



EDITION 2

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1400 FOUNTAIN GROVE PARKWAY, SANTA ROSA, CA 95403 U.S.A.

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.

SERIAL NUMBERS

HP 8510C ON-SITE SERVICE MANUAL

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10-5	INSPECT THE ERROR TERMS

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.

Theory of Operation (Chapter 3)

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

Safety/Licensing (Chapter 2)

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.

Service and Equipment Overview (Chapter 1)

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.

ORGANIZATION OF THIS ON-SITE SERVICE MANUAL

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.

INTRODUCTION

1. Service and Equipment Overview

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.

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.

SERVICE TOOLS AVAILABLE

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

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

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:

DEFINITION OF AN HP 8510 SYSTEM

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

Preventive Maintenance (Chapter 10)

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

This chapter describes the following:

Installation (Chapter 9)

- 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

This chapter describes the following:

Specifications and Performance Verification (Chapter 8)

TABLE OF SERVICE TEST EQUIPMENT

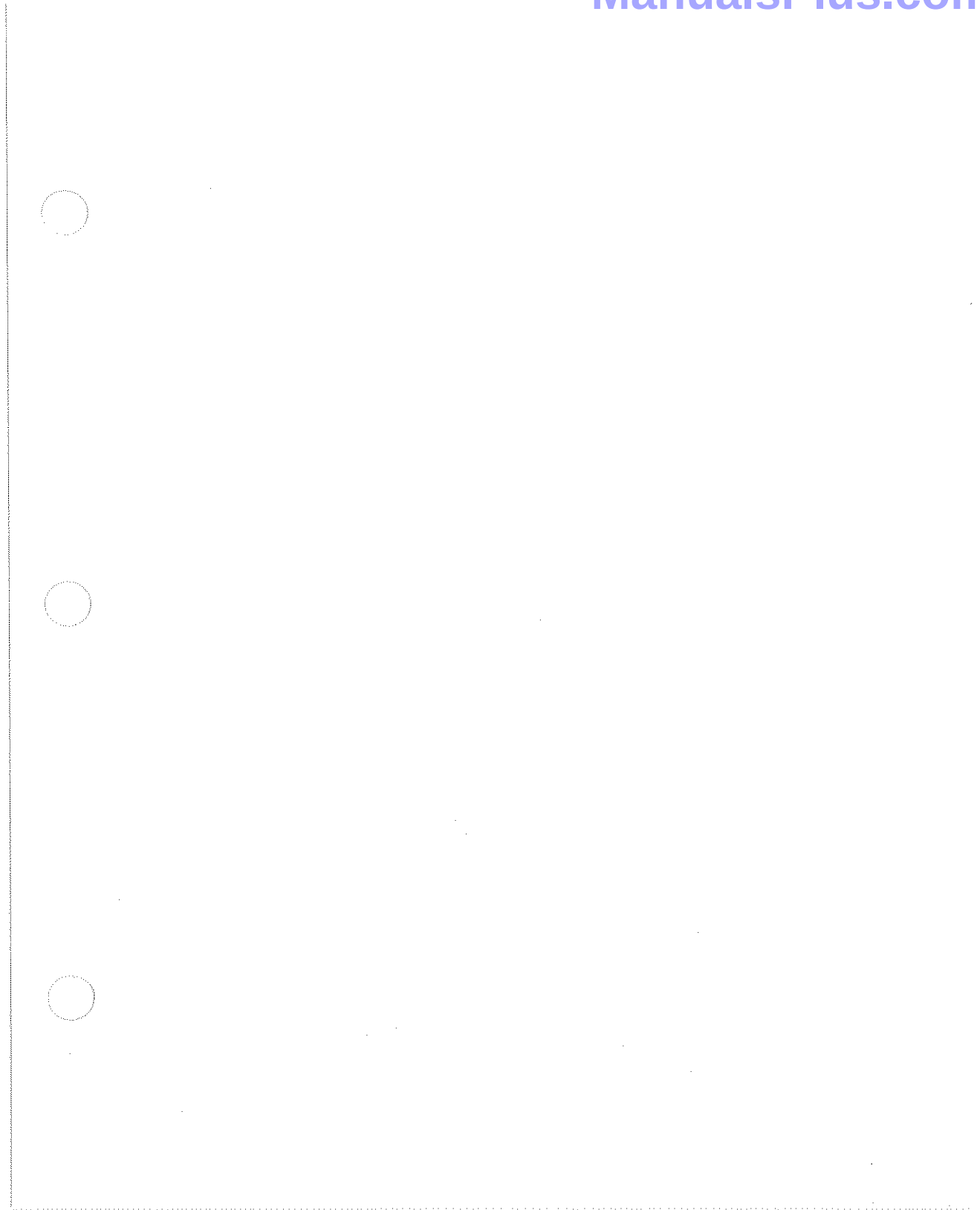
Table 1-1 lists the equipment required to verify, adjust, and troubleshoot the network analyzer. The table also notes the use and critical specifications of each item, and the recommended models. In addition to the test equipment listed in Table 1-1, the following tools are also required:

- #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"

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	
Verification Kit*	2.4 mm	HP 85056B	P.T	
	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 2.5 Mbytes RAM, and 3.0 for dual source systems	HP 9000 Series	A.P.T	
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	
Power Sensor	50 MHz to 50 GHz 1 uW to 100 mW 100 kHz to 50 GHz	HP 8487A	P.T	
Digital Multimeter	General Purpose VOM 32 mV to 300V, AC/DC 1000:1 Divider	HP 3466A	A.T	
High Voltage Probe	45 MHz to 26.5 GHz	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	
Power Splitter	45 MHz to 50 GHz (2.4 mm) 45 MHz to 26.5 GHz (3.5 mm)	HP 33340D opt. 010	P	
		HP 11667B	A.P.T	
		HP 11667C	A.P.T	
Pulse Generator	35 nS to 1 second 20 MHz $\pm$ 1 Hz	HP 8013B	A	
Function Generator	Dual 0 to 15 Vdc	HP 3325B	A	
Dual Power Supply	100 kHz to 26.5 GHz	HP 6205C	A	
Spectrum Analyzer	HP-IB Controllable	HP 8566A	A	
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.

Table 1-1. Service Test Equipment



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.



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.

WARNING

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.

HAZARDOUS INSTRUMENT AREAS WITH POWER ON

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.

HP 8510 SAFETY INFORMATION

2. Safety/Licensing

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.



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.

WARNING

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 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)

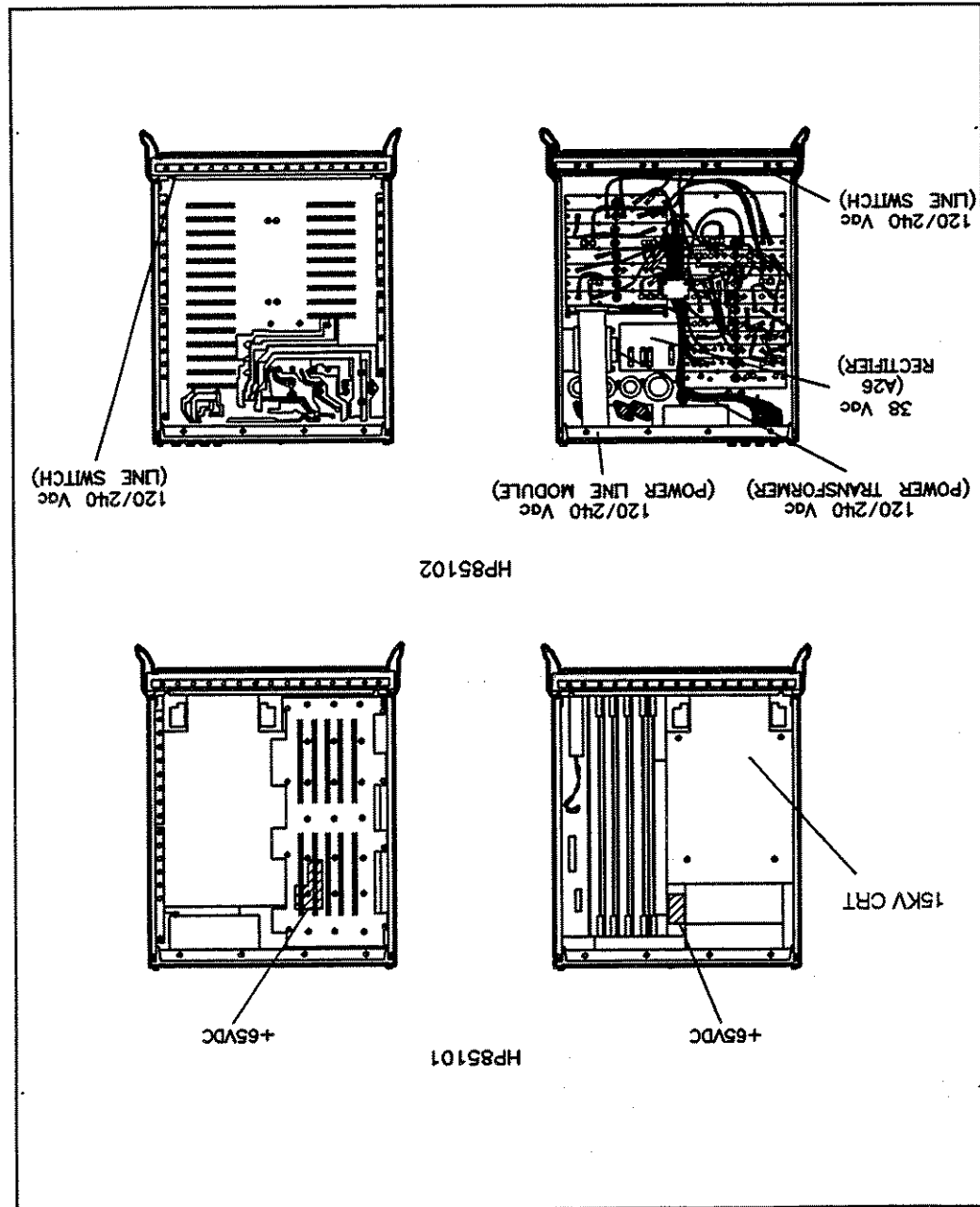
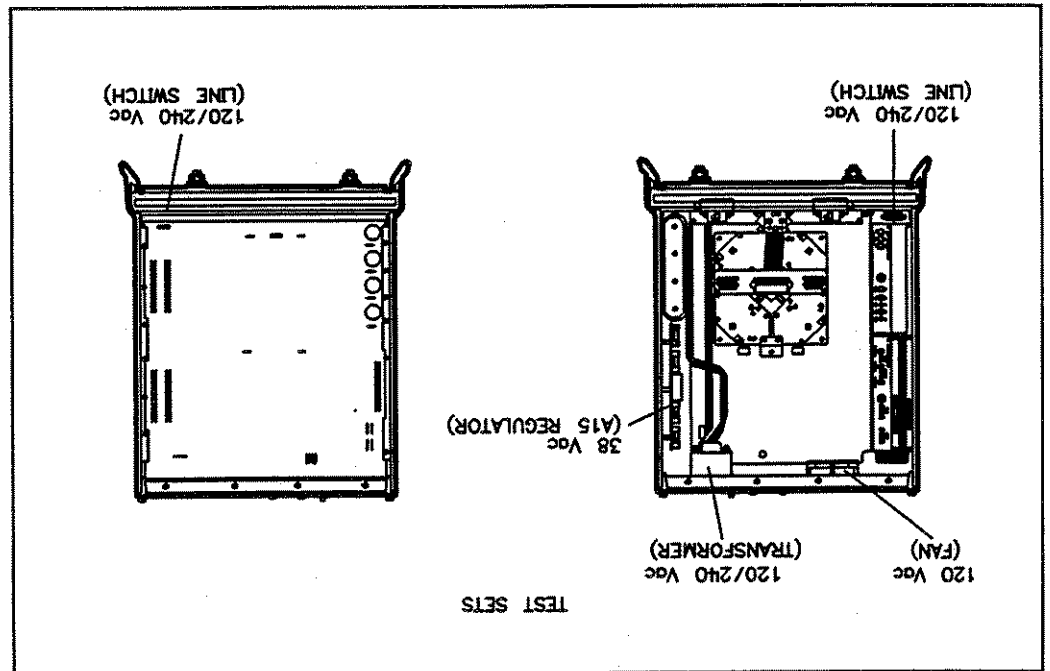


Figure 2-1. Location of Hazardous Voltages in HP 8510 Instruments (2 of 2)



Instruments with fan installed/Gerate mit eingebautem 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/Gerauschemission			
LpA < 70 dB Operator position Normal operation per ISO 7779		LpA < 70 dB am Arbeitsplatz normaler Betrieb nach DIN 45635 t. 19	

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

COMPLIANCE WITH GERMAN FTZ EMISSIONS REQUIREMENTS
The HP 8510C Network Analyzer complies with German FTZ 526/527 Radiated Emissions and Conducted Emissions requirements.

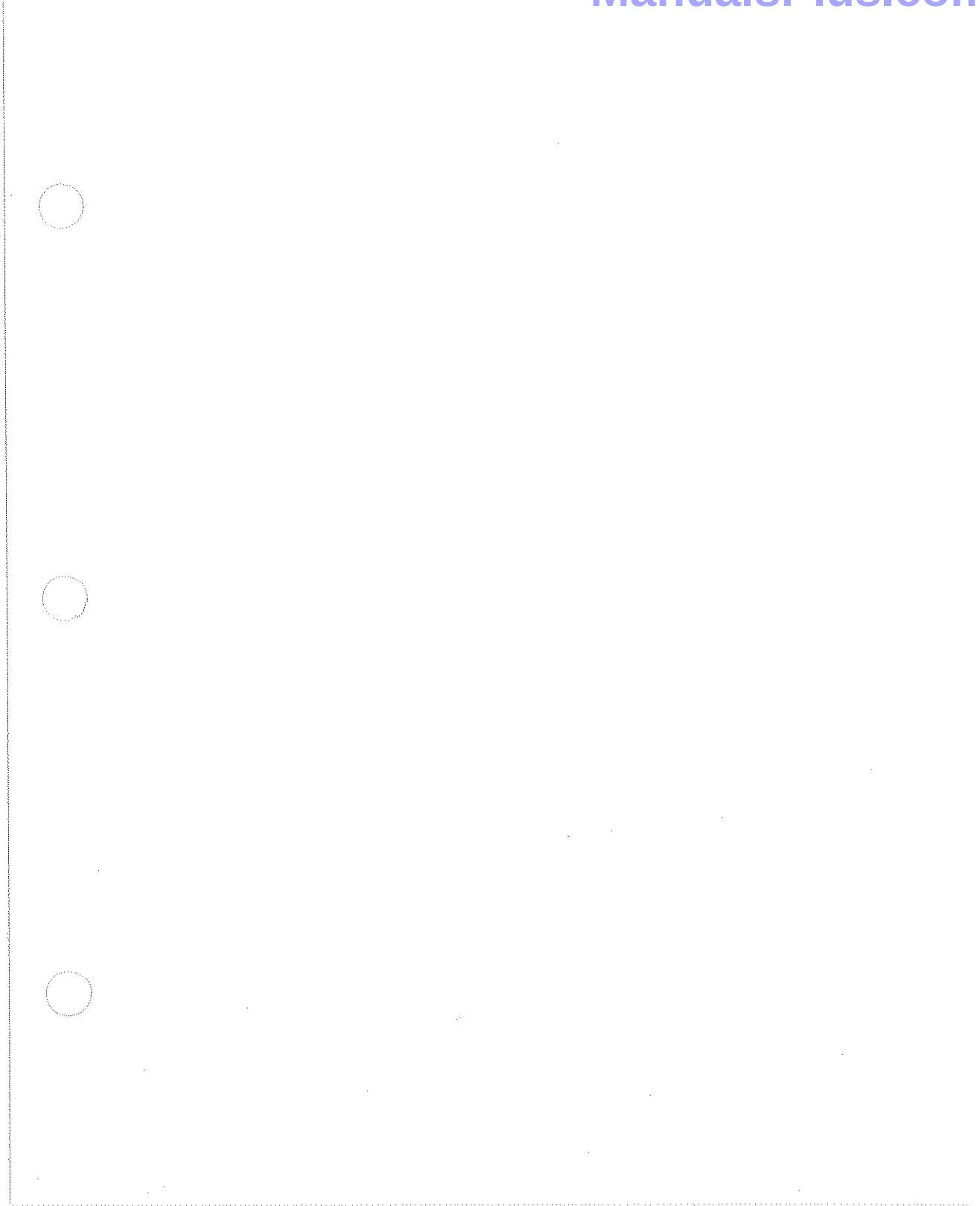
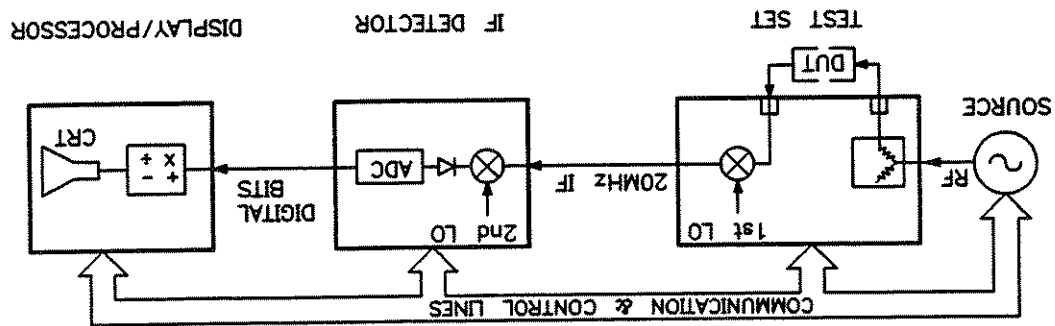


Figure 3-1. Forward Transmission Test Signal Path in HP 8510 Base System



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).

THE BASE SYSTEM

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.

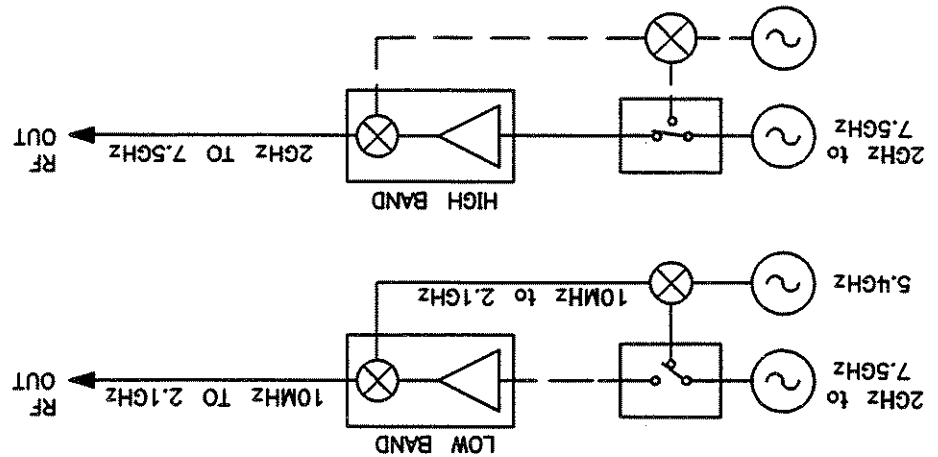
The final sections of this chapter describe a typical measurement sequence and explain the system phase-locked loop.

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 troubleshooted to the instrument level. The IF/detector and display/processor are troubleshooted to the assembly level. For additional source or test set information, refer to their manuals.

INTRODUCTION

3. Theory of Operation

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



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.

SOURCES

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 signal. 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.

converter.

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

after calibration.

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

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

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

Test sets have two main functions:

tion.

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

frequency range as many times as the selected averaging factor.

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.

Sweep Oscillators

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.

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.

Synthesized Sweepers

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.

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.

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.

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.

$$LO - RF = IF$$

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:

Mixer-Based Test Sets

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

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.

$$LO - RF = IF$$

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:

Sampler-Based Test Sets

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.

Test Set Typical RF Path

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.

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 transition 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.

Test Set Power-On Sequence

- 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.
- 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:

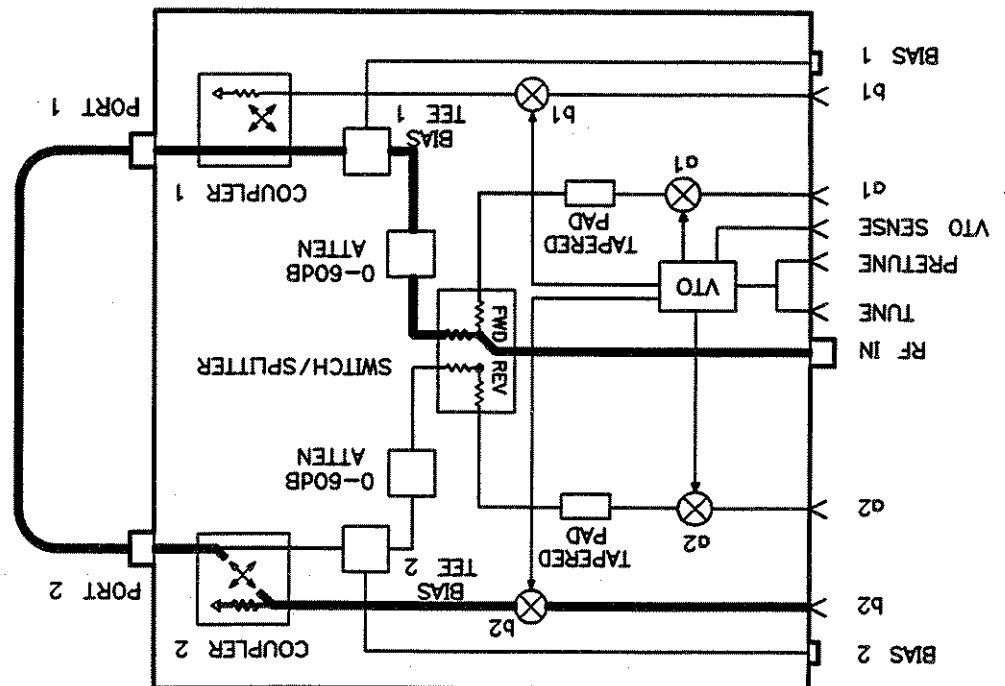
For the forward transmission measurement S21 ($b2/a1$), the RF signal path is as follows:

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.

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



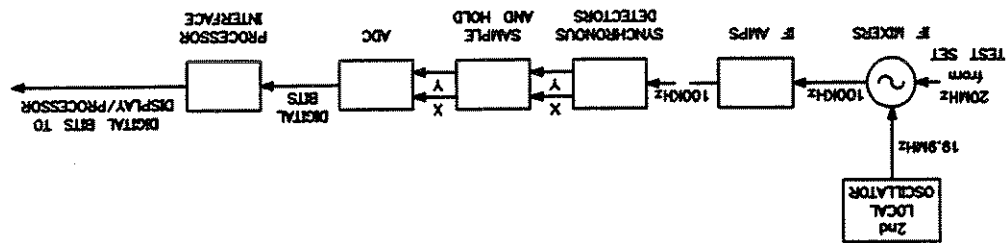
IF Mixers (A9, A11, A13, A14) buffer, filter and mix the 20 MHz signals (with the 19.9 MHz LO signal) down to 100 kHz. The assemblies are electrically and mechanically identical.

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

Test and Reference IF Amplifiers (A10, A12) autotune 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.

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



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

Signal Path Assemblies

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

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.

HP 85102 IF/DETECTOR

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.

Control Assemblies

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

Analog-to-Digital Converter (A18) assembly converts the X and Y pairs from the analog IF Processor Interface (A24) assembly transmits the digital bits to the display/processor and enables the IF/detector and display/processor to communicate.

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).

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.

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.

- Real-time clock¹
- The disc drive¹
- Two RS 232D ports¹
- Two HP-IB ports
- The HP 85101 interrupt system
- The HP 85102 interface
- The front panel interface
- The RFG counters

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:

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

Input/Output Assemblies

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

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:

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.

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

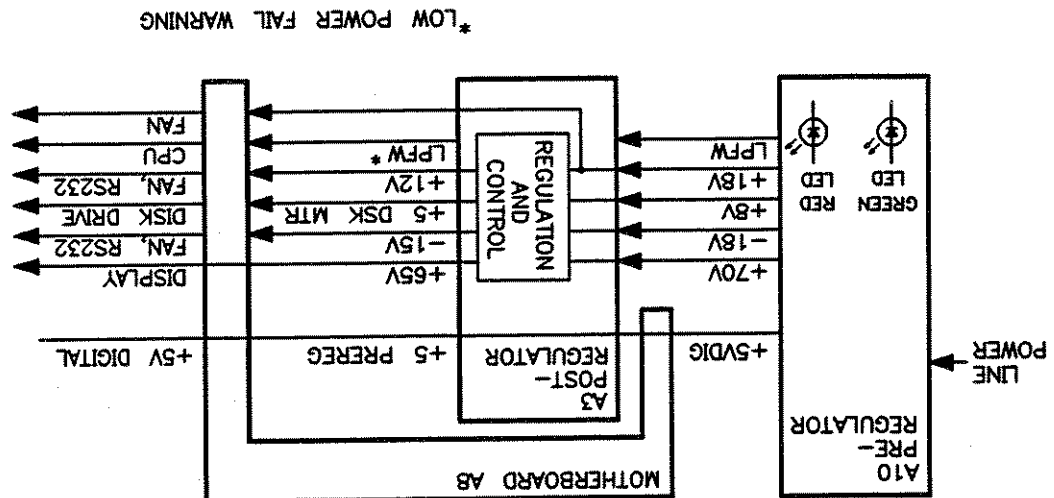
+70V -18V +8V +18V

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

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 current.

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.

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



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.

fully.

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

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.

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

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.

- Low power circuit
 - Variable fan speed circuit
 - Shutdown circuit
- The post-regulator consists of these circuits (among others):
- +5 DSK MTR (for the disc drive motor)
 - +12V (variable for the fan and fixed for RS 232 ports)
 - +5 PREFERENCE (digital supply, also called +5V DIG)
 - -15V (for the fan and [dropped to -12V] for RS 232 ports)
 - +65V (for the display)

indications for the individual voltage supplies:

start voltages to individual assemblies throughout the instrument. Five green LEDs provide status

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 con-

dition.

The Red LED is off in normal operation. It lights to indicate a +5V supply fault or power trans-

Shutdown Indicators: 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.

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.

SYSTEM PHASE LOCK OPERATION

9. The display/processor reads the sample pairs, processes them, and displays them on the CRT.
8. The IF/detector digitizes the X and Y sample pairs.
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.
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.
5. The test set down-converts the RF signals (test and reference) into separate 20 MHz IF frequencies.
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.
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.
2. The system achieves phase lock as explained in "System Phase Lock Operation" (next).
1. The HP 8510 display/processor sets the source and test set VTO start frequencies.

HP 8510 TYPICAL SYSTEM MEASUREMENT SEQUENCE

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

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.

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 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)

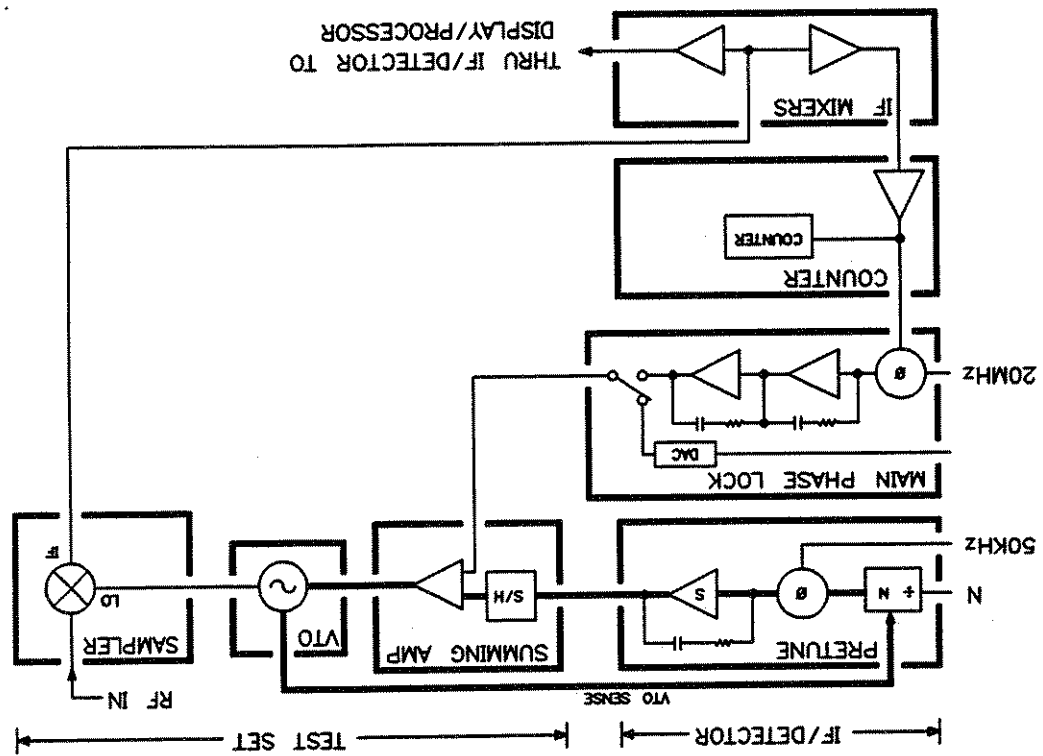
Four main assemblies constitute the phase lock system:

PRETUNE FAILURE

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:

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.

Figure 3-6. Simplified Pretune Phase-Locked Loop



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.

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 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.

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.

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.

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.

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 (a₁ or a₂) with the PIN switch on the IF counter board.

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

Pretune IF Count Sequence

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.

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 ($1.8 \text{ GHz} + 20 \text{ MHz} = 1.82 \text{ GHz}$). 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 ($1.82 \text{ GHz} / 9$).

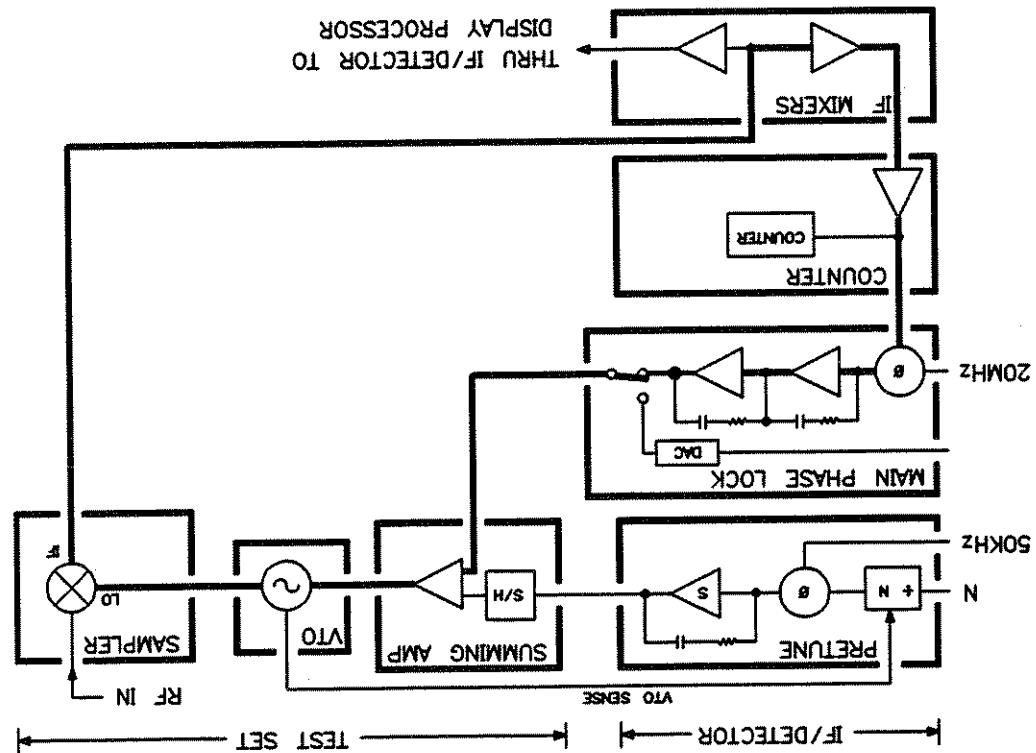


Figure 3-7. Simplified Main Phase Lock Loop

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.

Main Phase Lock Sequence

NO IF FOUND

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:

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).

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.

Phase Lock Learn Mode

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).

VTO OVER-RANGE

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

Monitoring the VTO

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.

PHASE LOCK LOST

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:

Monitoring Phase Lock

PHASE LOCK FAILURE

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 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.

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.

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

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 returning the LO to 498 MHz, it would find the required 20 MHz IF.



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.

- 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

ing:

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

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.

INTRODUCTION

4. Main Troubleshooting Procedure

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.



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 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."

Self-Test Failures

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.

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

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

WHAT'S WRONG

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

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."

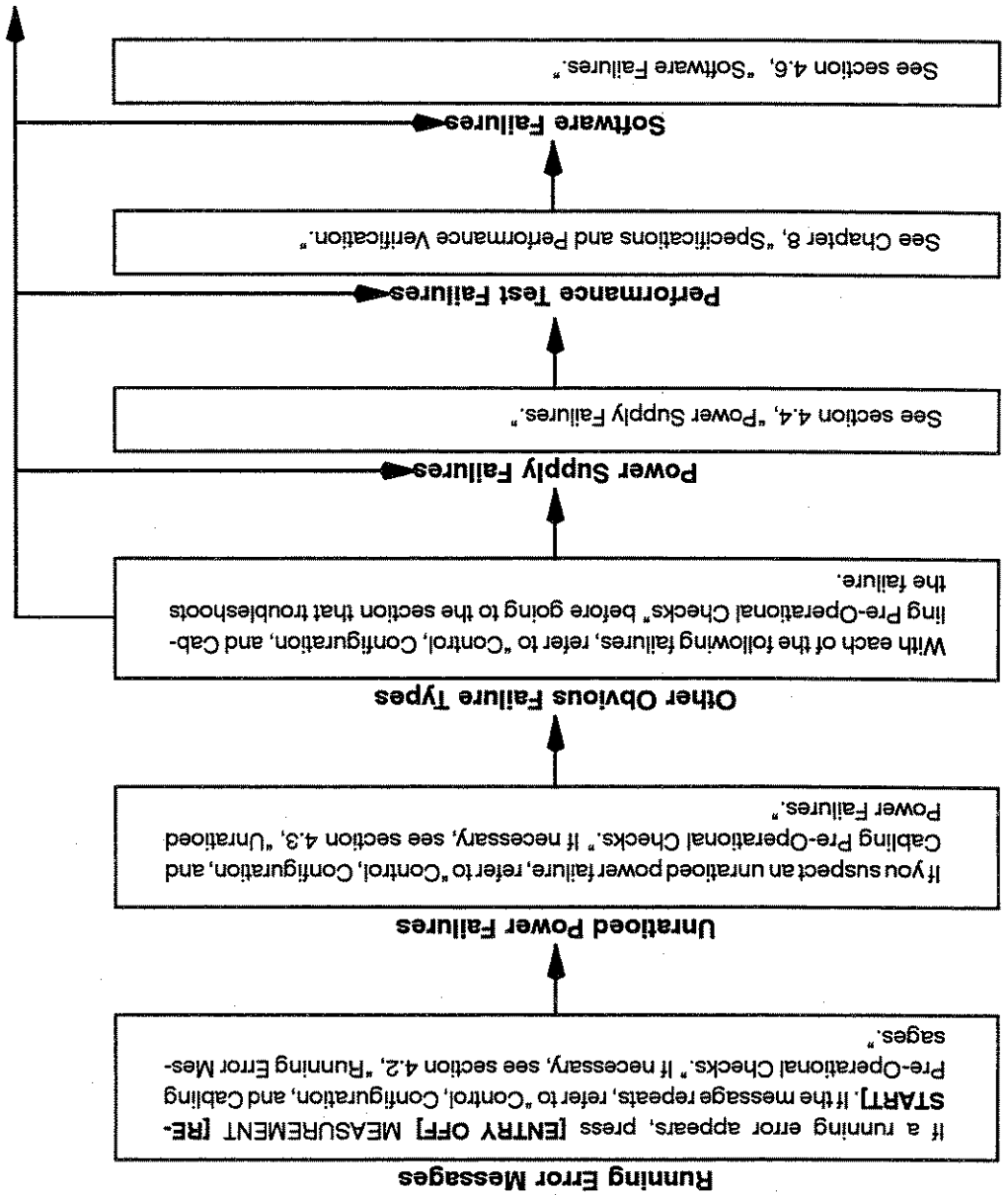
Other Obvious Failure Types

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."

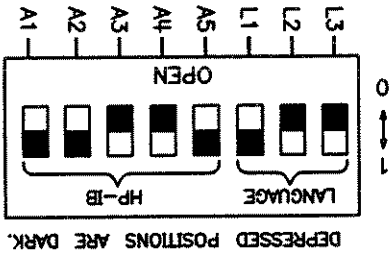
ABBREVIATED HP 8510C SYSTEM SERVICE FLOWCHART (cont.)
(See opposite page for detailed procedure)

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

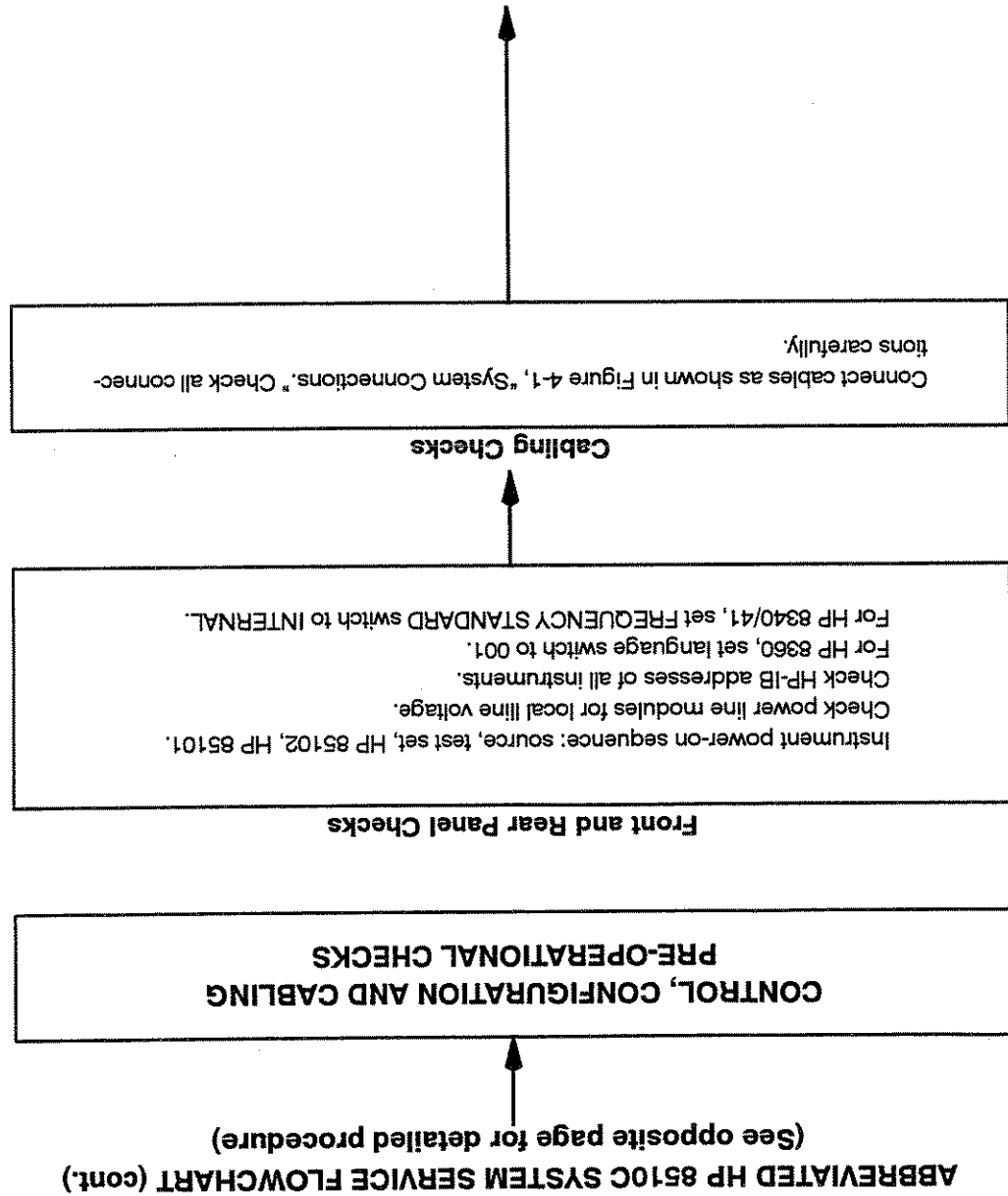
- Switch off power to all instruments. Switch on, in this sequence, the source, test set, HP 85102, (also HP 85101 if an early version with power switch).
- If the display is not clear, try to improve it with the intensity control.
- Source front panel: switch settings are of no concern, except for the 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:



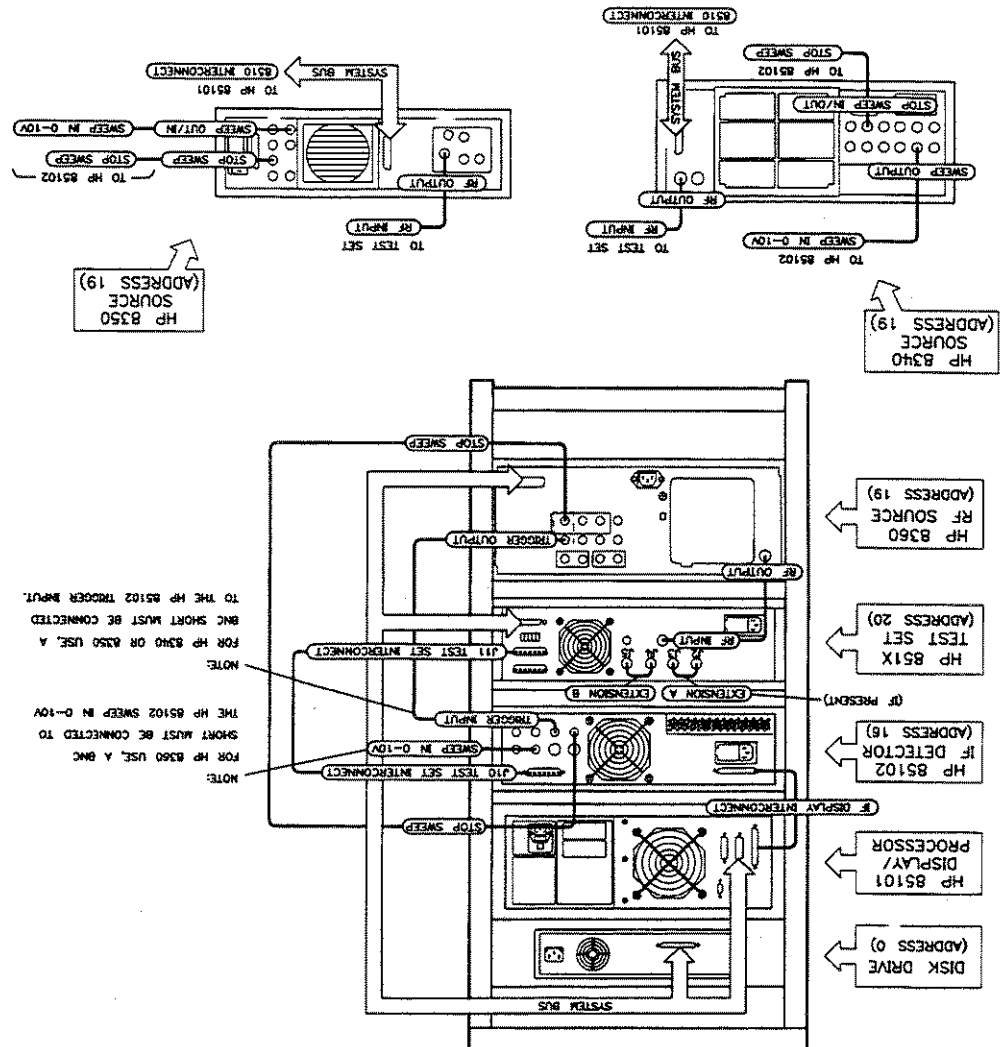
Cabling Checks

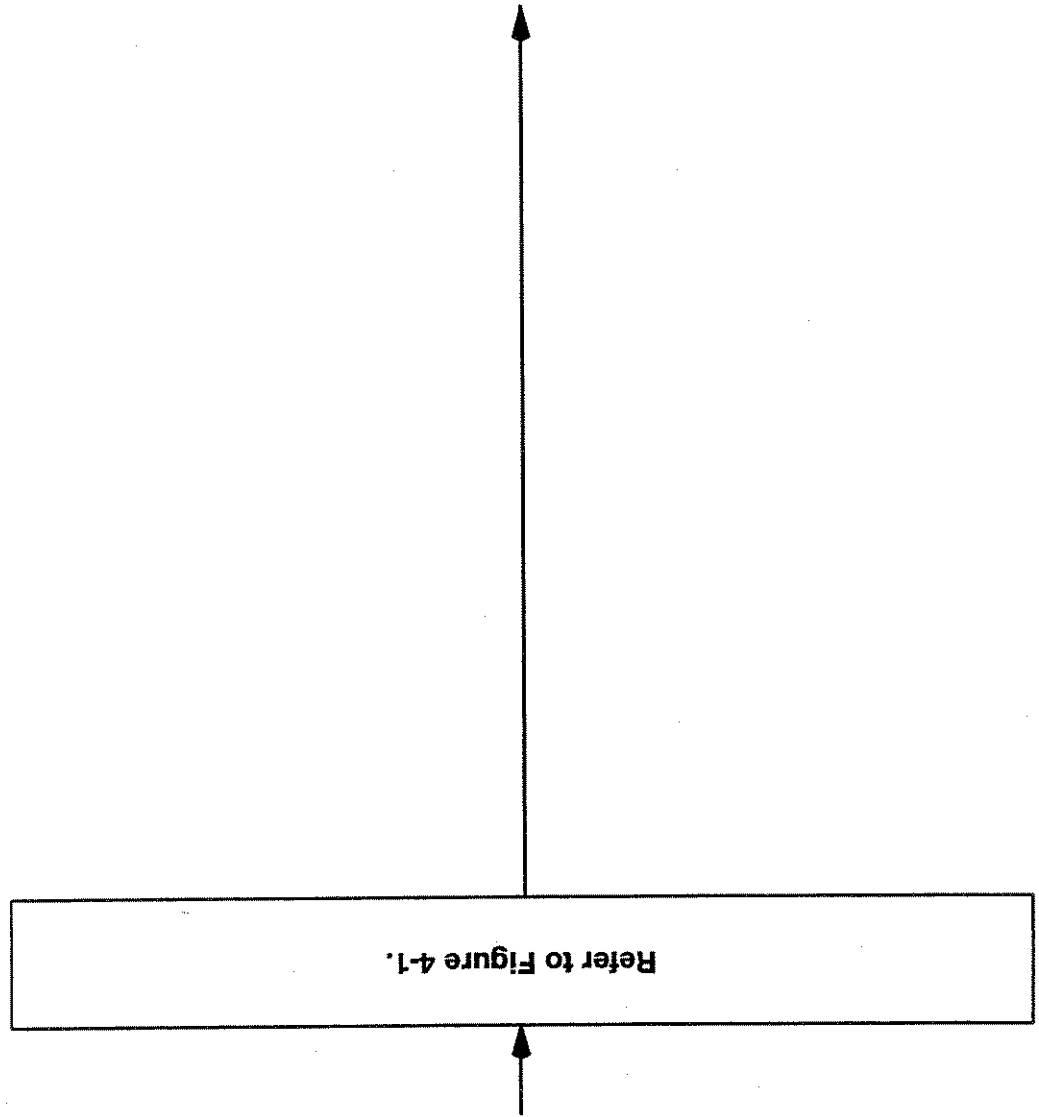
- If the source is an HP 8340/8341, make sure the rear panel FREQUENCY STANDARD switch is set to INTERNAL.
- Make sure the system cables are connected as shown in Figure 4-1, "System Connections."
- Make sure the test set rear panel reference port extension cables are in place. See chapter 9, "Installation," 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.



NOTES:





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

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	All	No modification required ¹	
83651A			
83621A	<3103A	HP 83601A upgrade kit ^{2, 5}	
83631A	3103A	08360-60167 firmware kit ⁵	
83622A	3104A to 3111A	08360-60201 firmware kit ⁵	
	≥ 3112A	No modification required ¹	
	≤ 3103A	08360-60167 firmware kit ⁴	note 3
83624A	3104A to 3111A	08360-60201 firmware kit ⁴	note 3
83640A	≥ 3112A	No modification required ¹	note 3
83642A			

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

Table 4-1. HP 8360 Upgrade Summary

- 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]**.

Firmware Revisions

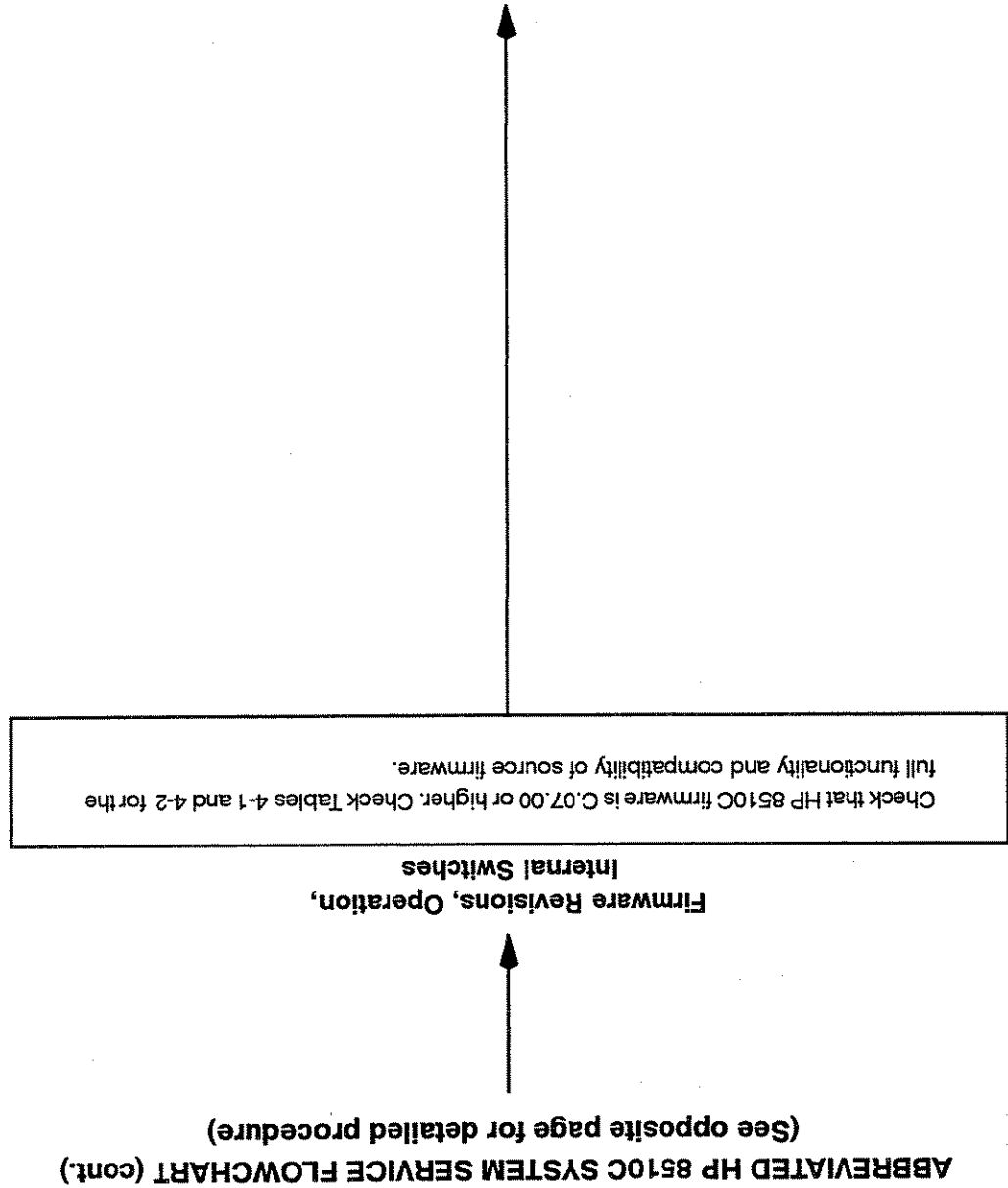
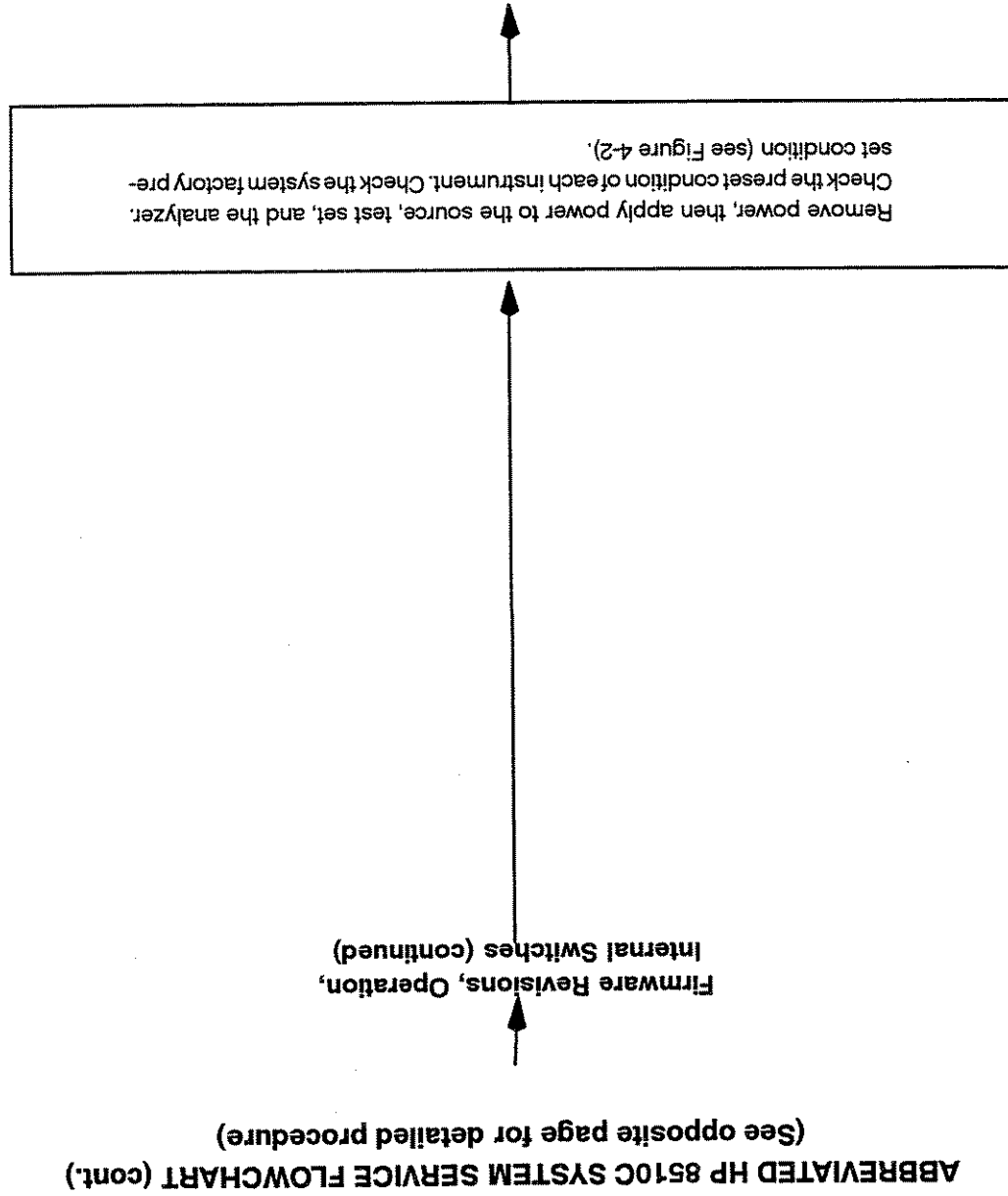


Figure 4-2.

- 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

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	83525-60074
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	

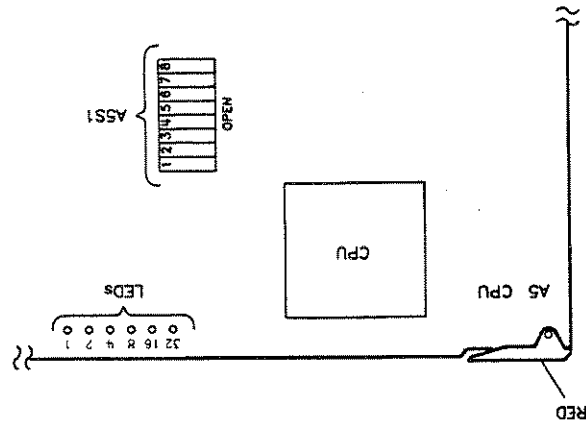
1. The sources listed above are the only compatible sources as of December 1990. Consult your HP customer engineer for additional information.
 To check the firmware revision on your HP 8360, press **[SHIFT] [49]**. The revision appears in the FREQUENCY/TIME window.
 To check the firmware revision on 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.



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

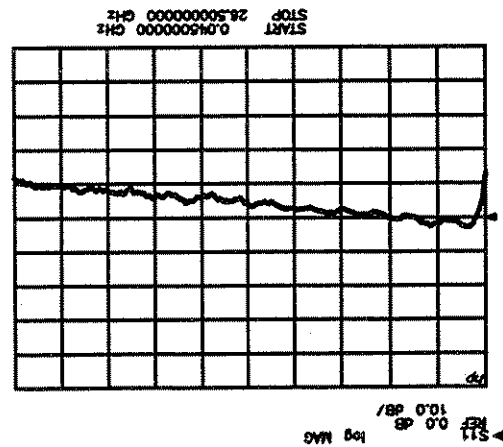
- Remove the test set top cover. Check the setting of configuration switch A3S1. The correct settings are shown at the left side of the HP 8510C System-Level Troubleshooting Block Diagram at the end of this procedure.
- If the source is an HP 8350, check the setting of configuration switch A3S1. The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

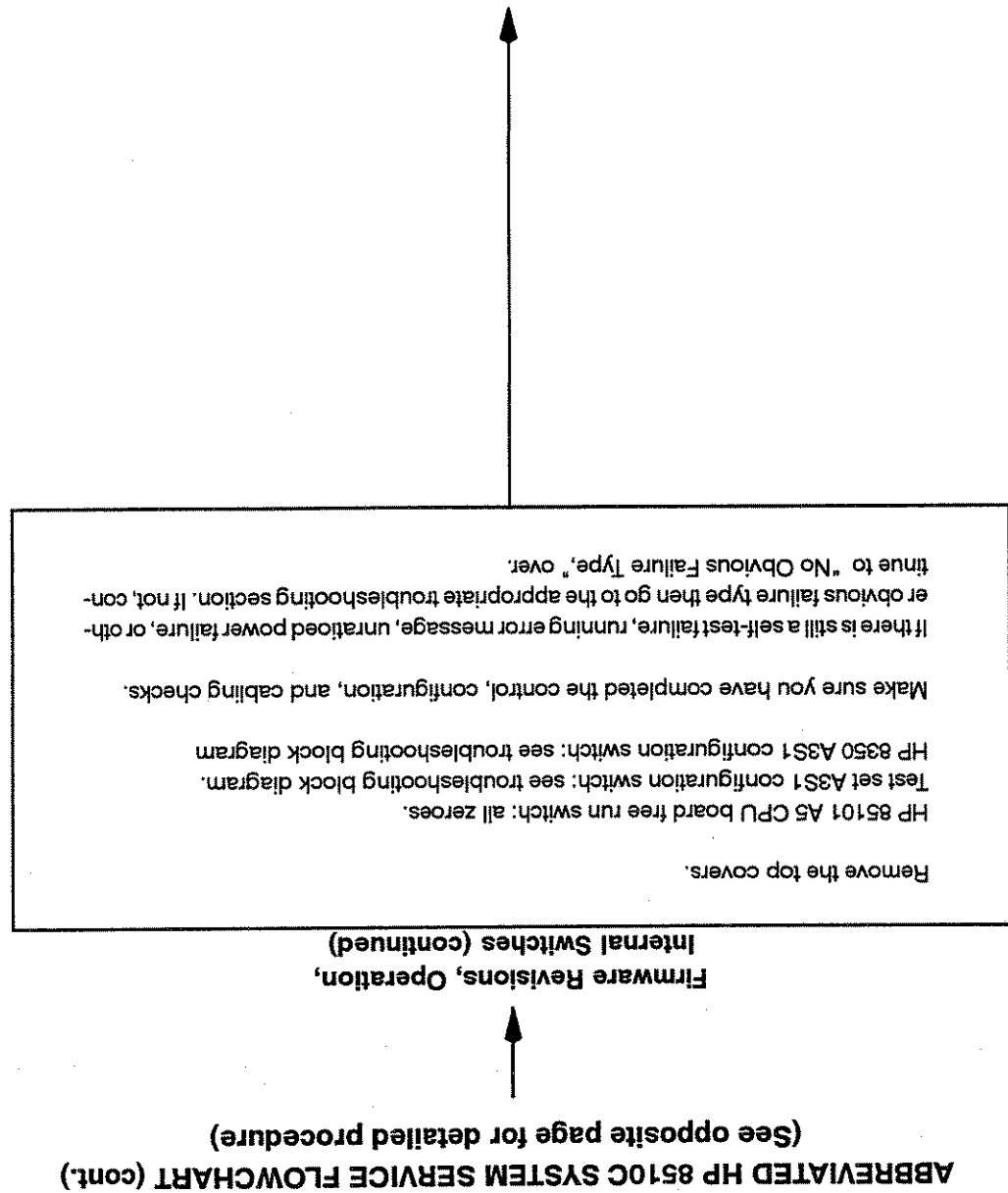
Figure 4-3. Location of Switch A3S1



- Remove the HP 8510C 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 4-2. System Factory Preset State





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.

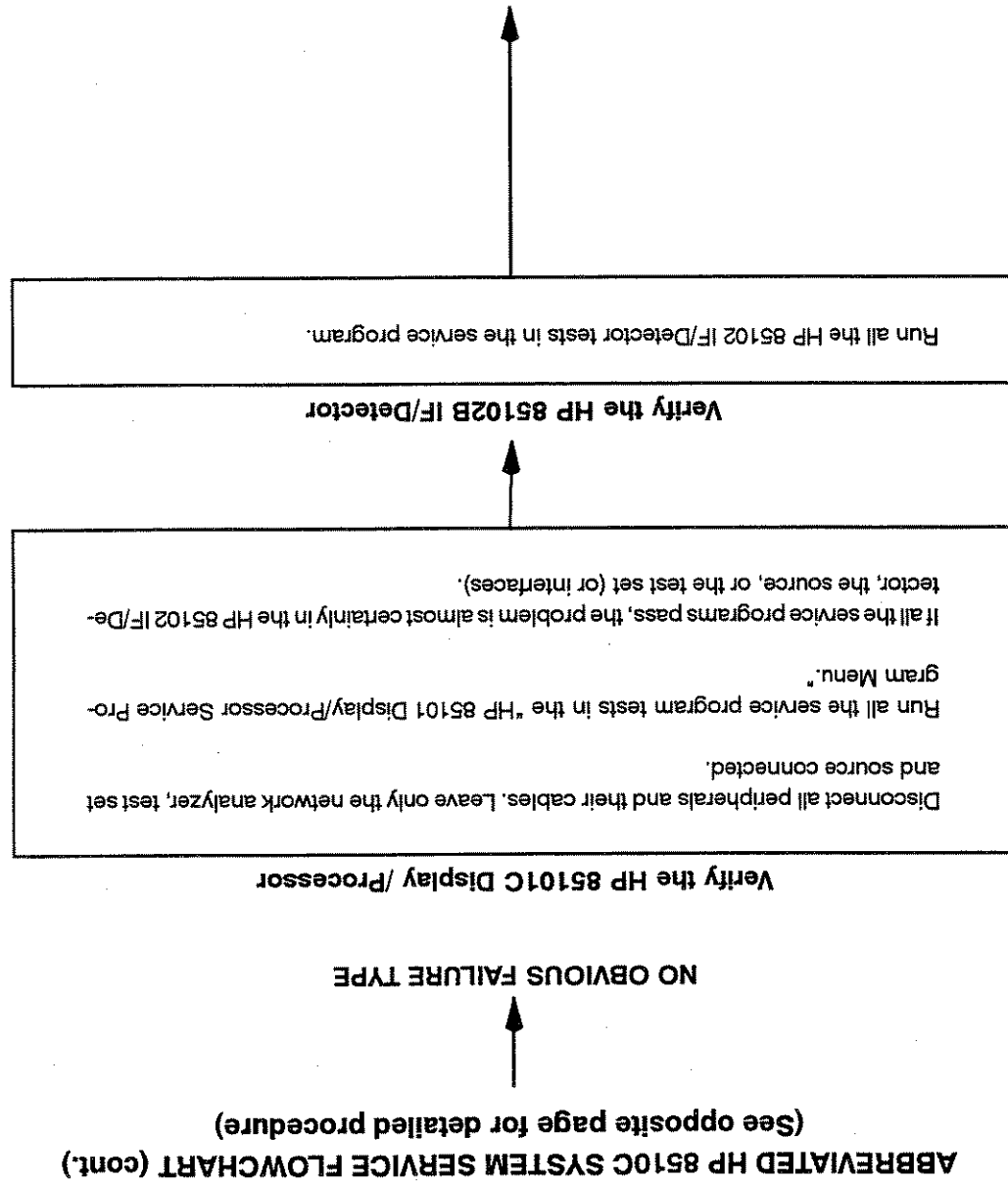
Refer to section 4.8, "Service Program," and run all the tests in the "HP 85101 Display/Processor Service Program Menu."

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.



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%.

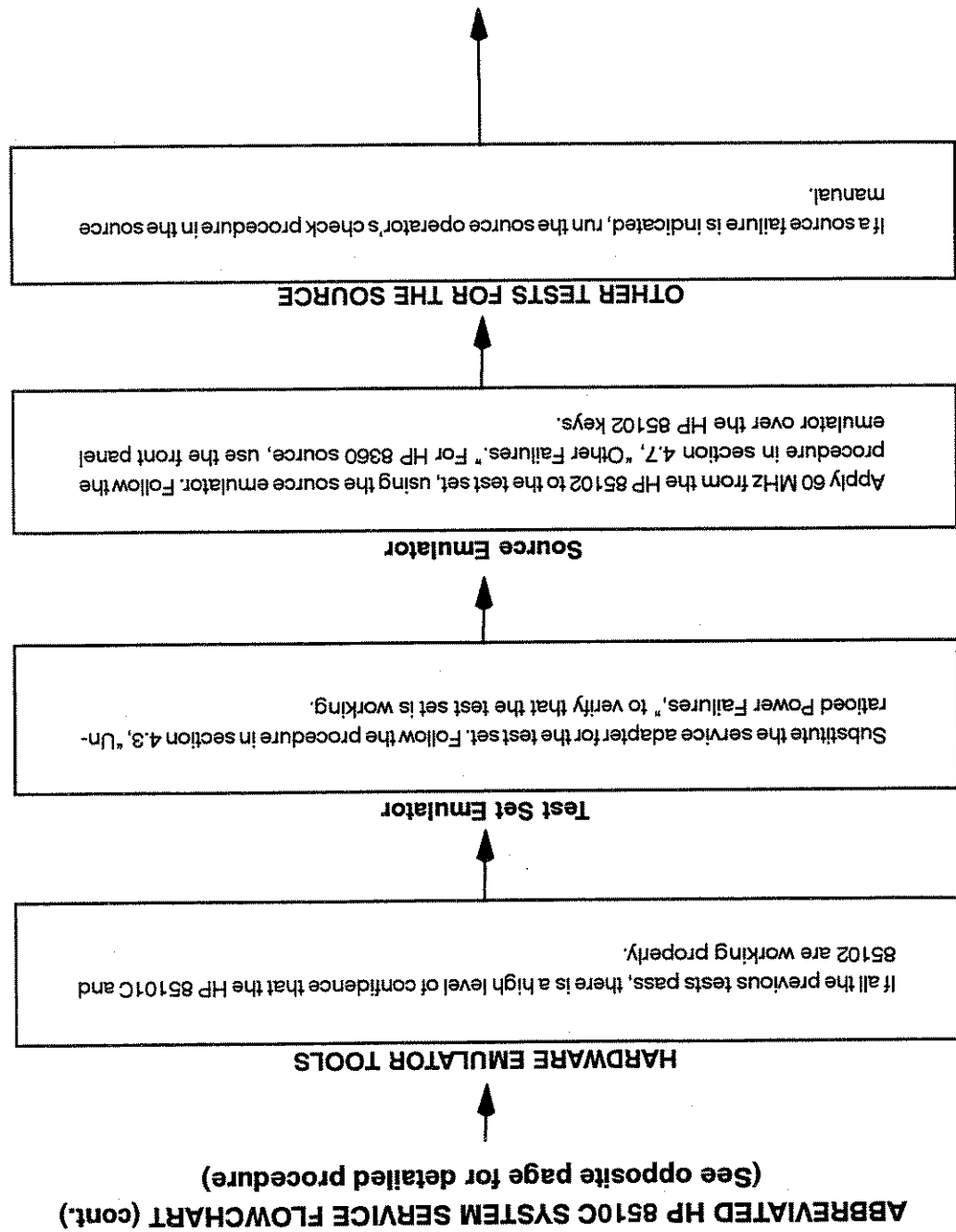
Source Emulator

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.

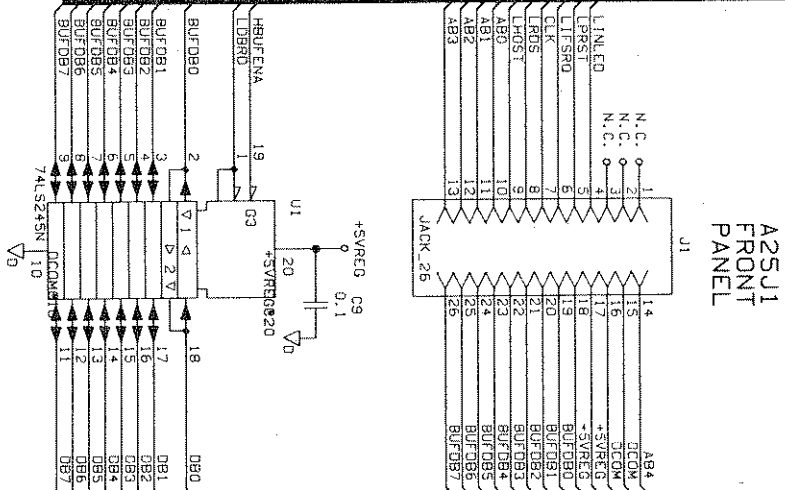
OTHER TESTS FOR THE SOURCE

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.

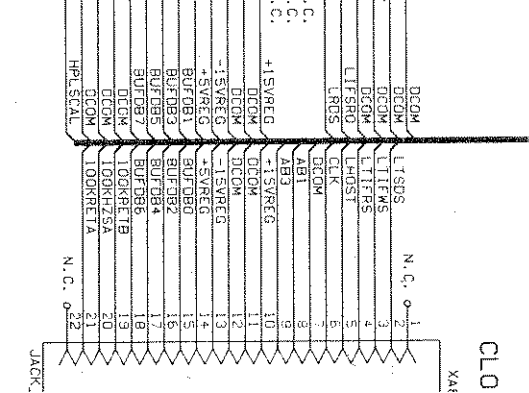
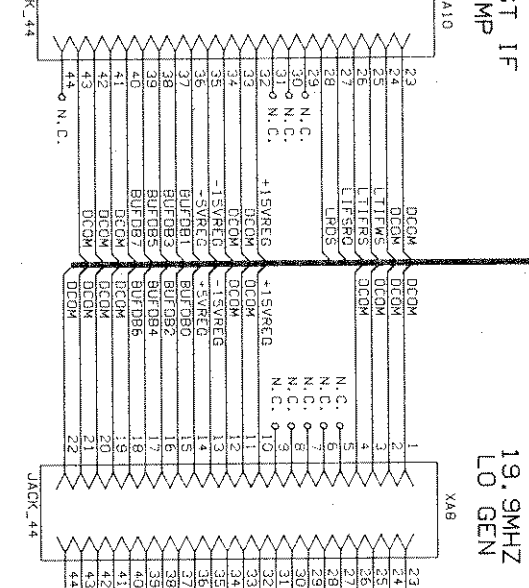
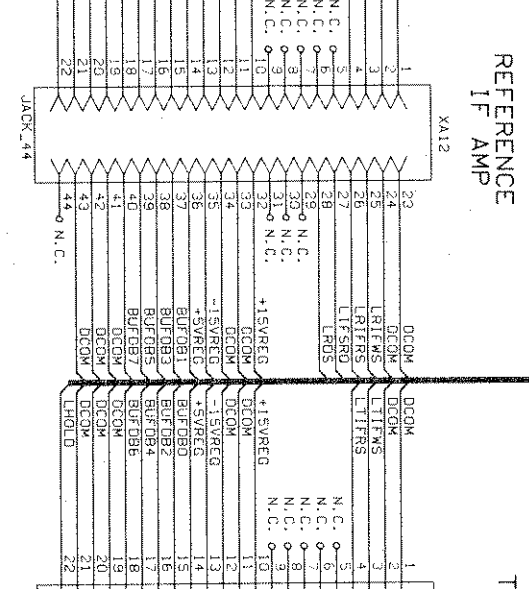
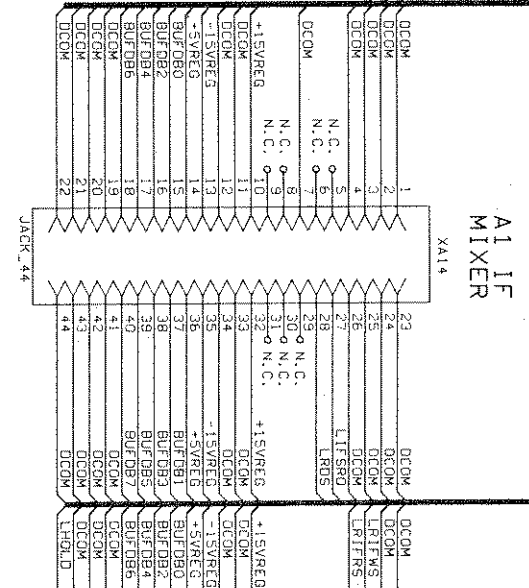
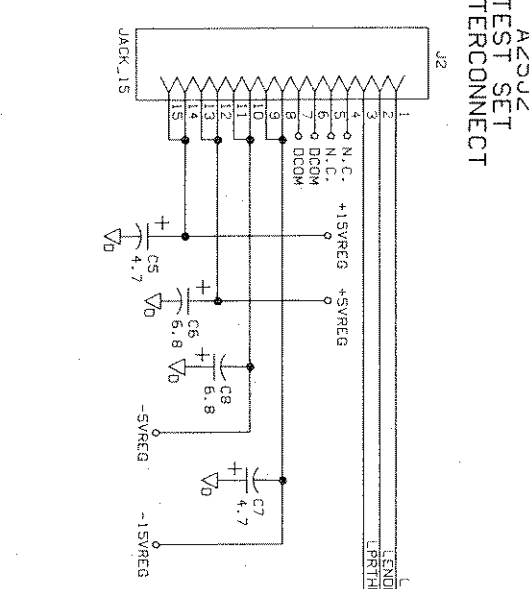
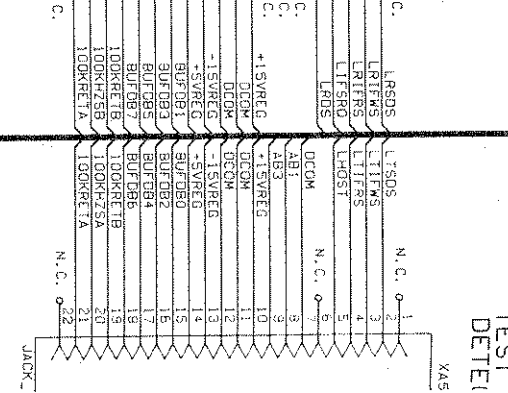
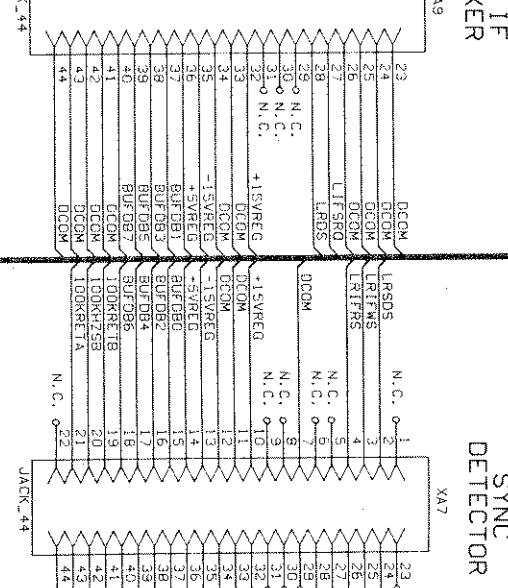
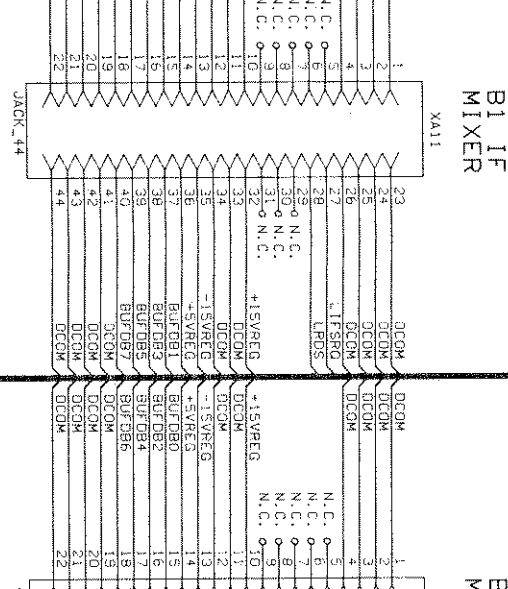
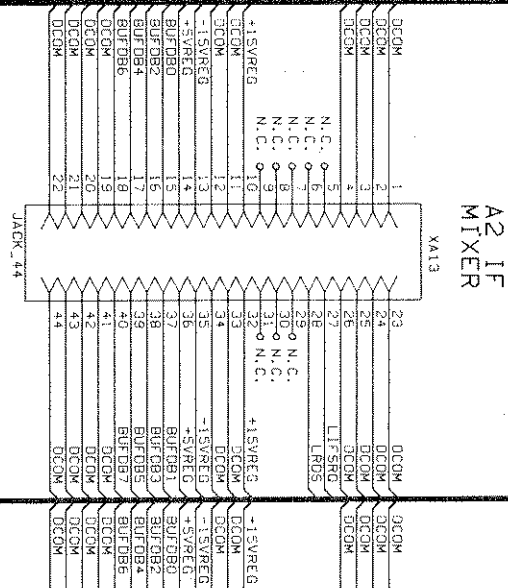
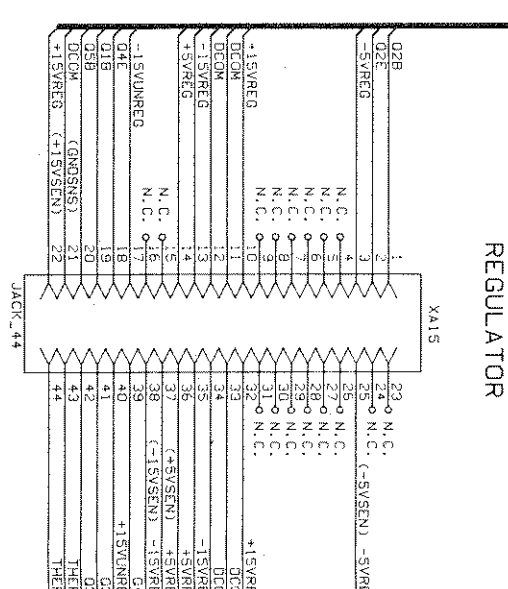
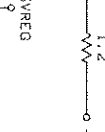
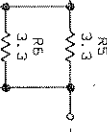
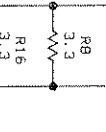
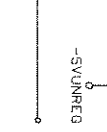
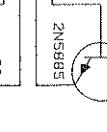
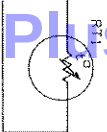




HP 85



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



A4 GRAPHICS
SYSTEM PROCESSOR

J2-56>	D14	XA4J1-110	XA4J1-55X
J2-57>	D12	XA4J1-109	XA4J1-54X
J2-58>	D10	XA4J1-108	XA4J1-53X
J2-59>	D8	XA4J1-107	XA4J1-52X
J2-60>	D6	XA4J1-106	XA4J1-51X
J2-61>	D4	XA4J1-105	XA4J1-50X
J2-62>	D2	XA4J1-104	XA4J1-49X
J2-63>	D0	XA4J1-103	XA4J1-48X
J2-64>	DGND	XA4J1-102	XA4J1-47X
J2-65>	L10	XA4J1-101	XA4J1-46X
J2-66>	L16	XA4J1-100	XA4J1-45X
J2-67>	A15	XA4J1-99	XA4J1-44X
J2-68>	A13	XA4J1-98	XA4J1-43X
J2-69>	A11	XA4J1-97	XA4J1-42X
J2-70>	A9	XA4J1-96	XA4J1-41X
J2-71>	A7	XA4J1-95	XA4J1-40X
J2-72>	A5	XA4J1-94	XA4J1-39X
J2-73>	A3	XA4J1-93	XA4J1-38X
J2-74>	A1	XA4J1-92	XA4J1-37X
J2-75>	DGND	XA4J1-91	XA4J1-36X
J2-76>	DGND	XA4J1-90	XA4J1-35X
J2-77>	N.C.	XA4J1-89	XA4J1-34X
J2-78>	N.C.	XA4J1-88	XA4J1-33X
J2-79>	DGND	XA4J1-87	XA4J1-32X
J2-80>	N.C.	XA4J1-86	XA4J1-31X
J2-81>	N.C.	XA4J1-85	XA4J1-30X
J2-82>	DGND	XA4J1-84	XA4J1-29X
J2-83>	DGND	XA4J1-83	XA4J1-28X
J2-84>	N.C.	XA4J1-82	XA4J1-27X
J2-85>	N.C.	XA4J1-81	XA4J1-26X
J2-86>	N.C.	XA4J1-80	XA4J1-25X
J2-87>	N.C.	XA4J1-79	XA4J1-24X
J2-88>	N.C.	XA4J1-78	XA4J1-23X
J2-89>	DGND	XA4J1-77	XA4J1-22X
J2-90>	N.C.	XA4J1-76	XA4J1-21X
J2-91>	DGND	XA4J1-75	XA4J1-20X
J2-92>	DGND	XA4J1-74	XA4J1-19X
J2-93>	N.C.	XA4J1-73	XA4J1-18X
J2-94>	N.C.	XA4J1-72	XA4J1-17X
J2-95>	SPARE7	XA4J1-71	XA4J1-16X
J2-96>	SPARE8	XA4J1-70	XA4J1-15X
J2-97>	N.C.	XA4J1-69	XA4J1-14X
J2-98>	N.C.	XA4J1-68	XA4J1-13X
J2-99>	N.C.	XA4J1-67	XA4J1-12X
J2-100>	DGND	XA4J1-66	XA4J1-11X
J2-101>	DGND	XA4J1-65	XA4J1-10X
J2-102>	N.C.	XA4J1-64	XA4J1-9X
J2-103>	N.C.	XA4J1-63	XA4J1-8X
J2-104>	DGND	XA4J1-62	XA4J1-7X
J2-105>	N.C.	XA4J1-61	XA4J1-6X
J2-106>	N.C.	XA4J1-60	XA4J1-5X
J2-107>	N.C.	XA4J1-59	XA4J1-4X
J2-108>	N.C.	XA4J1-58	XA4J1-3X
J2-109>	DGND	XA4J1-57	XA4J1-2X
J2-110>	DGND	XA4J1-56	XA4J1-1

A5 CPU

J2-56>	D14	XASJ1-110	XASJ1-55X
J2-57>	D12	XASJ1-109	XASJ1-54X
J2-58>	D10	XASJ1-108	XASJ1-53X
J2-59>	D8	XASJ1-107	XASJ1-52X
J2-60>	D6	XASJ1-106	XASJ1-51X
J2-61>	D4	XASJ1-105	XASJ1-50X
J2-62>	D2	XASJ1-104	XASJ1-49X
J2-63>	D0	XASJ1-103	XASJ1-48X
J2-64>	DGND	XASJ1-102	XASJ1-47X
J2-65>	L10	XASJ1-101	XASJ1-46X
J2-66>	L16	XASJ1-100	XASJ1-45X
J2-67>	A15	XASJ1-99	XASJ1-44X
J2-68>	A13	XASJ1-98	XASJ1-43X
J2-69>	A11	XASJ1-97	XASJ1-42X
J2-70>	A9	XASJ1-96	XASJ1-41X
J2-71>	A7	XASJ1-95	XASJ1-40X
J2-72>	A5	XASJ1-94	XASJ1-39X
J2-73>	A3	XASJ1-93	XASJ1-38X
J2-74>	A1	XASJ1-92	XASJ1-37X
J2-75>	DGND	XASJ1-91	XASJ1-36X
J2-76>	DGND	XASJ1-90	XASJ1-35X
J2-77>	N.C.	XASJ1-89	XASJ1-34X
J2-78>	N.C.	XASJ1-88	XASJ1-33X
J2-79>	DGND	XASJ1-87	XASJ1-32X
J2-80>	N.C.	XASJ1-86	XASJ1-31X
J2-81>	N.C.	XASJ1-85	XASJ1-30X
J2-82>	DGND	XASJ1-84	XASJ1-29X
J2-83>	DGND	XASJ1-83	XASJ1-28X
J2-84>	N.C.	XASJ1-82	XASJ1-27X
J2-85>	N.C.	XASJ1-81	XASJ1-26X
J2-86>	N.C.	XASJ1-80	XASJ1-25X
J2-87>	N.C.	XASJ1-79	XASJ1-24X
J2-88>	N.C.	XASJ1-78	XASJ1-23X
J2-89>	DGND	XASJ1-77	XASJ1-22X
J2-90>	N.C.	XASJ1-76	XASJ1-21X
J2-91>	DGND	XASJ1-75	XASJ1-20X
J2-92>	DGND	XASJ1-74	XASJ1-19X
J2-93>	N.C.	XASJ1-73	XASJ1-18X
J2-94>	N.C.	XASJ1-72	XASJ1-17X
J2-95>	SPARE6	XASJ1-71	XASJ1-16X
J2-96>	SPARE8	XASJ1-70	XASJ1-15X
J2-97>	N.C.	XASJ1-69	XASJ1-14X
J2-98>	N.C.	XASJ1-68	XASJ1-13X
J2-99>	N.C.	XASJ1-67	XASJ1-12X
J2-100>	DGND	XASJ1-66	XASJ1-11X
J2-101>	DGND	XASJ1-65	XASJ1-10X
J2-102>	N.C.	XASJ1-64	XASJ1-9X
J2-103>	N.C.	XASJ1-63	XASJ1-8X
J2-104>	DGND	XASJ1-62	XASJ1-7X
J2-105>	N.C.	XASJ1-61	XASJ1-6X
J2-106>	N.C.	XASJ1-60	XASJ1-5X
J2-107>	N.C.	XASJ1-59	XASJ1-4X
J2-108>	N.C.	XASJ1-58	XASJ1-3X
J2-109>	DGND	XASJ1-57	XASJ1-2X
J2-110>	DGND	XASJ1-56	XASJ1-1

A6 EEPROM

J2-56>	D14	XABJ1-110	XABJ1-55X
J2-57>	D12	XABJ1-109	XABJ1-54X
J2-58>	D10	XABJ1-108	XABJ1-53X
J2-59>	D8	XABJ1-107	XABJ1-52X
J2-60>	D6	XABJ1-106	XABJ1-51X
J2-61>	D4	XABJ1-105	XABJ1-50X
J2-62>	D2	XABJ1-104	XABJ1-49X
J2-63>	D0	XABJ1-103	XABJ1-48X
J2-64>	DGND	XABJ1-102	XABJ1-47X
J2-65>	L10	XABJ1-101	XABJ1-46X
J2-66>	L16	XABJ1-100	XABJ1-45X
J2-67>	A15	XABJ1-99	XABJ1-44X
J2-68>	A13	XABJ1-98	XABJ1-43X
J2-69>	A11	XABJ1-97	XABJ1-42X
J2-70>	A9	XABJ1-96	XABJ1-41X
J2-71>	A7	XABJ1-95	XABJ1-40X
J2-72>	A5	XABJ1-94	XABJ1-39X
J2-73>	A3	XABJ1-93	XABJ1-38X
J2-74>	A1	XABJ1-92	XABJ1-37X
J2-75>	DGND	XABJ1-91	XABJ1-36X
J2-76>	DGND	XABJ1-90	XABJ1-35X
J2-77>	N.C.	XABJ1-89	XABJ1-34X
J2-78>	N.C.	XABJ1-88	XABJ1-33X
J2-79>	DGND	XABJ1-87	XABJ1-32X
J2-80>	N.C.	XABJ1-86	XABJ1-31X
J2-81>	N.C.	XABJ1-85	XABJ1-30X
J2-82>	DGND	XABJ1-84	XABJ1-29X
J2-83>	DGND	XABJ1-83	XABJ1-28X
J2-84>	N.C.	XABJ1-82	XABJ1-27X
J2-85>	N.C.	XABJ1-81	XABJ1-26X
J2-86>	N.C.	XABJ1-80	XABJ1-25X
J2-87>	N.C.	XABJ1-79	XABJ1-24X
J2-88>	N.C.	XABJ1-78	XABJ1-23X
J2-89>	DGND	XABJ1-77	XABJ1-22X
J2-90>	N.C.	XABJ1-76	XABJ1-21X
J2-91>	DGND	XABJ1-75	XABJ1-20X
J2-92>	DGND	XABJ1-74	XABJ1-19X
J2-93>	N.C.	XABJ1-73	XABJ1-18X
J2-94>	N.C.	XABJ1-72	XABJ1-17X
J2-95>	SPARE7	XABJ1-71	XABJ1-16X
J2-96>	SPARE9	XABJ1-70	XABJ1-15X
J2-97>	N.C.	XABJ1-69	XABJ1-14X
J2-98>	N.C.	XABJ1-68	XABJ1-13X
J2-99>	N.C.	XABJ1-67	XABJ1-12X
J2-100>	DGND	XABJ1-66	XABJ1-11X
J2-101>	DGND	XABJ1-65	XABJ1-10X
J2-102>	N.C.	XABJ1-64	XABJ1-9X
J2-103>	N.C.	XABJ1-63	XABJ1-8X
J2-104>	N.C.	XABJ1-62	XABJ1-7X
J2-105>	N.C.	XABJ1-61	XABJ1-6X
J2-106>	N.C.	XABJ1-60	XABJ1-5X
J2-107>	N.C.	XABJ1-59	XABJ1-4X
J2-108>	N.C.	XABJ1-58	XABJ1-3X
J2-109>	DGND	XABJ1-57	XABJ1-2X
J2-110>	DGND	XABJ1-56	XABJ1-1

A7
INPUT/OUTPUT

J2-56>	D14	XA7J1-110	XA7J1-55X
J2-57>	D12	XA7J1-109	XA7J1-54X
J2-58>	D10	XA7J1-108	XA7J1-53X
J2-59>	D8	XA7J1-107	XA7J1-52X
J2-60>	D6	XA7J1-106	XA7J1-51X
J2-61>	D4	XA7J1-105	XA7J1-50X
J2-62>	D2	XA7J1-104	XA7J1-49X
J2-63>	D0	XA7J1-103	XA7J1-48X
J2-64>	DGND	XA7J1-102	XA7J1-47X
J2-65>	L10	XA7J1-101	XA7J1-46X
J2-66>	L16	XA7J1-100	XA7J1-45X
J2-67>	A15	XA7J1-99	XA7J1-44X
J2-68>	A13	XA7J1-98	XA7J1-43X
J2-69>	A11	XA7J1-97	XA7J1-42X
J2-70>	A9	XA7J1-96	XA7J1-41X
J2-71>	A7	XA7J1-95	XA7J1-40X
J2-72>	A5	XA7J1-94	XA7J1-39X
J2-73>	A3	XA7J1-93	XA7J1-38X
J2-74>	A1	XA7J1-92	XA7J1-37X
J2-75>	DGND	XA7J1-91	XA7J1-36X
J2-76>	DGND	XA7J1-90	XA7J1-35X
J2-77>	DTR1	XA7J1-89	XA7J1-34X
J2-78>	DSR1	XA7J1-88	XA7J1-33X
J2-79>	CTS1	XA7J1-87	XA7J1-32X
J2-80>	CRYPT10	XA7J1-86	XA7J1-31X
J2-81>	CRYPT12	XA7J1-85	XA7J1-30X
J2-82>	CRYPT14	XA7J1-84	XA7J1-29X
J2-83>	CRYPT16	XA7J1-83	XA7J1-28X
J2-84>	CRYPT18	XA7J1-82	XA7J1-27X
J2-85>	CRYPT20	XA7J1-81	XA7J1-26X
J2-86>	CRYPT22	XA7J1-80	XA7J1-25X
J2-87>	CRYPT24	XA7J1-79	XA7J1-24X
J2-88>	CRYPT26	XA7J1-78	XA7J1-23X
J2-89>	CRYPT28	XA7J1-77	XA7J1-22X
J2-90>	CRYPT30	XA7J1-76	XA7J1-21X
J2-91>	CRYPT32	XA7J1-75	XA7J1-20X
J2-92>	CRYPT34	XA7J1-74	XA7J1-19X
J2-93>	CRYPT36	XA7J1-73	XA7J1-18X
J2-94>	CRYPT38	XA7J1-72	XA7J1-17X
J2-95>	CRYPT40	XA7J1-71	XA7J1-16X
J2-96>	CRYPT42	XA7J1-70	XA7J1-15X
J2-97>	CRYPT44	XA7J1-69	XA7J1-14X
J2-98>	CRYPT46	XA7J1-68	XA7J1-13X
J2-99>	CRYPT48	XA7J1-67	XA7J1-12X
J2-100>	CRYPT50	XA7J1-66	XA7J1-11X
J2-101>	CRYPT52	XA7J1-65	XA7J1-10X
J2-102>	CRYPT54	XA7J1-64	XA7J1-9X
J2-103>	CRYPT56	XA7J1-63	XA7J1-8X
J2-104>	CRYPT58	XA7J1-62	XA7J1-7X
J2-105>	CRYPT60	XA7J1-61	XA7J1-6X
J2-106>	CRYPT62	XA7J1-60	XA7J1-5X
J2-107>	CRYPT64	XA7J1-59	XA7J1-4X
J2-108>	CRYPT66	XA7J1-58	XA7J1-3X
J2-109>	CRYPT68	XA7J1-57	XA7J1-2X
J2-110>	CRYPT70	XA7J1-56	XA7J1-1

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A6 EEPROM

D14	D15	XA6J1
D12	D13	XA6J1-110
D10	D11	XA6J1-109
D08	D09	XA6J1-108
D06	D07	XA6J1-107
D04	D05	XA6J1-106
D02	D03	XA6J1-105
D00	D01	XA6J1-104
DGND	D02	XA6J1-103
D10	D03	XA6J1-102
A17	D04	XA6J1-101
A15	D05	XA6J1-100
A13	D06	XA6J1-99
A11	D07	XA6J1-98
A09	D08	XA6J1-97
A07	D09	XA6J1-96
A05	D10	XA6J1-95
A03	D11	XA6J1-94
A01	D12	XA6J1-93
DGND	D13	XA6J1-92
N.C.	D14	XA6J1-91
N.C.	D15	XA6J1-90
N.C.	D16	XA6J1-89
N.C.	D17	XA6J1-88
N.C.	D18	XA6J1-87
N.C.	D19	XA6J1-86
N.C.	D20	XA6J1-85
N.C.	D21	XA6J1-84
N.C.	D22	XA6J1-83
N.C.	D23	XA6J1-82
N.C.	D24	XA6J1-81
N.C.	D25	XA6J1-80
N.C.	D26	XA6J1-79
N.C.	D27	XA6J1-78
N.C.	D28	XA6J1-77
N.C.	D29	XA6J1-76
N.C.	D30	XA6J1-75
N.C.	D31	XA6J1-74
N.C.	D32	XA6J1-73
N.C.	D33	XA6J1-72
N.C.	D34	XA6J1-71
N.C.	D35	XA6J1-70
N.C.	D36	XA6J1-69
N.C.	D37	XA6J1-68
N.C.	D38	XA6J1-67
N.C.	D39	XA6J1-66
N.C.	D40	XA6J1-65
N.C.	D41	XA6J1-64
N.C.	D42	XA6J1-63
N.C.	D43	XA6J1-62
N.C.	D44	XA6J1-61
N.C.	D45	XA6J1-60
N.C.	D46	XA6J1-59
N.C.	D47	XA6J1-58
N.C.	D48	XA6J1-57
N.C.	D49	XA6J1-56
DGND	D50	XA6J1-55

A7
INPUT/OUTPUT

D14	D15	XA7J1
D12	D13	XA7J1-110
D10	D11	XA7J1-109
D08	D09	XA7J1-108
D06	D07	XA7J1-107
D04	D05	XA7J1-106
D02	D03	XA7J1-105
D00	D01	XA7J1-104
DGND	D02	XA7J1-103
D10	D03	XA7J1-102
A17	D04	XA7J1-101
A15	D05	XA7J1-100
A13	D06	XA7J1-99
A11	D07	XA7J1-98
A09	D08	XA7J1-97
A07	D09	XA7J1-96
A05	D10	XA7J1-95
A03	D11	XA7J1-94
A01	D12	XA7J1-93
DGND	D13	XA7J1-92
N.C.	D14	XA7J1-91
N.C.	D15	XA7J1-90
N.C.	D16	XA7J1-89
N.C.	D17	XA7J1-88
N.C.	D18	XA7J1-87
N.C.	D19	XA7J1-86
N.C.	D20	XA7J1-85
N.C.	D21	XA7J1-84
N.C.	D22	XA7J1-83
N.C.	D23	XA7J1-82
N.C.	D24	XA7J1-81
N.C.	D25	XA7J1-80
N.C.	D26	XA7J1-79
N.C.	D27	XA7J1-78
N.C.	D28	XA7J1-77
N.C.	D29	XA7J1-76
N.C.	D30	XA7J1-75
N.C.	D31	XA7J1-74
N.C.	D32	XA7J1-73
N.C.	D33	XA7J1-72
N.C.	D34	XA7J1-71
N.C.	D35	XA7J1-70
N.C.	D36	XA7J1-69
N.C.	D37	XA7J1-68
N.C.	D38	XA7J1-67
N.C.	D39	XA7J1-66
N.C.	D40	XA7J1-65
N.C.	D41	XA7J1-64
N.C.	D42	XA7J1-63
N.C.	D43	XA7J1-62
N.C.	D44	XA7J1-61
N.C.	D45	XA7J1-60
N.C.	D46	XA7J1-59
N.C.	D47	XA7J1-58
N.C.	D48	XA7J1-57
N.C.	D49	XA7J1-56
DGND	D50	XA7J1-55

A2
DISC DRIVE POWER

J3	J3-1
J3	J3-2
J3	J3-3
J3	J3-4

A2
DISC DRIVE

J2	J2-1
J2	J2-2
J2	J2-3
J2	J2-4
J2	J2-5
J2	J2-6
J2	J2-7
J2	J2-8
J2	J2-9
J2	J2-10
J2	J2-11
J2	J2-12
J2	J2-13
J2	J2-14
J2	J2-15
J2	J2-16
J2	J2-17
J2	J2-18
J2	J2-19
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J2	J2-22
J2	J2-23
J2	J2-24
J2	J2-25
J2	J2-26
J2	J2-27
J2	J2-28
J2	J2-29
J2	J2-30
J2	J2-31
J2	J2-32
J2	J2-33
J2	J2-34

A1 FRONT PANEL
KEYBOARD

J1	J1-1
J1	J1-2
J1	J1-3
J1	J1-4
J1	J1-5
J1	J1-6
J1	J1-7
J1	J1-8
J1	J1-9
J1	J1-10
J1	J1-11
J1	J1-12
J1	J1-13
J1	J1-14
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J1	J1-25
J1	J1-26
J1	J1-27
J1	J1-28
J1	J1-29
J1	J1-30
J1	J1-31
J1	J1-32
J1	J1-33
J1	J1-34

TEST

J7	J7-1
J7	J7-2
J7	J7-3

SECURITY KEY

XA8J1	XA8J1-1
XA8J1	XA8J1-2
XA8J1	XA8J1-3
XA8J1	XA8J1-4
XA8J1	XA8J1-5
XA8J1	XA8J1-6
XA8J1	XA8J1-7
XA8J1	XA8J1-8
XA8J1	XA8J1-9
XA8J1	XA8J1-10
XA8J1	XA8J1-11
XA8J1	XA8J1-12
XA8J1	XA8J1-13
XA8J1	XA8J1-14
XA8J1	XA8J1-15
XA8J1	XA8J1-16
XA8J1	XA8J1-17
XA8J1	XA8J1-18
XA8J1	XA8J1-19
XA8J1	XA8J1-20
XA8J1	XA8J1-21
XA8J1	XA8J1-22
XA8J1	XA8J1-23
XA8J1	XA8J1-24

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

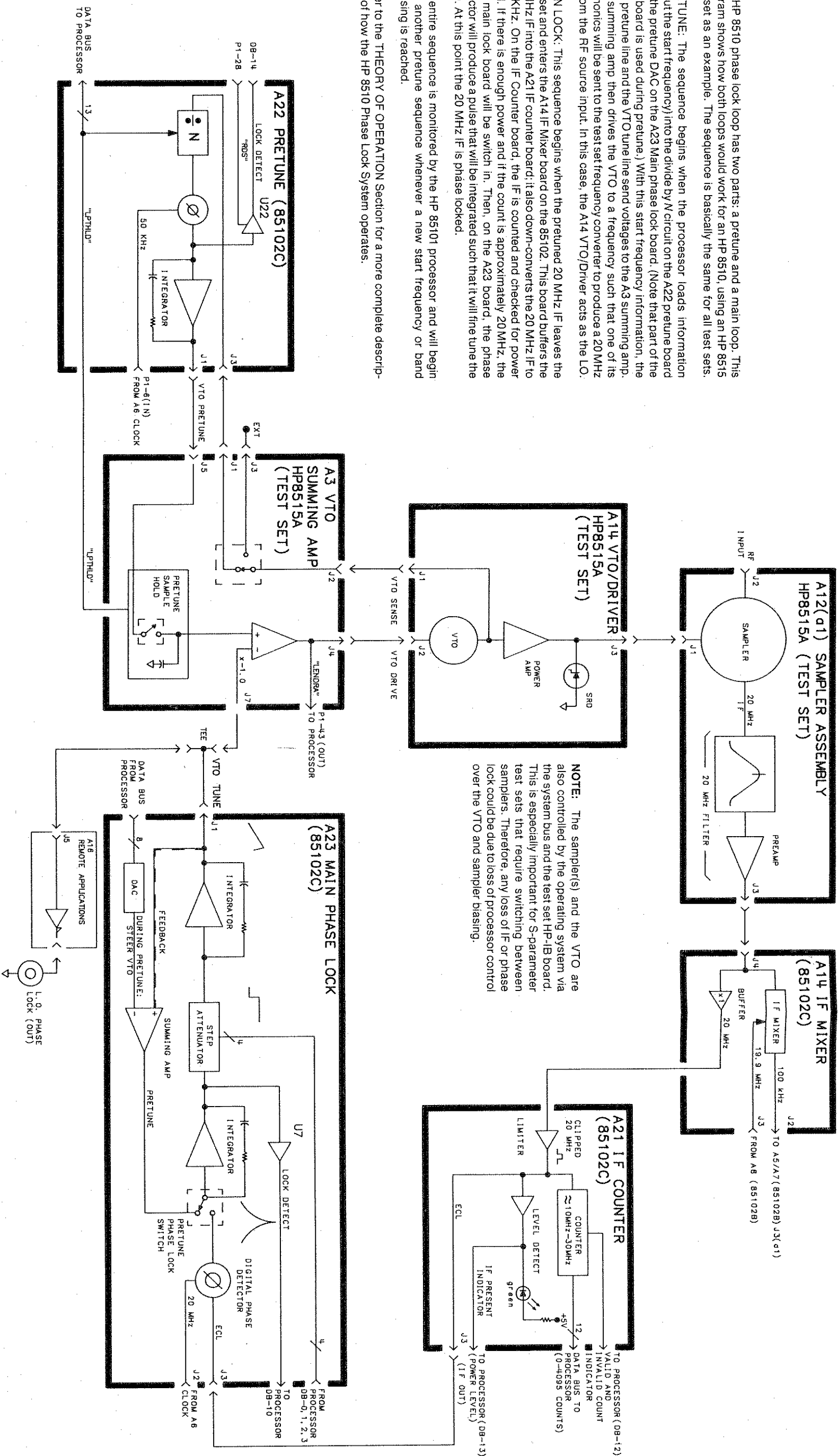
The HP 8510 phase lock loop has two parts: a pretune and a main loop. This diagram shows how both loops would work for an HP 8510, using an HP 8515 test set as an example. The sequence is basically the same for all test sets.

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.

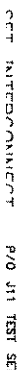
MAIN LOCK: This sequence begins when the pretuned 20 MHz IF leaves the test set and enters the A14 IF Mixer board on the 85102. This board buffers the 20 MHz IF into the A21 IF counter board; it also down-converts the 20 MHz IF to 100 KHz. On the IF Counter board, the IF is counted and checked for power 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 tune the VTO. At this point the 20 MHz IF is phase locked.

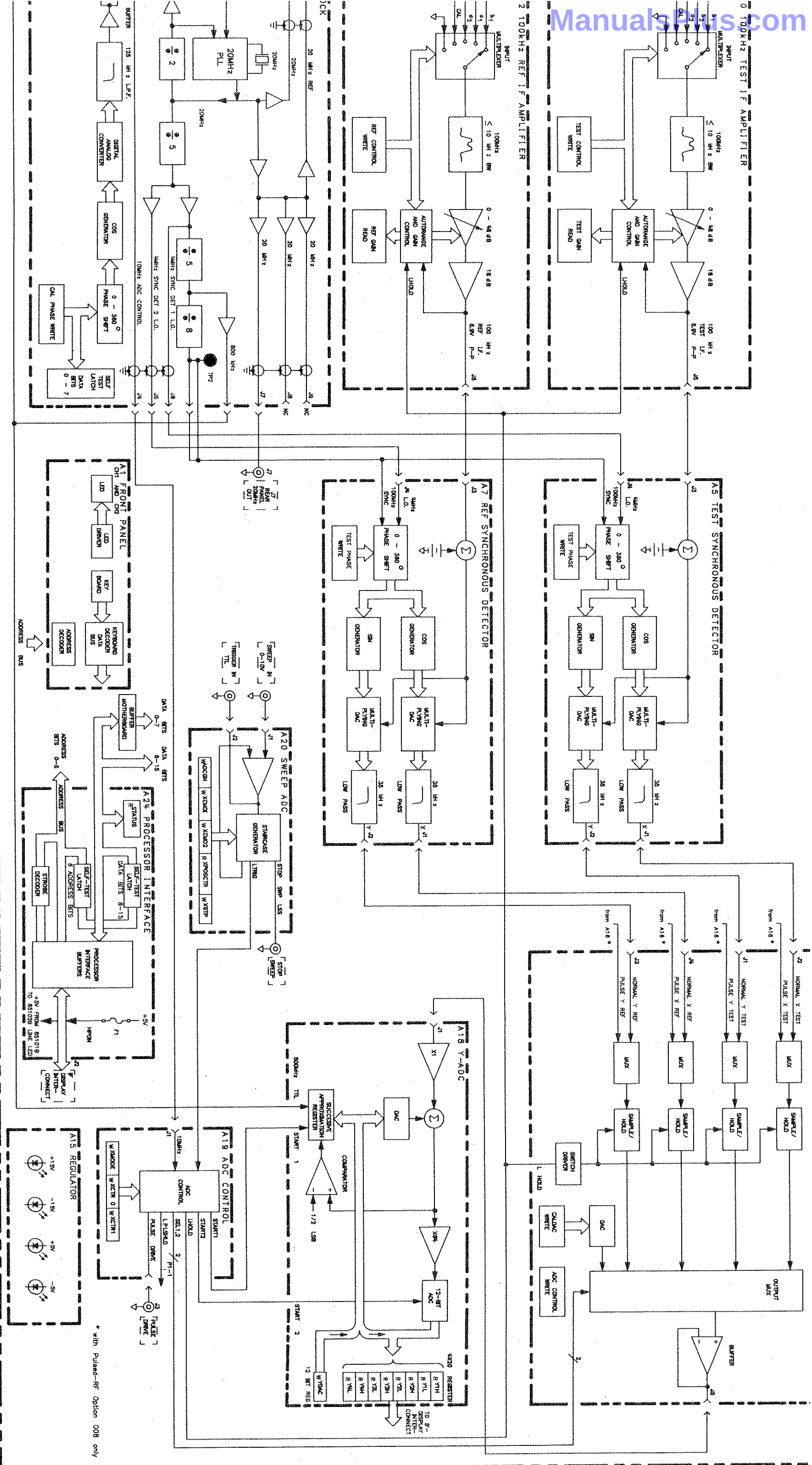
The entire sequence is monitored by the HP 85101 processor and will begin with another pretune sequence whenever a new start frequency or band crossing is reached.

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



HP 8510C Phase Lock Block Diagram

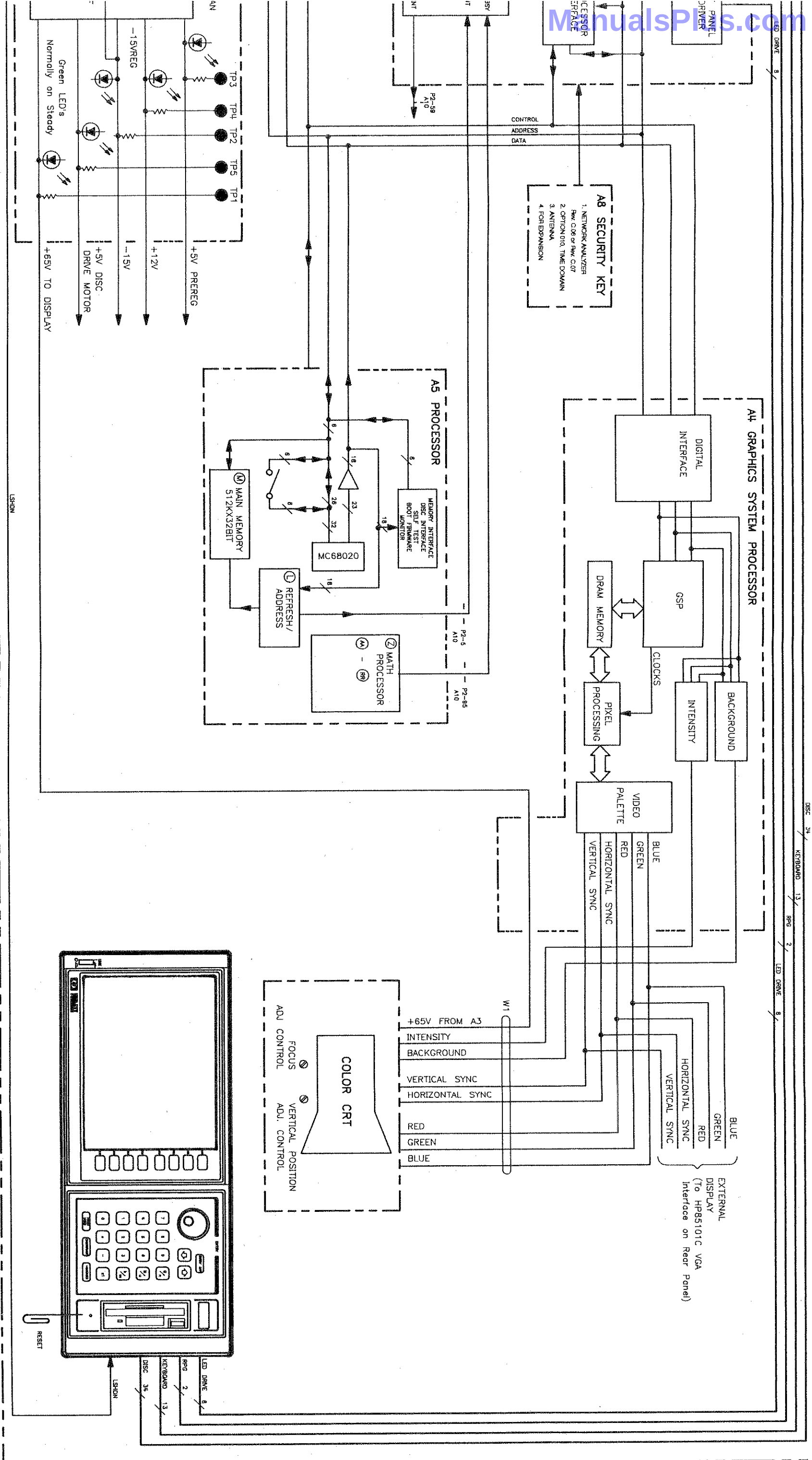




HP 85102C IF/Detector Overall Block Diagram

A17 SAMPLE/HOLD AMPS





HP 85101C Display/Processor Overall Block Diagram

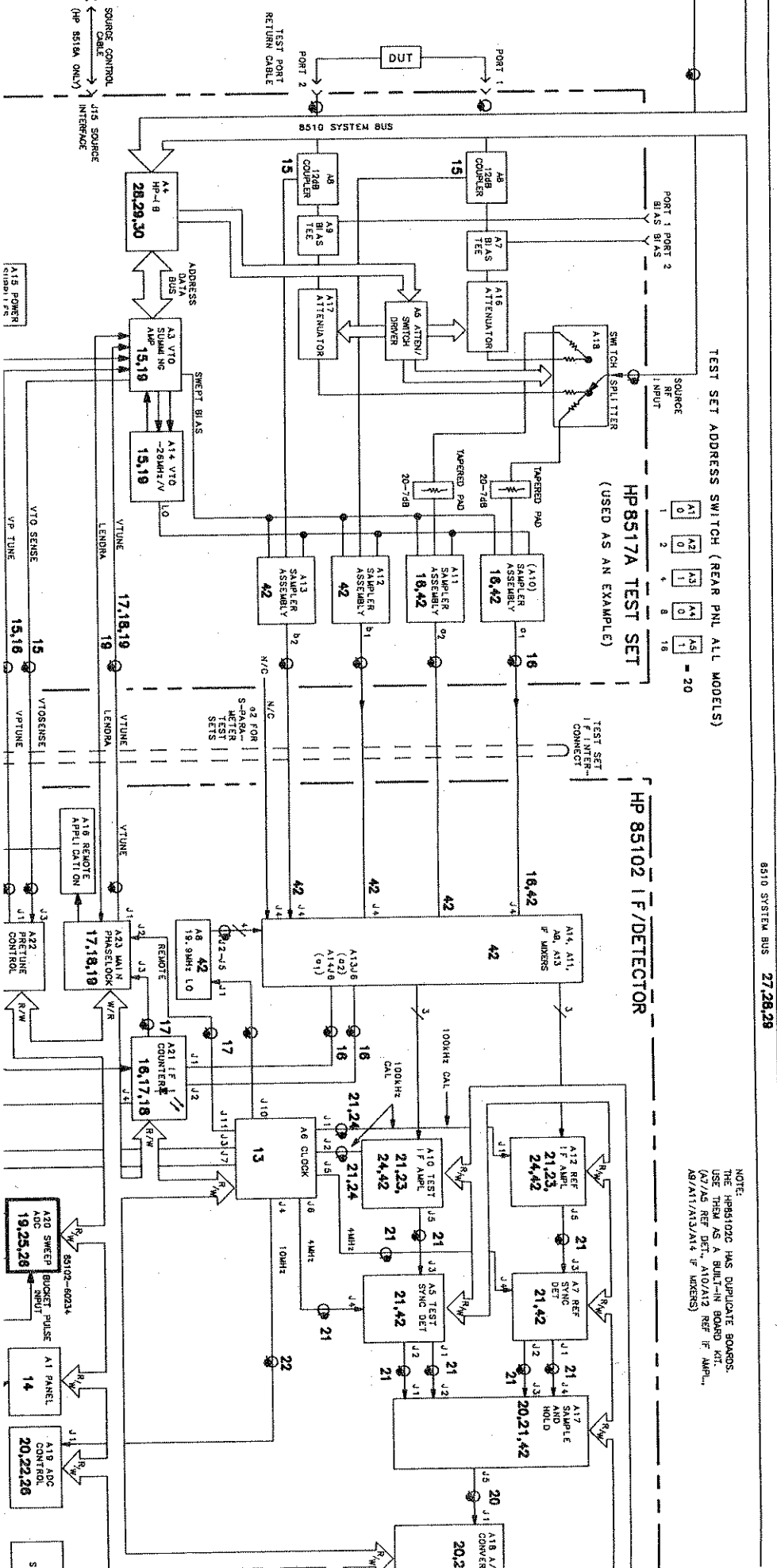
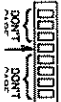
27,28,30,37,38,39,40,41

1. CHECK TO SEE THE SOURCE IP-#B ADDRESS IS 19.
FOR ALL EXCEPT HP#660-SERIES SOURCES:
A. PRESS **SHIFT** **[LOCAL]** TO READ THE IP-#B ADDRESS.
PRESS **[ENT]** TO CHANGE THE ADDRESS.
2. CHECK PRESET CONDITIONS AND SOURCE SELF TESTS.
3. USE **GOINX** (AND **HANDMAN**) IP FILTER TO SEE IF THE SYSTEM WORKS WITH **GOINX** HP INPUT (HP PART NUMBER 0855-0-117).

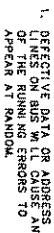
1. USE THE FRONT PANEL EMULATOR FOR SOURCES WITH BLANK FRONT PANELS. (HP PART NUMBER 08510-60022), 001st NA LANG ADDRESS¹⁸ 19

1. PRESS **SHIFT** **4** **0** TO CHECK THE HP3530B FIRMWARE REVISION. IT MAY BE REV. 6 OR GREATER.
2. PRESS **SHIFT** **0** **0** TO CHECK THE HP3530X PLUG-IN FIRMWARE REVISION. IT MUST BE REV. 7 OR GREATER FOR THE 3530X AND REV. 6 OR GREATER FOR THE HP3530X-SERIES PLUG-INS.
3. CHECK THE HP3530X-SERIES PLUG-IN CONFIGURATION SWITCHES.
 - A. FOR HP35322 THROUGH HP35372 SERIES:

B. FOR HP83580-SERIES:







1. A5 PROCESSOR EPROM (self test and service program PROM using chipdata)
2. A6 PROCESSOR RAM (test processor memory using data complement technique)
3. A7 DATA BUS TEST (test I/O data bus)
4. A8 DISPLAY PROCESSOR
5. A9 DISPLAY RAM
6. A7 THERM/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 interrupt)
10. A5 MULTIPLEXER (performance or complex multiply)
11. A7 DISC CONTROLLER
12. A4 NON-VOLATILE MEMORY TEST (read/write test)
13. F7 DETECTOR DATA (read/write test data and address lines)
14. KEYBOARD (read HP 85101C keyboard for a status key)

12. AG 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 track key)

15. FAILED PRETUNE/LOST PRETUNE
16. NO IF FOUND
17. PHASE LOCK FAILURE
18. PHASE LOCK LOST
19. YTO OVER-RANGE
20. AOC CAL FAILED
21. IF CAL FAILED - REFERENCE
IF CAL FAILED - TEST
IF CAL FAILED - BOM (channel)
22. AOC NOT RESPONDING
23. IF OVERLOAD
24. AUTORANGE CAL FAILED
25. SOURCE SWEEP SYNC ERROR
26. SWEEP TIME TOO FAST
27. SOURCE (9P-1B) SYNTAX ERROR
28. TEST SET (9P-1B) SYNTAX ERROR
29. SYSTEM BUS ADDRESS ERROR
30. SYSTEM BUS AND ERROR
31. UNABLE TO LOCK TO CH 10 MHz REF
32. CHANNEL NOT INSTALLED
33. CAUTION: TUNE DOMAIN KEY NOT INSTALLED
34. DISC HARDWARE PROBLEM
35. DISC COMMUNICATION ERROR
36. INITIALIZATION FAILED
37. DISC MEDIA WEAR/IN OUT - REPLACE SOON

```

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 settings
    correction only)

```

40. FAILURE -- SELF TEST FAILURE
41. INVALID SETUP -- CHECK SYSTEM BUS CONFIGURATION (associated with incorrect power level; address correction only)

42. Perform the unrotated power test for α , α_2 , β_1 , and β_2 . Refer to "Unrotated Power Functions" 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 not test it please, try to initialize a blank disc to further test the A2 disc drive.

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.

HOW TO USE THIS SECTION

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.

INTRODUCTION

4.1. Self Test Failures

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.

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.

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

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.

Self Test Sequence

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.

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)

5. Check these pins of the A5 assembly:
4. Check that all A5S1 switches (see Figure 2-3) are closed.
3. Confirm that the A5 CPU assembly is properly seated.
2. Confirm that the A4 GSP assembly is properly seated.
1. Check the +5V power supply at the post-regulator. Refer to the "Power Supply Failures" section for information on power supply test points.

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.

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.

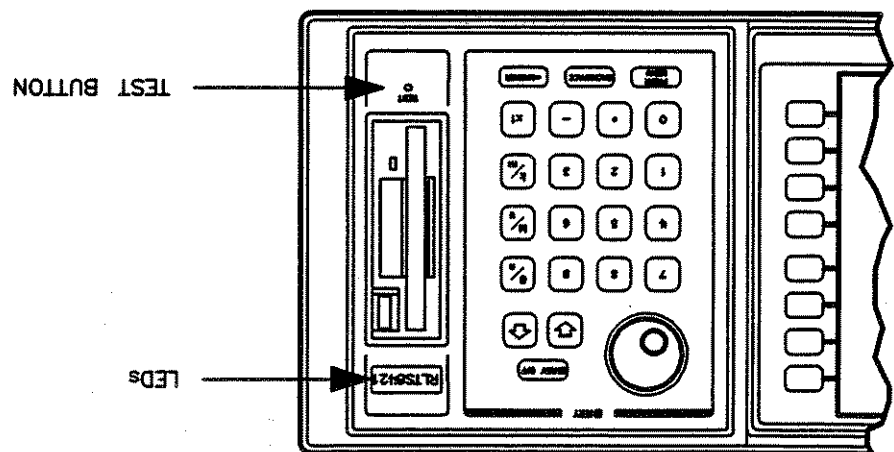
What To Do if the R-L-T-S-8-4-2-1 LEDs Stay Lit (Default Test 15)

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.
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.
5. The disk drive LED blinks.
4. TESTING appears on the CRT.
3. The four numbered LEDs (1, 2, 4, 8) briefly flash. They indicate the number of the current test.
2. Release the **TEST** button. All of the LEDs go out to signal the beginning of the self test.

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

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

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



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.

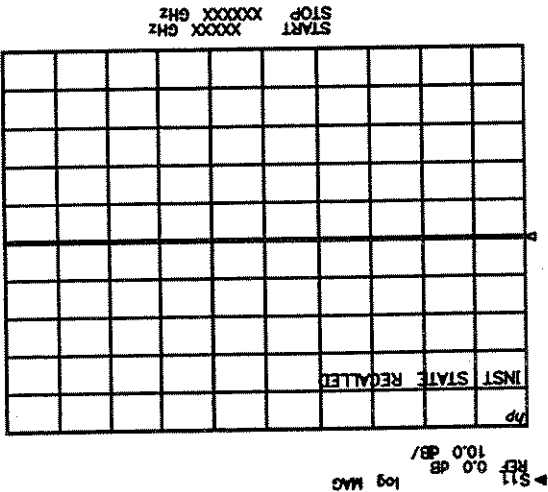
In most repair situations, subtest information is not required or useful because of HP's assembly level repair strategy for this instrument.

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.

Subtests

The type of display that you see depends on the contents of instrument state 8. This power-up state is factory set to an S11 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.

Figure 2-2. Typical Power-Up Display



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.

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 return 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 Troubleshoot-ing," 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.

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 TROUBLESHOOT A SELF TEST FAILURE

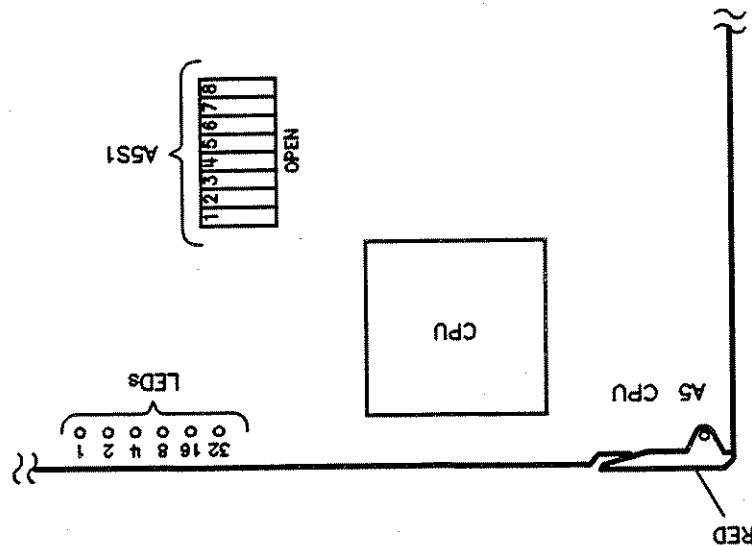
3. Either refer to Table 4.1-1 in "Self Test Failures and Troubleshooting" to identify and troubleshoot the problem, or rerun the test to confirm it.

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

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

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.

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



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.

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.

Self Test Menu

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 FAILURES AND TROUBLESHOOTING

Press the recessed **TEST** button to exit any self test.

How to Exit Self Test

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).

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.

How to Run the Self Test Sequence Repeatedly

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

- 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
- Supplemental troubleshooting help is provided by these features:

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.

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

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	.
7	A7 Public HP-IB	.	.	.	.	O	O
8	A7 System Bus	.	.	.	.	O	.
9	Interrupt System	.	.	.	.	O	O
10	A5 Multiplier	.	.	.	.	O	.
11	A7 disk Controller	.	.	.	.	O	O
12	A6 Nonvolatile Memory	.	.	.	.	O	.
13	IF/Detector Data	.	.	.	.	O	O
14	Keyboard (performed after test 2)	.	.	.	.	O	O

Table 2-1. Self Test Menu and LED Pattern

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).

4.1-12 Self-Test Failures

HP 8510C

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 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 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 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).

To manually verify the complete operation of each key on the Display/Processor and I/F/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.

Self Test 14 Selected from Menu

- 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).

Additional troubleshooting hints:

- 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%)

Most likely cause of failure:

TEST 14: KEYBOARD TEST

- 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 I/F/Detector, refer to the HP 85102 I/F/Detector tests part of the "Service Program" section.

Additional troubleshooting hints:

- 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%)

Most likely cause of failure:

Test 13: I/F/Detector Data

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



You can destroy the operating system 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 trouble-shooting 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.

- Cautions
- Prompts
- Tells
- Errors

The four types of HP 8510C error messages are:

DIFFERENT TYPES OF RUNNING ERROR MESSAGES

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** 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.

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.

RUNNING ERROR MESSAGES AS BUILT-IN DIAGNOSTICS

4.2. Running Error 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.

Prompt Type Messages

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.

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.

Caution Type Messages

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

ERROR MESSAGE CHARACTERISTICS

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

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.

CATEGORIES OF CAUTION RUNNING ERROR MESSAGES

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

- 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 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.
- In many cases, they will not stop the measurement sweep.
- They may be caused by either an internal problem or an operator error.

THINGS TO REMEMBER ABOUT RUNNING ERROR 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.

Error 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.*

Tell Type Messages

- Make sure that the line power applied to all instruments is correct. Check all connections. Refer to chapter 9, "Installation," if necessary.
- Before troubleshooting a caution running error message, first do the following:

Helpful Troubleshooting Hints

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.

System Level Troubleshooting Block Diagram

RUNNING ERROR MESSAGE TROUBLESHOOTING

- TEST SET SYNTAX ERROR
 - SYSTEM BUS ADDRESS ERROR
 - SOURCE SYNTAX ERROR
- ### HP-IB Running Error Messages

- SWEEP TIME TOO FAST
 - SOURCE SWEEP SYNC ERROR
- ### Source Sweep Running Error Messages

- AUTORANGE CAL FAILED
 - IF OVERLOAD
 - IF CAL FAILED
 - ADC CAL FAILED
 - ADC NOT RESPONDING
- ### IF/Detector ADC Running Error Messages

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

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.

Troubleshooting:

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

Possible cause of failure:

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.

ADC Cal Failed

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.

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

ALPHABETICAL LIST OF CAUTION RUNNING ERROR MESSAGES

- If the HP 85102 top cover has been removed, check the cables on the boards. Remove the instrument top cover (use a positive 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.
- Always disconnect all unnecessary peripheral instruments and non-terminated HP-IB cables from the system when troubleshooting.
- In systems without controllers, switch on power to the HP 85101C last.
- In systems with controllers, switch on power to the controller last, the HP 85101C next to last.
- Make sure the system is powered-up in the proper order, to avoid a possible phase lock error. The instrument power-on sequence is:
- 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.
- 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.
- 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.
- Make sure the source RF power and frequency are correct, as some phase lock errors are caused by these being improperly set.

ADC Not Responding

- 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.

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.

HP 8510C

Running Error Messages 4.2-7

- Hardware failure in the external disk drive
- Probable causes of failure:

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.

Disc Hardware Problem

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

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

Disc Communication Error

- Missing HP 85101C A8 security key
- Probable cause of failure:

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

Caution: Optional Function Not Installed

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

Troubleshooting:

- HP 85102 A10 or A12 IF amplifier

Probable cause of error:

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.

Autorange Cal Failed

plete troubleshooting information.

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.

Failure - Self Test Failure

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

Failure - RF Unlocked

information.

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 - Overmodulation

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

Failure - Fault Indicator On

formation.

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 - Check System Bus Configuration

- Disk media in an external disk drive is old

Most probable cause of failure:

a potential disk media failure.

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.

Disc Media Wearing Out - Replace Soon

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

Probable causes of failure:

This message indicates an internal disk drive communication failure.

Disc Read Or Write Error

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 sync 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]**.

- 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.

Probable cause of failure:

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.

No IF Found

- disk media
- HP 85101C disk drive

Most probable failure:

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

Initialization Failed

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

Troubleshooting:

- HP 85102 A23 main phase lock assembly

Probable cause of 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.

Phase Lock Failure

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

Most probable failure:

8510C.

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

Optional Function Not Installed

"Failures."

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

a problem with the HP 85102 or the source.

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

- Check the Test Set-IF interconnect cable.

are working

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

Troubleshooting:

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.

Pretune Failure Pretune Lost Failure

- 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 at
- Check all rear panel connections.

Troubleshooting:

- 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

Probable cause of failure:

If this error message occurs when the HP 8430/41 source is in the RAMMP 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.

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.

Phase Lock Lost

- 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."

Troubleshooting:

- HP 85102 20 MHz reference signal from A6 clock assembly
- HP 85102 A21 IF counter assembly
- LPRTILD 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.

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.

Source Sweep Sync Error

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

Troubleshooting:

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

Probable cause of failure:

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

Source HP-IB Syntax Error

- 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

Probable cause of failure:

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

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

- 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, "Unratioced Power Failures," to check operation of the test set

Troubleshooting:

- 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)

Probable cause of failure:

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.

HP 8510C

Running Error Messages 4.2-15

- 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

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

System Bus Address Error

- 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, "Unratioced Power Failures," to check source operation

Troubleshooting:

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

Probable cause of error:

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.

Sweep Time Too Fast

- 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, "Unratioced Power Failures," to check source operation.
- Use the trim sweep procedure in the Operating and Programming Manual to adjust the sweep ADC gain DAC

Troubleshooting:

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

Probable cause of failure:

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 LIFSRO low, alerting the CPU to the unlocked condition.

Unable To Lock To Ext 10 MHz Ref

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

Troubleshooting:

- 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

Probable cause of failure:

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

Test Set HP-IB Syntax Error

- Run the 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

Troubleshooting:

- 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

Probable cause of failure:

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

System Bus SRO Error

- 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]**

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."

Troubleshooting:

- 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

Probable cause of error:

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.

VTO Over-Range

- 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

Troubleshooting:

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

Failure are:

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

millimeter-wave system.

This message is not applicable unless you are looking to an external source such as in an HP 8510C



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.

User 1, 2, 3, and 4

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

DEFINITION OF TERMS

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.

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

The following test sets are covered in this section:

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.

INTRODUCTION

4.3. Unratioed Power Failures

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.

TROUBLESHOOTING WITH THE SERVICE ADAPTER

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.

Ratioed And Unratioed Responses

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

Table 2-1. RF Signal Paths and User Parameters

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.

RF Signal Paths

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

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

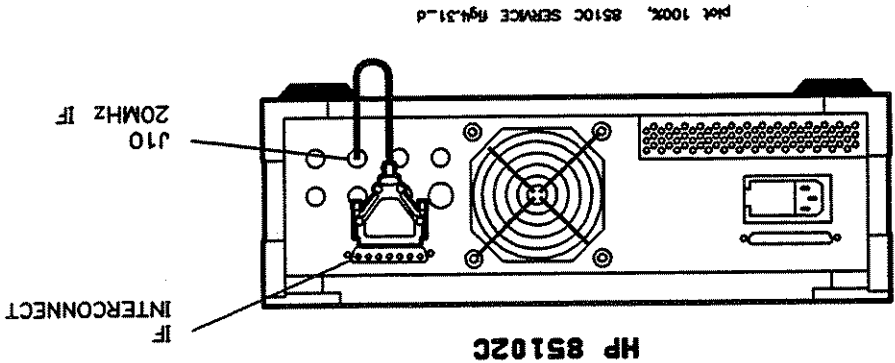
If All Signal Paths are Correct. The HP 85102 is working properly. The problem is most likely with the source or the test set. Perform the following procedure to verify operation of the test set.

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.

Service Adapter Conclusions

3. Examine each user parameter (IF response) by pressing the corresponding softkey to observe the unratioc 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 $-28\text{ dB} \pm 5\text{ dB}$).
2. Press the following keys: **RECALL** **[FACTORY PRESET]** **[MORE]** **[FACTORY PRESET]** **MARKER** **[STIMULUS]** **[MENU]** **[STEP]** **PARAMETER** **[MENU]**

Figure 2-1. Service Adapter Connections

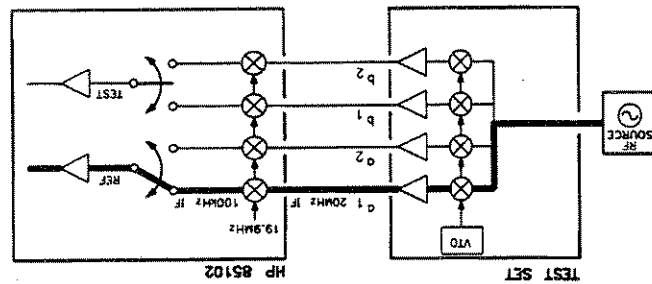


1. Disconnect the test set from J1 Test Set Interconnect on the HP 85102. Connect the service adapter as shown in Figure 2-1. The service adapter is not supplied with each HP 8510C; refer to chapter 5, "Replaceable Parts," to order this servicing tool.
- NOTE:** Ignore any phase lock error messages that may appear during this procedure.

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.

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



Option 002 deletes the programmable step attenuators and the dc bias tees. Option 003 "re-verses" 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.

HP 8517B, Option 002, 004, 007

HP 8516A Option 002/003

HP 8516A

HP 8515A

HP 8514B Option 002/003

HP 8514B

Use this procedure with the following test sets:

TEST SET UNRATIOED POWER TROUBLESHOOTING

ack RF Paths 1, 2, 3, and 4

se 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.

ack RF Paths 5 and 6

se 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..

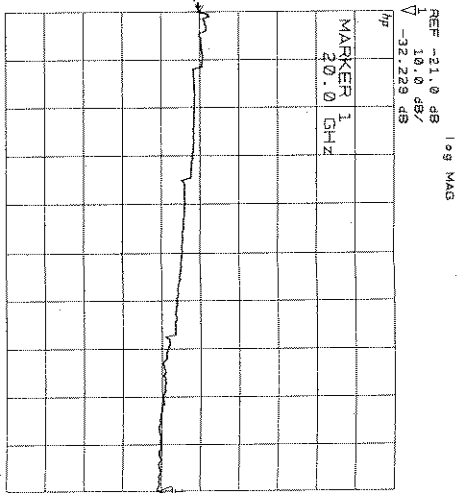
Press **PARAMETER** **MENU** **[User 2 b2]** **[REDEFINE PARAMETER]** **[DRIVE]** **[Port 1]** **[PHASE LOCK]** **[a1]** **[REDEFINE DONE]** to observe the b2 power level trace through path 6, illustrated on this foldout. The trace should be similar to the example trace (typically within ± 5 dB). Record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

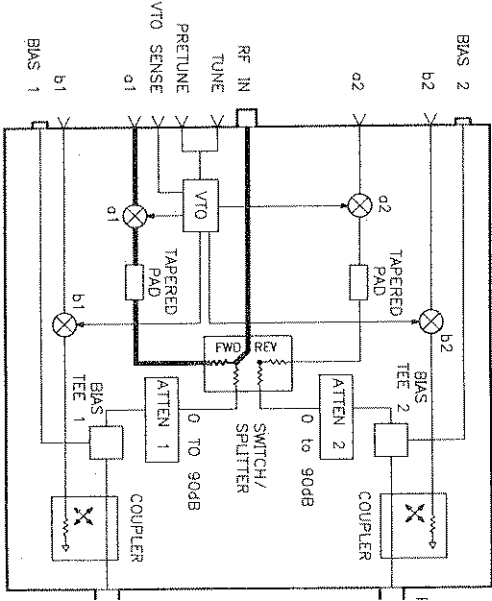
- If the observed results match a group of results in the table, investigate the most probable cause given in the table.
- If all the paths are good, then the test set is probably working properly. Return to the "Main Troubleshooting Procedure" to continue troubleshooting the system.
- If the observed 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	2	3	4	5	6	
a1	a2	b1 refl.	b2 refl.	b1 thru	b2 thru	Test set is not the problem
-	-	-	-	-	-	Source, source cable, VTO, cables from rear panel to switch splitter
B	B	B	B	B	B	Switch splitter
-	B	-	B	B	-	Switch splitter
B	-	B	-	-	B	Switch splitter
-	-	B	-	B	-	b1 sampler
B	-	-	-	-	-	a1 sampler
-	B	-	-	-	-	a2 sampler
-	-	-	B	-	B	b2 sampler
-	-	-	B	-	-	Port 1 connector or directional coupler
-	-	B	-	B	B	Attenuator 1, bias tee 1
-	-	B	-	-	B	Attenuator 2, bias tee 2
-	-	-	B	B	-	Port 2 connector or directional coupler
-	-	-	B	B	B	

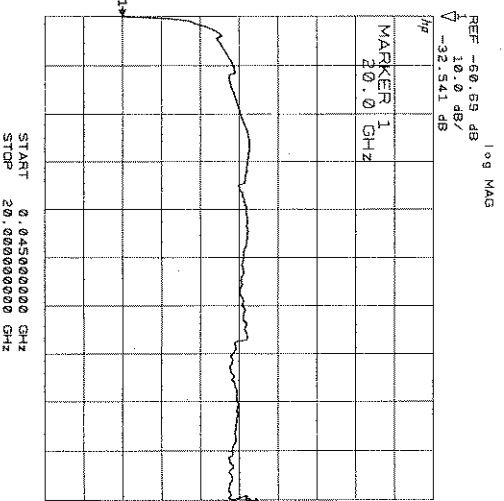
B = Bad
- = Good



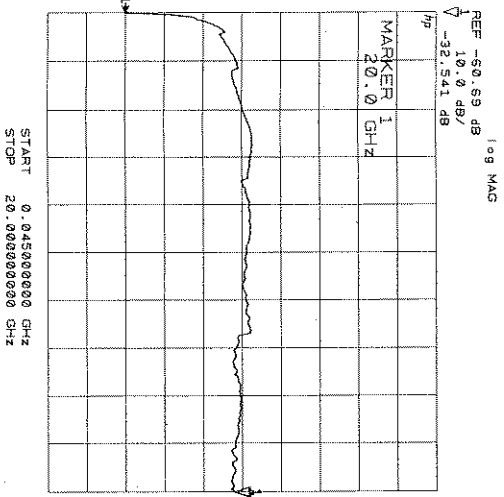
PATH 1 - a1



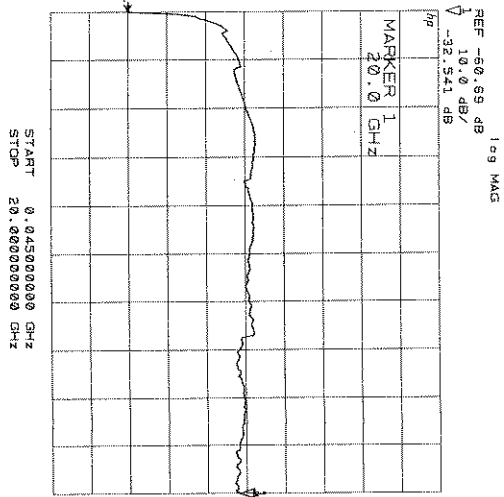
Good / Bad _____



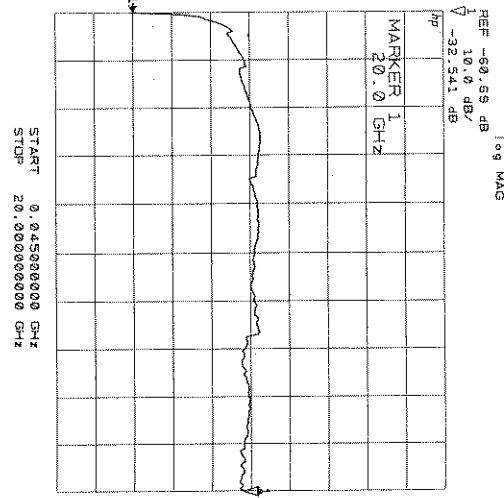
PATH 3 – b1 Reflected



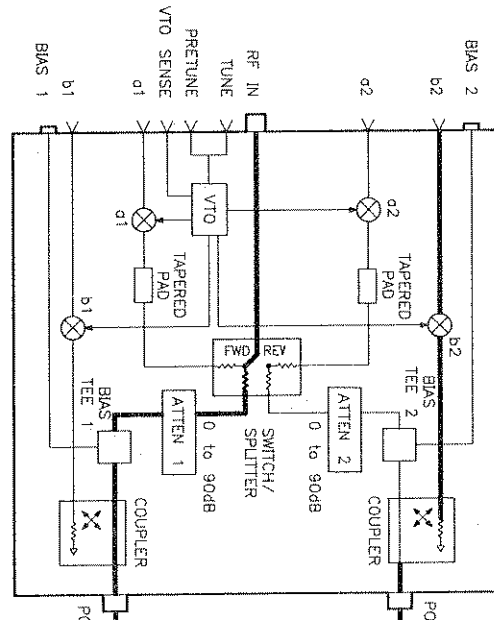
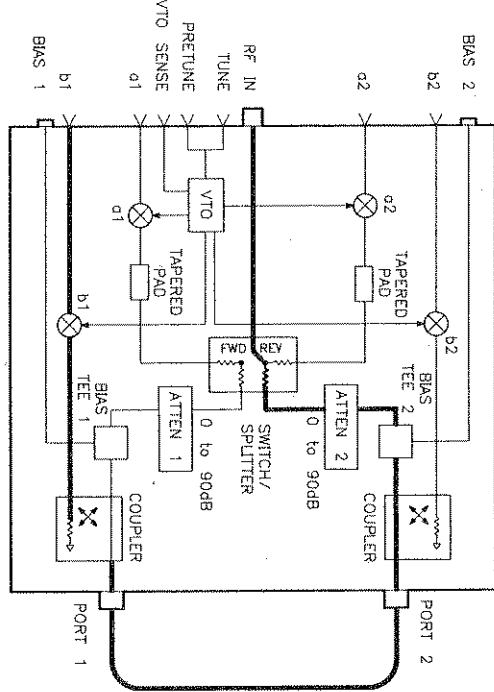
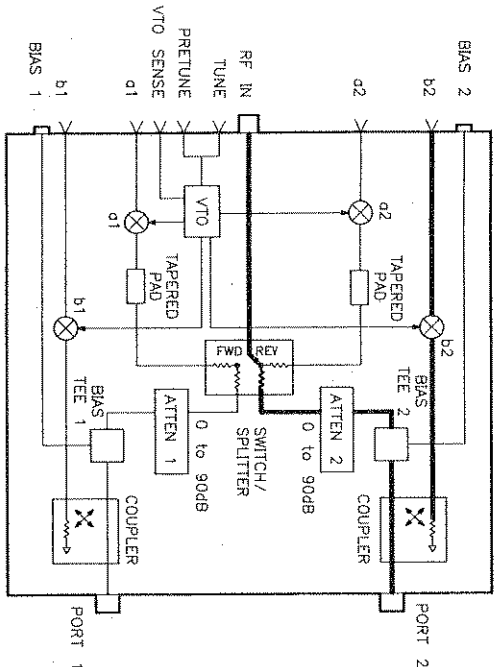
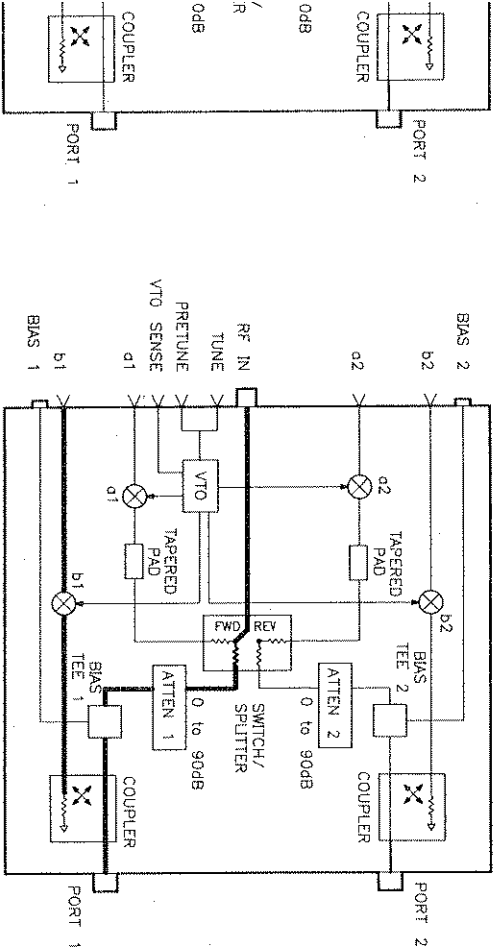
PATH 4 – b2 Reflected



PATH 5 – b1 Thru



PATH 6 – b2 Thru



Good / Bad _____

Good / Bad _____

Good / Bad _____

Good / Bad _____

Unratioed Power Failures

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

source into step mode. On the network analyzer menu, select **FACTORY PRESET** **STIMULUS** **MENU**

necessary to redefine what port and sampler the

REDEFINE PARAMETER **[DRIVE] [Port 2]**
define a2.

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

2. This reflects power back to the b1 and b2

agency 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.

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

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

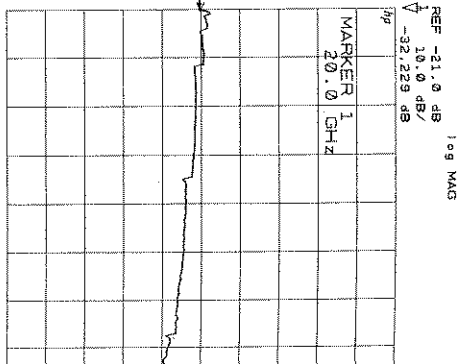
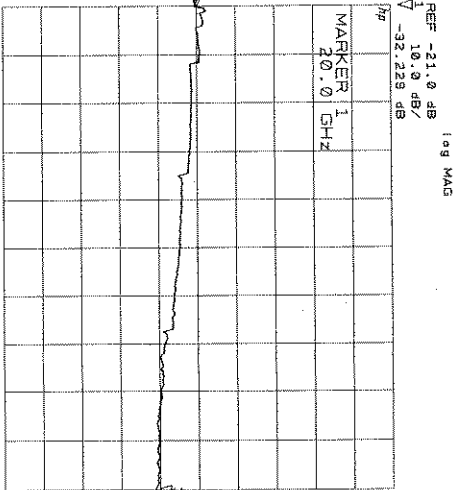
Find the Faulty Assembly

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.

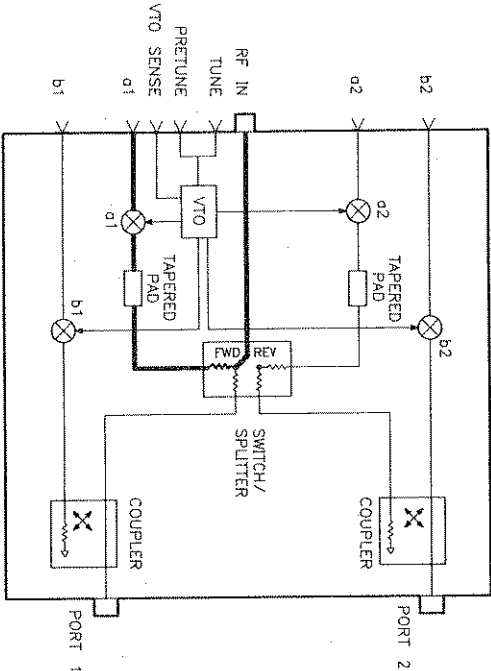
- If the observed results match a group of results in the table, investigate the most probable cause given in the table.
- If all the paths are good, then the test set is probably working properly. Return to the "Main Troubleshooting Procedure" to continue troubleshooting the system.
- If the observed 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	2	3	4	5	6	
a1	a2	b1 refl.	b2 refl.	b1 thru	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	-	b1 sampler
B	-	-	-	-	-	a1 sampler
-	B	-	-	-	-	a2 sampler
-	-	-	B	-	B	b2 sampler
-	-	-	-	-	B	Port 1 connector or directional coupler
-	-	B	-	B	B	Port 2 connector or directional coupler
-	-	-	B	B	B	

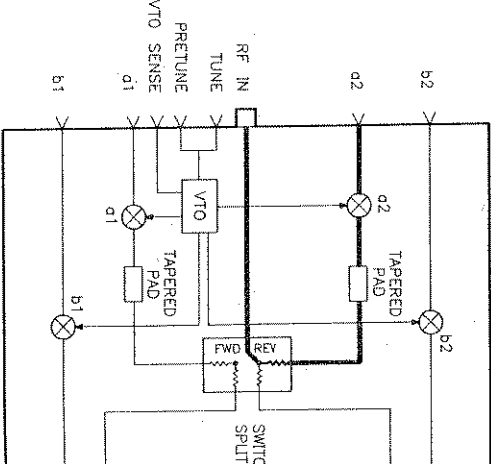
B = Bad
- = Good



PATH 1 - a1

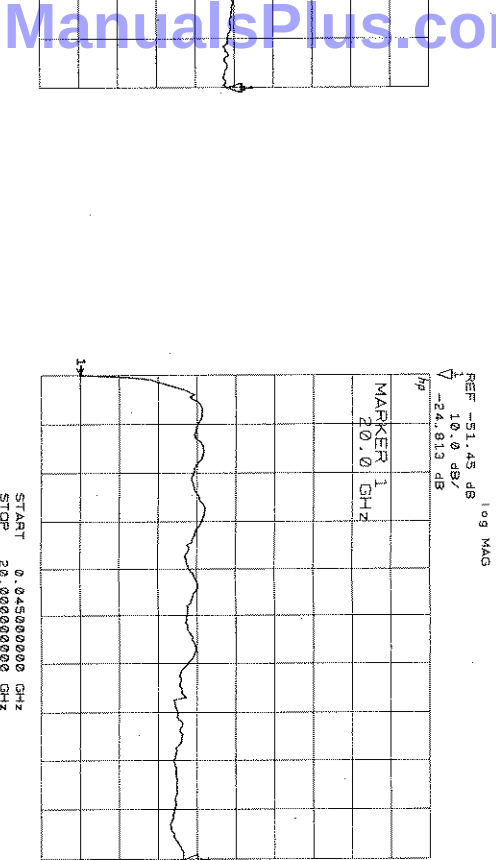


PATH 2 - a2

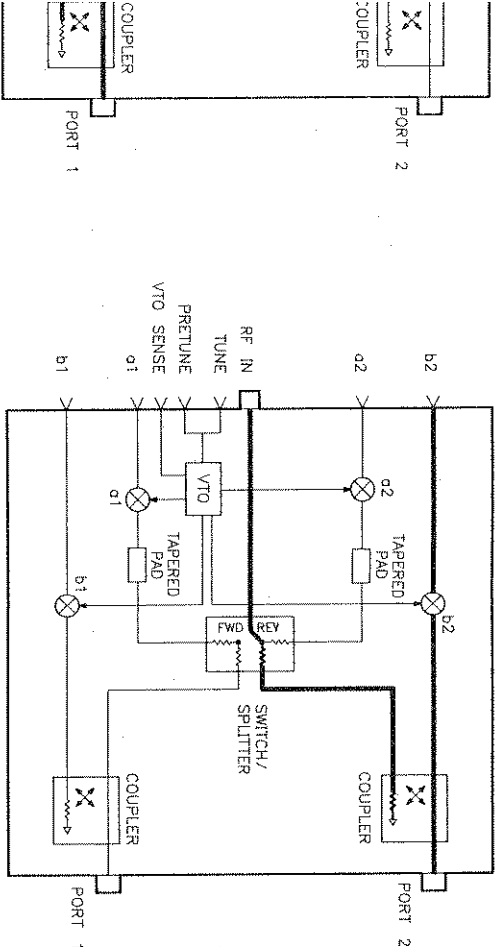


Good / Bad _____

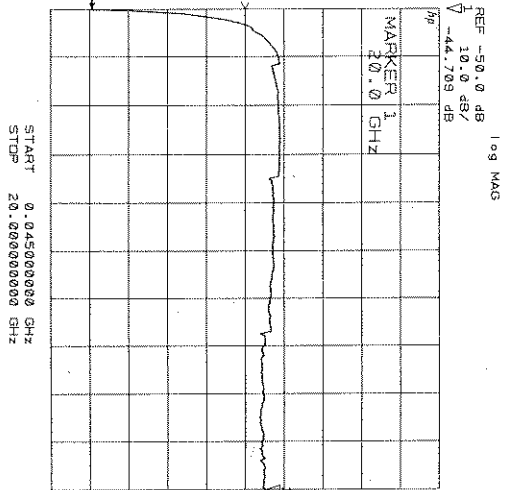
Good / Bad _____



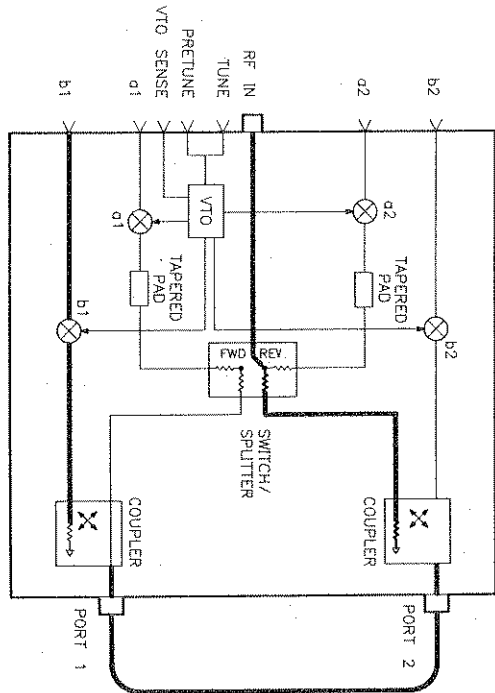
PATH 4 - b2 Reflected



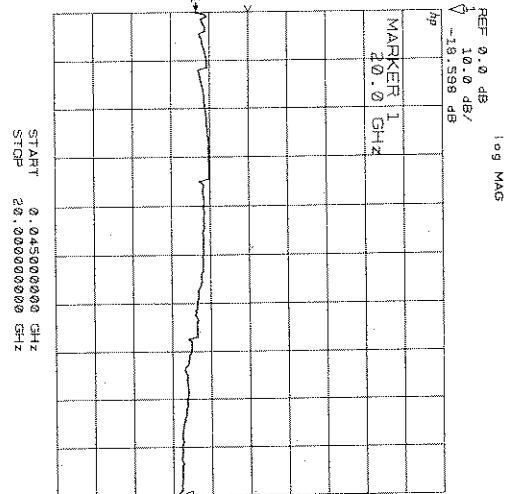
Good/Bad



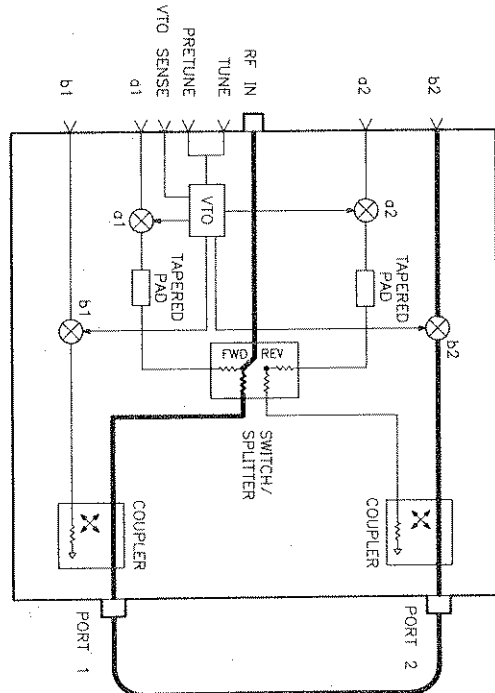
PATH 5 - b1 Thru



Good/Bad



PATH 6 - b2 Thru



Good/Bad

Figure 4.3-4. HP 8514B Option 002/003 RF Flow Diagrams and Typical Traces
Unradioed Power Failures

mode. On the network analyzer, press **[PRESET] [STIMULUS] [MENU]**

line what port and sampler the

[PARAMETER] [DRIVE] [Port 1]

[1] [PHASE LOCK] [a2] [REDEF]

power back to the b1 and b2

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

Figure 4 in Table 4.3-3.

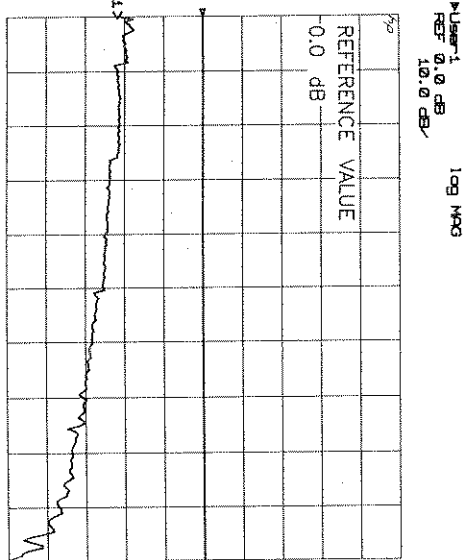
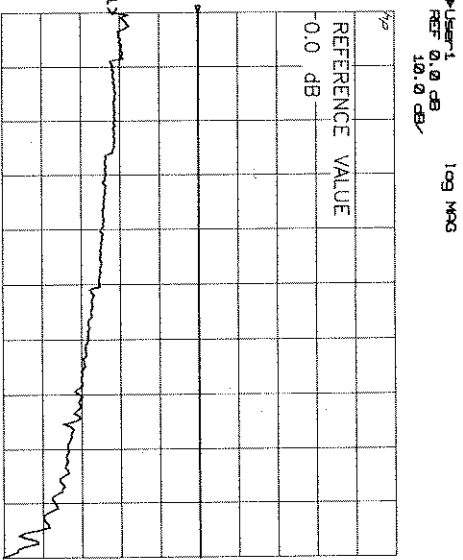
[PARAMETER] [DRIVE] [Port 2]
power level trace through path 5,
example trace (typically within
RF path diagram..

[PARAMETER] [DRIVE] [Port 1]
power 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.

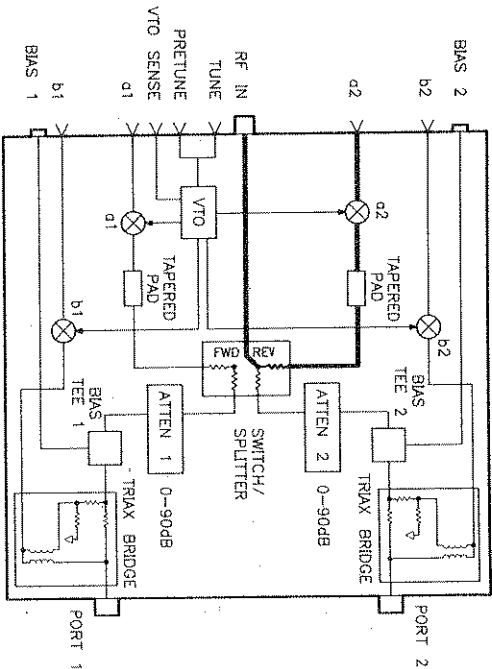
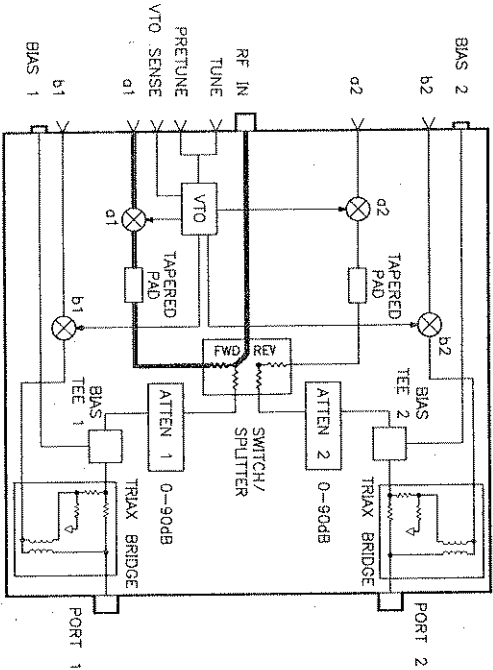
Path						Most Probable Failure
1	2	3	4	5	6	
a1	a2	b1 refl.	b2 refl.	b1 thru	b2 thru	Test set is not the problem
-	-	-	-	-	-	Source, source cable, VTO, cables from rear panel to switch splitter
B	B	B	B	B	B	Switch splitter
-	B	-	B	B	-	Switch splitter
B	-	B	-	-	B	Switch splitter
-	-	B	-	B	-	b1 sampler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



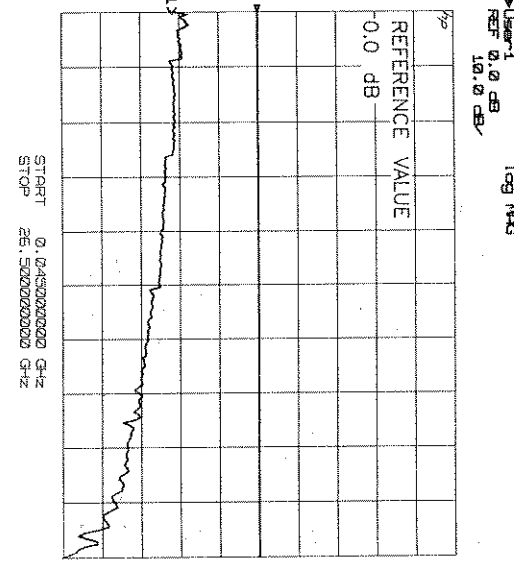
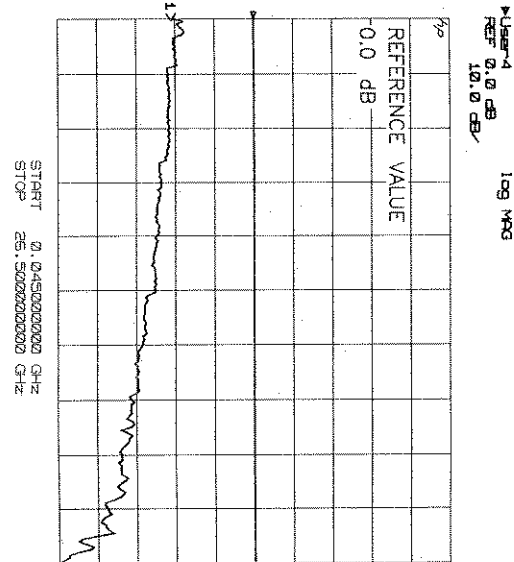
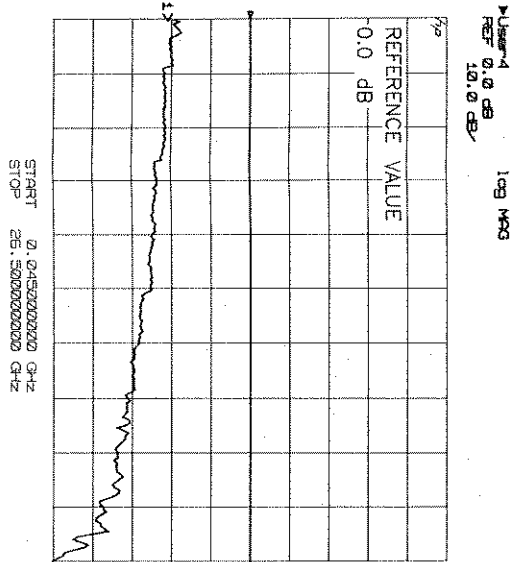
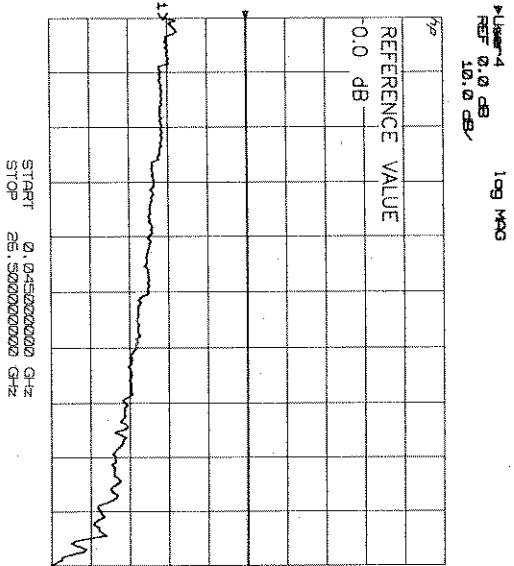
PATH 1 - a1

PATH 2 - a2



Good/Bad _____

Good/Bad _____

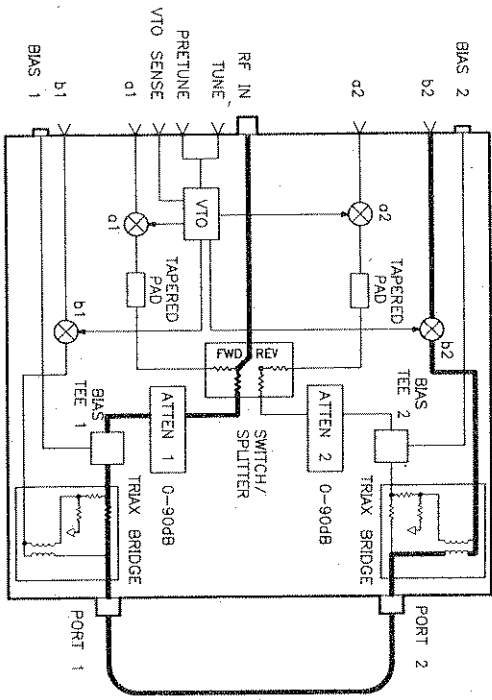
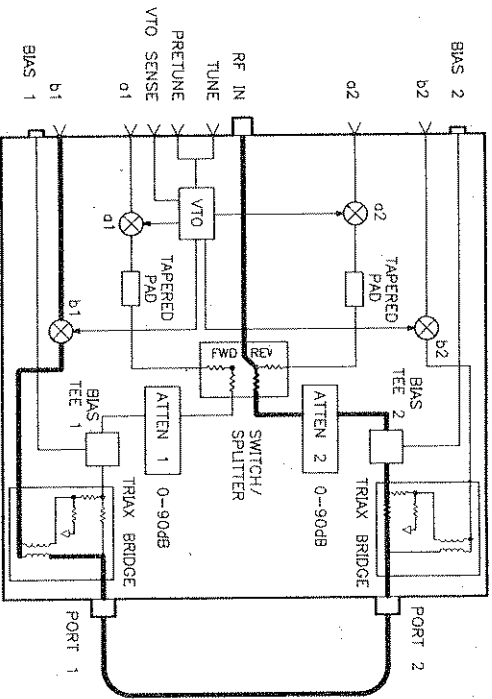
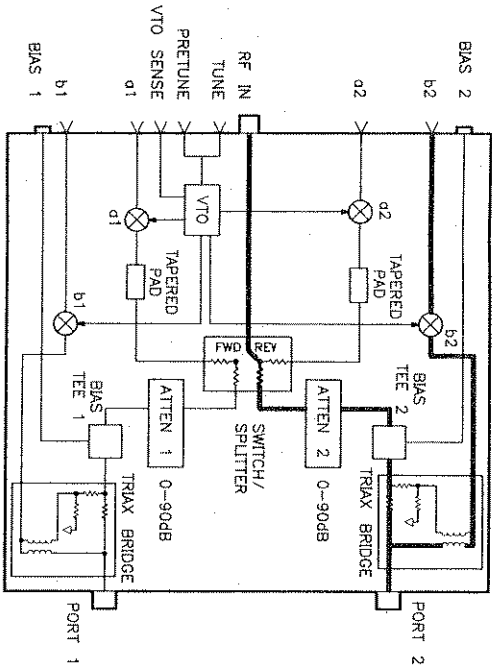
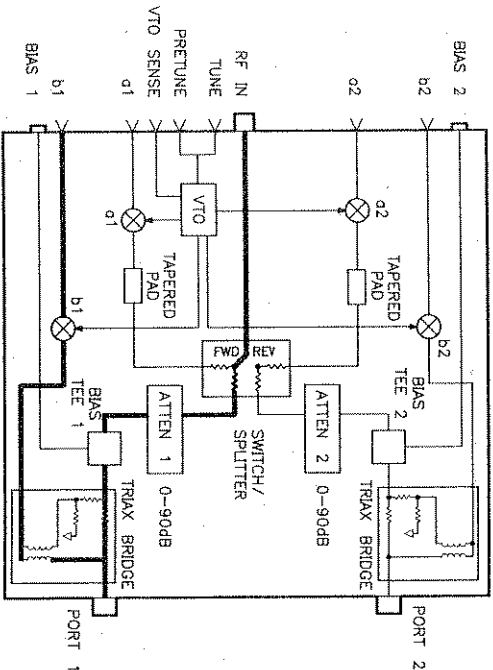


PATH 3 – b1 Reflected

PATH 4 – b2 Reflected

PATH 5 – b1 Thru

PATH 6 – b2 Thru



Good/Bad _____

Good/Bad _____

Good/Bad _____

Good/Bad _____

Unradioed Power Failures

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

3 source into step mode. On the network analyzer [FACTORY PRESET] STIMULUS [MENU]

necessary to redefine what port and sampler the

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

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

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

quency response traces on this foldout. Press *User 4 b1*. Each trace should be similar to the in ± 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..

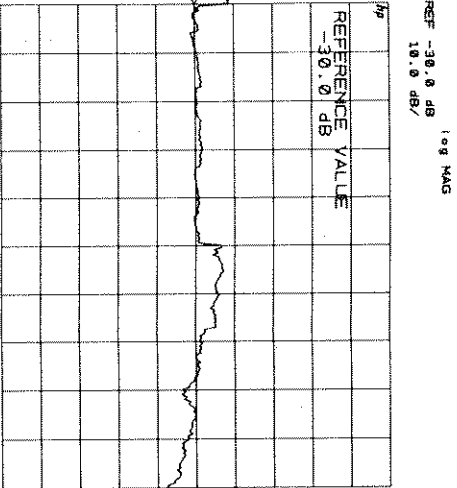
[REDEFINE PARAMETER] [DRIVE] [Port 1]

observe the b2 power level trace through path 6, be similar to the example trace (typically within or bad) under the RF path diagram.

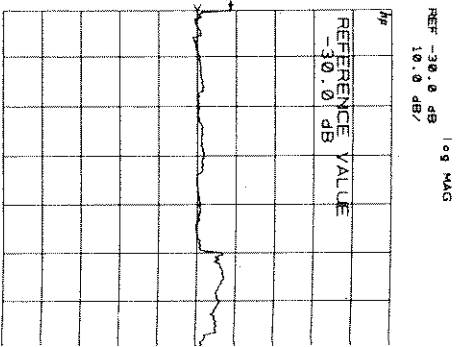
- Try to match the observed results recorded under the RF path diagrams with the results listed in the table of most probable failures, below. Out of 32 possible variations, the table lists the variations that result from 12 of the most *probable* failures.
- If the observed results match a group of 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	2	3	4	5	6	
a1	a2	b1 refl.	b2 refl.	b1 thru	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	-	b1 sampler
B	-	-	-	-	-	a1 sampler
-	B	-	-	-	-	a2 sampler
-	-	-	B	-	-	b2 sampler
-	-	-	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

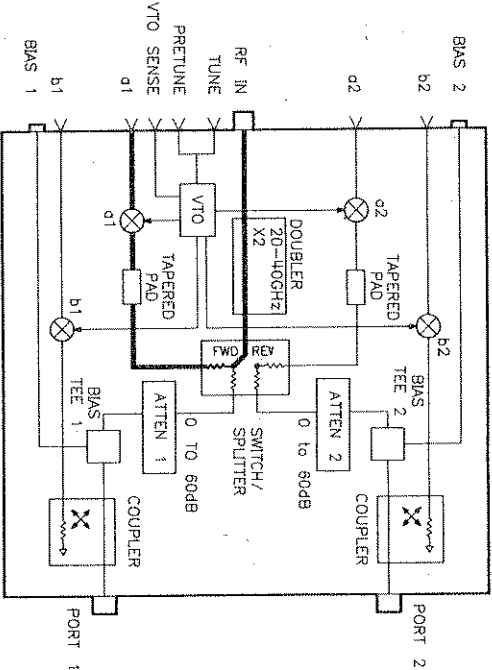


START 3.04500000 GHz
STOP 40.00000000 GHz

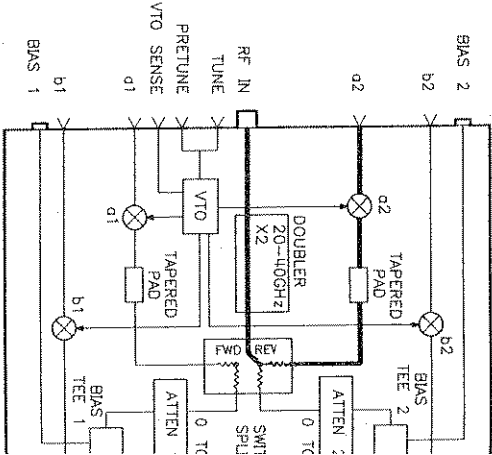


START 3.04500000 GHz
STOP 40.00000000 GHz

PATH 1 - a1

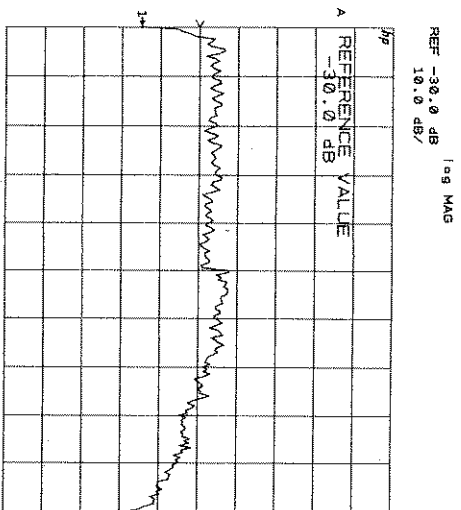


PATH 2 - a2

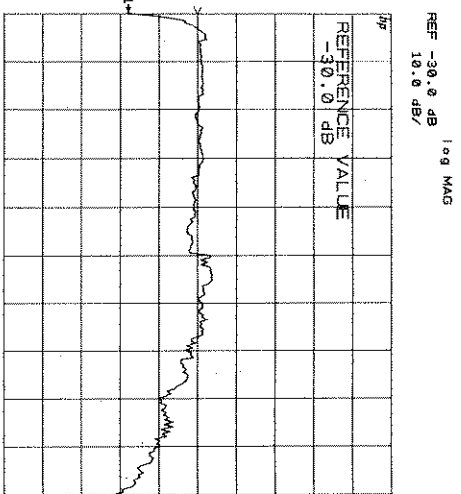


Good/Bad _____

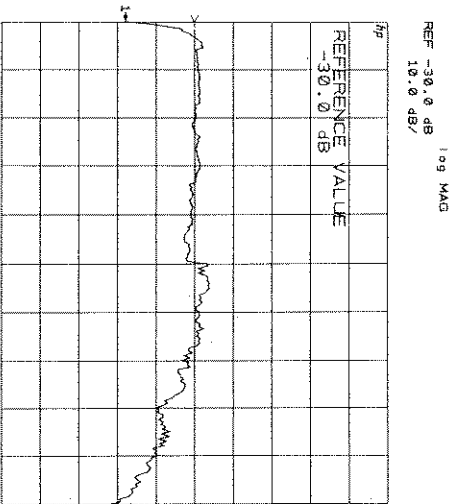
Good/Bad _____



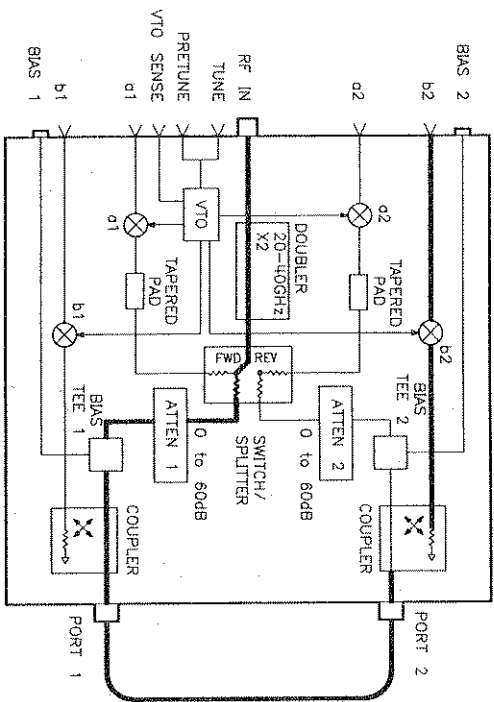
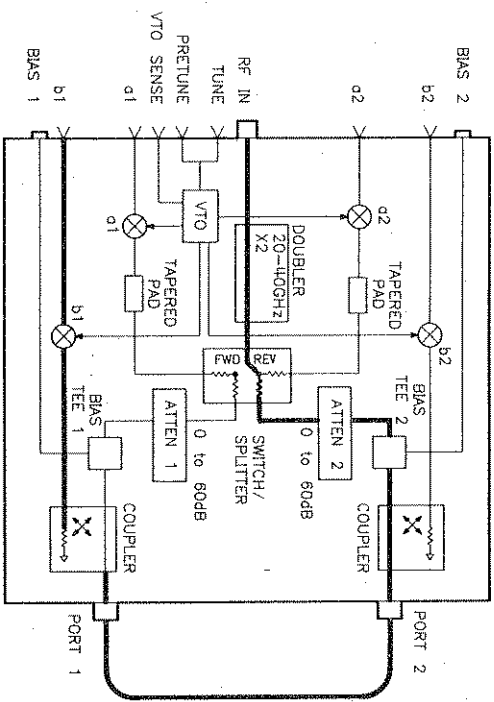
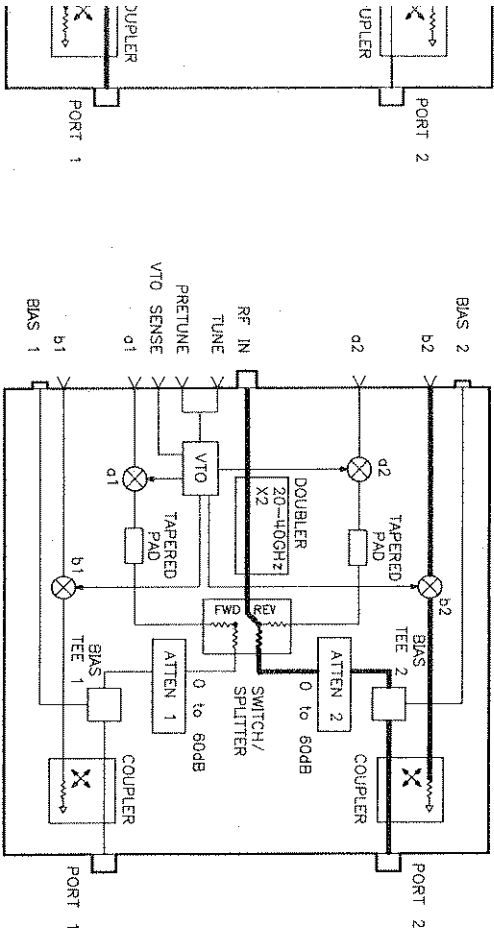
PATH 4 - b2 Reflected



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

mode. On the network analyzer, press **RESET] STIMULUS** **MENU**

the what port and sampler the

AMETER] [DRIVE] [Port 1]

[PHASE LOCK] [a2] [REDE-

power back to the b1 and b2

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

4) in Table 4.3-3.

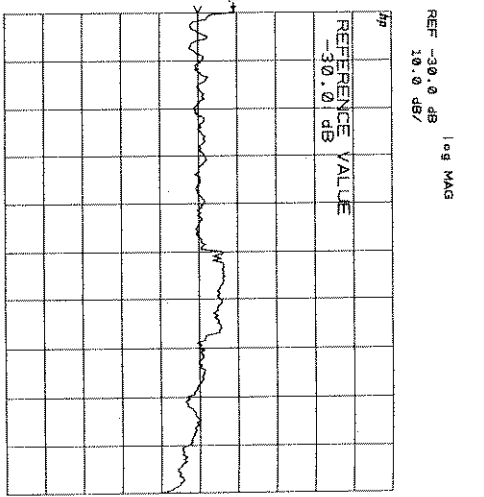
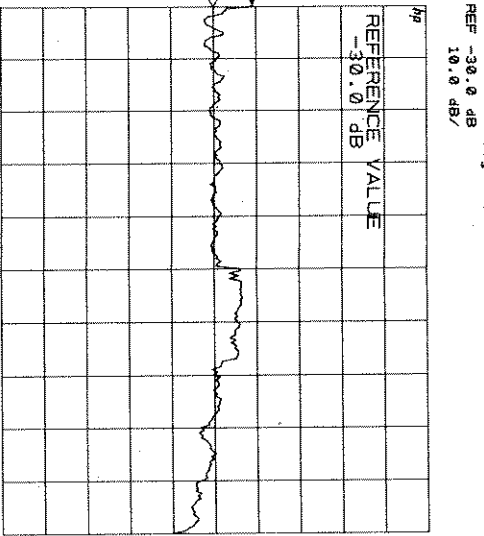
AMETER] [DRIVE] [Port 2]
ver level trace through path 5,
xample trace (typically within
if path diagram..

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

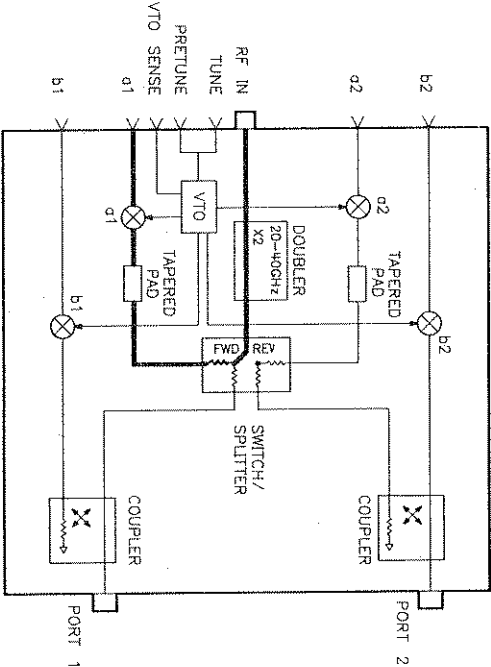
- Try to match the observed results recorded under the RF path diagrams with the results listed in the table of most probable failures, below. Out of 32 possible variations, the table lists the variations that result from 12 of the most *probable* failures.
- If the observed results match a group of 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	2	3	4	5	6	
a1	a2	b1 refl.	b2 refl.	b1 thru	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	-	b1 sampler
B	-	-	-	-	-	a1 sampler
-	B	-	-	-	-	a2 sampler
-	-	-	B	-	B	b2 sampler
-	-	B	-	B	B	Port 1 connector or directional coupler
-	-	-	B	B	B	Port 2 connector or directional coupler

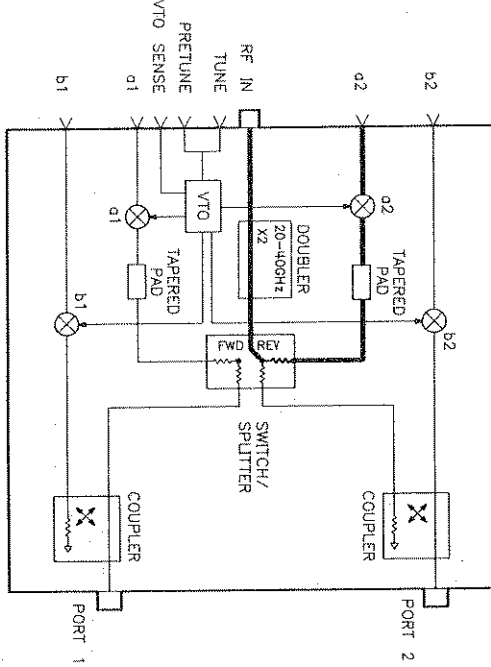
B = Bad
- = Good



PATH 1 - a1

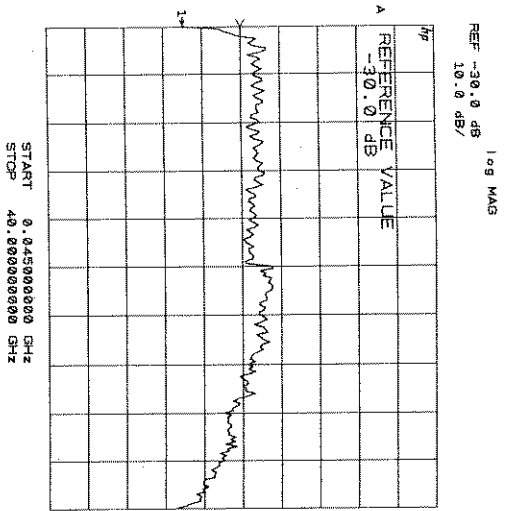


PATH 2 - a2

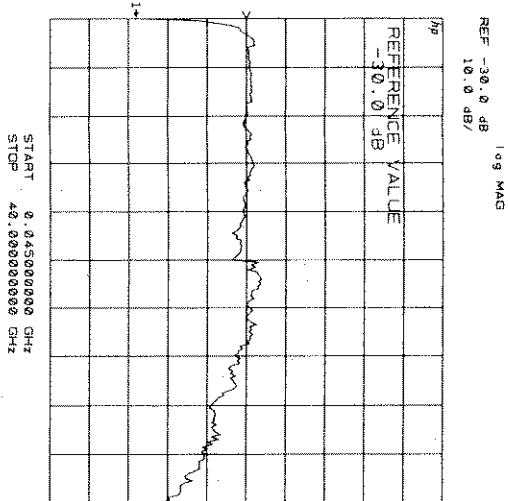


Good / Bad _____

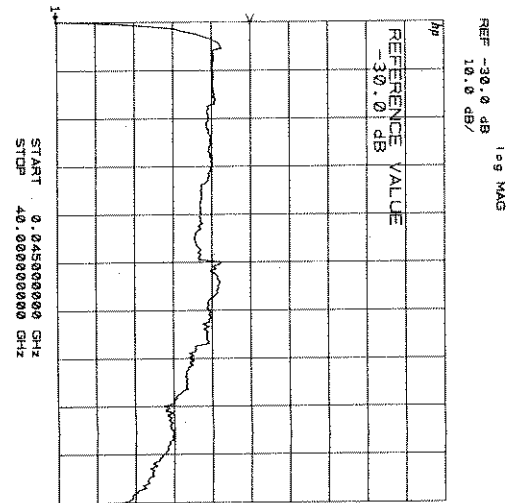
Good / Bad _____



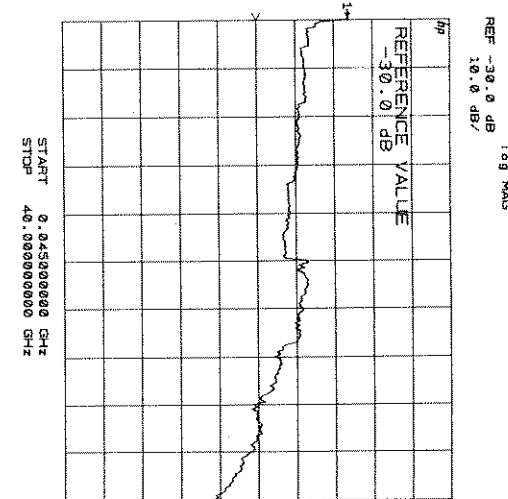
PATH 3 - b1 Reflected



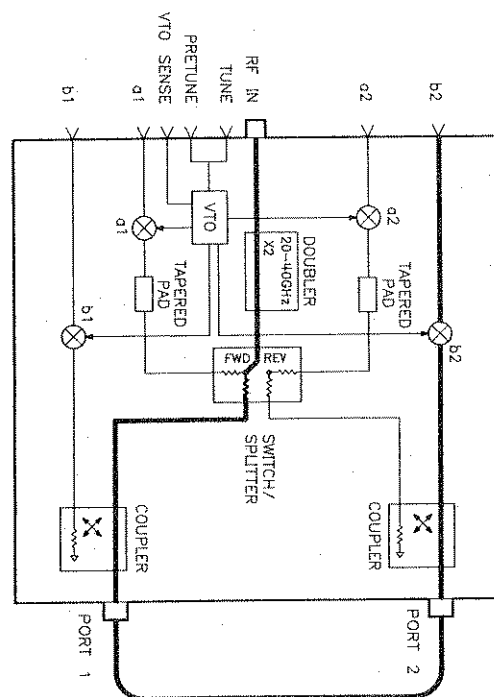
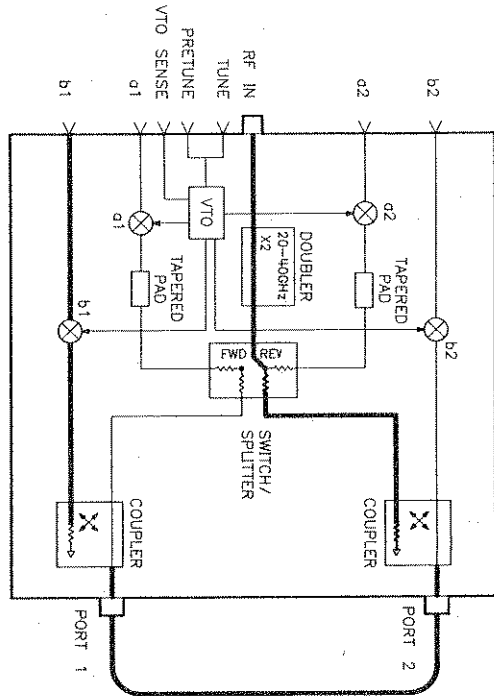
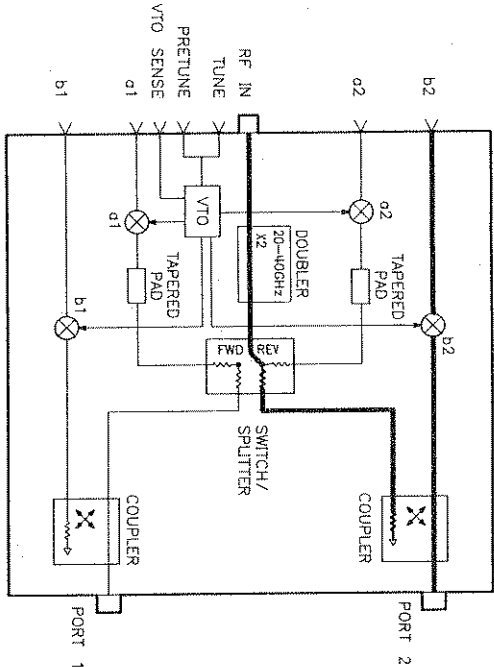
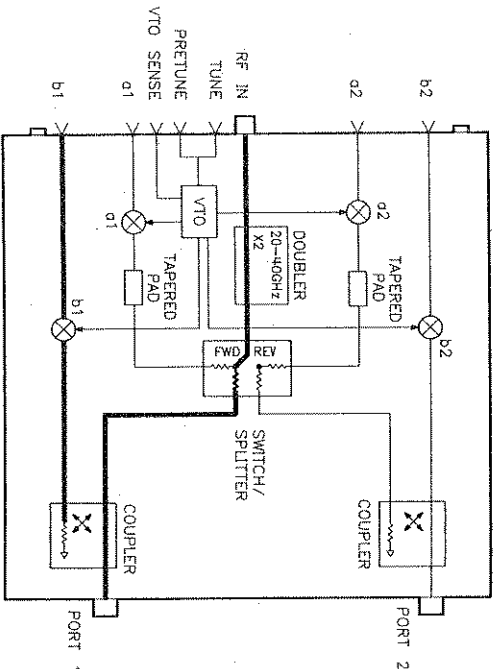
PATH 4 - b2 Reflected



PATH 5 - b1 Thru



PATH 6 - b2 Thru



Good/Bad _____

Good/Bad _____

Good/Bad _____

Good/Bad _____

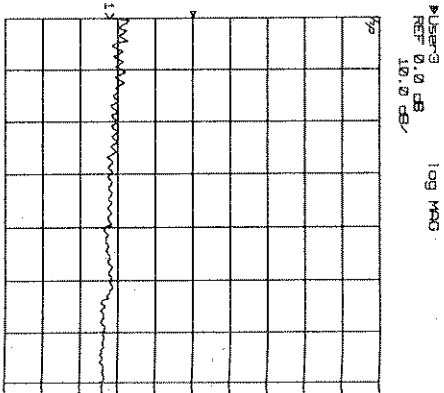
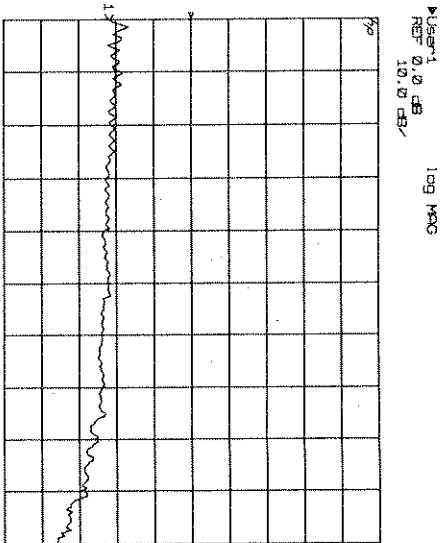
Figure 4.3-7. HP 8516A Option 002/003 RF Flow Diagrams and Typical Traces

Unratioed Power Failures

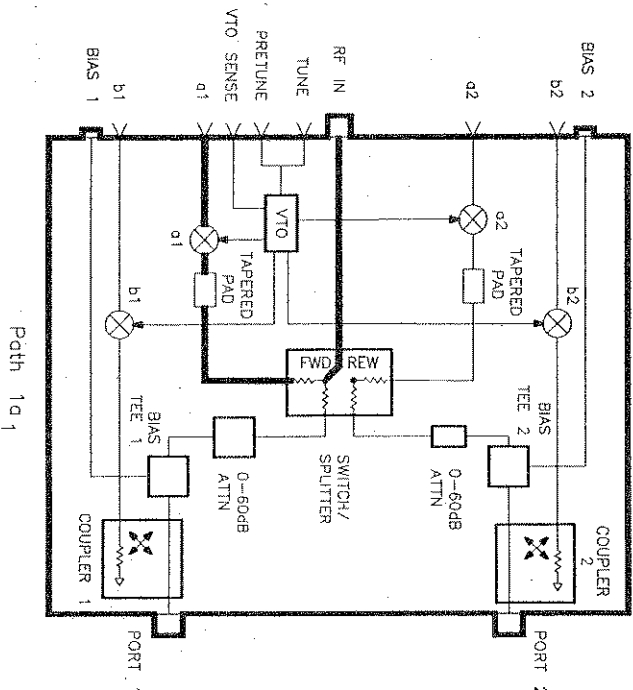
- Try to match the observed results recorded under the RF path diagrams with the results listed in the table of most probable failures, below. Out of 32 possible variations, the table lists the variations that result from 12 of the most *probable* failures.
- If the observed results match a group of 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	2	3	4	5	6	
a1	a2	b1 refl.	b2 refl.	b1 thru	b2 thru	Test set is not the problem
-	-	-	-	-	-	Source, source cable, VTO, cables from rear panel to switch splitter
B	B	B	B	B	B	
-	B	-	B	B	-	
B	-	B	-	-	B	Switch splitter
-	-	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

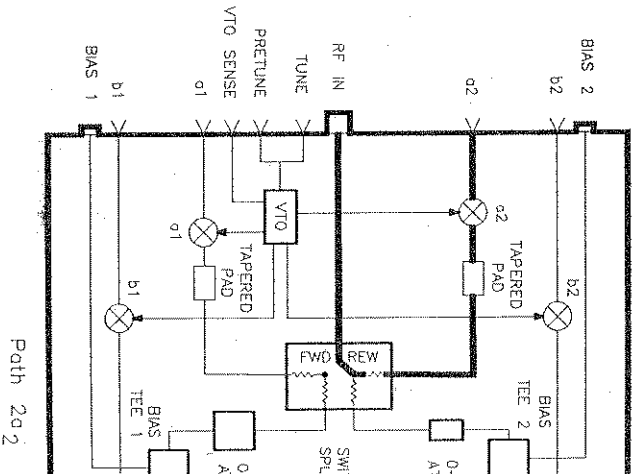


PATH 1 - a1



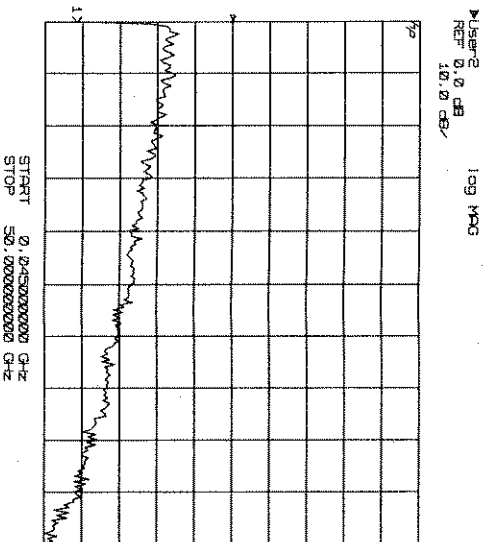
Good / Bad _____

PATH 2 - a2

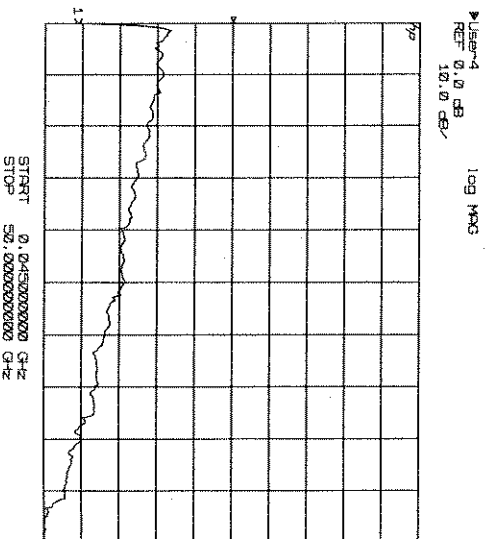


Good / Bad _____

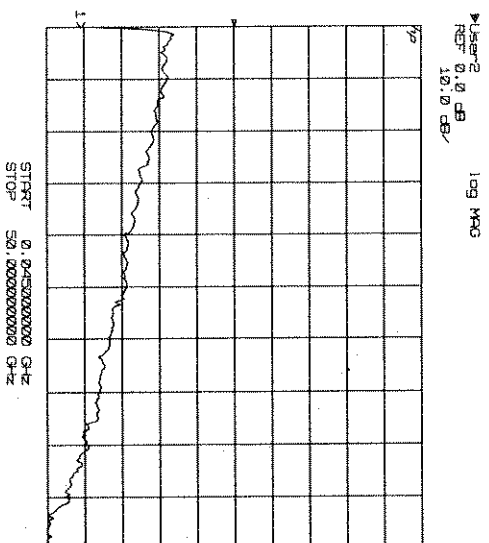
- 1) [REDEFINE PARAMETER] [DRIVE] [Port 2]
o observe the b1 power level trace through path 5,
d be similar to the example trace (typically within
1 or bad) under the RF path diagram..
- 2) [REDEFINE PARAMETER] [DRIVE] [Port 1]
o observe the b2 power level trace through path 6,
d be similar to the example trace (typically within
1 or bad) under the RF path diagram..



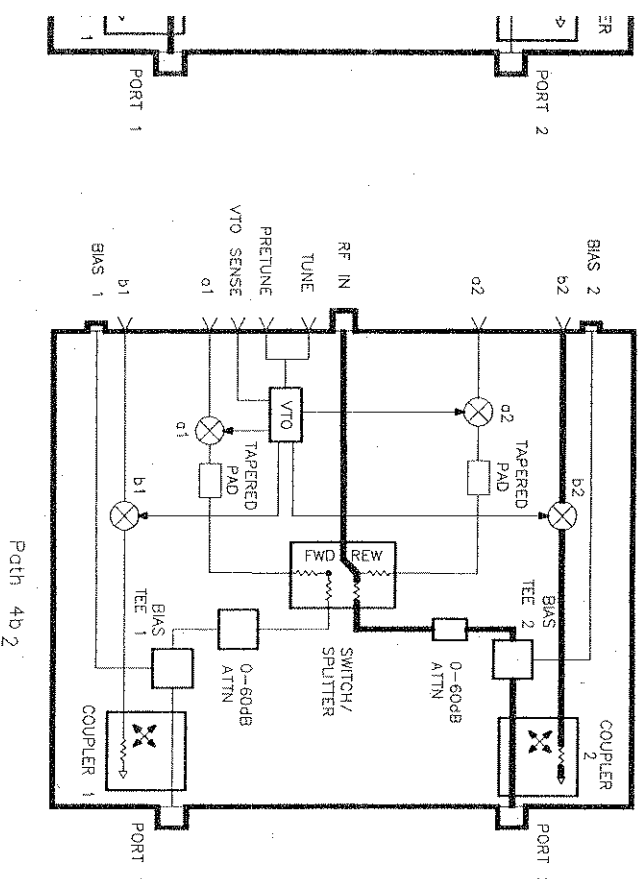
PATH 4 - b2 Reflected



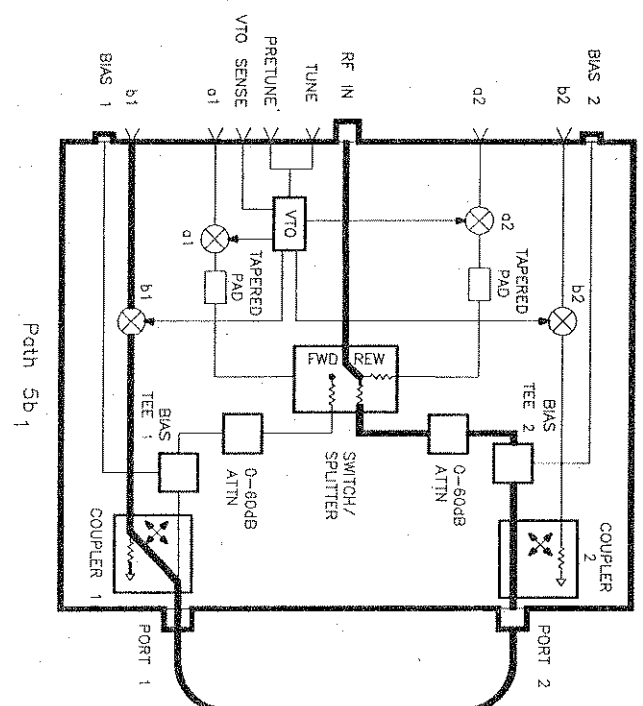
PATH 5 - b1 Thru



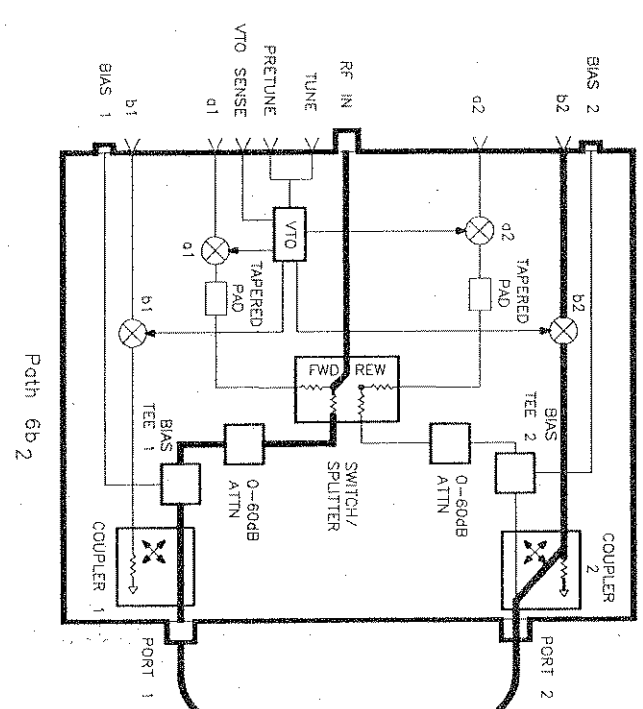
PATH 6 - b2 Thru



Good/Bad _____



Good/Bad _____



Good/Bad _____

Figure 4.3-8. HP 8517 RF Flow Diagrams and Typical Traces
Unratiod Power Failures

source into step mode. On the network analyzer [FACTORY PRESET] STIMULUS [MENU]

necessary to redefine what port and sampler the

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

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

2. This reflects power back to the b1 and b2

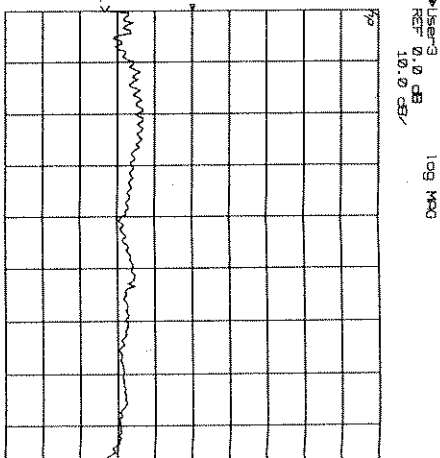
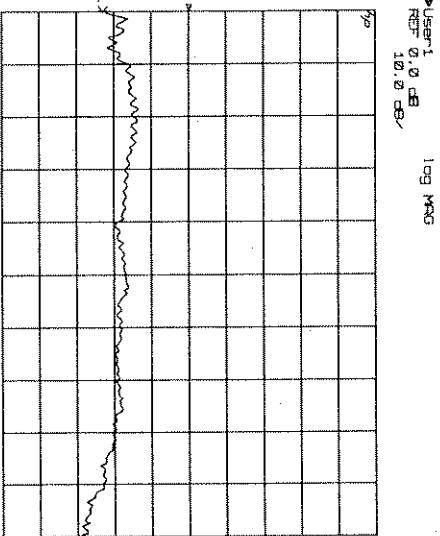
any response traces on this foldout. Press r 4 b 1]. Each trace should be similar to the ± 5 dB.

1 through User 4) in Table 4.3-3.

Path						Most Probable Failure
1	2	3	4	5	6	
a1	a2	b1 refl.	b2 refl.	b1 thru	b2 thru	Test set is not the problem
-	-	-	-	-	-	Source, source cable, VTO, cables from rear panel to switch splitter or input amplifier.
B	B	B	B	B	B	Switch splitter
-	B	-	B	B	-	Switch splitter
B	-	B	-	-	B	Switch splitter
-	-	B	-	B	-	b1 sampler, b1 buffer amplifier
B	-	-	-	-	-	a1 sampler, a1 buffer amplifier
-	B	-	-	-	-	a2 sampler, a2 buffer amplifier
-	-	-	B	-	B	b2 sampler, b2 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

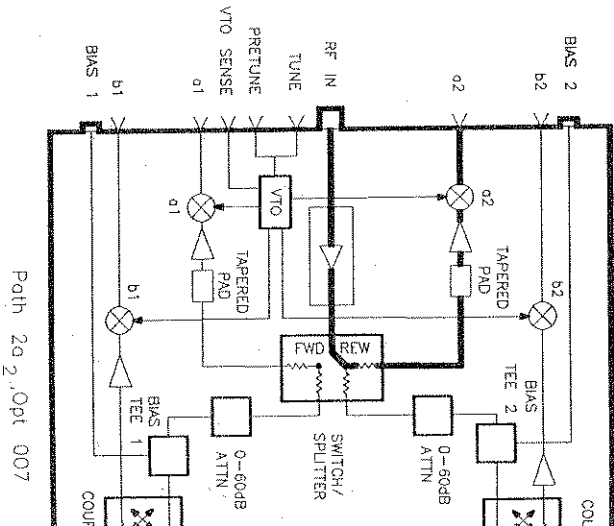
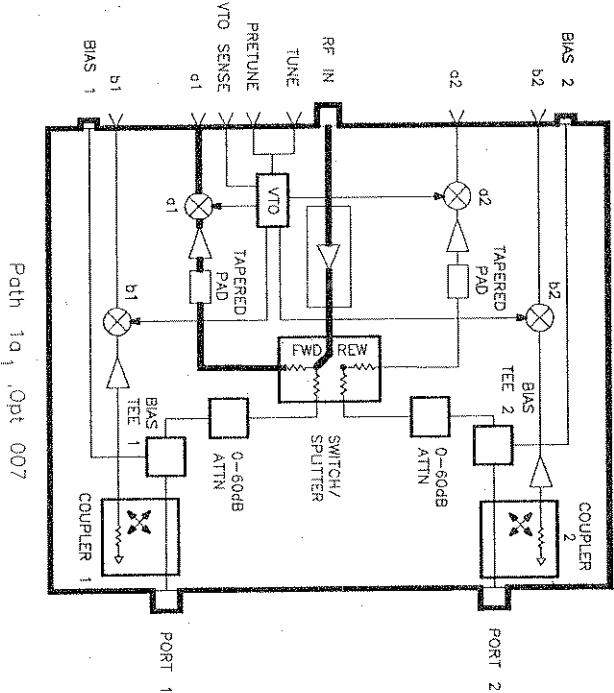
B = Bad
- = Good

- 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 1 - a1

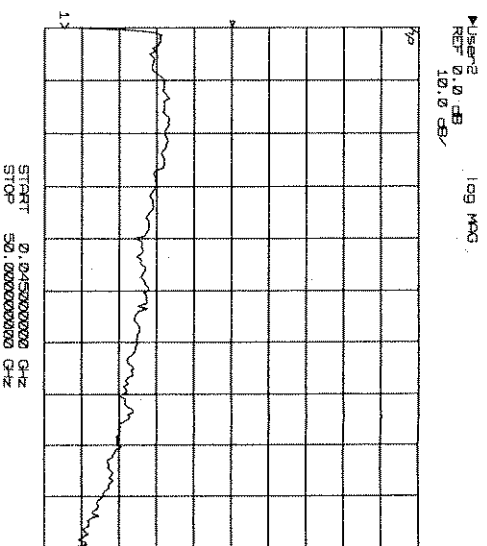
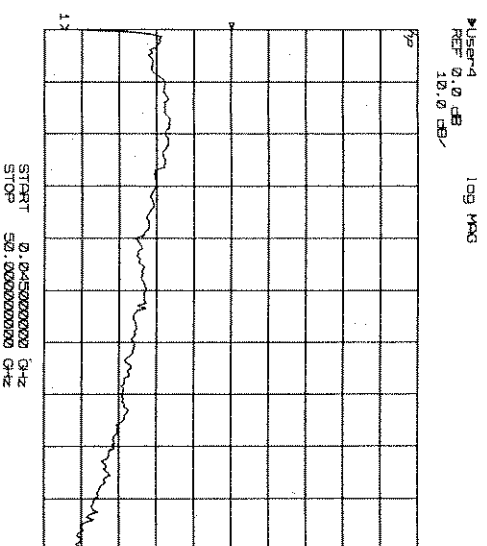
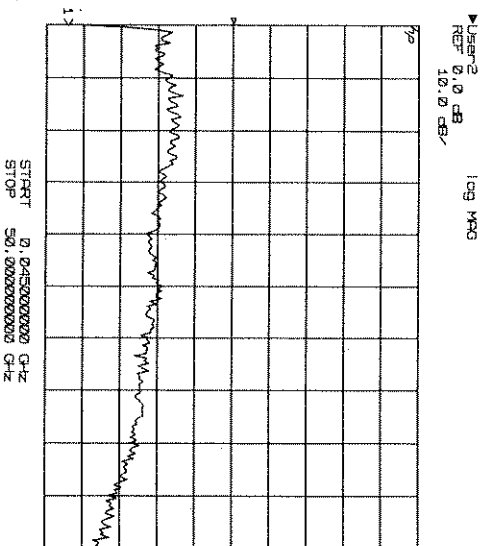
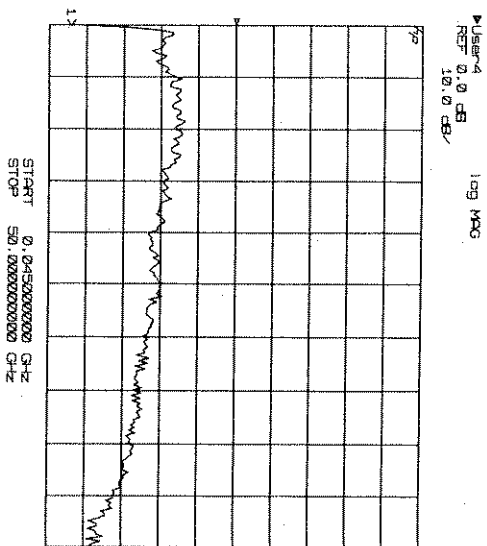
PATH 2 - a2



Good / Bad _____

Good / Bad: _____

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

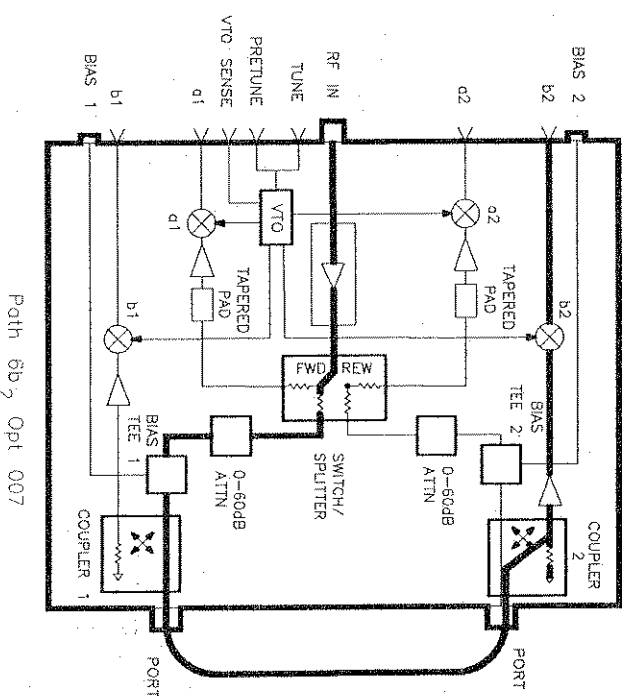
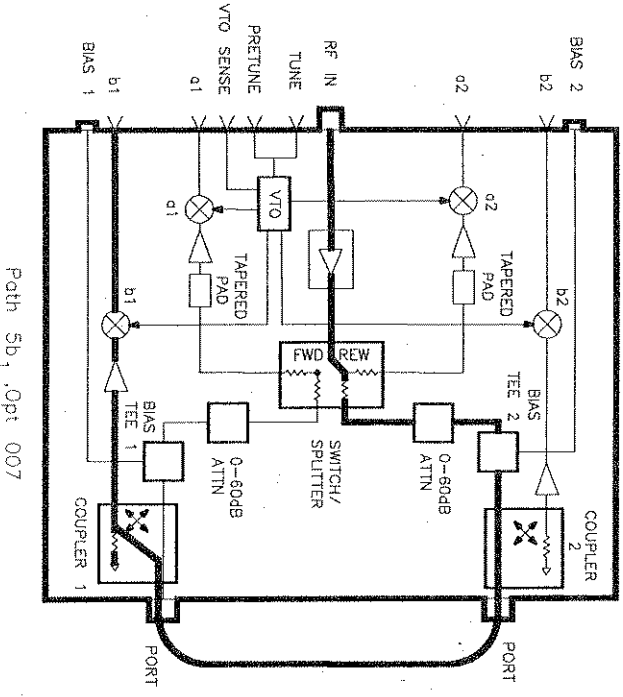
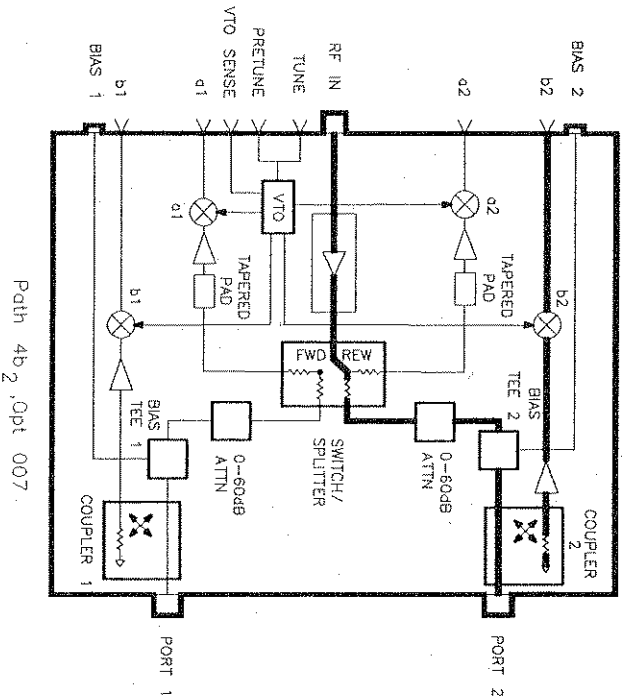
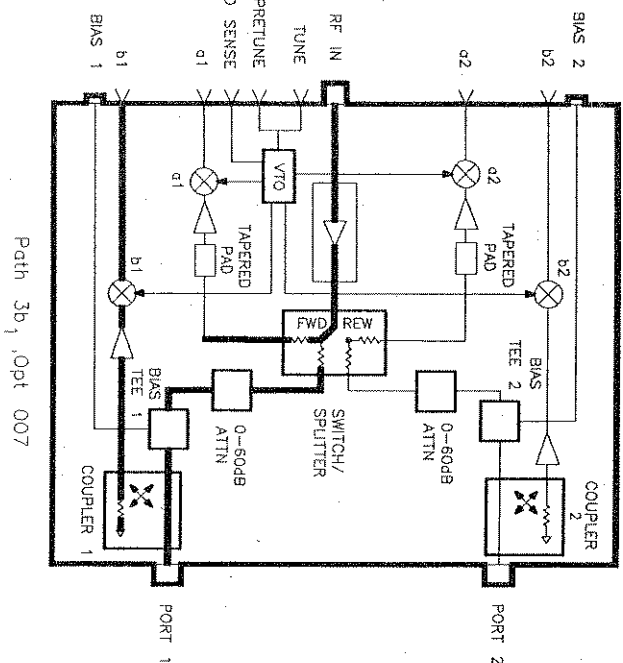


PATH 3 - b1 Reflected

PATH 4 - b2 Reflected

PATH 5 - b1 Thru

PATH 6 - b2 Thru



Good/Bad _____

Good/Bad _____

Good/Bad _____

Good/Bad _____

Figure 4.3-9. HP 8517B Option 007 RF Flow Diagrams and Typical Unratied Power Failures

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.

Assemblies:
Refer to Figure 4.4-1. The HP 85101 Display/Processor power supply consists of the following assemblies:
with the operation of the HP 8510C power supplies.
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

HP 85101C Power Supplies Summary

begin by troubleshooting the HP 85101C power supply.
summed that you know which unit has the suspected bad supply. If they are both suspected bad, The HP 85101C and 85102 supplies provide DC voltages to their own units independently. It is as-
bad assembly in either the HP 85101 or 85102 power supply in the shortest possible time.
Detector power supplies to the assembly level. The procedures are designed to let you identify the
This section consists of procedures to troubleshoot the HP 85101 Display/Processor and 85102 IF/
supply.

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

INTRODUCTION

4.4. Power Supply Failures

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

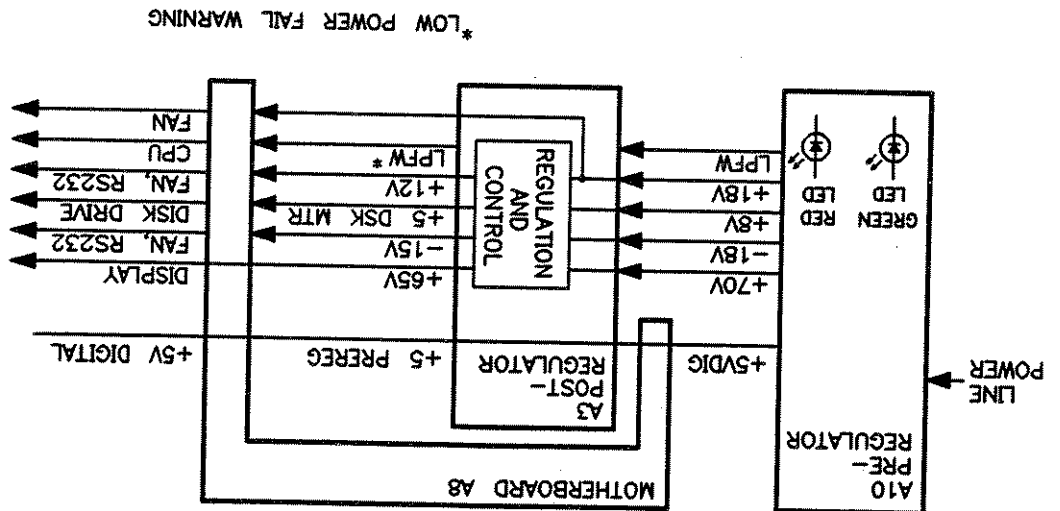
- A power transformer with two center-tapped secondary windings
- A separate bridge rectifier for each secondary winding
- Four regulators that supply $-5V$, $-15V$, $+5V$, and $+15V$
- Filtered but unregulated supply voltages of $-5V$, $-15V$, $+5V$, and $+15V$
- Fuses, test points, and LEDs for all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

The HP 85102 power supply consists of:

HP 85102 Power Supplies Summary

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.

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



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 <i>italics</i>.	
HP 8510C 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	
<i>Check the Line Voltage, Selector Switch, and Fuse</i>	
DETERMINE WHY THE RED LED ON A10 IS ON OR FLASHING	
<i>Disconnect A10W1</i>	
<i>Check the A10 Preregulator and Related Assemblies</i>	
<i>Measure Voltages on A10W1 and at A3J1</i>	
<i>Remove Assemblies</i>	
<i>Remove A8 Motherboard Connector Cables</i>	
<i>Check the Operating Temperature</i>	
<i>Inspect the A8 Motherboard</i>	
DETERMINE WHY THE GREEN LEDs ON A3 ARE NOT ALL ON	
<i>Remove the A3 Post-Regulator from its Motherboard Connector, Maintain A10W1 Cable Connection</i>	
<i>Check the A3 Fuses and Voltages</i>	
<i>Remove More Assemblies</i>	
<i>Disconnect Display Power Cable</i>	
<i>Inspect Motherboard</i>	
FAN TROUBLESHOOTING	
<i>Fan Speeds</i>	
<i>Check the Fan Voltages</i>	
INTERMITTENT PROBLEMS	
<i>Replace the A5 CPU board assembly</i>	
<i>If the problem continues, replace the A10 preregulator assembly</i>	

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

- 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 these LEDs are normal, then A10 is 95% verified. Continue this procedure at "Check the Green LEDs on the A3 Post-Regulator."
- 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.

CHECK THE GREEN AND RED LEDs ON THE A10 PREREGULATOR

- If the fan is not working, refer to "Fan Troubleshooting" near the end of this section.
 - If an error message appears on the display, refer to "Power Supply Error Messages" near the end of this section.
- Disconnect the HP 85101/85102 interconnect cable at the HP 85101C Display/Processor rear panel.

HP 85101C DISPLAY/PROCESSOR

Unplug A26

CHECK CONNECTOR P1

Check line voltage selector

Measure at fuses: $\pm 22V$ and $\pm 11Vdc$

Four green LEDs should be on.

CHECK THE LEDs AND OUTPUT VOLTAGES OF A26 RECTIFIER

Remove assemblies and check 5V LED on A15

CHECK THE +5V TEST POINTS ON A24 INTERFACE

If not, cycle power and measure the test points.

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

CHECK THE GREEN AND RED LEDs ON THE A15 REGULATOR

HP 85102B IF/DETECTOR

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

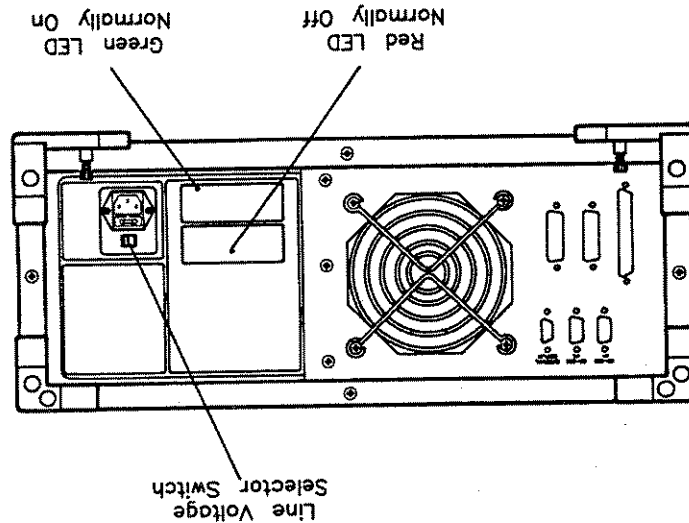
Refer to Figure 4.4-3 and measure the DC voltages on the A3 post-regulator test points. This figure

MEASURE VOLTAGES ON THE A3 POST-REGULATOR

- 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.
 - 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.
- 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.

CHECK THE GREEN LEDs ON THE A3 POST-REGULATOR

Figure 4.4-2. Location of A10 Preregulator Diagnostic LEDs

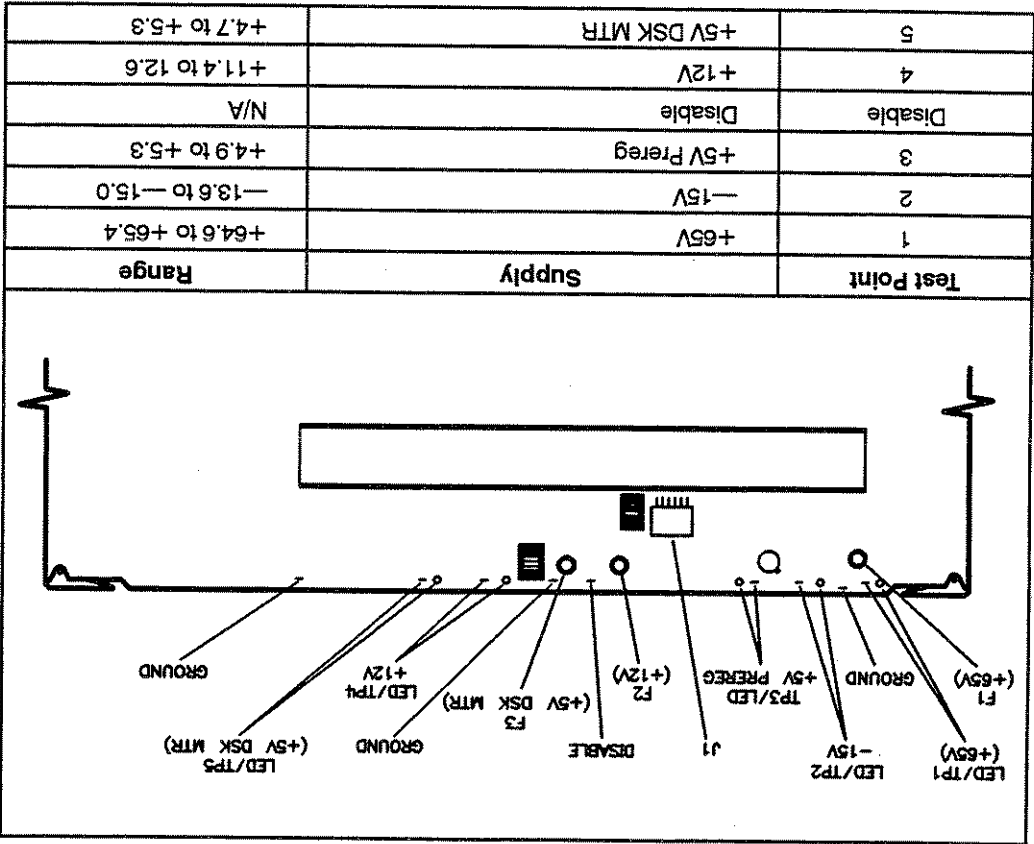


- If the green LED is not on steadily, then the line voltage is missing or is insufficient to power the HP 85101C. Continue this procedure at "Determine Why the Green LED on A10 is Not On Steadily."

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.

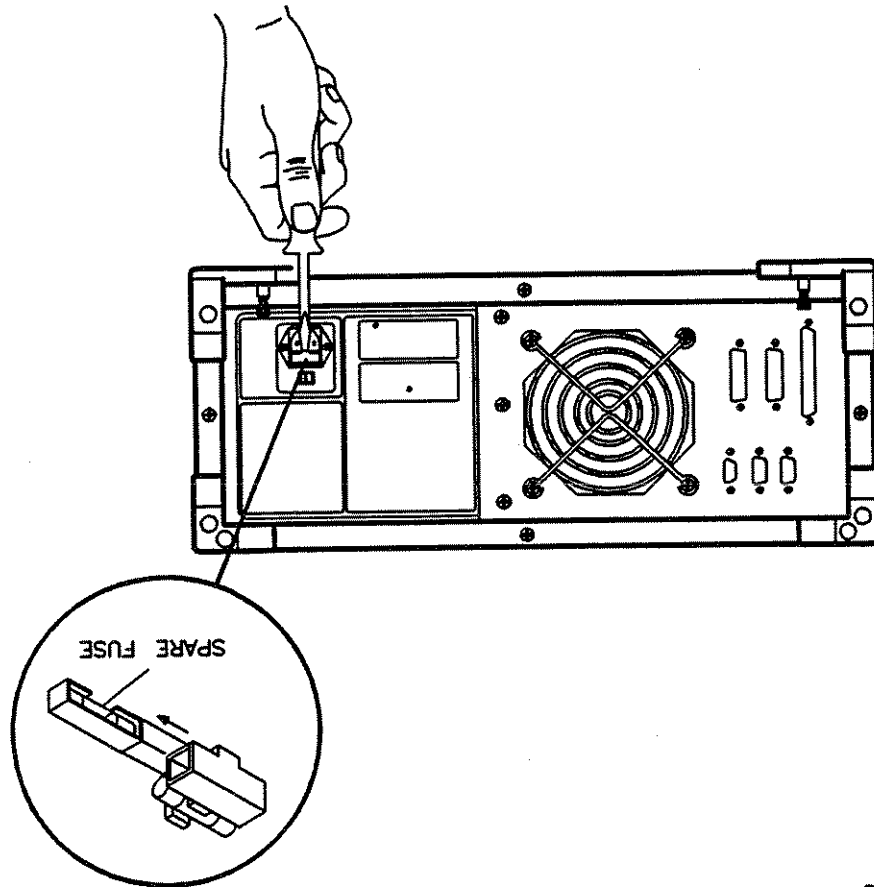
DETERMINE WHY THE GREEN LED ON A10 IS NOT ON STEADILY

Figure 4-4-3. A3 Post-Regulator LEDs and Test Point Voltages



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

Figure 4.4-4. Removing the Line 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.

Check the Line Voltage, Selector Switch, and 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.

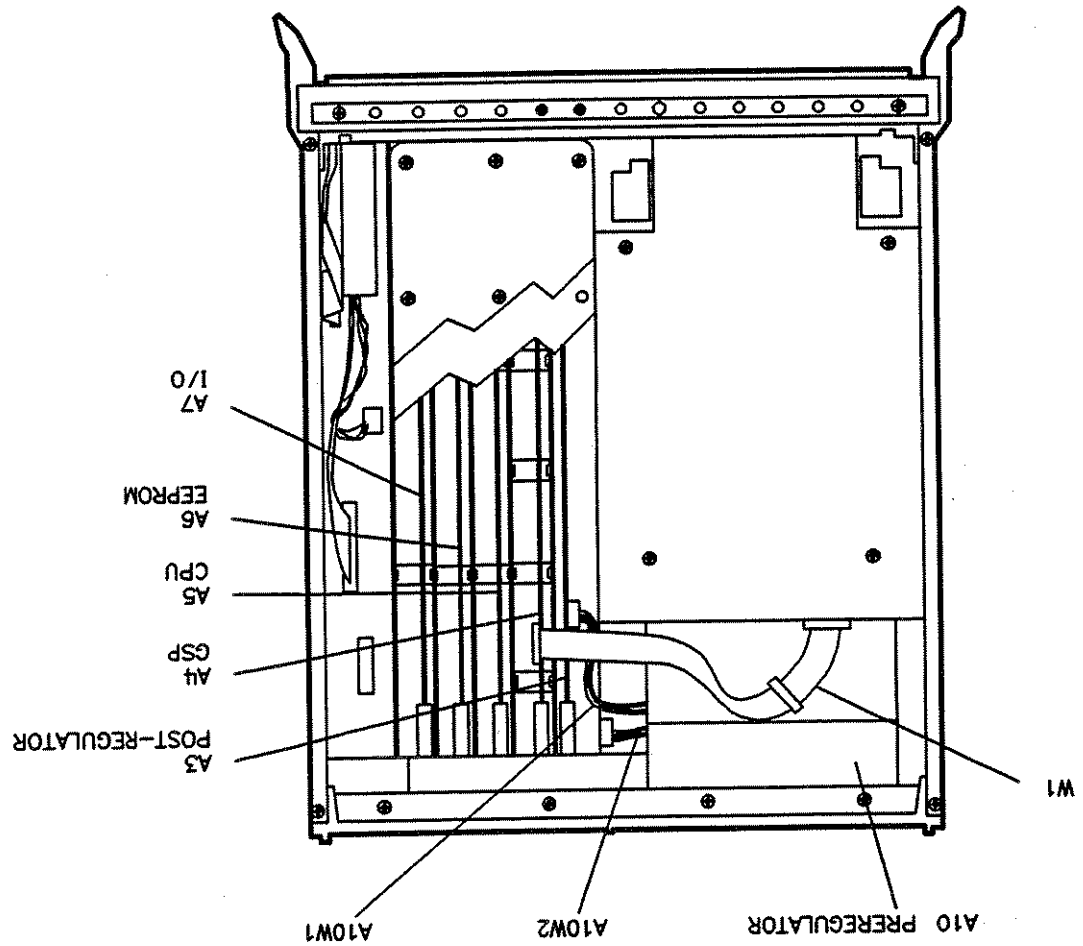
HP 8510C

Power Supply Failures 4.4-9

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.

Check the A10 Preregulator and Related Assemblies

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

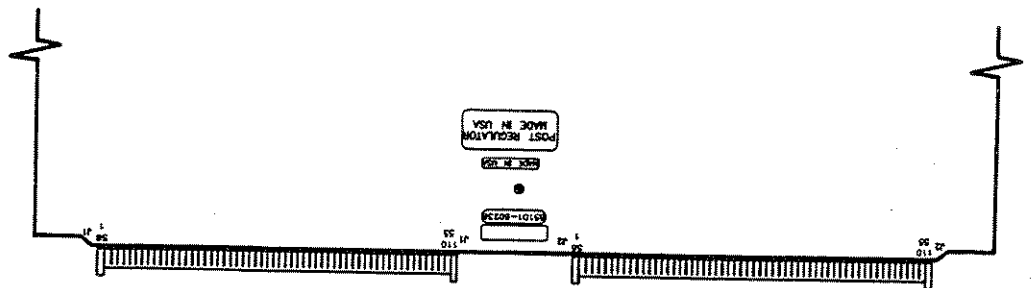


4.4-10 Power Supply Failures

HP 8510C

- 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.
- Turn off the HP 8510C and connect A10 preregulator cable A10W1 to the A3J1 post-regulator connector. Turn on the HP 8510C 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 within tolerance, the A10 preregulator is working properly. Continue with this procedure.
 - If the voltages are not within tolerance, replace the A10 preregulator.
- Compare the measured voltages with the voltages listed in Figure 4.4-7.
- 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 8510C and measure the voltages on the connector pins with a small probe.

Figure 4.4-6. A3 Post-Regulator Extender Board

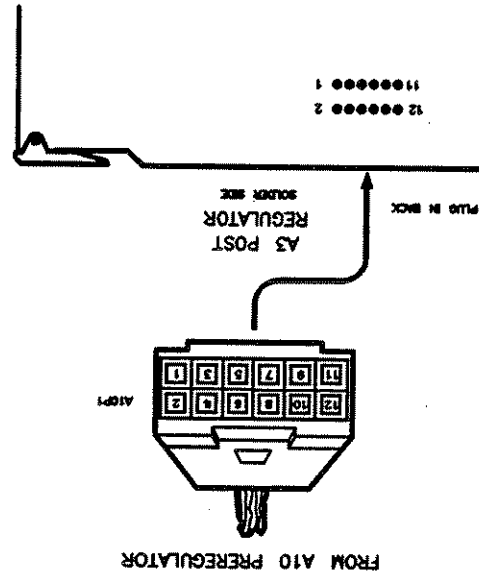


NOTE: The A3 post-regulator assembly has its own special extender board for troubleshooting. HP part number 85101-60236. The connector pin numbers are reversed from extenders for the other board assemblies.

- 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.

Figure 4.4-7. A10P1 Plug Detail and Output Voltages

*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 connects from preregulator A10 to A8 motherboard connector A8J8.				
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 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.

DETERMINE WHY THE GREEN LEDs ON A3 ARE NOT ALL ON

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.

- GNDSENSE
- +5V DISENSE
- +5V DIG
- DGN

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:

- If there does not appear to be a temperature problem, it is likely that the A10 preregulator is bad.
- If the fan does not seem to be operating correctly, refer to "Fan Troubleshooting" at the end of this section.
- If the fan does not exceed +55 degrees C (+131 degrees F), and that the HP 85101C fan is operating.

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

A8J1 keyboard cable
A8J2 disc drive cable

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.

- 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."

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

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."

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

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 pre-regulator A10.

Inspect Motherboard

Inspect the A8 motherboard for solder bridges and shorted traces.

- If any of the A3 green LEDs are off or flashing, continue with the next paragraph.
- 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."
- Turn off the HP 85101C and remove the display power cable W1 (illustrated in Figure 4.4-5). Turn on the HP 85101C.

Disconnect Display Power Cable

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).

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

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

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:

Remove More Assemblies

- 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.

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.

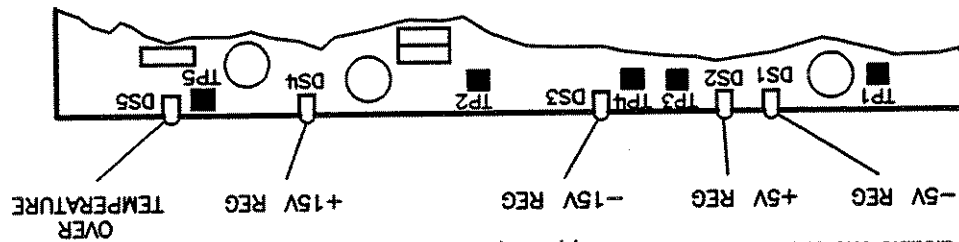
Exception: Some early models of HP 85102B derive the +5V power for the front panel LED from the HP 85101, and the line LED in these models will therefore not light when the HP 85101 and 85102 are not connected.

*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."

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

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:

Figure 4-4-8. A15 LEDs and Test Points



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).

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

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

CHECK THE GREEN AND RED LEDs ON THE A15 REGULATOR

- 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.

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

CHECK THE LEDS AND OUTPUT VOLTAGES OF A26 RECTIFIER

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

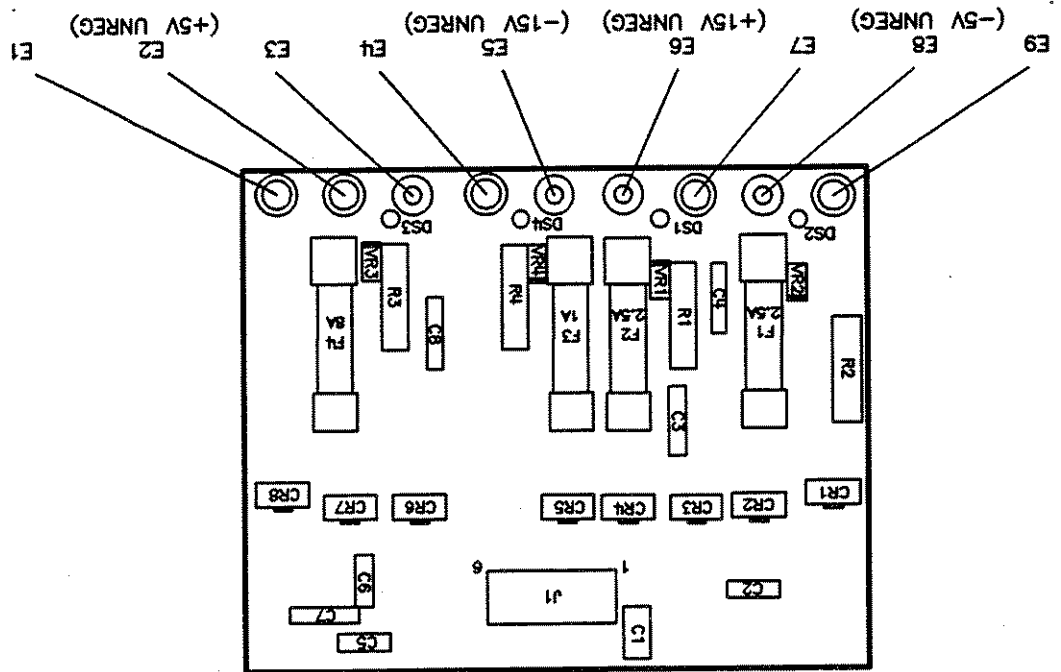
If any of the test points does not measure $+5\text{ Vdc}$, the supply is probably being loaded down by another assembly. Switch off the instrument and try removing assemblies one at a time. (Switch on power after removing each, and switch off power again before removing the next.) Check the $+5\text{V LED}$ 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 $+5\text{V LED}$ to light, the fault is probably in the A15 regulator. Replace A15.

CHECK THE +5V TEST POINTS ON A24 INTERFACE

- 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.

Figure 4.4-9. A26 Rectifier Fuse Locations



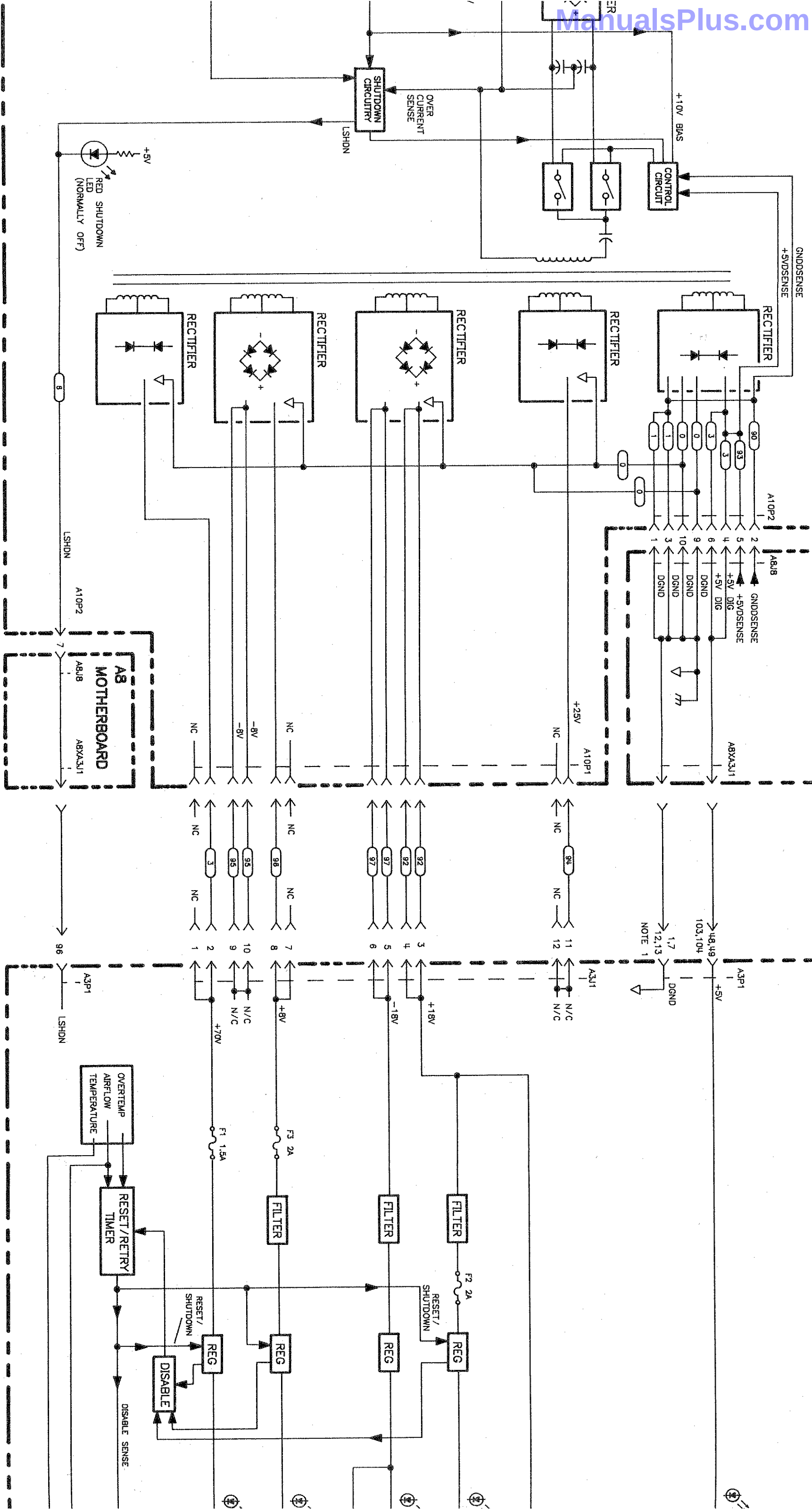
- If the voltages are approximately correct, replace A26.
- If the voltages are incorrect, the problem is in the power line module, transformer T1, or the connections.

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

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

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.

CHECK CONNECTOR P1



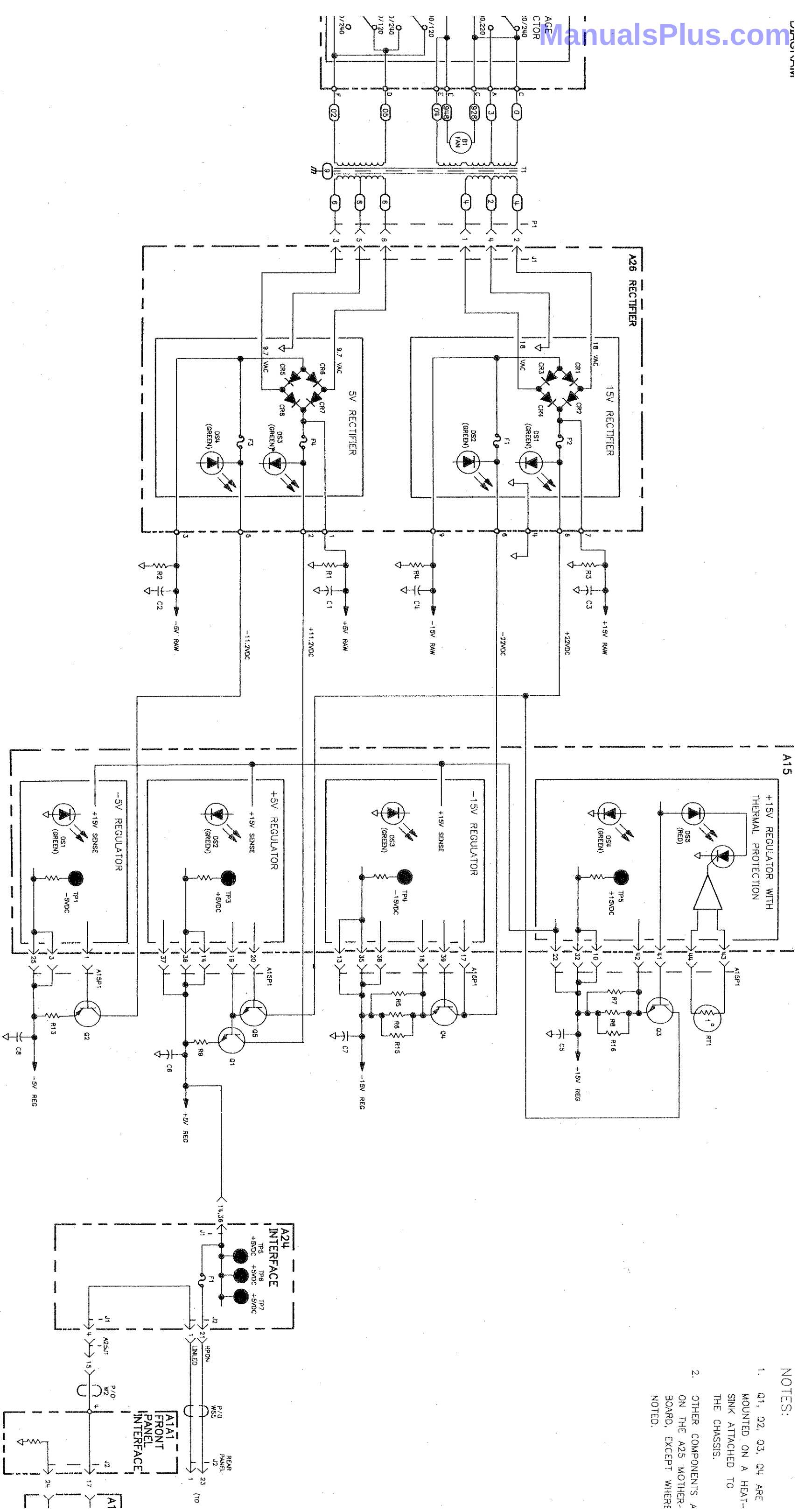


Figure 4.4-12 HP 85102C Power Supply Detailed Block Diagram

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

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 $\pm 23^{\circ}\text{C}$. Therefore the environmental temperature must remain in the range of $\pm 20^{\circ}\text{C}$ to $\pm 26^{\circ}\text{C}$. Once calibrated, the environmental temperature must not vary more than $\pm 1^{\circ}\text{C}$. 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 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.

PROCEDURE

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.

INTRODUCTION

4.5. Performance Test Failures

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.

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."

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.

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

HOW TO RESOLVE SOFTWARE AND FIRMWARE FAILURES

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.

INTRODUCTION**4.6. Software Failures**

Revision Number	Analyzer ¹	HP Part Number	Significant Contribution
A.01.00	HP 8510A	85101-100012,3	HP 8510A first release. Order A.02.00.
A.02.00	HP 8510A	85101-100012	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 (1 of 2)

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.

FIRMWARE REVISIONS

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.

- Any other details about the state of the system during failure that may be important to troubleshooting.
- 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.

[SOFTWARE REVISION]

- 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]**
- The exact system configuration including the model numbers of all system components in the system.

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:

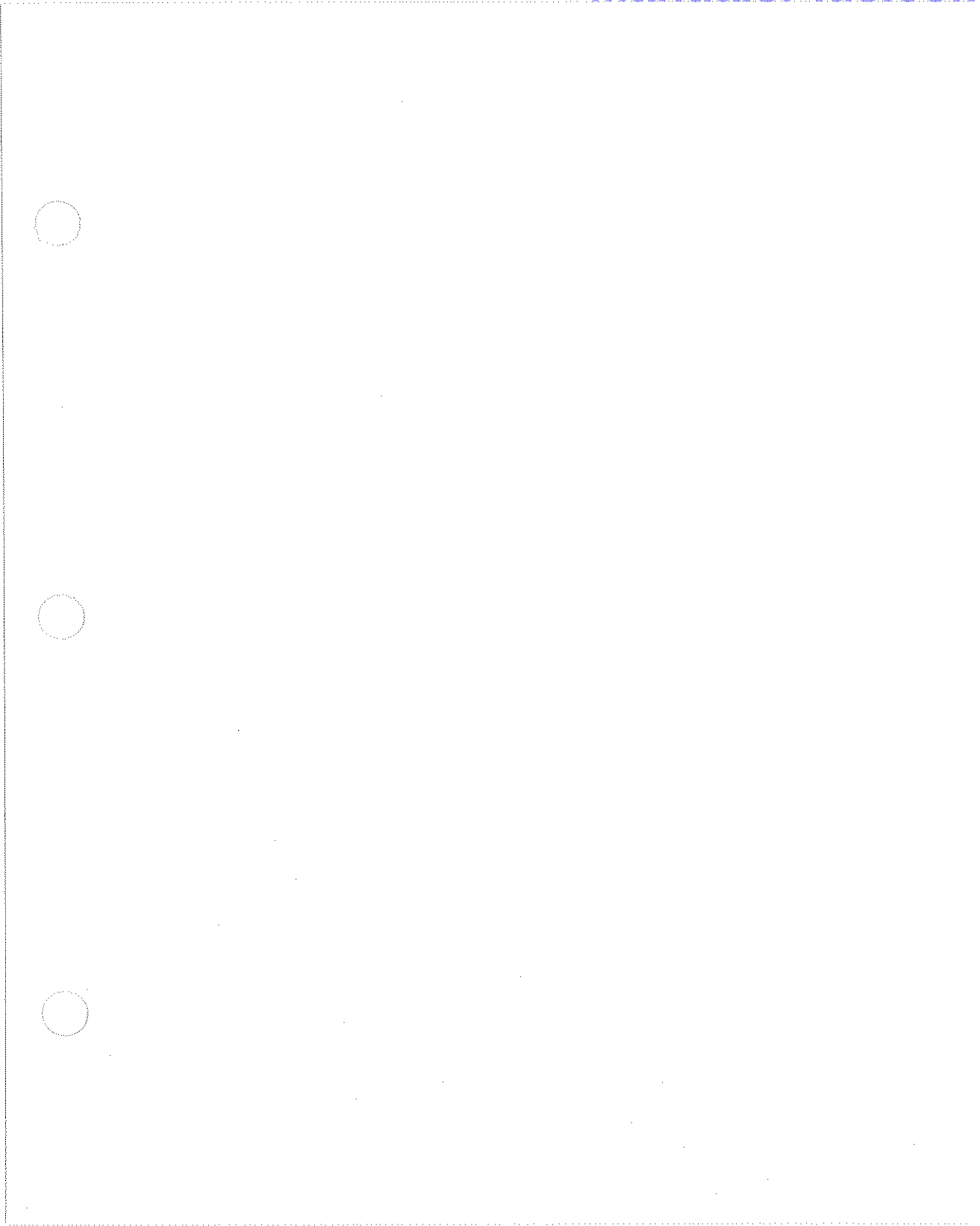
HP 8510C

Software Failures

4-6-3

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 11575C 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.			

Table 4-6-1. HP 8510 Operating System History (2 of 2)



HP 8510C

4.7-1 Other Failures

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

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

20 Hz.

A signal generator is required that is capable of generating a 1.5V p-p sine wave at approximately 20 Hz. 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. This test checks the HP 85102 A17 sample and hold, HP 85102 A18 ADC, and the HP 85102 A19 ADC control board assemblies.

20 HZ SINE WAVE 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.

NOISY DISPLAY TRACE TEST

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

INTRODUCTION

4.7. Other Failures

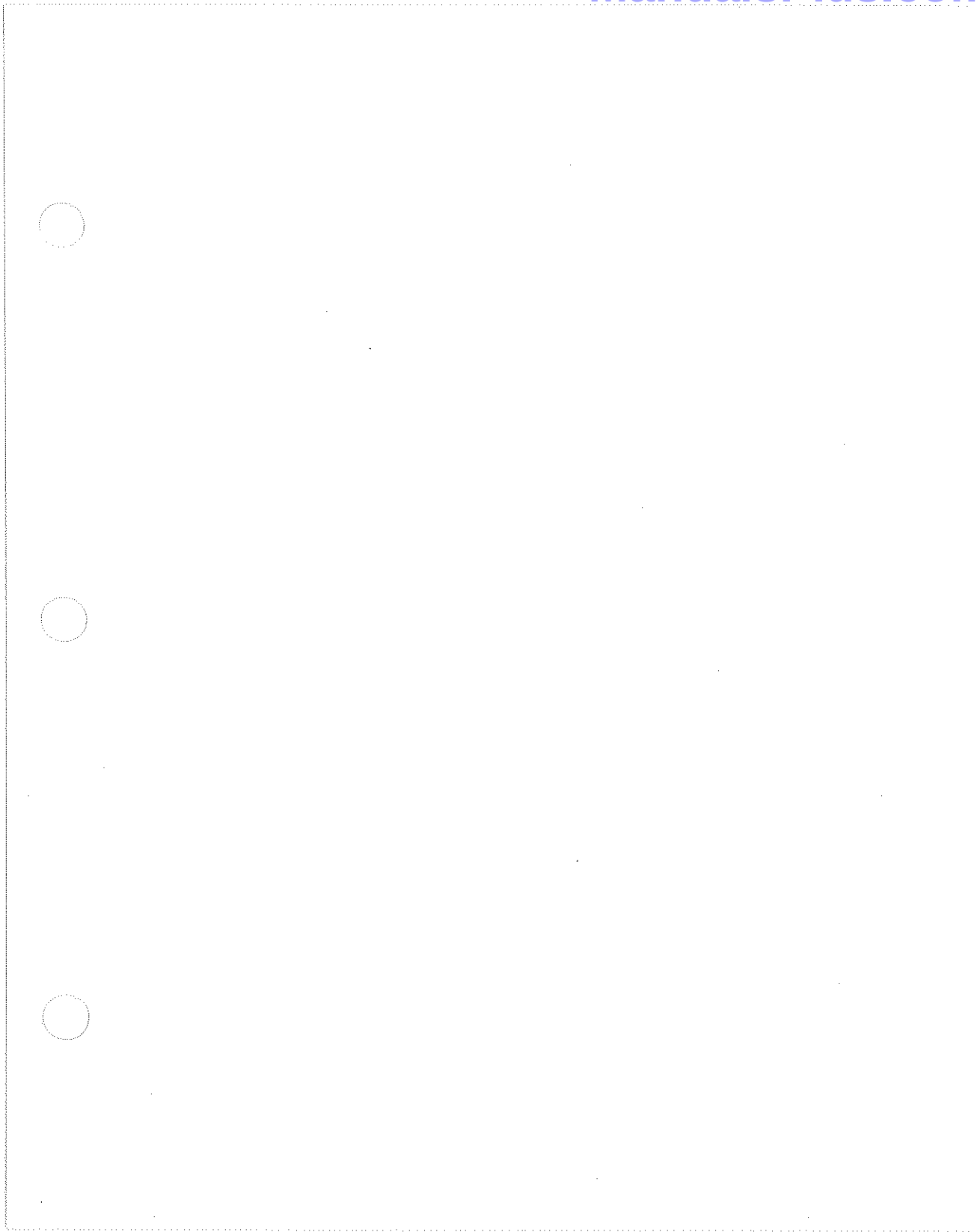
This test uses a source emulator in place of the source to verify system operation when the source is suspected of having a fault. A 60 MHz signal is injected into the test set to emulate the source. The "tripier" is a 60 MHz bandpass filter specially designed for the HP 8510. It operates by passing 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."

SOURCE EMULATOR/TRIPLER TEST

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.

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** **STIMULUS** **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.



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

- HP 85102 emulator board assembly
- HP 8510 service adapter
- Two BNC cables The 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.

TOOLS REQUIRED

- 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.

Run the service program to:

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. 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.

INTRODUCTION

4.8. Service Program

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.

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.

HP 85101 DISPLAY/PROCESSOR SERVICE PROGRAM MENU

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 8510 SERVICE PROGRAM MENU MAP

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 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 messages due to improperly-seated boards, or "extra" HP-IB cables attached to the analyzer but not to anything else.

HOW TO INTERPRET SERVICE PROGRAM TEST RESULTS

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

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

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

RUNNING THE HP 8510 SERVICE PROGRAM

HP 8510C

Service Program

4-8-3

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

Signature Analysis - (Data Bus) . . 8

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

Signature Analysis - Address Bus . . 7

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 - Multiplier . . 6

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.

Circle Test (Exercises Multiplier) . . 5

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.

Complex Multiply Test . . 4

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.

Multiplier Test . . 3

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.

Read/Write/Shift Accumulator Test . . 2

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.

DRAM Refresh Test . . 1

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.

HP 85101 CPU BOARD TESTS (A5)

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.



This is a screen test pattern used to vertically align the display to the softkey positions.

Softkey Label Alignment Pattern . . 8



Use the up/down keys, RPg knob, or the numeric keypad to select different patterns. To exit this test, press **=MARKER**.

- color purity
- grayscale
- focus
- astigmatism
- geometric distortion
- convergence



This test provides 15 screen patterns for use in evaluating and adjusting the display. With these patterns, the following display qualities can be evaluated:

Screen Test Patterns . . 7

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 EEPROM board, provided the board successfully initialized.

In the HP 8510C 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.

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.

Reset Memory to Default Hardware Cal Data . . 9

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.

Show Non-Volatile Memory Parameters . . 8

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.

ORDER OF TESTING

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.

HP 85102 PROMPT MESSAGE

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 $\pm 10V$ 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.

HARDWARE

NOTE: Read the following instructions before using the HP 85102 diagnostics.

This is the primary HP 85102 menu. It allows you to select any of the tests for the IF/Detector.

HP 85102 IF-DETECTOR SERVICE PROGRAM MENU

technicians.

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.

ADC Test (A18) . . . 3

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.

- pulse generator
- trigger generator
- sweep counter
- input buffer
- sweep crossing detector
- staircase generator

This test checks the following items on the A20 sweep ADC board:

Sweep ADC Test (A20) . . . 2

- 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

Other causes of failure on this test may be:

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.

ADC Control Test (A19) . . . 1

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.

the order below:

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

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.

20 MHz Mixer Test (A9, A11, A13, A14) . . . 7

- Faulty A18 ADC and/or A19 ADC control board
- Faulty A10 or A12 IF amplifiers
- Faulty A6 clock board

Other causes of failure of this test may be:

then you can run this test and have confidence in the results.
the ADC test (A18) and 100 kHz IF amp test (A10, A12) before running this test. If those tests pass, also used to detect failures with the A17 sample and hold board circuitry. However, you must run this test verifies that both A5 and A7 synchronous detector boards are working properly. It is

Synchronous Detector Test (A5, A7) . . . 6

- 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

Other causes of failure of this test may be:

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.

100 kHz IF Amplifier Test (A10, A12) . . . 5

- A faulty A18 ADC board, primarily the 10 volt reference.

Other causes of failure of this test may be:

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.

Cal DAC Test (A17) . . . 4

- 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.

Other causes of failure of this test may be:

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.

HP 85102 Front Panel Test . . C (k/m)

Run All The Above Tests . . B (M/u)

- A13 and/or A14 mixer boards that provide the 20 MHz signals to the A21 IF counter

Other causes of failure of this test may be:

- Amplifier limiter
- Gate generator
- Counter circuit
- Reference channel select switch

This test verifies the operation of the following circuits on the A21 IF counter:

IF Counter Test (A21) . . A (G/n)

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.

Main Phase Lock Test (A23) . . 9

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.

Pretune Phase Lock Test (A22) . . 8

- 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

Other causes of failure of this test may be:

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.

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.

FAILURE AFTER REPAIR

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.

IF THE TEST DOES NOT VERIFY OR ISOLATE THE FAILURE

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.

Select New HP-IB Address . . 6

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.

Increment Active Attenuator . . 5

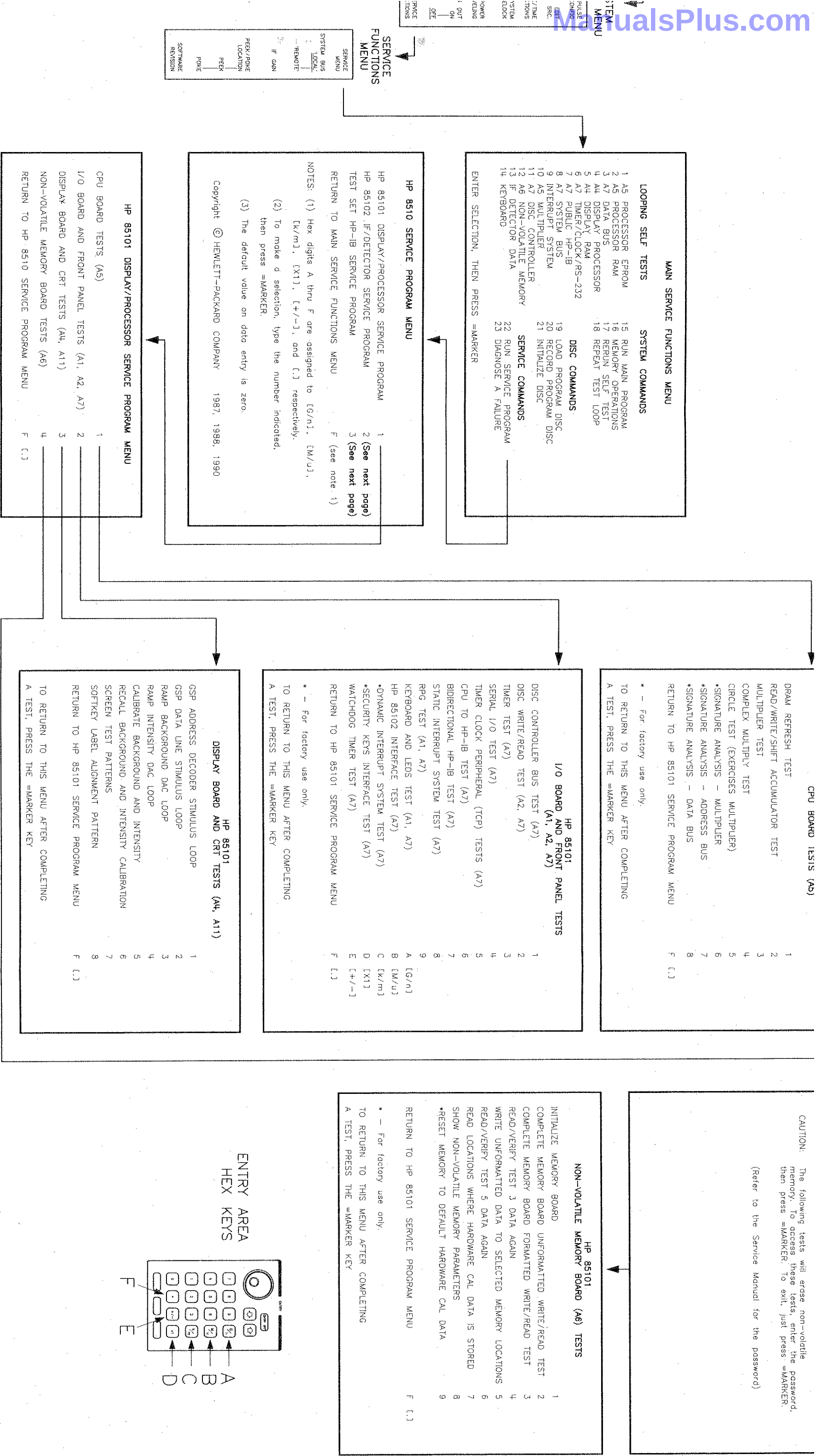


Figure 4.8-1 HP 8510C Service Program Menu (1 of 2)

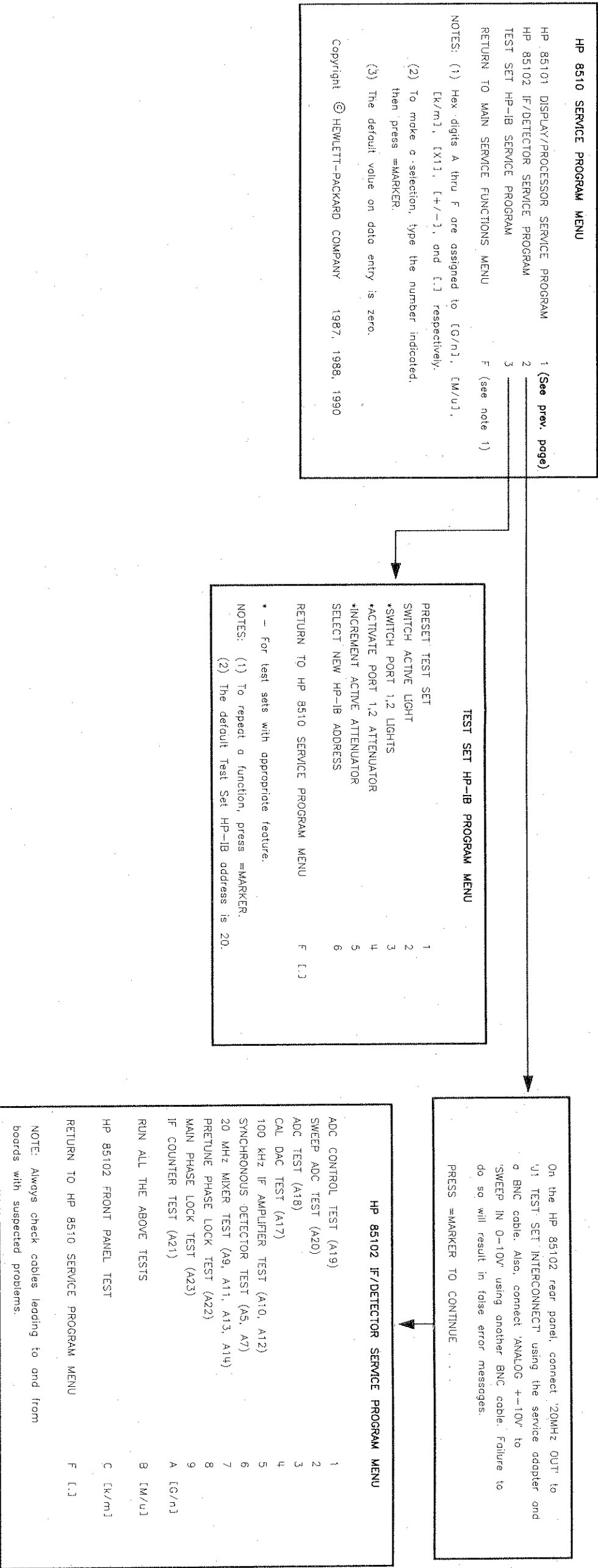


Figure 4.8-1 HP 8510C Service Program Menu (2 of 2)

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.

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.

Use the procedures in this section to generate and examine error terms. This information can be useful in two ways:

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:

Error terms can also serve a diagnostic purpose. Specific parts of the analyzer system and accessories contribute 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.

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.

INTRODUCTION

4.9. Error Terms

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.

ERROR TERMS INSPECTION PROCEDURE

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.

MEASUREMENT CALIBRATION

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.

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.

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.

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.

Avoid unnecessary bending and flexing of the cables following measurement calibration, to minimize cable instability errors.

Connectors must be clean, gaged, and within specification for error term analysis to be meaningful.

All parts of the network analyzer system, including cables and calibration devices, can contribute to systematic errors and impact the error terms.

These procedures are especially good for determining if a calibration is bad or the test set is faulty.

Consider the following while troubleshooting:

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 verification 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.

Procedure

- 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

Equipment

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 (Est 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.

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.

NOTES:

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. 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.

Transmission Tracking (Etr and Etr)

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).

Load Match (Elf and Elr)

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).

Isolation (Crosstalk) (Exf and Exr)

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.

Reflection Tracking (Err and Erf)

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.

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.

EXCHANGE ASSEMBLIES

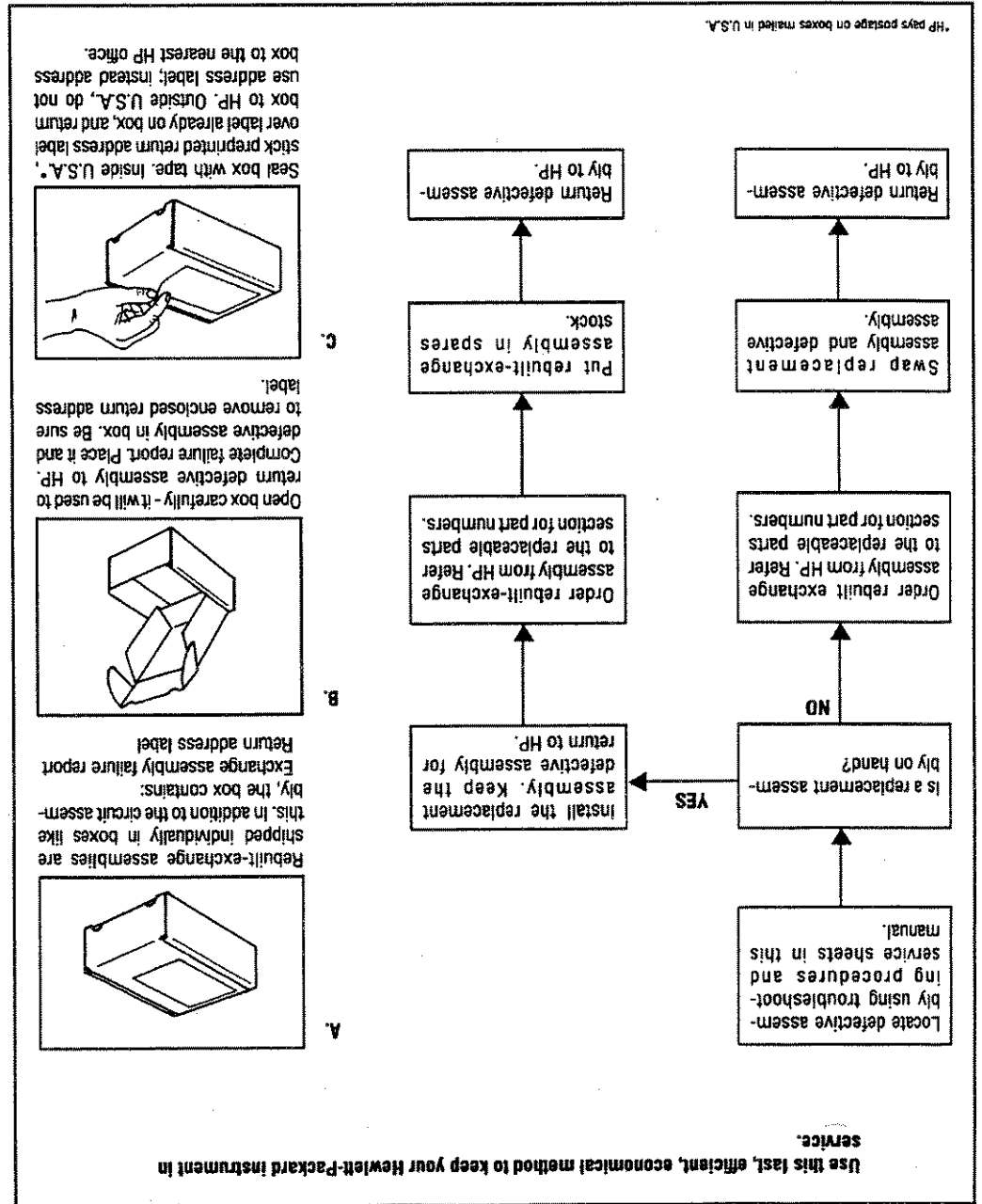
Some of the major assemblies can be replaced on a rebuild exchange (R-E) basis. Exchange, factory-repaired and tested assemblies are available only on a trade-in basis; the defective assemblies must be returned for credit, within 30 days. For this reason, assemblies required for spare parts stock must be ordered by the new assembly part number. Figure 5-1 explains the rebuild module exchange procedure. R-E assembly part numbers are listed in the parts lists below the part numbers for the corresponding new assemblies.

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.

5. Replaceable Parts

Figure 5-1. Module Exchange Program



REFERENCE DESIGNATORS		ABBREVIATIONS	
A	Assembly	A	Analog to Digital
B	Fan, Motor	AD	Analog to Digital
C	Capacitor	ADC	Analogue to Digital Converter
CA	Cable	AL	Aluminum
CBL	Cable	AMP	Amplifier
CER	Ceramic	APC	Amphenol Precision
CHAM	Chamber	ASSY	Assembly
CKT	Circuit	AWG	American Wire Gauge
CONDUCT	Conductor	AV	Assembly
CNTR	Counter	B	Band
CONN	Connector	BD	Board
CONT	Control, Controller	BLK	Black
CONVTR	Converter	BNC	Type of connector
CPU	Central Processing Unit	BP	Bandpass
CVR	Cover	BSC	Basic
D		BSHG	Bushing
DARL	Darlington Pair		
DBL	Double		
DEG	Degrees		
DET	Detector		
DIP	Dual In-Line Package		
E			
EEPROM	Electrically Erasable Programmable Read Only Memory		
EMU	Emulator		
EXT	External, Extension		
F			
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	Jack		
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		
NYL	Nylon		
O			
OD	Outside Diameter		

Table 5-1. Reference Designations, Abbreviations, Multipliers and Manufacturer's Code List (1 of 3)

P	Panel	RR	Rear	TA	Tantalum
PAN	Panel	RT	Right	TC	Thermoplastic
PAN-HD	Pan Head	S	Source	THD	Thread
PC	Printed Circuit	SCE	Source	THK	Thick
PD	Pad, Palladium, Pitch Diameter,	SCR	Screw, Silicon Controlled Rectifier	THKM	Thickness
PERF	Perforated	SER	Serial	TNG	Tongue
PKG	Package	SGL	Single	TPG	Tapping
PL	Phase Lock, Plain, Plug	SHFT	Shaft	TTL	Transistor Transistor Logic
PNP	Positive, Negative, Positive	SI	Silicon	TX	Torx
POLYU	Polyurethane (Transistor)	SK	Sink	U	
POZI	Posidrive	SKT	Skirt, Socket	UL	Underwriters' Laboratories, Inc
PROC	Processor	SLDR	Solder	UNCT	Undercut
PVC	Polyvinyl Chloride	SMB	Subminiature type B	V	
PW	Power Wirewound	SMPL	Sample (Snap-on connector)	V	Volt
PWR	Power	SPCL	Special	VGA	Video Graphics Adapter
R		STR	Strapped, Strip	W	
R	Right	SUBMIN	Subminiature	W	Watt, Width
REF	Reference	SW	Switch	WD	Width
RF	Radio Frequency	SWP	Sweep	X	
RFI	Radio Frequency Interference	SYNC	Synchronous	XDCR	Transducer
RGB	Red, Green, Blue	SYS	System	XSTR	Transistor
RND	Round	T	Thickness, Teeth		
RPG	Rotary Pulse Generator	T			

Table 5-1. Reference Designations, Abbreviations, Multipliers and Manufacturer's Code List (2 of 3)

HP 8510C

S-5 Replaceable Parts

MULTIPLIERS									
Abbreviation	Prefix	Multiple	Abbreviation	Prefix	Multiple	Abbreviation	Prefix	Multiple	Multiple
T	tera	10^{12}	da	deka	10	n	nano	10^{-9}	
G	giga	10^9	d	deci	10^{-1}	p	pico	10^{-12}	
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 S-1. Reference Designations, Abbreviations, Multipliers, and Manufacturer's Code List (3 of 3)

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

Table S-2. Software, Documentation and Accessories

HP 8510C

Replaceable Parts
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Figure 5-2. Available Service Tools (1 of 3)

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	FLTER, 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 SCOR	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 100B 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 6A 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	WHAIST STRAP ANTI-STATIC, ADJUSTABLE (DOES NOT INCLUDE CORD)*	28480	9300-1367
	9300-0980	GROUNDING CORD, 5 FEET LONG (USE WITH WHIST 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
	08511-20025	THE FOLLOWING HP 8511B SERVICE TOOLS MAY BE ORDERED AS A KIT (HP PART NUMBER 08511-60016), OR ORDERED SEPARATELY:	28480	08511-20025
	28480	RF TEST CABLE (TWO SUPPLIED IN KIT)	28480	28480
	08511-20031	RF CABLE SOURCE, 2 FT LG	28480	08511-20031
	28480	50 GHZ POWER SPLITTER	28480	28480
	28480	FIXED ATTENUATOR, 5 DB (TWO SUPPLIED IN KIT)	28480	28480
	28480	FIXED ATTENUATOR, 20 DB	28480	28480
	3334CD #020	FIXED LOAD, 50 OHM F 2.4 MM	28480	3334CD #020
	85138B	FIXED LOAD, 50 OHM F 2.4 MM	28480	85138B
	85138A	FIXED LOAD, 50 OHM M 2.4 MM	28480	85138A
	1250-2188	ADAPTER F 2.4MM F 2.4MM	28480	1250-2188
33	08510-60022	THE FOLLOWING ITEMS ARE INCLUDED IN THE 8510/8360 FRONT PANEL EMULATOR KIT AND ARE AVAILABLE SEPARATELY:	28480	08510-60022
	28480	8510/8360 FRONT PANEL EMULATOR KIT	28480	28480
34	08510-90266	INSTALLATION NOTE	28480	08510-90266
35	85101-80097	8510/8360 FRONT PANEL EMULATOR TAPE	28480	85101-80097
36	85102-80115	PANEL OVERLAY	28480	85102-80115

HP 8510C

Replaceable Parts
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Figure S-2. Available Service Tools (2 of 3)

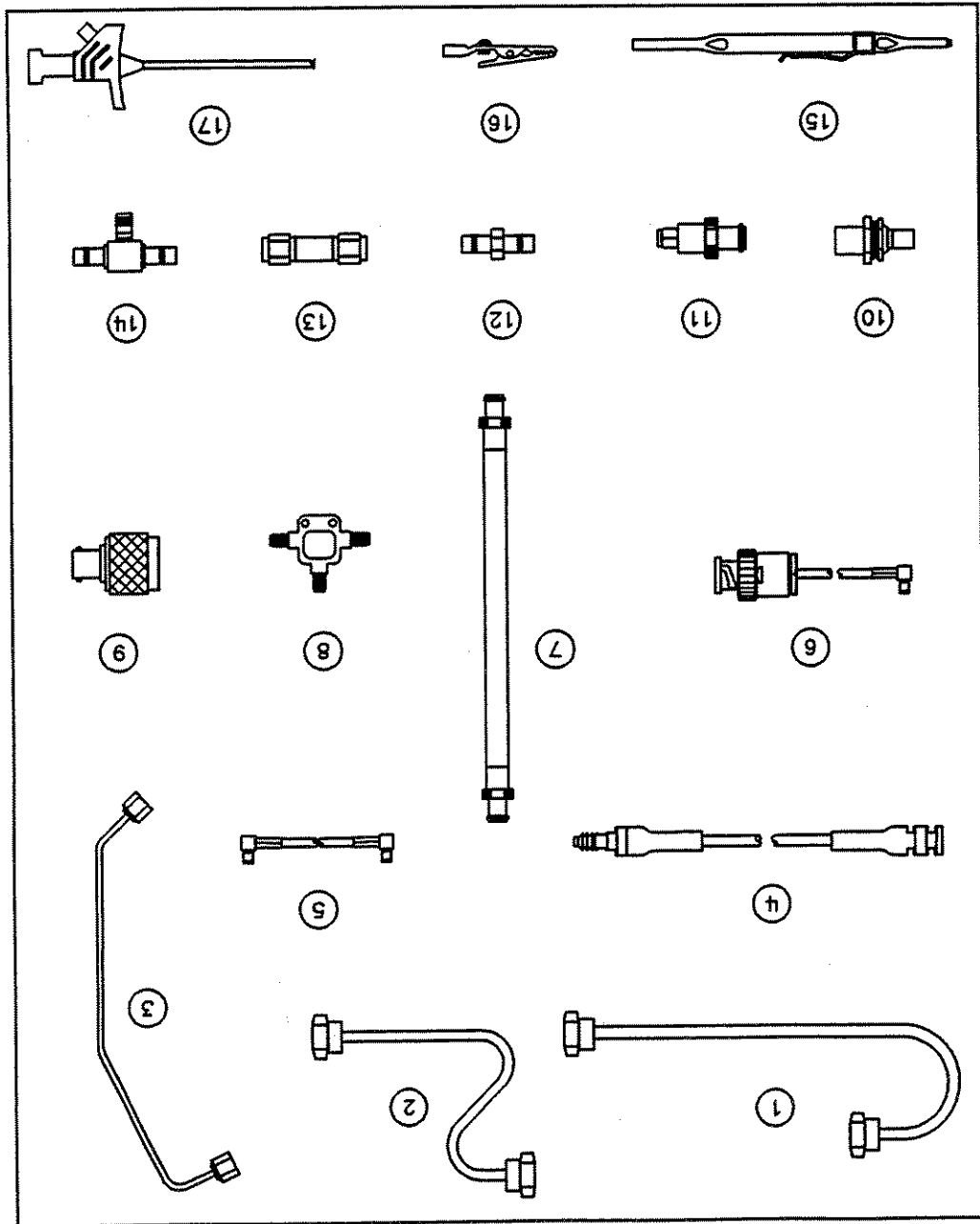
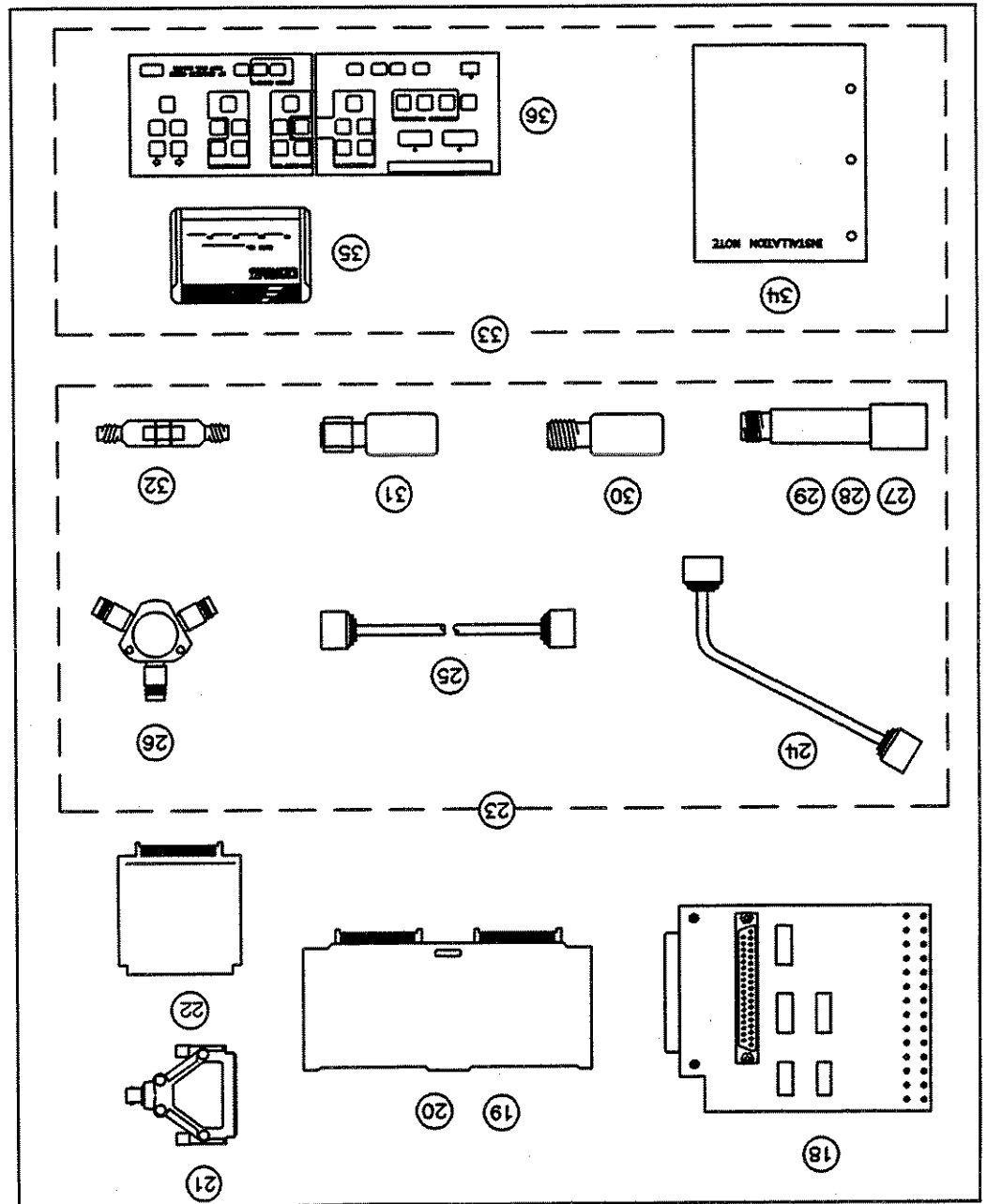


Figure 5-2. Available Service Tools (3 of 3)



HP 8510C

Replaceable Parts 5-11

Figure 5-3. HP 8510IC Top Internal (1 of 2)

Ref Design	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
A8/C1	85101-69269		SECURITY KEY IC, HP 8501C STANDARD (REBUILT-EX-CHANGE ONLY)	28480	85101-69269
A8/C2	85101-69268		SECURITY KEY IC, HP 8510C TIME DOMAIN (REBUILT-EX-CHANGE ONLY)	28480	85101-69268
A10	85101-60114		SECURITY KEY IC, HP 8510C REVISION 7.0 FIRMWARE	28480	85101-60114
A10	85101-66114		SECURITY KEY IC, HP 8510C REVISION 7.0 FIRMWARE	28480	85101-66114
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		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

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Figure 5-3. HP 8510C Top Internal (2 of 2)

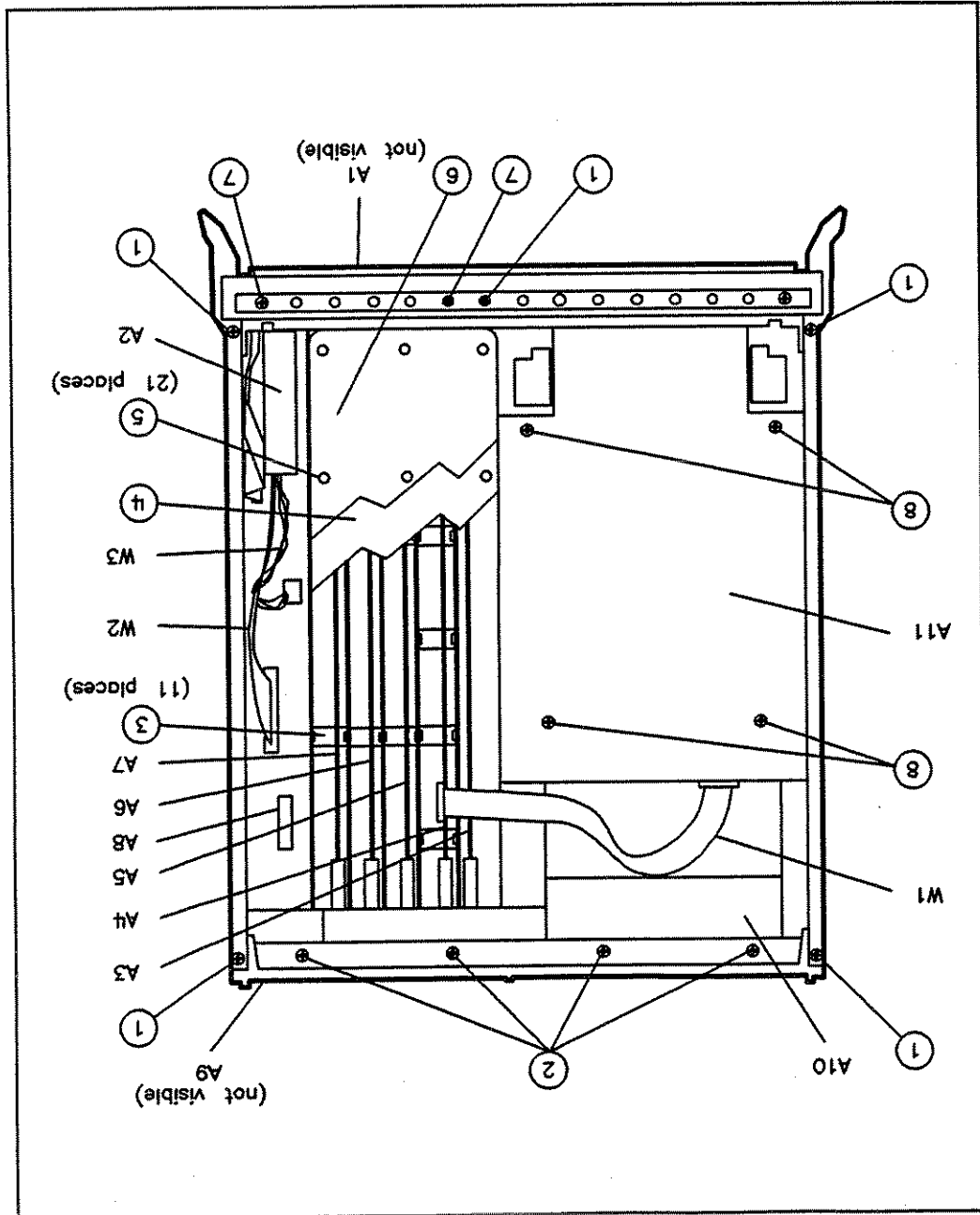
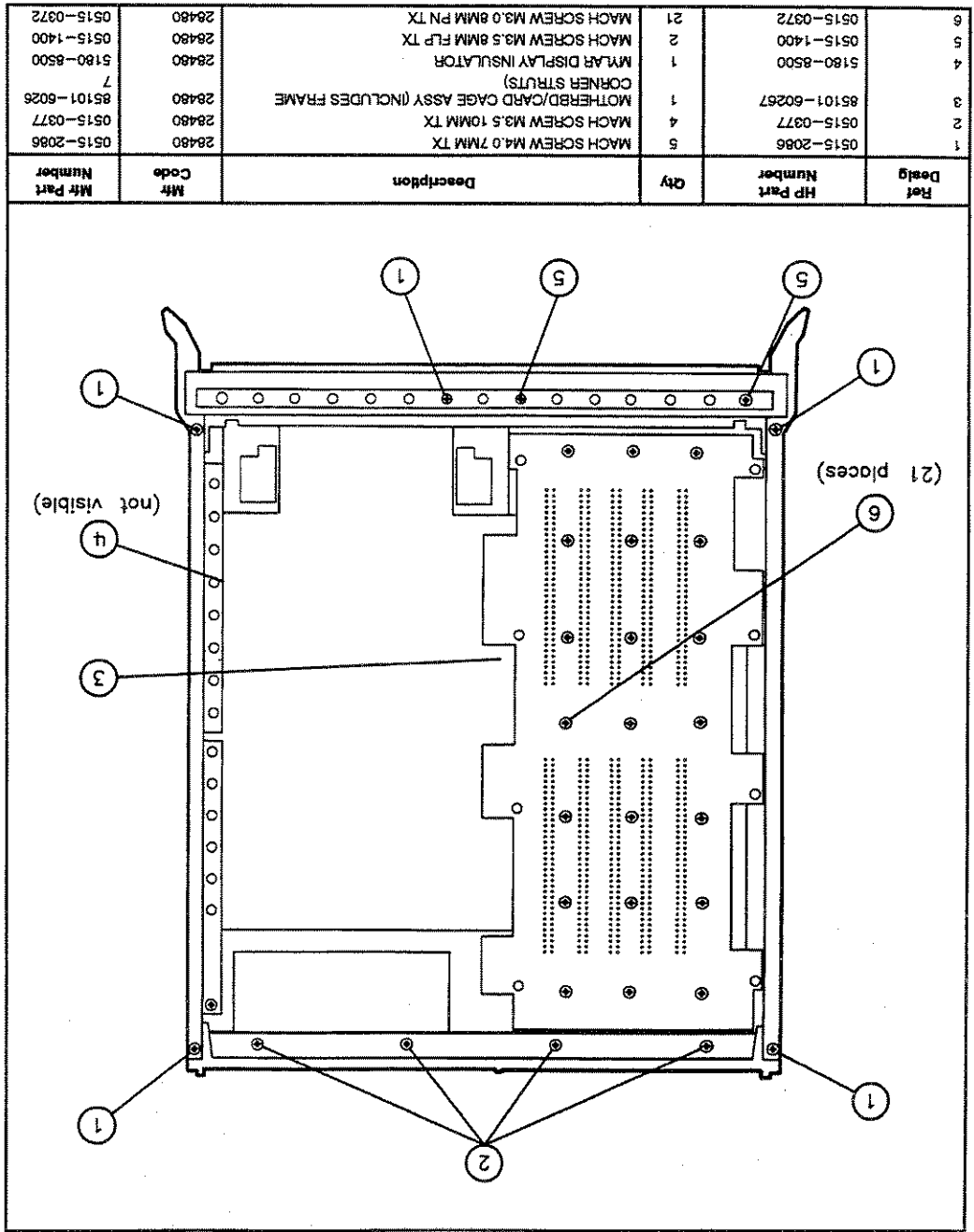


Figure 5-4. HP 8510C Bottom Internal



HP 8510C

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Figure 5-5. HP 8510C Front Panel External

Ref Design	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
1	85101-40011	1	BEZEL SUPPORT	28480	85101-4001
2	08757-40005	1	LINE SWITCH BUTTON	28480	08757-4000
3	1460-1573	1	SPRING-EXTENSION, 1.98-IN.-OD	28480	1460-1573
4	08753-00048	1	LINE SWITCH ACTUATOR	28480	08753-0004
5	08753-00036	1	SWITCH INSULATOR	28480	08753-0003
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 MTL C 3.5MM 3.8MMID	28480	3050-1192
9	08757-40012	1	SOFT KEYS COVER	28480	08757-4001

Figure 5-6. HP 85101C Front Panel Internal (1 of 2)

Ref Design	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 .97ID	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

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Figure 5-6. HP 85101C Front Panel Internal (2 of 2)

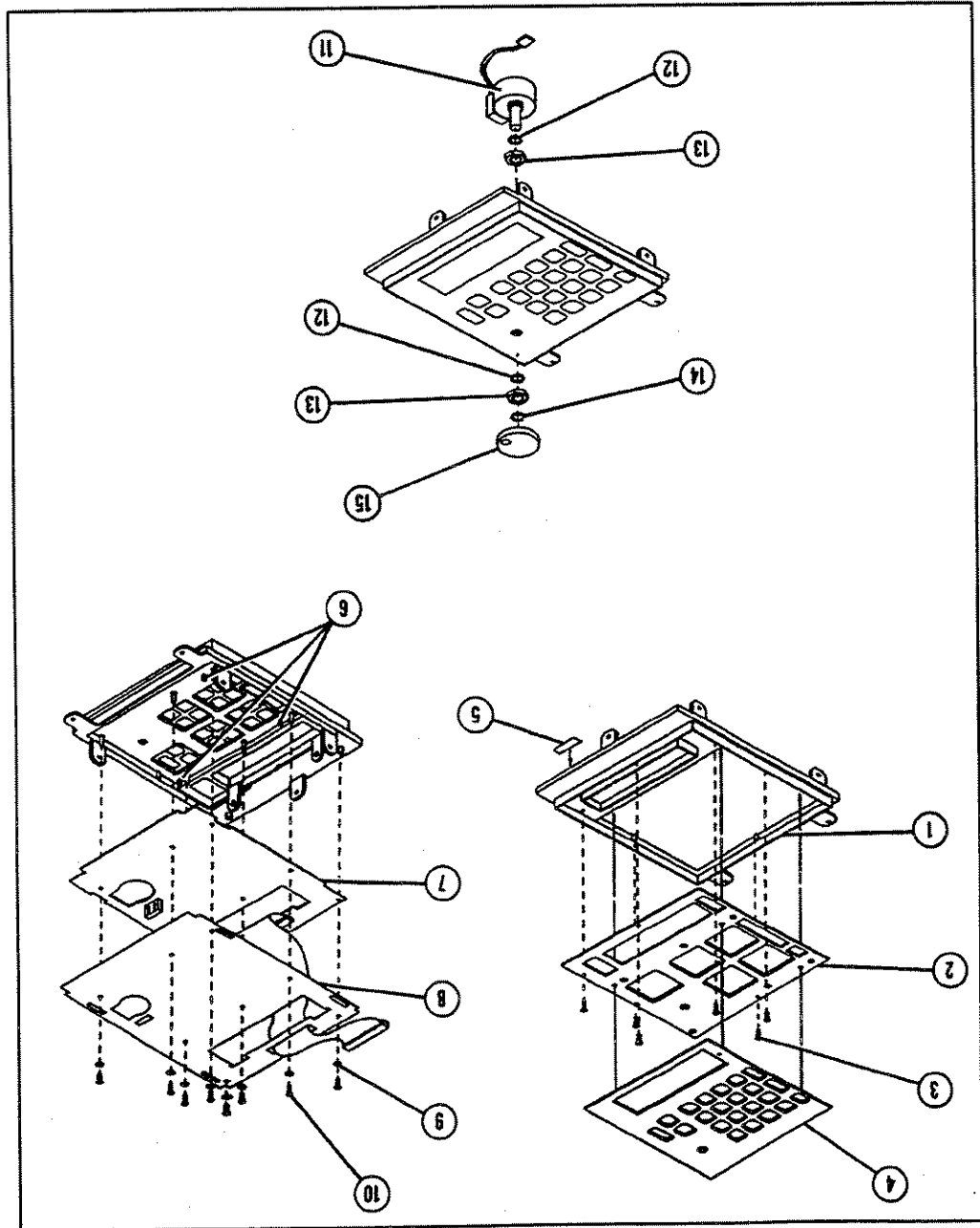


Figure 5-7. HP 85101C Rear Panel (1 of 2)

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	2180-0584	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

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Figure 5-7. HP 85101C Rear Panel (2 of 2)

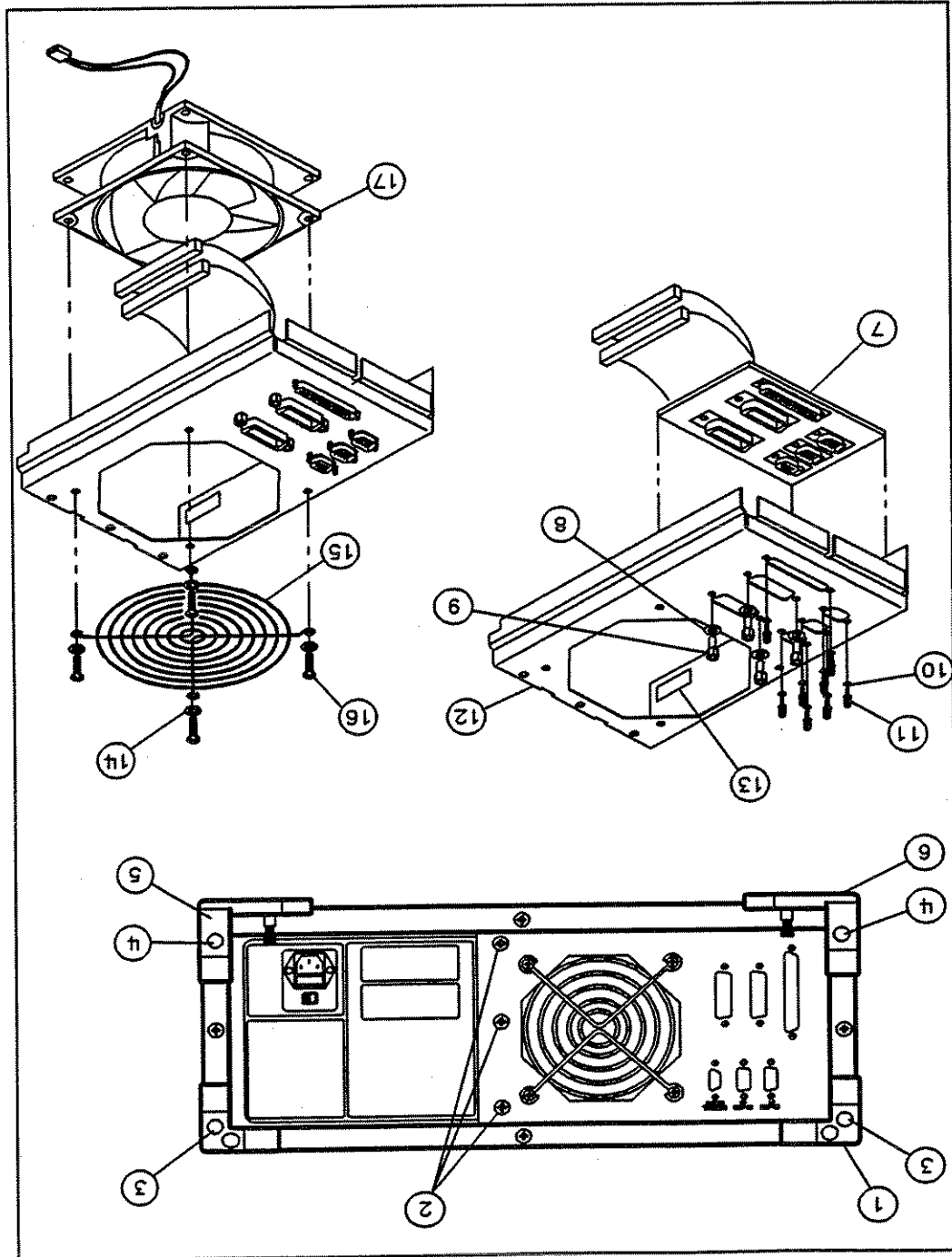
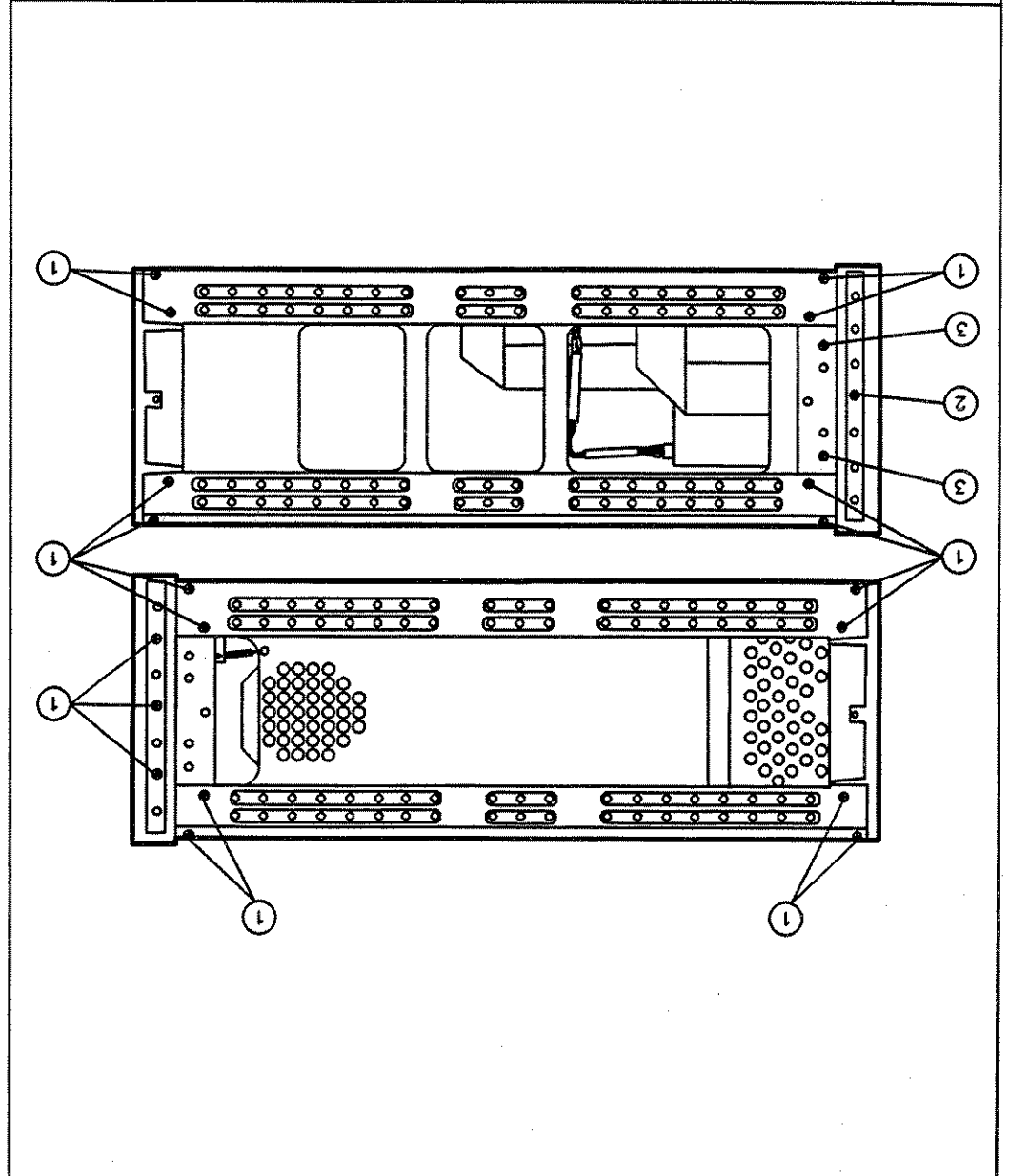


Figure 5-8. HP 85101C Left and Right Sides

Ref	Part	Qty	Description	Mfr Code	Mfr Part
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



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Figure 5-9. HP 8510IC Cabinet Parts (1 of 2)

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 FL P TX	28480	0515-2086

*NOTE: corner struts are part of motherbd/card cage assy.
(HP part number 85101-60267)

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Figure 5-9. HP 8510IC Cabinet Parts (2 of 2)

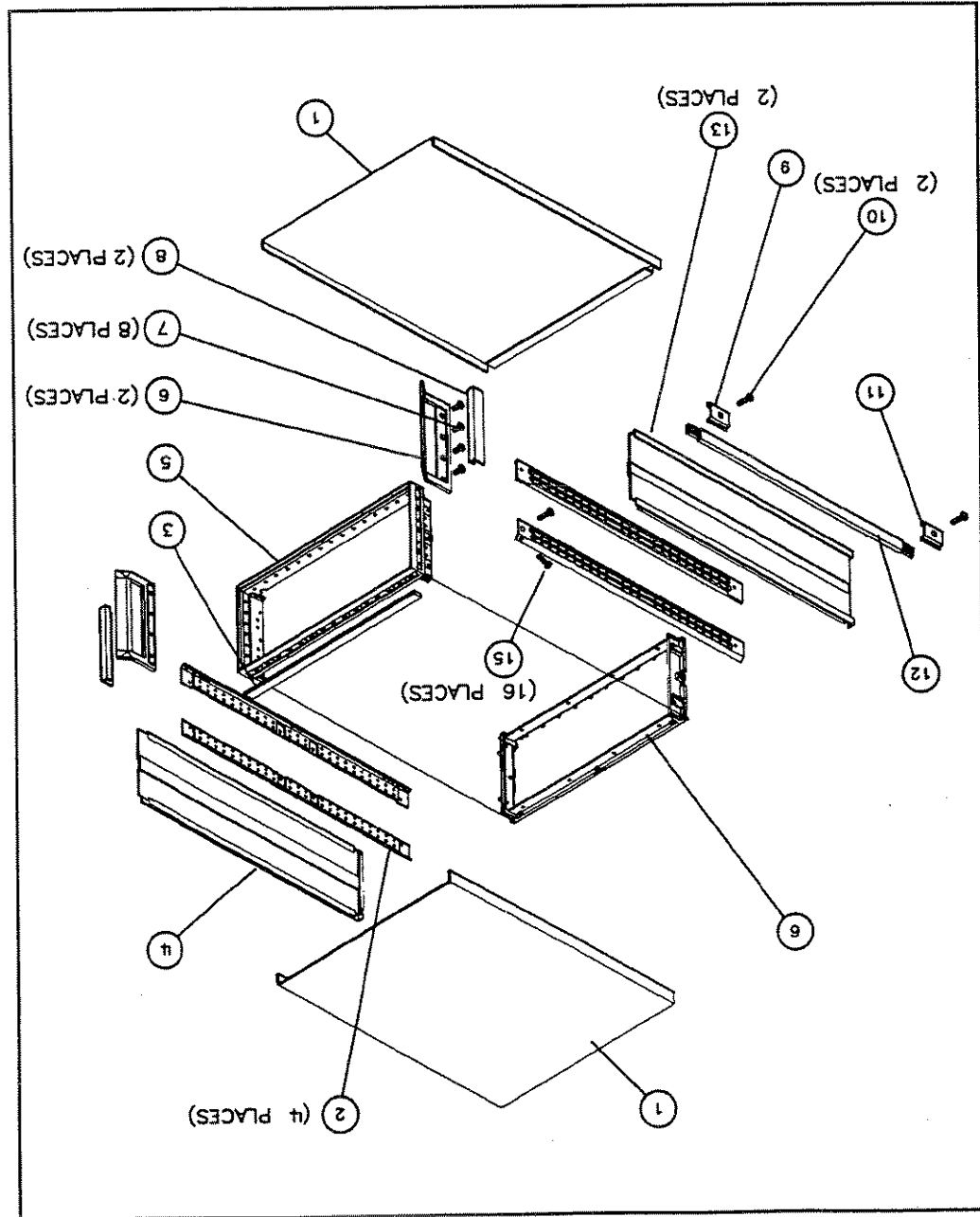
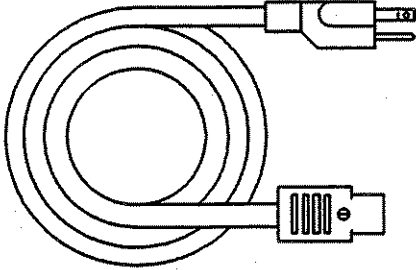
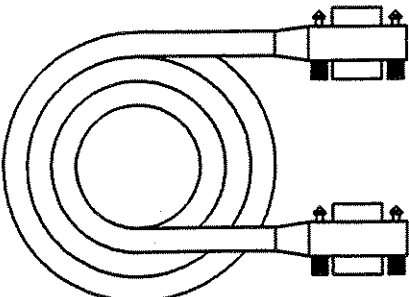
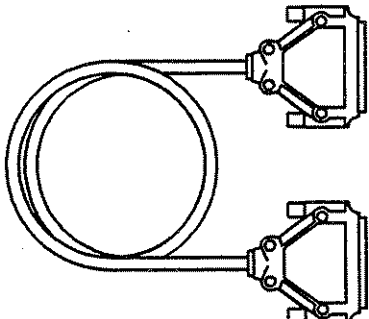
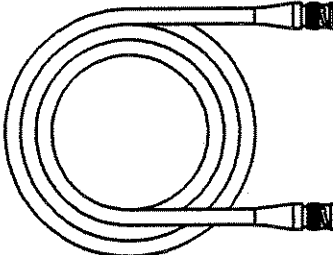
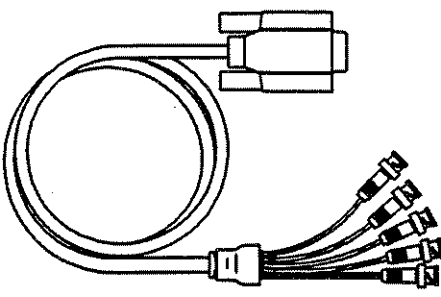
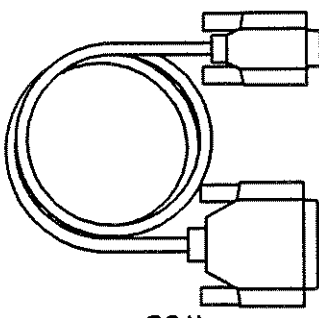


Figure 5-10. HP 8510C Cable Assemblies

Ref Design	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
W27	8120-1348	2	CABLE ASSY 18 AWG 3-CONDCT 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	08510-60101
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	24542S
 W27					
 W28					
 W29					
 W30					
 W64					
 W65					

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Figure 5-11. HP 85102 Board Location (1 of 2)

Ref	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2	85102-60203	1	NOT ASSIGNED	28480	85102-60203
A3	85102-60203	1	NOT ASSIGNED	28480	85102-60203
A4	85102-60203	1	NOT ASSIGNED	28480	85102-60203
A5	85102-60203	1	BOARD ASSY TEST SYNCHRONOUS DET. (NEW)	28480	85102-60203
A6	85102-60006	1	BOARD ASSEMBLY, CLOCK (NEW)	28480	85102-60006
A7	85102-60203	1	BOARD ASSY REF SYNCHRONOUS DET. (NEW)	28480	85102-60203
A8	85102-60008	1	BOARD ASSEMBLY, 19.9 MHZ L.O. (NEW)	28480	85102-60008
A9	85102-60206	1	BOARD ASSEMBLY, B2 IF MIXER (NEW)	28480	85102-60206
A10	85102-60010	1	BOARD ASSEMBLY, TEST IF AMPLIFIER (NEW)	28480	85102-60010
A11	85102-60206	1	BOARD ASSEMBLY, B1 IF MIXER (NEW)	28480	85102-60206
A12	85102-60010	1	(SAME AS A9; USE PREFIX A11); BOARD ASSEMBLY, REF IF AMPLIFIER (NEW)	28480	85102-60206
A12	85102-60010	1	(SAME AS A10; USE PREFIX A12); BOARD ASSEMBLY, REF IF AMPLIFIER (R-E)	28480	85102-60010
A13	85102-60206	1	(SAME AS A10; USE PREFIX A12); BOARD ASSEMBLY, A2 IF MIXER (NEW)	28480	85102-60010
A13	85102-60206	1	(SAME AS A9; USE PREFIX A13); BOARD ASSEMBLY, A2 IF MIXER (R-E)	28480	85102-60206
A14	85102-60206	1	(SAME AS A9; USE PREFIX A13); BOARD ASSEMBLY, A1 IF MIXER (NEW)	28480	85102-60206
A14	85102-60206	1	(SAME AS A9; USE PREFIX A14); BOARD ASSEMBLY, A1 IF MIXER (R-E)	28480	85102-60206
A15	85102-60015	1	(SAME AS A9; USE PREFIX A14); BOARD ASSEMBLY, REGULATOR (NEW)	28480	85102-60206
A15	85102-60015	1	BOARD ASSEMBLY, REGULATOR (R-E)	28480	85102-60015
A16	85102-60235	1	REMOTE APPLICATIONS BOARD (NEW)	28480	85102-60015
A16	85102-60235	1	REMOTE APPLICATIONS BOARD (R-E)	28480	85102-60235
A17	85102-60212	1	BOARD ASSEMBLY, SAMPLE AND HOLD (NEW)	28480	85102-60212
A18	85102-60208	1	BOARD ASSEMBLY, A/D CONVERTER (NEW)	28480	85102-60212
A18	85102-60208	1	BOARD ASSEMBLY, A/D CONVERTER (R-E)	28480	85102-60208
A19	85102-60019	1	BOARD ASSEMBLY, A/D CONVERTER (NEW)	28480	85102-60208
A19	85102-60019	1	BOARD ASSEMBLY, A/D CONVERTER (R-E)	28480	85102-60019
A20	85102-60234	1	BOARD ASSEMBLY, SWEEP ADC (NEW)	28480	85102-60234
A20	85102-60234	1	BOARD ASSEMBLY, SWEEP ADC (R-E)	28480	85102-60234
A21	85102-60021	1	BOARD ASSEMBLY, IF COUNTER (NEW)	28480	85102-60234
A21	85102-60021	1	BOARD ASSEMBLY, IF COUNTER (R-E)	28480	85102-60021
A22	85102-60204	1	BOARD ASSEMBLY, PRETUNE CONTROL (NEW)	28480	85102-60204
A22	85102-60204	1	BOARD ASSEMBLY, PRETUNE CONTROL (R-E)	28480	85102-60204
A23	85102-60227	1	BOARD ASSEMBLY, MAIN PHASE LOCK (NEW)	28480	85102-60204
A23	85102-60227	1	BOARD ASSEMBLY, MAIN PHASE LOCK (R-E)	28480	85102-60227
A24	85102-60024	1	BOARD ASSY, PROCESSOR INTERFACE (NEW)	28480	85102-60227
A24	85102-60024	1	BOARD ASSY, PROCESSOR INTERFACE (R-E)	28480	85102-60024
A26	85102-60026	1	BOARD ASSEMBLY, RECTIFIER (NEW)	28480	85102-60026
A26	85102-60026	1	BOARD ASSEMBLY, RECTIFIER (R-E)	28480	85102-60026

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Figure 5-11. HP 85102 Board Location (2 of 2)

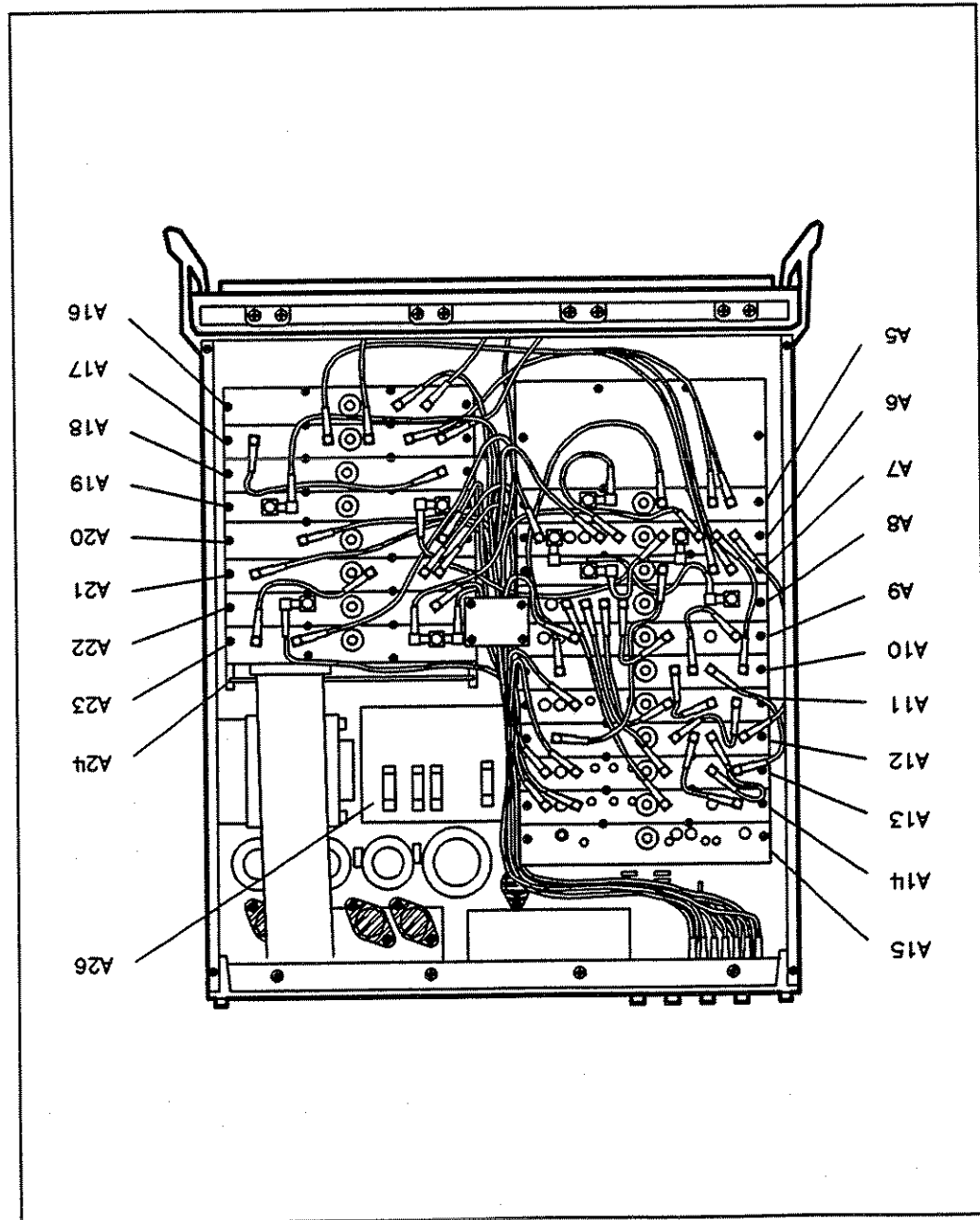


Figure S-12. HP 85102 Top Internal (1 of 2)

Ref	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 2N5685 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	28480	2200-0113
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	28480	2510-0138
10	3050-0005	4	WASHER-SHLDR NO. 6 .14-IN-ID .375-IN-OD	28480	3050-0005
11	3050-0139	4	WASHER-FL MTL C 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 CONVERTER	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 S-13. HP 85102 Cable Locations (1 of 2)

Ref	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
W1	85102-60131	1	CABLE ASSEMBLY A8J3-A1J3	28480	85102-60131
W2	85102-60132	1	CABLE ASSEMBLY A8J2-A8J3	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 A1J2-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 A1J1-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 A6J1-A23J2	28480	85102-60146
W17	85102-60147	1	CABLE ASSEMBLY A2J3-A23J3	28480	85102-60147
W18	85102-60148	1	CABLE ASSEMBLY A14J6-A2J1	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 A2J4-J6	28480	85102-60159
W30	85102-60160	1	CABLE ASSEMBLY J1A2-A1J4	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-A2J2	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	85102-60169
W41	85102-60224	1	CABLE ASSEMBLY A20J2-REAR PANEL J10	28480	85102-60223
W42	85102-60222	1	CABLE ASSEMBLY A16J1-A23J1	28480	85102-60224
W43			NOT ASSIGNED		
W44	85102-60174	1	CABLE ASSEMBLY A6J10-A8J1	28480	85102-60174

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Figure 5-13. HP 85102 Cable Locations (2 of 2)

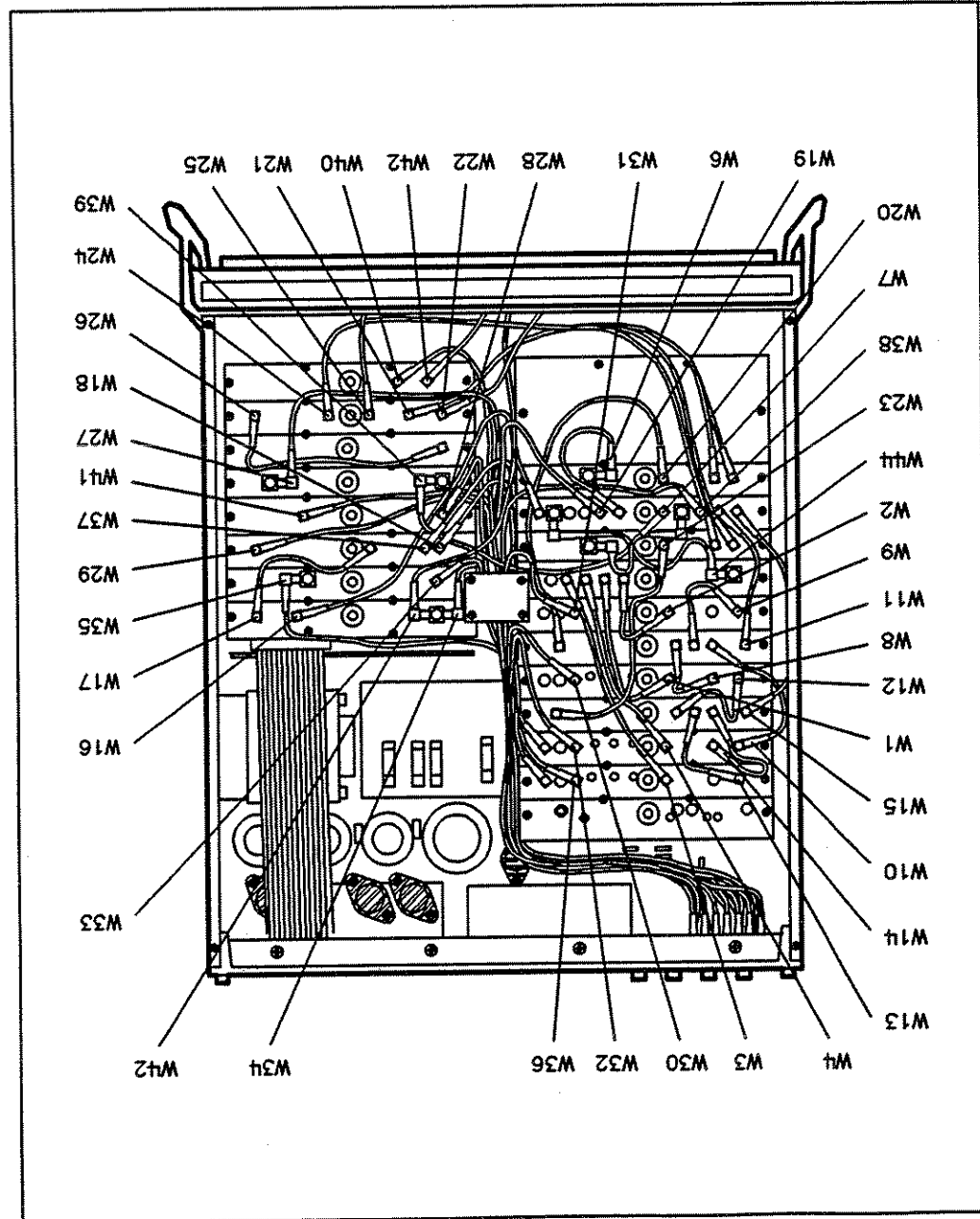
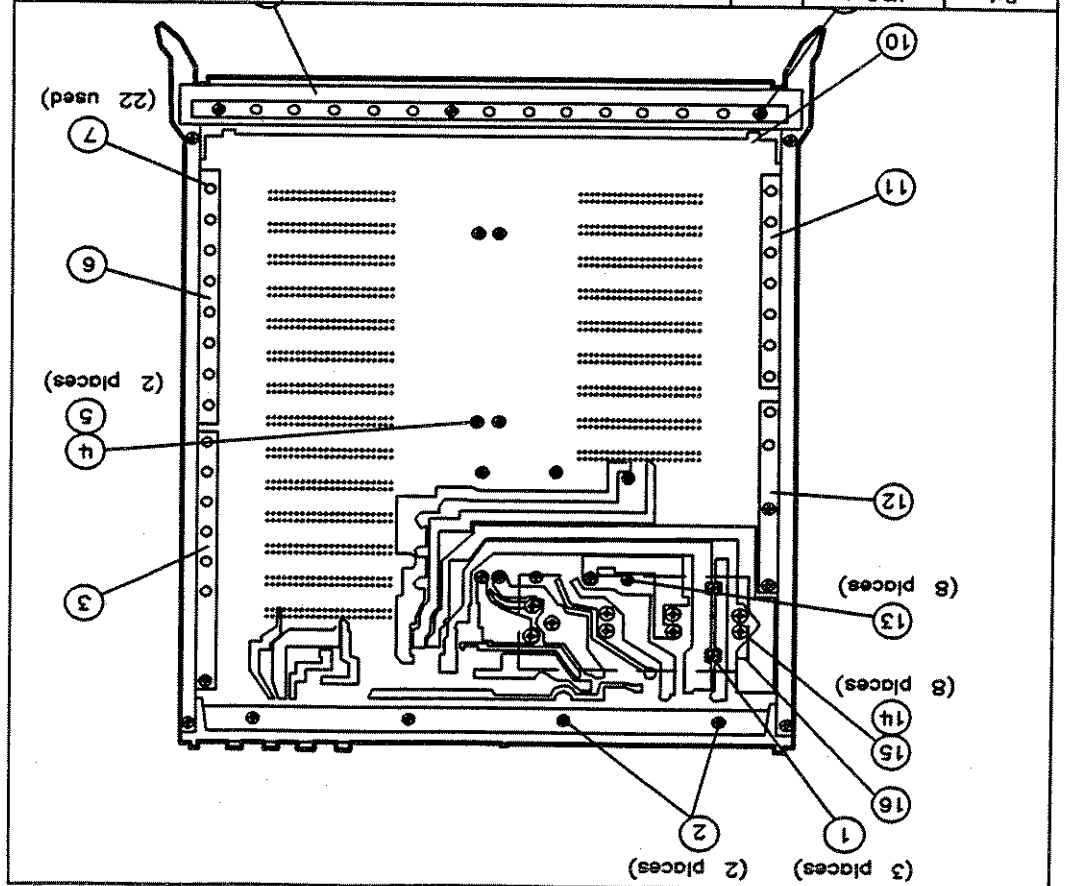


Figure 5-14. HP 85102 Bottom Internal

Ref	Design	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	ORDER BY DESC.
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	ORDER BY DESC.
6		85102-00035	1	BRACKET-L-FRONT	28480	ORDER BY DESC.
7		0624-0100	26	SCREW-TPG 4-40 .5-IN-LG PAN-HD-POZI STL	28480	ORDER BY DESC.
8		5021-8403	1	FRAME FRONT	28480	ORDER BY DESC.
9		0624-0589	8	SCREW-TPG 4-40 .25-IN-LG UNCT 82 DEG	28480	ORDER BY DESC.
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	ORDER BY DESC.
12		85102-00034	1	BRACKET-R-REAR	28480	ORDER BY DESC.
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	ORDER BY DESC.
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	ORDER BY DESC.



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Figure 5-15. HP 85102 Front

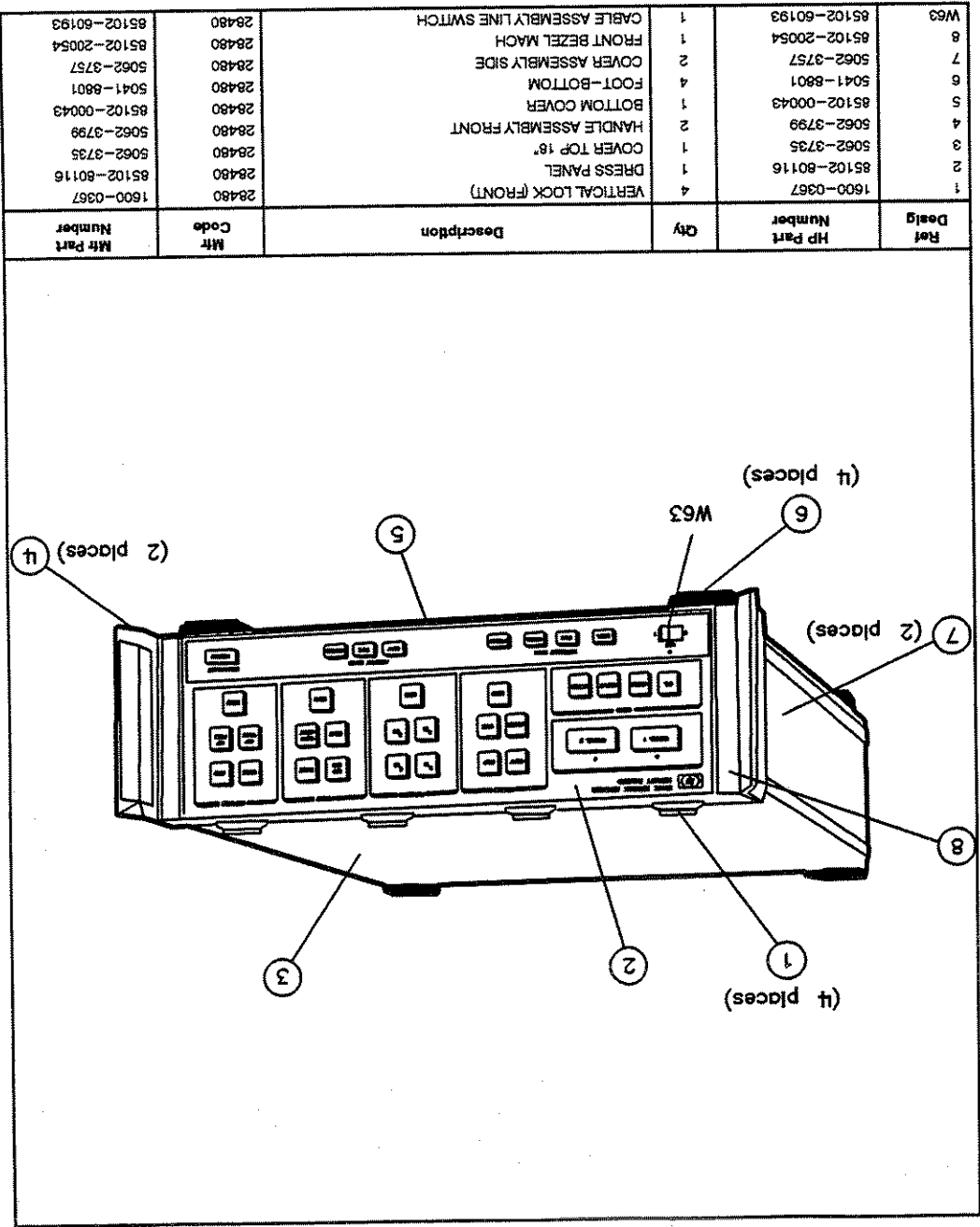


Figure 5-16. HP 85102 Rear (1 of 2)

Ref	HP Part Number	Qty	Description	Mfr Part Code	Mfr Part Number
B1	85102-20056	1	FAN ASSEMBLY	28480	85102-20056
E3	0360-0031	1	TERMINAL-CRIMP R-TNG #6 22-16-AWG RED	28480	0360-0031
E4	0360-1632	1	TERMINAL-SLID 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	2	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 BMB	28480	1250-1391
J4	1250-0870	1	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	1	CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-0870
J7	1250-0870	1	CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-0870
J8	1250-0083	1	CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-0083
J9	1250-1091	1	CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1091
J10	1250-0870	1	CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-0870
W19	85102-80149	1	CABLE ASSEMBLY A6J7-AJ7	28480	85102-80149
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-A1J4	28480	85102-60160
W32	85102-60162	1	CABLE ASSEMBLY J1A3-A9J4	28480	85102-60162
W34	85102-60164	1	CABLE ASSEMBLY J1A4-A13J4	28480	85102-60164
W35	85102-60165	1	CABLE ASSEMBLY J1A5-A2J1	28480	85102-60165
W36	85102-60166	1	CABLE ASSEMBLY J1A6-A2J1	28480	85102-60166
W38	85102-60168	1	CABLE ASSEMBLY J1A7-A2J3	28480	85102-60168
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
W55	85102-60191	1	CABLE ASSEMBLY DISPLAY INTERFACE	28480	85102-60191
W56	85102-60192	1	CABLE ASSEMBLY TEST SET INTERFACE	28480	85102-60192
1	2360-00193	3	NUT-HEX-W/LKWR 6-32-THD .109-IN-THK	00000	2360-00193
2	2360-00193	5	SCREW-MAACH 6-32-25-IN-LG PAN-HD-POZI	28480	2360-00193
3	0400-0010	4	GROMMET-RND .25-IN-ID .375-IN-GRV-OD	28480	0400-0010
4	2350-0043	1	NUT-HEX-OBL-CHAM 9/8-32-THD .094-IN-THK	00000	2350-0043
5	7121-2360	1	LABEL-SERIAL NUMBER	28480	7121-2360
6	7120-4835	1	LABEL-INFORMATION .75-IN-WD 2-IN-LG PPR	28480	7120-4835
7	3050-1094	1	WASHER-FL MTL NO. 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	5021-6540	1	LOCK FOOT LRT	28480	5021-6540
11	0515-1244	2	SCREW-MAACH 6-32-5-IN-LG PAN-HD-POZI	00000	0515-1244
12	85102-00056	2	REAR PANEL	28480	85102-00056
13	0590-1251	5	NUT-SFCLY 15/32-32-THD .1-IN-THK .562-WD	00000	0590-1251
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	0510-0110
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-MAACH 6-32 .75-IN-LG PAN-HD-POZI	00000	2360-0205
20	3050-0227	4	WASHER-FL MTL NO. 6 .149-IN-ID	28480	3050-0227
21	85102-20057	1	HEAT SINK	28480	85102-20057
22	5040-7221	2	FOOT-REAR	28480	5040-72

Figure 5-16. HP 85102 Rear (2 of 2)

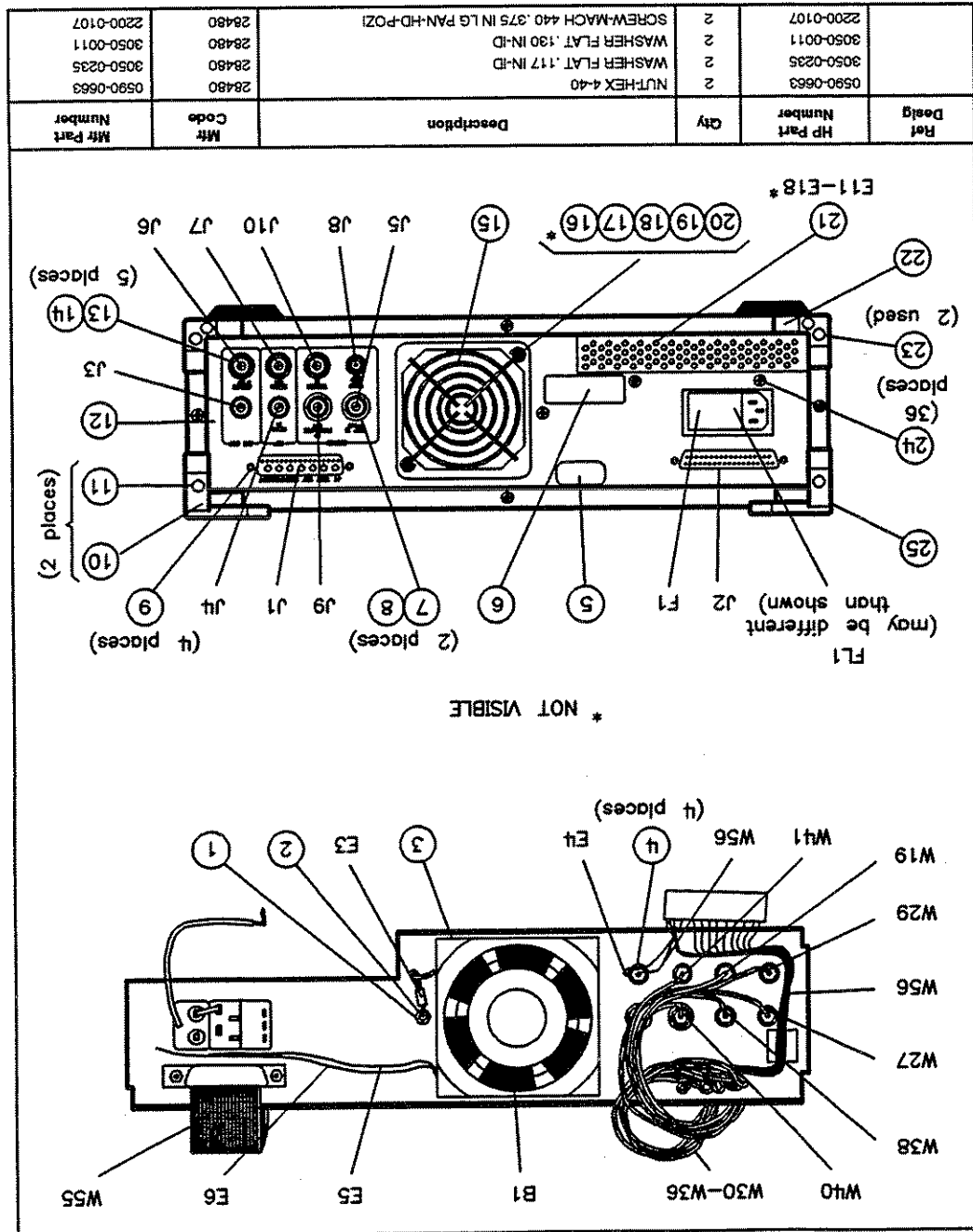
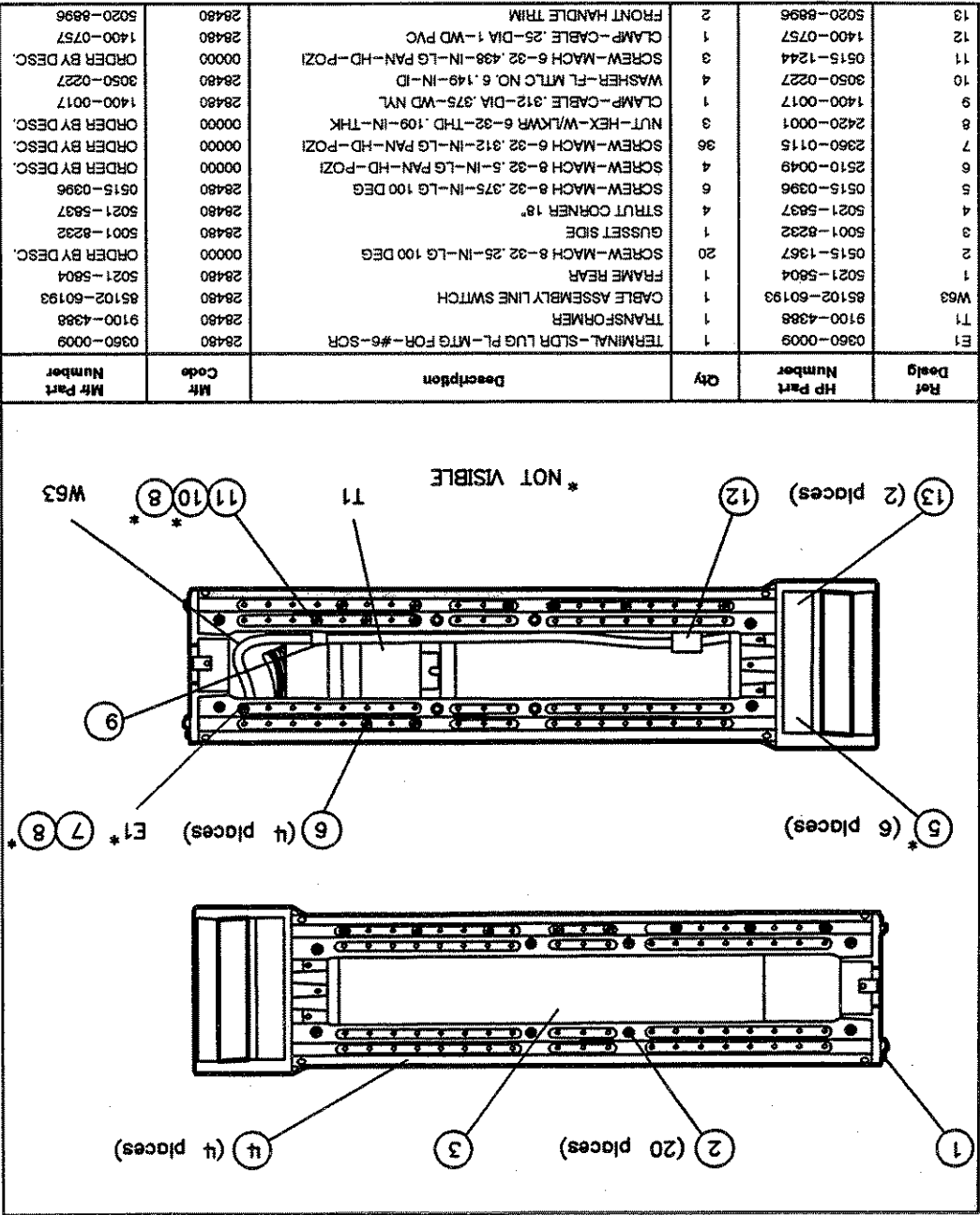


Figure 5-17. HP 85102 Left and Right Internal



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Replacable Parts S-37

Figure 5-18. HP 85102 Front Panel Board Assembly

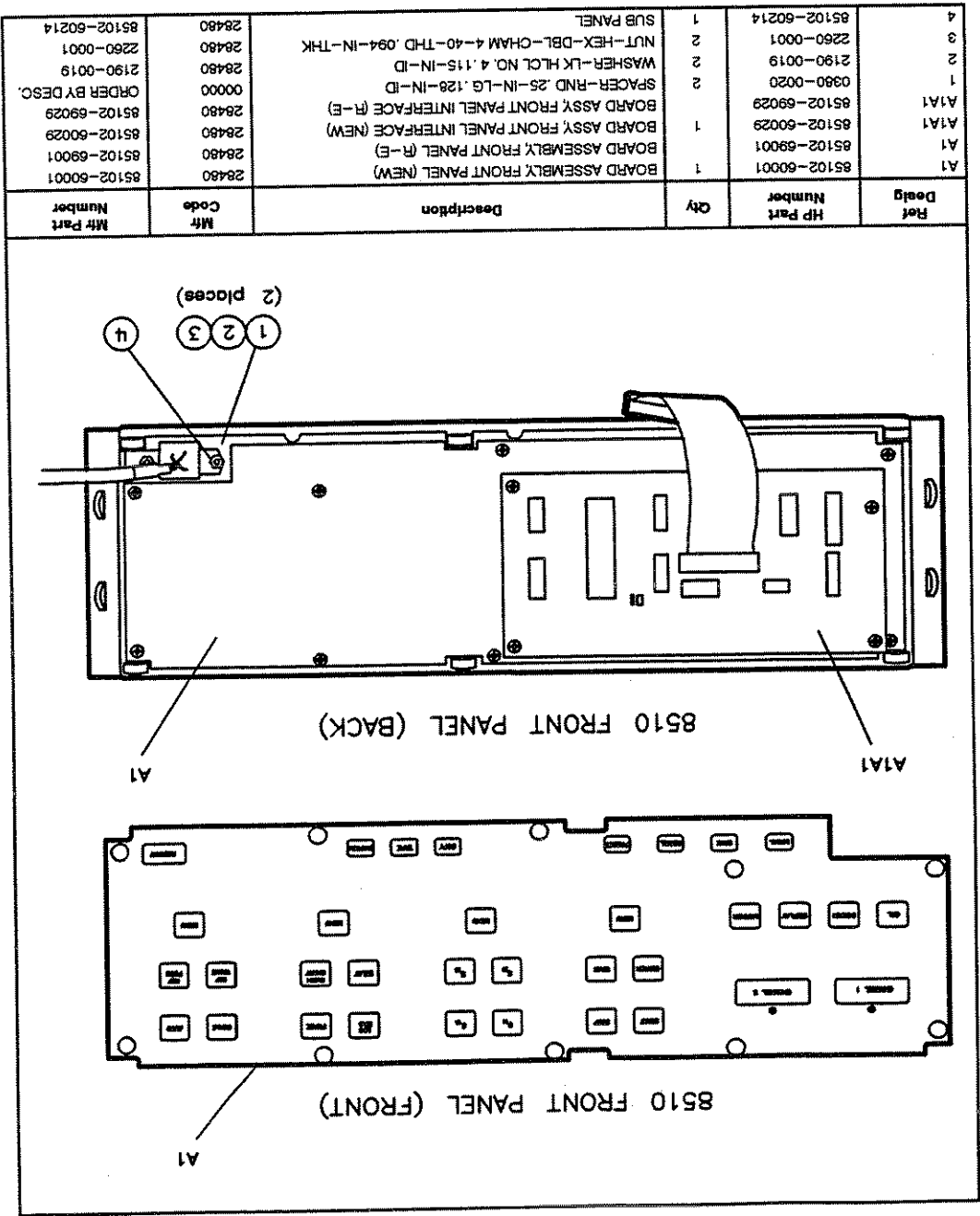


Figure 5-19. HP 85102 Motherboard (1 of 4)

Ref	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 .870UF+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	1251-6800	1	CONNECTOR 26-PIN M POST TYPE	28480	1251-6800
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 T066	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
CS	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-S2 PKG	24355	AD590KH
W1-2	8151-0013	2	WIRE 22 1X22	28480	8151-0013
X1	1200-0639	1	SOCKET-IC 20-CONT DIP DFP-SLDR	28480	1200-0639
XA2-XA24	1251-7882	23	CONNECTOR-PC EDGE 2-ROWS	28480	1251-7882

HP 8510C

Replaceable Parts 5-39

Figure 5-19. HP 85102 Motherboard (2 of 4)

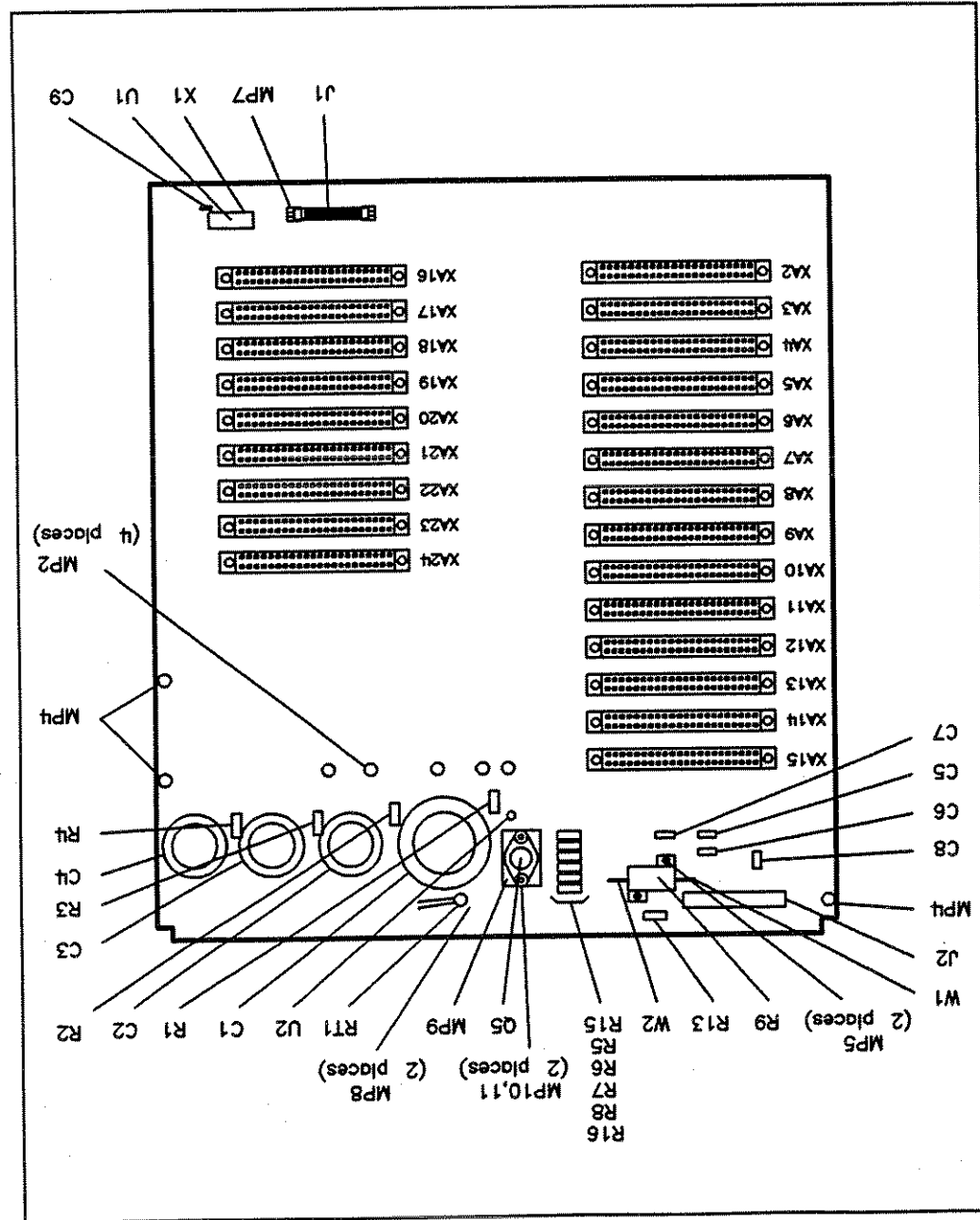


Figure 5-19. HP 85102 Motherboard (3 of 4)

Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A25	85102-60229	1	BOARD ASSEMBLY, MOTHER THE FOLLOWING PARTS ARE NOT SUPPLIED WHEN A25 IS ORDERED: A25C1, A25C2, A25C3, A25C4, A25Q1, A25Q2, A25Q3, A25Q4	28480	85102-60229
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

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Replaceable Parts 5-41

Figure 5-19. HP 85102 Motherboard (4 of 4)

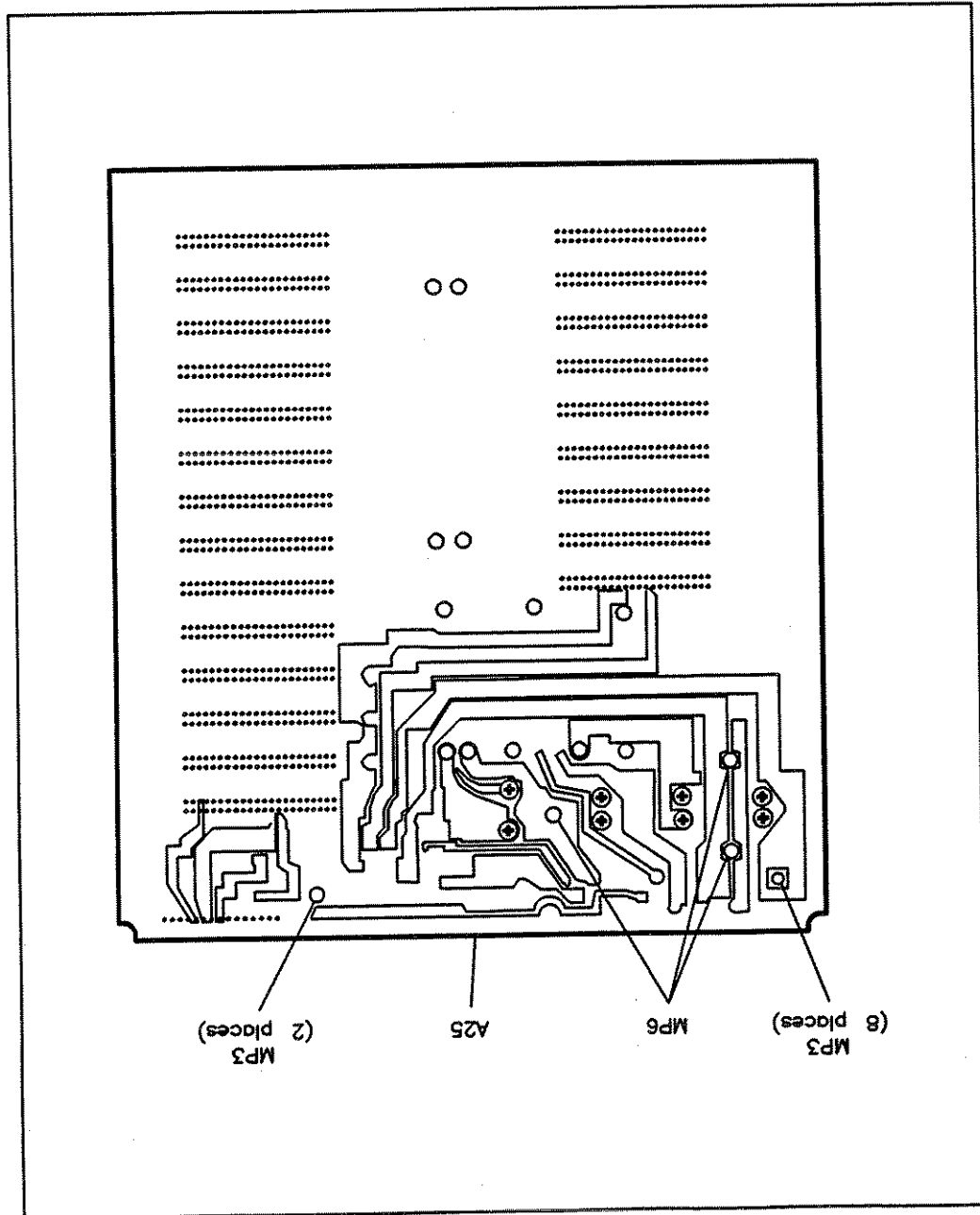


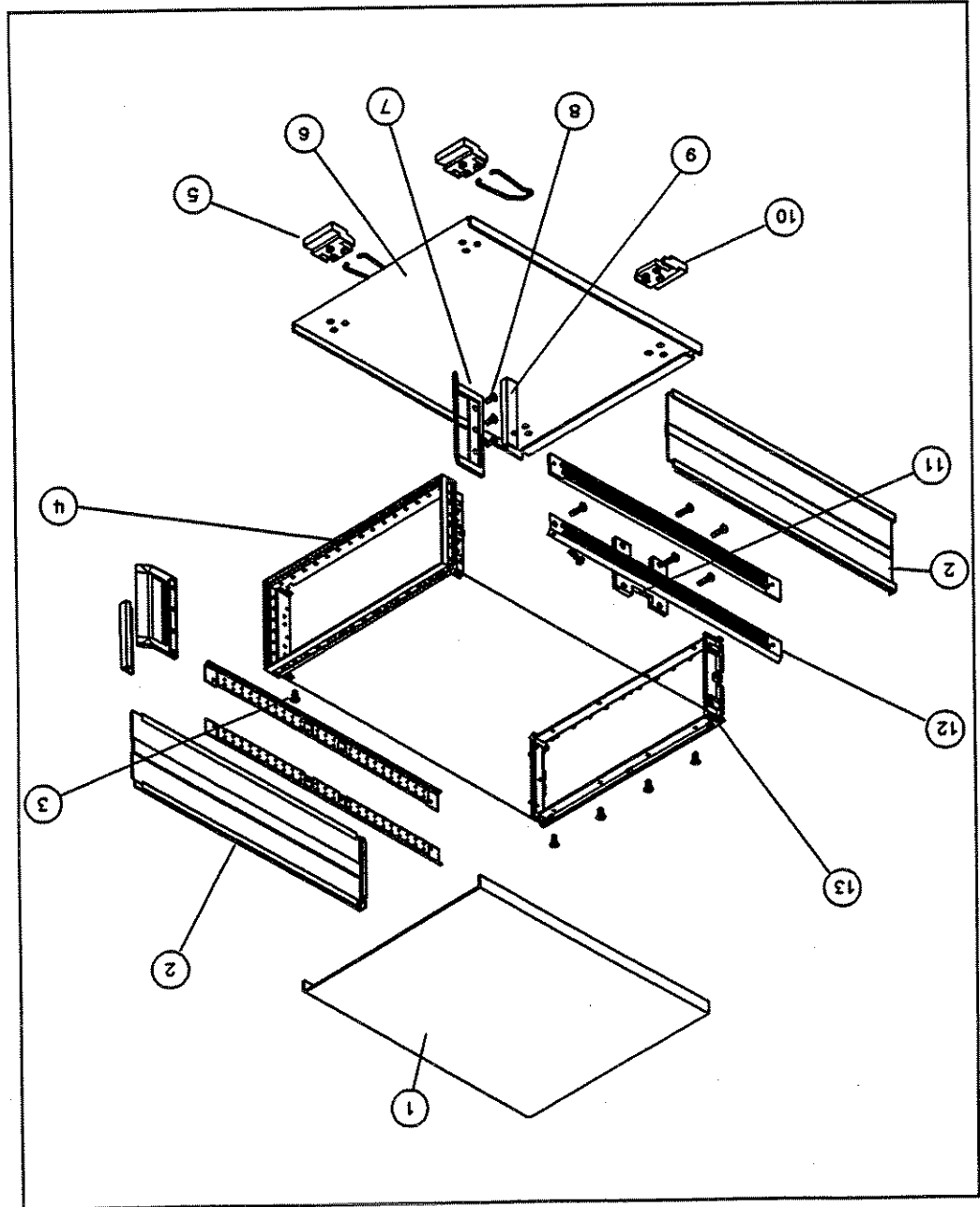
Figure 5-20. HP 85102 Cabinet Parts (1 of 2)

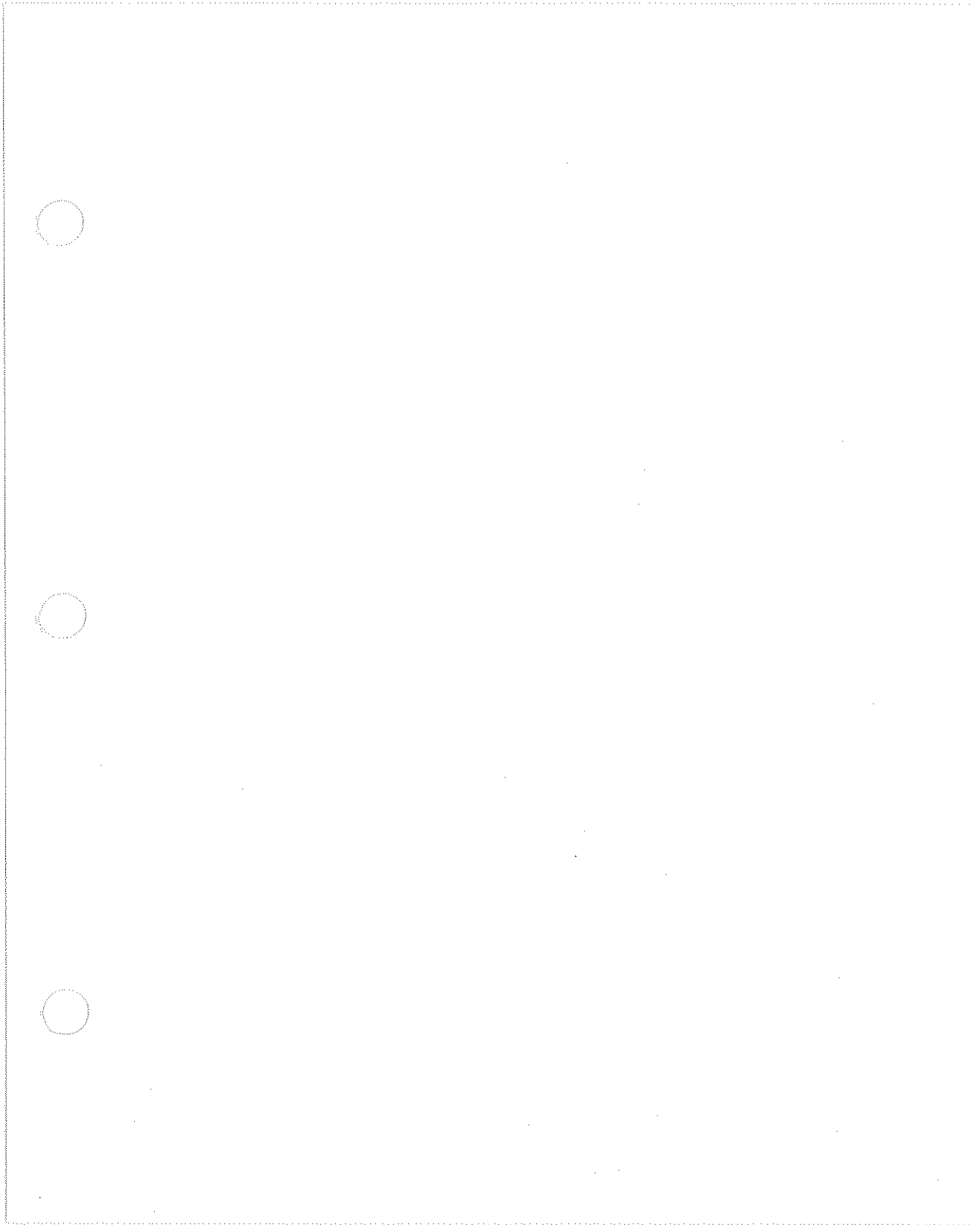
Ref Desig	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
1	5062-3735	1	COVER TOP 16"	28480	5062-3735
2	5062-3757	2	COVER ASSEMBLY SIDE	28280	5062-3757
3	0624-0589	8	SCREW-TPG 4-40 .25-IN-LG UNCT 82 DEG	28480	0624-0589
4	5021-8403	1	FRAME FRONT	28480	5021-8403
5	5041-8801	4	FOOT-BOTTOM	28480	5041-8801
6	85102-00061	1	BOTTOM COVER	28480	85102-00061
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

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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.

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

Table 6-1. Disassembly Tools

The AC line voltage inside the instrument can, if contacted, produce fatal electrical shock. DISCONNECT BOTH AC POWER CORDS FOR ALL DIS-ASSEMBLY 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.

WARNING

HP 8510C

Replacement Procedures 6-3

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

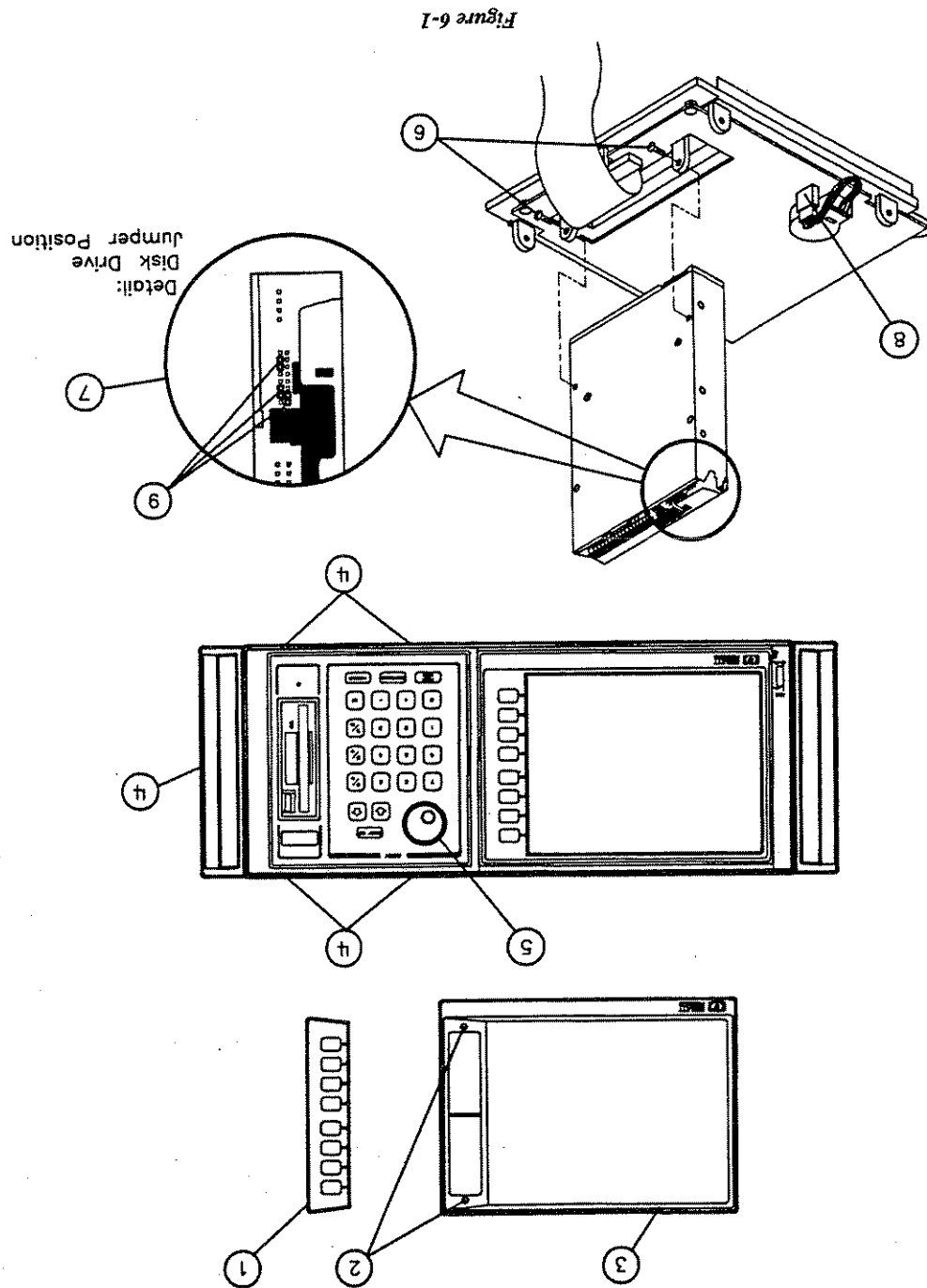
The items shown in parentheses refer to the corresponding item numbers in Figure 6-1.

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).



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).

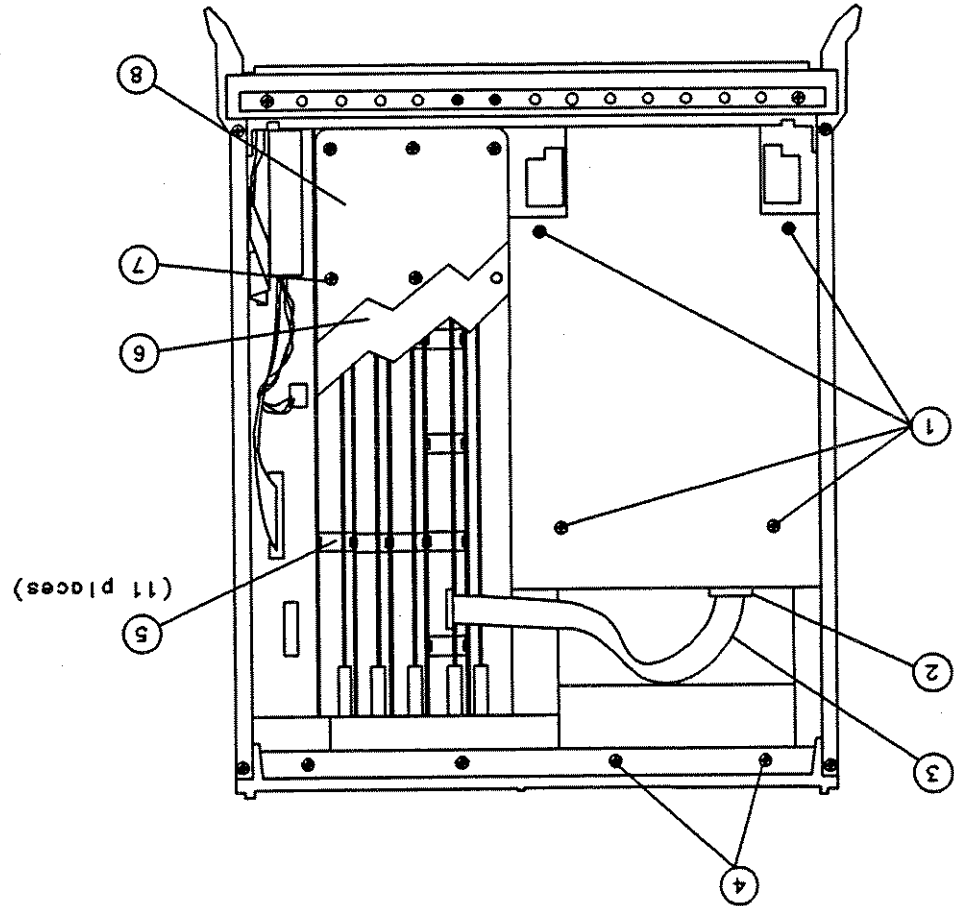
8. Disconnect the display power cable assembly (item 3) from the display processor board.
9. Gently slide the display forward and out of the steel display enclosure.

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.

Figure 6-2



- 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.
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).

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).

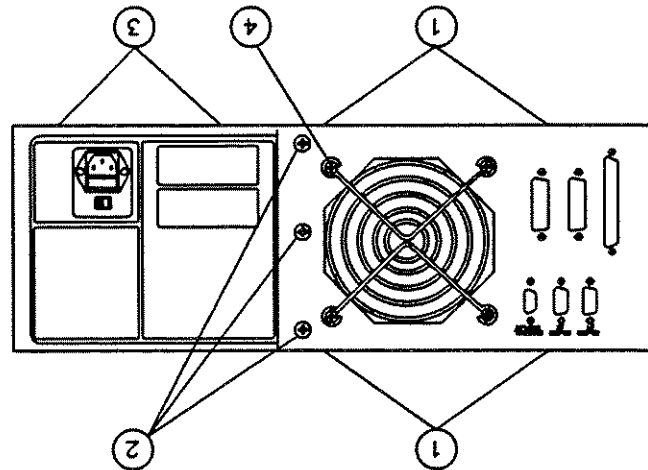


Figure 6-3

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 prerregulator 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 prerregulator assembly away from the frame. Disconnect the cable harness assembly at the J8 prerregulator connection on the motherboard.
6. To install a new prerregulator, reverse steps 2 through 5. Torque all screws to 113 N-cm (10 in-lb). Perform step 5 of rear panel replacement procedure.

To Reassemble

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 trans-former. The front panel is now free of the instrument.
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).

To Reassemble

HP 8510C

Replacement Procedures**6-13**



Even with the power cords disconnected, dangerous voltages may be present on the capacitors in the instrument. Perform the following procedure to DISCHARGE THE POWER SUPPLY CAPACITORS BEFORE PERFORMING THE DISASSEMBLY PROCEDURE.

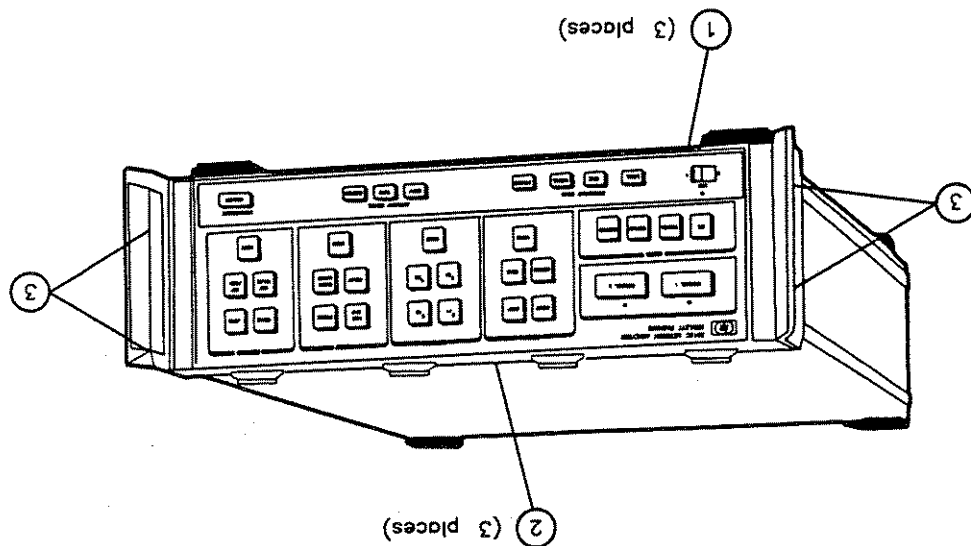
WARNING

Large Pozidrive screwdriver
Small Pozidrive screwdriver
Small flat blade screwdriver
1/4 in. nut driver
Insulated clip leads (2)

TOOLS REQUIRED

RECTIFIER BOARD REPLACEMENT

Figure 6-4



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).

To Disassemble

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.**

The items shown in parentheses refer to the corresponding item numbers in Figure 6-5.

CAPACITOR DISCHARGE PROCEDURE

Figure 6-5

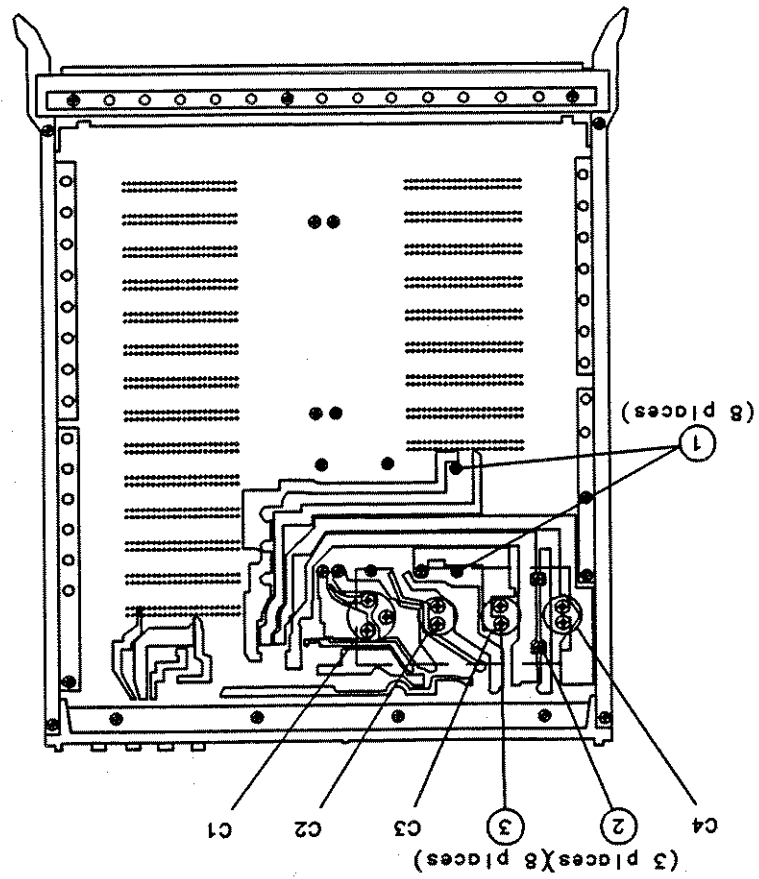
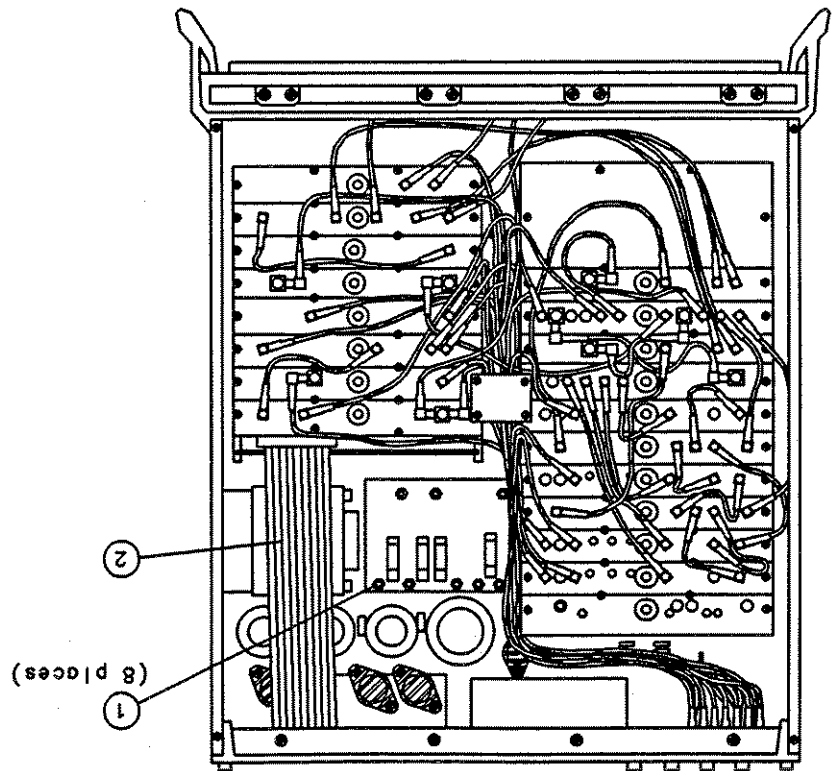


Figure 6-6



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 following 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).

9. Reverse the preceding steps. Torque screws to 113 N-cm (10 in-lb).
- To Reassemble**
8. Remove the rear panel.
7. Disconnect all wires from the transformer.
6. Remove two screws (item 1) from the left side frame and disconnect the ground wires.
5. Disconnect the wire harness assembly from J2 on motherboard.
4. Disconnect the ribbon cable from the A24 processor interface board. (See item 2, Figure 6-6.)
- Cable Locations in chapter 5 of this manual.)
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
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).
1. Disconnect the power cords and remove all covers.

To Disassemble

The items shown in parentheses refer to the corresponding item numbers in Figure 6-7.

PROCEDURE

Large Pozidrive screwdriver
Small Pozidrive screwdriver

TOOLS REQUIRED

REAR PANEL REPLACEMENT

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.

HP 8510C

Replacement Procedures

6-21

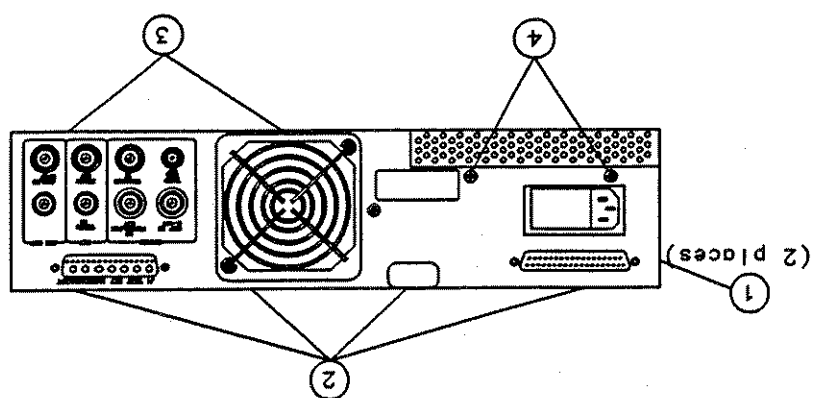


Figure 6-7

Assembly Replaced or Repaired		Adjustment Procedure Number, If Replaced	
HP 85101 Display/Processor			
A1 Front Panel	none	none	none
A2 Disk Drive	none	none	none
A3 Post-Regulator Board	none	none	none
A4 Graphic System Processor	1, 3	1, 3	1, 3
A5 CPU Board	1, 3	1, 3	1, 3
A6 EEPROM Board	1, 3	1, 3	1, 3
A7 Input/Output Board	none	none	none
A8 Not Assigned	none	none	none
A9 Rear Panel	none	none	none
A10 Preregulator	none	none	none
A11, Display	1, 3	1, 3	1, 3
HP 85102 IF Detector			
A1 Front Panel	none	none	none
A1A1 Front Panel Interface	none	none	none
A2-A4 Not Assigned	none	none	none
A5 Test Synchronous Detector	7	8	7
A6 Clock	8	7	8
A7 Reference Synchronous Detector	7	none	5
A8 19.9 MHz LO	none	5	6
A9 B2 IF Mixer	5	6	5
A10 Test IF Amplifier	6	5	5
A11 B1 IF Mixer	5	6	5
A12 Reference IF Amplifier	6	5	5
A13 A2 IF Mixer	5	5	5
A14 A1 IF Mixer	5	5	5
A15 Regulator	none	none	none
A16 Remote Applications	none	none	none
A17 Sample and Hold	none	none	none
A18 ADC	none	none	none
A19 ADC Control	none	4	none
A20 Sweep ADC	4	none	none
A21 IF Counter	none	none	none
A22 Pretune	none	none	none
A23 Main Phase Lock	none	none	none
A24 Interface	none	none	none
A25 Motherboard	none	none	none
A26 Rectifier	none	none	none

Table 6-2. Related Adjustment Procedures

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.

7. Adjustments

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.

NOTE: Many adjustment procedures require the use of various miscellaneous tools and accessories. 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.

ADJUSTMENT TOOLS

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.

EQUIPMENT REQUIRED

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.

WARNING

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.

SAFETY CONSIDERATIONS

Drivers	DISC	MAT, KBD	IO, GRAPH
Extensions			

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.

Loading BASIC 3.0 or Higher

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 2.0

Before loading the adjustments software, you must load a controller language system as follows:

LOADING THE CONTROLLER BASIC LANGUAGE SYSTEM

1. Remove the seal to adjust the component.
2. Reseal the component using a silicone rubber compound that does not contain acetic acid.

The steps to adjust a sealed component follow:

RESEALING OF COMPONENTS

Title	Procedure Number	Adjusted Assembly
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 7-1. Adjustment Procedures

5. Type LOAD BIN "filename" for each extension filename, then press **RETURN** or **EXECUTE** or **EXEC**.
- 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.
- If you have the double-sided language extensions and drivers disk, the procedure is complete.
4. When all the driver files are loaded, remove the disk.
- 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**.

Configuration	Driver File	Extension File
SRM	DCOMM	SRM
HP 9685 disk drive	HP9685	
CS80 disk drive	CS80	
HP 9122 disk drive	CS80	

If you have any of the following system configurations, the following driver and/or extension files also must be loaded:

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Adjustments

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			
ASL4	X OUTPUT FILTERING	7	Minimizes higher order products from appearing at the X-component output
ASL5	X OUTPUT FILTERING	7	Minimizes higher order products from appearing at the X-component output
ASL6	Y OUTPUT FILTERING	7	Minimizes higher order products from appearing at the Y-component output
ASL7	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 (1 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 7-2. Adjustable Components in Alpha-Numeric Order (2 of 2)

HP 8510C

Adjustments 7-7

Assembly Replaced or Repaired		Adjustment Procedure Number, If Replaced
HP 85101 Display/Processor		
A1 Front Panel	none	none
A2 Disk Drive	none	none
A3 Post-Regulator Board	none	none
A4 Graphic System Processor	1, 3	1, 3
A5 CPU Board	1, 3	1, 3
A6 EEPROM Board	1, 3	1, 3
A7 Input/Output Board	none	none
A8 Not Assigned	none	none
A9 Rear Panel	none	none
A10 Preregulator	none	1, 3
A11, Display	1, 3	1, 3
HP 85102 IF Detector		
A1 Front Panel	none	none
A2-A4 Not Assigned	7	8
A5 Test Synchronous Detector	7	8
A6 Clock	7	8
A7 Reference Synchronous Detector	7	7
A8 19.9 MHz LO	none	5
A9 B2 IF Mixer	5	6
A10 Test IF Amplifier	5	6
A11 B1 IF Mixer	5	5
A12 Reference IF Amplifier	6	5
A13 A2 IF Mixer	5	5
A14 A1 IF Mixer	5	5
A15 Regulator	5	5
A16 Remote Applications	none	5
A17 Sample and Hold	none	5
A18 ADC	none	5
A19 ADC Control	none	5
A20 Sweep ADC	4	5
A21 IF Counter	none	5
A22 Pretune	none	5
A23 Main Phase Lock	none	5
A24 Interface	none	5
A25 Motherboard	none	5
A26 Rectifier	none	5

Table 7-3. Adjustment Interdependence between Assemblies

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-B 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

Table 7-4. Test Equipment for HP 8510 Adjustments

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Adjustments 7-9

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.

NOTE: The CRT focus can be adversely affected by the CRT intensity set too high or by magnetic interference.

Focus Adjustment

3. Adjust the control until the softkey labels are aligned with the softkeys.
2. Insert a narrow, non-conductive, flat head screwdriver (at least 2 inches long) into the vertical position hole.
1. To access vertical position and focus adjustment controls, remove the side panel nearest the display.

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.

Vertical Adjustment

Warm-up time: 30 minutes.

There is one vertical position adjustment and one focus adjustment. In general, these adjustments should not be required.

DESCRIPTION AND PROCEDURE

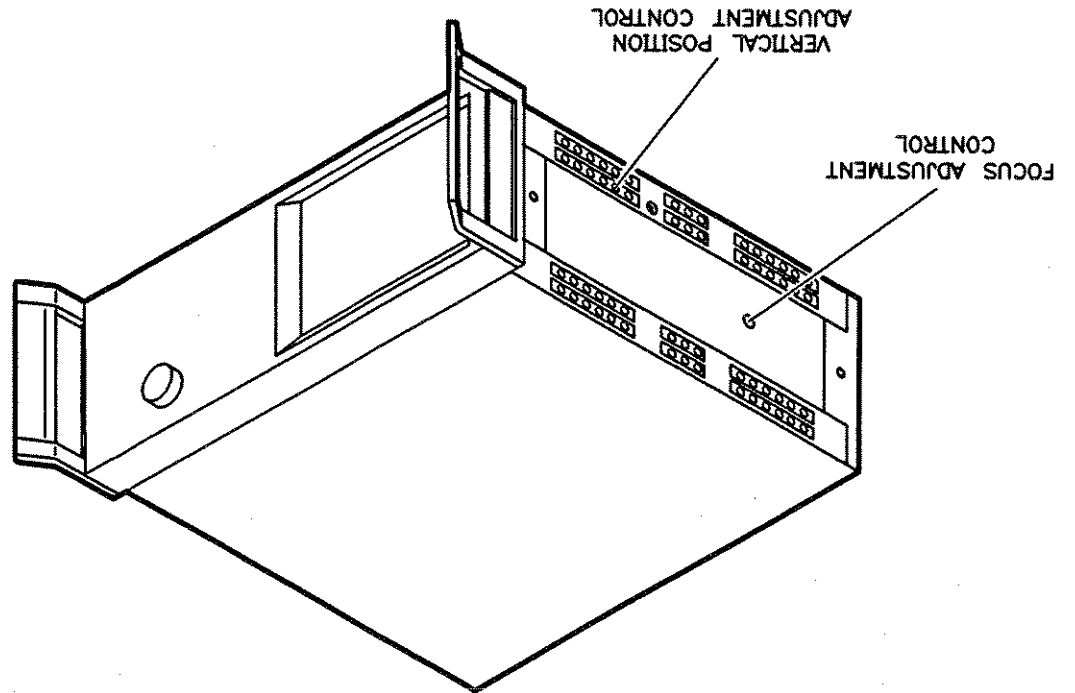
screwdriver (non-conductive) flat head

EQUIPMENT

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.

Procedure 1. Vertical Position and Focus Adjustments

Figure 7-1. Vertical Position and Focus Adjustment Controls



HP 8510C

Adjustments 7-11

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.

Applying an excessively strong magnetic field to the CRT face can permanently destroy the CRT.



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 from the CRT. Figure 7-2 shows the motion for degaussing the display.

DESCRIPTION AND PROCEDURE

any CRT demagnetizer or
bulk tape eraser

EQUIPMENT

Procedure 2. Display Degaussing (Demagnetizing)

BULK TAPE ERASER
OR
CRT DEMAGNETIZER

DEGAUSSER

≥ 4" (10cm)

(SIDE VIEW)

Figure 7-2. Motion for Degaussing the Display

Procedure 3. Display Intensity Adjustments

EQUIPMENT

- Tektronix J16 photometer
- Tektronix J6503 photometer probe
- Tektronix 016-0305-00 light occluder

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

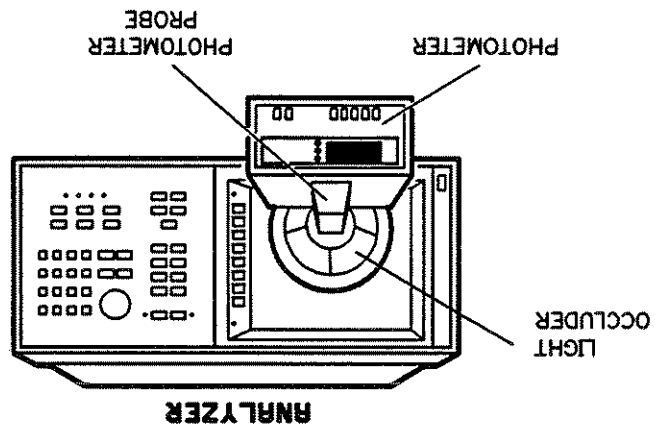


Figure 7-3. Maximum Intensity Adjustment Setup

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.
5. To start the adjustment, press **=MARKER**.

The level is set using a photometer that measures the output light.

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.

Operating Default Intensity Adjustment

4. When the adjustment is complete, press **=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).

HP 8510C

Adjustments 7-15

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

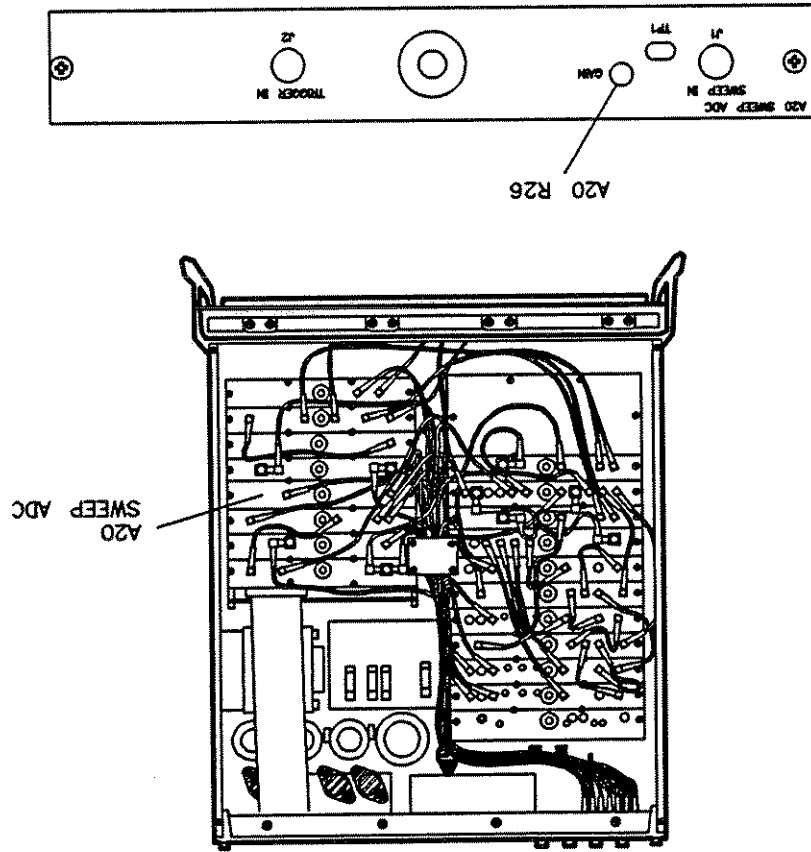
When the HP 8510 system is making a swept frequency measurement, it must sample the data at points equally spaced between the start and stop frequencies. The sweep analog-to-digital converter (ADC) controls when to trigger the sample-and-hold amplifiers so that the data will be taken at the correct frequencies. 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.

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Adjustments 7-17

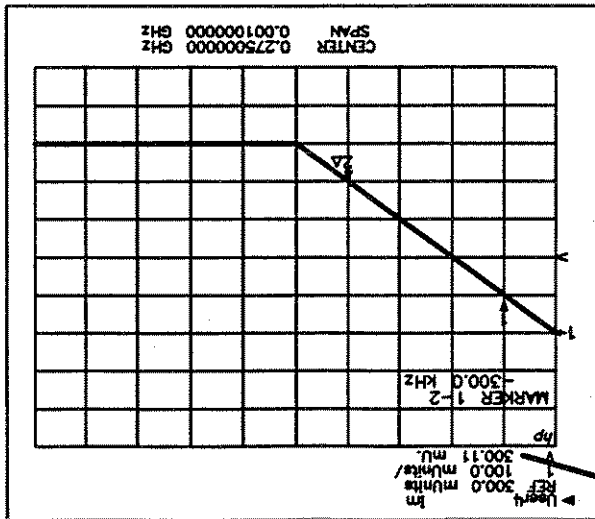
Figure 7-4. Location of Sweep ADC Gain Adjustment



8. The following prompt is displayed:
 ADJUST GAIN (R26) FOR 300 ± 0.03 units
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.)

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.
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
10. When the adjustment is complete, press [CONTINUE] to return to the menu.

Figure 7-5. Display of Sweep ADC Gain Adjustment



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."

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 $100 \text{ kHz} \pm 10 \text{ kHz}$ (see Figure 7-7).
10. The following prompt is displayed:
 ADJUST XTAL FILTER 1, 2 AND 3 FOR MINIMUM RIPPLE <1/2 dB (20 KHz BW)
 When a graphic appears on the analyzer CRT, the instrument has finished initializing. Press [CONTINUE] on the controller.

Figure 7-6. Location of the IF Mixer Adjustments

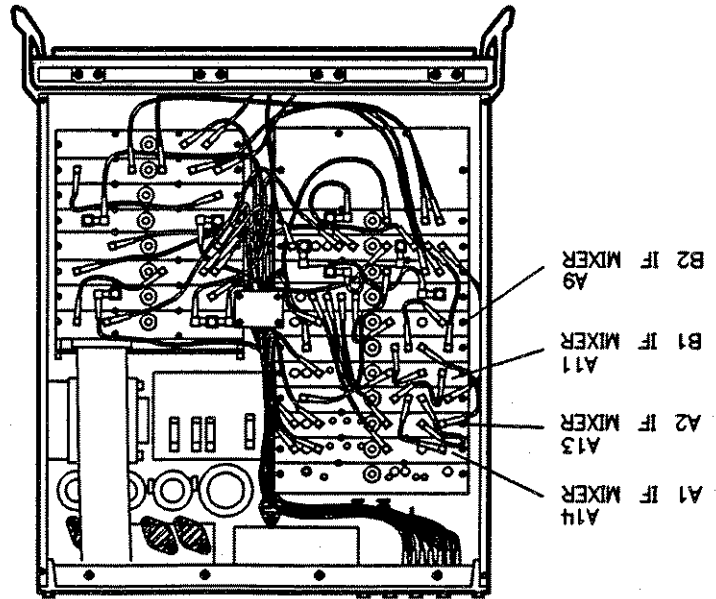
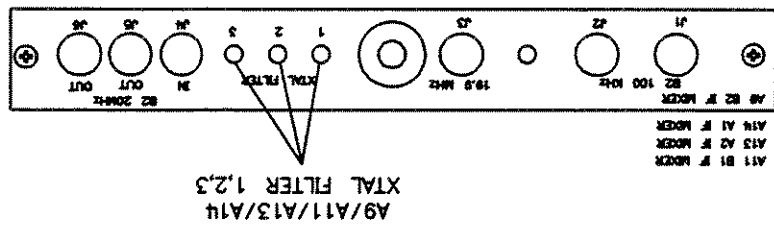
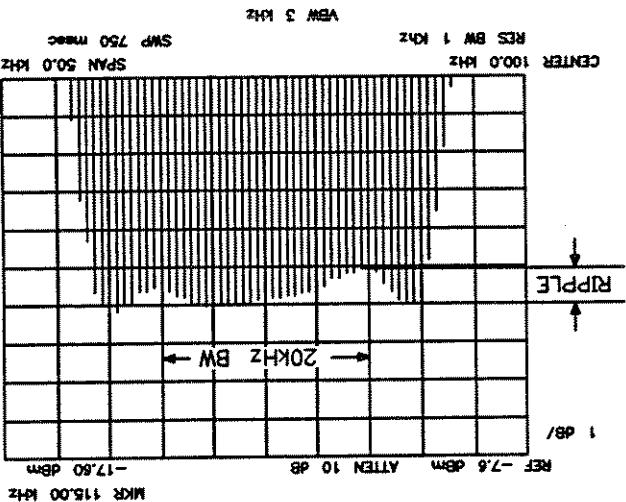


Figure 7-7. IF Mixer Adjustment Waveform



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.
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.

100 KHz LEVEL TOO LOW (<-20 dBm)

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 autotuning 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.

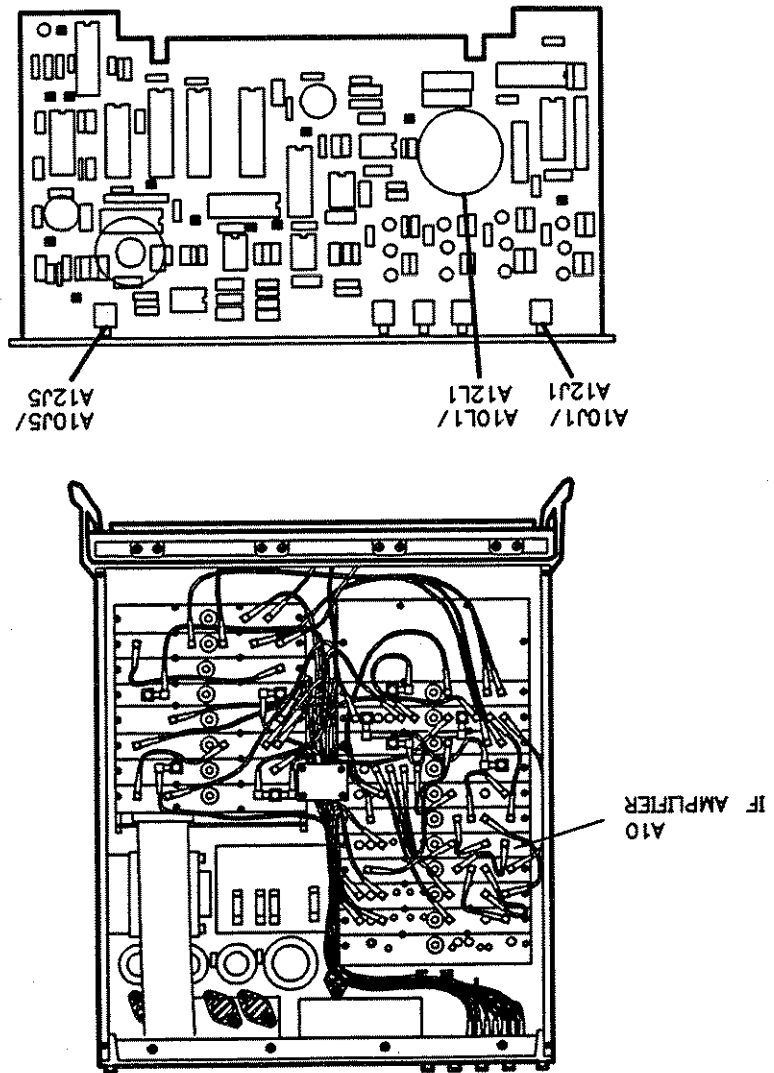
7. Switch on the analyzer power, but switch on the display/processor last to avoid system "lock-up."

8. When a graphic appears on the analyzer CRT, the instrument has finished initializing. Press **[CONTINUE]** on the controller.

HP 8510C

Adjustments 7-23

Figure 7-8. Location of IF Amplifier Adjustments



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.

AMPLIFIER OUTPUT >-20 dBm TOO HIGH. REPAIR BOARD OR TEST-SETUP.

OR

AMPLIFIER OUTPUT <-30 dBm TOO LOW. REPAIR BOARD OR TEST-SETUP.

15. If either of the following prompts is displayed, check the equipment setup for configuration errors, or refer to the troubleshooting chapter:
14. When the adjustment is complete, press **[CONTINUE]** on the controller to return to the menu.
13. Repeat step 10. If necessary, press **=MARKER** on the analyzer to recenter the trace.

(re-center trace with '=' marker key if necessary)

RE-ADJUST L1 TO PEAK TRACE ON 8510 CRT

>>>>>FINE ADJUST<<<<<<

12. The following prompt is displayed:

11. Press **[CONTINUE]**.

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.

ADJUST L1 TO PEAK TRACE ON 8510 CRT.

>>>>>COARSE ADJUST<<<<<<

9. The following prompt is displayed:

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 BA-SIC.)

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:

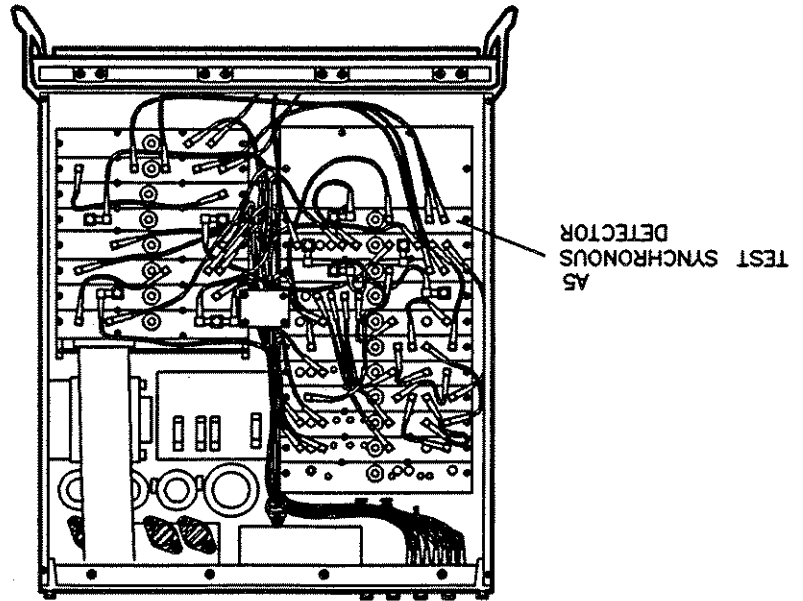
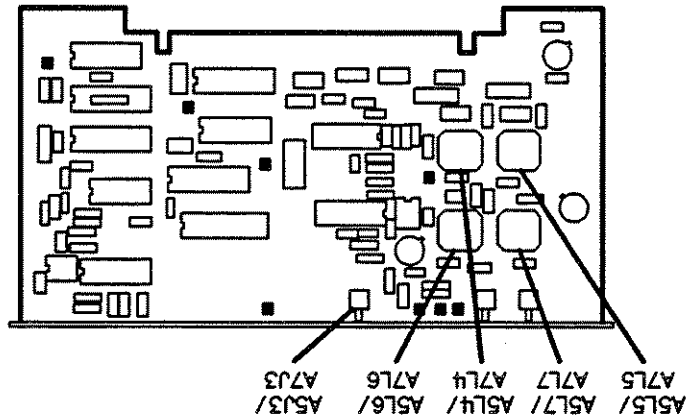
Adjustment on which SYNC DET module? Select a softkey.

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."

Figure 7-9. Location of Synchronous Detector Adjustments



9. When a graticule appears on the analyzer CRT, the instrument has finished initializing. Press [CONTINUE] on the controller.

HP 8510C

Adjustments 7-27

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.
 14. When the adjustment is complete, press **[CONTINUE]** to return to the menu.
 13. Alternately adjust L4 and L5 to minimize the ripple. Typically the ripple is less than 0.01 dB.
 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).
- Be careful not to rotate the inductors too far clockwise. Damage may occur to the inductors.



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.
- CHECK SETUP OR REPAIR BOARD
- IT MEASURES XXX DB BUT SHOULD BE >-15 DB
- SIGNAL LEVEL IS TOO LOW
- If the following prompt is displayed, check equipment setup for configuration errors, or refer to the troubleshooting chapter:
- THEN ADJUST L4 & L5 TO FURTHER REDUCE RIPPLE
- (minimize the high frequency ripple).
- USING THE 8510 DISPLAY, ADJUST L6 & L7 FOR MINIMUM RIPPLE
- CENTER THE CORES IN L4 & L5.
10. The following prompt is displayed:

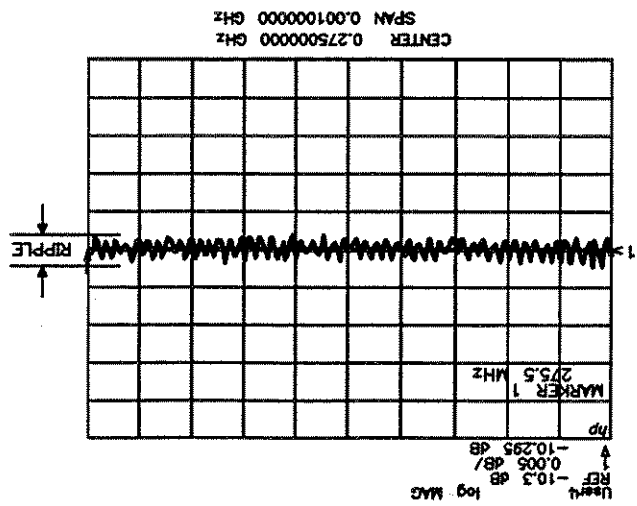


Figure 7-10. Synchronous Detector Adjustment Waveform

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 RS1, 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]**.

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.

FREQUENCY UNSTABLE, COUNT 1-COUNT 2 TOO LARGE

or

FREQUENCY IS OUT OF LIMIT

SECOND COUNT = XXXXXXXXXXXX

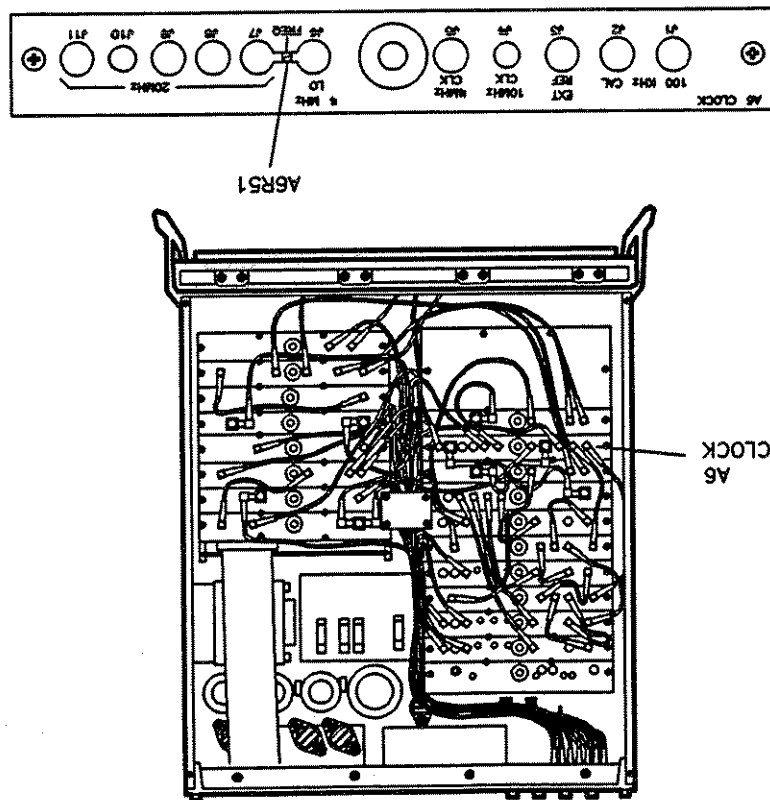
FIRST COUNT = XXXXXXXXXXXX

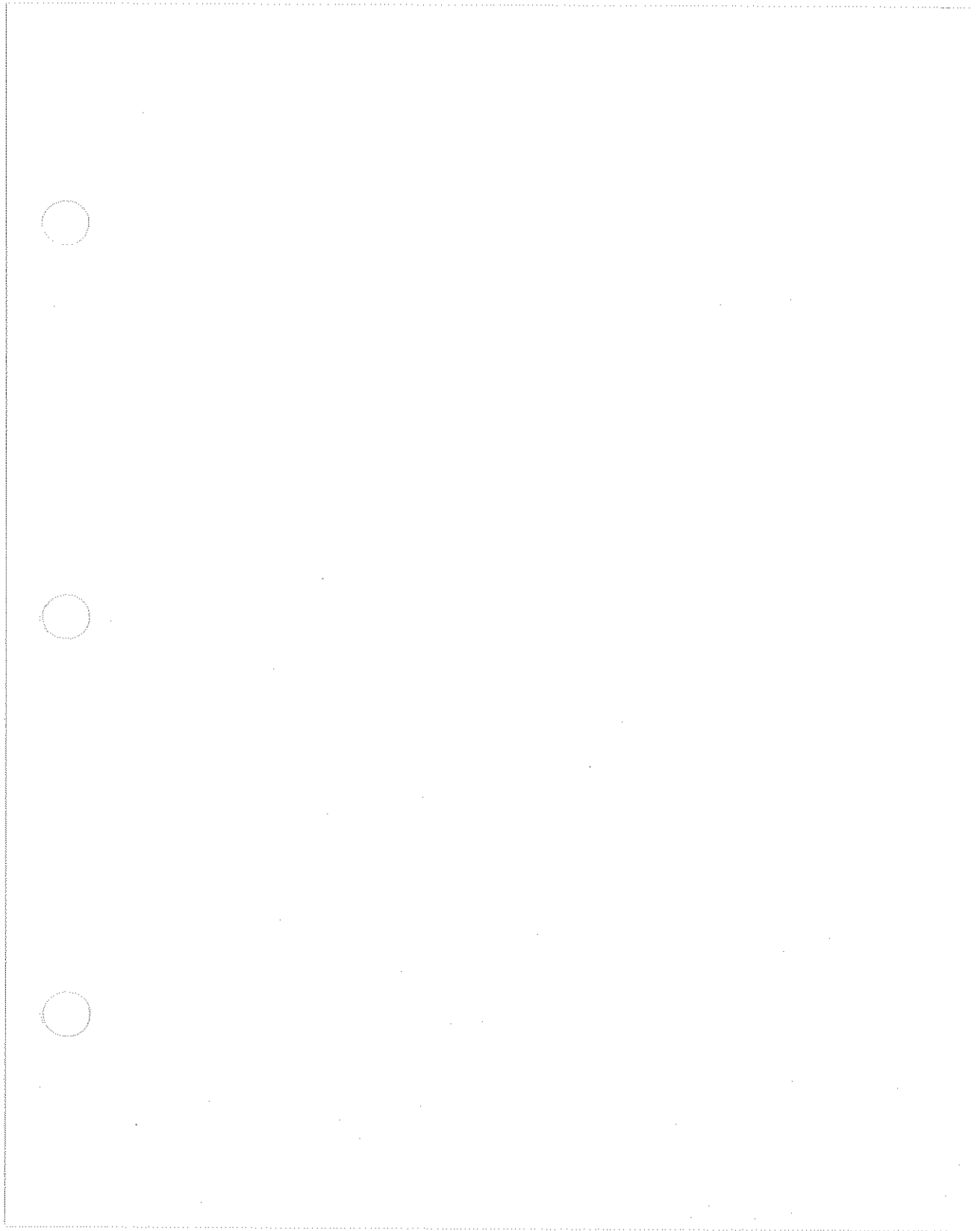
LIMIT: 20 MHz $\pm$ 50 Hz; Freq Delta < 10 Hz

20 MHz FREQUENCY COUNTS

10. If either of the following prompts is displayed, refer to the troubleshooting chapter:
9. When the adjustment is complete, press **[CONTINUE]** to return to the menu.
8. Refer to Figure 7-11 for the location of A6R51. Adjust A6R51 for a frequency counter reading of 20 MHz $\pm$ 50 Hz.
- ADJUST R51 FOR 20 MHz $\pm$ 50 Hz

7. The following prompt is displayed:





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.

SYSTEM PERFORMANCE

- 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

This chapter describes the following topics:

OVERVIEW

8. Performance Verification and Specifications

uncertainty equations later in this chapter.

The measurement errors of the system are explained in relationship to error model flowgraphs and manual for a detailed description of the systematic errors corrected by measurement calibration. called residual measurement errors. See the "Measurement Calibration" chapter in the operating or other factors related to time). Measurement errors that remain after measurement calibration are characterized and removed), and drift errors (those associated with temperature, humidity, pressure, which are stable and repeatable), random errors (those which are random in nature and cannot be Network analysis measurement errors can be separated into three types: systematic errors (those 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.

Measurement Errors

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 Process

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 modeling 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.

Calibration Kit

- 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.

The following characteristics and conditions of the system components affect the performance of the combined system configuration.

Individual System Components

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.

Frequency Tests 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.

Operational Checks Description

- Operational checks
- Frequency tests (HP 8340 and HP 8360 only)
- Total system uncertainty test
- Recommended process checks

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:

SYSTEM PERFORMANCE VERIFICATION

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.

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.

Systematic Errors. These errors result from imperfections in the calibration standards, connectors for standards and interface, interconnecting cables, and instrumentation. Measurement calibration can reduce systematic errors.

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".

- 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.
- 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.
- To assure the continued correct operation of the analyzer system, the following process checks should be done periodically.

Recommended Process Checks Description

The "Total System Uncertainty Test Procedure" is located later in this chapter.

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 same results as a factory system that was verified in a "bottoms-up" approach.

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.

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.

Total System Uncertainty Test Description

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.

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.	

Table 8-1. Equipment Required

EQUIPMENT REQUIRED

The table below shows the equipment required to do the system performance verification and to run the specifications/measurement uncertainties program.

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 sys-tems ("AVAILABLE MEMORY") .
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

5. To load the binary files, insert the language extensions disc in the disc drive and type:
LOAD BIN "ERR" LOAD BIN "CLOCK" LOAD BIN "MAT" LOAD BIN "I/O"

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 "HP-IB"

Remove the drivers disc.

7. Type MS1":,700,0" 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.

- [Verify System]** - This menu allows you to verify system performance.
- [System Uncert]** - This menu allows you to print or plot dynamic accuracy or total uncertainty for your system configuration.
- [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 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.
- A brief explanation of the menu choices follows:
 - Verify system
 - System uncertainty
 - System specifications
 - System configuration
15. The program presents the main menu. From here you can select one of four other menus:
14. To load the data files from the disc, press: **[Done]**
- 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.
- 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.
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.
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.
- The initial screen displays the program revision and the data revision numbers. These numbers are also listed on the disk label. Refer to these numbers if you contact an HP Sales and Service Office about your software product.
11. Type RUN to start the program.
10. Type LOAD "SPECS_8510" and wait for the program to be installed.
9. Set the active drive. Type MSI and enter the mass storage specifier.
8. Insert the program disk into the computer's disk drive.
- NOTE:** The mass storage device must be set to the correct location for the program to run smoothly.

- 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 "SYSTEMS("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.

In Case of Difficulty

- 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.

USING THE KEYBOARD OR MOUSE FOR PROGRAM CONTROL

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."

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 (unrated 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.

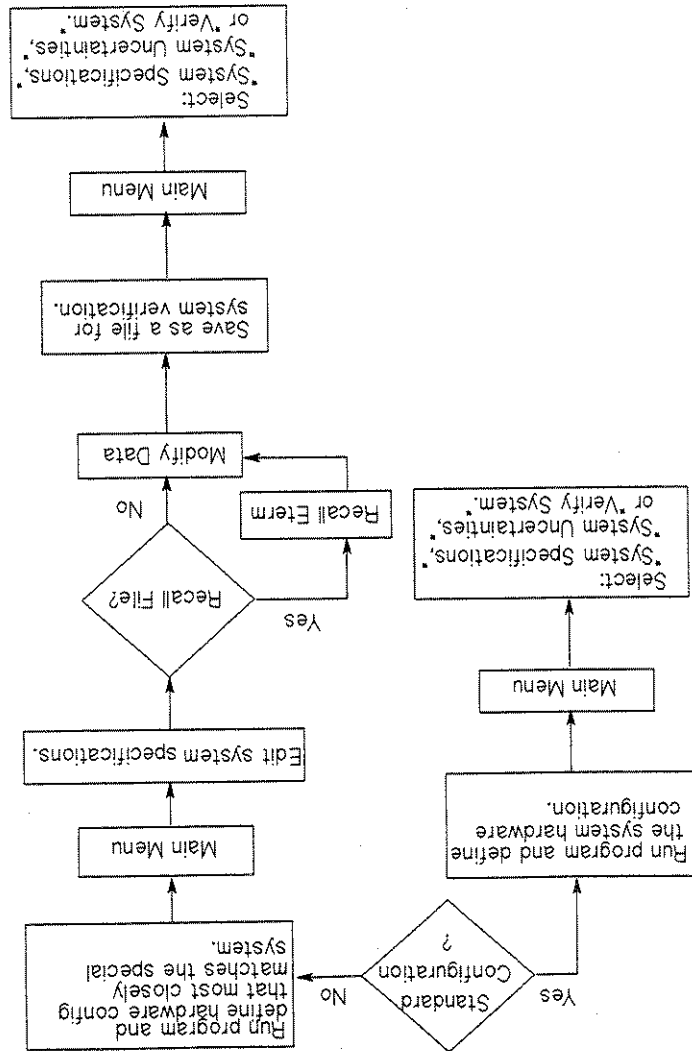
d. To calibrate a custom system, new features in the software allow you to modify error-term parameters.

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, follow the "Yes" path in Figure 8-1.
- NOTE: LIMITATION OF WARRANTY.

HP 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 warranted; however, if you customize the system at your facility, the performance warranty cannot be applied.

Figure 8-1. Flowchart for Selecting to Modify Specifications



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.

Using Markers on Uncertainty Plots

Markers automatically turn on when the uncertainty plot is displayed. The marker appears on the plot as a vertical dashed line. To display the plot and use the marker function, refer to the steps below:

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.

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.

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.

Choosing to Edit Specifications

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3. To enter an S11 value, press **[Previous]** until the asterisk beside S11 (lin) blinks (indicating the data field is activated).
 2. Locate the S-parameter data fields in the middle of the display. Notice the default values of S11 = S22 = 0, and S21 = S12.
 1. Press **[System Uncert]** in the Main menu.
- You can edit the S-parameter values for your specific device under test. Refer to the steps below:

Entering S-parameters of the DUT

5. Press **[Done]** to begin system verification.
 4. Use the softkeys within the menu to edit other selections as needed.
 3. Move the cursor to Verify Using: and select User Parameters.
 2. Press **[Select Standard]**.
 1. Press **[Verify System]** in the Main menu.
- You can choose user-generated specifications for system verification. Refer to the steps below:

Using user-generated specifications in system verification

4. Press **[Done]** to display uncertainty plots.
 3. Use the softkeys within the menu to edit other selections as needed.
 2. For Compute Using:, select User Parameters.
 1. Press **[System Uncert]** in the Main menu.
- To select edited error terms for generating system uncertainty data, refer to the steps below:

Generating customized system uncertainty plots

4. Press **[Done]** to display the specifications table.
 3. Use the softkeys within the menu to edit other selections as needed.
 2. Choose User Parameters for Table Type:.
 1. Press **[System Specs]** in the Main menu.
- To select edited error terms for generating system specifications tables, refer to the steps below:

Choosing User-Generated Error Terms

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:

PERFORMING SYSTEM VERIFICATION

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.

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.

Entering user labels or comments system verification reports

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.

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.

Entering user labels or comments on plots

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.

1. Locate the error term in the displayed table that represents the error term of the hardware change.

Refer to the steps below to edit the values:

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. To display an error term table for editing, select **[Edit Specs]** in the Main menu.

USING THE ERROR TERM TABLE EDITOR

- Recalling a custom error term table file
- Saving edited error term values
- Using the error term table editor

The topics are listed below:

The information you need to understand about customized error terms is explained in this section.

HANDLING CUSTOMIZED ERROR TERMS

In there are examples to help you understand how to change error terms for some typically used hardware modifications.

to help you determine which error term to change. 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. 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.

CHANGING ERROR TERM VALUES

For additional information on performing system verification, refer to the "Total System Uncertainty Test Procedure" later in this chapter.

1. Press **[Select Standard]**.
2. Go to Verify Using.
3. Select either Specifications for defined values or User Parameters to use the customized specifications.

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 Terms]** Use this key to save the edited error term table under a file name you specify.
- [Recall Terms]** 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, press the **[Done]** key to save edited terms.
2. From the Main menu, press **[Edit Specs]** **[Save Terms]**.
3. Enter a file name and directory, if needed, for the new data in the space provided.

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■ 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

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.

USING THE NEW SOFTWARE: A TUTORIAL

- ☐ In the **[Verify System]** menu, press **[Select Standard]**, then select Verify Using: User Parameters.
- ☐ In the **[System Uncert]** menu under Compute Using, select User Parameters.
- ☐ In the **[System Specs]** menu, for table type, choose User Parameters.

within the following menus:

- To use edited specifications, you need to select user parameters. The user parameters are available within the following menus:
- Return to the Main menu and choose **[System Specs]**, **[System Uncertainty]**, or **[Verify System]**.
- Edit more specifications.

At this point, the user can make any of the following choices:

3. Press **[Done]** to retrieve the file.
2. Edit the file name and directory if necessary.
1. From the Main menu, press **[Edit Specs]** **[Recall Eterms]**.

To recall a customized error term table file, use the steps below:

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.

RECALLING A CUSTOM ERROR TERM FILE

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.

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 50 Ω 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?

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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 $20 \times \log(1 + \text{error})$.
- The "Lower Limit" is $20 \times \log(1 - \text{error})$.
- 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 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 $+2^\circ$ 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.

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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.



- HP 8511A test set
- No source
- No calibration kit
- No cables
- No verification kit

- 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
- Question: What is the difference

Table 8-6 for the answer.

■ 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.

Table 8-6 for the answer.

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Port 1: Ld1c, Lt1c, Ctm1, Cpt1
Port 2: Ld2c, Lt2c, Ctm2, Cpt2

swers.

■ **Question:** What are the new values for the following error terms? Refer to Table 8-8 to verify an-

- ☐ -45 dB at 2 GHz
- ☐ -41 dB at 8 GHz
- ☐ -35 dB at 20 GHz
- ☐ -31 dB at 26 GHz

You find the cable's reflection magnitude stability, C_{rm} , to be the following values:

The S21/M phase measurements showed $\pm 0.1^\circ$ around 0° at 1 GHz.

- ☐ ± 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

indicated below:

Looking at S21/M (data/memory), you find the cable's transmission magnitude repeatability to as

by the same amount that the cables are bent during a measurement. together and store the transmission measurement in memory. Next, you bend the connected cables while you are working on the system, you perform a 2-port calibration. Then, you connect the cables

the non-standard cables? Refer to the *HP 8510C On-Site Service Manual* as needed.

■ **Question:** Which transmission and reflection tests do you perform to determine the stability of

■ **Question:** What is the value of this error term for the cables described above?

$$\frac{Loss1 - Loss2}{\sqrt{F_1(GHz)} - \sqrt{F_2(GHz)}}$$

term (assuming $F_1 > F_2$):

The error term is "Loss/sqrt(F_1 - GHz) port 1, 2 cable." Use the following formula to calculate the error

quency (in GHz).

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 fre-

HINT: Hint: Consider how the cables impact your measurements.

• **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.

You are using a pair of non-standard 3.5 mm flexible cables. You want to approximate the measure- ment 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.

Using Non-Standard Test Cables, Exercise C.

- **Task:** Generate the worst-case uncertainty specifications for an S21 magnitude measurement, using the lower limits.
 - ☐ 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
- **Question:** What are the measurement uncertainties in each frequency range for the attenuator measurement?

To determine the attenuator uncertainties, use the following 3.5 mm HP 8510 system:

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.

Using a Non-Ideal Test Device, Exercise D.

HINT: Remember to select User Parameters when generating the uncertainty curves for the non-standard cables. 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?

$$C_{\text{m}x} + C_{\text{p}f} \times (\text{frequency in GHz})$$

b. Use the following equation to determine the phase stability:

$$L_{\text{d}x} + L_{\text{f}x} \times \sqrt{(\text{frequency in GHz})}$$

a. Enter the error terms Lf1c, Lf2c, Cpt1, and Cpt2 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):

- **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.

Questions	Answers
1. Which effective error term would dominate when you measure the following: a. For a good 50 Ω termination? b. For a short circuit? c. For an amplifier with 10 dB of gain? d. For switch isolation?	The directivity term. The source match term. The load match term. The crosstalk term.
2. What is the raw directivity at 26.5 GHz? How does this value compare with the data sheet value?	The value should be about -27 dB. 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.

Table 8-2. Examining Error Term Tables Answers

“Examining Error Term Tables” Answers

Exercise questions from the tutorials are repeated in the first column of the tables. Answers are stated in the column beside the question.

ANSWERS TO TUTORIAL QUESTIONS

Questions	Answers
How can you verify that the S11 magnitude uncertainty curve is correct?	At $S_{11} = 0$, 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.

Table 8-4. Tutorial Exercise 3a. Answers

Exercise 3a: Answers to Using a Custom Calibration Kit

The answers to tutorial exercises 3a, 3b, 3c, and 3d, are provided in these tables.

"Editing Specifications Examples" 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 $S_{11} = 0$ (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.
Does the value correspond with the data sheet?	Too large can be considered to be > 6 dB uncertainty, where the noise power equals the signal power, or > 10 dB uncertainty, which is off the graph, corresponding to 70 dB dynamic range. 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.

Table 8-3. Computing Uncertainty Curves Answers

"Computing Uncertainty Curves" Answers

The answers to Computing Uncertainty Curves, questions 1, 2, and 3 are in Table 8-3:

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.

Table 8-6. Tutorial Exercise 3b. Answers

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 ret (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 8-5. Error Terms to Modify for Generating Uncertainty Curves

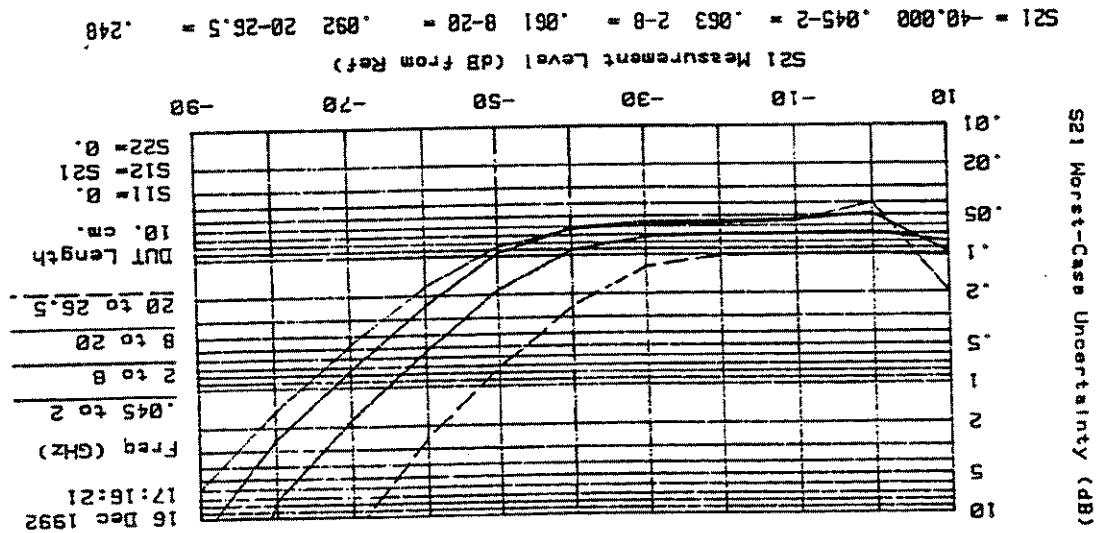
Exercise 3b: Answers to Using A Special Test Set

The error terms that need to be modified for generating the S21 magnitude uncertainty curves are in Table 8-5 below:

HP 8510C

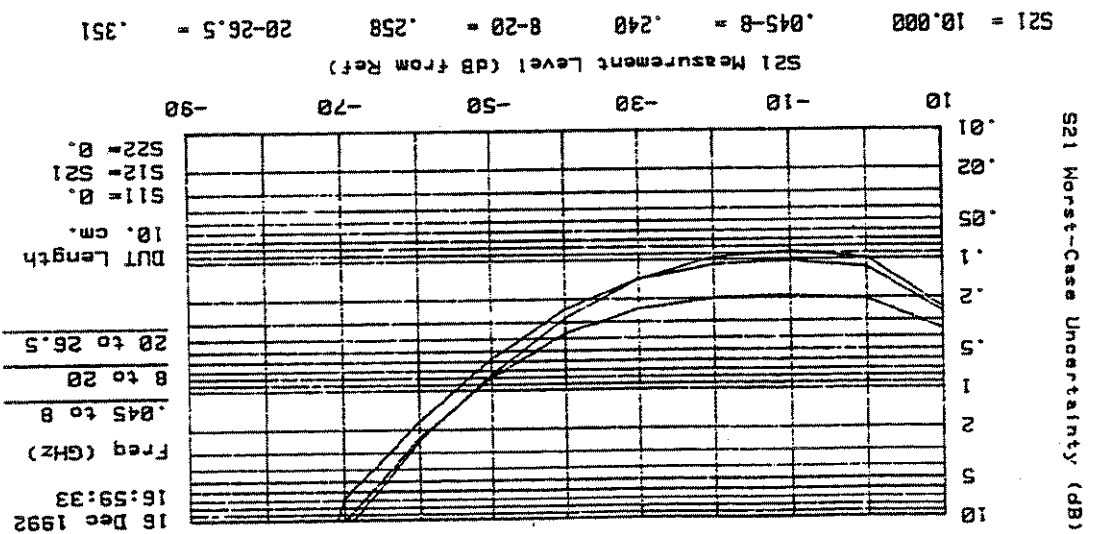
Performance Verification and Specifications 8-27

Figure 8-4. S21 Magnitude Lower-Case Uncertainty, User Parameters for Special Test Set



S21 MAGNITUDE LOWER WORST-CASE UNCERTAINTY (USER) PARAMETERS
HP8510C / HP8515A / HP83631A / HP85052C / TL / NOCABLES
EXERCISE 3c

Figure 8-3. S21 Magnitude Upper-Case Uncertainty, User Parameters for Special Test Set



S21 MAGNITUDE LOWER WORST-CASE UNCERTAINTY (USER) PARAMETERS
HP8510C / HP8511A / NOSOURCE / NOCALKIT / BL / NOCABLES
EXERCISE 3b

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.

Question		What are the new calculated values for port 1 and port 2 error terms?		Ld1c		Ld2c		Lf1c		Lf2c		Cm1		Cm2		Cp1		Cp2	
Port 1	Eterm	Ld1c	Ld2c	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-45.0 dB	-0.02 dB	-41.0 dB	-0.03 dB	-31.0 dB	-0.06 dB	-35.0 dB	-0.04 dB
Port 2	Eterm	Ld1c	Ld2c	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-45.0 dB	-0.02 dB	-41.0 dB	-0.03 dB	-31.0 dB	-0.06 dB	-35.0 dB	-0.04 dB
2.0 GHz	Eterm	Ld1c	Ld2c	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-45.0 dB	-0.02 dB	-41.0 dB	-0.03 dB	-31.0 dB	-0.06 dB	-35.0 dB	-0.04 dB
8.0 GHz	Eterm	Ld1c	Ld2c	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-45.0 dB	-0.02 dB	-41.0 dB	-0.03 dB	-31.0 dB	-0.06 dB	-35.0 dB	-0.04 dB
20 GHz	Eterm	Ld1c	Ld2c	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-45.0 dB	-0.02 dB	-41.0 dB	-0.03 dB	-31.0 dB	-0.06 dB	-35.0 dB	-0.04 dB
26.5 GHz	Eterm	Ld1c	Ld2c	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-0.40 dB	-0.25 dB	-45.0 dB	-0.02 dB	-41.0 dB	-0.03 dB	-31.0 dB	-0.06 dB	-35.0 dB	-0.04 dB

Table 8-8. Error Term Values Needed for This Custom Cable

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 8-7. Tutorial Exercise 3c. Answers

Exercise 3c: Answers to Using Non-Standard Test Cables

HP 8510C

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Figure 8-6. S21 Magnitude Uncertainty Using HP 85131F Cables

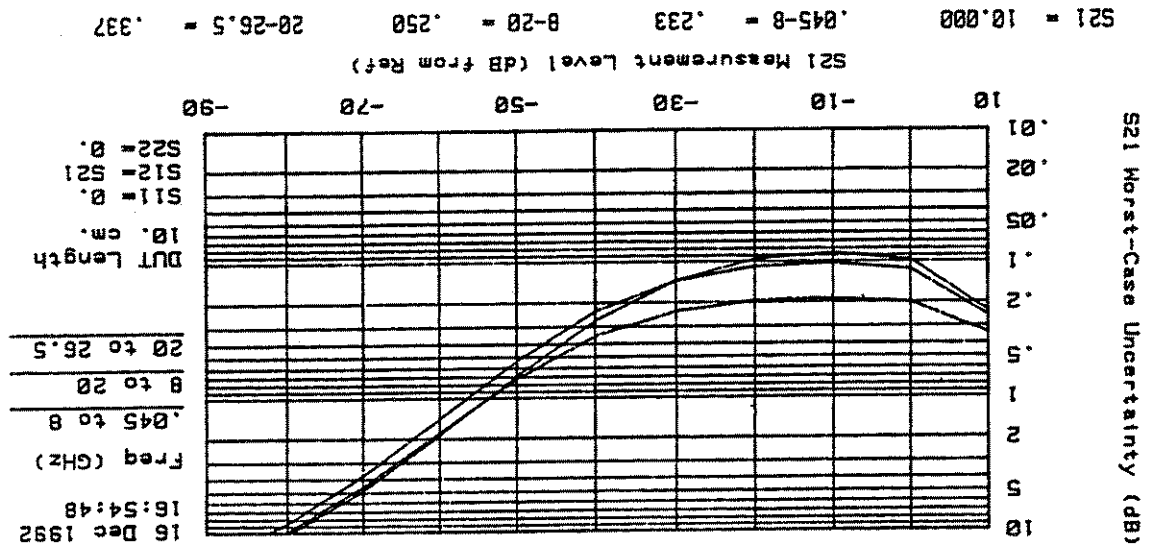
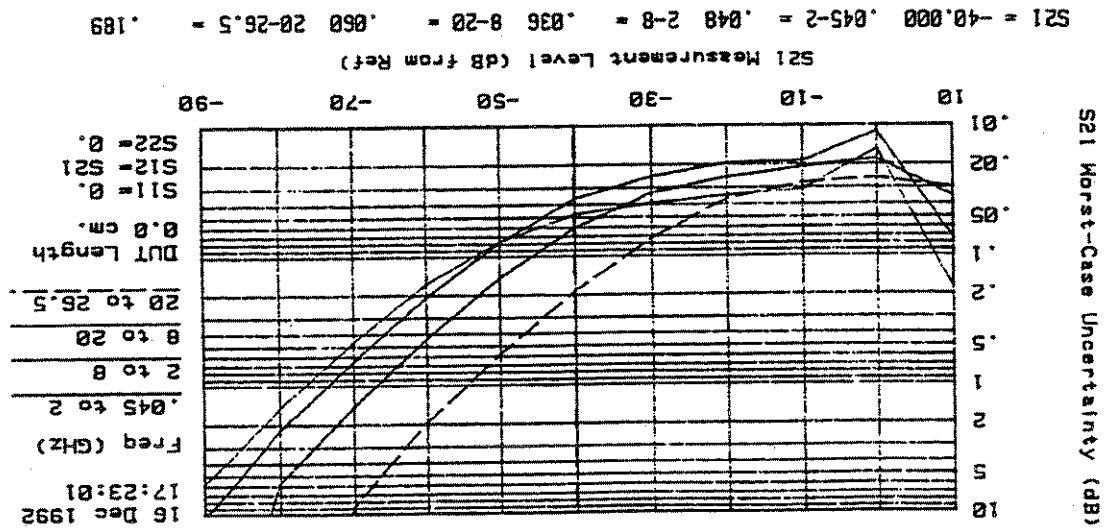


Figure 8-5. S21 Magnitude Uncertainty Using Custom Cables

S21 MAGNITUDE UPPER WORST-CASE UNCERTAINTY (USER) PARAMETERS
 HP8510C / HP8511A / NOSOURCE / NOCALKIT / BL / NOCABLES



S21 MAGNITUDE LOWER WORST-CASE UNCERTAINTY DATA SHEET
 HP8510C / HP8515A / HP83631A / HP85052C / TL / HP85131F

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.



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 $+23^{\circ}\text{C} \pm 3^{\circ}$. Therefore, the environmental **TEMPERATURE MUST** remain in the range of $+20^{\circ}\text{C}$ to $+26^{\circ}\text{C}$. Once the measurement calibration has been done, the ambient temperature must be held to $\pm 1^{\circ}\text{C}$.

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



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.

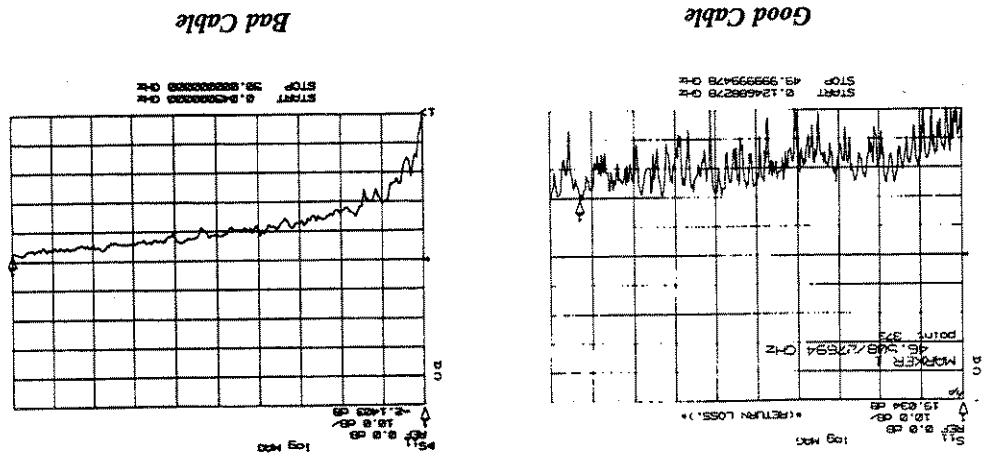
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1. Replace the load with a short.
 2. To measure the insertion loss of the cable over the entire specified band, press **MARKER**, turn the front panel knob, and look for the worst case measurement.
Power holes > 0.5 dB indicate a bad cable. See Figure 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.

Insertion Loss of Cables

Figure 8-7. Return Loss Measurement of Cables



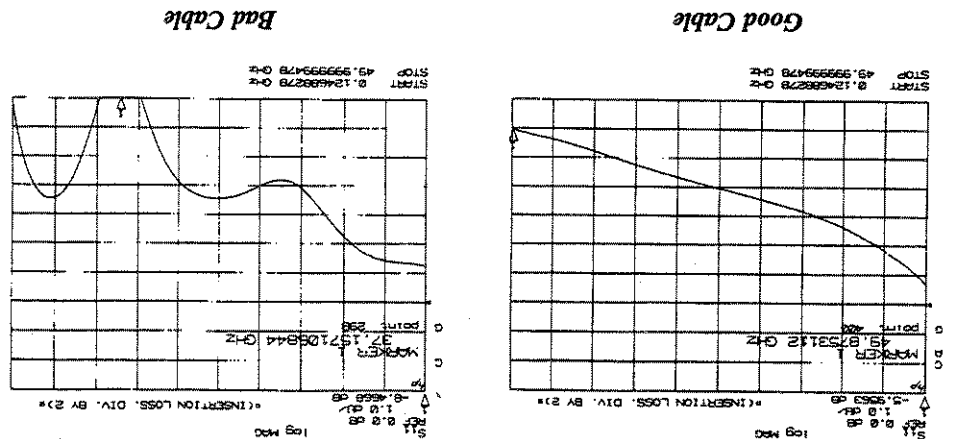
See Figure 8-7 for an example of a return loss measurement. Refer to the cable manual to see if the cable meets the return loss specification.

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1. To measure magnitude and phase stability, press the following keys on the analyzer:
[DISPLAY] [DUAL CHANNEL] [SPLIT]
CHANNEL 1 [LOG MAG] [MENU] [AVERAGING ON] [6] [4] [X1]
CHANNEL 2 [PARAMETER] [S11] [FORMAT] [PHASE] [MENU] [AVERAGING ON] [6] [4] [X1]
RESPONSE [MENU] [AVERAGING ON] [6] [4] [X1]
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 (I)]
CHANNEL 2 [DISPLAY] [DATA→MEMORY 2] [MATH (I)]
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/M]

Magnitude and Phase Stability of Cables

Figure 8-8. Insertion Loss Measurements of Cables

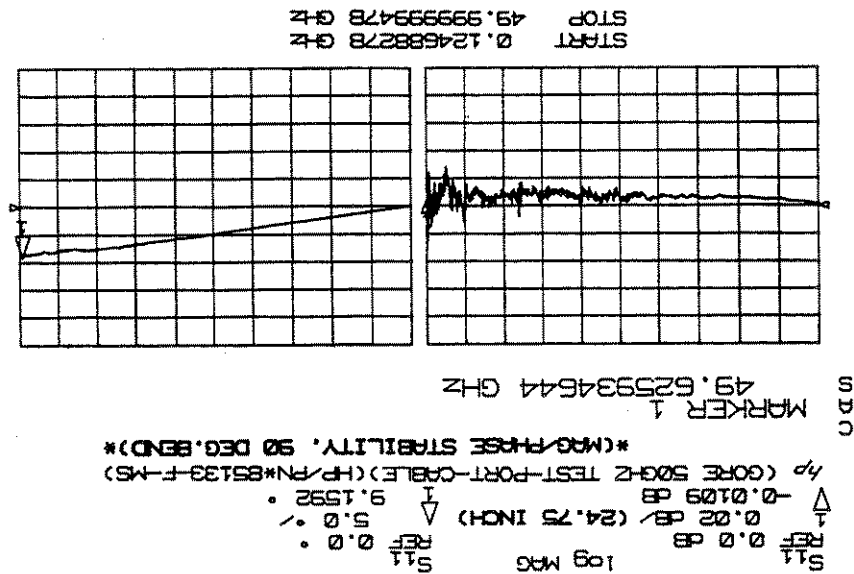


CHANNEL 1 [DISPLAY] [SINGLE CHANNEL] [DATA] [MENU] [AVERAGING ON] 1 2 8 [X1]

1. To measure the cable connector repeatability, connect a broadband termination at the end of the cable.
2. Press the following keys on the analyzer:
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.

Cable Connector Repeatability

Figure 8-9. Cable Magnitude and Phase Stability



- MARKER** [turn the front panel knob] **MARKER 2**
- 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.

Press:

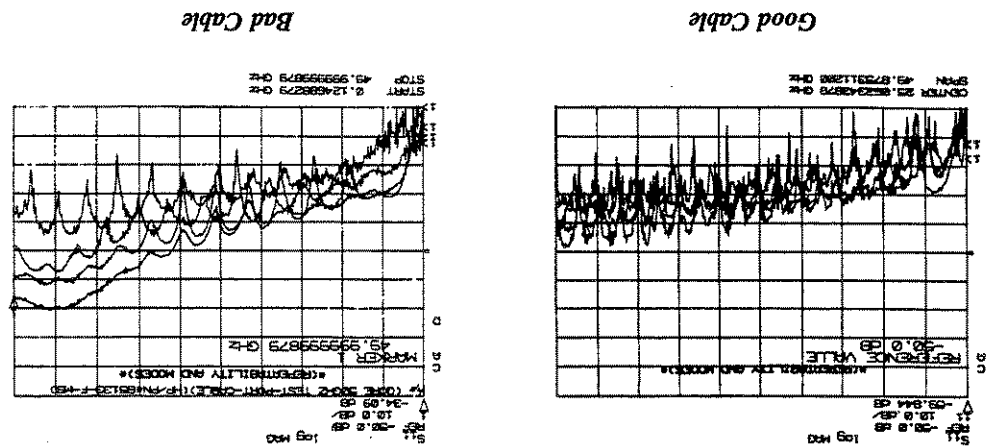
7. Place a marker on the largest deflection that goes above and below the reference line and is within the specified frequency range. See Figure 8-9 for example plots of this measurement.

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.

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.

DYNAMIC RANGE CHECK

Figure 8-10. Connector Repeatability Examples



NOTE: The connector repeatability measurement should be done at the test port as well as at the end of the test port cable.

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.

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.
5. To add the data trace of the reconnected cable to memory, press:

[DISPLAY] [DATA→MEMORY 1]
4. Disconnect and then reconnect the cable to the test port. Tighten the connection to the specified torque for the connector type.
3. To normalize the data trace press:

[DISPLAY] [MORE] [MATH OPERATIONS] [MATH (-)] [DATA→MEMORY 1] [MATH (-)] [REF VALUE] [5] [0] [x1]

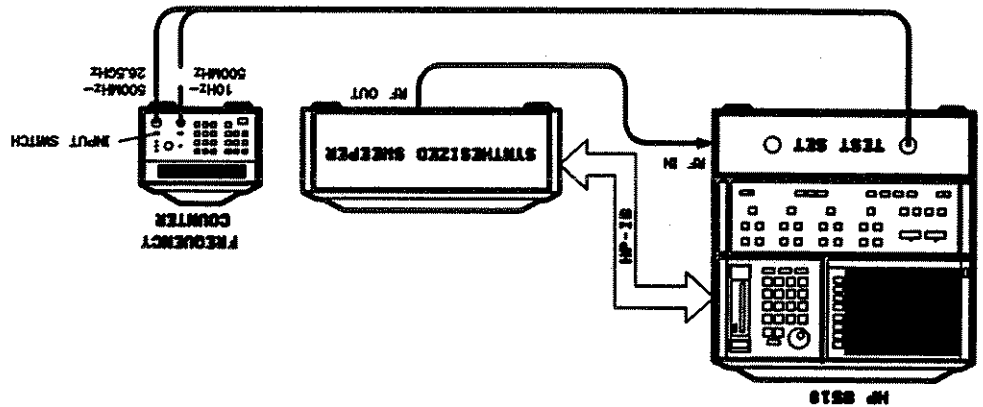
3. Compare the measured dynamic range to the specification on the generated table.
- NOTE:** Test sets with option 003 (reversed coupler) have a different specification for forward and reverse measurements. Measure the dynamic range in both S12 and S21 parameters.
- Allow at least one complete sweep (until the asterisk at the left side of the CRT disappears).

FORMAT LOG MAG
 PARAMETER S21
 RESPONSE MENU [AVERAGING ON]
 (for sweepers) 1 2 8 x1
 (for synthesizers) 1 0 2 4 x1
 MEASUREMENT RESTART

2. On the analyzer, press:
1. Terminate each test port with a broadband load (included in the calibration kit).

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.)
- Measure the frequency with the counter, and record this value on the test record located at the end of this chapter.
- test set, whichever is higher.
- STIMULUS [CENTER] [MENU] [SINGLE POINT] and enter the start frequency of the source or test set, whichever is higher.
3. To set the frequency from the analyzer front panel, press:
INSTRUMENT STATE [RECALL] [MORE] [FACTORY PRESET]
2. To preset the instruments, press:

Figure 8-11. CW Frequency Accuracy Setup



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.

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.

CW FREQUENCY ACCURACY TEST

- NOTE: Allow at least one hour for the system instruments to warm up.
- Source frequency accuracy is tested across the entire sweep range in both the swept and CW sweep modes.
- The frequency tests are only for HP 8340/8360 sources. The HP 8350 source frequency accuracy is tested during the total system uncertainty test.

FREQUENCY TEST PROCEDURES

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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

software.

6. Insert the HP 8510 operating disc into the analyzer disc drive to run the front panel emulation

of this chapter.

Measure the frequency with the counter, and record the value on the test record located at the end

counter. The input switch must also be set to the 500 MHz-26.5 GHz position.

NOTE: Make sure the test set output is connected to the 500 MHz-26.5 GHz input on the frequency

5. From the analyzer front panel, enter **[2] [6] [-] [5] [G/n]**.

For the HP 83651:

end of this chapter.

Measure the frequency with the counter and record the value on the test record located at the

[CW] [4] [0] [G/n]

[SERVICE] [MORE] [TOOLS MENU] [MORE] [DISABLE DOUBLER] (asterisk on)

On the synthesizer, press:

GHz measurement.

engaged to produce the 26.5 GHz RF output, the operation of the doubler is verified in the 26.5 GHz. This verifies a 40 GHz output except for the operation of the doubler. Since the doubler is

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. In the HP 83640, an internal frequency doubler is used to generate frequencies of ≥ 20 GHz

of this chapter.

Measure the frequency with the counter, and record the value on the test record located at the end

counter. The input switch must also be set to the 500 MHz-26.5 GHz position.

NOTE: Make sure the test set output is connected to the 500 MHz-26.5 GHz input on the frequency

5. From the analyzer front panel, enter **[2] [6] [-] [5] [G/n]**.

For the HP 83640:

of this chapter.

Measure the frequency with the counter, and record the value on the test record located at the end

counter. The input switch must also be set to the 500 MHz-26.5 GHz position.

NOTE: Make sure the test set output is connected to the 500 MHz-26.5 GHz input on the frequency

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Performance Verification and Specifications

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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).

1. Connect the equipment as shown in Figure 8-12.

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. 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.

SWEEP FREQUENCY ACCURACY TEST

If the measured values do not meet the specifications listed on the test record, refer to the source manual for adjustment and troubleshooting instructions.

In Case of Difficulty

10. Follow the instructions on the analyzer CRT to exit the front panel emulator software.

Measure the frequency with the counter and record the value on the test record located at the end of this chapter.

[k4] (more) [k4] (Disable Doubler) (asterisk on)
[SERVICE] [D4] (more) [k2] (Tools Menu)

FREQUENCY [CW] [5] [0] [G/M]

9. To set the stop frequency of the HP 83651, press the following keys on the analyzer.

8. Put the keypad overlay on the analyzer front panel. (The overlay is part of the front panel emulator kit.)

[2] (FRONT PANEL EMULATOR) [= MARKER]

[LOAD FILE]

[1] [3] (LOAD PROGRAM DISC) [= MARKER]

[TEST MENU]

[MORE] [SERVICE FUNCTIONS]

AUXILIARY MENUS [SYSTEM]

7. On the analyzer, press:

is engaged to produce the 26.5 GHz RF output, the operation of the doubler is verified in the 26.5 GHz measurement.

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PRESSET **USER CAL** **[FREQ CAL MENU]** **ONCE**

3. To initiate an auto track, press the following keys on the synthesizer:

For All Other HP 8360 Series Synthesizers:

Continue with step 6.

5. Follow the instructions on the analyzer CRT to exit the front panel emulator software.

ment calibration.

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 measure-

The user cal takes a few minutes to complete.

[USER CAL] [k0] (Full User Cal) (proceed)

4. To initiate a synthesizer full user cal, that includes auto track and sweep span cal, press:

for kit.)

Put the keypad overlay on the analyzer front panel. (The overlay is part of the front panel emula-

[2] (FRONT PANEL EMULATOR) **=MARKER**

[LOAD FILE]

[1] [9] (LOAD PROGRAM DISC) **=MARKER**

[TEST MENU]

[MORE] [SERVICE FUNCTIONS]

AUXILIARY MENUS **SYSTEM**

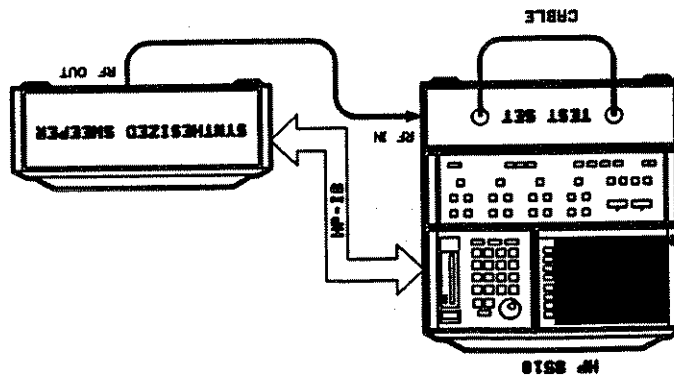
3. Run the front panel emulation software. On the analyzer, press:

For HP 83621/31/51 Synthesizers:

INSTRUMENT STATE **RECALL** **[MORE] [FACTORY PRESET]**

2. To preset the system instruments, press:

Figure 8-12. Swept Frequency Accuracy Setup



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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.
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.
11. Press STIMULUS **CENTER** and return the frequency to the original setting. The phase measurement should return to 0°.
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.
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.)
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.
7. To normalize the measurement, press:

MENUS **[DISPLAY] [DATA→MEMORY 2] [MATH (I)]**
6. Press the following keys on the analyzer:

PARAMETER **[SZ1] FORMAT [PHASE] STIMULUS [MENU] [STEP]**

Allow at least one complete sweep (until the asterisk is gone).

For All Synthesizers:

4. Continue with step 6.
3. To initiate an auto track, press the following keys on the synthesizer:

[PRESET] [SHIFT] [PEAK]

For HP 8340/41 Series Synthesizers:

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.

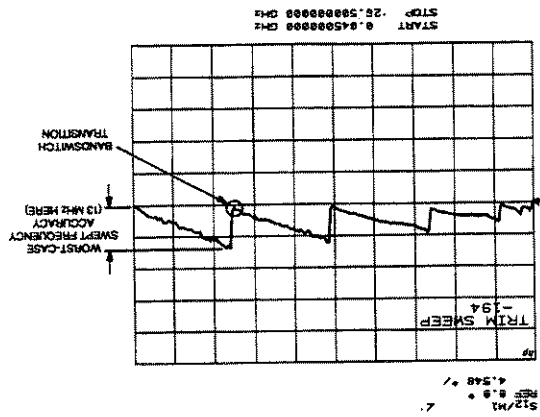
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If the measured values do not meet the specifications listed on the test record, refer to the source manual for adjustment and troubleshooting instructions.

In Case of Difficulty

Figure 8-14. Typical Trace Variation for HP 8340/41 Sweep Frequency Accuracy



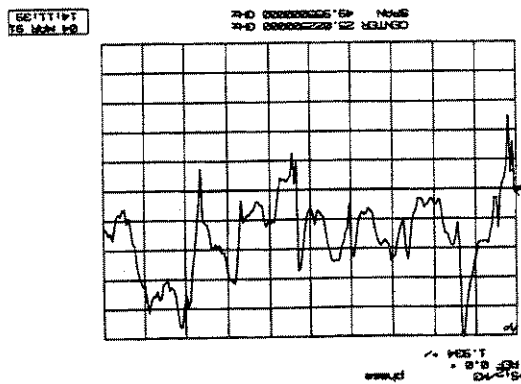
Record the maximum trace variation on the test record located at the end of this chapter.

figure below.

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

For HP 8340/41 Series Synthesizers:

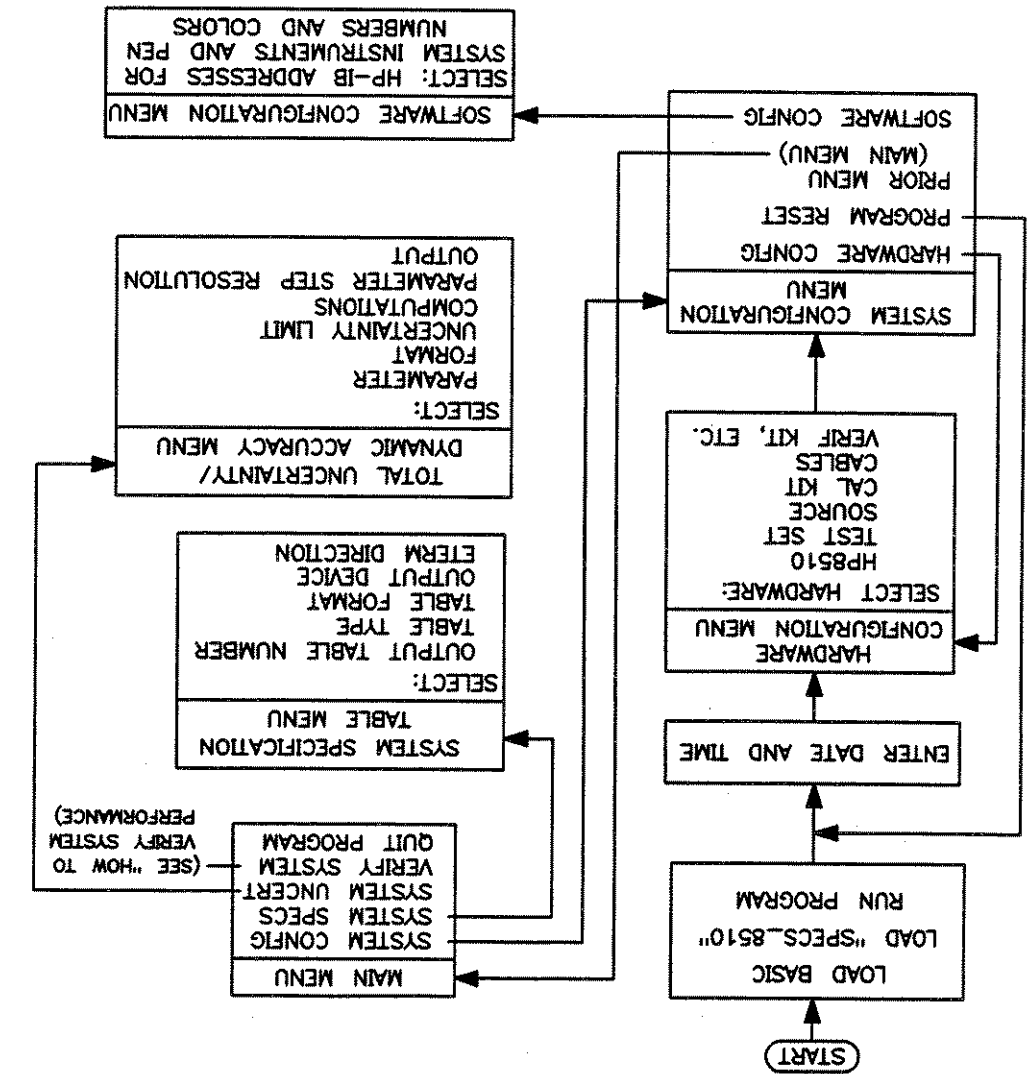
Figure 8-13. Typical Ramp Sweep Frequency Accuracy



1. Perform the "How to Load the Software" procedure earlier in this chapter.
2. To run the performance verification, press:

[Verify System] [Serial Numbers].

Figure 8-15. Performance Verification Program



The figure below shows a menu map of the performance verification program. Step-by-step instructions follow.

TOTAL SYSTEM UNCERTAINTY TEST PROCEDURE

- tion device measurements.
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.
10. Press **[Select Standard]** and fill in the serial number for the verification standard listed. deleted 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]**.
- Save the measurement calibration in one of the analyzer registers. When the measurement calibration is completed and saved, press **[Resume]**.
- 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.
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.
8. Measure the environmental temperature and record the results on the test record at the end of this chapter.
7. Insert the calibration kit data disc into the analyzer disc drive. Press **[Resume]**.
- 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.
- 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 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]**.
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]**.
- NOTE: Tighten all connections to the correct torque.
5. Follow the cable connection instructions on the CRT and then press **[Resume]**.
- If the list does not match your system, press **[Prior Menu]** **[System Config]** to return to the hardware configuration menu to correct the list. If the list does match your system, press **[Resume]**.
4. To begin a measurement calibration, insert the calibration kit data disc into the analyzer disc drive, and press **[System Cal]**.
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.

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.

HP 8510C

Performance Verification and Specifications

8-47

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.

Example 8-1. Comparing Measurement Uncertainties

Freq	Total	Factory	System Measurement
0.045	0.01348	0.00484	0.00864
1.000	0.01242	0.00378	0.00864
2.000	0.01241	0.00378	0.00863

Note: Uncertainties for frequency data points below 500 MHz do not apply when used with BS12 or BS14 test sets.

PASSED: S11 Verification Measurement of the 20 dB Attenuator.

Legend: M -- Parameter Verification Not Required.

NOTE: Total Uncert = Factory System Uncertainty + User System Uncertainty.

Port	Param	Value	Unc	Factory	User	Total
S11	Mag	1.00	0.00	0.00	0.00	0.00
S11	Phs	0.00	0.00	0.00	0.00	0.00
S21	Mag	1.00	0.00	0.00	0.00	0.00
S21	Phs	0.00	0.00	0.00	0.00	0.00
S31	Mag	1.00	0.00	0.00	0.00	0.00
S31	Phs	0.00	0.00	0.00	0.00	0.00
S41	Mag	1.00	0.00	0.00	0.00	0.00
S41	Phs	0.00	0.00	0.00	0.00	0.00
S51	Mag	1.00	0.00	0.00	0.00	0.00
S51	Phs	0.00	0.00	0.00	0.00	0.00
S61	Mag	1.00	0.00	0.00	0.00	0.00
S61	Phs	0.00	0.00	0.00	0.00	0.00
S71	Mag	1.00	0.00	0.00	0.00	0.00
S71	Phs	0.00	0.00	0.00	0.00	0.00
S81	Mag	1.00	0.00	0.00	0.00	0.00
S81	Phs	0.00	0.00	0.00	0.00	0.00
S91	Mag	1.00	0.00	0.00	0.00	0.00
S91	Phs	0.00	0.00	0.00	0.00	0.00
S101	Mag	1.00	0.00	0.00	0.00	0.00
S101	Phs	0.00	0.00	0.00	0.00	0.00

S11 Phase (deg)

Factory Phase (deg)

User Phase (deg)

Total Phase (deg)

Mag (dB)

Phs (deg)

Factory Mag (dB)

User Mag (dB)

Total Mag (dB)

Factory Phs (deg)

User Phs (deg)

Total Phs (deg)

Factory Total (dB)

User Total (dB)

Total Total (dB)

Factory Total (deg)

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Total Total (dB)

Factory Total (deg)

User Total (deg)

Total Total (deg)

Factory Total (dB)

User Total (dB)

Total Total (dB)

Factory Total (deg)

User Total (deg)

Total Total (deg)

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.

HP 8510C PERFORMANCE VERIFICATION
 Model: 8510C
 Part: 8510C
 Rev: 1.0
 Date: 11/15/95

Port 1 (A) is on the left and Port 2 (B) is on the right.
 Port 1 (A) is on the left and Port 2 (B) is on the right.

Port	Param	Value	Unc	Factory	User	Total
S11	Mag	1.00	0.00	0.00	0.00	0.00
S11	Phs	0.00	0.00	0.00	0.00	0.00
S21	Mag	1.00	0.00	0.00	0.00	0.00
S21	Phs	0.00	0.00	0.00	0.00	0.00
S31	Mag	1.00	0.00	0.00	0.00	0.00
S31	Phs	0.00	0.00	0.00	0.00	0.00
S41	Mag	1.00	0.00	0.00	0.00	0.00
S41	Phs	0.00	0.00	0.00	0.00	0.00
S51	Mag	1.00	0.00	0.00	0.00	0.00
S51	Phs	0.00	0.00	0.00	0.00	0.00
S61	Mag	1.00	0.00	0.00	0.00	0.00
S61	Phs	0.00	0.00	0.00	0.00	0.00
S71	Mag	1.00	0.00	0.00	0.00	0.00
S71	Phs	0.00	0.00	0.00	0.00	0.00
S81	Mag	1.00	0.00	0.00	0.00	0.00
S81	Phs	0.00	0.00	0.00	0.00	0.00
S91	Mag	1.00	0.00	0.00	0.00	0.00
S91	Phs	0.00	0.00	0.00	0.00	0.00
S101	Mag	1.00	0.00	0.00	0.00	0.00
S101	Phs	0.00	0.00	0.00	0.00	0.00

Port	Param	Value	Unc	Factory	User	Total
S11	Mag	1.00	0.00	0.00	0.00	0.00
S11	Phs	0.00	0.00	0.00	0.00	0.00
S21	Mag	1.00	0.00	0.00	0.00	0.00
S21	Phs	0.00	0.00	0.00	0.00	0.00
S31	Mag	1.00	0.00	0.00	0.00	0.00
S31	Phs	0.00	0.00	0.00	0.00	0.00
S41	Mag	1.00	0.00	0.00	0.00	0.00
S41	Phs	0.00	0.00	0.00	0.00	0.00
S51	Mag	1.00	0.00	0.00	0.00	0.00
S51	Phs	0.00	0.00	0.00	0.00	0.00
S61	Mag	1.00	0.00	0.00	0.00	0.00
S61	Phs	0.00	0.00	0.00	0.00	0.00
S71	Mag	1.00	0.00	0.00	0.00	0.00
S71	Phs	0.00	0.00	0.00	0.00	0.00
S81	Mag	1.00	0.00	0.00	0.00	0.00
S81	Phs	0.00	0.00	0.00	0.00	0.00
S91	Mag	1.00	0.00	0.00	0.00	0.00
S91	Phs	0.00	0.00	0.00	0.00	0.00
S101	Mag	1.00	0.00	0.00	0.00	0.00
S101	Phs	0.00	0.00	0.00	0.00	0.00

Example 8-2. Table for Comparing Measurement Uncertainties

	Freq GHz
	Total Uncertainty
—	
Factory Uncertainty	
=	
System Measurement Uncertainty	

Example 8-3. Performance Verification (S21 Measurement)

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 Difference between the factory and verification measurements (this must be less than the total uncertainty of the system being verified)
- 9 Total measurement uncertainty which is the sum of the factory system uncertainty and the uncertainty of the system being verified
- 10 Result of the performance verification measurement
- 11

PASSED: S21 Verification Measurement of the 20 dB Attenuator.

NOTE: Total Uncert = Factory System Uncertainty + User System Uncertainty.

Freq (GHz)	Factory Meas'd (dB)	User Meas'd (dB)	Diff (dB)	Total Uncert (dB)	Factory Meas'd Phase (deg)	User Meas'd Phase (deg)	Diff Phase (deg)	Total Uncert Phase (deg)
1.500	-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	.009	.090	-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	-20.171	.004	.088	-117.16	-117.38	.22	1.69
8.000	-20.203	-20.199	.004	.087	56.56	56.87	-.30	1.94
10.000	-20.210	-20.202	.008	.089	36.25	36.64	-.39	2.04
15.000	-20.254	-20.252	.002	.148	-4.06	-3.71	-.35	2.61
20.000	-20.262	-20.262	.000	.148	-64.56	-64.29	-.27	2.86
30.000	-20.287	-20.282	.005	.148	-125.19	-124.87	-.32	3.12
40.000	-20.332	-20.332	.000	.147	113.64	114.13	-.49	3.62
50.000	-20.346	-20.346	.000	.147	53.08	53.56	-.48	3.88
60.000	-20.378	-20.366	.012	.146	-7.46	-6.96	-.50	4.12
70.000	-20.389	-20.386	.003	.142	-67.99	-67.59	-.40	4.36
80.000	-20.394	-20.386	.008	.142	-88.26	-87.94	-.31	4.43
90.000	-20.407	-20.407	.000	.246	-128.69	-129.30	-.39	5.21
100.000	-20.439	-20.435	.004	.256	170.58	170.93	-.35	5.63
120.000	-20.479	-20.473	.006	.280	109.85	110.27	-.42	5.96
150.000	-20.522	-20.519	.003	.290	49.16	49.61	-.51	6.30
200.000	-20.560	-20.557	.003	.290	8.53	8.81	-.28	6.54

Two example printouts are used to explain the various columns.

Interpreting the Performance Verification Results

Example 8-4. Performance Verification (S22 Measurement)

- 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

HP85100 PERFORMANCE VERIFICATION
10:11:47 10 Aug 1990

Verif Std: 20 dB Attenuator
Verif Kit: HP85053B -- 3.5mm
Snr #: 01371
D-101n: 12/20/88
D-101m: 12/20/88

Network Analyzer: HP85100
Test Set: HP8515A
Source: HP8531A
Calibration Kit: HP85052D
Calibration Technique: BL
Test Port Cables: HP85131B

NBS Test Numbers: #:
#:
#:
#:

Comments:
#:
#:
#:
#:

S22 MAGNITUDE (1in)		S22 PHASE (deg)								
Factory	User	Factory	User							
Mag'd	Mag'd	Phase	Phase							
Diff	Diff	Uncert	Uncert							
Total	Total	Mag'd	Mag'd							
Uncert	Uncert	Uncert	Uncert							
+/	+/	+/	+/							
(N)	(N)	(N)	(N)							
(B)	(B)	(B)	(B)							
(A-B)	(A-B)	(A-B)	(A-B)							
+	+	+	+							
1.500	1.500	0.1317	0.1115	0.0202	0.1234	91.87	90.59	-6.72	N	58.38
2.000	2.000	0.1505	0.1219	0.0284	0.1235	70.02	70.03	-1.01	N	50.33
3.000	3.000	0.1791	0.1452	0.0339	0.1789	32.09	31.51	1.29	N	61.87
4.000	4.000	0.2306	0.1782	0.0523	0.1776	-5.04	-12.63	8.79	N	47.05
6.000	6.000	0.2290	0.1533	0.0756	0.1776	-47.38	-58.99	11.61	N	48.55
7.500	7.500	0.2100	0.1516	0.0584	0.1774	-09.14	-08.16	-2.98	N	53.75
8.000	8.000	0.2055	0.1220	0.0835	0.1774	-104.17	-105.72	1.55	N	55.16
9.000	9.000	0.1887	0.1441	0.0446	0.1214	-131.76	-108.12	-23.64	N	80.20
10.500	10.500	0.1994	0.2020	-0.0025	0.1215	-169.07	-139.57	-29.49	N	73.77
12.000	12.000	0.2107	0.2779	-0.0672	0.1215	163.47	-171.06	-25.47	N	68.65
13.500	13.500	0.2398	0.3423	-0.1025	0.1217	138.67	147.41	-8.74	N	58.77
15.000	15.000	0.2981	0.3504	-0.0523	0.1213	116.06	109.97	6.09	N	46.65
16.500	16.500	0.3383	0.3561	0.0178	0.1213	94.42	69.98	24.44	N	41.41
18.000	18.000	0.3520	0.2459	0.1061	0.1213	70.36	44.07	26.08	N	40.17
19.500	19.500	0.3494	0.1550	0.1943	0.1213	51.79	42.00	2.60	N	40.79
20.000	20.000	0.3354	0.0775	0.2579	0.1213	49.02	45.60	3.42	N	42.53
21.000	21.000	0.3832	0.1839	0.1253	0.0783	36.25	58.79	-22.54	N	180.00
22.500	22.500	0.3244	0.2906	0.0258	0.0787	26.45	35.22	-8.77	N	180.00
24.000	24.000	0.3524	0.03913	-0.0390	0.0792	6.22	-2.29	8.51	N	84.45
25.500	25.500	0.3858	0.0336	0.0222	0.0799	-23.62	-35.31	11.69	N	72.72
26.500	26.500	0.3829	0.4705	-0.0876	0.0807	-52.04	-07.63	35.58	N	73.81

NOTE: Total Uncert = Factory System Uncertainty + User System Uncertainty.

Legend: N -- Parameter Verification Not Required.
F -- Parameter Verification Failed.

5 FAILED: S22 Verification Measurement of the 20 dB Attenuator.

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.

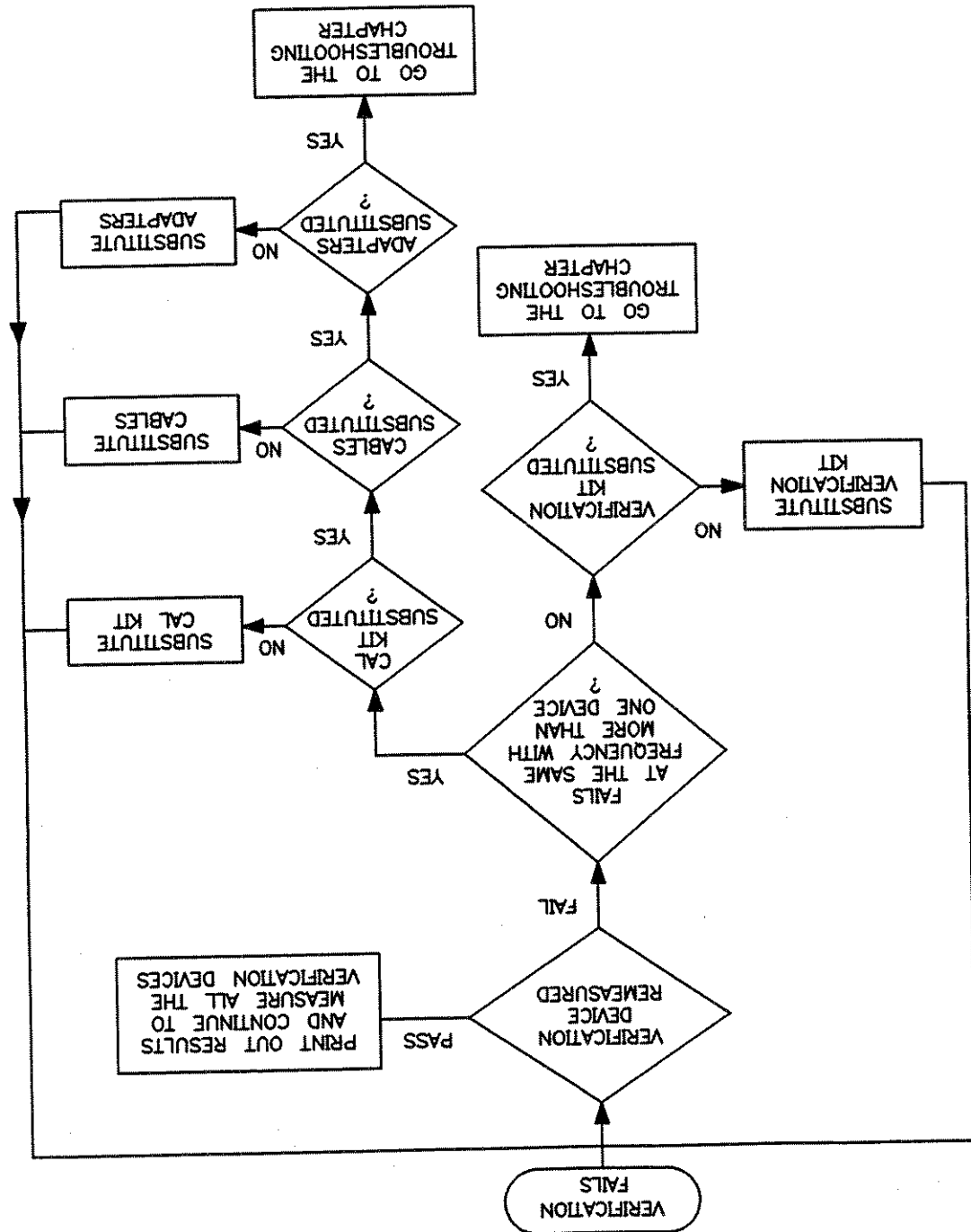
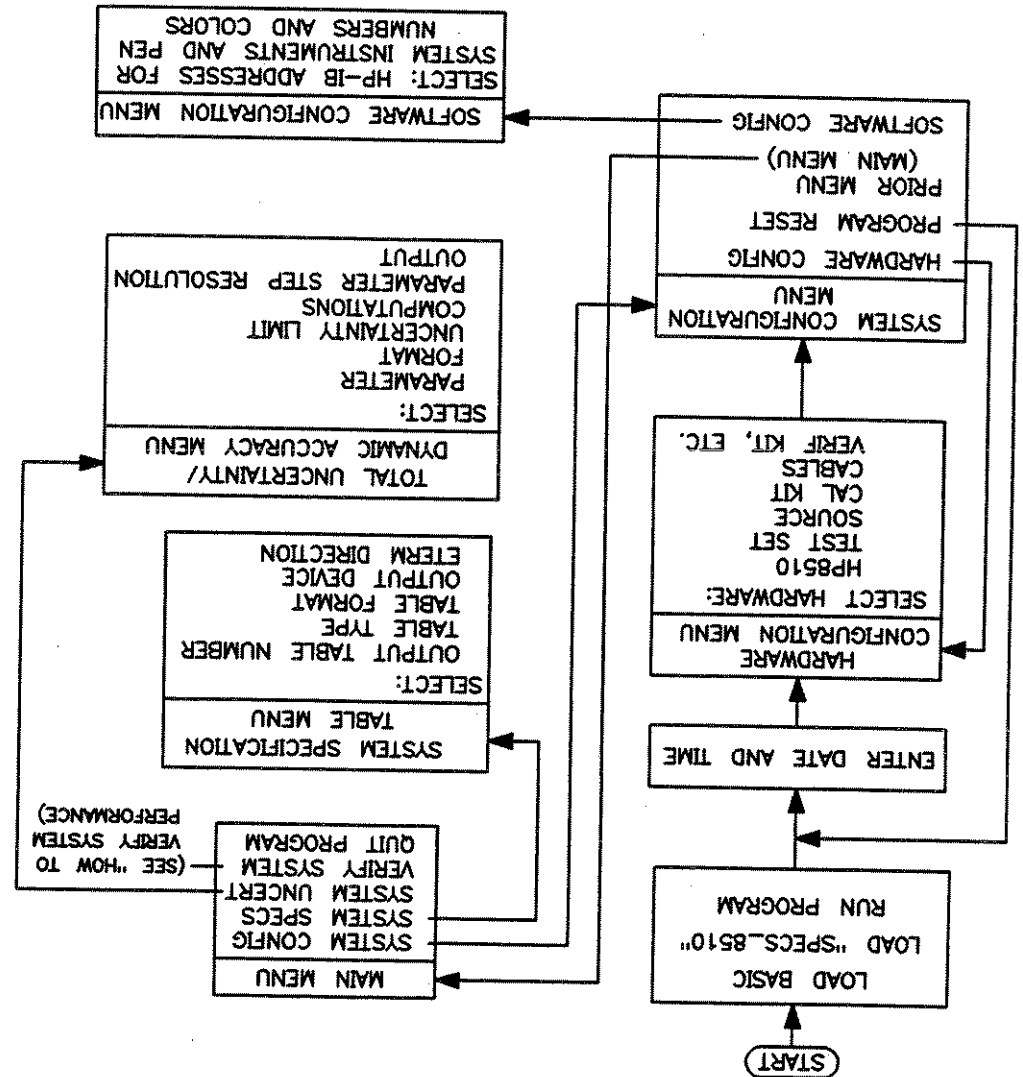


Figure 8-16. Menu Map of System Specifications and Uncertainties Program



The figure below shows a menu map of the system specifications and uncertainties program. Step-by-step instructions follow.

HOW TO RUN THE SYSTEM SPECIFICATIONS AND UNCERTAINTIES PROGRAM

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.

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).
5. Press **[Prior Menu]** to return to the main menu.
4. Make the selections you want and press the **[Print]** softkey to print them out.
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.
3. Press the **[Next]** or **[Previous]** softkeys to change the selection in the window.
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.
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.
2. To specify which type of system specifications you want to generate, press:
 1. Perform the "How to Load the Software" procedure located earlier in this chapter.

[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

- 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.

Example 8-5. Residual Errors

- 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, 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.

1	System Specifications -- Residual Errors (Correction ON)	
2	Network Analyzer: HP8510B -- Enhanced Model	
	Test Set: HP8510A003 -- 2.4mm S-Powermeter (45MHz-40GHz)	
	Source: HP85865A -- 93dB & 95dB Synth. (10MHz-40GHz)	
	Calibration Kit: HP85865A -- 2.4mm Slotted Standard Grade	
	Calibration Technique: SL -- Sliding Load Cal	
	Test Port Cables: HP85133D -- pair short cables (2.4mm-1mm)	
3	Description of Error Term	Symbol
	Power of Source (dBm) P _S	-3.15
	Power Slope of Source/Freq-ghz (dB) P _{SF}	.35
	Mismatching factor (x) M _S	1024
	Loss of Attenuator 1 (dB) L _{A1}	0.00
	Loss of Attenuator 2 (dB) L _{A2}	0.00
	Cable Flex Factor (Lin) C _F	1.0000
	Drift in Room Temperature (deg C) D _T	1.0000
4	Effective Fwd Directivity (dB) E _{FD}	-41.90
	Effective Fwd Refl tracking (+/-dB) E _{FR}	.0014
	Effective Fwd Source match (dB) E _{FS}	-37.90
	Effective Fwd Crosstalk (dB) E _{FC}	-111.95
	Effective Fwd Trans tracking (+/-dB) E _{FT}	.0453
	Effective Fwd Load match (dB) E _{FL}	-41.90
	Effective Fwd Noise on trace (+/-dB) E _{FNt}	.0009
	Effective Fwd Noise floor (dB) E _{FNf}	-99.31
	Effective Power Ref (out) port1 (dBm) E _{PR1}	-11.32
	Effective Power max (in) port2 (dBm) E _{PM2}	-5.88
	Effective Power min (in) port2 (dBm) E _{PM2}	-110.59
	Effective Dyn Rng (Ref-Min) p12 (dB) E _{DR-X2}	99.28
	Effective Dyn Rng (Ref-Min) p12 (dB) E _{DR-X2}	104.72
5	Effective Dyn Rng (Max-Min) p12 (dB) E _{DR-X2}	104.72
6	Effective Dyn Rng (Max-Min) p12 (dB) E _{DR-X2}	104.72
7	Effective Dyn Rng (Max-Min) p12 (dB) E _{DR-X2}	104.72

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.

INTERPRETING THE SPECIFICATION AND UNCERTAINTIES PRINTOUTS

Example 8-6. Raw Test Port Errors

NOTE: Refer to the system error model later in this chapter for the association of the error terms with the system error flow graph.

- 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.

System Specifications -- Test Port Errors (Correction Off)									
Test Set:		Network Analyzer:		Sources:		Calibration Kit:		Test Port Cables:	
HP85160A03 -- 2.4mm S-parameter (45MHz-40GHz)		HP836X016 -- 836X A 8516 Synth. (10MHz-40GHz)		HP85055A -- 2.4mm Slotted Standard Grade		SL -- Sliding Load		HP85133D -- pair short cables (2.4mm-2.4mm)	
Description Of Error Term									
Symbol		Frequency (GHz)		Error Term		Description Of Error Term			
Dn1		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn2		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn3		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn4		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn5		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn6		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn7		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn8		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn9		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn10		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn11		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn12		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn13		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn14		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn15		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn16		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn17		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn18		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn19		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn20		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn21		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn22		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn23		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn24		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn25		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn26		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn27		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn28		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn29		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn30		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn31		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn32		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn33		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn34		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn35		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn36		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn37		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn38		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn39		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn40		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn41		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn42		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn43		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn44		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn45		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn46		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn47		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn48		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn49		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn50		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn51		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn52		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn53		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn54		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn55		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn56		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn57		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn58		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn59		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn60		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn61		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn62		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn63		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn64		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn65		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn66		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn67		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn68		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn69		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn70		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn71		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn72		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn73		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn74		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn75		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn76		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn77		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn78		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn79		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn80		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn81		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn82		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn83		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn84		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn85		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn86		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn87		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn88		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn89		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn90		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn91		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn92		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn93		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn94		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn95		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn96		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn97		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn98		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn99		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn100		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn101		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn102		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn103		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn104		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn105		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn106		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn107		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn108		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn109		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn110		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn111		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn112		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn113		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn114		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn115		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn116		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn117		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn118		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn119		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn120		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn121		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn122		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn123		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn124		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn125		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn126		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn127		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn128		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn129		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn130		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn131		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn132		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn133		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn134		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn135		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn136		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn137		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn138		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn139		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn140		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn141		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn142		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn143		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn144		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn145		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn146		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn147		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn148		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn149		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn150		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn151		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn152		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn153		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn154		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn155		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn156		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn157		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn158		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn159		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn160		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn161		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn162		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn163		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn164		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn165		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn166		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn167		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn168		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn169		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn170		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn171		0.0000		0.0000		0.0000		Drift Source Frequency	
Dn172		0.0000		0.0000		0.0000			

Example 8-7. Raw B1 Channel Errors

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.

System Specifications -- B1 Channel Errors (Correction OFF)							
Network Analyzer:				Frequency (GHz)			
HP8510B -- Enhanced Model				F2=20-36			
Test Set:				F2=20-36			
HP8510A003 -- 2.4mm S-Parameter (45MHz-40GHz)				F2=20-36			
Source:				F2=20-36			
HP8360A -- 836X & 8516 Synth. (10MHz-40GHz)				F2=20-36			
Calibration Kit:				F2=20-36			
HP85056A -- 2.4mm Slotless Standard Grade				F2=20-36			
Calibration Technique:				F2=20-36			
SL -- Sliding Load Cal				F2=20-36			
Test Port Cables:				F2=20-36			
HP85133D -- pair short cables (2.4mm-2.4mm)				F2=20-36			
Description Of Error Term				Term			
Low Freq Cutoff port to B1				(GHz)	Fc1B1	(dB)	Fc1B1
Low Freq Slope port to B1				(dB)	Fs1B1	(dB)	Fs1B1
Port Mag/deg-c port to B1				(+/deg)	Dm1B1	(dB)	Dm1B1
Port Ph/deg-c port to B1				(+/deg)	Dp1B1	(deg)	Dp1B1
Loss/deg-ghz port to conv B1				(dB)	Ld1B1	(dB)	Ld1B1
Loss/Freq-ghz conv to I.f. B1				(dB)	Lf1B1	(dB)	Lf1B1
Damage Level B1				(dBm)	DL1B1	(dBm)	DL1B1
Port at Conv for 0.1 db Comp B1				(dBm)	PC1B1	(dBm)	PC1B1
Raw rms Noise on Trace B1				(+/dB)	Rn1B1	(dBm)	Rn1B1
Raw rms Noise Floor B1 I.f.				(dBm)	Rn1B1	(dBm)	Rn1B1
Raw rms Noise Floor B1 Conv				(dBm)	Rn1B1	(dBm)	Rn1B1
Residuals of B1 I.f.				(dBm)	Rn1B1	(dBm)	Rn1B1
Linearity of Xtal B1				(+/dB)	L1B1	(dB)	L1B1
I.f. Gain Err1 -34--45 dbm B1				(+/dB)	Ge1B1	(dB)	Ge1B1
I.f. Gain Err2 -46--58 dbm B1				(+/dB)	Ge2B1	(dB)	Ge2B1
I.f. Gain Err3 -59--70 dbm B1				(+/dB)	Ge3B1	(dB)	Ge3B1
I.f. Gain Err4 -70--80 dbm B1				(+/dB)	Ge4B1	(dB)	Ge4B1
Mag error vs Phase shift B1				(+/dB)	MP1B1	(dB)	MP1B1

Example 8-8. Raw B2 Channel Errors

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-converted). 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.

System Specifications -- B2 Channel Errors (Correction Off)											
Test Set:				Source:				Calibration Kit:			
HP8510B -- Enhanced Model				HP8516M003 -- 2.4mm S-Parameter (45MHz-40GHz)				HP836X016 -- 036X 3.5dB Synth. (10MHz-40GHz)			
HP85056A -- 2.4mm S-parameter Standard Grade				SL -- Sliding Load Cal				HP85133D -- pair short cables (2.4mm-2.4mm)			
Calibration Technique:				5L -- Sliding Load Cal				Test Port Cables:			
35-40				20-35				2-20			
Frequency (GHz)				Symbol: .045-2				Term:			
Description of Error Term				Unit				Value			
Low Freq Cutoff port2 to B2				(Hz)				f2b2: 0.000			
Low Freq Slope port2 to B2				(dB)				f2b2: 0.000			
Drift Ph/deg-c port2 to B2				(deg)				p2b2: 0.0000			
Drift Ph/deg-c port2 to B2				(deg)				p2b2: 0.0000			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			
Loss/deg-c port2 to conv B2				(dB)				l2b2: -3.65			

Example 8-9. Raw A1 Channel Errors

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.

System Specifications -- A1 Channel Errors (Correction Off)											
Network Analyzer:											
HP8510B -- Enhanced Model											
HP8516A03 -- 2.4m S-parameter (45MHz-40GHz)											
HP85X016 -- 8516 Synth, (10MHz-40GHz)											
HP8556A -- 2.4m Slotless Standard Grade											
SL -- Silding Load Cal											
HP8513D0 -- pair short cables (2.4m/2.4m)											
Test Port Cables:											
Description Of Error Term											
[Symbol] : [Unit]											
Low Freq Slope Source to A1											
[dB] : [dB]											
[dB] : [dB]											
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[dB] : [dB]											
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Example 8-10. Raw A2 Channel Errors

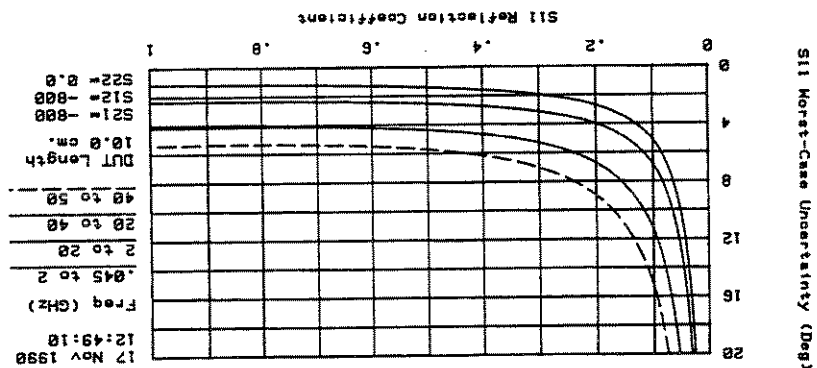
- NOTE:** Refer to the system error model later in this chapter for the association of the error terms with the system error flow graph.
- 1 Table type: specifications of raw errors associated with the A2 channel signal path.
 - 2 The system instruments, calibration kit, and calibration technique (selected 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.

System Specifications -- A2 Channel Errors (Correction OFF)			
Network Analyzer:		HP8510B -- Enhanced Model	
Test Set:		HP8510A03 -- 2.4mm S-parameter (45MHz-40GHz)	
Source:		HP85501A -- 85X & 85L Synth. (10MHz-40GHz)	
Calibration Kit:		HP85556A -- 2.4mm S1016S Standard Grade	
Calibration Technique:		SL -- Sliding Load Cal	
Test Port Cables:		HP85133D -- gold shot cables (2.4mm-2.6mm)	
Description of Error Term		Symbol:	Frequency (GHz)
Low Frequency Source to A2		(SMT) FSCA2	0.000 0.000 0.000
Low Frequency Source to A2		(DF) FSCA2	0.00 0.00 0.00
Input Magnitude Source to A2		(A2) DSCA2	.0475 .0475 .0475
Input Phase Source to A2		(A2) DSCA2	0.0000 0.0000 0.0000
Input Magnitude Source to A2		(A2) DSCA2	.0475 .0475 .0475
Input Phase Source to A2		(A2) DSCA2	0.0000 0.0000 0.0000
Loss/Reflection Source to A2		(A2) LSCA2	-26.47 -26.66 -26.21
Loss/Reflection Source to A2		(A2) LSCA2	-8.77 -8.84 -8.77
Loss/Reflection Source to A2		(A2) LSCA2	-12.00 -11.50 -12.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
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Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
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Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
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Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
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Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00
Loss/Reflection Source to A2		(A2) LSCA2	0.00 0.00 0.00

Example 8-11. S11 Uncertainty Specifications Plots

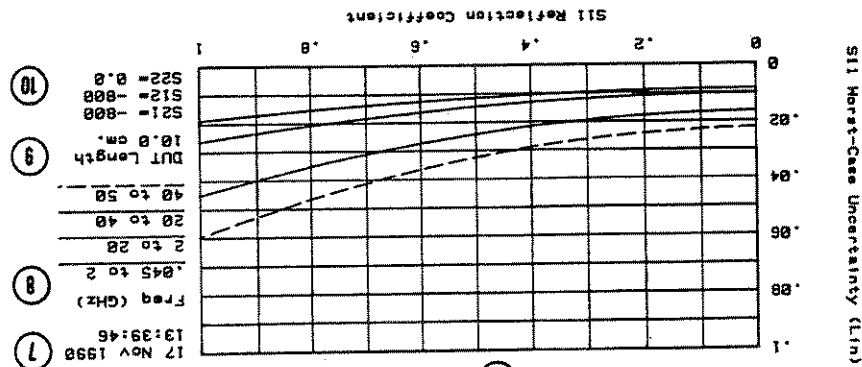
- 1 Measurement parameter: S11.
 2 Data format: magnitude (unitless) or transmission coefficient magnitude or phase (phase shift of data versus frequency).
 3 Uncertainty limits: upper or lower (the limits only apply to transmission measurements).
 4 Type of plot: worst-case uncertainties (this is a "field" "bottoms-up" uncertainty analysis, 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.

NOTES:



S11 PHASE UPPER WORST-CASE UNCERTAINTY SPECIFICATIONS

HP8510C / HP8517A / HP83651A / HP85056A / SL / HP85133F



S11 MAGNITUDE UPPER WORST-CASE UNCERTAINTY SPECIFICATIONS

HP8510C / HP8517A / HP83651A / HP85056A / SL / HP85133F

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

Example 8-12. S11 Uncertainty Specifications Table

- 1 Measurement parameter: \$S_{11}\$.
- 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 of 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 (\$S_{11}\$ or \$S_{22}\$), the values of the other three \$S\$-parameters will be = 0 (linear). For transmission plots (\$S_{21}\$ or \$S_{12}\$), \$S_{11}\$ and \$S_{22} = 0\$ (linear), and \$S_{21} = S_{12}\$.
- 7 DUT length is assumed to be 10 cm airline (the DUT length for the data sheet values is 0 cm).
- 8 System instrument: 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).

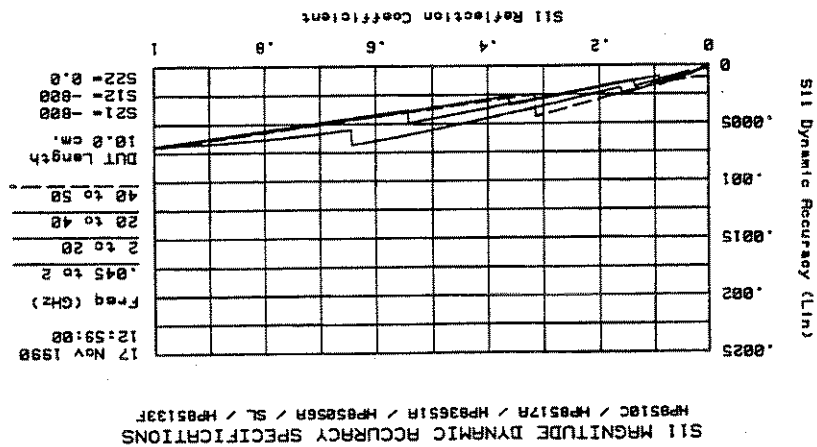
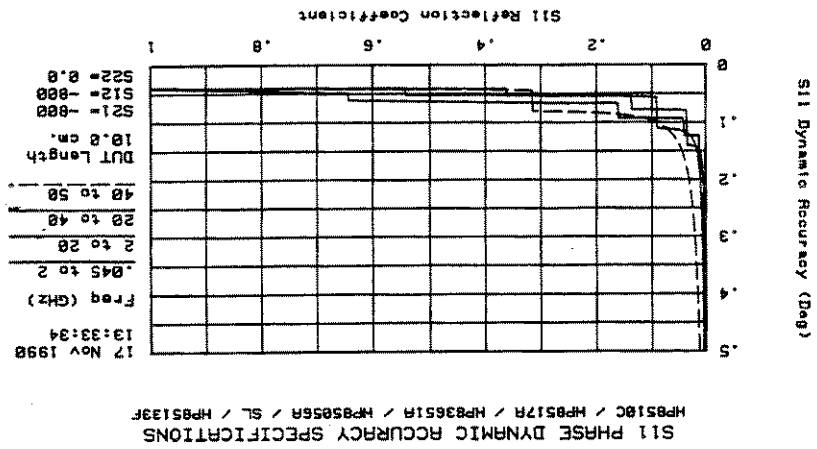
NOTES

S11 UPPER WORST-CASE UNCERTAINTY SPECIFICATIONS									
17 NOV 1950 13:13:58									
521 = 800, 512 = 800, 522 = 0 Device Length 10.0 cm.									
Wavelength: 10.0 cm									
Test Set:									
HP8517H = 2.4m S-Powermeter (45MHz-506Hz)									
Source:									
HP8555H = Synthesizer (45MHz-50.06Hz)									
HP8505B = -- 2.4m S10less Standard Grade									
S1 = -- Standing Load Cell									
HP8513P = pair short cables (2.4m-2.4m)									
Ref 1:									
-045-2									
2-20									
20-40									
40-50									
(Mag Lin) (Deg)									
0.000	0.00554	180.000	0.01070	180.000	0.01072	12.610	0.01531	20.899	0.02214
0.050	0.08558	10.025	0.10170	12.610	0.10172	12.610	0.15531	20.899	0.22444
0.100	0.08709	5.113	0.09354	6.812	0.09354	6.812	0.16851	11.292	0.27848
0.150	0.08684	3.498	0.09015	4.925	0.09015	4.925	0.17387	8.215	0.32445
0.200	0.09094	2.708	0.09347	4.003	0.09347	4.003	0.17935	6.722	0.42141
0.250	0.09527	2.245	0.10151	3.126	0.10151	3.126	0.18477	5.508	0.52516
0.300	0.09980	1.946	0.10851	2.294	0.10851	2.294	0.19477	4.508	0.62670
0.350	0.10458	1.740	0.11657	1.694	0.11657	1.694	0.20487	3.437	0.72754
0.400	0.10968	1.592	0.12657	1.270	0.12657	1.270	0.21582	2.476	0.82996
0.450	0.11507	1.483	0.13771	0.912	0.13771	0.912	0.22735	1.491	0.93861
0.500	0.12072	1.400	0.14958	0.555	0.14958	0.555	0.23915	0.450	1.05211
0.550	0.12664	1.332	0.16188	0.202	0.16188	0.202	0.25168	0.154	1.17374
0.600	0.13284	1.284	0.17458	0.000	0.17458	0.000	0.26488	0.000	1.30055
0.650	0.13937	1.247	0.18769	0.000	0.18769	0.000	0.27859	0.000	1.43417
0.700	0.14619	1.219	0.19939	0.000	0.19939	0.000	0.29289	0.000	1.57382
0.750	0.15329	1.198	0.21059	0.000	0.21059	0.000	0.30768	0.000	1.71912
0.800	0.16064	1.183	0.22049	0.000	0.22049	0.000	0.32292	0.000	1.86918
0.850	0.16827	1.173	0.22929	0.000	0.22929	0.000	0.33812	0.000	2.02409
0.900	0.17614	1.167	0.23736	0.000	0.23736	0.000	0.35326	0.000	2.18414
0.950	0.18424	1.164	0.24478	0.000	0.24478	0.000	0.36839	0.000	2.34949
1.000	0.19257	1.164	0.25238	0.000	0.25238	0.000	0.38340	0.000	2.52110

HP 8510C

Performance Verification and Specifications 8-65

Example 8-13. S11 Dynamic Accuracy Specifications Plots



Example 8-14. S11 Dynamic Accuracy Specifications Table

- 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 instrument: selected in the hardware configuration menu.
 - 8 Reflection coefficient (linear magnitude).
 - 9 Magnitude uncertainty data for each frequency band (linear magnitude).
 - 10 Phase data for each frequency band (degrees).

S11 DYNAMIC ACCURACY SPECIFICATIONS									
17 Nov 1990 13:10:06									
S21 = -800, S12 = -800, S22 = 0, Device Length = 10.0 cm.									
Network Analyzer: HP8510C -- Color Model									
Test Set: HP85178 -- 2.4mm S-Parameter (45MHz-50GHz)									
Source: HP8351A -- Synthesizer (45MHz-50.06GHz)									
Calibration Kit: HP85056A -- 2.4mm Slotless Standard Grade									
Test Port Cables: HP85133F -- pair short cables (2.4mm-2.4mm)									
40-50									
(Mag Lin) (Deg) (Mag Lin) (Deg) (Mag Lin) (Deg) (Mag Lin) (Deg)									
0.00									

521 MAGNITUDE UPPER WORST-CASE UNCERTAINTY SPECIFICATIONS
HP8510C / HP8517A / HP83651A / HP85056R / 5L / HP85133F

Example 8-16. S21 Uncertainty Specifications Table

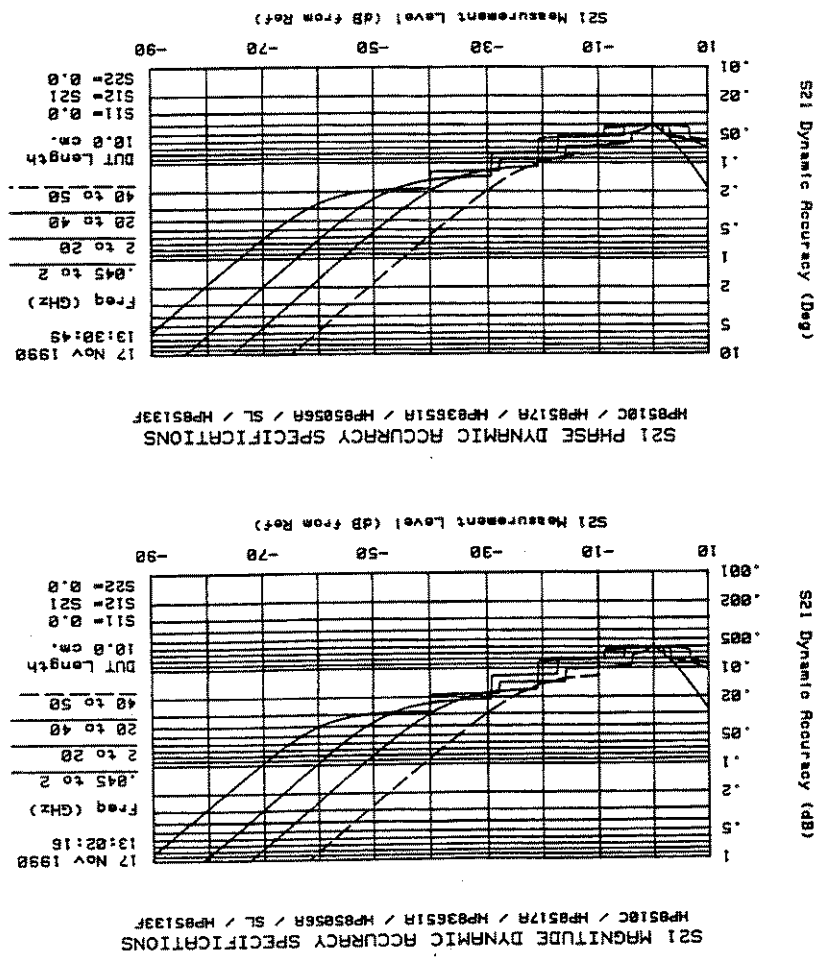
- NOTES:
- 1 Measurement parameter: S21.
 - 2 Uncertainty limits: upper or lower (the limits only apply to transmission measurements).
 - 3 Type of plot: worst-case uncertainty analysis (This is a "field" "bottom-up" uncertainty analysis of the HP 8510 being verified, using the worst case specifications 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).

1	17 Nov 1990 13:16:55	S11= 0.0, S12= 0.0, S21= 0.0, S22= 0.0 Device length= 10.0 cm.	Network Analyzer	Test Set:	HP8517A -- 2.4mm S-Parameter (45MHz-50GHz)	HP8551A -- Synthesizer (45MHz-50.0GHz)	HP8556A -- 2.4mm S-Parameter Standard Grade	SL -- Sliding Load Cal	HP8133F -- pair short cables (2.4mm-2.4mm)	Level 1	0.45-2	2-20	20-40	40-50	4	5	6	7	8
2																			
3																			
4																			

HP 8510C

Performance Verification and Specifications 8-69

Example 8-17. S21 Dynamic Accuracy Specifications Plots



Example 8-18. S21 Dynamic Accuracy Specifications Table

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).

[illegible]

~~\$21 DYNAMIC ACCURACY SPECIFICATIONS~~

~~S1 = Ø.0, S1Z = 521, S2Z = Ø.0 Device Length 10.0 cm.~~

~~17 Nov 1950 13:08:57~~

~~MIL-STD-883C -- Color Model~~
~~#P8510C -- Z.4mm S-parameter (.45MHz-50GHz)~~
~~#P8517A -- Synthesizer (.45MHz-50.6GHz)~~
~~#P85B51A -- .2.4mm S-parameter Standard Grade~~
~~#P8505BA -- Sliding Load Cal~~
~~#P8513F -- pair short cables (2.4mm x 2.4mm)~~
~~Test Port Cables~~
~~Calibration Technique~~
~~Calibration Kit:~~
~~Source:~~
~~Test Set:~~

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 crossstalk, effective load match, and effective transmission tracking.

Sources of Systematic Errors

SOURCES OF MEASUREMENT ERRORS

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 measurement. 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 thus 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 Random Errors

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.

- Etd, Erd = effective directivity
- Ets, Ers = effective source match
- Etr, Err = effective reflection tracking
- Etc, Erc = effective crossstalk
- Etl, Erl = effective load match
- Etf, Ert = effective transmission tracking
- Crm, Ctm = cable stability (deg./GHz)
- Ab1, Ab2 = dynamic accuracy
- F = frequency

The listing below shows the abbreviations used for systematic errors that are in the error models and uncertainty equations.

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.

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.

MEASUREMENT UNCERTAINTY EQUATIONS

These types of errors are not accounted for in the uncertainty analysis.

seating.

The contact surfaces category includes cleaning procedures, scratches, worn plating, and rough

ductors, and handling procedures for beadless airlines.

The connection techniques category includes torque limits, flush setting of sliding load center con-

Two additional categories of measurement errors are connection techniques and contact surfaces.

Sources of Additional Measurement Errors

- Dmxbx, Dmsax = drift magnitude
- Dpxbx, Dpsax = drift phase
- Dptbxx, Dptfax = drift phase/f

The list below shows the drift errors in the error models and uncertainty equations.

verter.

connecting cables within the test set and the conversion stability of the microwave frequency con-

The primary causes for instrumentation drift are the thermal expansion characteristics of the inter-

tion drift affects the magnitude and phase of both reflection and transmission measurements.

Drift has two categories: frequency drift of the signal source and instrumentation drift. Instrumenta-

Sources of Drift Errors

- Rnt = raw noise on trace (rms)
- Rnf = raw noise on floor (rms)
- Crt1 = port 1 connector reflection repeatability error
- Crt1 = port 1 connector transmission repeatability error
- Crt2 = port 2 connector reflection repeatability error
- Crt2 = port 2 connector transmission repeatability error

ty equations.

The listing below shows the abbreviations used for random errors in the error models and uncertain-

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 =

$$Erm = \sqrt{\text{Systematic}^2 + (\text{Drift})^2}$$

$$\text{Systematic} = Etd + Etr S11 + Ets S11^2 + S21 S12 Etl + Ab1 S11$$

$$\text{Random} = \sqrt{(Cr)^2 + (Rr)^2 + (Nr)^2}$$

$$Cr = \sqrt{(Crm1)^2 + (2Ctm1S11)^2 + (Crm1S11)^2 + (Crm2S21S12)^2}$$

$$Rr = \sqrt{(Crt1 + 2Crt1S11 + Crt1S11^2) + (Crt2S21S12)^2}$$

$$Nr = \sqrt{(Etm1S11)^2 + Etm2^2}$$

$$\text{Drift \& Stability} = Dm1b1 S11$$

where

- Emt = effective noise on trace
- Emt = effective noise floor
- Crt1 = connector repeatability (transmission)
- Crt1 = 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
- Ets = effective source match error
- Etr = effective reflection tracking error
- Etl = effective load match error
- Etd = effective directivity error
- Crt2 = Connector repeatability (reflection)

C_{pt1} = cable phase/frequency port 1
 D_{ps1} = drift phase/degree source to port 1
 D_{pts1} = drift phase/degree/frequency source to port 1

where

$$Erp = \text{Arcsin} (Er_{m/S11}) + 2C_{pt1f} + D_{ps1} + D_{pts1f}$$

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.

Reflection Phase Uncertainty (Erp)

- 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 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.

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:

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:

Etc = effective crosstalk error
 Etl = effective load match error
 Etr = effective transmission tracking error
 Ets = effective source match error
 Dms1 = drift magnitude ° C source to port
 Crm2 = cable 2 reflection magnitude stability
 Ctm2 = cable 2 transmission magnitude stability
 Crm1 = cable 1 reflection magnitude stability
 Ctm1 = cable 1 transmission magnitude stability
 Crt1 = connector repeatability (transmission)
 Crr1 = connector repeatability (reflection)
 Emt = effective noise on trace
 Emt = effective noise floor
 Crr2 = Connector repeatability (reflection) port 2
 Crt2 = Connector repeatability (transmission) port 2

where

Drift & Stability = Dm2b2S21

$$Nt = \sqrt{(EtmS21)^2 + Emt^2}$$

$$Rt = S21 \sqrt{(Crt1)^2 + (Crt2)^2 + (Crr1S11)^2 + (Crr2S22)^2}$$

$$Ct = S21 \sqrt{(Ctm1)^2 + (Ctm2)^2 + (Crm1S11)^2 + (Crm2S22)^2}$$

$$\text{Random} = \sqrt{(Ct)^2 + (Rt)^2 + (Nt)^2}$$

$$\text{Systematic} = (Etl + EtsS11 + EtrS22 + EtsEtrS21S12 + Ab2) S21$$

$$Etr + \text{Systematic} + \sqrt{(\text{Random})^2 + (\text{Drift \& Stability})^2}$$

$$\text{Transmission magnitude uncertainty (forward direction)} = Etm =$$

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 (Etm)

TRANSMISSION UNCERTAINTY EQUATIONS

$Cpt1$ = Cable phase/frequency port 1
 $Cpt2$ = Cable phase/frequency port 2
 $Dps1$ = drift phase/degree source to port 1
 $Dpts1$ = drift phase/degree/frequency source to port 1

where

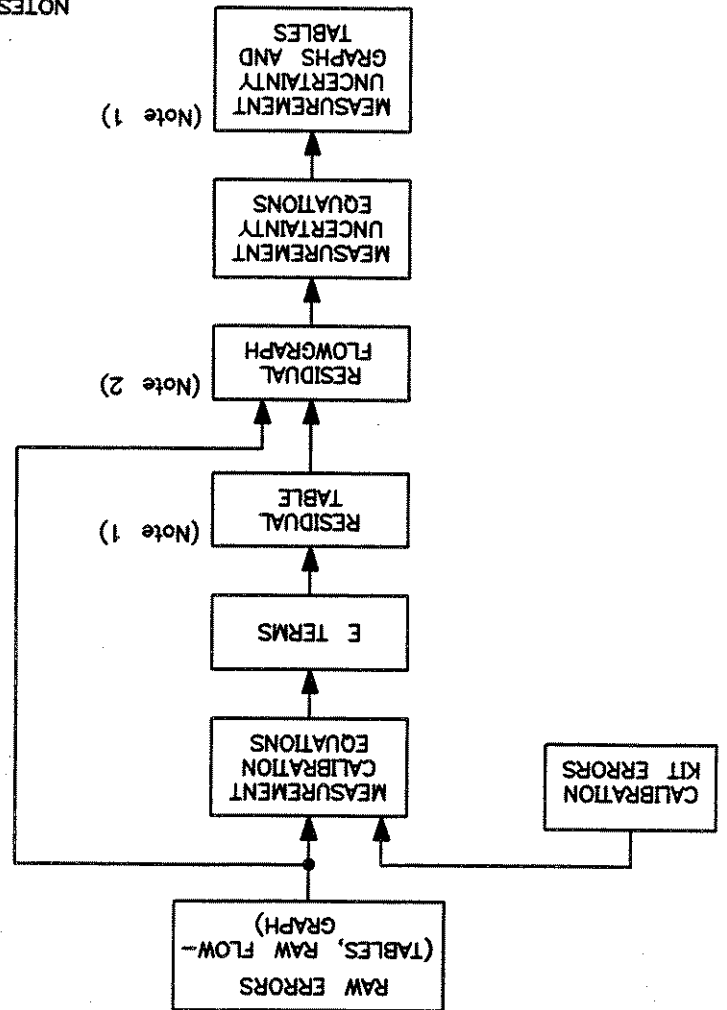
$$Etp = \text{Arsin} (Et/S21) + Cpt1f + Cpt2f + Dps1 + Dpts1f$$

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.

Transmission Phase Uncertainty (Etp)

- 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 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.

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

SYSTEM ERROR MODELS

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 flowgraph 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.

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).

Error Term	Term Symbol	Additional Information
Power of Source $\pm$	Ps	Condition
Averaging factor	Avg	Condition
Loss of Attenuator 1 $\pm$	La1	Condition
Loss of Attenuator 2 $\pm$	La2	Condition
Cable Flex Factor *	Cff	Condition
Drift in Room Temperature*	Drt	Condition
Effective Directivity *, $\dagger$	Erd, Erd	Fac. Comp.
Effective Refl Tracking *, $\dagger$	Erf, Erf	Fac. Comp.
Effective Source match *, $\dagger$	Ers, Ers	Fac. Comp.
Effective Crosstalk *	Erc, Erc	Fac. Comp.
Effective Trans Tracking *, $\dagger$	Ert, Ert	Fac. Comp.
Effective Load Match *, $\dagger$	El, El	Fac. Comp.
Effective Noise on Trace *	Ent, Ent	Fac. Comp.
Effective Noise Floor *	Emf, Emf	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 Dry Ring (Ref-min) pt1,2	Edr1, Edr2	Fac. Comp.
Effective Dry Ring (max-min) pt1,2	Edrx1, Edrx2	Fac. Comp.

* Used in the corrected error model flowgraph to determine measurement uncertainty.
 $\dagger$ Related to specifications of calibration kit devices and measurement calibration techniques.
 $\ddagger$ Used in the corrected error model flowgraph to determine dynamic accuracy.

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	Elem 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/sqrt(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 ‡	Ldc1, Ldc2	Cust. Site
Loss/sqrt(f-GHz) port 1,2 Cable ‡	Lfc1, Lfc2	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 *	Cpt1, Cpt2	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 8-11. Test Port Error Term Symbols

Error Term	Etterm Symbol	Additional Information
low Freq Cutoff port1,2 to b1, b2 ‡	Fc1b1, Fc2b2	Fac. Comp.
Source to a1, a2	Fcsa1, Fcsa2	Fac. Comp.
low Freq Slope port1,2 to b1, b2 ‡	Fs1b1, Fs2b2	Fac. Comp.
Source to a1, a2	Fssa1, Fssa2	Fac. Char.
Drift Mag/deg-c port1,2 to b1, b2 *	Dm1b1, Dm2b2	Fac. Char.
Source to a1, a2	Dmsa1, Dmsa2	Fac. Char.
Drift Ph/deg-c port1,2 to b1, b2 *	Dp1b1, Dp2b2	Fac. Char.
Source to a1, a2	Dpsa1, Dpsa2	Fac. Char.
Drift Ph/deg-c/F-GHz pt1,2 to b1, b2 *	Dp1b1, Dp2b2	Fac. Char.
Source to a1, a2	Dpsa1, Dpsa2	Fac. Char.
Loss/DC port1,2 to converter b1, b2 ‡	Ld1b1, Ld1b2	Typical
Source to a1, a2	Ldsa1, Ldsa2	Typical
Loss/sqrt(F-GHz) port1,2 to conv. b1, b2 ‡	Lf1b1, Lf2b2	Typical
Source to a1, a2	Lfsa1, Lfsa2	Typical
Loss/DC converter to I.F. ‡	Ldv1b1, Ldv1b2	Typical
Source to a1, a2	Ldva1, Ldva2	Typical
Loss/(F-GHz) conv. to I.F. ‡	Lv1b1, Lv1b2	Typical
Source to a1, a2	Lva1, Lva2	Fac. Char.
Damage Level ‡	D1a1, D1a2	Fac. Char.
Power at conv. for 0.1 compress. ‡	Pcb1, Pcb2	Fac. Char.
Source to a1, a2	Pcca1, Pcca2	Fac. Char.
Raw rms Noise on Trace	Rnb1, Rnb2	Fac. Char.
Source to a1, a2	Rnta1, Rnta2	Fac. Char.
Raw rms I.F. Noise Floor	Rnb1, Rnb2	Fac. Char.
Source to a1, a2	Rnta1, Rnta2	Fac. Char.
Residuals at I.F. ‡	Reb1, Reb2	Fac. Char.
Source to a1, a2	Rea1, Rea2	Fac. Char.
Linearity of Xtal ‡	Lxb1, Lxb2	Fac. Char.
Source to a1, a2	Lxa1, Lxa2	Fac. Char.
I.F. Gain Err1 -34>-46 dbm ‡	Ge1b1, Ge1b2	Fac. Char.
Source to a1, a2	Ge1a1, Ge1a2	Fac. Char.
I.F. Gain Err2 -46>-58	Ge2b1, Ge2b2	Fac. Char.
Source to a1, a2	Ge2a1, Ge2a2	Fac. Char.
I.F. Gain Err3 -58>-78 dbm	Ge3b1, Ge3b2	Fac. Char.
Source to a1, a2	Ge3a1, Ge3a2	Fac. Char.
I.F. Gain Err4 -70>-∞ dbm	Ge4b1, Ge4b2	Fac. Char.
Source to a1, a2	Ge4a1, Ge4a2	Fac. Char.
Mag Error vs Phase Shift B1, B2, A1, A2	Mpb1, Mpb2	Fac. Char.
Source to a1, a2	Mpa1, Mpa2	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

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.



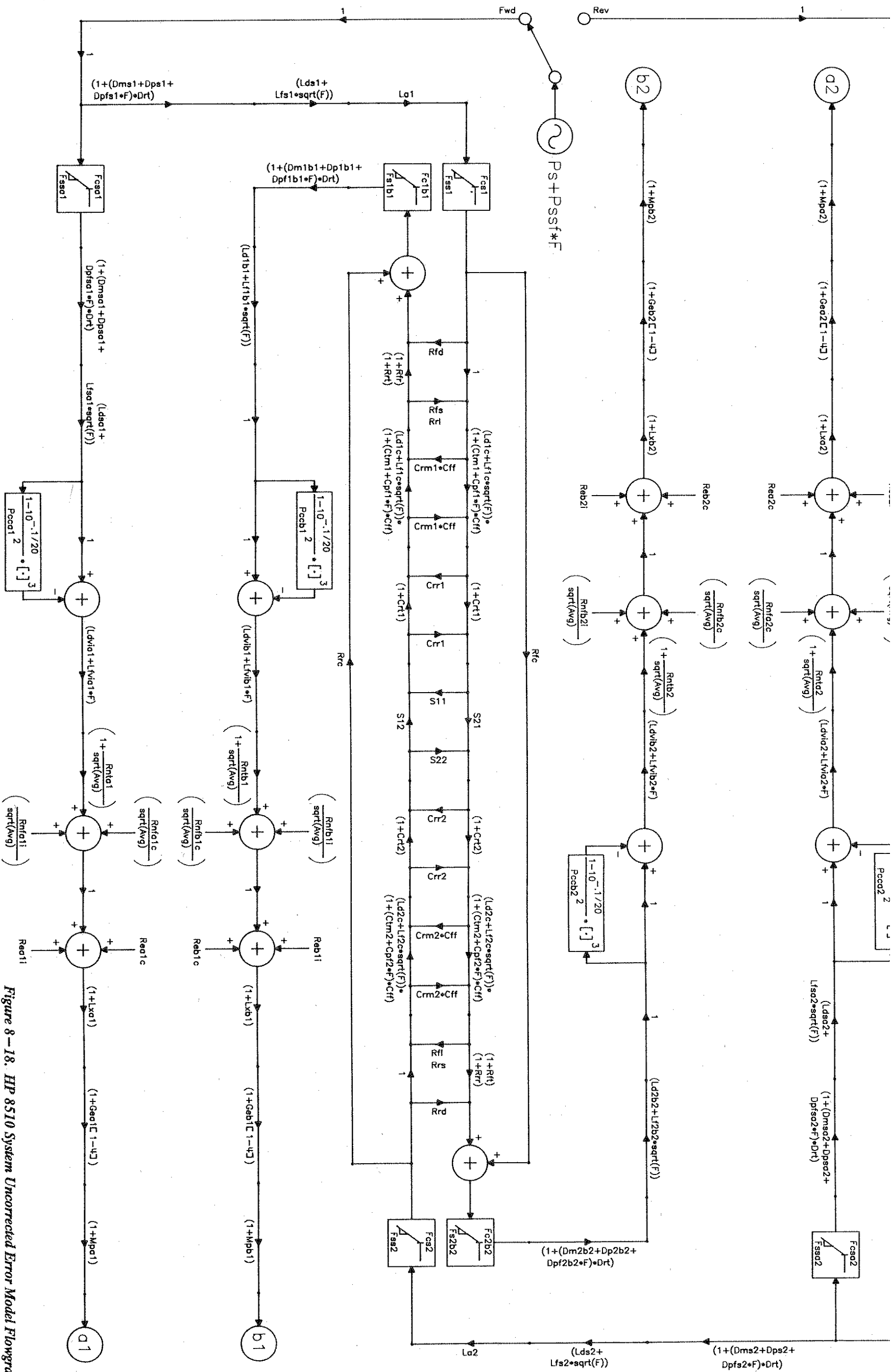


Figure 8-18. HP 8510 System Uncorrected Error Model Flowgraph

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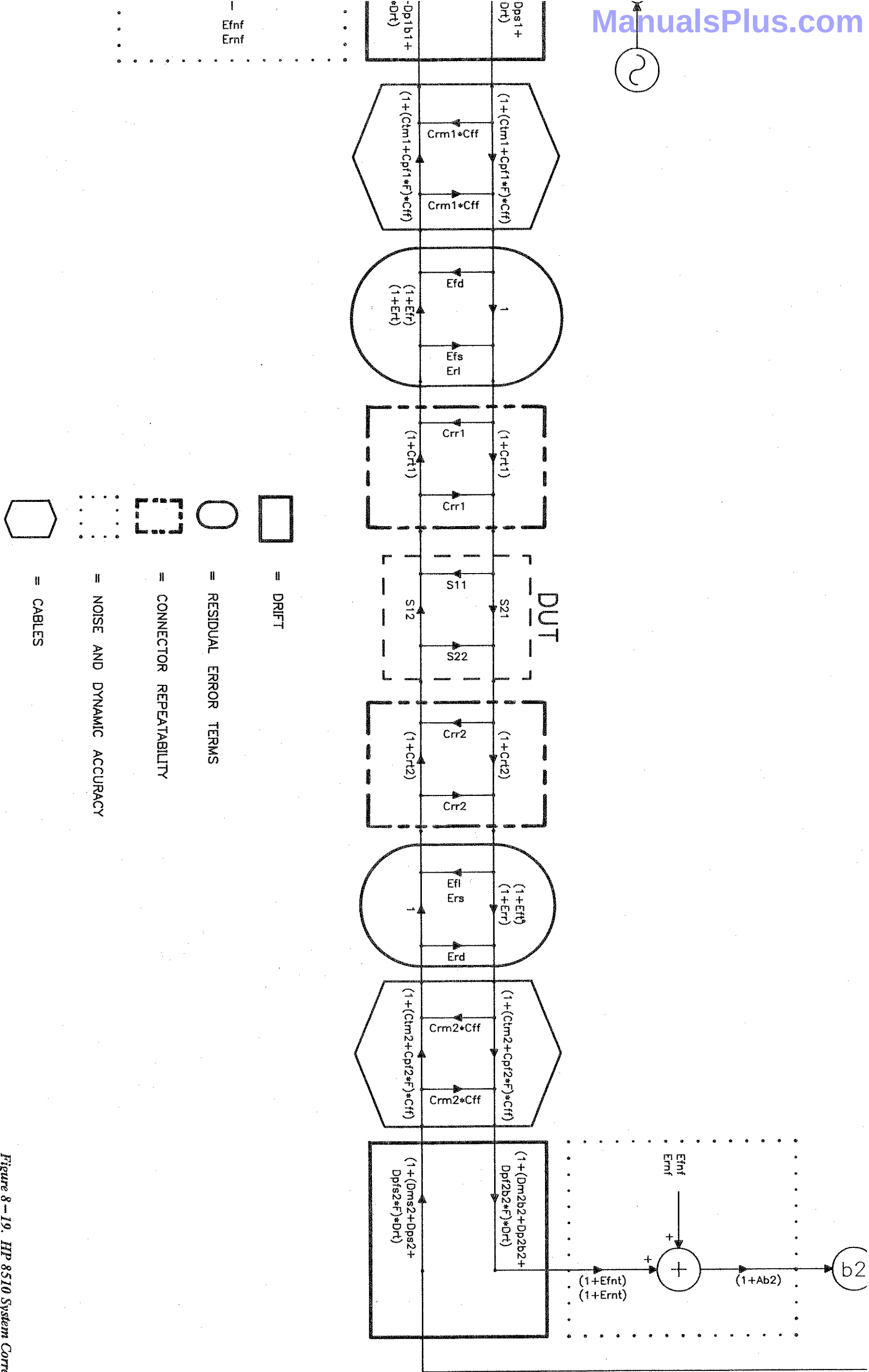
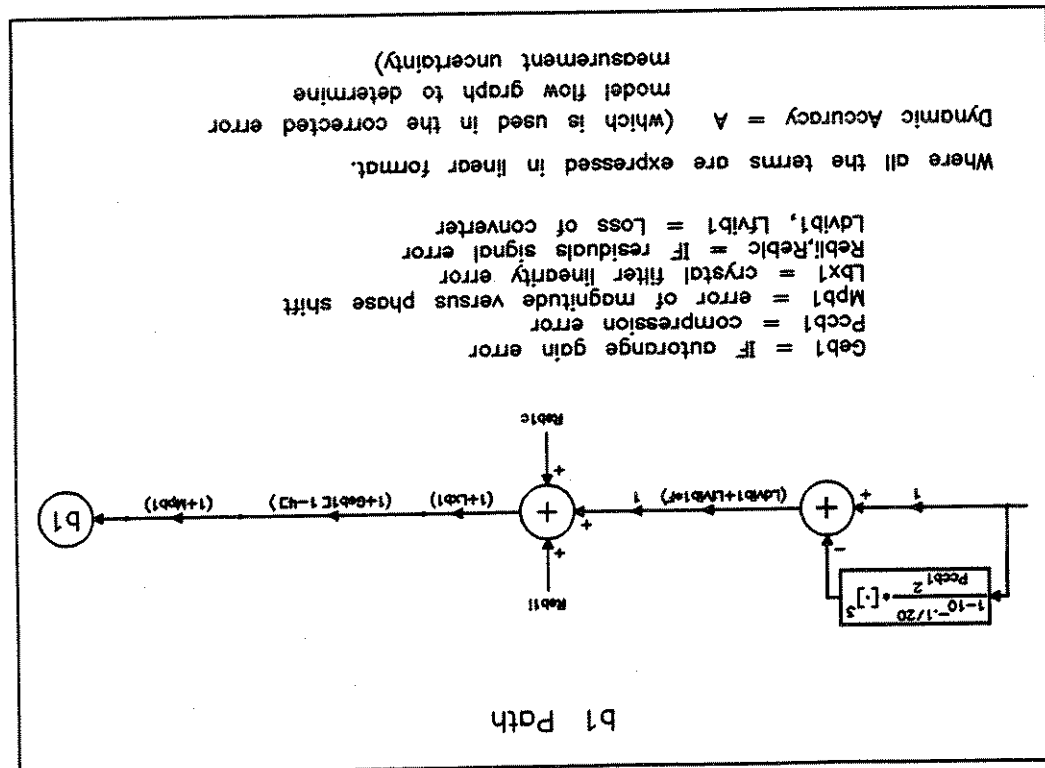


Figure 8-19. HP 8510 System Corrected Error Model Flowgraph
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To establish a measurement traceability path to a national standard for a network analyzer system, the overall system performance is verified through the measurement of device characteristics 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.

MEASUREMENT TRACEABILITY

Figure 8-20. Dynamic Accuracy Error Model Flowgraph



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.

DYNAMIC ACCURACY ERROR MODEL

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.

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.

SUBSTITUTION OF SYSTEM COMPONENTS

Figure 8-21. National Institute of Standards Technology Traceability Path for HP 8510 System Calibration and Verification Standards

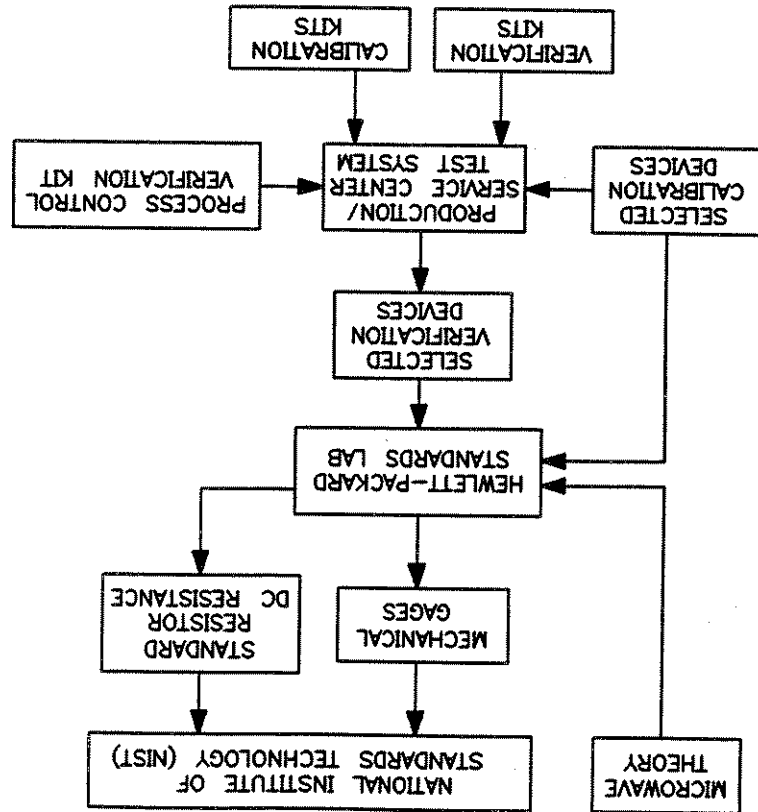


Figure 8-21 shows the traceability path for the calibration and verification standards.

The information listed in this section helps to correctly generate specifications, prepare the program for performance verification, and interpret any results.

REFERENCE INFORMATION FOR PERFORMANCE VERIFICATION AND SPECIFICATIONS

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.

CALIBRATION CYCLE

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 Kit Substitution

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.

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.

Cable Substitution

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.

Adapters (Test Port)

NOTE: If incorrect characters or traces appear on the printout, turn OFF the printer enhancement selection in the software configuration menu.

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.

Aborting Plots and Printouts with the **[ABORT]** Key

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.

-800 dB or 180 Degree Values

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.

45 MHz Calibration and Verification

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.

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.

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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 by pressing **USER** or **SHIFT USER**, depending on your keyboard).

Controller CRT Displays and High-Resolution Monitors

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.

Connections and Connector Maintenance

- 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

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:

Calculated Error Terms

Reference manual.

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.

BASIC 5.0 and HP-UX Systems (setting the time on your system)

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.

ATTENTION Messages...and "SCPP" Settings

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.

- No source
- No test port cables
- No cal kit
- No verification kit

When generating specifications for systems using an HP 8511 frequency converter test set, specify the following in the hardware configuration menu:

HP 8511 Frequency Converter Test Sets

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 8510 mm-Wave Systems

Origin = date the verification kit was certified
 Factory = verification kit disc data
 Field = uncertainty calculated by the program

Explanation of the Wording on Tables

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} .

DUT Length (N cm) and Default S-Parameter Values

The program is capable of responding to many of the BASIC operating system key presses, including **INSERT CHAR**, **DELETE CHAR**, **INSERT LINE**, etc.

Controller Keyboard Keys

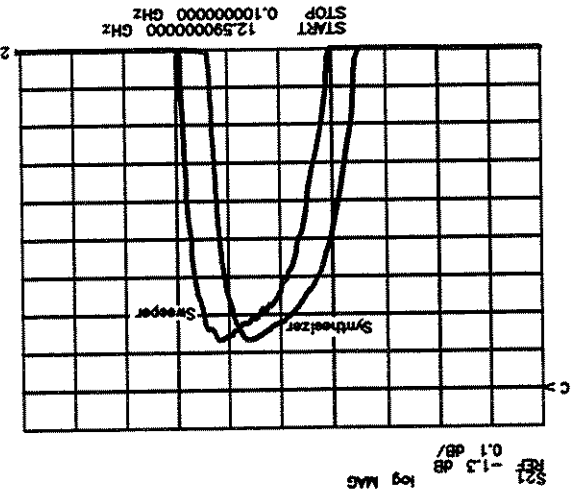
Some controllers do not have enough screen memory to allow you to scroll through a display of a table. This is especially true for high resolution monitors. HP recommends that you always print out the specifications.

Limited Scrolling Capabilities on the Controller CRT

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.

Measurement Calibration Method

Figure 8-22



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.

Magnitude Errors Due to Device Frequency Response

Frequency accuracy of HP 8350B/83592A (25±5 degrees C)					BAND:	
0	1	2	3	Full Band	Frequency range (GHz)	Frequency accuracy (MHz):
±5	±6	±8	±10	±15	Ramp sweep (typical)	±5
±5	±6	±25	±30	±50	Ramp sweep (typical, using Trim Sweep)	±5

Additional magnitude and phase errors are introduced into the system by these sweepers.

HP 8350B Sweep Oscillators as System Sources

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.

233661

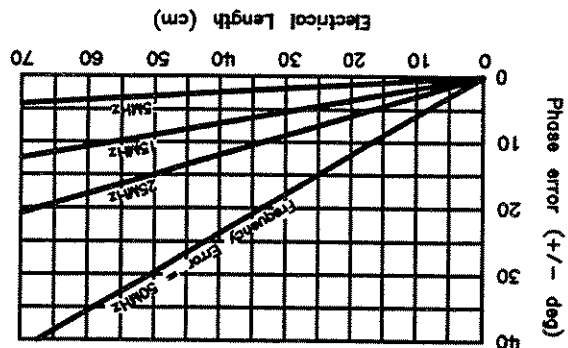
731/237627-86

738/230170-83

738/234708-85

738/236940-86

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:

NIST Numbers*Figure 8-23*

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:

$$\Delta\theta = (-360/c)(F)(L)$$

In measurements of devices with finite electrical length, the frequency accuracy of the sweeper causes additional uncertainty in phase measurements. The phase uncertainty $D\theta$ is given by the following equation:

Phase Errors Due to Device Electrical Length

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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.

Plotters and Printers

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.

- 20 dB attenuator
- 40 or 50 dB attenuator
- Airline (length varies with kit type)
- 25 ohm mismatch airline (length varies with kit type)

ing:

The four devices are slightly different for each configuration. However, every kit has one of the following: the system is in step mode. sweep time to 500 milliseconds. Remember that sweep time does not apply to synthesizers because 128 for sweepers (for example HP 8350B). For sweepers, the program always sets the HP 8510 The averaging factor should always be 1024 for synthesizers (for example, HP 8360/8340/8341) and change any of the HP 8510 parameters or stimulus settings that the program uses for your system. A complete performance verification requires that you measure all of the devices in your kit. Do not

Performance Verification Criteria

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.

Parameter Step Resolution (Software Configuration Menu)

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.

Omit Isolation Measurement for HP 8350B Sources

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.

Remote or Local Operation

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.)

Ramp Mode Operation for Synthesizers

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.

Program Modifications

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.

Plot traces are designed for all controller/CRT combinations, but they appear best on high resolution color monitors. The S14 test set have the same uncertainty values for an HP 8510 using an HP 8340 source and an HP 8514 test set. This overlay cannot be distinguished on low resolution monitors or plotters. For example, ever three traces appear (instead of four), it is because the bands have the same values and are overlaid. Some traces may appear to be missing from program plots that show four frequency bands. When-

Plot Traces on the Controller CRT

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.

Plotter Pens

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.

Plot Label Information

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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.

$$\text{Lower Limit} = 20 \log [1 U_{ij}/S_{ij}]$$

$$\text{Upper Limit} = 20 \log [1 U_{ij}/S_{ij}]$$

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:

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.

Uncertainty and Dynamic Accuracy Limits: Upper or Lower

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.

Trim Sweep Procedure

- S-parameter test sets use long links
- Reflection/transmission test sets use short links

A rule-of-thumb for these extension links is:

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.

Test Set Rear Panel Extension Links

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 Channel Signal Path Specifications: a1, b1, a2, b2

If a printer is connected to the system, cycle the power to all the instruments (including the printer).

If the HP 8510, and re-run the program.

If the system or the controller will not respond during verification, press **LOCAL** and **PRESERVE** on

System Hang-Ups or Other Problems

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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: $-60 \text{ dB} - 6 \text{ dB} = -54 \text{ dB}$. And, if the lower limit was minus infinity, the measurement of the filter could be considered -54 dB or less.

Test Facility _____		Report Number _____		Date _____		Date of Last System Calibration _____		Customer _____	
Tested By _____		Model Number _____		Trace Number _____		Cal Due Date _____			
1. Frequency Counter									
Ambient temperature _____ °C		Relative Humidity _____ %		Ambient temperature at performance verification _____ °C					
Ambient temperature at measurement calibration _____ °C									

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

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 (3 σ) 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.

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)	
Start Freq			0.1% of sweep (HP 8360)	± 150 kHz
Stop Freq			1% of sweep (HP 8340/41)	

Performance Test Record

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

The following options are available for the HP 8510C:

OPTIONS

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

- Microwave source
- HP 851x test set
- HP 8510 (which consists of an HP 85101 display/processor and an HP 85102 IF detector)

The basic system is defined as follows:

1. Preparing the site
2. Checking the shipment and unpacking the system
3. Configuring and connecting the system
4. Checking the system operation

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:

OVERVIEW

9. System Installation

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.

ATTENTION
Static Sensitive
Handle only at Static Safe
Work Stations



NOTE: Accuracy enhancement is dependent, in part, on a stable temperature environment. If your environmental temperature has a tendency to fluctuate more than $\pm 1^{\circ}\text{C}$, periodically perform a system verification to ensure that the system has been correctly calibrated.

Temperature	
For operation	$+5^{\circ}\text{C}$ to $+40^{\circ}\text{C}$ (41°F to 104°F)
For measurement calibration	$+20^{\circ}\text{C}$ to $+26^{\circ}\text{C}$ ($+68^{\circ}\text{F}$ to $+79^{\circ}\text{F}$)
For performance verification	$\pm 1^{\circ}\text{C}$ ($\pm 1.8^{\circ}\text{F}$) of the measurement calibration temperature
For storage	-40°C to $+65^{\circ}\text{C}$ (-40°F to $+158^{\circ}\text{F}$)
Humidity	
For operation	5% to 95% at $+40^{\circ}\text{C}$ or less (non-condensing)
For storage	5% to 95% at $+65^{\circ}\text{C}$ 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)

Table 9-1. Environmental Conditions

The environment must meet the conditions listed in the table below.

ENVIRONMENTAL REQUIREMENTS

Preparing the Site

Preparing the Site

Standard Equipment				
Instrument	Maximum VA Rating ¹	VA Subtotal	Maximum BTU/hour	Subtotal BTU/hour
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

Table 9-2. Maximum VA Ratings and BTU/Hour Ratings of HP Instruments

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.

Install air conditioning and heating, if required.

System Heating and Cooling

HP 8510 conducted and radiated interference is in compliance with German Messempfaenger-Postverfuerung 526/527/1979 (Kennzeichnung Mit F-Nummer/Funkschuttszeichen).

Electromagnetic Interference

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.

- Frequency: 47.5 to 66 Hertz
- Power: 1100 VA maximum
- Voltage: 90 to 127, 195 to 253 volts AC

Example HP 8510 System (includes test equipment and peripherals):

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.

ELECTRICAL REQUIREMENTS

*Refer to Figure 9-4 for examples of system configurations.

	Height	Width	Depth
HP 85043 System Cabinet	124 cm (49 in)	90 cm (36 in)	95 cm (38 in)
Bench-Top System* (arranged as single stack) (arranged as two stacks)	60 cm (24 in) —	45 cm (18 in) 113 cm (45 in)	60 cm (24 in) 60 cm (24 in)

Table 9-3. System 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.

SPACE REQUIREMENTS

OTHER REQUIREMENTS

Install a telephone next to the system in case assistance is needed.

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

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

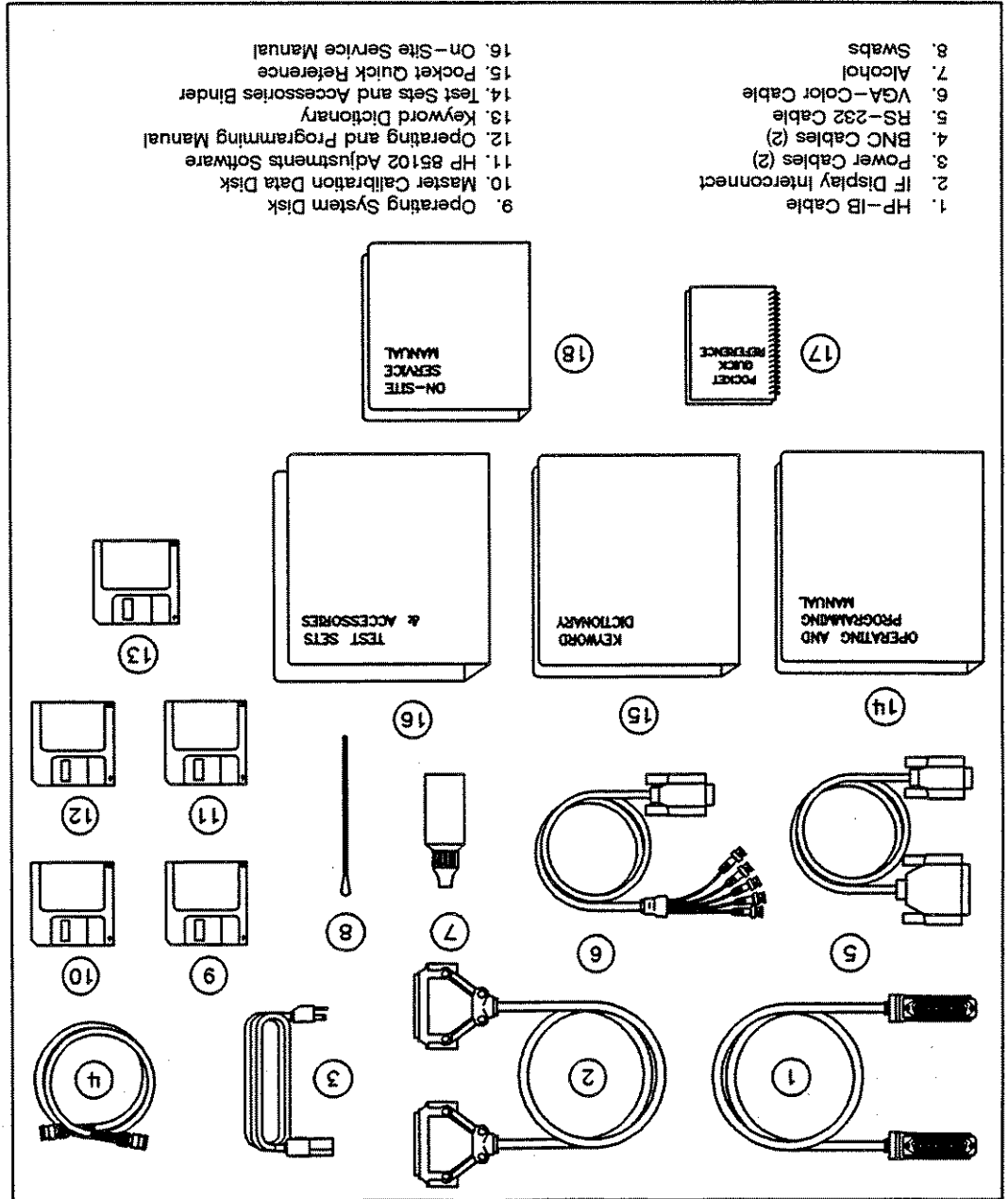
If any container or instrument is damaged or incomplete, save the packing materials and notify both the carrier and Hewlett-Packard.

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.

Figure 9-1. Accessories Supplied



HP 8510C

System Installation

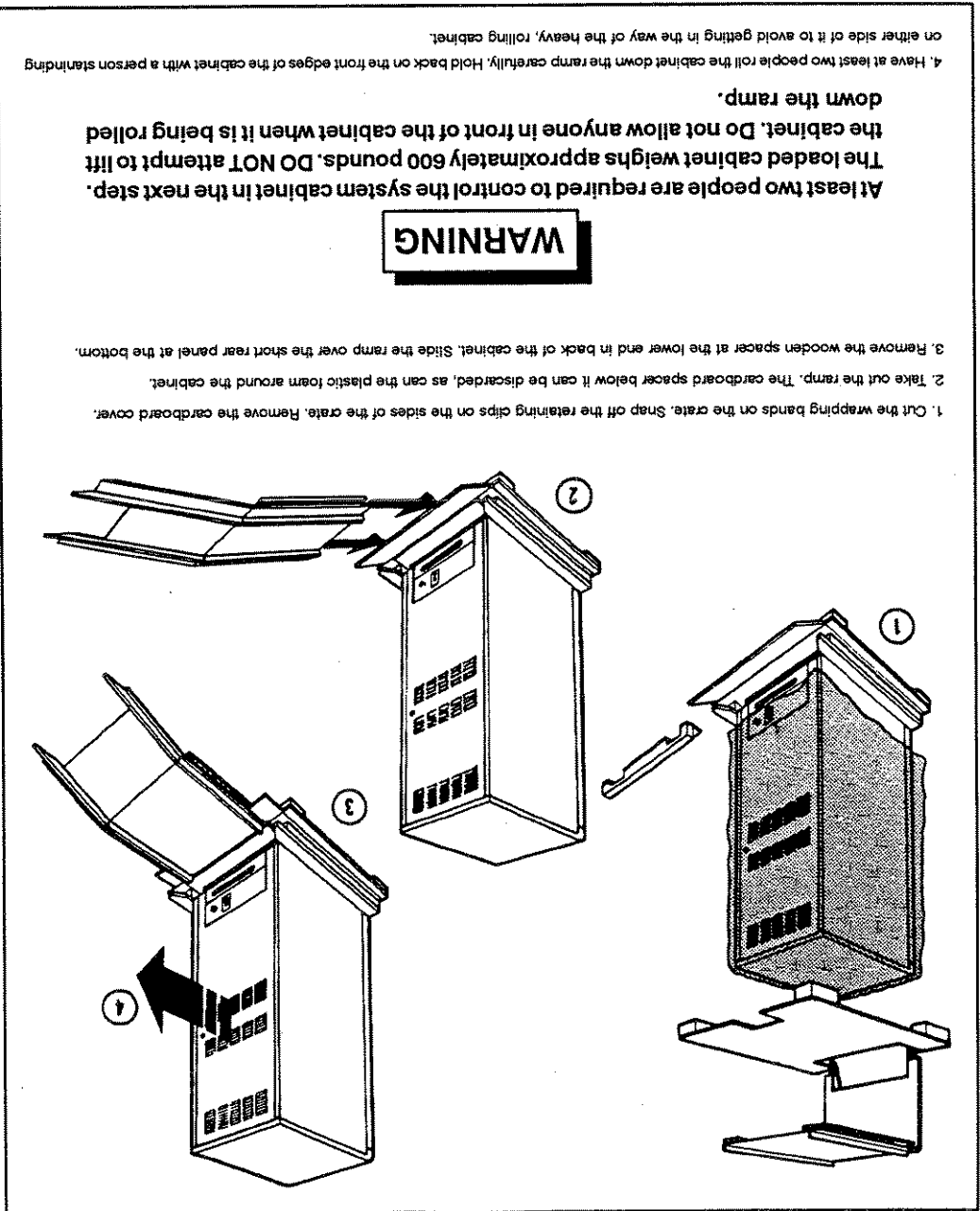
9-9

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.



Unpacking the System 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.



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.

To check the firmware revision on your HP 8350A, 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.

1. Converts HP 8350A to HP 8510 compatibility		
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	

Note: The sources listed above are the only compatible sources as of December 1990. Consult your HP customer engineer for additional information.

Table 9-4. Source Compatibility and Modification Kits

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.

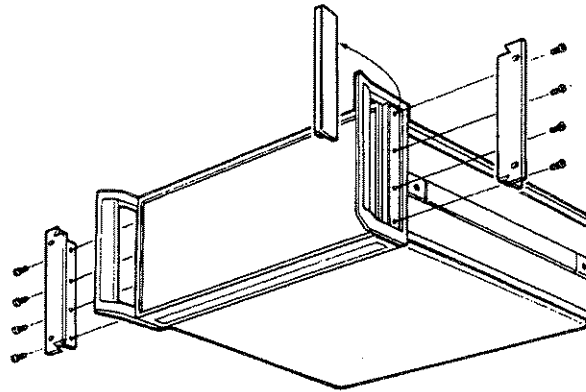


Figure 9-3. Attaching Flanges to Instruments With and Without Handles

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.

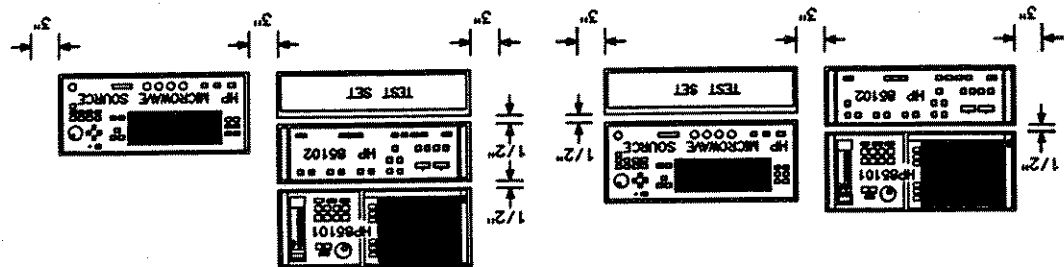
CONFIGURING THE SYSTEM ON A BENCH-TOP

Set up instruments in one of the configurations in Figure 9-4. Different configurations are possible, including single stack and equal stack (2x2) styles.

MAKING SYSTEM CONNECTIONS

The HP 8510 system requires that several types of cables be connected (see following figure).

Figure 9-4. Typical Bench—Top Configurations



DO NOT REMOVE INSTRUMENT FEET on any of the system components.
DAMAGE WILL OCCUR to the instruments if ventilation is restricted.
CONFIGURATION A
CONFIGURATION B

WARNING

Notes:

- 1.. Power cables must be connected to HP 85101, HP 85102, test set, source, and any peripherals. Connect the reference port extension cables as shown in Figure 9-7. (Not applicable for HP 85110,8516, 8517.)
- 2, 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.

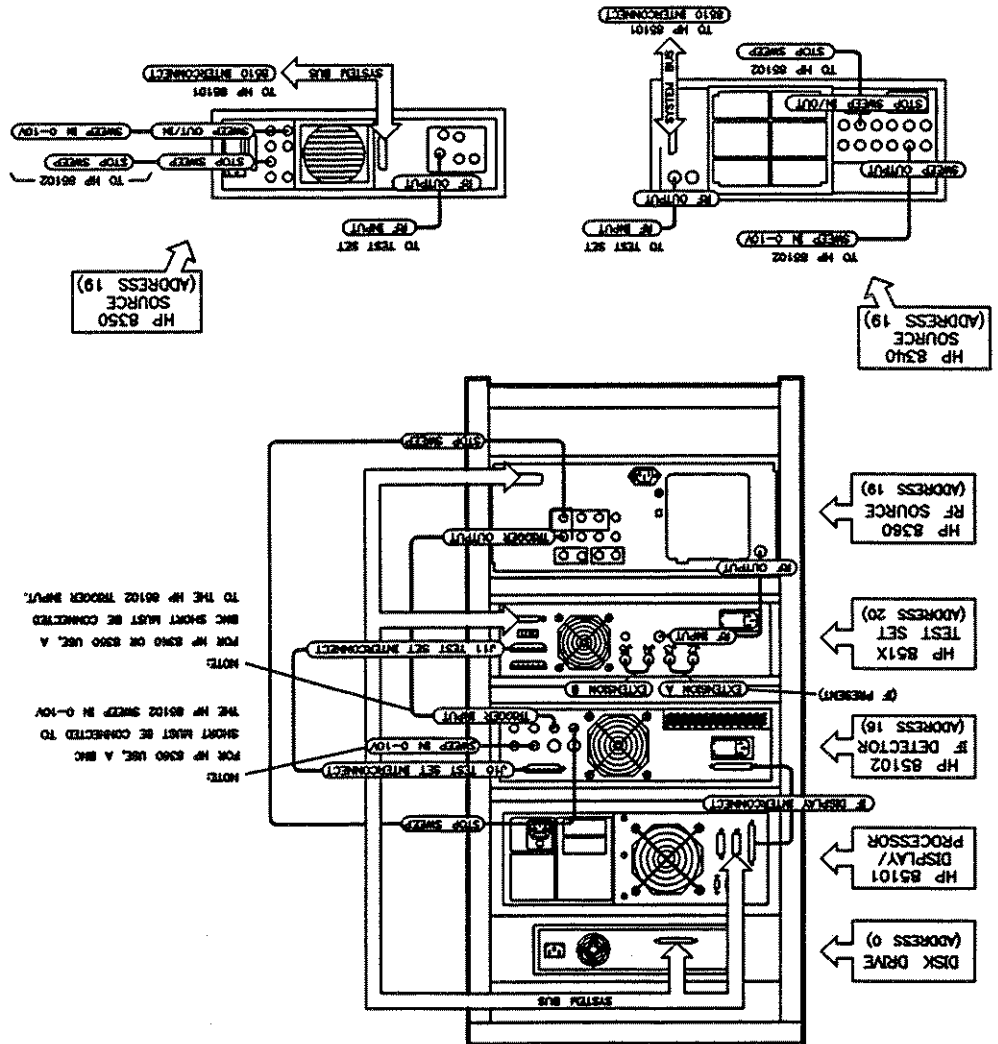
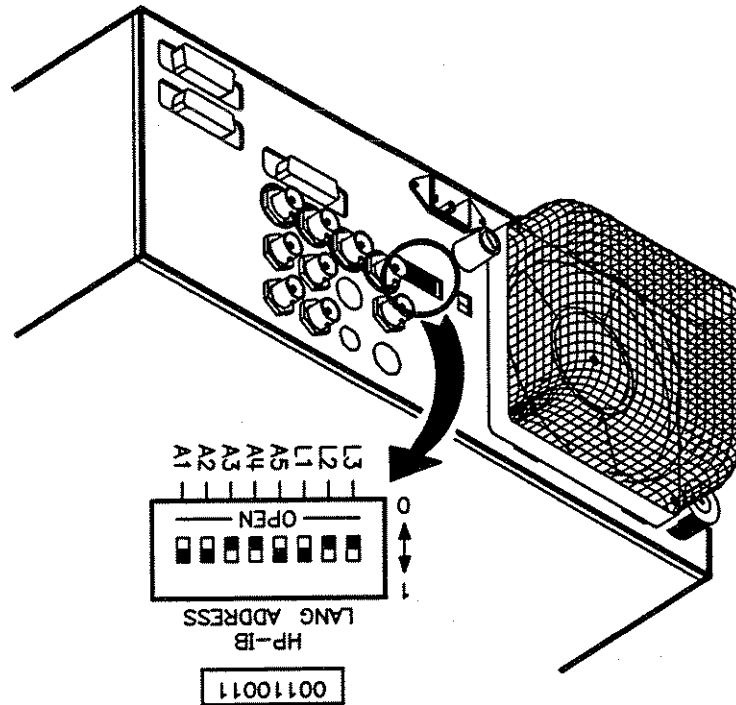


Figure 9-6. HP 8360-Series Source HP-IB/Language Switch

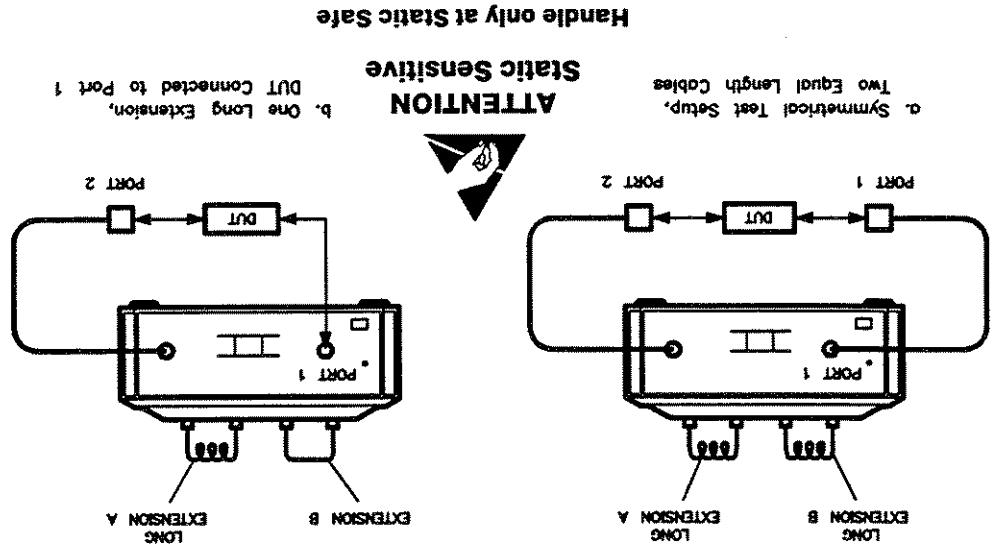


Darkened switch positions indicate a depressed switch.

When using an HP 8360-series source, its rear panel HP-IB/Language switch should be set as shown in Figure 9-6.

HP 8360-Series Source HP-IB/Language Switch

Figure 9-7. Reference Port Extension Cables



RECOMMENDED WHEN USING RAMP MODE

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.

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.

An uninterrupted safety earth ground must be provided from the main power source to the supplied power cable(s) to prevent injury or death.

WARNING

Grounding Power Cables

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.

Serial Printer Setup

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)

The following HP-IB cables are available:

- 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.

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:

NOTE: Always turn off power to instruments when connecting 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.)

Hewlett-Packard Interface Bus (HP-IB) Cables

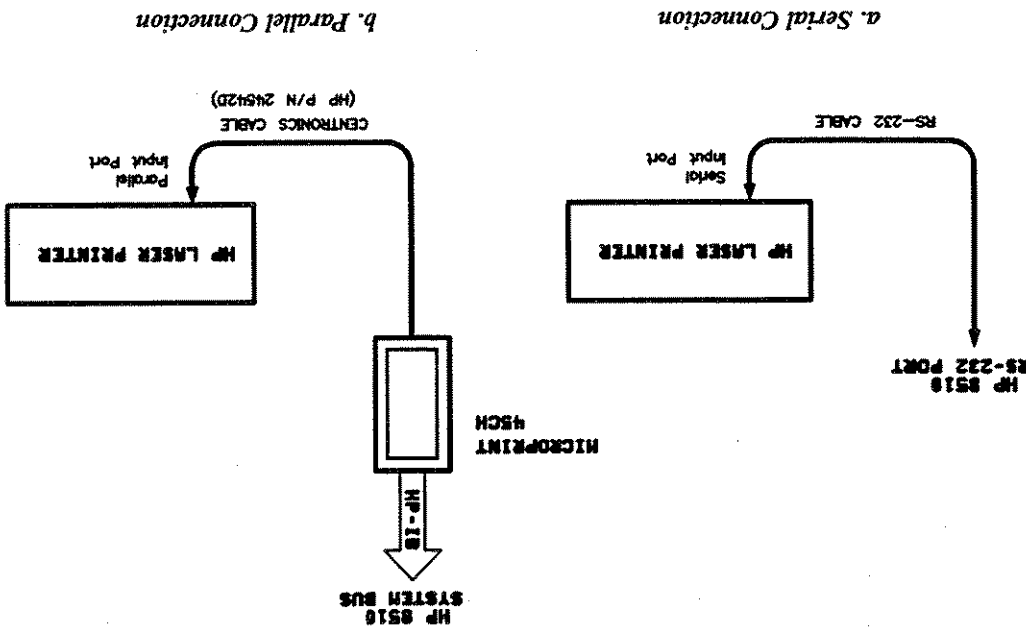
1. If using the Microprint 45CH, you must set it to address 01 as explained in its user's guide. The two other Microprint 45 versions come already set to address 701.
 2. Connect the 45CH HP-IB input to the HP 8510C system bus.
- HP p/n 82241A ABG for Australia
 - HP p/n 82241A ABU for the United Kingdom
 - HP p/n 82241A ABB for Europe
 - HP p/n 82241A ABJ for Japan

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.

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.

Parallel Printer Setup

Figure 9-8. HP Laser Printer Connections



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.

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.

For further information about printer setup, refer to "Copy" in the HP 8510C Operating and Programming Manual.

6. Turn ON the laser printer.
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]**.
4. Make sure the 45CH AC adapter module is set to the proper line voltage, then plug it in.
3. Connect the output of the 45CH to the laser printer Centronics input.

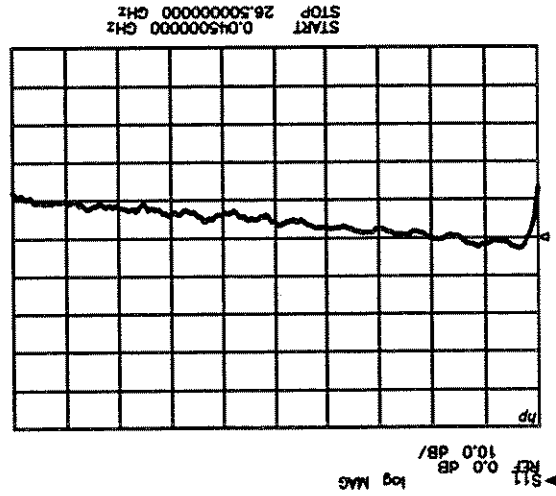


Figure 9-9. Typical Preset State Display

Press INSTRUMENT STATE **[RECALL]** **[MORE]** **[FACTORY PRESET]** on the analyzer. The CRT should show a trace similar to the figure below.

PRESET CHECK

- TESTING
- LOADING OPERATING SYSTEM
- SYSTEM INITIALIZATION IN PROGRESS
- RECALLING INSTRUMENT STATE

Press the analyzer front panel TEST activator to run the self-test sequence. Observe the CRT for the following sequence:

HP 8510 SELF-TEST

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.

CHECKING SYSTEM OPERATION

engineer.

If the problem still exists, refer to the troubleshooting chapter or contact your local HP customer

sequence.

addresses, referring to Figure 9-5. Then power-up the system instruments again in the correct sequence. Switch off the line power to all instruments and carefully recheck all cable connections and HP-IB

term bus address errors.

The most likely causes of problems for newly installed systems are poor cable connections or system bus address errors.

- Abnormal system response or operation
- Error messages or error codes on the analyzer CRT

Incorrect operation can be indicated by:

IN CASE OF DIFFICULTY

operating manual.

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

troubled power.

Refer to "Unratioed Power Failure" in the troubleshooting chapter for a procedure to check the unratioed power.

USER PARAMETERS (UNRATIOED POWER) CHECK

er change in scale.

Press **AUTO** again. The trace should reappear near the center of the display, probably with another change in scale.

display.

Connect an RF cable to ports 1 and 2 of the test set. The trace should rise toward the top of the

of the display, probably with a change in scale.

Press **AUTO** in the RESPONSE area of the analyzer. The trace should reappear near the center

play.

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.

S-PARAMETER TEST SET CHECK



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.

INSPECT AND CLEAN CONNECTORS

Additionally, it is recommended that the source fan filter (if any) be inspected once a week and cleaned as necessary.

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 overheats, the system will shut down until the temperature drops to the operating range.

MAINTAIN PROPER AIR FLOW

- Maintain proper air flow.
- Inspect and clean connectors.
- Clean the glass filter (and CRT as required).
- Degauss the display.
- Inspect the error terms.

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:

OVERVIEW

10. Preventive Maintenance

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.

ATTENTION
Static Sensitive
 Handle only at Static Safe
 Work Stations



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.

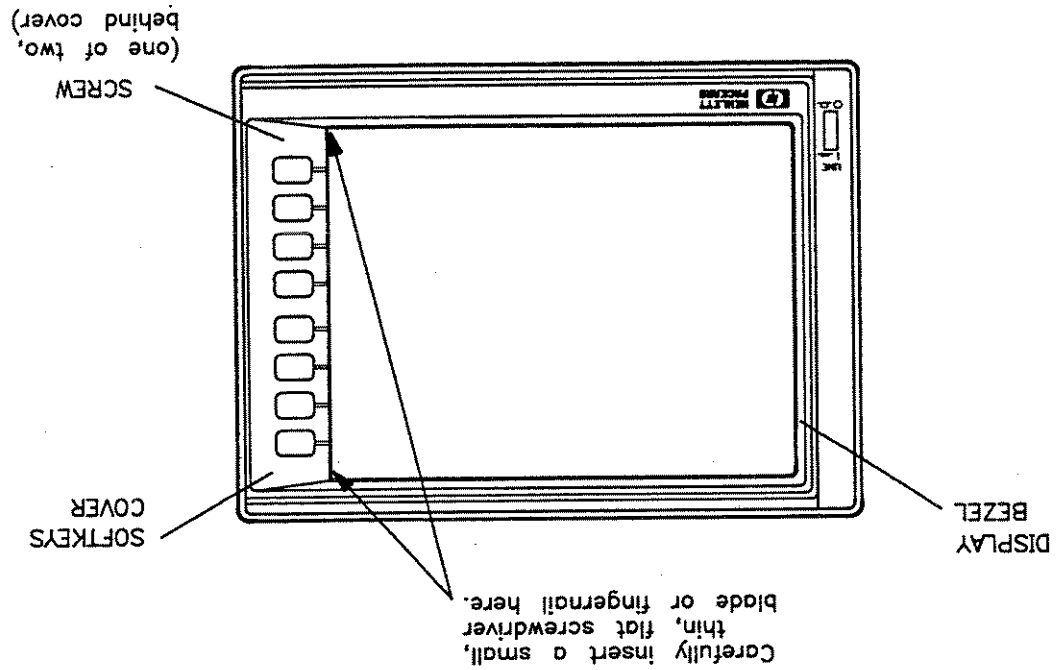
Cleaning the Test Set Rear Panel Extensions

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.

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.

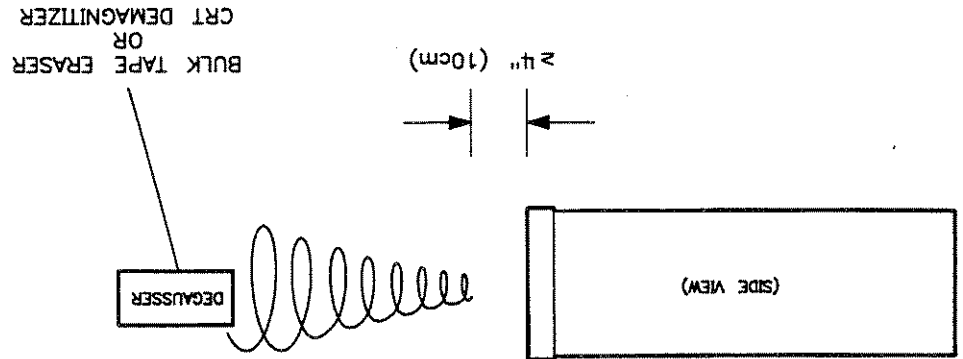
Figure 10-1. Removing the Glass Filter



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.

CLEANING THE CRT

Figure 10-2. Motion for Degaussing the Display



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.

Applying an excessively strong magnetic field to the CRT face can destroy the CRT.



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 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.

DEGAUSS (DEMAGNETIZE) THE DISPLAY

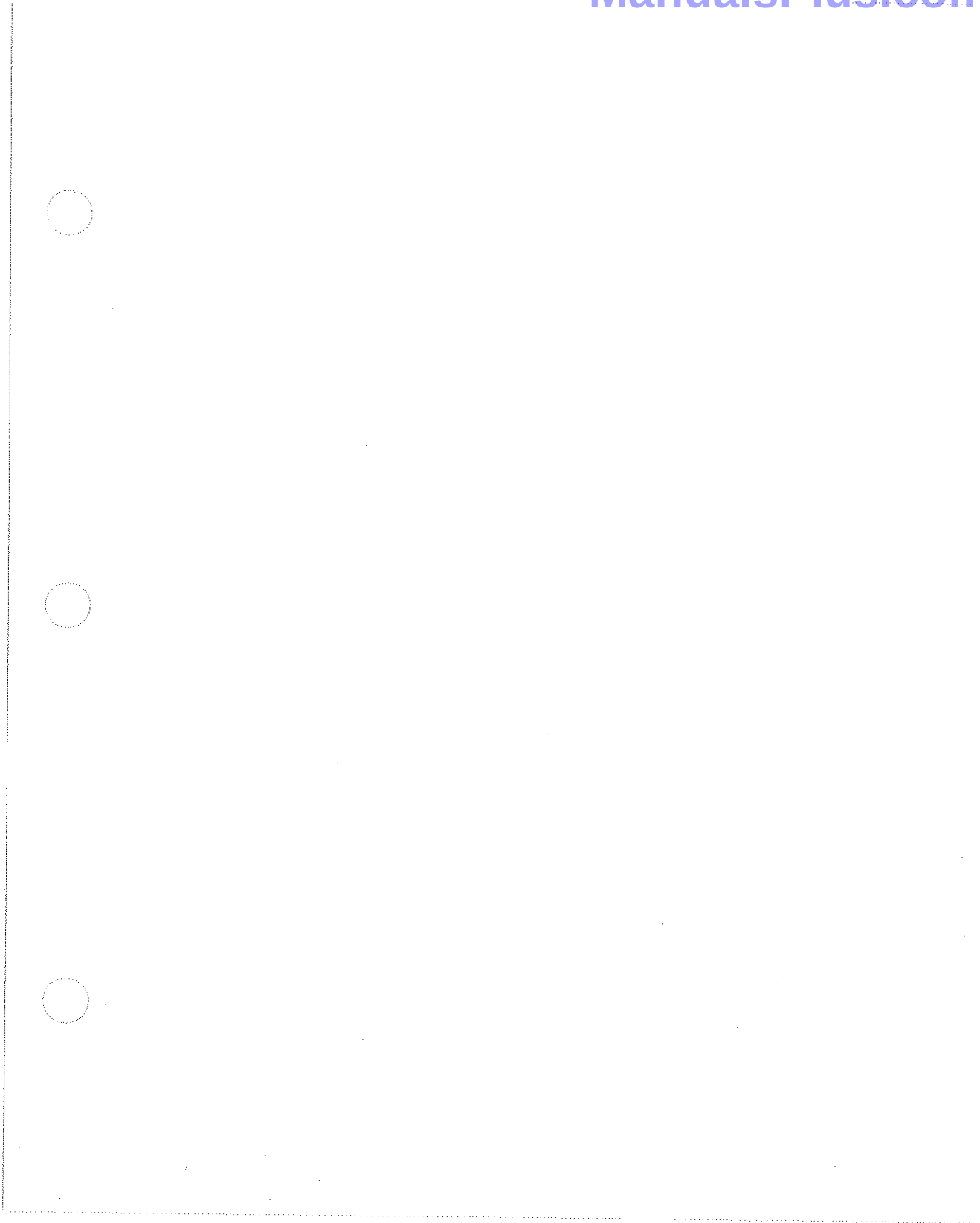
INSPECT THE ERROR TERMS

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.



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.

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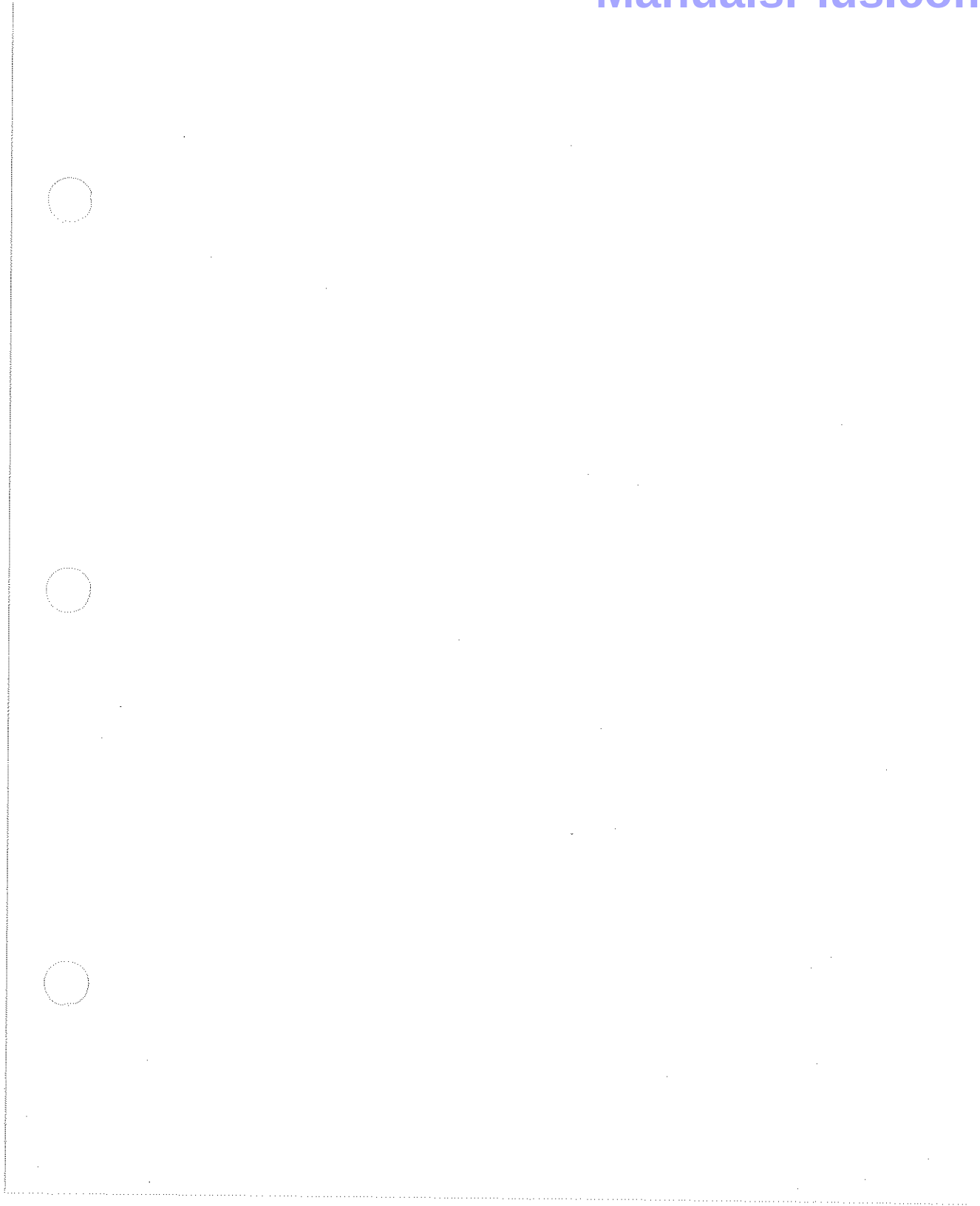
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WARRANTY

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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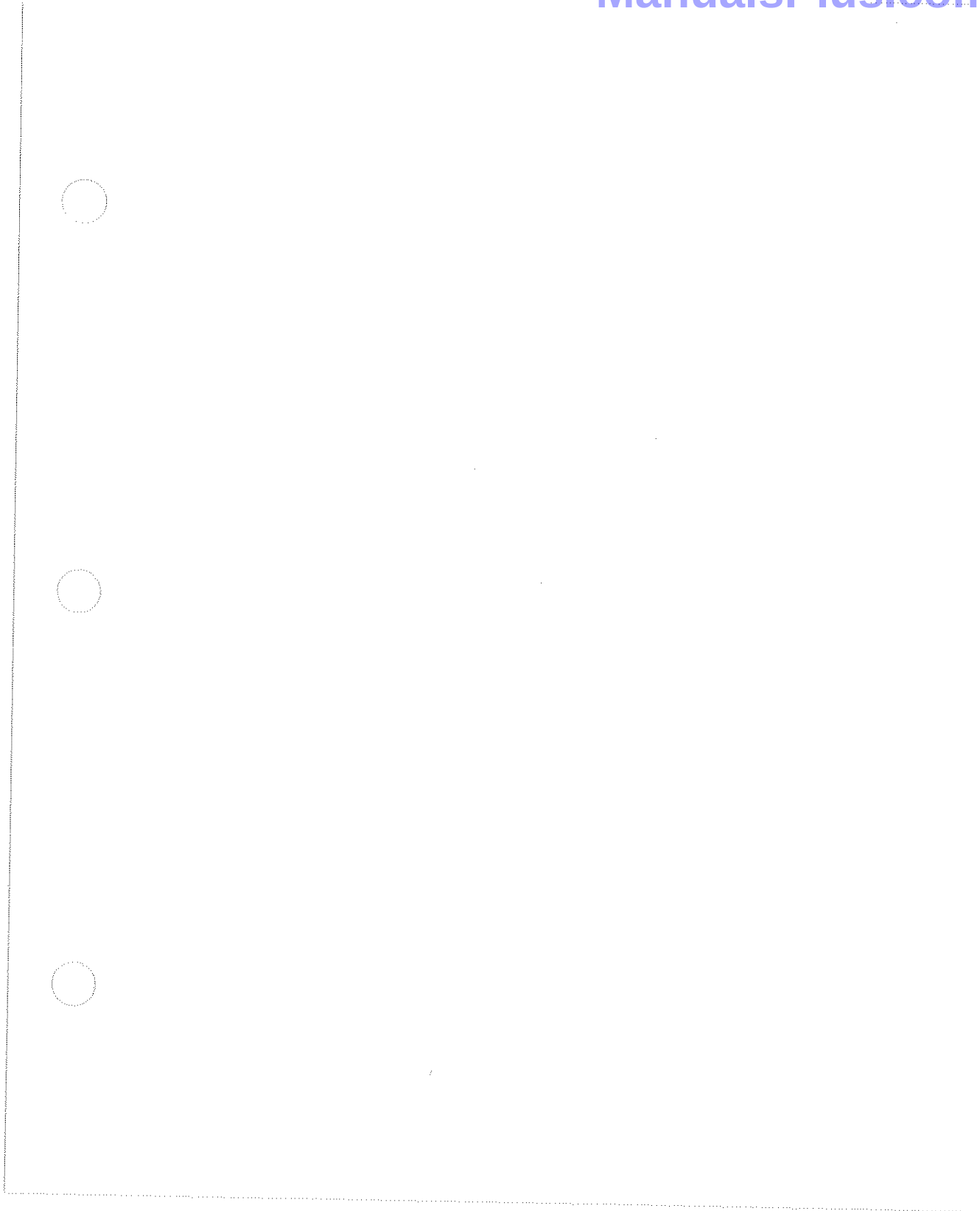
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- Performing System Verification
 - Entering user labels or user comments
 - Entering S-parameters of the DUT
 - Choosing user-generated error terms
 - Using markers on uncertainty plots
 - Using new features
 - Choosing to edit specifications
- Using the software
- Defining a custom system in the software
- Using the keyboard and mouse for program control
- Loading the software

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:

What's in This Chapter?

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.

Quick Start

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.

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. Refer to these numbers if you contact an HP Sales and Service Office about your software product.

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.

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 warranted; however, if you customize the system at your facility, the performance warranty cannot be applied.

Limitation of Warranty

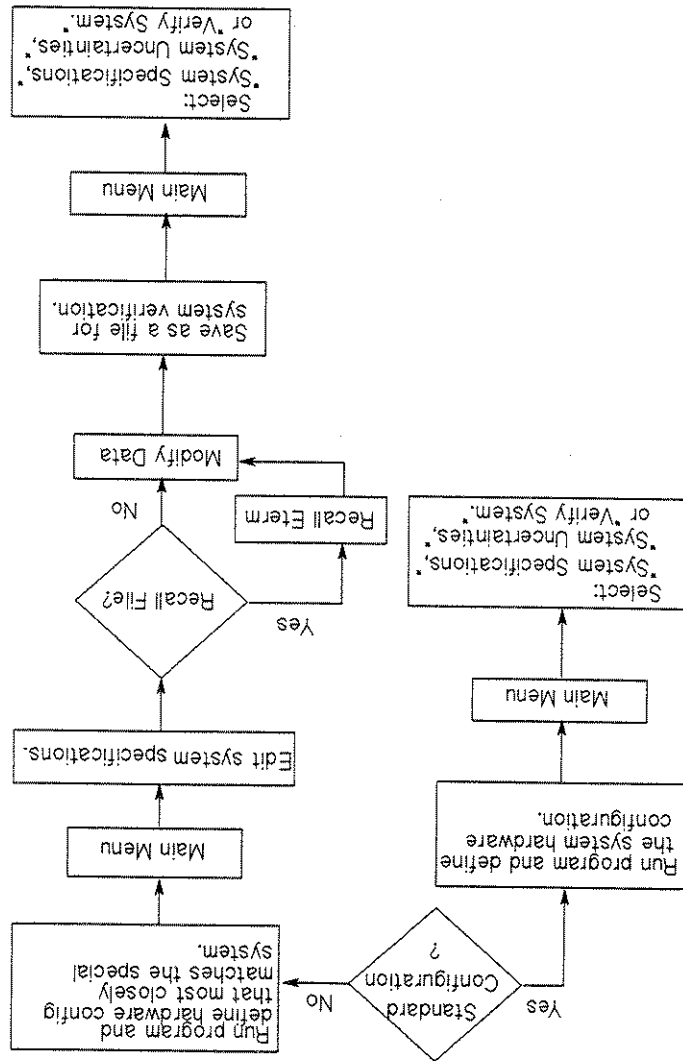
A custom network analysis system is one that uses models of test equipment in the measurement setup that are not listed or predefined in the specification and verification software.

Defining a Custom System in the Software

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.

Tab

Figure 1-1. Flowchart for Selecting to Modify Specifications



Refer to the flowchart below for an overview of choosing either the specifications editing process, or the standard factory-defined specifications:

Using the Software

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.

1-6 Quick Start

HP 8510C Software Supplement

1. Press **Syst Uncert** in the Main menu.

steps below:

To select edited error terms for generating system uncertainty data, refer to the

Generating customized system uncertainty plots

1. Press **Syst 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.

the steps below:

To select edited error terms for generating system specifications tables, refer to

Choosing User-Generated Error Terms

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.



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.

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.

use the marker function, refer to the steps below:

Markers automatically turn on when the uncertainty plot is displayed. The marker appears on the plot as a vertical dashed line. To display the plot and

Using Markers on Uncertainty 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.

Entering user labels or comments on plots

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 $S11 = 0$, and $S21 = S12$.
3. To enter an $S11$ value, press **Previous** until the asterisk beside $S11$ (1in) 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.

You can edit the S-parameter values for your specific device under test. Refer to the steps below:

Entering S-parameters of the DUT

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.

You can choose user-generated specifications for system verification. Refer to the steps below:

Using user-generated specifications in system verification

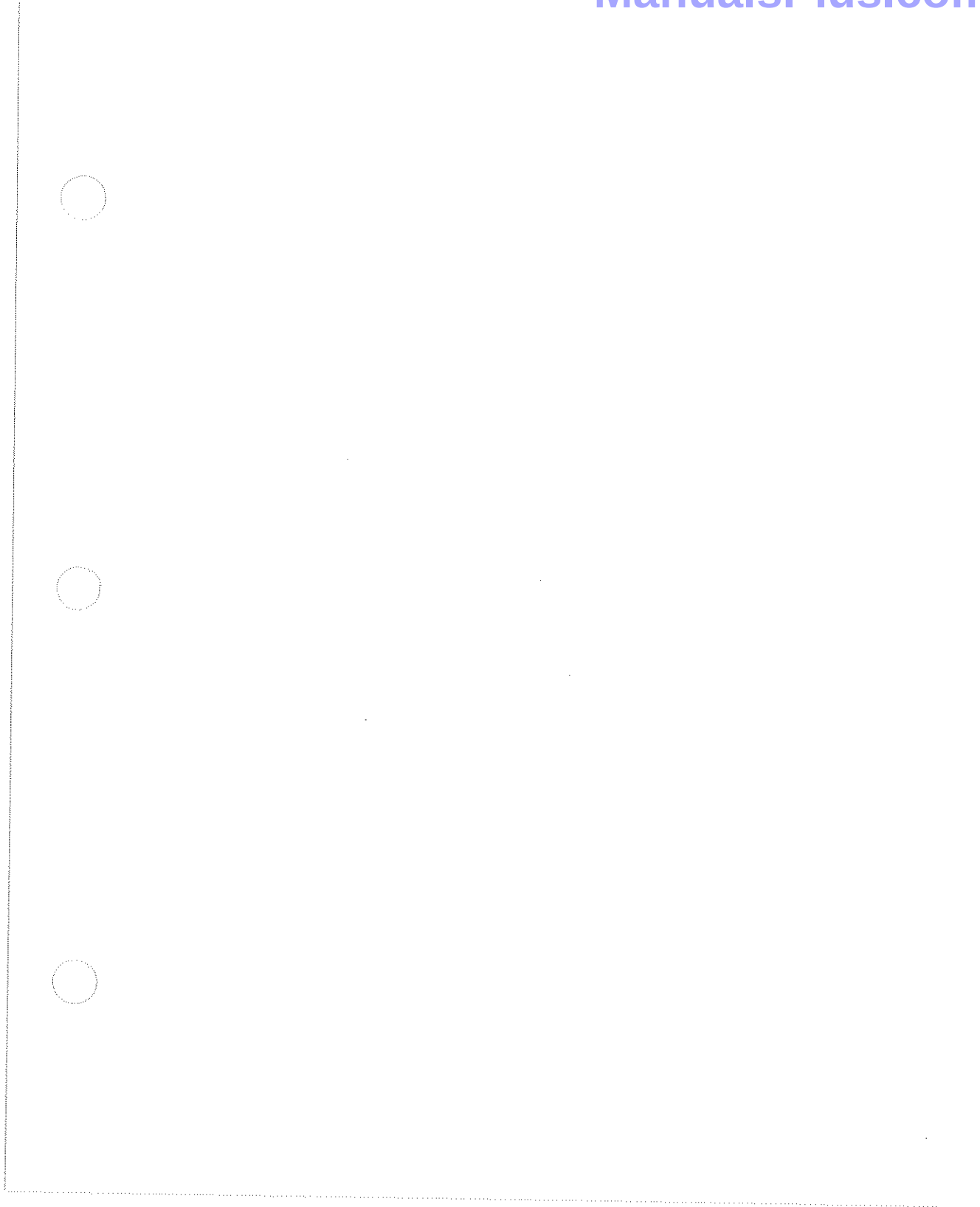
2. For **Compute Using**:, select **User Parameters**.
3. Use the softkeys within the menu to edit other selections as needed.
4. Press **Done** to display uncertainty plots.

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*.



- Recalling a custom error term table file
- Saving edited error term values
- Using the error term table editor

The sections of Chapter 2 are listed below:

What's in This Chapter?

In Chapter 3 there are examples to help you understand how to change error terms for some typically used hardware modifications.

term to change.
location of the device in this illustration to help you determine which error S11, S21, S22, and S12 and is in the center of the graph. You can use the error term gets modified with respect to the unique components within your review the error term labels and locations in. You need to understand which Refer to Figures 8-12 and 8-13 in the *HP 8510C On-Site Service Manual* and enter for the error terms changed.

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

Changing Error Term Values

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.

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, press the **Done** key to save edited terms.
 2. From the Main menu, press **Edit Specs** **Save Eterms**.

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.

- In the **Verify System** menu, press **Select Standard**, then select **Verify Using: User Parameters**.
 - In the **System Uncert** menu under **Compute Using**, select **User Parameters**.
 - In the **System Specs** menu, for table type, choose **User Parameters**.
- To use edited specifications, you need to select user parameters. The user parameters are available within the following menus:
- Return to the Main menu and choose **System Specs**, **System Uncertainty**, or **Verify System**.
 - Edit more specifications.

At this point, the user can make any of the following choices:

3. Press **Done** to retrieve the file.
2. Edit the file name and directory if necessary.
1. From the Main menu, press **Edit Specs** **Recall Eterms**.

To recall a customized error term table file, use the steps below:

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.

Recalling a Custom Error Term File



Note

To enter a file name, press **Next** or **Previous** until the blinking asterisk * appears beside the blank input 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.

3. Enter a file name and directory, if needed, for the new data in the space provided.

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

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.

Using the New Software: A Tutorial

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:

User parameter values are tables which have been modified by the user with the **Edit Specs** function.

Specification values are used during system verification.

Data sheet values are published in HP's technical literature. The values do not include effects due to cable stability or system drift errors.

Table Type Choose Specification, Data Sheet, or User Parameter values.

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.

Select **System Specs** from the Main menu. Review the following descriptions to learn more about a few of the menu selections.

Examining Error Term Tables, Exercise 1

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

Selecting the Hardware for an HP 8510SX System

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 Selection applies only to transmission measurements
Limit where:

- The "Upper Limit" is $20 \times \log(1 + \text{error})$.
- The "Lower Limit" is $20 \times \log(1 - \text{error})$. 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 sweep-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?

- Port match of -35 dB
- Effective directivity of -35 dB

terms to the values listed:
 short terminations. These factors require that you change the following error load at 26.5 GHz is 35 dB. There is a $+2^\circ$ phase error on both the open and reflection measurements at 26.5 GHz. The known return loss of a broadband manufacturer. You want to use this kit on an HP 8510SX system to make

You have purchased a 3.5 mm broadband load calibration kit from another

Using a Custom Calibration Kit, Exercise 3a

Review the modify/edit key descriptions of the menu selections in Chapter 2 of this guide.

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.

- Exercise 3d shows you how to edit error terms to calculate uncertainties for measuring a non-ideal test device.

- Exercise 3e shows you how to edit error terms for custom cables in a test setup.
- Exercise 3b shows you how to modify error terms for a custom test set.
- Exercise 3a shows you how to modify error terms for a custom system.

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.

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.

Editing Specifications, Exercise 3

Hint:

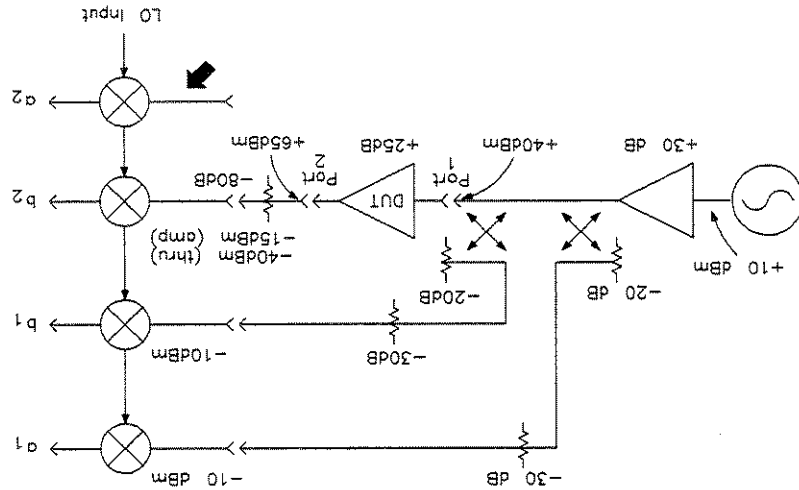
In the hardware configuration menu, select the HP 85052D calibration kit and edit the effective terms. Remember to select User Parameters when generating the S11 magnitude uncertainty curve.

- Reflection tracking of 0.024

- *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.

- *Task:* Plot the S21 magnitude uncertainty upper-case uncertainty.
 - Load match of -30 dB
 - Source match of -25 dB
 - Reflection tracking of 0.011
 - Effective directivity of -30 dB
- Use the broad band-load calibration method. Assume the following:
- No verification kit
 - No cables
 - No calibration kit
 - No source
 - HP 8511A test set
- For the hardware configuration, choose the following:

Figure 3-1. Equipment Setup Block Diagram



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.

Using a Special Test Set, Exercise 3b

$$\frac{\sqrt{F_1(GHz) - F_2(GHz)}}{Loss1 - Loss2}$$

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 $F_1 > F_2$):



Hint:

Consider how the cables impact your measurements.

■ **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.

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.

Using Non-Standard Test Cables, Exercise C.



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.

■ **Question:** What is the difference between this result and the lower-case uncertainty?

3-10 Using the New Software: A Tutorial

HP 8510C Software Supplement

- 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):
- **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.
- Port 1: $Ld1c$, $Lf1c$, $Crm1$, $Cpf1$
 Port 2: $Ld2c$, $Lf2c$, $Crm2$, $Cpf2$
- **Question:** What are the new values for the following error terms? Refer to Table 3-7 to verify answers.
- Port 1: $Ld1c$, $Lf1c$, $Crm1$, $Cpf1$
 Port 2: $Ld2c$, $Lf2c$, $Crm2$, $Cpf2$
- **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):
- **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 $\pm 0.1^\circ$ around 0° at 1 GHz.
- You find the cable's reflection magnitude stability, Crm , 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 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 $\pm 0.1^\circ$ around 0° at 1 GHz.
- You find the cable's reflection magnitude stability, Crm , 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: $Ld1c$, $Lf1c$, $Crm1$, $Cpf1$
 Port 2: $Ld2c$, $Lf2c$, $Crm2$, $Cpf2$
- **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):

**Hint:**

Remember to select User Parameters when generating the uncertainty curves for the non-standard cables.

cables?

After allowing the software to recompute the uncertainties, look at the uncertainty curves. How do they compare with a system that uses HP 85131F

$$C_{tmx} + C_{pfx} \times (\text{frequency in GHz})$$

b. Use the following equation to determine the phase stability:

$$L_{dxc} + L_{fxc} \times \sqrt{(\text{frequency in GHz})}$$

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?

Questions		Answers	
1. Which effective error term would dominate when you measure the following: a. For a good 50Ω termination? b. For a short circuit? c. For an amplifier with 10 dB of gain? d. For switch isolation?		The dominant error terms are: The directivity term. The source match term. The load match term. The crossstalk term.	
2. What is the raw directivity at 26.5 GHz? How does this value compare with the data sheet value?		The value should be about -27 dB. 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.	

Table 3-1. Examining Error Term Tables Answers

"Examining Error Term Tables" Answers

Exercise questions from the tutorials are repeated in the first column of the tables. Answers are stated in the next column beside the question.

Answers to Tutorial Questions

The answers to Examining Error Term Tables, exercises 1, 2, and 3 are in Table 3-1:

Questions	Answers
1. On the S11 magnitude uncertainty curve (at 26.5 GHz), what is the estimated effective directivity? How does the estimated value compare with the data sheet value?	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). -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? Does the value correspond with the data sheet?	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. 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.

Table 3-2. Computing Uncertainty Curves Answers

"Computing Uncertainty Curves" Answers

The answers to Computing Uncertainty Curves, questions 1, 2, and 3 are in Table 3-2:

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 3-4. Error Terms to Modify for Generating Uncertainty Curves

The error terms that need to be modified for generating the S21 magnitude uncertainty curves are in Table 3-4 below:

Exercise 3b: Answers to Using A Special Test Set

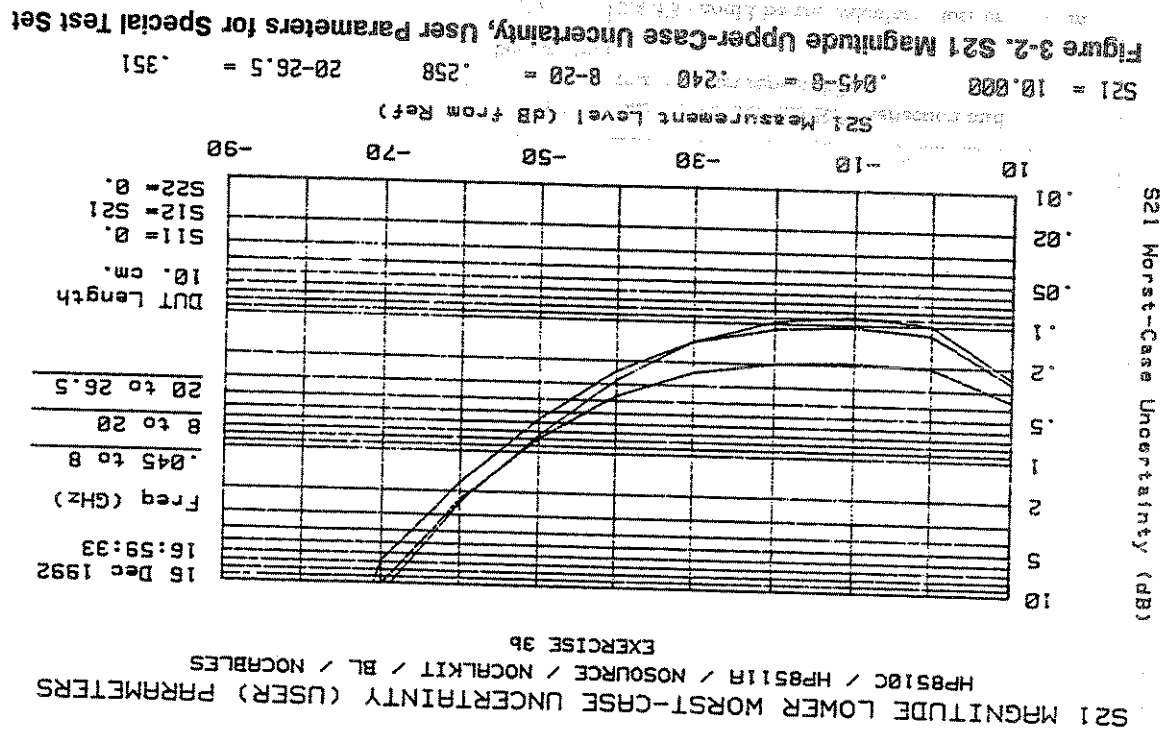
Question	Answer
How can you verify that the S11 magnitude uncertainty curve is correct?	At $S_{11} = 0$, the value for the 26.5 GHz curve should be about -35 dB, or 0.0178 linear, since that is the of return loss of the load.

Table 3-3. Tutorial Exercise 3a. Answers

Exercise 3a: Answers to Using a Custom Calibration Kit

The answers to tutorial exercises 3a, 3b, 3c, and 3d. are provided in these tables.

"Editing Specifications Examples" Answers



Questions	What is the difference between the S21 upper-case magnitude uncertainty and the lower-case uncertainty?
Answers	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.

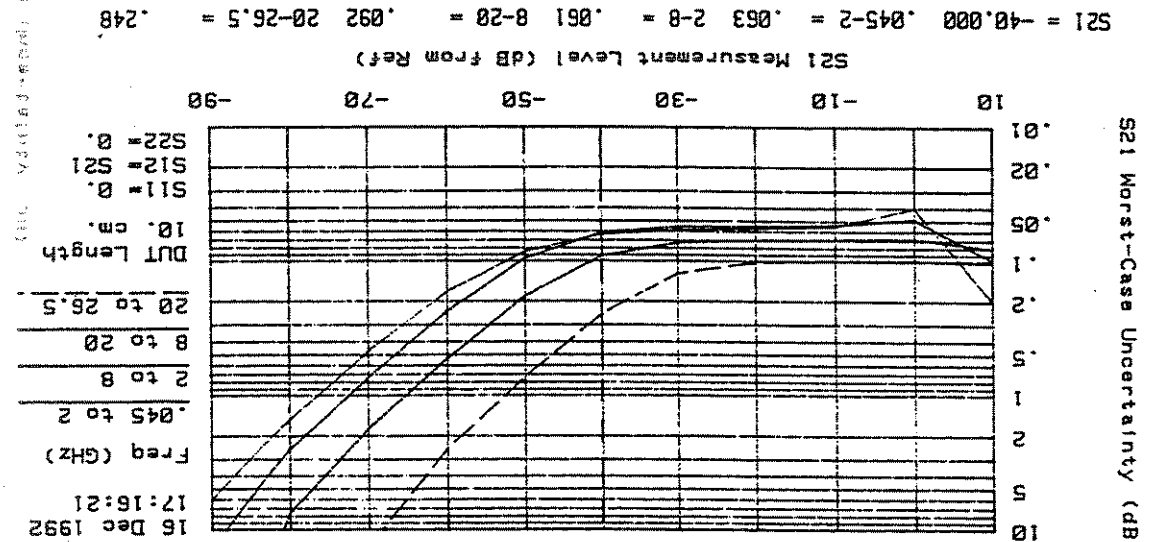
Table 3-5. Tutorial Exercise 3b. Answers

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 cables?	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 3-6. Tutorial Exercise 3c. Answers

Exercise 3c: Answers to Using Non-Standard Test Cables

Figure 3-3. S21 Magnitude Lower-Case Uncertainty, User Parameters for Special Test Set

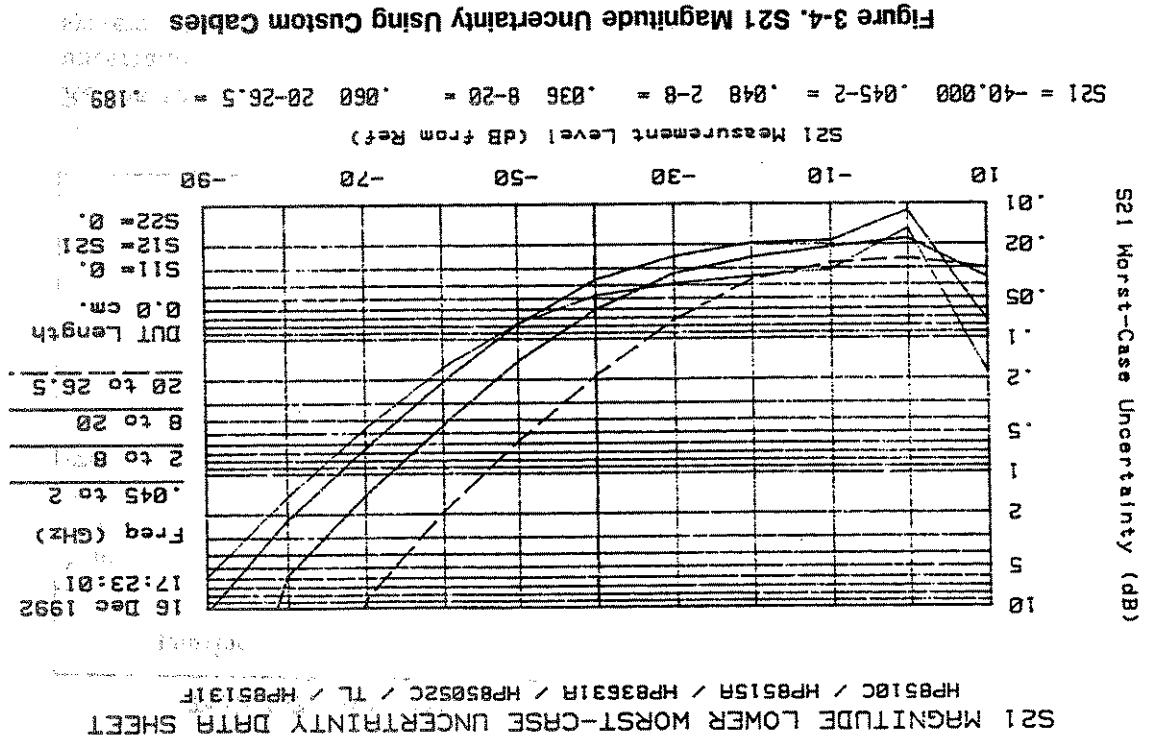


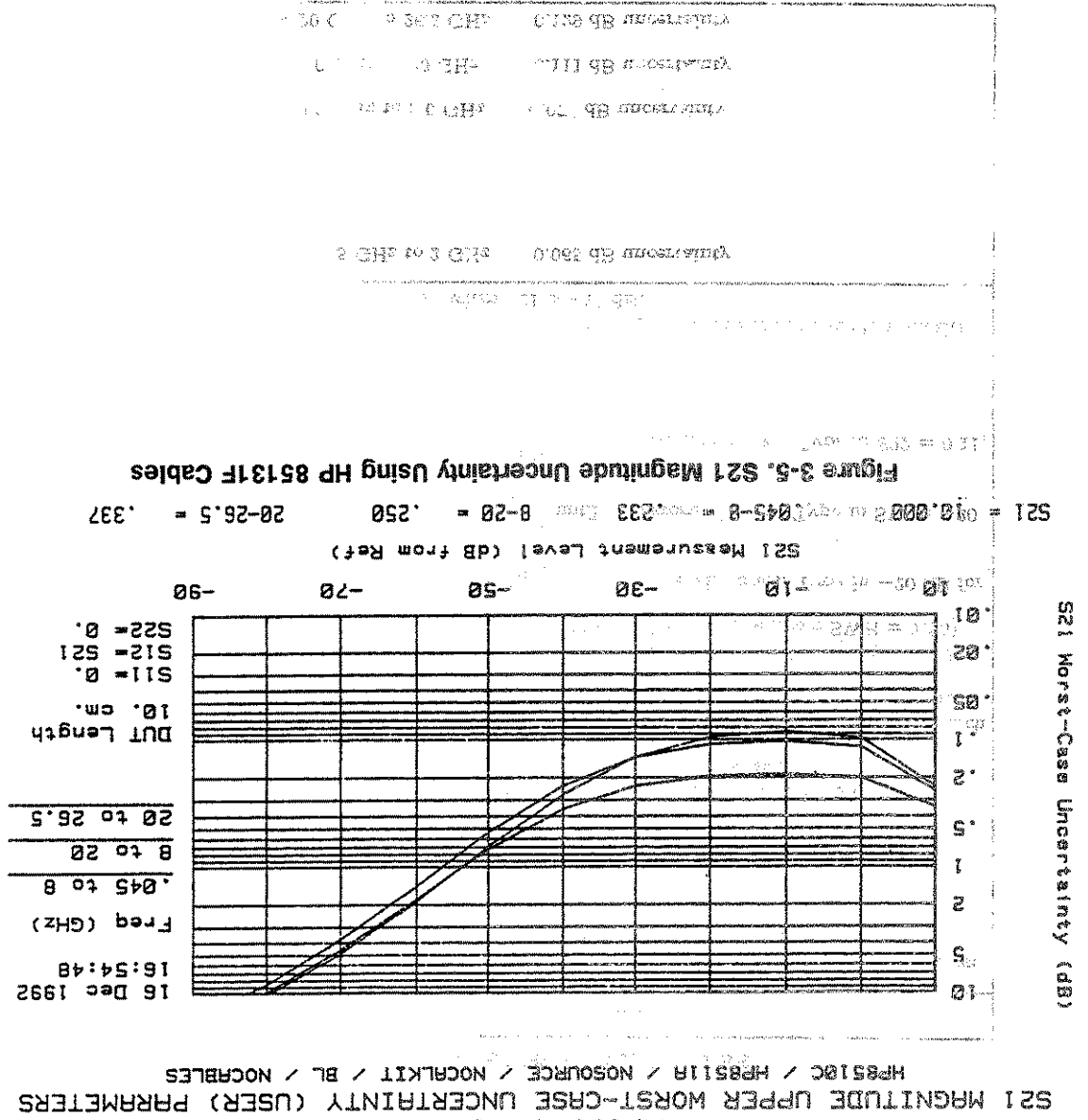
S21 MAGNITUDE LOWER WORST-CASE UNCERTAINTY (USER) PARAMETERS
HP8510C / HP8515R / HP83631R / HP85052C / TL / NOCABLES
EXERCISE 3c

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.

Question		What are the new calculated values for port 1 and port 2 error terms?	
Port 1	ETerm	Ld1c	Lf1c
Port 2	ETerm	Ld2c	Lf2c
2.0 GHz	Cpt2	Ctm2	Crm2
8.0 GHz	Cpt1	Ctm1	Crm1
20 GHz			
26.5 GHz			

Table 3-7. Error Term Values Needed for This Custom Cable





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 = 0.20 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

Exercise 3d: Answers to Using Non-Ideal Test Device
Table 3-8. Tutorial Exercise 3d. Answers

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$$f_{\text{eff}} = \frac{1}{2} \left(\frac{1}{f_1} + \frac{1}{f_2} \right) \quad (1)$$

1. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ 2. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ 3. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ 4. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

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IN THE UNITED STATES IN AUSTRALIA IN JAPAN Yokogawa-Hewlett-Packard Ltd. 29-21 Takaido-Higashi, 3 Chome Sugiyama-ku Tokyo 168 (03) 331-6111 IN CANADA Hewlett-Packard (Canada) Ltd. 17500 South Service Road Kirkland, Quebec H9J 2X8 (514) 697-4232 IN FRANCE Hewlett-Packard France F-91947 Les Ulis Cedex Orsay (6) 907-78-25 IN SINGAPORE Hewlett-Packard Singapore Pte. Ltd. 1150 Depot Road Singapore 0410 Telox HPSGSO RS34209 Fax (65) 2788990 IN TAIWAN Hewlett-Packard Taiwan 8th Floor, Hewlett-Packard Building 337 Fu Hsing North Road Taipei (02) 712-0404 IN OTHER EUROPEAN COUNTRIES Hewlett-Packard (Schweiz) AG Allmend 2 CH-8967 Widen (Zurich) (0041) 57 31 21 11 Palo Alto, California 94304	IN THE UNITED STATES IN CALIFORNIA Hewlett-Packard Co. 1421 South Manhattan Ave. P.O. Box 4230 Fullerton, CA 92631 (714) 999-6700 Hewlett-Packard Co. 301 E. Evelyn Mountain View, CA 94039 (415) 694-2000 Colorado Hewlett-Packard Co. 24 Inverness Place, East Englewood, CO 80112 (303) 649-5000 Georgia Hewlett-Packard Co. 2000 South Park Place P.O. Box 105005 Atlanta, GA 30339 (404) 955-1500 Illinois Hewlett-Packard Co. 5201 Tollview Drive Rolling Meadows, IL 60008 (312) 255-9800 New Jersey Hewlett-Packard Co. 120 W. Century Road Paramus, NJ 07653 (201) 265-5000 Texas Hewlett-Packard Co. 930 E. Campbell Rd. Richardson, TX 75081 (214) 231-6101

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