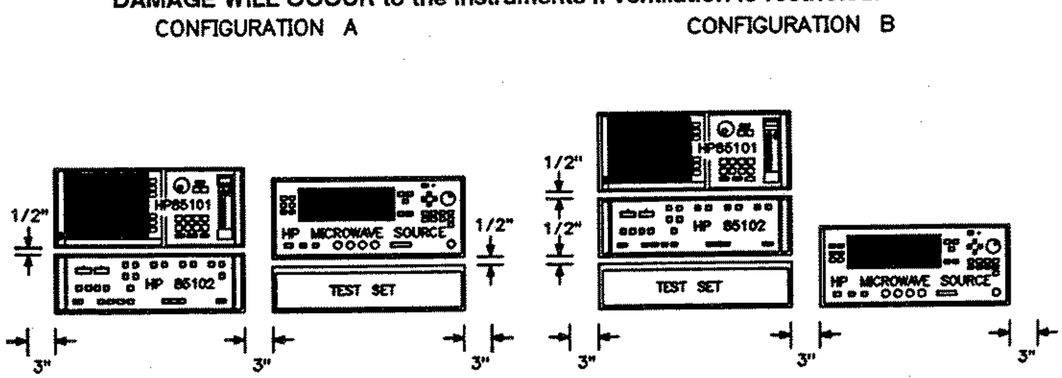
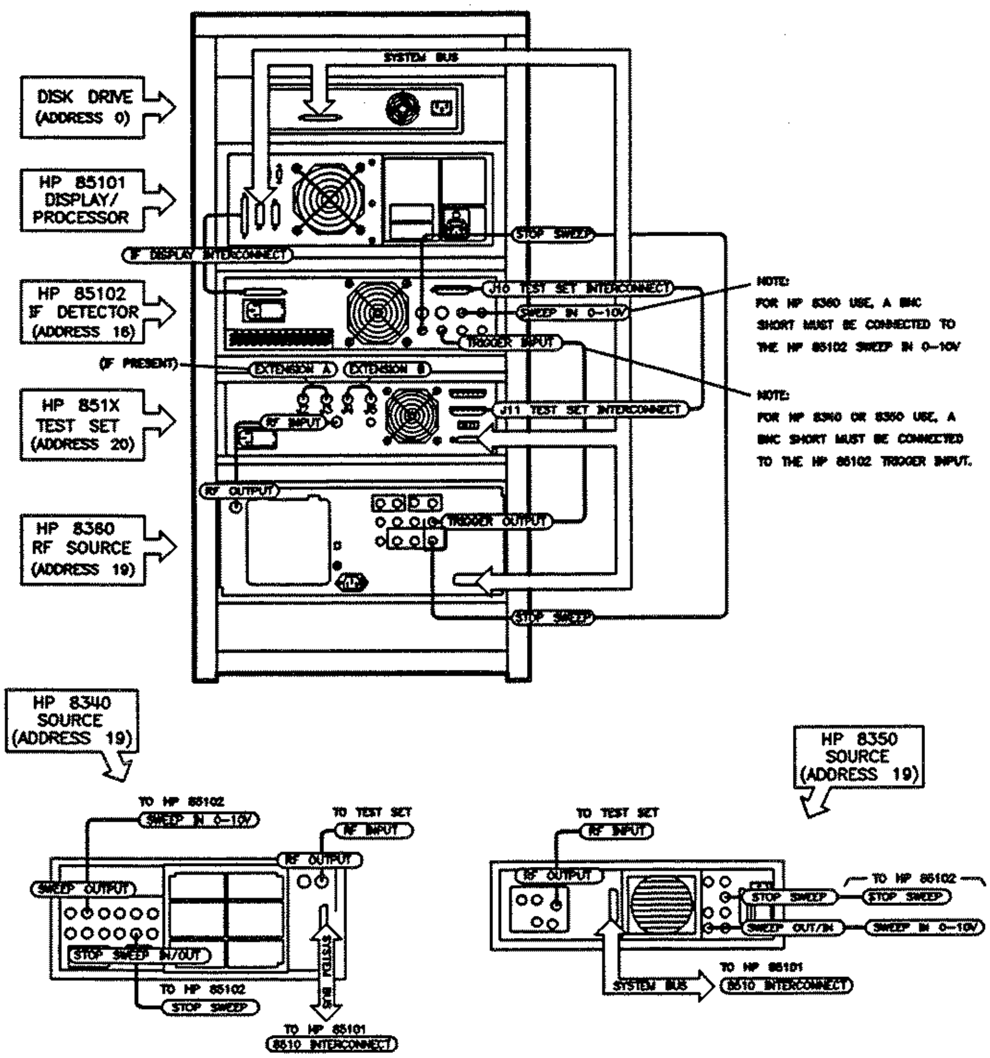


Figure 9-4. Typical Bench–Top Configurations

MAKING SYSTEM CONNECTIONS

The HP 8510 system requires that several types of cables be connected (see following figure).



Notes:

1.. Power cables must be connected to HP 85101, HP 85102, test set, source, and any peripherals.
2, Connect the reference port extension cables as shown in Figure 9-7. (Not applicable for HP 85110,8516, 8517.)
3. For systems without controllers, connect any peripherals to the 8510 interconnect on the HP 85101. For systems with controllers, connect any peripherals and the controller to the HP−IB connector on the HP 85101.
4. An HP 8340 or HP8360 requires a source interconnect cable connection when the test set used is an HP 8516.

Figure 9-5. System Connections

HP 8360–Series Source HP–IB/Language Switch

When using an HP 8360–series source, its rear panel HP–IB/langague switch should be set as shown in Figure 9-6.

Darkened switch positions indicate a depressed switch.

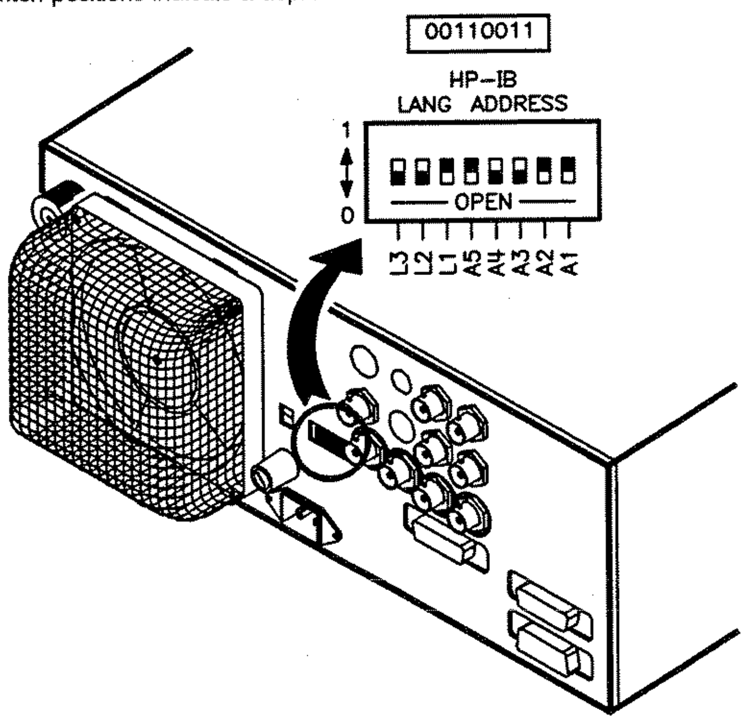


Figure 9-6. HP 8360–Series Source HP–IB/Language Switch

Grounding Power Cables

WARNING

An uninterrupted safety earth ground must be provided from the main power source to the supplied power cable(s) to prevent injury or death.

In compliance with international safety standards, the HP 8510 system instruments are equipped with 3–wire power cables.

For systems using the HP cabinet, connect the instruments directly to the power strip inside the cabinet, using the 3–conductor grounded power cables supplied with the system cabinet. Do not modify these power cables.

Reference Port Extension Cables (not applicable for HP 85110, 8516, 8517)

Connect the reference port extension cables (RPECs), as indicated in the following figure, to balance the test port signal path with the reference signal path. Part numbers of the long and short RPECs are listed in the test set manuals.

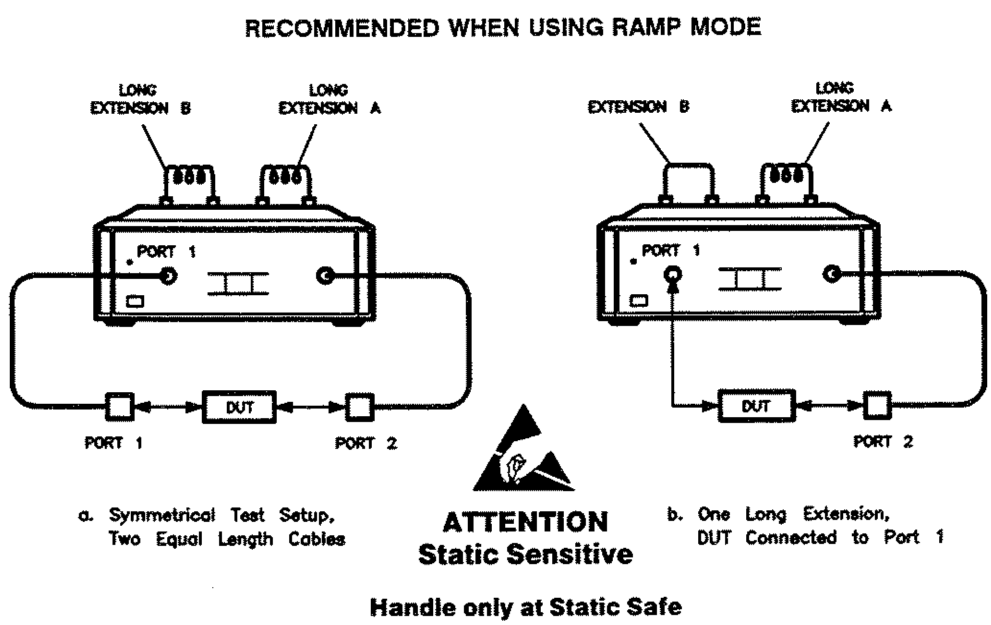


Figure 9-7. Reference Port Extension Cables

Hewlett–Packard Interface Bus (HP–IB) Cables

HP–IB allows either the system display/processor or an external controller to operate the various instruments of the system. (HP–IB interface operates according to IEEE 488–1978 and IEC 625 standards and IEEE 728–1982 recommended practices.)

NOTE: Always turn off power to instruments when connecting HP–IB cables.

As many as fifteen instruments can be connected in parallel on HP–IB, but proper voltage levels and timing relationships must be maintained. Observe the following limitations:

- 2 meters (6 feet) is the maximum cable length to each instrument.
- 20 meters (65 feet) is the maximum total cable length between all units.

The following HP–IB cables are available:

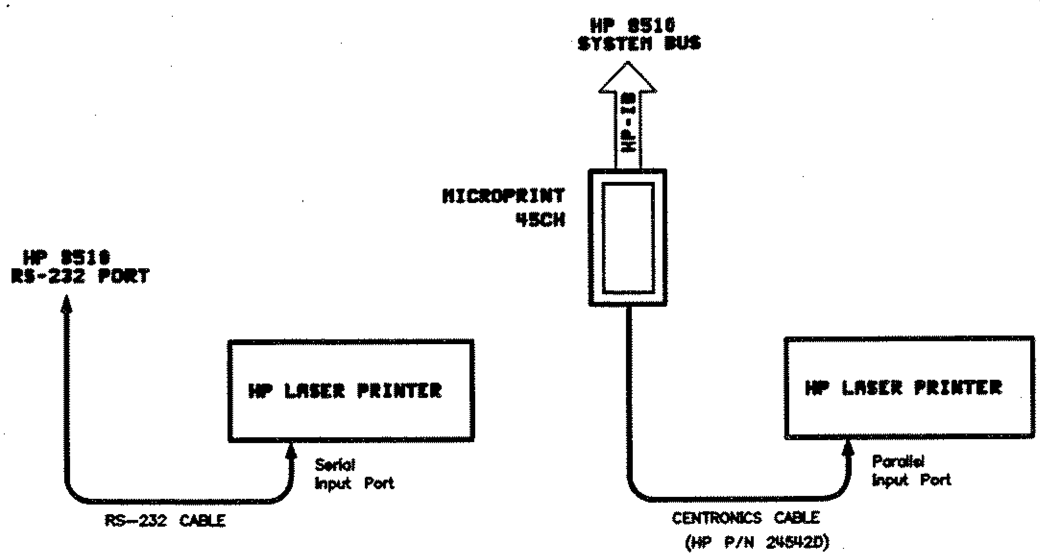
HP 10833C 4 m (13 feet)
HP 10833B 2 m (6 feet)
HP 10833A 1 m (3 feet)
HP 10833D 0.5 m (1.5 feet)

Serial Printer Setup

1. See Figure 9-8. Connect the desired HP 8510C serial input to the laser printer serial input and turn ON the laser printer.

2. Use the laser printer controls to select the serial bus, and select a BAUD rate of 9,600. Refer to the laser printer user's guide for instructions. These settings will remain in effect even if you turn the laser printer OFF.

For further information about printer setup, including parity, stop bit, and so forth, refer to the following information: "Address of Printer: RS–232 Port #1" in the HP 8510C Keyword Dictionary, and "Copy" in the HP 8510C Operating and Programming Manual.



a. Serial Connection *b. Parallel Connection*

Figure 9-8. HP Laser Printer Connections

Parallel Printer Setup

As shown in Figure 9–8, the parallel setup requires an HP–IB to Centronics converter. You can use the Microprint 45C (no longer in production), 45CH, or 45CX (high speed version). The 45CH is available directly from HP, the 45CX is available from Intelligent Interfaces Inc. of Stone Mountain, Georgia, U.S.A.

MicroPrint 45CH requires an AC adapter. The United States and Canada part number (HP p/n 92203J) includes the adapter. All other countries order HP p/n 92203K and the appropriate AC adapter:

- HP p/n 82241A ABG for Australia
- HP p/n 82241A ABU for the United Kingdom
- HP p/n 82241A ABB for Europe
- HP p/n 82241A ABJ for Japan

1. If using the Microprint 45CH, you must set it to address 01 as explained in its user's guide. The two other Microprint 45 versions come already set to address 701.

2. Connect the 45CH HP–IB input to the HP 8510C system bus.

3. Connect the output of the 45CH to the laser printer Centronics input.

4. Make sure the 45CH AC adapter module is set to the proper line voltage, then plug it in.

5. Make sure the HP 8510C is set up for an HP−IB printer at address 701. On the HP 8510C, press [LOCAL] ***[MORE] [PRINTER: HP−IB].***

6. Turn ON the laser printer.

For further information about printer setup, refer to "Copy" in the HP 8510C Operating and Programming Manual.

SWITCHING ON POWER

- In systems with controllers, switch on power to the controller last, HP 85101 next to last.
- In systems without controllers, switch on power to the HP 85101 last.

MAKING A BACKUP OPERATING SYSTEM DISK

Hold down the [=MARKER] key on the analyzer and cycle the power on the analyzer (switch on HP 85101 last). Holding down the [=MARKER] key makes the instrument detect a failure so it will show self test error 14, sub test 2. Press [=MARKER] again to enter the power−up self test menu.

Disable the write−protect feature on the blank disk by sliding the tab to the closed position. Insert the disk into the analyzer and press [2] [1] [=MARKER]. The disk is initialized when the analyzer CRT shows "INITIALIZATION COMPLETE."

Press [2] [0] [=MARKER]. When the disk is recorded, write−protect it by sliding the tab to the open position.

CHECKING SYSTEM OPERATION

The following system operation checks confirm that the system is functional and ready for performance verification or operation or both. These simple checks are optional and primarily serve to establish confidence in the integrity of the system.

HP 8510 SELF–TEST

Press the analyzer front panel TEST activator to run the self–test sequence. Observe the CRT for the following sequence:

- TESTING
- LOADING OPERATING SYSTEM
- SYSTEM INITIALIZATION IN PROGRESS
- RECALLING INSTRUMENT STATE

PRESET CHECK

Press INSTRUMENT STATE [RECALL] ***[MORE] [FACTORY PRESET]*** on the analyzer. The CRT should show a trace similar to the figure below.

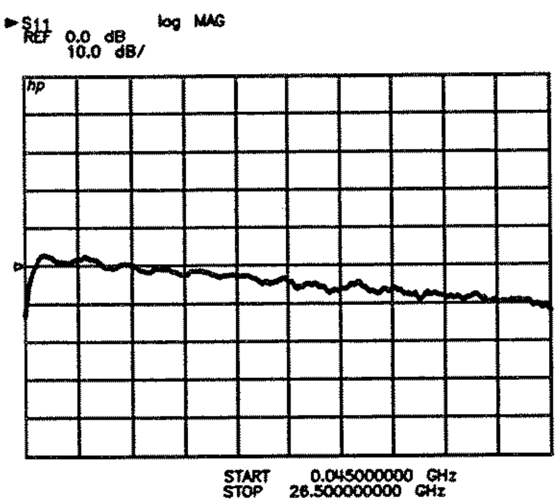


Figure 9-9. Typical Preset State Display

S–PARAMETER TEST SET CHECK

Press [S12] (in the PARAMETER area of the analyzer) to further confirm that the system is ready for performance verification or operation. The trace should drop to the bottom graticule of the display.

Press [AUTO] in the RESPONSE area of the analyzer. The trace should reappear near the center of the display, probably with a change in scale.

Connect an RF cable to ports 1 and 2 of the test set. The trace should rise toward the top of the display.

Press [AUTO] again. The trace should reappear near the center of the display, probably with another change in scale.

USER PARAMETERS (UNRATIOED POWER) CHECK

Refer to "Unratioed Power Failure" in the troubleshooting chapter for a procedure to check the unratioed power.

This concludes the basic system tests. To thoroughly check the performance of the system, refer to the "Performance Verification and Specifications" procedures. To operate the system, refer to the operating manual.

IN CASE OF DIFFICULTY

Incorrect operation can be indicated by:

- Error messages or error codes on the analyzer CRT
- Abnormal system response or operation

The most likely causes of problems for newly installed systems are poor cable connections or system bus address errors.

Switch off the line power to all instruments and carefully recheck all cable connections and HP–IB addresses, referring to Figure 9-5. Then power–up the system instruments again in the correct sequence.

If the problem still exists, refer to the troubleshooting chapter or contact your local HP customer engineer.

10. Preventive Maintenance

OVERVIEW

Preventive maintenance consists of five tasks that should be performed at least every six months. If the instrument is used daily on a production line or in a harsh environment, the tasks should be performed more often. Preventive maintenance contains these tasks:

- Maintain proper air flow.
- Inspect and clean connectors.
- Clean the glass filter (and CRT as required).
- Degauss the display.
- Inspect the error terms.

MAINTAIN PROPER AIR FLOW

It is necessary to maintain constant air flow in and around your HP 8510 system. If the message, "CAUTION: Test Set Is Too Hot!!" is displayed, immediately inspect for items (a piece of paper for example) on the test set fan. Items on top of the test set or around the system may also impede the air flow. The test set **will not** shut down if it becomes too hot! If the HP 85101 or HP 85102 overheat, the system will shut down until the temperature drops to the operating range.

Additionally, it is recommended that the source fan filter (if any) be inspected once a week and cleaned as necessary.

INSPECT AND CLEAN CONNECTORS

For accurate and repeatable measurement results, it is essential that connectors on calibration and verification devices, test ports, cables and other devices be cleaned and gaged regularly. It is also necessary that standard devices are handled and stored properly, and that all connectors are regularly inspected for signs of damage. This not only ensures the best performance from the connectors, but also extends their life. Refer to the *Operating and Service Manual* for the calibration kit and the *Microwave Connector Care Manual*, shipped with this instrument, for a detailed description of microwave connector care techniques. This manual also describes proper techniques for making connections.

Visually inspect the test port connectors. They should be clean and the center pin centered. If so, gage the microwave connectors (gages are supplied in HP calibration kits). Confirm that the recession is correct. Refer to the "Specifications" section in the test set manual for connector specifications.

Also inspect, clean, and gage the connectors of the calibration and verification kit devices. Refer to the kit manuals for center pin recession specifications.

Cleaning the Test Set Rear Panel Extensions

Over a period of time, the test set rear extensions can affect the performance of the HP 8510 system unless they, and the corresponding bulkhead connectors they are connected to, are kept clean. Use a foam swab and alcohol to clean the rear extensions and the bulkhead connectors. Be careful not to damage the center conductors of the bulkhead connectors.

Notice that these bulkhead connectors provide a direct path to the samplers. The appropriate static precautions, as outlined in the *Microwave Connector Care Manual* and test set manual, should be used to prevent damage to the static-sensitive samplers.

ATTENTION
Static Sensitive

Handle only at Static Safe
Work Stations

CLEAN THE GLASS FILTER (AND CRT AS REQUIRED)

A gasket between the CRT and glass filter limits air dust infiltration between them. Therefore, cleaning the outer surface of the glass filter is usually sufficient. Use a soft cloth and, if necessary, a cleaning solution recommended for optical coated surfaces: HP part number 8500-2163 is one such solution.

If, after cleaning the outer surface of the glass filter, the CRT appears dark or dirty or unfocused, clean the inner surface of the filter, and the CRT.

CLEANING THE CRT

1. Remove the softkeys cover (a plastic cover through which the front panel softkeys protrude): *carefully* insert a thin, flat screwdriver blade (or your fingernail) between the upper left corner of the softkeys cover and the glass filter (see Figure 10-1). Be extremely careful not to scratch or break the glass. Carefully pull the cover forward and off.

2. Remove the two screws that are now uncovered.

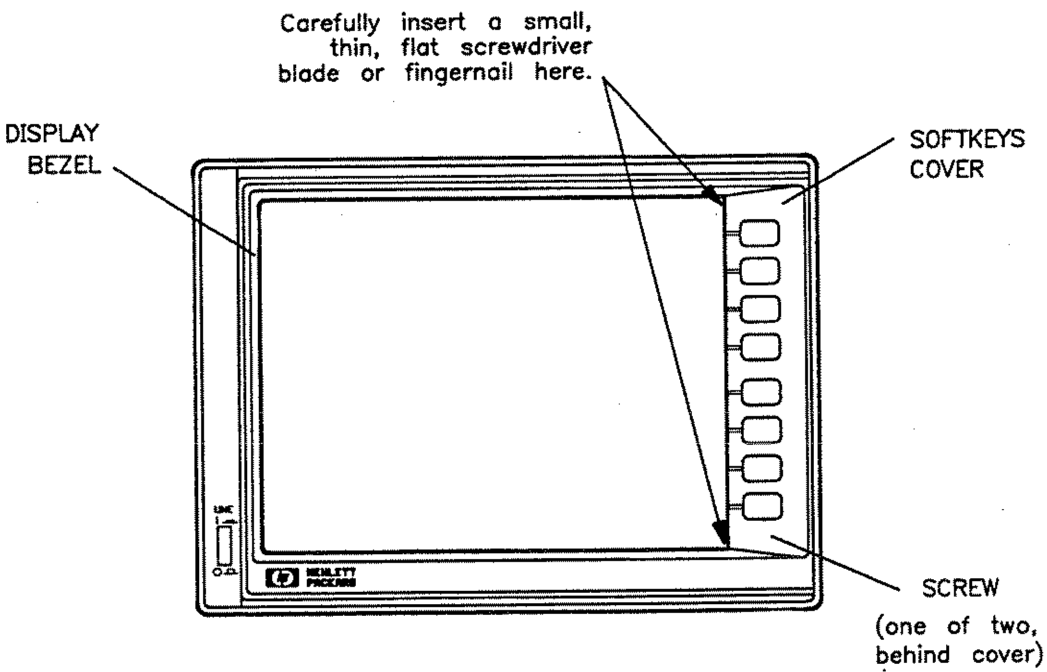


Figure 10-1. Removing the Glass Filter

3. Remove the display bezel assembly by pulling out the end that is now free. Pivot the bezel around its left edge until it is released.

4. Clean the CRT surface and the inner glass filter surface gently, as in step 1.

5. Allow the surfaces to dry and then reassemble the instrument.

DEGAUSS (DEMAGNETIZE) THE DISPLAY

If the display becomes magnetized, or if color purity is a problem, cycle the power several times.

Leave the instrument off for at least 15 seconds before turning it on. This will activate the automatic degaussing circuit in the analyzer display. If this is insufficient to achieve color purity, a commercially available demagnetizer must be used (either a CRT demagnetizer or a bulk tape eraser can be used). Follow the manufacturer's instructions keeping in mind the following: it is imperative that at first it be placed no closer than 4 inches (10 cm) from the face of the CRT while demagnetizing the display. If this distance is too far to completely demagnetize the CRT, try again at a slightly closer distance until the CRT is demagnetized. Generally, degaussing is accomplished with a slow rotary motion of the degausser, moving it in a circle of increasing radius while simultaneously moving away from the CRT. Figure 10-2 shows the motion for degaussing the display.

CAUTION

Applying an excessively strong magnetic field to the CRT face can destroy the CRT.

Like most displays, the CRT can be sensitive to large magnetic fields generated from unshielded motors. In countries that use 50 Hz, some 10 Hz jitter may be observed. If this problem is observed, remove the device causing the magnetic field.

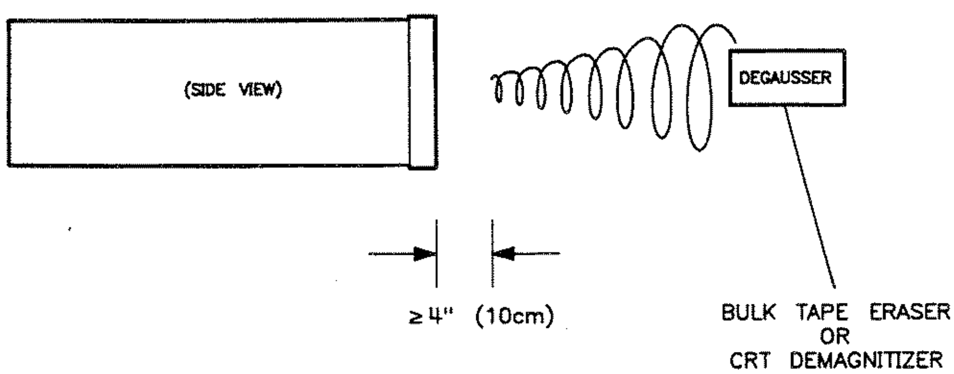


Figure 10-2. Motion for Degaussing the Display

INSPECT THE ERROR TERMS

Error terms (E-terms or calibration coefficients) are an indication of the condition of the instrument, its calibration kits, and cables. When tracked over a period of time, error terms can signal and identify system component and performance degradation. Error term comparisons are best made with data generated periodically by the same instrument and calibration kit (the kit normally used with the analyzer). For this reason, generating error terms at the time of installation and at regular intervals thereafter is recommended.

A log book can be a helpful to store the error term plots. Error term plots are generated by performing the verification procedure.

Refer to the operating manual for information on how to perform a full

2-port or TRL 2-port microwave calibration. To inspect the error terms or compare them to typical values, refer to "Error Terms" in this manual.

Instrument History

INTRODUCTION

This manual applies directly to analyzers with serial prefix numbers indicated on the title page. If your analyzer has a lower serial prefix and you need additional documentation, it will be located in this section.

HP 8510C On-Site Service Manual

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HP 8510C Performance Verification and Specifications Supplement

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WARRANTY

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of 90 days from date of delivery. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

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What's in This Guide?

This supplement provides the information needed to use version A.03.01 specification and verification software. The new features in the software allow you to perform system verification using error terms that you customized for your test setup.

This supplement should be used along with the original *HP 8510C On-Site Service Manual* performance verification and specifications software instructions (manual part number 08510-90282).

The chapters of this supplement provide the information described below:

- Refer to Chapter 1, "Quick Start" to learn how to access and use the new Edit Specs menu. The information is brief and assumes that you already understand how to edit error terms.
- Refer to Chapter 2, "Changing Error Term Values" to learn how to change pre-defined error terms. This section provides information about how to change an error term.
- Refer to Chapter 3, "Using the Software; A Tutorial" to try some editing exercises. In the exercises, you edit the error terms for specific cables, for calibration kits that are not Hewlett-Packard kits, and for test setups that use other than Hewlett-Packard test equipment.

What's New in This Software?

This supplement applies to revision A.03.01 of the HP 8510 Network Analyzer System Specifications and Performance Verification Program.

If you are already familiar with the HP 8510 Specifications and Performance Verification software, you know the program allows you to automate the characterization of standard systems.

Some new features added to this software are listed below. In addition, the user interface has been improved. Now you can use the software to do the following:

- Edit specifications
- Save and recall edited specifications
- Use markers on uncertainty plots
- Use user-generated parameters for plots or for system verification
- Enter s-parameters of the device-under-test for calculating uncertainty curves
- Plot RSS uncertainty, dynamic range, and test-port power levels
- Enter user labels on plots and user comments on verification printouts

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1

Quick Start

This chapter is written for the user who has previous experience modifying and editing hardware specifications. Use Chapter 2 in this supplement for additional information and Chapter 3 to work through the new features with tutorial instructions.

What's in This Chapter?

The first section of Chapter 1 gives basic instructions for installing the software. The information about using the keyboard or mouse for program control is located here along with the following:

- Loading the software
- Using the keyboard and mouse for program control
- Defining a custom system in the software
- Using the software
  - Choosing to edit specifications
  - Using new features
  - Using markers on uncertainty plots
  - Choosing user-generated error terms
  - Entering S-parameters of the DUT
  - Entering user labels or user comments
- Performing System Verification

Loading the Software

The procedure below describes how to load the software, only. For specific information about backing up the program or copying the program onto a hard disk, refer to Chapter 8 in the *HP 8510C On-Site Service Manual*. Load and run the "SPECS_8510" program from the program disk.

1. Insert the program disk into the computer's disk drive.
2. Set the active drive. Type `MSI` and enter the mass storage specifier.
3. Type `LOAD "SPECS_8510"` and wait for the program to be installed.
4. Type `RUN` to start the program.

The initial screen displays the program revision and the data revision numbers. These numbers are also listed on the disk label. Refere to these numbers if you contact an HP Sales and Service Office about your software product.

Using the Keyboard or Mouse for Program Control

Use of the keyboard or mouse is supported in the software program. The list below provides a brief overview of the different methods for controlling the cursor and modifying values.

Cursor Keys	Use the cursor keys (arrow keys) to move the cursor up, down, left, and right.
Done or (Select)	Use either the Done softkey or the (Select) keyboard key to complete data entry. Always press the Done key to retain edited data.
(Home)	Use the (Home) key to page forward. Combine the (Shift) key with the (Home) key to return to previous pages.
Mouse	Use the mouse to position the cursor on a specific character or field. Click the mouse select button to edit the data. You may find that using the mouse is less efficient than using the cursor keys. The sensitivity of the mouse makes it awkward to position.

Tab Use the keyboard tab key to move from one data entry field to the next, or when columns are used, from one column to the next. Combine the **Shift** key with the **Tab** key for reverse-tabbing.

Defining a Custom System in the Software

A custom network analysis system is one that uses models of test equipment in the measurement setup that are not listed or predefined in the specification and verification software.

Limitation of Warranty

Hewlett-Packard does not warrant the performance of systems that are customized by the user. That is, systems already customized at the factory as special systems are warranteed; however, if you customize the system at your facility, the performance warranty cannot be applied.

The first menu that appears in version A.03.01 software is the Hardware Configuration menu. From this menu, choose the model numbers of the hardware you are using. If you plan to make measurements with a custom test setup, choose model numbers from this menu that most closely matches the capability of the equipment you are using.

To calibrate a custom system, new features in the software allow you to modify error-term parameters. You can store the error-term changes in tables, compute customized specifications from the new error terms, then use the tables for plots and system verification.

If you plan to use hardware configuration values listed in the Hardware Configuration menu already, refer to Chapter 8 in the *HP 8510C On-Site Service Manual*. To create unique specifications for a custom system, continue reading this supplement.

Using the Software

Refer to the flowchart below for an overview of choosing either the specifications editing process, or the standard factory-defined specifications:

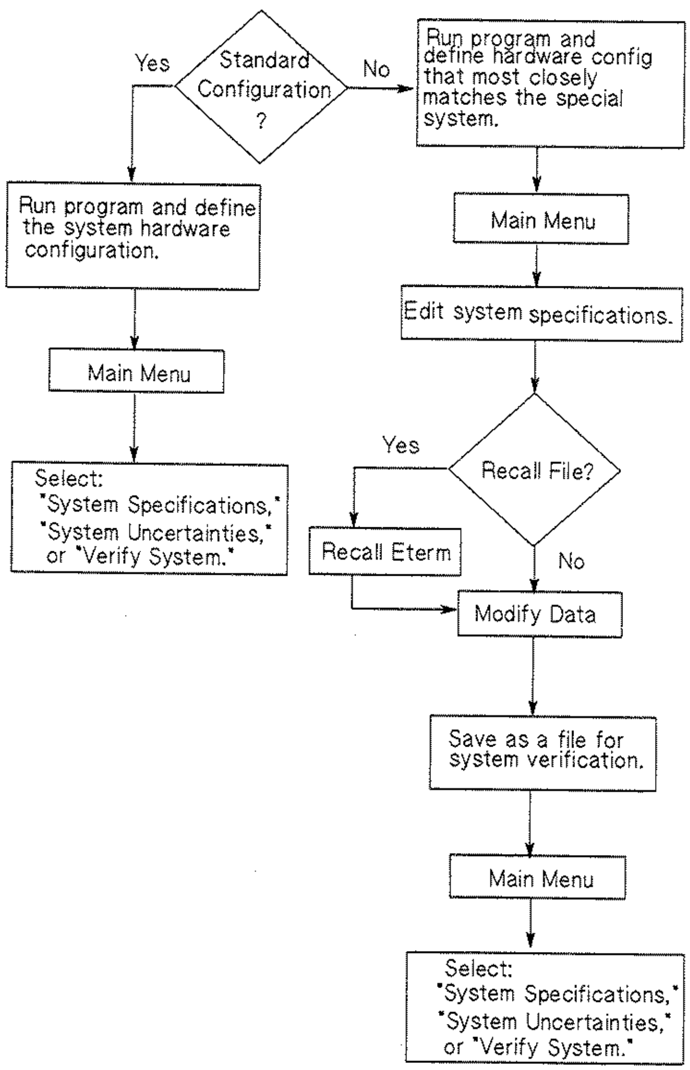


Figure 1-1. Flowchart for Selecting to Modify Specifications

Choosing to Edit Specifications

1. After installing the software program, press `Hardware Config` from the System Config menu.
   - Select hardware models that most closely match the equipment you are using.
     - Exact model numbers may not match, but similar capabilities (frequency range, power range, and so forth) need to be matched as closely as possible.
     - Selections such as `no source` and `no calibration kit` are available if there are no similar models of equipment.
   - After completing hardware configuration and model selection, press `Done` to save the information.
2. From the Main menu display, select `Edit Specs`.

By selecting `EDIT SYST SPECS` from the Main menu, you can modify error terms for your hardware configuration. You can use the modified data to compute custom uncertainties to use during performance verification. Refer to "Using the Error Term Table Editor" to learn how to edit specifications..

Using New Features

In addition to the ability to edit error terms and compute custom specifications you can save, recall, and label your customized information.

Using Markers on Uncertainty Plots

Markers automatically turn on when the uncertainty plot is displayed. The marker appears on the plot as a as vertical dashed line. To display the plot and use the marker function, refer to the steps below:

1. From the Main menu, press `Syst Uncert`.
2. From the plot options, choose the desired selections.
3. Press `Done` to display the graph.
4. To move the marker, use the left- or right-arrow keys.

Note You can control the position of the marker with the mouse, however, it is not recommended. The mouse's sensitivity may make it too awkward to use.

---

5. Read the marker values along the bottom row of the display. The readings include the X-axis value, and marker readouts for each frequency range.
6. Use the `Marker (ON) OFF` key to turn markers on or off.
7. Use the `Mkr Sens` key to change the marker sensitivity. You can choose a marker sensitivity of 1, 3, or 10. The setting determines the distance the marker moves on the graticule each time you press the left- or right-arrow key.

Choosing User-Generated Error Terms

To select edited error terms for generating system specifications tables, refer to the steps below:

1. Press `System Specs` in the Main menu.
2. Choose `User Parameters` for `Table Type:`.
3. Use the softkeys within the menu to edit other selections as needed.
4. Press `Done` to display the specifications table.

Generating customized system uncertainty plots

To select edited error terms for generating system uncertainty data, refer to the steps below:

1. Press `System Uncert` in the Main menu.

2. For `Compute Using:`, select `User Parameters`.
3. Use the softkeys within the menu to edit other selections as needed.
4. Press `Done` to display uncertainty plots.

Using user-generated specifications in system verification

You can choose user-generated specifications for system verification. Refer to the steps below:

1. Press `Verify System` in the Main menu.
2. Press `Select Standard`.
3. Move the cursor to `Verify Using:` and select `User Parameters`.
4. Use the softkeys within the menu to edit other selections as needed.
5. Press `Done` to begin system verification.

Entering S-parameters of the DUT

You can edit the S-parameter values for your specific device under test. Refer to the steps below:

1. Press `System Uncert` in the Main menu.
2. Locate the S-parameter data fields in the middle of the display. Notice the default values of S11 = S22 = 0, and S21=S12.
3. To enter an S11 value, press `Previous` until the asterisk beside `S11 (lin)` blinks (indicating the data field is activated).
4. Use the keyboard to enter the new S11 (linear) value.
5. Move to the next data field and press `Next` or `Previous` as needed to edit the remaining S-parameter data fields and to enter the device length (in cm). *Notice that S11 and S22 are in linear units, while S21 and S12 are in dB.*
6. Press `Done` to display the DUT's system uncertainty.

Entering user labels or comments on plots

If desired, use the features in this software to enter your own titles or comments on plots. The label you enter appears on the 3^{rd} or 4^{th} line of the title at the top of the plot.

1. Press System Uncert in the Main menu.
2. Move to User Label 1 and press Previous until the asterisk in the data field blinks.
3. From the keyboard, enter the label or title you want to appear on the output.
4. If desired, repeat the above two steps to enter User Label 2.
5. Press Done when you are finished entering user labels to display the plot.

Entering user labels or comments system verification reports

If desired, use the features in this software to enter your own titles or comments on system verification reports. The comment you enter appears on the test record for the selected verification kit device.

1. Press Verify System in the Main menu.
2. Press Select Standard.
3. Move to the Comment selection at the bottom of the screen.
4. Press Previous until the asterisk in the data field blinks.
5. From the keyboard, enter a one-line comment that you want to appear on the system verification report.
6. If desired, repeat the above two steps to enter a second comment line.
7. Press Done when you are finished entering comments.

Performing System Verification

After configuring the system, decide whether you want to choose user generated specs or software defined uncertainties. Select `Verify System` in the Main menu. In this menu, you can start the HP 8510C system verification using either the defined system specifications or custom specifications calculated from edited error term values. To choose the desired specifications for system verification, follow the steps below:

1. Press `Select Standard`.
2. Go to `Verify Using`.
3. Select either `Specifications` for defined values or `User Parameters` to use the customized specifications.

For additional information on performing system verification, refer to the "Total System Uncertainty Test Procedure" in Chapter 8 of the *HP 8510C On-Site Service Manual.*

2

Changing Error Term Values

Before you start editing the error terms, determine the characteristics of the equipment in your system that are not already defined in the software. As an example, you may plan to use a calibration kit that is manufactured by a company other than HP. You need to determine the directivity of the load in this kit. You may want to use custom cables; if so, you need to know the loss factor. You also need to know which error terms to edit and what values to enter for the error terms changed.

Refer to Figures 8-12 and 8-13 in the *HP 8510C On-Site Service Manual* and review the error term labels and locations in. You need to understand which error term gets modified with respect to the unique components within your system setup. In Figure 8-12, the device-under-test is identified with the labels S11, S21, S22, and S12 and is in the center of the graph. You can use the location of the device in this illustration to help you determine which error term to change.

In Chapter 3 there are examples to help you understand how to change error terms for some typically used hardware modifications.

What's in This Chapter?

The sections of Chapter 2 are listed below:

- Using the error term table editor
- Saving edited error term values
- Recalling a custom error term table file

Using the Error Term Table Editor

To display an error term table for editing, select `Edit Specs` in the Main menu.

Note

Refer to the Chapter 8, included in this kit, Figures 8-12 and 8-13. Find the error term of interest on the figure. The figure can help you determine the relative, physical location of the error term in your system configuration.

Refer to the steps below to edit the values:

1. Locate the error term in the displayed table that represents the error term of the hardware change.
2. Use the mouse, arrow keys, or (Tab) key to position the cursor at the term that needs to be edited.
3. Use the number keys to enter the values.
4. Continue editing error terms until your system or device is defined.
5. Press `Done` when you have finished editing error terms.
6. At the prompt `Re-compute effective terms from raw terms?`, respond with `Yes`.

The function of the Edit Specs menu keys are described below:

`Undo Term` Use this key to restore all values of the currently highlighted error term to the value listed just prior to your most recent change. If you have changed an error term, then changed it again, but you want to restore the value to your first change, press `Undo Term`. Use `Reset All` only if you want to use the software's predefined error terms.

`Undo All` Use this key to restore the values of all the error terms to the previous change. As with `Undo Term`, this key changes all the error terms of the table to previously changed values. Use `Reset All` only if you want to use the software's predefined error terms.

`Reset Term`	Use this key to restore the value of the currently highlighted error term to the software's predefined error term values.
`Save Eterms`	Use this key to save the edited error term table under a file name you specify.
`Recall Eterms`	Use this key to display a data field for you to enter the name of an error term table file to recall. You need to press `Next` or `Previous` until the asterisk flashes before entering a filename.
`Done`	Use this key when you have finished editing the error term table. New uncertainties are computed based on the error terms.
`Prior Menu`	Use this key to return to a previous menu.

Saving Edited Error Term Values

Use the new features in the software to save your specific error terms in a user-parameters file. Use the following steps to save customized error terms.

The original data files are isolated from changes made to the error term tables for your specific system. As a result, you can choose to use standard error terms, or your customized values.

1. After editing error term tables, pres the `Done` key to save edited terms.
2. From the Main menu, press `Edit Specs` `Save Eterms`.

3. Enter a file name and directory, if needed, for the new data in the space provided.

Note

To enter a file name, press `Next` or `Previous` until the blinking asterisk * appears beside the blank input field. The blinking asterisk indicates that you can edit the current field. The program allows you to choose a previously entered file name or type in a new one. Use the `Next` and `Previous` keys to select another file name.

Recalling a Custom Error Term File

After saving the custom file to disk, you can recall it for use whenever the system you plan to use matches your current hardware configuration.

To recall a customized error term table file, use the steps below:

1. From the Main menu, press `Edit Specs` `Recall Eterms`.
2. Edit the file name and directory if necessary.
3. Press `Done` to retrieve the file.

At this point, the user can make any of the following choices:

- Edit more specifications.
- Return to the Main menu and choose `System Specs`, `System Uncertainty`, or `Verify System`.

To use edited specifications, you need to select user parameters. The user parameters are available within the following menus:

- ☐ In the `System Specs` menu, for table type, choose `User Parameters`.
- ☐ In the `System Uncert` menu under `Compute Using`, select `User Parameters`.
- ☐ In the `Verify System` menu, press `Select Standard`, then select `Verify Using: User Parameters`.

3

Using the New Software: A Tutorial

The tutorial chapter is intended to help you get comfortable using new features in the software that are not documented in Chapter 8, included with this kit.| The features allow you to create your own equipment specifications for a calibration test setup. Additional marker features simplify determining the results of these customized setups.

What's in This Chapter?

This chapter contains some exercises to help you learn to use the software. Answers to the questions are provided in tables at the end of the chapter. You will learn about using the new features of the software. For more extensive information about using the standard features of the software, refer to Chapter 8, Specifications and Performance Verification.

- Selecting the hardware for an HP 8510SX system
- Examining error term tables, exercise 1
- Computing uncertainty curves, exercise 2
- Editing specifications, exercise 3
- Answers to tutorial questions

Selecting the Hardware for an HP 8510SX System

After loading the software (as directed in "Quick Start," Chapter 1), the first selection menu that appears is the Hardware Configuration menu. For this tutorial, select the following equipment:

- HP 8510C network analyzer
- HP 8515A test set
- HP 83631A synthesized source
- HP 85052C 3.5 mm TRL cal kit (choose TRL calibration)
- HP 85131F 3.5 mm test port cable set
- HP 85053B 3.5 mm verification kit

Examining Error Term Tables, Exercise 1

Select `System Specs` from the Main menu. Review the following descriptions to learn more about a few of the menu selections.

`Output Table` You can look at the residual errors with correction on, the test port errors with correction off, the test set channel (B1, B2, A1, A2) errors with correction off, or `All Tables`.

`Table Type` Choose `Specification`, `Data Sheet`, or `User Parameter` values.

Data sheet values are published in HP's technical literature. The values do not include effects due to cable stability or system drift errors.

Specification values are used during system verification.

User parameter values are tables which have been modified by the user with the `Edit Specs` function.

To examine the error terms tables, select `All Tables`. You see displayed both the effective (corrected) and raw (uncorrected) error terms. Refer to Table 3-1 at the end of this chapter for answers to the questions below:

1. Which effective error term would dominate when you measure the following?
   a. A very good 50Ω termination?
   b. A short circuit?
   c. An amplifier with 10 dB of gain?
   d. The isolation of a switch?
2. What is the raw directivity at 26.5 GHz?
   How does it compare to the data sheet?
3. What is the difference between “system” and “receiver” dynamic range?

Computing Uncertainty Curves, Exercise 2

Select `System Uncert` from the Main menu. Review the following descriptions to learn more about a few of the menu selections.

`Parameter` — Select the appropriate s-parameter.

`Format` — Choose magnitude or phase.

`Uncertainty Limit` — Selection applies only to transmission measurements where:

- The "Upper Limit" is 20×log (1+error).
- The "Lower Limit" is 20×log (1−error). The lower limit always produces the *larger* uncertainty value.

`Compute` — Choose from the worst-case uncertainty, RSS uncertainty, dynamic accuracy, dynamic range, or test-port power levels.

- RSS uncertainties are calculated with the RSS of all systematic errors, but the 3-sigma values of random errors are still used for 99.7% certainty.
- Dynamic accuracy shows the worst-case uncertainty due to IF residuals and detector inaccuracies, without the effects of noise, frequency response, directivity, port match, cross-talk, and connector repeatability.

`Compute Using` — The uncertainty may be computed using `Specification`, `Data Sheet`, or `User Parameter` (user modified) values.

The specific s-parameters and electrical length of the DUT can also be entered. This is important for determining the phase uncertainty of HP 8350B sweeper-based systems.

Look at the worst-case uncertainty curves (data sheet) for S11 and S21 magnitude and phase. Notice that you can generate read-out values on the display with the vertical "marker." Instructions about using the marker are in "Quick Start," Chapter 1. Refer to Table 3-2 for answers to the questions.

1. On the S11 magnitude uncertainty curve (at 26.5 GHz), do the following:
   - Estimate effective directivity
   - Compare the estimate with the data sheet value
2. On the S21 magnitude uncertainty curve (at 26.5 GHz), do the following:
   - Estimate system dynamic range
   - Compare the estimate with the data sheet value
3. Compare the S11 and S21 phase uncertainty curves (specifications) with the data sheet. Why are they different?

Editing Specifications, Exercise 3

The exercises in this section present typical examples of customizing a test setup. Each exercise presents a task, followed with a related question. The answers to the questions are in tables located at the end of the chapter. You are referred to the specific table number for the exercise you are doing.

Each exercise presents a different aspect of changing error terms for customizing specifications. The exercises do not need to be completed in any particular order.

- Exercise 3a shows you how to modify error terms for a custom system.
- Exercise 3b shows you how to modify error terms for a custom test set.
- Exercise 3c shows you how to edit error terms for custom cables in a test setup.
- Exercise 3d shows you how to edit error terms to calculate uncertainties for measuring a non-ideal test device.

Select `Edit Specs` from the Main menu. This selection allows you to edit the system specifications tables. You can change power levels, averaging factors, or error terms. After you finish editing, the software prompts you to recompute the effective terms that are calculated by the program (crosstalk, noise on trace, noise floor, power ref, power max, and power min).

Review the modify/edit key descriptions of the menu selections in Chapter 2 of this guide.

Using a Custom Calibration Kit, Exercise 3a

You have purchased a 3.5 mm broadband load calibration kit from another manufacturer. You want to use this kit on an HP 8510SX system to make reflection measurements at 26.5 GHz. The known return loss of a broadband load at 26.5 GHz is 35 dB. There is a +2° phase error on both the open and short terminations. These factors require that you change the following error terms to the values listed:

- Effective directivity of −35 dB
- Port match of −35 dB

- Reflection tracking of 0.024

Hint: In the hardware configuration menu, select the HP 85052D calibration kit and edit the effective terms. Remember to select `User Parameters` when generating the S11 magnitude uncertainty curve.

- *Task:* Generate an S11 magnitude uncertainty curve for this measurement.
- *Question:* How can you verify that the S11 magnitude uncertainty curve is correct? Answers are provided in Table 3-3.

Using a Special Test Set, Exercise 3b

You want to compute the S21 uncertainty at 26.5 GHz for a customized high-power measurement setup using the HP 8511A. A block diagram of the setup is shown in Figure 3-1.

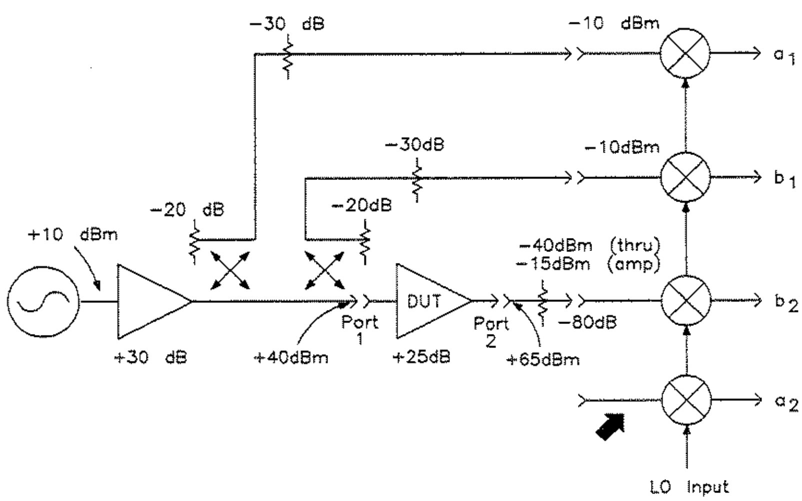


Figure 3-1. Equipment Setup Block Diagram

For the hardware configuration, choose the following:

- HP 8511A test set
- No source
- No calibration kit
- No cables
- No verification kit

Use the broad band-load calibration method. Assume the following:

- Effective directivity of −30 dB
- Reflection tracking of 0.011
- Source match of −25 dB
- Load match of −30 dB

- *Task:* Plot the S21 magnitude uncertainty upper-case uncertainty.

■ *Question:* What is the difference between this result and the lower-case uncertainty?

Hint: Modify the effective terms and the raw-loss terms. Don't forget to select `User Parameters` when you start generating the S21 magnitude uncertainty curves.

Using Non-Standard Test Cables, Exercise C.

You are using a pair of non-standard 3.5 mm flexible cables. You want to approximate the measurement uncertainty for an HP 8510SX system over the system's entire frequency range. While you cannot guarantee the results, you can change certain error terms to provide satisfactory results.

■ *Question:* Assuming you have specified `No Cables` in the Hardware Configuration menu, which error terms do you need to degrade to account for this cable? Refer to Table 3-6 for answers.

Hint: Consider how the cables impact your measurements.

The cable's known worst-case loss is 1.85 dB at 16 GHz and 0.25 dB at 45 MHz. You can determine the RF cable loss by assuming that, similar to HP cables, the total loss on these cables has a constant DC-loss component and an RF-loss component that varies with the square root of the frequency (in GHz).

The error term is "Loss/sqrt(F−ghz) port 1, 2 cable." Use the following formula to calculate the error term (*assuming* $F_1 > F_2$):

$$\frac{Loss1 - Loss2}{\sqrt{F_1\,(GHz) - F_2\,(GHz)}}$$

- *Question:* What is the value of this error term for the cables described above?
- *Question:* Which transmission and reflection tests do you perform to determine the stability of the non-standard cables? Refer to the *HP 8510C On-Site Service Manual* as needed.

While you are working on the system, you perform a 2-port calibration. Then, you connect the cables together and store the transmission measurement in memory. Next, you bend the connected cables by the same amount that the cables are bent during a measurement.

Looking at S21/M (data/memory), you find the cable's transmission magnitude repeatability to as indicated below:

- □ ±0.02 dB, for frequency range ending at 2 GHz
- □ ±0.03 dB, for frequency range ending at 8 GHz
- □ ±0.04 dB, for frequency range ending at 20 GHz
- □ ±0.06 dB, for frequency range ending at 26 GHz

The S21/M phase measurements showed ±0.1° around 0° at 1 GHz.

You find the cable's reflection magnitude stability, C_{rm}, to be the following values:

- □ −45 dB at 2 GHz
- □ −41 dB at 8 GHz
- □ −35 dB at 20 GHz
- □ −31 dB at 26 GHz

- *Question:* What are the new values for the following error terms? Refer to Table 3-7 to verify answers.

  Port 1: Ld1c, Lf1c, Crm1, Ctm1, Cpf1

  Port 2: Ld2c, Lf2c, Crm2, Ctm2, Cpf2

- *Task:* Knowing the information above, press `Edit Specs`. Enter the new values for the above error terms. Use the `Next` and `Tab` keys to edit values.

  a. Enter the error terms Lf1c, Lf2c, Cpf1, and Cpf2 as constants over the software's frequency breakpoints. At any frequency, you can calculate the actual total RF loss with the following equation (where $x = 1$ or 2, depending on the port used):

$$Ldxc + Lfxc \times \sqrt{(frequency\ in\ GHz)}$$

b. Use the following equation to determine the phase stability:

$$Ctmx + Cpfx \times (frequency\ in\ GHz\ )$$

After allowing the software to recompute the uncertainties, look at the uncertainty curves. How do they compare with a system that uses HP 85131F cables?

Hint: Remember to select `User Parameters` when generating the uncertainty curves for the non-standard cables.

Using a Non-Ideal Test Device, Exercise D.

You want to determine the measurement uncertainties for a 20 dB fixed attenuator. You want to use this attenuator to make a measurement over the frequency range of 45 MHz to 26.5 GHz. The attenuator has a worst case SWR of 1.25. The device length is about 3 cm. (Refer to the section at the end of this chapter for the answers.)

To determine the attenuator uncertainties, use the following 3.5 mm HP 8510 system:

- □ HP 8510C network analyzer
- □ HP 8515A test set
- □ HP 83631A synthesized source
- □ HP 85052B calibration kit (choose a sliding load calibration)
- □ HP 85131B/D cables
- □ HP 85053B verification kit

- *Task:* Generate the worst-case uncertainty specifications for an S21 magnitude measurement, using the lower limits.
- *Question:* What are the measurement uncertainties in each frequency range for the attenuator measurement?

Answers to Tutorial Questions

Exercise questions from the tutorials are repeated in the first column of the tables. Answers are stated in the next column beside the question.

"Examining Error Term Tables" Answers

The answers to Examining Error Term Tables, exercises 1, 2, and 3 are in Table 3-1:

Table 3-1. Examining Error Term Tables Answers

Questions	Answers
1. Which effective error term would dominate when you measure the following:	The dominant error terms are:
a. For a good 50Ω termination?	The directivity term.
b. For a short circuit?	The source match term.
c. For an amplifier with 10 dB of gain?	The load match term.
d. For switch isolation?	The crosstalk term.
2. What is the raw directivity at 26.5 GHz?	The value should be about −27 dB.
How does this value compare with the data sheet value?	The raw directivity at 26.5 GHz on the data sheet is −27 dB.
3. What is the difference between "system" and "receiver" dynamic range?	Notice that in the first table (Residual Errors - Correction On), there are two values for effective dynamic range. One refers to the system dynamic range, while the other refers to the receiver dynamic range. These terms are defined below: a. System dynamic range = $P_{ref} - P_{min}$ b. Receiver dynamic range = $P_{max} - P_{min}$ *P_{ref} is the nominal or reference power at the test port.* *P_{min} is the minimum power that can be measured above the noise floor.* *P_{max} is the maximum power that can be applied to port 2 before 0.1 dB compression.*

"Computing Uncertainty Curves" Answers

The answers to Computing Uncertainty Curves, questions 1, 2, and 3 are in Table 3-2:

Table 3-2. Computing Uncertainty Curves Answers

Questions	Answers
1. On the S11 magnitude uncertainty curve (at 26.5 GHz), what is the estimated effective directivity?	The value is 0.004 linear, which is equivalent to −48 dB. To estimate the effective directivity, look for the uncertainty when S11 = 0 (a perfect load).
How does the estimated value compare with the data sheet value?	−48 dB is close to the data sheet value of 50 dB.
2. On the S21 magnitude uncertainty curve (at 26.5 GHz), what is the estimated system dynamic range?	The estimated value is around 68 dB or 70 dB, depending upon how you read the graph. To estimate the dynamic range, look on the S21 uncertainty curve. The curve shows S21 in dB from reference power. Find where the uncertainty becomes too large. Too large can be considered to be >6 dB uncertainty (estimated dynamic range about 68 dB), where the noise power equals the signal power, or >10 dB uncertainty, which is off the graph, corresponding to 70 dB dynamic range.
Does the value correspond with the data sheet?	The data sheet value of 74 dB corresponds with the estimated value.
3. Compare the S11 and S21 phase uncertainty curves with the data sheet. Why are they different?	The data sheet values for these curves do not include the effects of cable stability and system drift errors.

"Editing Specifications Examples" Answers

The answers to tutorial exercises 3a, 3b, 3c, and 3d. are provided in these tables.

Exercise 3a: Answers to Using a Custom Calibration Kit

Table 3-3. Tutorial Exercise 3a. Answers

Question	Answer
How can you verify that the S11 magnitude uncertainty curve is correct?	At S11 = 0, the value for the 26.5 GHz curve should be about −35 dB, or 0.0178 linear, since that is the of return loss of the load.

Exercise 3b: Answers to Using A Special Test Set

The error terms that need to be modified for generating the S21 magnitude uncertainty curves are in Table 3-4 below:

Table 3-4.
Error Terms to Modify for Generating Uncertainty Curves

Error Term	Value
Power of source	10 dB
Effective directivity	−30 dB
Effective reflection tracking	0.011 dB
Effective source match	−25 dB
Effective load match	−30 dB
Effective power ref (out) port 1	40 dBm
Loss/DC source to port 1	30 dB
Loss/DC port 1 to B1	−50 dB
Loss/DC port 2 to B2	−80 dB
Loss/DC source to A1	−50 dB

Table 3-5. Tutorial Exercise 3b. Answers

Questions	Answers
What is the difference between the S21 upper-case magnitude uncertainty and the lower-case uncertainty?	As expected, the lower-case uncertainty is larger than the upper-case uncertainty. The plots for both the upper- and lower-case uncertainty are shown in Figure 3-2 and Figure 3-3.

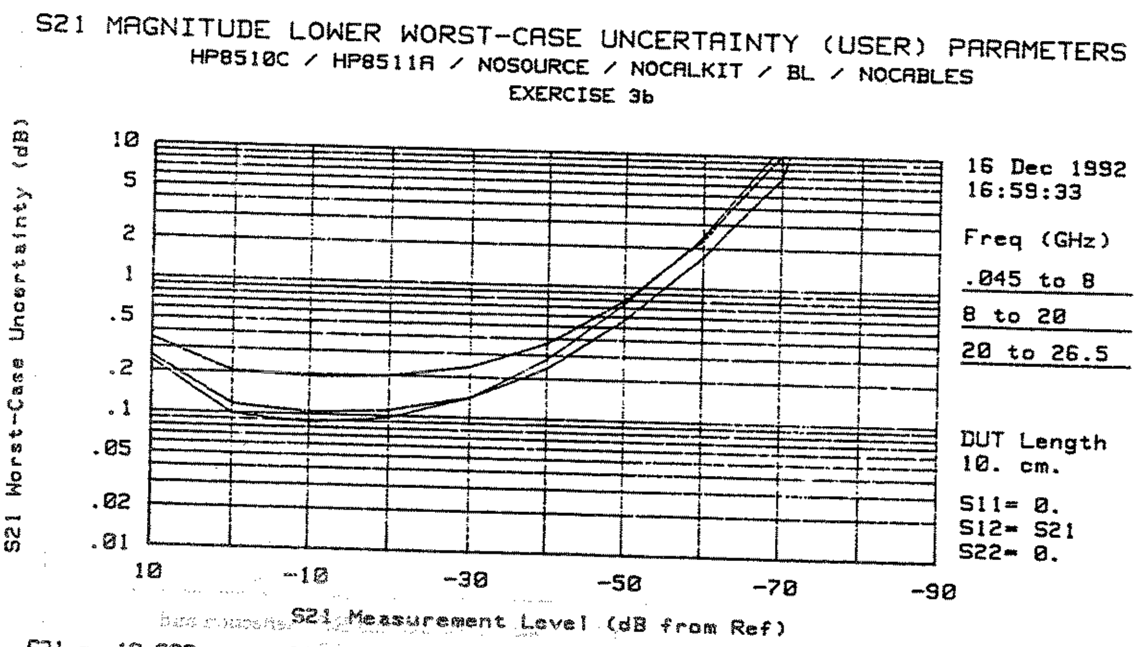


Figure 3-2. S21 Magnitude Upper-Case Uncertainty, User Parameters for Special Test Set

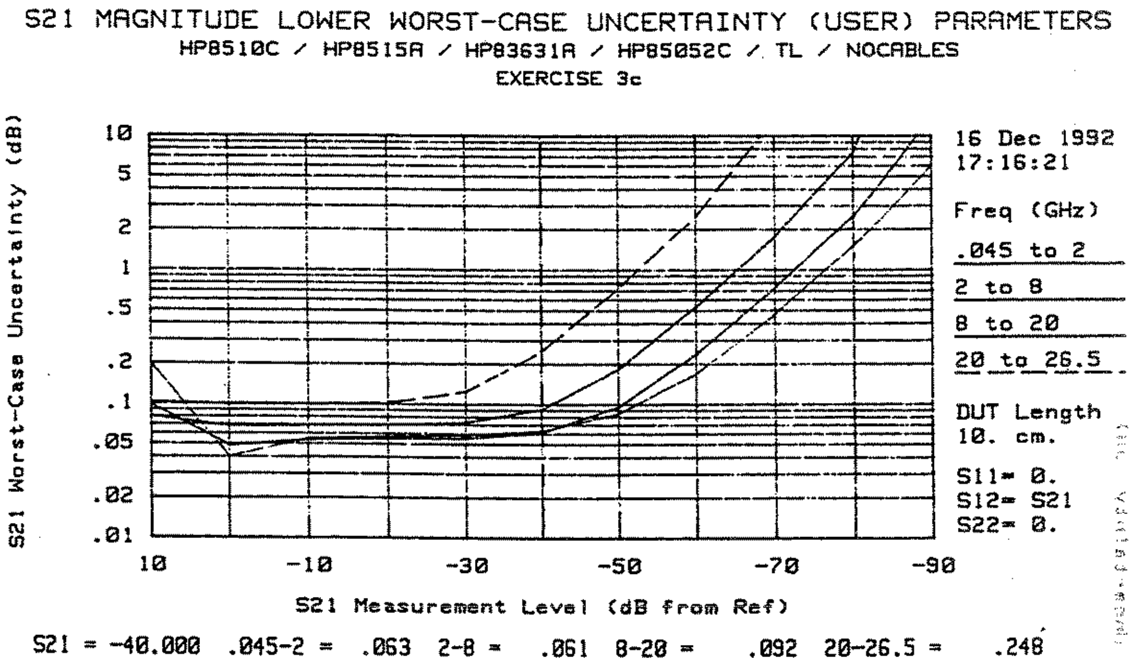


Figure 3-3. S21 Magnitude Lower-Case Uncertainty, User Parameters for Special Test Set

Exercise 3c: Answers to Using Non-Standard Test Cables

Table 3-6. Tutorial Exercise 3c. Answers

Questions	Answers
Assuming you have specified `No Cables` in the Hardware Configuration menu, which error terms do you need to degrade to account for these cable?	Cable loss, DC and RF. Reflection and transmission repeatability.
What is the calculated worst-case loss of the custom cables?	0.4 dB should be the calculated loss error term result.
Which reflection and transmission test should you perform to determine the stability of the non-standard cables?	For transmission stability: Connect the cables together and measure S21. Look at S21/M, then bend the cables.
	For reflection stability: Connect the short to port 1 cable and measure S11. Look at S11/M, then bend the cables. Repeat the reflection measurement on port 2 cable and measure S22.

Table 3-7. Error Term Values Needed for This Custom Cable

Question	Port 1 ETerm	Port 2 ETerm	2.0 GHz	8.0 GHz	20 GHz	26.5 GHz
What are the new calculated values for port 1 and port 2 error terms?	Ld1c	Ld2c	−0.25 dB	−0.25 dB	−0.25 dB	−0.25 dB
	Lf1c	Lf2c	−0.40 dB	−0.40 dB	−0.40 dB	−0.40 dB
	Crm1	Crm2	−45.0 dB	−41.0 dB	−35.0 dB	−31.0 dB
	Ctm1	Ctm2	0.02 dB	0.03 dB	0.04 dB	0.06 dB
	Cpf1	Cpf2	0.10 dB	0.10 dB	0.10 dB	0.10 dB

Review the graph of the new error terms in the figures below. The uncertainties are higher for the system using non-standard cables than for the system using HP 85131F cables. See Figure 3-4 and Figure 3-5.

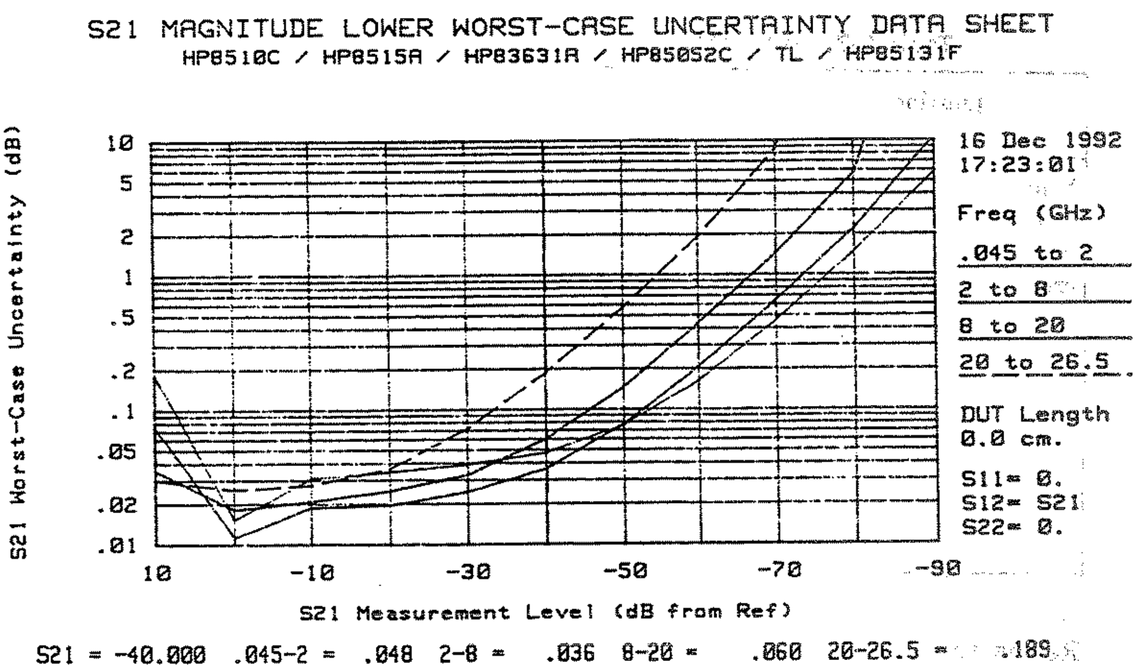
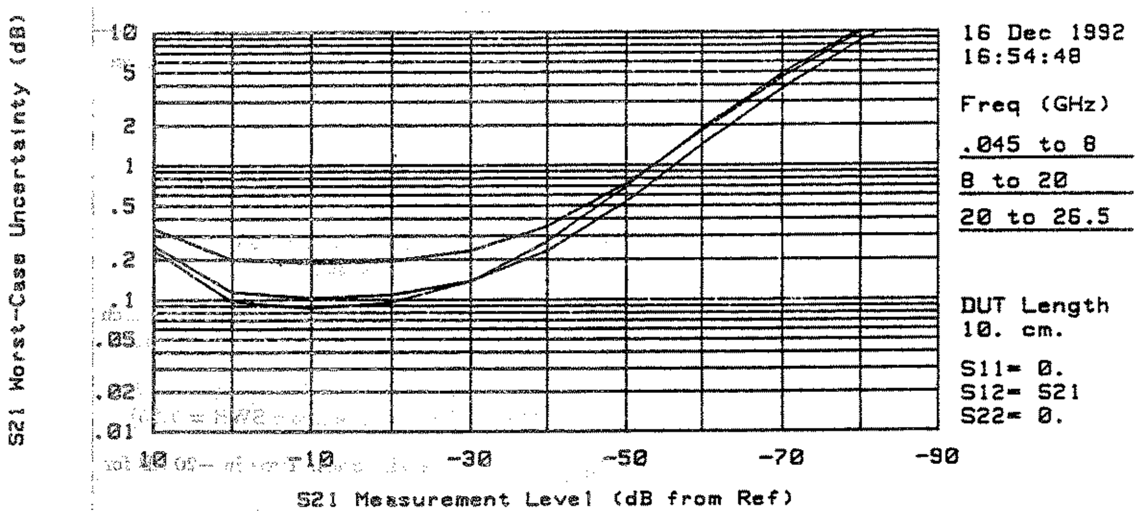


Figure 3-4. S21 Magnitude Uncertainty Using Custom Cables

S21 MAGNITUDE UPPER WORST-CASE UNCERTAINTY (USER) PARAMETERS
HP8510C / HP8511A / NOSOURCE / NOCALKIT / BL / NOCABLES



S21 = 10.000 .045-8 = .233 8-20 = .250 20-26.5 = .337

Figure 3-5. S21 Magnitude Uncertainty Using HP 85131F Cables

Exercise 3d: Answers to Using Non-Ideal Test Device

Table 3-8. Tutorial Exercise 3d. Answers

Questions	Answers
What are the measurement uncertainties for each frequency range in the attenuator measurement?	a. After setting up the hardware configuration for the non-ideal test device, go to the Main menu and press the `System Uncert` key. b. Select a plot for S21 magnitude, `Lower Limit`, `Worst-Case Uncertainty`, and `Computed Using = Specifications`. c. Notice that by default, the program assumes an "ideal" test device which has S21 = S12, with no reflection from either the input or output ports. d. Next, move to the space for entering S11 and press `Previous` until the asterisk blinks. Type in S11 = 0.11, the linear value (from SWR = 1.25). e. Go to S21, press `Previous` until the asterisk blinks. Type in −20 dB for S21. f. Go to S12, press `Previous` until the asterisk blinks. Type in S12 = −20 dB. g. Go to S22, press `Previous` until the asterisk blinks. Type in S22 = 0.11, the linear value. h. Enter the device length as 3 cm. i. Press `Done` to display the uncertainty plot. Use the marker to read the uncertainty values when S21 is −20 dB.
Using the marker, what are the uncertainty values when S21 is −20 dB for the different frequency ranges?	at 0.045 GHz to 2 GHz 0.065 dB uncertainty at 2.0 GHz to 8.0 GHz 0.077 dB uncertainty at 8.0 GHz to 20 GHz 0.111 dB uncertainty at 20 GHz to 26.5 GHz 0.129 dB uncertainty

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