Errata

Title & Document Type: 8510B Network Analyzer System Manual

Manual Part Number: 08510-90074

Revision Date: July 1987

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement business is now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual provides the best information we could find. It may be incomplete or contain dated information, and the scan quality may not be ideal. If we find a better copy in the future, we will add it to the Agilent website.

Support for Your Product

Agilent no longer sells or supports this product. You will find any other available product information on the Agilent Test & Measurement website: www.tm.agilent.com.

Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.

Agilent Technologies

SYSTEM MANUAL

HP 8510B
NETWORK ANALYZER

This manual applies directly to HP 8510B Network Analyzers beginning with serial number 2643A03500, and to all HP 8510As that have been upgraded to HP 8510Bs.

FIRMWARE AND SOFTWARE REVISIONS

This manual applies directly to the following software and firmware. Refer to the MANUAL UPDATE section for any changes.

Part Number		Revision
85101-80069	Operating System Firmware w/option 010	B.03.00
85101-80070	Operating System Firmware	B.03.00
08510-10031	Specification and Performance Verification (program disc)	A.01.00
08510-10032	Specifications and Performance Verification (data disc)	A.01.00

1400 FOUNTAINGROVE PARKWAY, SANTA ROSA, CA 95401 U.S.A.

MANUAL PART NO. 08510-90074
Microfiche Part No. 08510-90075

Printed: July 1987

HEWLETT PACKARD

CERTIFICATION

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

WARRANTY

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of delivery, or, in the case of certain major components listed in section six of this Operating and Service manual, for the specified period. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

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

LIMITATION OF WARRANTY

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

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

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

ASSISTANCE

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

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

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Documentation Overview

This section contains information about each volume and when to use it. A SUBJECT INDEX, covering the manual set, is provided in this volume so that you can look up separate subject headings. In addition, each manual has its own TABLE OF CONTENTS.

This entire manual set is divided into sections by TABS with separate subject headings and color levels. Each section is organized in such a fashion that its tab accurately reflects the contents of that section. By organizing the manual set in this manner, it will be easier to use and find information by glancing at the tabs. However, Hewlett-Packard recommends that you familiarize yourself with the entire manual set before using the system. You can begin as follows:

1. Read the INSTALLATION section of the System Manual to set up your system.
2. Read the first two sections of the Operating and Programming Manual to familiarize yourself with the operation of the front panel, measurement calibration, transmission measurements and reflection measurements.
3. Use the rest of the manual as a reference when needed.

The HP 8510B manual set consists of the following five volumes:

OPERATING and PROGRAMMING MANUAL

HP part number 08510-90070

This volume describes how to use the HP 8510 to make network analysis measurements. It also contains all of the information necessary to operate and program the system. It has the following subjects:

Getting Started
Introduction to HP 8510B Operation
Basic Network Mesaurements
Time Domain Measurements
Programming the HP 8510B
Reference Data
Subject Index

KEYWORD DICTIONARY

HP part number 08510-90072

This volume is an alphabetical list of the HP 8510B's programming mnemonics. It contains information for programming the HP 8510B, including programming hints, samples, and priorities.

SYSTEM MANUAL

HP part number 08510-90074

This volume should be used first. It contains the information necessary to properly install the system and verify its performance:

System and Documentaion Overview
Installation
General Characteristics
Specifications
Performance Tests
Subject Index, for the System and Service Manuals

TEST SET and ACCESSORIES MANUAL

HP part number 08510-90076

This volume is shipped empty except for a copy of the Microwave Connector Care Manual and the following major tabs:

Test Sets
Calibration Kits
Verification Kits
Cables/Adapters
Rack/Fixtures/Etc.
Reference Documents
Manual Update Information

You should use this binder to store the separate manuals shipped with each test set and accessory. Note that each test set or accessory manual is shipped with its own specially designed tab.

NOTE: The four volumes above can be ordered as a set (HP Part 08510-90067). The SERVICE manual is ordered with the HP 8510B as Option 915 or separately by its HP Part 08510-90078.

SERVICE MANUAL (OPTION 915)

HP part number 08510-90078

This volume contains troubleshooting information and strategy, including Replaceable Parts, Adjustments, and Procedures for using the built-in diagnostic tests. It is aimed at board-level repair — no component level schematics are provided. Also included are two service tools to be used with the built-in Service Program diagnostics.

The Service and Replaceable Parts Sections of your test set manuals should be added to this binder behind the appropriate tabs.

MICROFICHE

On the title page of each manual is a microfiche part number. This number can be used to order a package of 10 X 15 centimeter (4 X 6 inch) microfilm transparencies of the manual. Each microfiche contains up to 60 photo duplicates of the manual pages. The microfiche package also includes the latest manual change supplement.

Refer any questions regarding this manual, the manual change supplement, or the instrument to the nearest Hewlett-Packard Sales/Service Office. Always identify the instrument by model number, complete name, and complete serial number in all corresponderce. A worldwide listing of HP Sales/Service Offices is provided at the back of this section.

MANUAL UPDATES (Change Sheets)

Whenever a change is made to any of the manuals a special package will be made available which contains this new or changed information. Be sure to refer to the Manual Update section in your Test Sets and Accessories Manual and follow the instructions for logging these changes.

System Overview

The HP 8510 is a high performance vector network analyzer used for S-parameter measurements. With the use of a high resolution synthesized RF source, such as the HP 8340A/B, and a S-parameter test set, the HP 8510 system is able to measure and display, on two independent display channels, magnitude, phase, and group delay responses of active and passive networks, operating across a range of frequencies from 45 MHz to 26.5 GHz. Option 010 provides the capability of transforming measured data from the frequency domain to the time domain.

The HP8510 System consists of a Display/Processor, IF/Detector, single or multiple test sets, and a RF source. Additional system capabilities, including automated Performance Testing, are obtained by adding an HP desktop computer (controller), printer, plotter, disc drive, test fixtures, software or various accessories. Millimeter-wave measurements in waveguide bands up to 100 GHz are possible with the addition of a second source and a test set kit.

SYSTEMS COVERED BY THIS MANUAL

Attached to each instrument is a serial number plate. The first four digits followed by a letter comprise the serial number prefix. The last five digits are the suffix. The prefix is the same for all identical instruments. It changes only when a change is made to the instrument. the suffix, however, is assigned sequentially and is different for each instrument. This manual applies directly to systems with the serial number prefix or prefixes listed on the title page. These numbers are recorded at the factory upon initial shipment so that service and warranty information can be maintained by the factory for the specific combination shipped.

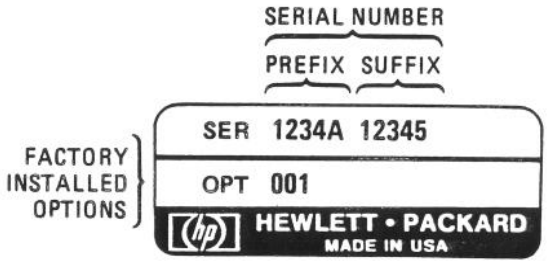

Figure 1. Typical Serial Number Plate

An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. An unlisted serial prefix indicates that the instrument is different from those documented in this manual. In this case, the manual is accompanied by a *Manual Change* supplement.To keep this manual as current as possible, Hewlett-Packard recommends that you periodically request the latest manual change supplement. Refer to the tab labeled Manual Update in your manual for more information on Manual Change Supplements.

SAFETY CONSIDERATIONS

Refer to the safety sheet at the rear of this section for general safety instructions. Other cautions and warnings that appear throughout this manual should also be carefully followed to prevent bodily injury or damage to the equipment. This instrument should be serviced only by qualified personnel who are aware of the hazards involved.

COMPATIBLE TEST SETS

HP 8511A Frequency Converter. Operates from 45 MHz to 26.5 GHz and requires external, customer-furnished couplers, or signal separating devices, to provide complete test set capability. This instrument contains four RF to IF converters.

HP 8514B S-parameter Test Set. Operates from 45 MHz to 20 GHz. This test set is suited for making S-parameter measurements on one and two port devices. This test set includes ruggedized 3.5mm connector test ports, directional couplers for signal splitting, two 90 dB step attenuators for changing the incident power at either port and provisions for applying dc bias from external power supplies to the test port center conductor.

HP 8515A S-parameter Test Set. Has all of the features of the HP 8514B, with the added capability of operating from 45 MHz to 26.5 GHz.

Test Set Options:

001	Adds IF Switching for Multiple Test Set Operation
002	Deletes the Step Attenuators and Bias Tees
908	Adds the Rack Flange Kit
910	Adds an Additional Operating and Service Manual
913	Adds the Rack Flange and Handle Kit

COMPATIBLE SOURCES

HP 8340B Synthesized Sweeper. Delivers the combined high-performance of a synthesizer and a broadband sweep oscillator in one instrument that is completely controllable via the Hewlett-Packard Interface Bus. This source operates from 10 MHz to 26.5 GHz

HP 8340B Options:

005	Rear Panel RF Output Without Attenuator
006	Delete Pulse Modulation
007	Relaxed Phase Noise Specifications

HP 8341B Synthesized Sweeper. Has the same features of the HP 8340B, however, it operates from 10 MHz to 20 GHz.

HP 8341B Options: 004 Rear Panel Output With Attenuator

HP 8350B Sweep Oscillator Mainframe. An HP 8350B must have Revision 6, or higher, of the firmware to make it compatible with an HP 8510 system. Refer to Appendix A of the Installation Manual for more information on retrofit kits and how to check for the correct revision number.

HP 83592A RF plug-in. Has a frequency range of 10 MHz to 20 GHz.

HP 83592B RF plug-in. Has a frequency range of 10 MHz to 20 GHz.

HP 83595A RF plug-in. Has a frequency range of 10 MHz to 26.5 GHz.

NOTE: Other HP 83500-series RF Plug-ins may be used, but may limit full system verification capability. For a more complete discussion on Plug-in compatibility please refer to Appendix A of the Installation Manual.

MEASUREMENT ACCESSORIES

7mm

HP 85050B 7mm Calibration Kit. Contains a set of precision calibration standards used to calibrate an HP 8510 network analyzer system when making error corrected measurements of devices with a 7mm connector interface.

HP 85050C 7mm Precision Calibration Kit. Offers the highest precision calibration using either the Thru-Reflect-Line (TRL) or the Offset Load calibration techniques, which are accomplished using a short circuit, an open circuit, a fixed broadband load, and a precision transmission line.

HP 85050D 7mm Economy Calibration Kit. Enables calibration using a short, an open, and a precision broadband fixed load (>40 dB return loss to 18 GHz) to provide convenient and economical calibration.

HP 85051B Verification Kit. Includes a set of 7mm measured standards used to verify the performance of an HP 8510 network analyzer operating with error correction.

HP 85132C 7mm Test Port Return Cable. This test port return cable is designed specifically to adapt from the test set ports (3.5mm) to the device under test (7mm). This cable is specified from DC to 18 GHz, is 81 cm in length, and is to be used when the device under test is connected directly to the test set port. *The HP 85130B NMD-3.5 to 7mm adapter Set is recommended for use with this cable.*

HP 85132D 7mm Test Port Return Cable Set. These cables differ from the above only in length (they are 53 cm long) and insertion loss specifications. They are connected directly to the test set ports and are used when the device under test is to be connected between the cables. With this cable set, the use of the HP 85130B Adapter Set is not required.

3.5mm

HP 85130B NMD-3.5mm to 7mm Adapter Set. Contains a pair of precision NMD-3.5mm to 7mm adapters used for converting the 3.5mm test ports of the HP 8514B and HP 8515A Test Sets to a 7mm connector interface.

HP 85052B 3.5mm Calibration Kit. Contains a set of precision calibration standards used to calibrate an HP 8510 network analyzer when making error corrected measurements of devices with a 3.5mm connector interface.

HP 85052E 3.5mm Economy Calibration Kit. Contains only one sliding load that can be made either male of female and contains no connector gages. In all other respects this kit is the same as the HP 85052B kit.

HP 85053B 3.5mm Verification Kit. Includes a set of 3.5mm measured standards used to verify the performance of an HP 8510 network analyzer operating with error correction.

HP 85131C 3.5mm Test Port Return Cable. This test port return cable is designed specifically to adapt from the test set ports (3.5mm) to the device under test (3.5mm). This cable is specified from DC to 26.5 GHz, is 81cm in length, and is to be used when the device under test is connected directly to the test set port.

HP 85131D 3.5mm Test Port Return Cable Set. These cables differ from the above only in length (they are 53 cm long) and insertion loss specifications. They are connected directly to the test set ports and are used when the device under test is to be connected between the cables.

Type N

HP 85054B Type N Calibration Kit. Contains a set of precision calibration standards used to calibrate an HP 8510 network analyzer system when making error corrected measurements of devices with a Type N connector interface.

HP 85055A Type N Verification Kit. Includes a set of Type N measured standards used to verify the performance of the HP 8510 network analyzer operating with error correction.

Type N Test Port Return Cables. Are **not** manufactured by Hewlett-Packard. Use one of the cables or cable sets recommended for 7mm devices and adapt to the device under test. The required 7mm to Type N adapters are included in the Type N calibration kit.

TEST CONFIGURATION ACCESSORIES

HP 85043A Racked System Kit. Is a rack, complete with support rails, a work surface and AC power distribution. The kit includes rack mounting hardware for all instruments and its thermal design is such that no rack fan is needed.

HP 11612A Bias Network. Is used to supply DC bias. This network is supplied with 3.5mm connectors and operates from 45MHz to 26.5GHz. **Standard S-parameter test sets include built-in bias networks.**

HP 11590B Bias Network. Is used to supply DC bias. This network is supplied with 7mm connectors and operates from 100MHz to 18GHz. **Standard S-parameter test sets include built-in bias networks.**

HP 11635A Bias Decoupling Network. Prevents transistor bias oscillations. One network is recommended for bipolar transistor measurement applications with **all** test sets.

HP 8349B 2-20 GHz Microwave Amplifier. May be used to increase input power level to S-parameter test sets and thereby increase system dynamic range. Option 001 (rear panel in/out installed) is recommended for use in racked configurations.

MILLIMETER-WAVE MEASUREMENT SYSTEMS

Complete systems are available for high performance millimeter-wave measurements in the 26.5 GHz to 40 GHz, 33 GHz to 50 GHz, 40 GHz to 60 GHz, 50 GHz to 75 GHz, and 75 GHz to 100 GHz waveguide bands.

HP 85106A Millimeter-wave Network Analyzer Sub-system. Is a factory integrated system that includes both the instruments and hardware in common with all millimeter system configurations. The addition of the hardware supplied with one or more of the waveguide test set kits, calibration kits, and source modules gives a complete measurement system in the waveguide bands(s) of interest.

HP 83554A Millimeter-wave Source Module. This source module is an efficient frequency multiplier that translates microwave signals in the 11 to 20 GHz range to millimeter-wave signals. This particular module produces a millimeter-wave output of 26.5 GHz to 40 GHz.

HP 83555A Millimeter-wave Source Module. This module is similar to the HP 83554A but produces a millimeter-wave output of 33 GHz to 50 GHz.

HP 83556A Millimeter-wave Source Module. This module is similar to the HP 83554A but produces a millimeter-wave output of 40 GHz to 60 GHz.

HP 85100V Millimeter-wave Source Module. This module is similar to the HP 83554A but produces a millimeter-wave output of 50 GHz to 75 GHz.

HP 85100W Millimeter-wave Source Module. This module is similar to the HP 83554A but produces a millimeter-wave output of 75 GHz to 100 GHz.

HP 85100A LO/IF Kit. Includes the LO and IF amplifiers, cabling, connecting hardware and waveguide stands that are part of the HP 8510 millimeter-wave system. This kit is included as part of the HP 85106A subsystem and is only required separately for customer configured milimeter-wave measurement systems.

HP 11643A-Series Test Set Kits. These millimeter-wave test set kits contain the band-dependent hardware necessary to assemble a reflection/transmission test set for use with the HP 8510 millimeter-wave system.

Kit	Frequency
HP R11643A	26.5 – 40.0 GHz
HP Q11643A	33.0 – 50.0 GHz
HP U11643A	40.0 – 60.0 GHz
HP V11643A	50.0 – 75.0 GHz
HP W11643A	75.0 – 100 GHz

HP 11644-Series Precision Calibration Kits. Each Calibration Kit allows full use of internal HP 8510 vector accuracy enhancement, offering fully error-corrected, high resolution, wide dynamic range magnitude and phase measurements with accuracy and speed comparable to the microwave HP 8510 system. A precision 10 cm straight section is included for use in procedures to **verify** system performance.

Kit	Frequency
HP R11644A	26.5 – 40.0 GHz
HP Q11644A	33.0 – 50.0 GHz
HP U11644A	40.0 – 60.0 GHz
HP V11644A	50.0 – 75.0 GHz
HP W11644A	75.0 – 100 GHz

SYSTEM SOFTWARE

Option 010, Time Domain Firmware. The HP 8510B option 010 has the capability of displaying the time domain response. This provides the ability to view the response of a test device as a function of time or distance. Displaying the reflection coefficient of a network versus time determines the magnitude and location of each discontinuity, of displaying the transmission coefficient of a network versus time determines the characteristics of individual transmission paths. Time domain operation retains all accuracy inherent with the calibration that is active in the frequency domain. The time domain capability is useful for the design and characterization of such devices as Surface Acoustic Wave (SAW) filters, SAW delay lines, RF cables, and RF antennas.

HP 85012B Time Domain Firmware. Adds the Time Domain feature, after the system has been purchased.

The following software is compatible with HP 9000 series 200 and 300 computers.

HP 85161A Measurement Automation Software. Provides calibration, measurement, and data output capabilities for the HP 8510 system with a minimum of operator interaction.

HP 85171A Integrated Touchstone software for the HP 9000 Series 300 Personal Microwave Workstation. Allows computer aided design of microwave circuitry using the HP 8510 system Touchstone is a U.S. registered trademark of EEsof Inc.

HP 85014B Active Device Measurement Application Pac. For use with the Transistor Measurement System. Allows complete automated S-parameter measurements of active devices in-fixture.

TRANSISTOR MEASUREMENT SYSTEM ACCESSORIES

HP 85041A Transistor Test Fixture. Includes a precision measurement fixture and a data disc (in both 3.5" and 5.25" media types). The fixture is only useful in automated applications with the HP 85014B software. The data disc contains fixture characterization and performance verification data for use with the HP 85014B software.

HP 8717B Transistor Bias Supply. Provides manual or automatic biasing for transistor testing and characterization. For automatic bias control also include:

Option 001	Programming Capability
Option 011	Programming Cable

HP 4145A/B Semiconductor Parameter Analyzer. Automatically applies and controls bias when used in conjunction with a HP 85014B (Active Device Measurement Application Pac). Two bias connect cables (HP Part No. 85014-60002) are required for use with the HP 4145A/B.

OTHER MEASUREMENT ACCESSORIES

Plotters

HP 7440A Eight-Pen Colorpro Plotter. (Option 002) ISO A4 or 8.5 X 11 in. chart size.

HP 7475A Six-Pen Graphics Plotter. (Option 002) ISO A4/A3 or 8.5 X 11 in. and 11 X 17 in. chart size.

HP 7550A Eight-Pen Graphics Plotter.

NOTE: An external computer is not required to copy the HP 8510B CRT screen to a plotter.

Disc Drives

HP 9122D 3.5 in. Dual Disc Drive.

HP 9153A 10 Mbyte Winchester with 3.5 in. Disc Drive.

HP 9153B 20 Mbyte Winchester with 3.5 in. Disc Drive.

HP 9133L 40 Mbyte Winchester with 3.5 in. Disc Drive.

NOTE: Measurement data, instrument states, and calibration sets may be stored directly to an external disc without the aid of a computer. Compatible with CS/80 format only.

HP-IB Cables

HP 10833A 1m (3.3 ft.) Cable.

HP 10833B 2m (6.6 ft.) Cable.

HP 10833D 0.5m (1.6 ft.) Cable.

WARRANTY AND SUPPORT PRODUCTS

Option W03 Warranty Conversion. Converts the standard one-year return-to-HP warranty to a 90-day on-site warranty at no additional cost. For support after the 90-day warranty expires, Hewlett-Packard recommends HP 8510B +02A or +02B on-site service and +23C on-site calibration service, effective the fourth month and continuing on a month to month basis.

Option W30 Extended Service. Adds two additional years of return-to-HP service, to follow the first year of warranty. This provides three full continuous years of HP service.

NOTE: Options W03 and W30 can be ordered at the time of sale only. These warranty options are not available for all models. Consult your local Hewlett-Packard representative for further details.

HP 8510A +24D 3-Day User Course. Training for two students is provided with each HP 8510B at no charge (except one is included with the HP8510E). Order this item for additional enrollments.

HP 8510T +23N Installation. On-site system installation and verification, where available.

HP 8510B +02A or +02B. On-site basic monthly maintenance contract, where available.

HP 8510T +23G On-Site Calibration. Recommended once a year. System performance characterization using traceable verification devices where available.

HEWLETT-PACKARD INTERFACE BUS (HP-IB).

The HP 8510B is factory-equipped with a remote programming interface using the Hewlett-Packard Interface Bus (HP-IB). HP-IB is Hewlett-Packard's hardware. software, documentation, and support for IEEE-488 and IEC-625, worldwide standards for interfacing instruments. This provides a remote operator with the same control of the instrument available to the local operator, except for control of the power line switch and internal tests. Remote control is maintained by a controlling computer that sends commands or instructions to and receives data from the HP 8510B using the HP-IB. Several output modes are available for outputting data. Through a subset of HP-GL (Hewlett-Packard Graphics Language), user graphics can be plotted on the HP 8510B CRT.

The HP 8510B itself can use HP-IB to output measurement results directly to a compatible printer or plotter without the use of an external computer.

COMPUTER

An external controller is not required for error correction or time domain capability. However, system measurements can be automated with the addition of an HP9000 series 200 or 300 computer. In addition, performance test procedures and some adjustments are semi-automated and require the use of an external controller. For more information about compatible computers, consult your Hewlett-Packard customer engineer.

SERVICE

Refer to your Service Manual for information on:

Ordering Replacement Parts
Adjusting your System
An Explanation of the Running Error Messages
An Explanation on how to troubleshoot and repair the HP 8510B

In the event that you did not order the Service Manual and Adapter Emulator Kit (Option 915), refer any questions regarding service information you may have to the nearest Hewlett-Packard Sales and Service Office or your personal Hewlett-Packard representative. Always identify the instrument by model number, complete name, and complete serial number in all correspondence. A worldwide listing of HP Sales and Service Offices is provided at the back of this section.

Should you find it necessary to return your system to Hewlett-Packard for repair, please fill out and attach to your instrument the blue instrument repair card you will find in the rear of this section.

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 apparatus will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect the apparatus against damage.

Indicates dangerous voltages.

Earth terminal (sometimes used in manual to indicate circuit connected to grounded chassis).

WARNING

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

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the equipment. 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 imparied, the product must be made inoperative and be secured against any unintended operation.

BEFORE APPLYING POWER

Verify that the product is configured to match the available main power source per the input power configuration instructions provided in this manual.

If this product is to be energized via an autotransformer, make sure the common terminal is connected to the neutral (grounded side of 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 tot he 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.

X-RAY RADIATION NOTICE

ACHTUNG

Model HP 85101B

WARNING

Während des Betriebs erzeugt dieses Gerät Röntgenstrahlung. Das Gerät ist so abgeschirmt, daß die Dosisleistung weniger als 36 pA/kg (0,5 mR/h) in 5cm Abstand von der Oberfläche der Katodenstrahlröhre beträgt. Somit sind die Sicherheitsbestimmungen verschiedener Länder, u.A. der deutschen Röntgenverordnung eingehalten.

Die Stärke der Röntgenstrahlung hängt im Wesentlichen von der Bauart der Katodenstrahlröhre ab, sowie von den Spannungen, welche an dieser anliegen. Um einen sicheren Betrieb zu gewährleisten, dürfen die Einstellungen der Niederspannungsund des Hochspannungsnetzteils nur nach der Anleitung in Kapitel V des Handbuches vorgenommen werden.

Die Katodenstrahlröhe darf nur durch die gleiche Type ersetzt werden. (Siehe Kapitel Vi für HP – Ersatzteile).

Das Gerät ist in Deutschland zugelassen unter der Nummer: BW/179/84/Rö

When operating, this instrument emits x-rays; however, it is well shielded and meets safety and health requirements of various countries, such as the X-ray Radiation Act of Germany.

Radiation emitted by this instrument is less than 0.5 mR/hr at a distance of five (5) centimeters from the surface of the cathode-ray tube. The x-ray radiation primarily depends on the characteristics of the cathode-ray tube and its associated low-voltage and high-voltage circuitry. To ensure safe operation of the instrument, adjust both the low-voltage and high-voltage power supplies as outlined in Section V of this manual (if applicable).

Replace the cathode-ray tube with an identical CRT only. Refer to Section VI for proper HP part number.

Number of German License: BW/179/84/Rö

GEWERBEAUFSICHTSAMT STUTTGART

- Zentrale Stelle für Sicherheitstechnik und Vorschriftenwesen in Baden-Württemberg -

Gewerbeaufsichtsamt · Jägerstr. 22 · Postfach 703 · 7000 Stuttgart 1

Firma
Hewlett Packard GmbH
Herrenberger Str. 110/130

7030 Böblingen

Stuttgart, den 06.05.1987
Fernsprecher
(07 11) 2 05 01 (Behördenzentrum)
Durchwahl 2050 - 4798
Aktenzeichen: Z 5108/HP/Ws/Hh
(Bitte bei Antwort angeben)

Zulassungsschein Nr. BW/179/84/Rö
(Neufassung)

Gemäß § 9 der Röntgenverordnung vom 1. März 1973 (BGBl. I S. 173) wird die Zulassung der Bauart durch den Bauartzulassungsbescheid vom 20.06.1984 und Nachtrag 1 vom 06.05.1987 für die nachfolgend aufgeführten Störstrahler bescheinigt:

Gegenstand	:	Display/Processor
Firmenbezeichnung	:	HP Typ: 85 101 B
Bildröhre	:	Hewlett-Packard Typ: 5083-5791
Hersteller	:	Hewlett-Packard Co. 1400 Fountaingrove Parkway Santa Rosa, CA 95401, USA
Betriebsbedingungen	:	Hochspannung max. 23,5 kV Strahlstrom 7,5 µA
Zulassungskennzeichen	:	BW/179/84/Rö

Die Bauartzulassung ist befristet bis 20.06.1994.

Für den Strahlenschutz wesentliche Merkmale

1. Die Art und Qualität der Bildröhre,

2. die der Hochspannungserzeugung und -stabilisierung dienenden Bauelemente.

...

Auflagen:

1. Die Geräte sind bezüglich der für den Strahlenschutz wesentlichen Merkmale entsprechend den vorgestellten und geprüften Mustern und Antragsunterlagen herzustellen.

2. Die Geräte sind einer Stückprüfung daraufhin zu unterziehen, ob sie bezüglich der für den Strahlenschutz wesentlichen Merkmale der Bauartzulassung entsprechen.

   Die Prüfung muß umfassen:

   a) Kontrolle der Hochspannung an jedem einzelnen Gerät,

   b) Messung der Dosisleistung nach Festlegung im Bauartzulassungsbescheid.

3. Die Herstellung und die Stückprüfung sind durch den von der Zulassungsbehörde bestimmten Sachverständigen überwachen zu lassen.

4. Die Geräte sind deutlich sichtbar und dauerhaft mit dem Kennzeichen

   BW/179/84/Rö

   zu versehen sowie mit einem Hinweis folgenden Mindestinhalts:

   "Die in diesem Gerät entstehende Röntgenstrahlung ist ausreichend abgeschirmt.
   Beschleunigungsspannung maximal 23,5 kV."

Hinweis für den Benutzer des Geräts:

Unsachgemäße Eingriffe, insbesondere Verändern der Hochspannung oder Auswechseln der Bildröhre können dazu führen, daß Röntgenstrahlung in erheblicher Stärke auftritt. Ein so verändertes Gerät entspricht nicht mehr dieser Zulassung und darf infolgedessen nicht mehr betrieben werden.

Reutter

GEWERBEAUFSICHTSAMT STUTTGART

Dieses Gerät wurde nach den Auflagen der Zulassungsbehörde einer Stückprüfung unterzogen und entspricht in den für den Strahlenschutz wesentlichen Merkmalen der Bauartzulassung. Die Beschleunigungsspannung beträgt maximal 23,5 kV.

Hewlett-Packard Co.
1400 Fountaingrove Parkway
Santa Rosa, CA 95401, USA

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System Installation

This section provides instructions for installing and interconnecting an HP 8510 system in a rack or on a bench. The basic system is defined as an HP 8510 (which consists of an HP 85101 display/processor and an HP 85102 IF detector), an HP 851x test set and a microwave source. Other peripherals, such as controllers, plotters, printers, disc drives, and millimeter devices, may be added to the basic system.

The information in this manual is divided into four parts:

- Pre-installation (how to choose an appropriate installation site)
- Installation (how to hook up and run the system)
- Appendixes (less commonly needed information)
- Index (alphabetical listing, with page number, of topics covered).

Two check lists are provided to ensure that steps are not overlooked. Experienced installers need refer to little else.

The checklists also serve as indexes of more detailed information. For example, the first topic of the following "HP 8510 System Pre-Installation Checklist" is "Space Requirements." If you want to know more about the space requirements of an HP 85043A rack-mounted system, turn to the page indicated. If you're satisfied with the space reserved for your system, check the "Done" box and move on to "Electrical Requirements."

If the system ordered has been shipped in the system rack, assemble the manual set (see "Documentation") and confirm that all of the instruments' fuses and line voltage settings are correct (see "Power Considerations"). Then check for loosened connections and conclude the installation procedure with the "Operator's Check".

If option HP 8510T +23N on-site installation and verification has been ordered, contact your Hewlett-Packard Customer Engineer to assist in answering pre-installation questions and, after all of the instruments have arrived, to install the system and conduct its performance verification.

Figure 1. Typical HP 8510 System Bench Installation

Table 1. HP 8510 System Pre-Installation Checklist

(Refer to topic headings on the indicated pages for details.)

Topic	Done	Page
Space Requirements		
HP 85043A Rack-Mounted System		
90 cm x 130 cm (36 in x 51 in, includes clearance)	[ ]	3
Bench-Top or Other Rack System		
Bench, table or other rack to hold instruments	[ ]	3
Automatic System		
Controller table 930 mm x 712 mm (36 in x 28 in)	[ ]	3
Electrical Requirements		
HP 85043A Rack-Mounted System		
1 multiple-outlet power strip[1] (1875 VA)	[ ]	3
Bench-Top or Other Rack System		
2 multiple-outlet power strips[1] (1875 VA each)	[ ]	4
Environmental Requirements for Accuracy-Enhanced Measurements		
Temperature: +20°C to +26°C (+68°F to +79°F)	[ ]	4
Humidity: 20% to 80% RH	[ ]	4
Altitude: 0 to 4500 metres (15,000 feet)	[ ]	4
RFI and EMI susceptibility defined	[ ]	4
Antistatic tabletop mat	[ ]	4
Communications Recommendations		
Telephone close to system	[ ]	5
Operating Supplies		
Plotter paper, spare pens, etc. on hand	[ ]	5
System Components		
Shipping containers inspected	[ ]	5
Instruments already on hand verified	[ ]	5, A[2]
Instruments (and rack) unpacked	[ ]	6
Serial numbers verified	[ ]	6
On-Site Installation		
Customer engineer contacted, installation scheduled	[ ]	6

[1] extra outlets are for service
[2] appendix A, one of six, at end of manual

Pre-Installation

A site must be provided that meets the space, power, environmental, and communications requirements of the system ordered, as described below.

SPACE REQUIREMENTS

HP 85043A Rack-Mounted System

Sufficient space must be provided for the rack plus a minimum clearance of 15 cm (6 in) behind and on both sides of the rack to allow proper ventilation. The HP 8510 system rack, HP 85043A, measures 124 cm high, 60 cm wide and 80 cm deep (49 x 24 x 32 in). The total depth of the rack with the work surface installed is 115 cm (45 in). The 183 cm (6 foot) tall rack differs only in height.

Bench-Top or Other Rack System

A bench or table large enough and strong enough to hold the system instruments should be provided. One with a power distribution strip along the back is suggested. The exact dimensions and weights of HP 8510 system instruments are included in the tables of supplemental characteristics in the individual instrument manuals.

Typical systems are about 53 cm (21 in) high, 60 cm (24 in) deep and 45 cm (18 in) wide, when arranged as a single stack. When configured as two adjacent stacks, plan a minimum width of 113 cm (45 in) to allow for ventilation clearance (see Figure 2). Basic systems weigh about 80 kilograms (180 pounds).

Other racks can be used for an HP 8510 system (see Appendix G). Hewlett-Packard will cooperate in evaluating non-standard rack systems. However, HP is not obligated to support user-configured rack systems. Please consult your Hewlett-Packard Customer Engineer for advice and for warranty and support details regarding such systems.

Automatic System

Provide another table for the controller. The recommended table is HP 92170G, which is 72 cm (28 in) high by 93 cm (36 in) wide by 71 cm (28 in) deep and mounted on casters.

ELECTRICAL REQUIREMENTS

The basic HP 8510 system electrical requirements are summarized in Table 2. The specific instrument manuals are more detailed.

Table 2. Electrical Requirements of Basic HP 8510 System

Voltage	90 to 132, 180 to 264 volts ac
Power	1000 VA maximum
Frequency	47.5 to 66 Hertz

The system should be connected to a grounded circuit capable of supplying 2000 VA (includes test equipment and peripherals) without interruption, and without interference from other equipment such as air conditioners or large motors. An additional power line outlet should be provided for each peripheral and the controller of an automatic system.

In a HP 85043A rack system, power is supplied to the rack through its heavy-duty grounded primary power cable, and to the individual instruments in the rack through special power cables included with the rack.

For a bench-top or non-HP 85043A rack system, power line outlets should be provided for each of the system instruments (display/processor, IF detector, test set and source) and any peripherals.

In addition to the power outlets required for operation of the HP 8510 system, three power line outlets should be provided for service equipment. Hewlett-Packard manufactures a six-outlet strip, HP 92199A, with a continuous power rating of 1875 VA.

ENVIRONMENTAL REQUIREMENTS

For specified performance, the environment of the HP 8510 should meet the following criteria:

Operating Environment

- Temperature: 0°C to +55°C (+32°F to +135°F)
  Note the accuracy-enhanced temperature requirements which follow.
- Relative humidity: 5% to 95% at +40°C or less (non-condensing)
- Altitude up to 4600 metres (approximately 15,000 feet)

In addition to the above requirements, the following considerations should be observed:

- The environment should be as dust-free as possible, and the air filters in the instruments and the rack should be cleaned regularly.
- Electrostatic discharge (ESD) should be controlled by use of static-safe work procedures. For bench installation, the HP 92175T tabletop antistatic mat will decrease the possibility of damage from ESD.

Storage environmental requirements are detailed in Table 3.

Accuracy-Enhanced Measurement Requirements

Measurement calibration must be performed within the window of 20°C to 26°C (68°F to 79°F).

Performance verification and actual device measurements must be made within ±1°C (±1.8°F) of the measurement calibration temperature, from 19°C to 27°C (66.2°F to 80.8°F).

Electromagnetic Interference

HP 8510 conducted and radiated interference is in compliance with United States CISPR Publication 11 (1975), and German Messempfaenger-Postverfuegung 526/527/79 (Kennzeichnung Mit F-Nummer/ Funkschutzzeichen).

COMMUNICATIONS RECOMMENDATION

It is recommended that a telephone be located close to the system in case assistance is needed.

OPERATING SUPPLIES

Take the time now to collect the individual items that your system will use: plotter paper, pens, adapters, connector care literature and supplies.

SYSTEM COMPONENTS

The instruments ordered as components of the HP 8510 system may be shipped separately from different points of origin, and may not arrive as a single shipment. However all system instruments ordered are coordinated to arrive within two weeks of each other.

Shipping Containers Inspected

Inspect all shipping containers. If your shipment is damaged or incomplete, save all packing materials and notify both the shipping carrier and the nearest Hewlett-Packard Sales and Service Office. Hewlett-Packard will arrange for repair or replacement of damaged or incomplete shipments without waiting for a settlement from the transportation company. Notify the HP customer engineer of any problems.

It is recommended that the shipping containers be kept in one area and not unpacked until all the instruments are delivered. Table 3 summarizes recommended storage conditions. Before unpacking, verify that all system components ordered have arrived by comparing the shipping forms to the original system purchase order.

Table 3. Recommended HP 8510 System Storage Environment

	Instruments	HP 98200A Tape Cartridge
Temperature	−40 to +75°C (−40 to +167°F)	0 to +45°C (+32 to +113°F)*
Humidity	65°C maximum wet-bulb temperature, 5% to 95% RH, non condensing	30°C maximum wet bulb temperature, 20% to 20% to 80% RH, non-condensing*
Pressure Altitude	less than 15,300 metres (50,000 feet)	
*Limiting factors		

Instruments Already on Hand Verified

Any system instruments or computer equipment already on hand (not shipped with the system) should be verified before being integrated into the system. Also refer to Appendix A to check the compatibility of such instruments.

Instruments (and Rack) Unpacked

Most of the system instruments are double-crated to better withstand the rigors of shipping. Typical packaging is illustrated in Appendix B, which also includes repacking recommendations. Details specific to an instrument (contents and part numbers, for example) are in its manual or packing list or both.

Some of the instruments are heavy. Handle them carefully to avoid injury. Unpacking them on the floor is recommended.

The system rack is heavy and can be unwieldy, all the more so when shipped with instruments installed. Follow the instructions which accompany the rack. Those instructions are included in Figure 12 (Appendix C).

Serial Numbers Verified

As you unpack the system components, verify that the serial numbers listed on the shipping documents are the same as those on the rear panels of the instruments. Keep the packing materials in case they are needed for reuse.

ON-SITE INSTALLATION

If you have ordered HP 8510+23N, On-Site Installation and Verification, be sure that all system components have been delivered, unpacked, and collected at the installation site. Then contact the Hewlett-Packard customer engineer to schedule the installation, configuration, and system verification.

Installation

GETTING STARTED

To install and verify an HP 8510 system yourself, refer to the following checklist (Table 4) and supplemental information as required.

Table 4. HP 8510 System Installation Checklist

(Refer to topic headings on the indicated pages for details.)		
Topic	**Done**	**Page**
Documentation		
Assemble the HP 8510 manual set	[ ]	7
Setting Up the Instruments		
Bench-Top or Non-HP 85043A Rack-Mounted System		
Instruments in place	[ ]	8
HP 85043A Rack-Mounted System		
Rack prepared for installation of instruments	[ ]	9
Instrument feet removed and flanges attached	[ ]	9, 10
Instruments installed in rack	[ ]	10
Automatic System		
Controller in place	[ ]	10
Power Considerations		
Instruments set and fused for local line voltage	[ ]	11
Power cables grounded	[ ]	11
Electrical Connections		
Instruments connected electrically (Use Table 3)	[ ]	11-16
Turn On Instruments		
Instruments turned on in proper sequence	[ ]	16
Operator's Checks		
"Operator's Checks" performed and passed	[ ]	17, 18
In Case of Difficulty		19

ASSEMBLE THE MANUAL SET

The HP 8510 system manual consists of several volumes. Pages for each volume are wrapped in plastic and inserted loose in the appropriate volume binder.

Remove the protective plastic film from each stack of pages and clip those pages into the binders. Note that some binders have tabbed sections which may not be used, depending on the instruments and accessories ordered for the system.

SET UP THE INSTRUMENTS

HP 8510 systems can incorporate a variety of instruments. Thus many configurations are possible. The instructions given here are for the basic HP 85043A rack-mounted system and a typical bench-top configuration.

Bench-Top or Non-HP 85043A Rack-Mounted Systems

Two typical bench-top configurations are illustrated in Figure 2. Many are possible, including single stack and equal stack (2x2) configurations. Just keep in mind the configuration guidelines of Table 5 and the reasons for them as you configure your own system.

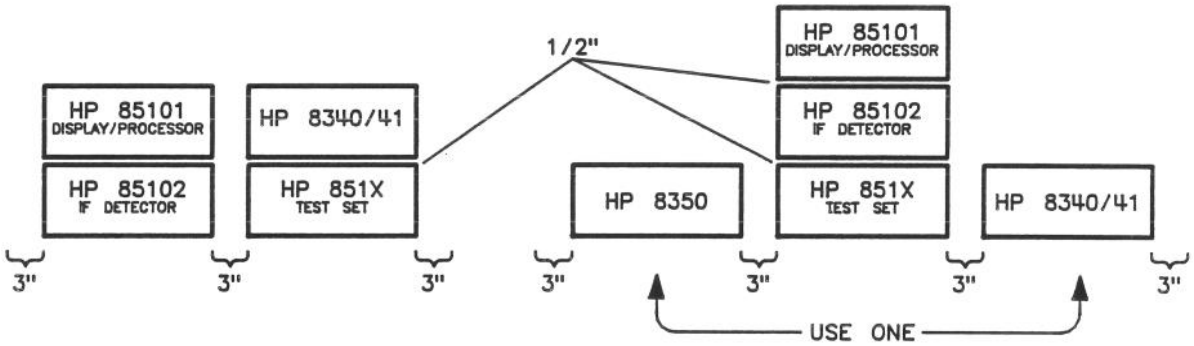


Figure 2. Typical Bench Configurations

Table 5. HP 8510 System Configuration Guidelines

To ensure adequate cooling and reliable operation:

- Remove any instruction card assemblies from the bottoms of instruments to maintain vertical separation. (Remove feet first then reinstall feet.)
- Keep all instrument feet on to maintain 12 mm (1/2 inch) vertical space.
- Keep covers on during operation.
- Maintain 75 mm (3 inch) side separation.
- Do not place deeper instruments on top of HP 8350.

For ease of installation and convenience in use:

- Place test set directly on bench.
- Position HP 85102 before locking it to HP 85101.
- Place HP 85101 on top of HP 85102 and lock them together (see Figure 3).
- Place HP 85101 Display/Processor at eye level.

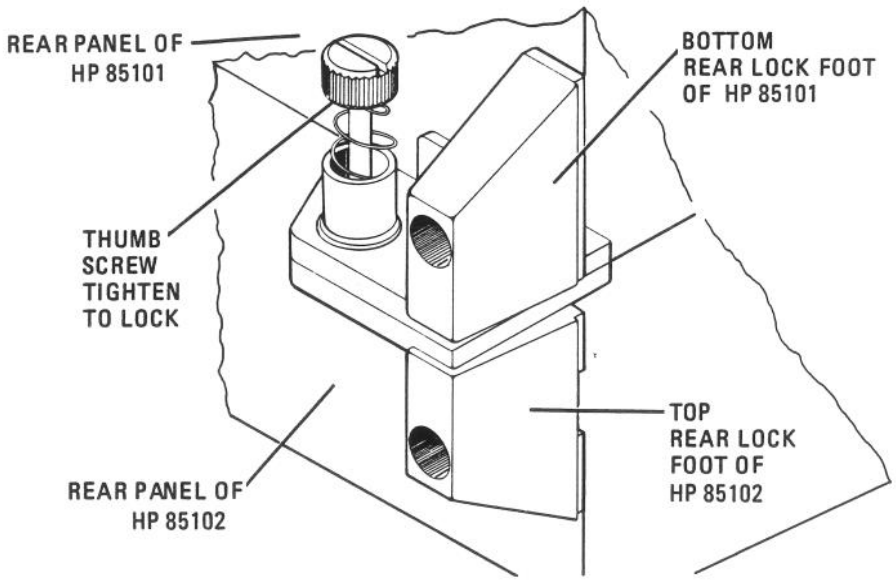


Figure 3. Locking HP 85101 and HP 85102 Instruments Together

Note: Use the RF cable supplied with the test set to connect it to the source. Longer cables with greater losses will lessen dynamic range.

Using a rack other than the HP 85043A for a HP 8510 system is possible. See Appendix G. But temperature and air-flow tests must precede non-standard rack configurations. Consultation with your Hewlett-Packard Customer Engineer on the proposed configuration is strongly recommended. Recall that the HP 85043A system rack does not include a cabinet fan.

HP 85043A Rack-Mounted System

The HP 85043A system rack has been designed specifically for one instrument configuration: one set of instruments arranged one way. Other configurations, different instruments or arrangements, may result in measurement inaccuracy and reliability problems due to overheating. Note that cooling is accomplished by the correct placement of the instruments and baffles, and the instruments' fans. No other fans are required.

The following instructions are quite abbreviated. Refer to the system rack manual as required for additional details.

Rack Prepared for Installation of Instruments: Locate the rack in its operating area. Then lower the foot at each bottom corner of the rack to prevent further movement and stablize it.

Instrument Feet and Cards Removed: Remove the four plastic feet of each instrument before racking it. Slide each foot toward the center and pull up to remove as illustrated by Figure 4.

Remove any instruction card assemblies from the instruments' bottom covers.

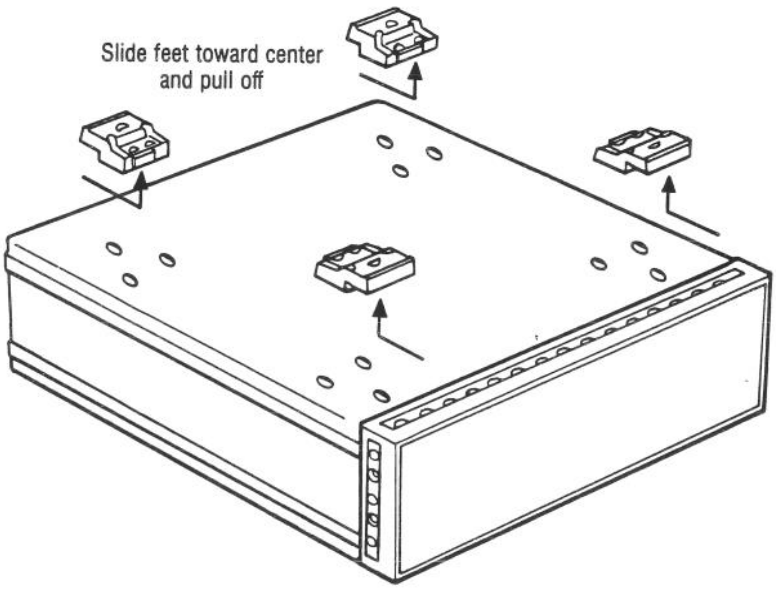


Figure 4. Lock Foot Removal

Rack Flanges Attached: Rack mount flanges may be attached with the instrument placed partly on the support shelves of the rack. Note that longer screws are supplied to accommodate the thickness of the handle and flange. Figure 13 in Appendix D illustrates how to install rack flanges on instruments with and without handles.

Instruments Installed in Rack: Slide each instrument into the rack and secure it with the dress screws provided.

Automatic System

Provide a table to hold the controller. The recommended table is HP 92170G.

POWER CONSIDERATIONS

All of the HP 8510 system instruments can be set to operate in these voltage ranges: 90 to 132V, 180 to 255V. Some of the instruments may have wider ranges as noted in their operating and service manuals.

If the line voltage is not within range, use an autotransformer.

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.

Instruments Set and Fused for Local Line Voltage

In all HP 8510 systems, the line voltage and fuses for each instrument must be set 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. Correct fuse values are listed on the instruments' rear panels.

CAUTION

Severe damage to the instruments can result if line voltage settings or fuse selections are incorrect when power is applied.

For additional information concerning line voltage or fuse requirements, refer to the Operating and Service manuals supplied with the instrument in question.

Power Cables Grounded

In compliance with international safety standards, the HP 8510 system instruments are equipped with 3-wire power cables. When connected to properly installed power line outlets, these cables ground the individual chassis of these instruments.

The cables needed for the electrical interconnections of an HP 8510 system are shipped in the accessories boxes of the HP 8510 instruments.

In HP 85043A installations, the instruments are connected directly to the power strip inside the cabinet, using the 3-conductor grounded power cords supplied with the system rack. Do not modify these power cords regardless of the ac line voltage or the type of cabinet external power plug used. Use these cables instead of the power cords supplied with the instruments.

If the cabinet external power plug does not correspond to the local power outlet, replace it with the appropriate 3-wire grounded plug.

ELECTRICAL CONNECTIONS

The HP 8510 system requires the connection of several types of cables. Descriptions of the cables and considerations regarding them follow. See Table 6 and Figures 5 through 7.

Table 6. Electrical Connections

For all systems, perform cable connection steps 1 through 5 (6 and 7 optional). Then perform steps 8 through 12 according to the system source.

The step numbers correspond to the connectors identified in Figures 5 and 6.

Step	Cable	From Instrument	To Instrument	Where Found
1	Line[1]	85101 display/processor: line module (rear panel slide switch set to System Controlled)		85101 accessory box
1	Line[1]	85102 IF detector: line module		85101 accessory box
1	Line[1]	Test Set: line module		test set manual box
2	IF-D[2]	85101: IF Display Interconnect	85102: IF Display Interconnect	85101 accessory box
3	TSIF[3]	85102: J1 Test Set Interconnect	Test Set: Test Set Interconnect	test set accessory box
4	RPEC[4]	Test Set: J2 & J3	Test Set: J4 & J5	test set accessory box
5	HP-IB[5]	85101: 8510 Interconnect	Test Set: J12 8510 System Bus	test set accessory box
6	HP-IB[5]	85101: 8510 Interconnect	Printer, Plotter, Disc Drive	supplied with peripheral
7	HP-IB[5]	85101: HP-IB	Controller: HP-IB	supplied with controller
HP 8340/41-based systems				
8	Line[1]	8340/41: line module		instrument box
9	BNC[6]	8340/41: Stop Sweep In/Out	85102: Stop Sweep	85101 accessory box
10	BNC[6]	8340/41: Sweep Output	85102: Sweep In 0 to 10V	85101 accessory box
11	HP-IB[5]	8340/41: HP-IB	85101: 8510 Interconnect	instrument box
12	RF[7]	8340/41: RF Output	Test Set: RF Input	supplied with test set
HP 8350-based systems				
8	Line[1]	8350: line module		instrument box
9	BNC[6]	8350: Stop Sweep	85102: Stop Sweep	85101 accessory box
10	BNC[6]	8350: Sweep Out/In	85102: Sweep In 0 to 10V	85101 accessory box
11	HP-IB[5]	8350: HP Interface Bus	85101: 8510 Interconnect	instrument box
12	RF[7]	8350: RF Output	Test Set: RF Input	supplied with test set

[1] Line: line power cord (shown in Appendix E)
[2] IF-D: IF Display Interconnect Cable (shown in Figure 7)
[3] TSIF: Test Set IF Interconnect Cable (labelled as such)
[4] RPEC: Reference Port Extension Cable (shown in Figure 7)
[5] HP-IB: HP Interconnect Bus Cable (shown in Figure 7 and 8)
[6] BNC: BNC Cable (shown in Figure 7)
[7] RF: Flexible Source Cable [and adapter] (shown in Figure 7)

These parts are described further in the section titled "Electrical Connections." Part numbers are listed in the various instrument manuals.

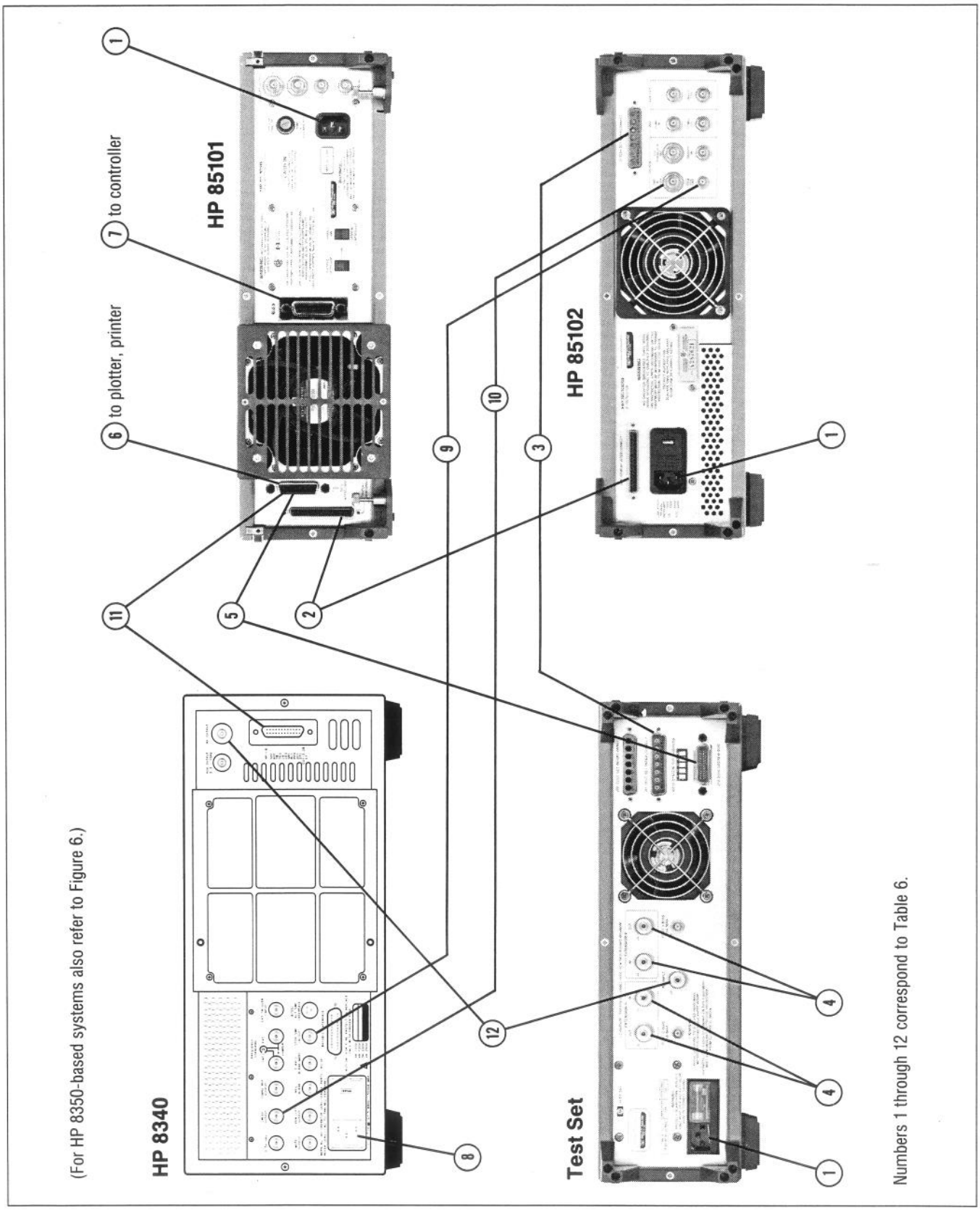


Figure 5. Typical HP 8510 System Rear Panel Connectors

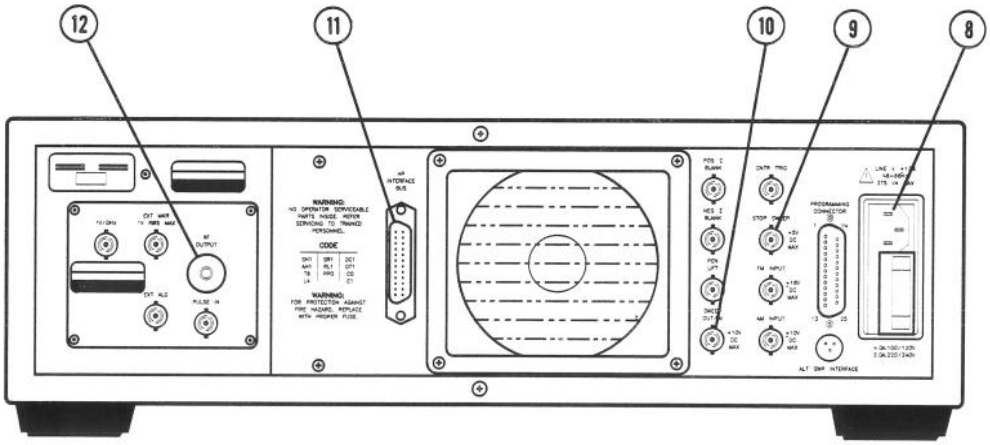


Figure 6. HP 8350 Rear Panel Connectors

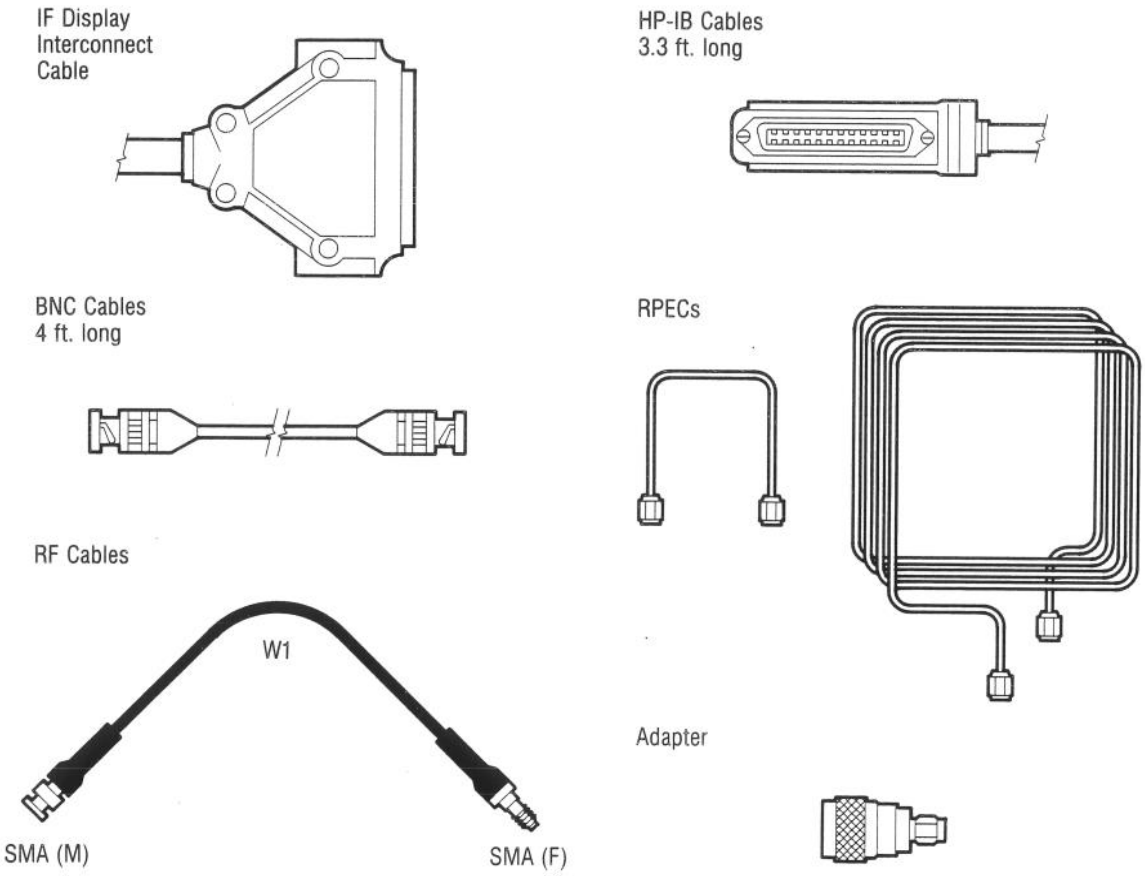


Figure 7. HP 8510 System Cables and Adapter

Power Cables

If the power cables supplied do not mate with the local power outlets, refer to Table 9 in Appendix E of this manual. Table 9 lists the variety of plugs available on power cords and the HP part number.

IF-Display Interconnect Cable

This cable connects the two instruments which constitute the HP 8510 itself. It is labelled "IF Display Interconnect" and documented further in the HP 8510 manual.

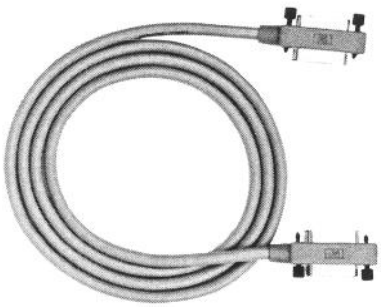
HP-IB Cables

The Hewlett-Packard Interface Bus (HP-IB) is Hewlett-Packard's hardware, software, documentation and support for IEEE-488 and IEC-625, world-wide standards for interfacing instruments. HP-IB allows either the system display/processor or an external controller to operate the various instruments of the system.

NOTE: Turn off power to instruments when connecting HP-IB cables.

Using the HP-IB cables supplied in the system configurations recommended will ensure system data integrity. However other configurations are possible with other cables (see Figure 8). As many as fifteen instruments can be connected in parallel on HP-IB, but proper voltage levels and timing relationships must be maintained. Therefore, observe the following restrictions:

- 2 metres (6 feet) is the maximum cable length to each instrument.
- 20 metres (65 feet) is the maximum total cable length between all units.



HP-IB Cable Part Numbers	Length
HP 10833A	1 m (3.3 ft.)
HP 10833B	2 m (6.6 ft.)

Figure 8. HP-IB Cables Available

Reference Port Extension Cables

Reference port extension cables (RPECs) are used to balance the RF reference and test signal path lengths of test sets. They are connected to the test set rear panel at connectors J2 through J5. HP RF cable in the following table means any of the cables or sets recommended for use in an HP 8510 system.

Connect the RPECs as indicated in Table 7. Part numbers of the long and short RPECs are listed in the test set manuals.

Note that operating the HP 8340/41 in **[STEP]** or **[CW]** mode lets you use the short RPEC under any circumstances.

Table 7. Choosing the Correct RPEC

Object at Port	Port 1	Port 2
RF Cable	Connect **long** RPEC to Extension B (J2, 3)*	Connect **long** RPEC to Extension A (J4, 5)*
DUT	Connect **short** RPEC to Extension B (J2, 3)*	Connect **short** RPEC to Extension A (J4, 5)*
*Use a 5/16 open end torque wrench set to 8 in-lb.		

In brief:

- Port 1 is balanced by Extension B
- Port 2 is balanced by Extension A
- With DUT directly connected to Port, use short RPEC
- With RF cable connected to Port, use long RPEC

Cables fabricated for custom applications should be balanced with custom-made RPECs of similar electrical length.

BNC Cables

The BNC cables required for system connections are supplied in the accessories boxes of the various instruments and documented further in those instruments' manuals.

RF Flexible Source Cable

Use the flexible RF source cable supplied with each test set to connect the source to the test set. Some sources also require the use of the supplied adapter.

TURN ON INSTRUMENTS

Power can be applied to the instruments in the HP 8510 system in any order with two restrictions:

- In systems with controllers: controller last, HP 85102 next to last
- In systems without controllers: HP 85102 last

NOTE: The HP 85101 front panel LED indicates power received from the HP 85102, not line power. If the HP 85101 display/processor does not turn on, confirm the following:

- HP 85101 rear panel LINE switch set to SYSTEM CONTROLLED
- HP 85102 front panel LINE switch set to I (on)

OPERATOR'S CHECKS

The following operator's checks should confirm that the HP 8510 system is functional and ready for performance verification or operation or both. These simple checks are optional and primarily serve to establish confidence in the integrity of the system.

HP 8510 Self-Test

As soon as the HP 8510 is turned on, it performs a self-test sequence (described more completely in the service documentation). During this sequence you may observe on the CRT:

- TESTING
- a diagonal line
- LOADING OPERATING SYSTEM
- SYSTEM INITIALIZATION IN PROGRESS
- RECALLING INSTRUMENT STATE

The instrument state recalled will vary according to whatever settings had been stored in instrument state 8. However, all properly functioning systems will display the firmware system issue information illustrated in Figure 9.

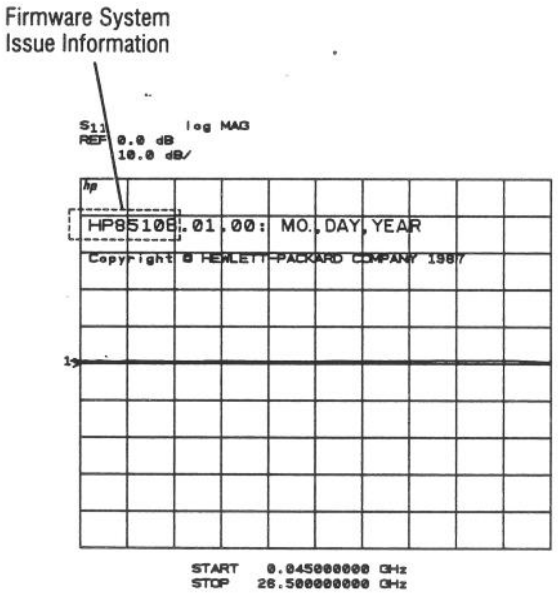


Figure 9. Power-on Firmware System Issue Information

Preset Check

Press the green **[PRESET]** key on the HP 85102 and about a second later the CRT should show a trace similar to Figure 10. Additionally the CRT should indicate that the measurement parameter is S11, the format is log MAG, and the REF is 0.0 dB at a scale of 10.0 dB/(division).

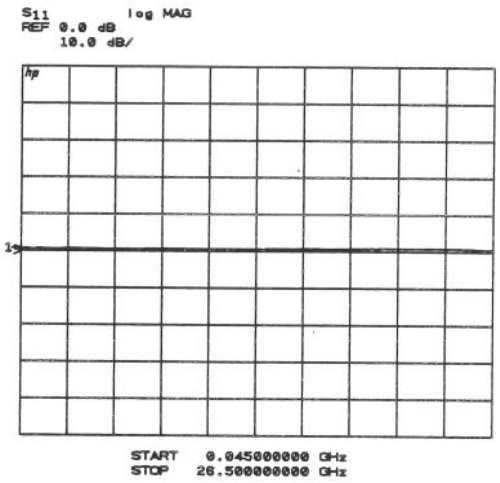


Figure 10. Typical Preset State Display

S-Parameter Test Set Check

To further confirm that the system is ready for performance verification or operation, press **[S12]** (in the parameter area of the HP 85102). The trace should drop to the bottom graticule of the display. The **test set** S12 LED (next to a2) should light.

Press **[AUTO]** in the response area of the IF detector. The trace should reappear near the center of the display, probably with a change in scale.

If an appropriate RF cable is handy, connect it to Ports 1 and 2 of the test set. The trace should rise toward the top of the display.

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

This concludes the basic system tests. To thoroughly check the performance of the system, refer to the Performance Verification procedures in "Performance Tests" if desired.

To operate the system, refer to "Operating and Programming."

IN CASE OF DIFFICULTY

Improper operation can be indicated several ways:

- Running error message(s) on the HP 85101 display/processor CRT
- Inappropriate system response or operation.

The most likely cause of improper operation for newly installed systems is an incorrect cable connection. Carefully recheck all cable connections. Power-up the system instruments again in the correct sequence. If the problem is not HP-IB related, refer to the System Service manual or contact your local HP customer engineer.

"SYSTEM BUS ADDRESS ERROR" indicates a HP-IB problem. For some reason, the various instruments on the instrument bus are unable to communicate with each other. Especially for systems incorporating previously used instruments, the problem may be an improperly set HP-IB address. The HP 8510 may be looking for an instrument at one address while that instrument is set for a different address. Refer to Appendix F to begin troubleshooting this problem.

Appendixes

APPENDIX A: HP 8510 SOURCE COMPATIBILITY

The synthesizers, sweep oscillators and plug-ins must have the modifications or firmware revisions or both as noted in Table 8 for HP 8510 compatability. Instruments with revision numbers lower than those listed can be made HP 8510-compatible with the modification kits listed below.

To check the HP 8350B firmware revision number, press the HP 8350 **[SHIFT] [4] [9]** keys. The firmware revision number will appear in the right-hand FREQUENCY/TIME display.

To check the HP 83500-series RF plug-in firmware revision number, press the HP 8350 **[SHIFT] [9] [9]** key. The firmware revision number will appear in the plug-in POWER window.

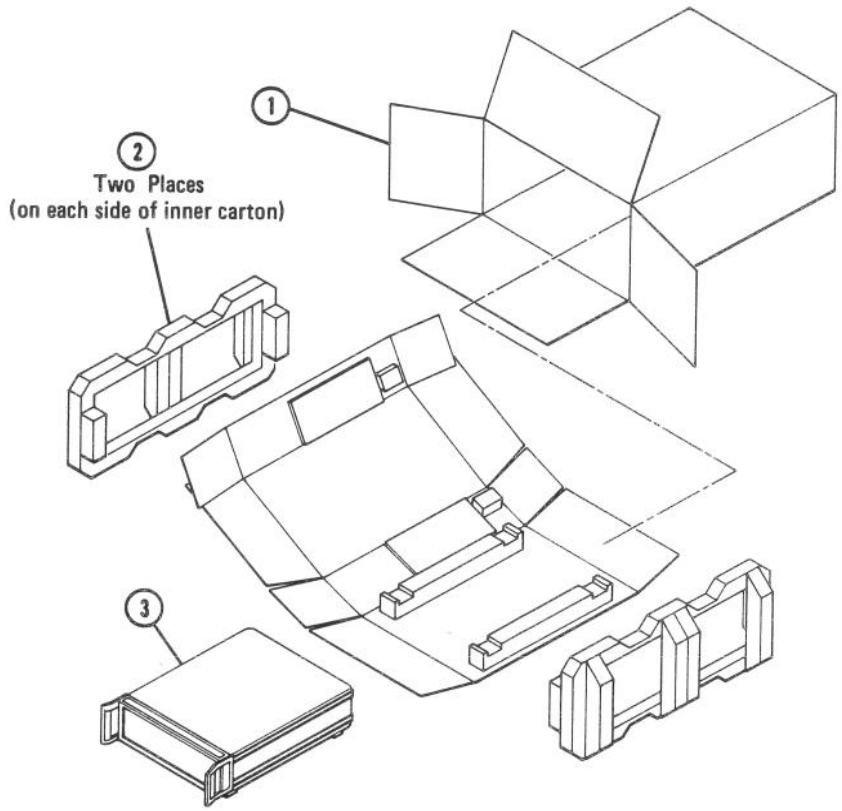
Table 8. Modification Kits for HP Instruments

Instrument	Firmware Revision Number (or Higher)	Modification Kit
HP 8340A synthesizer	all	unnecessary
HP 8340B synthesizer	all	unnecessary
HP 8341A synthesizer	all	unnecessary
HP 8341B synthesizer	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 83570A RF plug-in	6	83525-60074
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 8620 sweep oscillator	can not be used	
HP 86200-series plug-ins	can not be used	

[1] Converts HP 8350A to HP 8510 compatability

Note: The sources listed above are the only compatible sources as of June 1987. Consult your Customer Engineer for additional information.

APPENDIX B: UNPACKING HP 8510 SYSTEM INSTRUMENTS



1. Open the marked end of the outer carton and fold all four flaps outward.
2. Carefully place the open end of the carton face downward on the floor. Pull the outer carton upward so that only the inner carton remains, surrounded by the two foam rails. It will be helpful to have another person hold the inner carton (and the instrument) as you do this.

   Remove the foam rails from the sides of the inner carton and lay the inner carton flat. Then open the inner carton and remove the instrument.
3. Remove the polyethylene wrapper (not shown) from the instrument.

Figure 11. Unpacking HP 8510 System Instruments

Repacking

If it is necessary to ship any of the instruments in the HP 8510 system, pack each instrument separately and use the original packaging materials if possible. Containers and materials used for factory shipments are also available, through any Hewlett-Packard office.

If an instrument is being returned to Hewlett-Packard for service, please complete and attach a blue service tag indicating the nature of the problem and who to contact for more information about the service required. Identify the instrument by model number and full serial number and list the other HP 8510 system instruments it is being used with.

These general instructions should be followed whenever instruments are packed for shipping:

Instruments not originally shipped in a system rack must be removed prior to reshipment. *Do not store or install instruments in the rack when it is on its side or back. Major damage to the instruments and to the rack can occur.*

Wrap the instrument in heavy paper or anti-static plastic.

Place the wrapped instrument in a strong shipping container. A double-wall cardboard carton made of 350-pound test material is adequate.

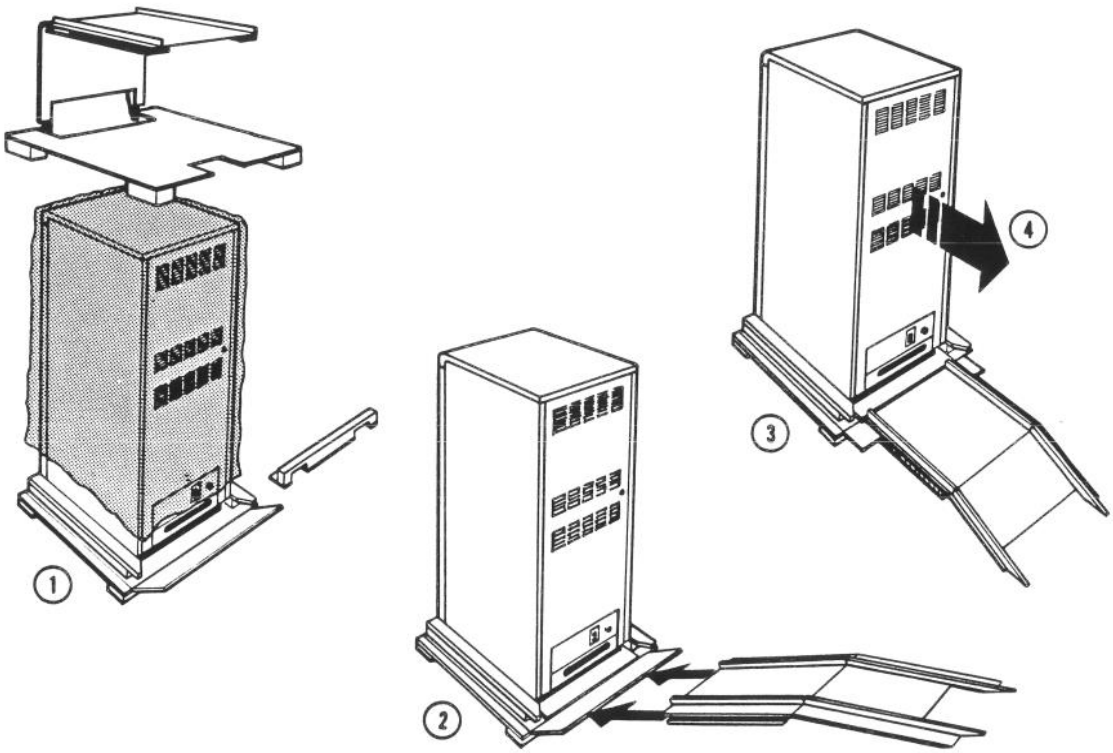
Place enough shock-absorbing material around all sides of the instrument to provide a firm cushion and prevent any movement of the instrument inside the container. A three-inch to four-inch layer is generally sufficient.

Seal each shipping container carefully and mark it FRAGILE to ensure careful handling.

APPENDIX C: UNCRATING THE HP 85043A SYSTEM RACK

WARNING

Injury may result if racks are handled carelessly. Racks loaded with instruments are especially heavy and prone to tip unless handled with care.



1. Remove the wrapping bands and retaining clips on the crate, and remove the cardboard cover.

   Lift the ramp and cardboard spacer off of the rack. Discard the spacer and the plastic foam around the rack.

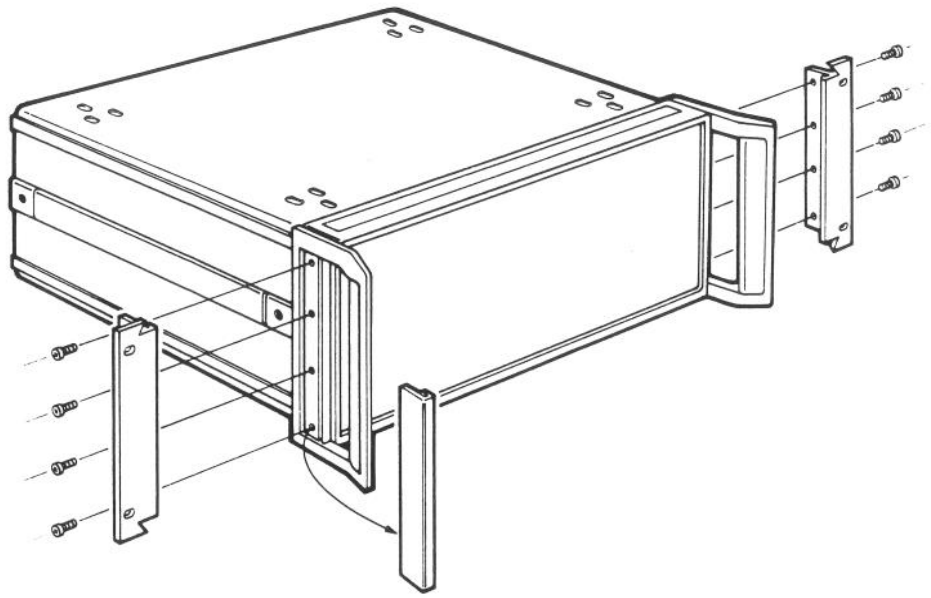
2. At the rear of the rack, remove the wooden spacer at the bottom.

   Slide the ramp slot onto the short rear panel.

3. Carefully roll the rack down the ramp to the floor.

Figure 12. Uncrating the HP 85043A System Rack

APPENDIX D: RACK FLANGE ATTACHMENT



1. Remove the plastic front handle trim strips using a small flat-bladed screwdriver or knife.
2. Remove the flat head machine screws used to attach the handles.
3. a. Reattach the handles and flanges with the longer screws supplied in the kit, or

   b. Attach the flanges with the machine screws supplied.

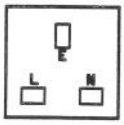
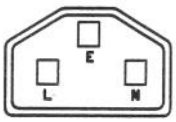
Note: Instruments manufactured before March 1985 may use English rather than metric screws. Replacements are as follows:

- flat head machine screws, 8-32 x 0.375 in, HP Part Number 2510-0195
- round head machine screws, 8-32 x 0.625 in, HP Part Number 2510-0194

Figure 13. Attaching Flanges to Instruments With and Without Handles

APPENDIX E: MAINS PLUGS AND AC POWER CORDS AVAILABLE

Table 9. Mains Plugs and AC Power Cords

Plug Type[1]	Cable HP Part Number[2]	CD[3]	Plug Description[2]	Cable Length (inches)	Cable Color	For Use in Country
250V 	8120-1351 8120-1703	0 6	Straight BS1363A 90°	90 90	Mint Gray Mint Gray	United Kingdom, Cyprus, Nigeria, Zimbabwe, Singapore
250V 	8120-1369 8120-0696	0 4	Straight ZNSS198/ASC112 90°	79 87	Gray Gray	Australia, New Zealand
250V 	8120-1689 8120-1692	7 2	Straight CEE7-VII 90°	79 79	Mint Gray Mint Gray	East and West Europe, Saudi Arabia, Egypt, Republic of So. Africa, India (unpolarized in many nations)
125V 	8120-1348 8120-1398 8120-1754 8120-1378 8120-1521 8120-1676	5 5 7 1 6 2	Straight NEMA5-15P 90° Straight NEMA5-15P Straight NEMA5-15P 90° Straight NEMA5-15P	80 80 36 80 80 36	Black Black Black Jade Gray Jade Gray Jade Gray	United States, Canada, Japan (100V or 200V), Mexico, Philippines, Taiwan
250V 	8120-2104	3	Straight SEV1011.1959 24507,Type 12	79	Gray	Switzerland
250V 	8120-0698	6	Straight NEMA6-15P			United States, Canada
220V 	8120-1957 8120-2956	2 3	Straight DHCK 107 90°	79 79	Gray Gray	Denmark
250V 	8120-1860	6	Straight CEE22-VI (System Cabinet Use)			

1. E = Earth Ground; L = Line; N = Neutral
2. Part number shown for plug is industry identifier for plug only. Number shown for cable is HP Part Number for complete cable including plug.
3. The Check Digit (CD) is a coded digit that represents the specific combination of numbers used in the HP Part Number. It should be supplied with the HP Part Number when ordering any of the power assemblies listed above, to expedite speedy delivery.

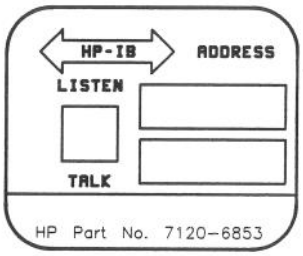
APPENDIX F: HP-IB ADDRESS CHECK

In HP-IB communications, each instrument is identified by an HP-IB address. This decimal-based address code must be different for each instrument on the bus.

Check the HP-IB address of each of the instruments in the system. Most of the HP-IB addresses are factory preset and need not be modified for normal system operation. The standard factory-set addresses for system instruments are listed in Table 10.

Table 10. Standard HP-IB Addresses and Label

Instrument	HP-IB Address (decimal)
HP 8510	16
System bus	17
Source	19
Test set	20
Plotter	5
Printer	1
Pass-thru	31
Disc drive	0
Controller	721



To see the address of the HP 8510, press the **[LOCAL]** key on the front panel of the HP 85101. The HP-IB softkey menu will be displayed along the right-hand edge of the CRT. Then press the key adjacent to the label **[ADDRESS of 8510]**. The address of the HP 8510 will be displayed. If the number displayed is not 16, press **[1] [6] [x1]**. The display should now show 16. This HP 8510 address is not affected by preset or by turning the line switch off or on.

To see what address the HP 8510 is set to communicate with any other system instrument, press the appropriate softkey of the HP-IB menu. Addresses at which the HP 8510 communicates with other instruments can be changed by entering the new number and pressing the **[x1]** key. Addresses may be changed only in this manner. Detailed information on HP 8510 front panel and softkey operation is provided in the Operating and Programming sections of the system manual.

Note that the above procedure does not change the other instrument's address. The other instrument addresses are typically changed with internal or rear panel binary-weighted switches, or front panel entry. Instructions are provided in the manual for each instrument.

Individual HP-IB address labels (see Table 10) can be used on the rear panel of each instrument in the system for quick reference to the HP-IB address.

APPENDIX G: CUSTOMER SUPPLIED CABINET CONSIDERATIONS

The crucial factor for determining whether a customer supplied cabinet or rack will degrade HP 8510 system performance is this:

The air temperature at the intake of each instrument's fan must not exceed the ambient temperature specified for that instrument.

As with all electrical instruments, HP 8510 system reliability decreases as temperature varies from ambient. Ideally instrument temperatures should be maintained as near ambient as possible even though HP instruments meet performance and reliability standards at the recommended temperature extremes.

The recommended minimum clearances for adequate airflow cooling are:

- 0.5 inch vertical separation (between top and bottom of stacked instruments)
- 3.0 inch horizontal separation (between instrument side and cabinet)
- 6.0 inch rear separation (between rear panel of instrument and cabinet)

The following information may be helpful in choosing a cabinet or rack:

- The basic HP 8510 system consists of a display/processor, an IF/detector, a test set, and a source.
- The basic HP 8510 system consumes 1000 VA.
- An airflow of five hundred (500) cfm through the cabinet typically limits cabinet temperature to less than 5°C above ambient.
- Increase airflow proportionally if additional (heat-producing) instruments are added to the basic HP 8510 system.

INDEX

Letters refer to Appendixes at end of manual.

MEASUREMENT CHARACTERISTICS

Number of Display Channels

Two display channels available

Measurement Parameters

S_{11}, S_{21}, S_{12}, S_{22}. Parameters may be redefined by the user for special applications. Conversion to Z_1 (input impedance), Z_2 (output impedance), Y_1 (input admittance), Y_2 (output admittance), and 1/S is also provided.

Domains Available

Frequency, Time[1], and Auxiliary Voltage (rear panel output acting as device stimulus, range is ± 10 V_{dc}).

Formats

Cartesian. log/linear magnitude, phase, group delay, SWR, real part of complex parameter, imaginary part of complex parameter.

Smith Chart. Marker format can be selected as log magnitude, linear magnitude, R + jX, or G + jB.

Polar. Marker format can be selected as log magnitude, linear magnitude, phase, or real and imaginary.

Data Markers

Five independent data markers read out the value of the formatted parameter and stimulus (frequency, time[1], or auxiliary voltage).

Marker Functions

Discrete/Continuous. Markers can indicate data at actual data points or they can interpolate between data points to allow the setting of a marker at an exact stimulus value.

Delta Marker. Marker readout shows difference between active marker and the reference marker (any marker can be used as the reference).

Marker search. Specific trace values can be located, such as MAX, MIN, and target (e.g. −3.00 dB point).

1. Time Domain (the inverse Fourier Transformation of Frequency Domain data) is available only with Option 010.

Marker Resolution

Log Magnitude: 0.001 dB to 0.1 dB.
Linear Magnitude: 0.001 x 10^{-12} to 0.1 units.
Phase: 0.001 x 10^{-12} to 0.1 degrees.
Group Delay: 0.001 x 10^{-12} to 0.1 seconds.

Group Delay Characteristics

Group Delay is computed by measuring the phase change within a specified frequency step (determined by the frequency span and the number of points per sweep). The phase change, in degrees, is then divided by the frequency step, in Hz (times −360).

Aperture

Determined by the frequency span, the number of steps per sweep, and the amount of smoothing applied.

Minimum aperture = (frequency span)/(#points−1)
Maximum aperture = 20% of the frequency span.

Range

The maximum delay is limited to measuring no more than ±180 degrees of phase change within the minimum aperture.

$$\text{Range} = 1/(2 \times \text{Minimum Aperture})$$

For example, with a minimum aperture of 200 kHz, the maximum delay that can be measured is 2.5 μsec.

Accuracy

The following graph shows group delay accuracy at 20 GHz with an HP 8515A Test Set and an HP 8340B operating in stepped sweep mode.

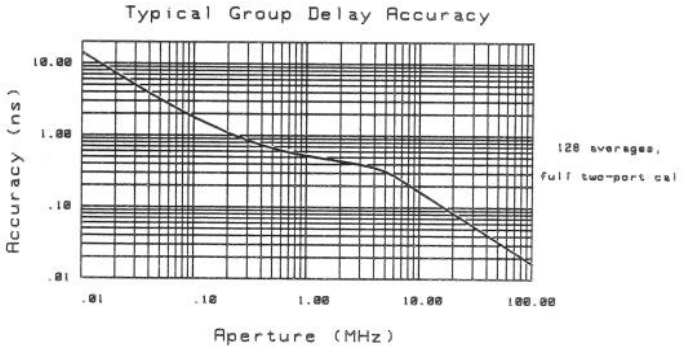


Figure 1. Group delay vs. aperture

In general, the following formula can be used to determine the accuracy, in seconds, of a specific group delay measurement.

$$\pm \frac{0.003 \times \text{Phase Accuracy (deg)} + \text{Delay (sec)} \times \text{Linearity (Hz)}}{\text{Aperture (Hz)}}$$

Depending on the aperture and the device length, the Phase Accuracy used is either incremental phase accuracy or worst case phase accuracy. The above graph shows this transition.

SOURCES USED WITH THE HP 8510 SYSTEM

Compatible sources

The following swept sources are fully compatible with the HP 8510B:

HP 8340A/B Synthesized Sweeper
HP 8341A/B Synthesized Sweeper
HP 8350B Sweep Oscillator with HP 835xx RF plug-in (except stepped sweep mode)

Refer to the HP 8510 Installation Manual, Appendix A, for more information on compatible sources for your HP 8510 system.

Sweep Limits

Set Start/Stop or Center/Span of the stimulus parameter (frequency, time, or Auxiliary Voltage).

Measured number of points per Sweep

Selectable as 51, 101, 201, 401, or 801 points. In frequency list mode, the number of points can ranges from 3 to 401.

Sweep Modes

Ramp sweep (analog)

Stepped sweep (with HP 8340/41 only)

Frequency list sweep. Define up to 30 different arbitrary sub-sweep frequency ranges by specifying Start/Stop, Center/Span, or CW sweeps. Define the number of points or step size for each range. All frequencies are synthesized if using the HP 8340/41, frequency domain only.

Single point (single frequency)

Fast CW mode (HP-IB only). Raw data (real and imaginary) is sent immediately to HP-IB as soon as it is taken. Must be triggered externally (TTL). With external trigger (no averaging), data is available approximately 1 msec after the trigger pulse is received.

Alternate Sweep

The two channels, including markers, may be coupled (same source parameters) or uncoupled (different source parameters).

Sweep Time

Minimum sweep time is automatically selected, depending on the number of points per sweep (and the averaging factor if in stepped mode). Longer sweep times may be entered by the user from 0.1 to 100 seconds.

Trigger modes

Sweep Trigger. Set to either Continual, Hold, Single, or Number of Groups Sweep.

Data Trigger. Data taking is triggered automatically in stepped mode and by the sweep voltage in ramp mode. In step mode, data taking can be triggered over HP-IB.

External Data Trigger. Data is taken only when a TTL pulse is received at the rear panel EXTERNAL TRIGGER input.

Source Power

Set source power (dBm) or power slope (dBm/GHz). With the S-parameter test sets with built-in attenuators, the Port 1 or Port 2 signal level can be controlled by setting the internal attenuator of the test set.

Multiple Frequency Control Mode

In this mode, the HP 8510B controls up to three frequency ranges independently: the frequency of the primary source (HP 8340/41 synthesized sweeper), the frequency of a secondary source (may be phase-locked HP 8350B sweep oscillator), and the frequency of the network analyzer receiver.

Frequency Control. All frequency ranges can be separately defined as functions of the device under test frequency, by specifying a multiplier (a ratio of integers) and an offset for each frequency.

Definition Storage. The active multiple frequency mode parameters are stored in non-volatile memory and may be saved on disc or tape with the hardware configuration.

Sweep Modes. All sweep modes can be used in multiple frequency mode. However, ramp sweeps are limited to less than one source band.

External LO phase-lock control. In applications where an external LO is used in place of a test set, LO phase lock control is provided to phase lock a sweep oscillator with DC FM capability (e.g. HP 8350B) to a synthesized sweeper (e.g. HP 8340).

ACCURACY ENHANCEMENT AND CALIBRATION CHARACTERISTICS

Calibration Types Available

Frequency Response. Simultaneous magnitude and phase correction of frequency response errors for either reflection or transmission measurements. Requires a short or open circuit termination (reflection) or a through connection (transmission).

Response/Isolation Cal. Compensates for frequency response and directivity (reflection) or frequency response and crosstalk (transmission) of test sets. Requires a short or open circuit and load termination (reflection) or through connection and load termination (transmission).

One Port Cal. Correction of test set Port 1 or Port 2 directivity, frequency response and source match errors. Requires three known standards, for example, open, short, and load (fixed, sliding, or offset) terminations.

Two Port Cal. Compensates for Port 1 and Port 2 directivity, frequency response and source match errors. Requires three known standards, for example, open, short, and load (fixed, sliding, or offset) terminations.

Full Two Port Cal. The following are the four kinds of Full Two Port Cal:

- **Traditional.** For use with an S-parameter test set, requires three known standards at each port, for example, short, open (or offset short), and load (fixed, sliding, or offset) terminations, A through connection is also required.
- **One Path Two Port Cal.** A two port cal for one port Reflection/Transmission test sets, such as with the millimeter wave systems. Provides a full two port error-corrected measurement when the test device is turned around and measured in both directions.
- **Thru-Reflect-Line (TRL).** A two port calibration which requires a through connection, a reflection standard, and a reference transmission line. For use with S-parameter test sets only.
- **Noninsertable Cal. (Adapter Removal).** A two port calibration for noninsertable devices, such as those with identical sexed connectors on both ports. For S-parameter test sets only.

Reference Plane Extension

Redefine the plane of measurement reference (zero phase) to other than that established at calibration. A new reference plane is defined in seconds of delay from the test set port and ranges between ±1 seconds.

Set Z_0

Can redefine the characteristic impedance of a measurement to other than 50 Ω.

Calibration Kits

Select either standard (7 mm, 3.5 mm, Type N-50 Ω) calibration kits or define other standards (e.g., open circuit capacitance coefficients, offset short length, fixed or offset loads, sliding loads, etc.).

Data for a group of defined standards (called a CAL KIT) may be stored in memory or on a cassette tape via the built-in tape drive or on disc using an external disc drive. Data for two CAL KIT's may be stored in memory at any one time.

The definitions of the standards contained in the HP 85050B 7 mm Calibration Kit and the HP 85052B 3.5 mm Calibration Kit are in the CAL KIT memories at time of shipment from the factory.

Calibration Storage

Eight separate calibration sets may be stored in non-volatile memory. If any 801 point full two-port calibrations are stored, storage may be limited to as few as four cal sets.

Data Averaging

Similar to a variable bandwidth IF filter, this function computes the running average of a number of data traces in ramp mode or data points in stepped mode. Averaging factors range from 1 to 4096 in powers of 2. In stepped sweep mode, each data point is averaged before being displayed.

Trace Smoothing

Similar to variable bandwidth video filter, this function computes the moving average of adjacent data points in a single trace. Smoothing aperture defines the trace width (number of points) to be averaged, and ranges from 0.125% to 20% of the trace width. This function also sets the aperture for group delay measurements.

DATA HARDCOPY

Data Plotting

Hard copy plots are automatically produced by the HP 8510B when used with an HP-GL compatible digital plotter such as the HP 7440A ColorPro plotter.

Plotter Functions. Plot Trace(s), Graticule(s), Marker(s), or Text with any plotter pen. Operating and system parameters can also be plotted.

Formats. Full or quarter page plots.

Analog Output. Available for driving analog recorders (+7.8V to −7.8V).

Data Listings

Printouts of instrument data are produced directly by the HP 8510B when used with a compatible HP-IB printer such as the HP 2225A ThinkJet printer. Operating and system parameters can also be printed.

DISPLAY CONTROL

CRT Formats

Single channel, dual channel overlay (both traces on one graticule), dual channel split (each trace on separate graticules).

Trace Functions

Display Data. Display current measurement data, memory data, or current measurement and memory data simultaneously.[2]

Trace Math. Vector math (+, −, ×, ÷) of current linear measurement values and memory data.

2. Due to display memory limitations, the HP 8510B cannot display Data and Memory on both channels (4 traces) with 801 data points. The traces are limited to 401 points for the CRT display. However, when accessing the data over HP-IB, all 4 traces (801 points each) are valid. Data displayed is a worst case representation of the actual data taken. In all instances, peak to peak data is displayed.

Display Annotations

Frequency (start/stop, center/span, or CW), scale/div, reference value, marker data, soft key functions, warning and caution messages, and trace identification.

Scale Resolution

Magnitude:
Log format (dB/div): 0.001 to 500
Linear format (units/div): 10 X 10^{-12} to 500

Phase:
Cartesian (degrees/div): 10 X 10^{-12} to 500
Polar (degrees/display graticule): 45

Reference Value

Ranges between ±500 units (dB, degrees, seconds, etc.)

Reference Position

Ranges from the 0 (bottom) to 10 (top) graticule position.

Auto

Automatically selects Scale Resolution and Reference Value to center the trace on the CRT graticules for easy viewing.

Electrical Delay

Offset measured phase or group delay data by a defined amount of electrical delay, in seconds. Operates similar to an electronic line stretcher. Amount of electrical delay can range between ±1 seconds. Electrical delay can also be displayed in electrical length (meters) or physical length by entering a relative propagation velocity.

Waveguide Delay. A non-linear phase delay may be used to account for dispersion in waveguide. The waveguide cutoff frequency must be entered.

Magnitude Offset/Slope. May be used to modify displayed magnitude data.

Auto Delay. Automatically selects the electrical delay for a flat phase response.

Security Features

Frequency Blanking. Blank all frequency information on the display. Requires an instrument preset to re-enable frequency information on the display.

CRT OFF. The entire CRT display can be turned off.

Memory Purge. The entire HP 8510 memory, including the operating system, can be reinitialized. The EEPROM Read/Write test may be used to **purge all non-volatile memory**, including the operating system. This test reads and writes an alternating pattern, and checks the results.

Title

Add custom titles (50 characters maximum) to the display of the HP 8510B. Titles are plotted when making data hardcopies.

INSTRUMENT CONTROL

Control Knob, Step Keys, Data Entry Keyboard and =Marker key

Instrument parameters may be set in one or all of four ways. The control knob allows for continuous adjustment of a parameter, while the data entry keyboard is used to enter an exact function value. The step keys can be used to increment or decrement parameter values. The **=Marker** key can be used to set the function to the active marker value (e.g. Reference value **=Marker** sets the reference value to the amplitude value of the active marker).

Menu and Softkey Keyboards

Instrument measurement functions may be accessed through menu keys which select a given set of functions to appear on the softkey keyboard. Selection of the appropriate softkey then selects the desired instrument function.

STORAGE

Internal Memory

Instrument State. As many as eight instrument states can be stored via the SAVE menu. These instrument states can then be recalled via the RECALL menu. Instrument states include all control settings, memory trace data, active list frequency tables,and custom display titles. Save register 8, however, is reserved for the power up state, which can be defined by the user. Instrument states are stored in non-volatile memory.

Hardware Configurations. One hardware configuration is stored in active non-volatile memory. This configuration is not changed at instrument Preset. The hardware configuration includes all instrument addresses and the multiple frequency mode parameters.

Data Traces. Eight traces of data can be stored in the trace memories. Traces 1-4 are stored in non-volatile memory.

Calibration Sets. Eight separate calibration sets may be stored in non-volatile memory. If any 801 point full two-port calibrations are stored, storage may be limited to as few as four cal sets.

Other Media

All types of data may be stored to and retrieved from the built-in tape drive or an external disc drive.

Tape Drive. The built-in tape drive can be used to store and retrieve different types of data on a cassette tape cartridge (HP 98200A). Data is stored in a block format (2K bytes/block). Each tape cassette has 85 blocks.

External Disc Drive. Data can also be stored on disc using an external disc drive with command subset SS/80. Data files are stored in Hewlett-Packard's standard LIF format, which can be read by a wide variety of computers, including the HP 9000 Series 200 or 300.

Recommended disc drives:

HP 9122D Dual 3 1/2" Drive
HP 9153A 10 Megabyte Winchester Hard Disc
HP 9133H 20 Megabyte Winchester Hard Disc
HP 9133L 40 Megabyte Winchester Hard Disc

TIME DOMAIN (OPTION 010)

Description

With the Time Domain option, data from transmission or reflection measurements is converted from the frequency domain to the time domain using the inverse Fourier transform and presented on the CRT display. The Time Domain response shows the measured parameter value versus time. Markers may also be displayed in electrical length (or physical length if the relative propagation velocity is entered).

Time Stimulus Modes

Two types of time domain stimulus waveforms can be simulated during the transformation – a step and an impulse. Although these waveforms are generated mathematically with the inverse FFT, the results for linear circuits are the same as would be obtained if the actual time waveforms had been applied and measured.

Low Pass Step. This stimulus, similar to a traditional Time Domain Reflectometer (TDR) waveform, is used to measure low pass devices. The Frequency Domain data must extend from DC (extrapolated value) to a value within the range of the source and test set used. The step response is typically used for reflection measurements only.

The Low Pass Step waveform displays a different response for each type of impedance (R,L,C), giving useful information about the discontinuities being measured.

Response Resolution[3]. In Low Pass Step mode, Response Resolution is determined by the step rise time (10%-90%) of the time stimulus. This depends on both the frequency span and the window used (see *Windows*):

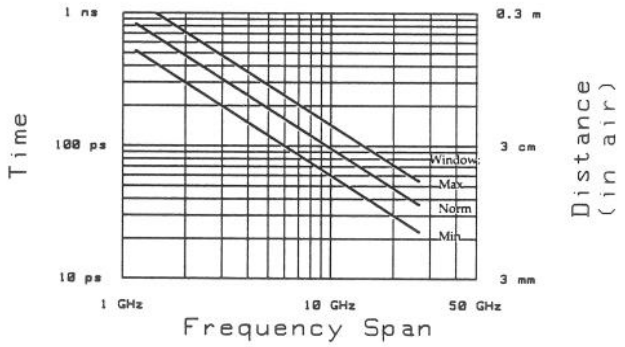


Figure 2. Lowpass step response resolution

In general, step rise time t_r is given by

$t_r = 0.45/(\text{Frequency span}) \times$ 1.0 Minimum window
2.2 Normal window
3.3 Maximum window

Example: For a frequency span of 26.5 GHz, the fastest rise time achievable is 17.0 ps (0.5 cm in air). This increases to 22.5 ps (0.7 cm in air) when the frequency span is reduced to 20 GHz.

3. Response resolution is the ability to resolve two closely spaced responses of equal magnitude. For example, in time impulse response, two equal responses that are separated in time by less than one impulse width cannot be resolved as two separate responses.

Low Pass Impulse

This stimulus is also used to measure low pass devices, and is the mathematical derivative of the Low Pass Step response. The Frequency Domain data should extend from DC (extrapolated value) to a value within the range of the source and test set used. The Time Domain response shows changes in the parameter value versus time. The impulse response can be used for reflection (fault location) or transmission measurements.

Response Resolution[4]. In Low Pass Impulse mode, Response Resolution is defined by the 50% impulse width of the time stimulus. This depends on both the frequency span and the window used (see *Windows*):

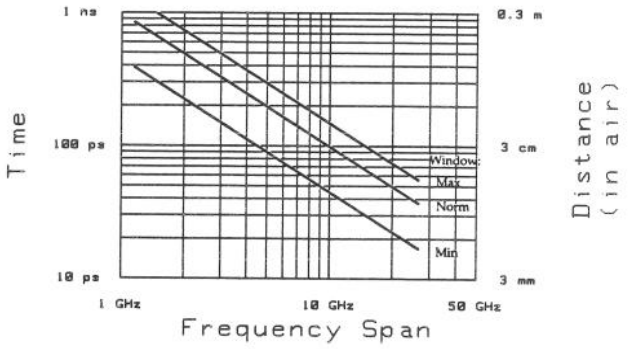


Figure 3. Low pass impulse response resolution

In general, Low Pass impulse width t_w is given by

$t_w = 0.6/(\text{Frequency span}) \times$ 1.0 Minimum window
1.6 Normal window
2.4 Maximum window

Example: For a frequency span of 26.5 GHz, the fastest low pass impulse width achievable is 22.6 ps (0.7 cm in air). This increases to 30 ps (0.9 cm in air) when the frequency span is decreased to 20 GHz.

Bandpass Impulse

The Bandpass Impulse simulates a pulsed RF signal (with an impulse envelope) and is used to measure the Time Domain response of band-limited devices. The Start and Stop frequencies are selectable by the user to any values within the limits of the source and test set used. The Bandpass Time Domain response shows changes in the parameter values versus time. Bandpass Time Domain responses are useful for both reflection and transmission measurements.

Response Resolution[4]. In Bandpass Impulse mode, Response Resolution is defined by the 50% impulse width of the time stimulus. This depends on both the frequency span and the window used (see *Windows*):

4. Response resolution is the ability to resolve two closely spaced responses of equal magnitude. For example, in time impulse response, two equal responses that are separated in time by less than one impulse width cannot be resolved as two separate responses.

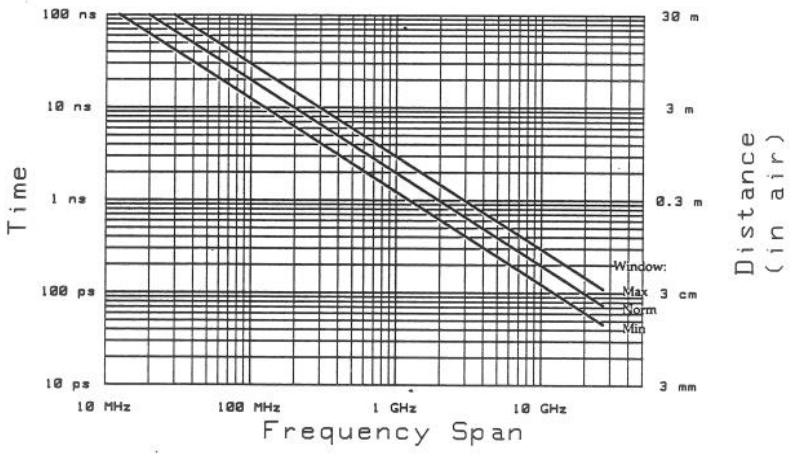


Figure 4. Bandpass impulse response resolution

In general, Low Pass impulse width t_w is given by

t_w = 1.2/(Frequency span) × 1.0 Minimum window
1.6 Normal window
2.4 Maximum window

Example: For a frequency span of 26.5 GHz, the fastest bandpass Impulse width achievable is 45.3 ps (1.4 cm in air). This increases to 60 ps (1.8 cm in air) when the frequency span is decreased to 20 GHz.

TIME DOMAIN RANGE

The Time Domain Range, the range over which the display is free of response repetition, depends on the frequency span and the number of points as shown in the following graph[5]:

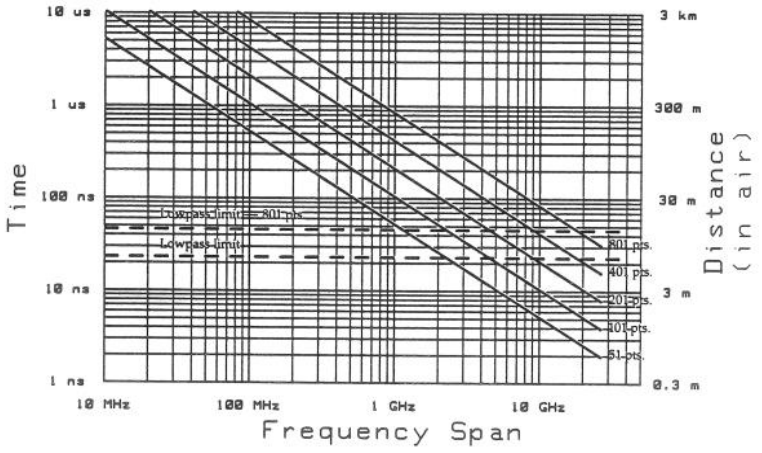


Figure 5. Time domain range

5. In lowpass mode (step or impulse), range is limited by the minimum spacing between frequency domain data points (45 MHz, or 22.5 MHz with 801 points). This limit is labeled on the graph as "lowpass limit".

In general, Range is defined by the equation:

$$\text{Range (sec)} = \frac{\text{(Number of points in Frequency Domain} - 1)}{\text{Frequency Span (Hz)}}$$

Range Resolution

Range-Resolution is the ability to locate a single response in time. It is a function of the Time span selected and the number of data points.

Range-Resolution = Time Span/(number of points − 1)

Range-resolution better than 1 mm (3 ps) can typically be achieved. This is determined by source stability.

Windows

The windowing function can be used to modify (filter) the Frequency Domain data to reduce overshoot and ringing in the Time Domain response. Three types of Windows are available — Minimum, Normal, and Maximum. Typical Impulse width and sidelobe response for each window are shown in the table below.

Window	Impulse Width	Sidelobes (rel to pk)	Step Rise Time	Step Sidelobes
Minimum	Minimum	−13 dB	Minimum	−21 dB
Normal	1.6×Minimum	−44 dB	2.2×Minimum	−60 dB
Maximum	2.4×Minimum	−90 dB	3.3×Minimum	−90 dB

Gating

The gating function can be used to isolate individual Time Domain responses. In converting back to the frequency domain the effects of the responses outside the gate are removed. The location and span of the gate can be controlled by setting either the gate center position and time span or by setting the gate start and stop times.

REMOTE PROGRAMMING

Interface

HP-IB interface operates according to IEEE 488-1978 and IEC 625 standards and IEEE 728-1982 recommended practices.

System Interface

The 8510B System Bus is an HP-IB port used exclusively by the HP 8510B to control and extract information from the other instruments in the system (RF source, test set, digital plotter, disc drive etc.).

Addressing

The HP-IB addresses of the HP 8510B and all instruments connected to the 8510 System Interface can be verified or set from the HP 8510B front panel via the LOCAL menu. Addresses can range from 0 to 30 decimal. The factory selected addresses are the following:

HP 8510B Network Analyzer	16
Swept Source #1	19
Swept Source #2	18
Test Set	20
Plotter	05
Printer	01
Disc Drive	00
Pass-through Address	17

Pass-through Address

Instruments connected to the 8510B System Bus may be accessed via the Pass-through Address.

Transfer Formats

Binary (internal 48 bit floating point complex format)
ASCII
32/64 bit IEEE 754 Floating Point Format

Transfer Speed

See *Measurement Throughput Summary*.

User-accessible Graphics

Using a subset of HP Graphics Language (HP-GL), vector or text graphics may be written on the HP 8510B CRT via HP-IB. Up to 1.5K bytes of data can be stored at one time (4 bytes per vector, 2 bytes per character). User graphics may also be stored on tape or disc.

Interface Function Codes

SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, E1

REAR PANEL CONNECTORS

Sweep In

Input for 0 to 10V sweep voltage from compatible sweep oscillator.

Stop Sweep

Input and output for stop sweep signal from compatible sweep oscillator.

10 MHz In

Input for external 10 MHz reference.
Input level: −10 dBm to +20 dBm, typical
Input Frequency Accuracy: ±0.005% (50 ppm)

20 MHz Out

Output of internal 20 MHz reference oscillator.
Frequency Accuracy: ±0.01%, typical
Output Level: ECL, AC coupled

Analog +10V

Settable output voltage used for Auxiliary Voltage domain measurements.

Range: −9.995 to +10.000 Volts
Linearity: ±0.1%, typical
Resolution: 4.88 mV, nominal

May also be used for plotting data to Analog recorders. Range is then ±7.8V.

External Trigger

TTL input to trigger acquisition of single data point. Delay is included to equalize the signal path delay from the test port. Data is taken on the negative-going TTL pulse.

Pulse Repetition Period:	1 msec minimum with no averaging. If averaging, add (200μs × averaging factor).
Pulse Width:	1μs minimum.

LO Phaselock Out

Phase Lock control when an external LO is used in place of a test set. Designed for the HP 8350B sweep oscillator with RF plug-in.

Range: ±6 Volts
FM slope: −20 MHz/Volt
Output impedance: 100 Ω

MEASUREMENT THROUGHPUT SUMMARY

The following table shows typical measurement times for an HP 8510B system.

	Number of points				
	51	**101**	**201**	**401**	**801**
Measurement[1]					
Ramp sweep[2]	270ms	340ms	470ms	740ms	1.3s
Stepped sweep					
Avg. factor=1	4.0s	7.7s	17s	33s	64s
Avg. factor=128	9.0s	18s	36s	72s	150s
Time Domain Conversion[3]	50ms	100ms	200ms	400ms	800ms
HP-IB Data Transfer to computer[4]					
Internal Format	20ms	30ms	50ms	100ms	200ms
ASCII Format	240ms	460ms	900ms	1.8s	3.6s
IEEE 754 Floating Point					
Format					
32 bit	20ms	40ms	80ms	160ms	320ms
64 bit	40ms	80ms	150ms	300ms	590ms

1. Full two port error-corrected measurements. Includes system retrace time, but does not include source band-switch times (typically 50ms each). Time domain gating is assumed off.
2. Assumes minimum settable sweep time. If averaging is used, multiply the above ramp sweep measurement times by the averaging factor to get the total time.
3. Option 010 only, gating off. Conversion time only.
4. Measured with an HP 9000 Series 300 computer. Single Point data transfers can be accomplished in approximately 1ms per point using the Fast CW mode.

HP 8510B/TEST SET CHARACTERISTICS

Refer to the test set manual for information on test set characteristics such as:

Frequency Range
Test Port Nominal Impedance
Nominal Operating Power Level
RF Input Damage Level
Minimum and Maximum Reference Channel Power

HP 8510 Specifications

Read and use this section before attempting to test the performance of the system. The software, provided in the plastic holder in this manual, is used for Specifications and Performance Tests.

This section contains the following topic headings:

OVERVIEW: Describes, in general, what specifications are and how they are generated using the software.

PROGRAM FEATURES: Describes how the program is structured in menu form and what some of the menus allow you to do.

GETTING STARTED PROCEDURE: A step-by-step procedure that will show you how to load and run the program, and then use the menus to generate specifications for a typical system.

MENU MAP: An illustration of the menu structure that can be used as a quick reference guide.

EXAMPLES: Printed and plotted examples of specifications for a typical HP 8510B system.

REFERENCE: Describes many important details about HP 8510 Specifications, including system criteria (assumptions) and other details about interpreting, printing, and plotting Specifications. Be sure to read this material because it applies to Specifications and Performance Verification.

NOTE: In case of a revision to the software (that affects this section of the manual), any changes will be documented in a Manual Update supplement available by contacting your nearest HP office.

OVERVIEW

HP 8510 Specification and Performance Verification Software

Specifications for the HP 8510 describe the network analyzer system performance. This performance will be different for each type of HP 8510 system configuration depending upon test set, source, connector type, calibration method, and cables. Because of the large number of possible system configurations, printing the specifications for each system is impractical. However, this software allows you to print-out the system specifications for almost any HP 8510 system configuration on the controller CRT or on a printer. It is NOT required to have the HP 8510 connected to the controller when generating specifications but connection is required when verifying system performance with this same software.

Specifications for the HP 8510 are generated using a 200 or 300 series controller (except 9826), HP BASIC (3.0 or greater), and the specification/verification software that is shipped in a plastic holder in the back this manual. Therefore, except for the specifications printed in the data sheet and the examples in this section, there are no specifications printed in the manual.

Both the specifications and the performance test use the same software. The software is provided on sets of separate discs in two sizes (3.5 in. and 5.25 in.). The discs are:

DATA BASE files disc:

This is a data base that the program reads. This disc contains all error term values for the Network Analyzer and all of the Test Sets, Sources, Cal Kits, Verification Kits, Cables, etc.

PROGRAM discs:

This is the program that contains all the user interface menus and all of the algorithms necessary to read the DATA BASE files disc in order to model the system errors. This disc also contains the program that will allow you to test the system performance.

NOTES:

1) The specifications that this program will calculate are based upon a statistical performance analysis of a large number of production systems. In almost every case, the specification limit was set three standard deviations from the mean value (in the high-confidence direction if the specification is single-sided). In regular production operation, any parameter which exceeds the specification limit will cause the unit to be returned to a prior workstation for adjustment or rework. An analysis of the overall production operation has shown that the system-level specifications meet a confidence level of 99.9%

2) The software will only generate Specifications and allow Performance Testing for system hardware that is included on the data base disc. For example, specifications for systems using cables other than those available through HP cannot be generated because error models for them are not contained on the data disc.

3) The Program is contained on two (single sided format) discs. The Data base is on one disc.

4) A total of 2 megabytes of controller memory is required to run the program. Be sure that your controller has at least this amount of memory. One megabyte memory boards are available for all 200 and 300 series computers.

5) Specifications for systems using HP 8511 Frequency Converter test sets can be generated using this software (refer to the Reference information in this section). However, refer to the HP 8511 manual (shipped with HP 8511 Frequency Converters) for instructions and separate software used for testing the performance of an HP 8511 system.

PROGRAM FEATURES

The program consists of a number of menus and forms that are selected by controller hardkeys and softkeys. After the program is running, a prompt will allow you to set the time and date so that it will appear on your printouts. The program has softkeys that 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.

When the program is running, the first menu that you see is the *Hardware Configuration* menu. It will display a form on the controller CRT that will allow you to select each piece of hardware in the system, including cables, cal kit, test set, source, etc. It will also allow you to select the type of calibration method you will use (explained later). After the selections are made, the program will load files from the data disc into controller memory so that it can compute the specifications. Later, if you want to generate specifications for a system with different hardware, you simply change those items in the Hardware Configuration menu and the program reads the new files from the disc. The program will retain the files it has already read so it does not have to re-read files already in controller memory.

The program also has a *Software Configuration* menu that allows you to select bus addresses for the printer or plotter configuration (HP 8510 System bus or HP-IB bus) you are using.

After selecting the initial hardware configuration, the program's *Main* menu will appear. From the Main menu, you can select one of the following menus:

SYSTEM SPECIFICATIONS TABLE MENU — Select this menu and you can then specify which type of system specifications you want to generate. These specifications are the limiting values of the individual system errors that describe system performance. They can be residual errors where HP 8510 correction is ON (after accuracy enhancement) or they can be system test port errors where correction is OFF. You can choose several types of tables and formats for both forward and reverse error terms, including the same specifications printed in the HP 8510 data sheet (which do not include temperature drift and cable errors). The table type labeled System Specifications do include cable and temperature drift errors; these are the specifications that apply to a practical system and they are usually printed in tabular form, showing the Error Terms in dB or linear values over the system bandwidth.

TOTAL UNCERTAINTY & DYNAMIC ACCURACY MENU — Select this menu and you can print or plot Dynamic Accuracy or Total Uncertainty for the system configuration you specify.

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: as the down-converted RF signal passes through the HP 85102 IF-Detector, it will either be attenuated or amplified in order to be further down-converted and processed for display. Because of this, the signal will have some magnitude and phase inaccuracies that vary with signal levels. By plotting the Dynamic Accuracy specifications for your system, you can see how dynamic accuracy changes with power level. This is often used for transmission measurements.

By selecting the Uncertainty computation values, you can plot or print the magnitude or phase uncertainties for all four S-Parameter measurements. These uncertainty values (with correction ON) are calculated by using equations derived from a flowgraph model. Therefore, total uncertainty can be described as the summation of all the residual errors that will affect your measurement. Also, the uncertainty limit can be selected as upper or lower. However, these limits only apply to transmission measurements (refer to the Reference material for more information).

After printing-out any or all of these specifications, you can return to the HARDWARE CONFIGURATION menu and change any of the items. For example, you might change calibration kits. Then you can print-out the specifications for the same system but with the different calibration kit and compare the results.

The program has many other features that make it fast and easy to use, especially when you want to generate system specifications for variations in your system hardware. The Getting Started Procedure below will help you get acquainted with this program.

GETTING STARTED PROCEDURE: Generating Specifications

The following paragraphs describe how to load, run, and use the software to generate specifications. After reading and using this information, refer to the section titled PERFORMANCE TESTS to verify the specifications.

NOTE: Some systems (typically those with stand alone drives and hard disc drives) may require that you specify which disc drive is the default drive, also called the MSI (mass storage is). In general, you can specify the MSI by typing:

MSI ":,700,0"

Then press [ENTER] or [RETURN]. Here, the quotation marks are required by the controller so that it knows you are specifying a piece of information. The colon and the commas also have to be in place so that the controller knows 700 is the BUS address and 0 is the drive address. In case of any problem, refer to your BASIC system User's Guide for complete instructions.

1. LOAD BASIC and BIN files

   NOTE: If your controller is already loaded with BASIC (3.0 or greater) and all the Drivers and Language Extensions, go to step 2 below.

   The program will run on most 200 and 300 series controllers, except for a 9826 bacause of its limited CRT display. A BASIC operating system is required: BASIC 3.0 or greater. In addition, the controller must have 2 megabytes of memory for the program to run. A printer and/or plotter is also recommended if you want a hard-copy of the specifications.

   Load the controller with BASIC and the following BIN files:

   Language Extensions: ERR, CLOCK, GRAPH, MAT, IO.
   Drivers: HPIB, (DISC and CS80 for stand alone drives)

   NOTE: If you do not know how to load BASIC, refer to the manual that accompanies the BASIC operating system. However, there is a simplified procedure below that may help you. Also, if you do not have the necessary BIN files (Binary Language Extensions and Drivers) loaded into the controller you may get an error message like, "missing option 10," which means that you have not loaded a driver like CLOCK that the program needs in order to run.

   Simplified BASIC loading procedure:

   a. While the controller is OFF, insert the BASIC language system disc in the default drive (typically 0). Then turn the controller ON.

   b. When BASIC is loaded, the drive LED will go off and a prompt will appear on the controller CRT: BASIC Ready. Remove the disc.

   c. Insert the Language Extensions disc in the drive and, one at a time, load the files listed above. For example, type:

      LOAD BIN "ERR"

      Then press [ENTER] or [RETURN] on the keyboard. When the file is loaded the drive LED will go OFF. After loading all the Extensions, remove the disc. Insert the Drivers disc and load the files listed above in the same manner.

2. After BASIC and the BIN files are loaded you can perform the following steps to generate specifications. You do not have to connect the HP 8510 to perform these steps. Therefore, you can ignore any CRT prompts that inform you that the HP 8510 is NOT connected.

   NOTE: If your controller was already ON and running...that is, if you omitted Step 1 above, you should clear out the common area of your controller's memory by typing: *SCRATCH C* and pressing [RETURN] or [ENTER].

   Insert PROGRAM disc number 1 into the default drive or the drive you specify as the MSI. Type in the *load* command and the filename as shown below. Be sure to type it exactly as shown:

   LOAD "SPECS_8510"

   Notice that there is an *underline* between the S and the 8. This is required because BASIC will not allow a space between words used as a filename. Also, you can always type the BASIC command *CAT* and press **[RETURN]** or **[EXECUTE]** to be sure what the filename is.

3. After the first program disc is loaded (the disc drive LED is off and motor stopped), remove the disc and press the controller **[RUN]** key or type **RUN** and press **[RETURN]** or **[EXECUTE].** The program should now display its title banner information and a [RESUME] softkey — do not press this softkey yet.

   HP 8510 Specification and Performance Verification Software

   Note the HP Part Number (08510-10031) and the revision number. You can always contact your nearest HP office for information about revisions to this software to be sure you have the latest version.

   Press the **[RESUME]** softkey.

4. The program will now prompt you to load Program disc number 2. Insert Program disc 2 into the default or MSI drive and press the **[RESUME]** softkey. The program will load the subroutines from this disc; during this time the CRT will be blank. After it is finished loading remove the disc.

5. The next CRT display will allow you to set the date and time on the controller CRT. Before you set the date and time, insert the Data disc into the default or MSI drive.

   At this point, you can press the controller **Y** key and the program will continue or you can press the controller **N** key for NO. When you press **N**, the CRT will display the form that allows you to change the DATE. Here, type in the date, the month, and the year. For example, you can type *09 July 1987* and the entry will appear as *9 JUL 87*. The program can usually distinguish and correct any differences between what you type in and what it will accept and display. Notice that it will always abbreviate the month if it has more than three letters and you do not need to type the quotes for any entry. When complete, press the keyboard **[ENTER]** or **[RETURN]** key.

   NOTE: The time and date can always be reset by using the [PROGRAM RESET] key in the *Configuration* menu that is explained later. Also, you can always press **[RETURN]** when prompted for the Y/N response, and the program will continue without changing the date or time.

Next, enter the correct time. Your controller has an internal clock that is activated by this selection. Enter the time in the same manner as the date. Notice also that the BASIC keyboard keys (insert and delete) can also be used to make entries. After setting the time and date, the CRT will display your entry again to make sure it is correct. If it is, press **Y** for yes, if not, press **N** for no. Remember that the program will only display its title banner, prompts that it is loading configuration files, and the time/date setting if it is run from the beginning (power-up).

If you did not have the MSI drive properly set, the CRT would display the MSI and Data File Directory. This display is important for specifying that the DATA files are located in a separate drive. You would change the locations or simply press **Y** (yes) to continue. For example, if you wanted to load the program from a hard disc, or if you wanted to put the Data disc in a separate drive, you would enter the address of that drive. Note that *700* is the default entry and it implies a drive address of *700,0*. To enter the address of a second drive with an address of *700,1* — you would type: ":,700,1" and press the keyboard [RETURN] or [ENTER] key.

NOTE: You can use a dual disc drive or even a hard disc, but you need to know how to configure the controller. This means that the MSI will have to be specified for the DATA disc. All of this type of information is in the manuals for your BASIC operating system.

6. Next, the controller CRT will inform you that the program is loading files and it will ask you to wait. It will load:

   - MENUS (ITF or 236) — CRT menu displays.
   - DESCRIPT — descriptions of the ERROR terms.
   - HARDWARE — hardware configuration menu.
   - SOFTWARE — software configuration menu.
   - TABLE — the tables that will list specs.
   - UNCPLOT — plotting the specs.
   - VERIF — the verification menu.
   - SERNO — the serial number forms.
   - ETERMS — the Eterm menu.

   If the program has already been loaded, or run one time, it will not reload the start-up configuration files and only the Hardware configuration menu will appear even if you do a BASIC reset. However, this procedure is intended for first-time use. Also, you may want to refer to the Menu Map, found at the end of this procedure as you continue.

   After the program loads the configuration files it will display the HARDWARE CONFIGURATION menu. This menu will allow you to select the type of system equipment that you want.

   The examples that follow this procedure use the equipment in an HP 8510T system:

   - Network Analyzer: HP 8510B — Enhanced Model
   - Test Set: HP 8514B S-Parameter — 3.5mm
   - Source: HP 8340A/B — Synthesizer
   - Calibration Kit: HP 85052B — 3.5mm slotless
   - Calibration Technique: Sliding Load (explained later)
   - Test Port Cables: HP 85131B 3.5mm pair short cables
   - Verification Kit: HP 85053B 3.5mm

7. Select the equipment above or select the equipment for your system. Note that the CRT display will have a highlighted field around the active selection. Use the **[NEXT]** and **[PREVIOUS]** keys to change the selection in the highlighted area, if required. Notice that the program will load a default system configuration if no selections are made. After making the selection, move the shaded active form selection to the next equipment selection by pressing the controller **[TAB]** key or the controller keyboard arrow (Up/Down) keys. You can use the controller NEXT and PREVIOUS keys to change the selection.

   Make all the selections you want until the hardware configuration is correct.

8. Then press the softkey labeled **[Done]** and the program will load the files from the data base disc. The program will remember the last system configuration you select and, when you run it again (without turning the controller OFF), that same configuration will appear on the CRT. However, you can reset the configuration by using the [Program Reset] softkey.

   The SYSTEM CONFIGURATION menu will now appear on the controller CRT. Go to the Main Menu by pressing **[PRIOR MENU].** This menu has the selections that will send you to select the SYSTEM SPECS, UNCERT DATA, SYSTEM CONFIG, or VERIFY SYSTEM menus.

   Note that the SYSTEM CONFIG selection will allow you to return you to the Hardware Configuration menu in case you made a mistake or want to select another system configuration. Also, the QUIT PROG selection should always be used when you want to exit the program for any reason.

   NOTE: Specifications for HP 8511 Systems should be selected with no source, no cal kit, and no verification kit.

9. Here is a brief explanation of the menu choices:

   SYSTEM CONFIG — Select this menu if you want to return to the Hardware Configuration menu or if you want to use the software configuration menu to set the addresses of your printer/plotter, or select plot trace pens/colors. This menu will also allow you to reset the program — this means that all menu choices will be returned to the program's default state and the program will begin again from the time and date setting.

   Press **[SYSTEM CONFIG]** to look at the Configuration menu. Then press **[HARDWARE CONFIG]** and notice that the program will put you back in that menu. Press **[DONE]** to exit the menu and then press **[SOFTWARE CONFIG].**

   Examine the selections in the Software Configuration menu. You may want to read some of the information in the REFERENCE section in order to fully understand what the items in this or any other menu mean. Also, notice that the asterisk (*) that appears beside each selection indicates when that selection is active or has been changed. Try using the [NEXT] and [PREVIOUS] keys to make the asterisk blink. Enter a different number in the field and move to the next selection using the keyboard arrow (up/down) keys or the **[TAB]** key. The blinking asterisk means that you can now select the new entry or the original one by activating the asterisk.

   Press **[PRIOR MENU]** after you have examined this menu and then return to the Main menu by pressing **[PRIOR MENU]** again.

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. This is because the program is designed to keep data in controller memory so that you can perform other computer tasks. For example, you can pause the program in the middle and do something else on your controller — then you can re-run the program and it will not have to reload files from the data disc.

The remaining selections in the Main menu are:

QUIT PROGRAM — Always use this selection when you are finished using this program.

VERIFY SYSTEM — This menu is selected when you want to verify system performance. Do not press this selection now. This is explained in the sections titled PERFORMANCE TESTS. Refer to that section for this selection.

SYSTEM UNCERT — This menu is selected when you want to see the calculated uncertainty limits for each type of S-parameter measurement. Do not press this selection now.

SYSTEM SPECS — When this selection is made, the Specifications menu will appear.

10. Press **[SYSTEM SPECS]**.

In this menu, the system specifications can be selected in two different table types: (1) Specifications and (2) Data Sheet. The Data Sheet table is identical to the Specifications table except that the cable stability errors and system drift errors are excluded. In addition, the tables can be generated in two different modes:

CORRECTION ON (after accuracy enhancement) — These system specifications are values of residual errors after error correction has been made. In other words, these values are based upon having a proper calibration performed as specified in the Configuration Menu by the type of calibration and type of calibration kit used.

CORRECTION OFF (uncalibrated) — These system specifications are values based upon the same system configuration but without making a calibration.

The difference between these two table modes is that the system errors contributing to any measurements would be reduced with a valid calibration. This means that Accuracy Enhancement (calibrated system) noticeably improves the system's accuracy because some of the contributing errors are removed or reduced by calibration. For example, the measurement reference planes are at the test ports or cables with 0 dB and 0 degrees phase shift — this is opposed to an Uncorrected system where the measurement planes are not established.

Notice that the active window (inverse video) is used in this menu to allow you to choose 1) the table you want, 2) the type of table: Data Sheet or Specifications, 3) table format as linear or in dB, 4) the output device as the CRT or the Printer, and 5) Eterm direction (forward or reverse).

Press the [Next] or [Previous] softkeys to change the selection in the window.

For example, if you select [All Tables], [Specifications], [dB], and [CRT] and press the [Done] softkey, the controller CRT will quickly display or scroll (explained in item 14 in Reference) through the system specifications. However, you can print them out using the [PRINT] softkey.

At this point, you can make the selections you want and, when done, print them out. Then you can go to the other specification menu, SYSTEM UNCERT, to print or plot the remaining specifications: Uncertainty Data and Dynamic Accuracy.

Press **[Prior Menu]** to return to the main menu.

11. Press **[SYSTEM UNCERT]** – In this menu, you can select the Dynamic Accuracy or the Uncertainty specifications for any S-Parameter your system can measure. These specifications are available as plots or tables, based upon Data Sheet or System Specification values with upper or lower limits (explained in item 6 in Reference).

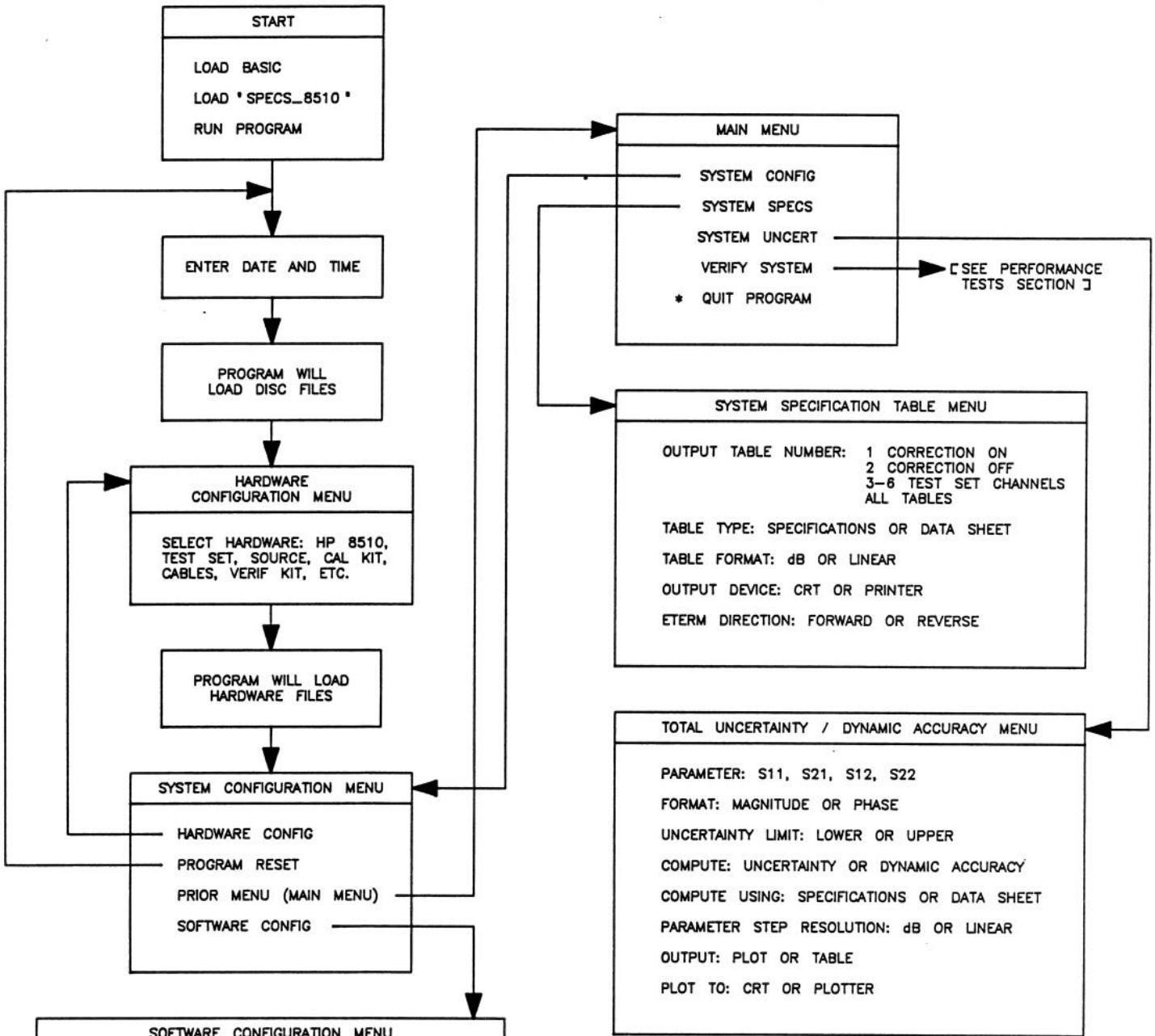
    The same keys used in the System Specs Menu are used to select and toggle the selections in this menu. Make the menu selections you want and press the **[DONE]** softkey when finished.

    The program will compute the values and you should hear the controller beep each time the values for a particular frequency band are completed.

    The table or plot will appear on the controller CRT with a softkey selection for sending the display to the printer or plotter. Notice that you can make plots using a plotter or a printer.

At this point, you should be able to use the Specifications portion of the program without relying upon this procedure. The examples that follow this section are typical tables and plots generated by this program. Be sure to read all of the information in the Reference Section following the examples and use the Menu Map as a guide the next time you use the program.

NOTE: If you want to Performance Test your system at this time, keep the program running and refer to the section titled Performance Tests. If you want to exit the program, press the [QUIT PROGRAM] key in the Main Menu.



NOTE: THE PROGRAM HAS SOME SOFTKEY SELECTIONS THAT ARE NOT SHOWN. THEY ALLOW YOU TO MOVE FROM MENU TO MENU. THESE SOFTKEYS ARE NOT SHOWN HERE. TYPICALLY, THEY ARE [DONE], [PRIOR MENU], AND [MAIN MENU].

* ALWAYS RETURN TO THE MAIN MENU AND USE THE [QUIT PROGRAM] KEY WHEN YOU ARE FINISHED OR WHEN YOU WANT TO EXIT THE PROGRAM FOR ANY REASON.

System Specifications — Residual Errors (Correction ON)

Network Analyzer:	**HP 8510B — Enhanced Model**
Test Set:	**HP 8515A — 3.5 mm S-Parameter (45 MHz-26.5 GHz)**
Source:	**HP 8340A/B — Synthesizer (10 MHz-26.5 GHz)**
Calibration Kit:	**HP 85052B — 3.5 mm Slotless**
Calibration Method:	**SL — Sliding Load Cal**
Test Port Cables:	**HP 85131B/D — 3.5 mm pair short cables**

Description Of Error Term		Eterm Symbl	Frequency (GHz) .045-2	2-8	8-20	20-26.5
Power of Source	(dBm)	Ps	+10.00	+10.00	+10.00	+4.00
AVeraGing factor	(x1)	Avg	1024	1024	1024	1024
Loss of Attenuator 1	(dB)	La1	0.00	0.00	0.00	0.00
Loss of Attenuator 2	(dB)	La2	0.00	0.00	0.00	0.00
Cable Flex Factor	(Lin)	Cff	1.0000	1.0000	1.0000	1.0000
Drift in Room Temperature	(deg C)	Drt	1.0000	1.0000	1.0000	1.0000
Effective Fwd Directivity	(dB)	Efd	−48.00	−44.00	−44.00	−44.00
Effective Fwd Refl tracking	(+/−dB)	Efr	.0030	.0030	.0060	.0060
Effective Fwd Source match	(dB)	Efs	−40.00	−33.00	−31.00	−31.00
Effective Fwd Crosstalk	(dB)	Efc	−118.47	−113.90	−106.92	−94.51
Effective Fwd Trans tracking	(+/−dB)	Eft	.0086	.0176	.0376	.0596
Effective Fwd Load match	(dB)	Ef1	−48.00	−44.00	−44.00	−44.00
Effective Fwd Noise on Trace	(+/−dB)	Efnt	.0008	.0008	.0012	.0025
Effective Fwd Noise Floor	(dB)	Efnf	−95.02	−91.45	−86.47	−74.06
Effective Power Ref (out) port1	(dBm)	Epr1	−5.26	−9.05	−14.54	−25.74
Effective Power maX (in) port2	(dBm)	Epx2	+2.26	+3.05	+3.54	−1.26
Effective Power miN (in) port2	(dBm)	Epn2	−100.27	−100.48	−100.97	−99.77
Effective Dyn Rng (Ref-min) pt2	(dB)	Edrr2	95.00	91.43	86.43	74.02
Effective Dyn Rng (maX-min) pt2	(dB)	Edrx2	102.53	103.53	104.51	98.51

— EXAMPLE —

Data Sheet — Residual Errors (Correction ON)

Network Analyzer: HP 8510B — Enhanced Model
Test Set: HP 8515A — 3.5 mm S-Parameter (45 MHz-26.5 GHz)
Source: HP 8340A/B — Synthesizer (10 MHz-26.5 GHz)
Calibration Kit: HP 85052B — 3.5 mm Slotless
Calibration Method: SL — Sliding Load Cal
Test Port Cables: HP 85131B/D — 3.5 mm pair short cables

Description Of Error Term		Eterm Symbl	Frequency (GHz) .045-2	2-8	8-20	20-26.5
Power of Source	(dBm)	Ps	+10.00	+10.00	+10.00	+4.00
AVeraGing factor	(x1)	Avg	1024	1024	1024	1024
Loss of Attenuator 1	(dB)	La1	0.00	0.00	0.00	0.00
Loss of Attenuator 2	(dB)	La2	0.00	0.00	0.00	0.00
Cable Flex Factor	(Lin)	Cff	1.0000	1.0000	1.0000	1.0000
Drift in Room Temperature	(deg C)	Drt	1.0000	1.0000	1.0000	1.0000
Effective Fwd Directivity	(dB)	Efd	−48.00	−44.00	−44.00	−44.00
Effective Fwd Refl tracking	(+/−dB)	Efr	.0030	.0030	.0060	.0060
Effective Fwd Source match	(dB)	Efs	−40.00	−33.00	−31.00	−31.00
Effective Fwd Crosstalk	(dB)	Efc	−118.47	−113.90	−106.92	−94.51
Effective Fwd Trans tracking	(+/−dB)	Eft	.0086	.0176	.0376	.0596
Effective Fwd Load match	(dB)	Ef1	−48.00	−44.00	−44.00	−44.00
Effective Fwd Noise on Trace	(+/−dB)	Efnt	.0008	.0008	.0012	.0025
Effective Fwd Noise Floor	(dB)	Efnf	−90.25	−86.68	−81.70	−69.29
Effective Power Ref (out) port1	(dBm)	Epr1	−5.26	−9.05	−14.54	−25.74
Effective Power maX (in) port2	(dBm)	Epx2	+2.26	+3.05	+3.54	−1.26
Effective Power miN (in) port2	(dBm)	Epn2	−100.27	−100.48	−100.97	−99.77
Effective Dyn Rng (Ref-min) pt2	(dB)	Edrr2	95.00	91.43	86.43	74.02
Effective Dyn Rng (maX-min) pt2	(dB)	Edrx2	102.53	103.53	104.51	98.51
Effective Rev Directivity	(dB)	Erd	−48.00	−44.00	−44.00	−44.00
Effective Rev Ref1 tracking	(+/−dB)	Err	.0030	.0030	.0060	.0060
Effective Rev Source match	(dB)	Ers	−40.00	−33.00	−31.00	−31.00
Effective Rev Crosstalk	(dB)	Erc	−118.47	−113.90	−106.92	−94.51
Effective Rev Trans tracking	(+/−dB)	Ert	.0086	.0176	.0376	.0596
Effective Rev Load match	(dB)	Er1	−48.00	−44.00	−44.00	−44.00
Effective Rev Noise on Trace	(+/−dB)	Ernt	.0008	.0008	.0012	.0025
Effective Rev Noise Floor	(dB)	Ernf	−90.25	−86.68	−81.70	−69.29
Effective Power Ref (out) port2	(dBm)	Epr2	−5.26	−9.05	−14.54	−25.74
Effective Power maX (in) port1	(dBm)	Epx1	+2.26	+3.05	+3.54	−1.26
Effective Power miN (in) port1	(dBm)	Epn1	−100.27	−100.48	−100.97	−99.77
Effective Dyn Rng (Ref-min) pt1	(dB)	Edrr1	95.00	91.43	86.43	74.02
Effective Dyn Rng (maX-min) pt1	(dB)	Edrx1	102.53	103.53	104.51	98.51

— EXAMPLE —

System Specifications — Test Port Errors (Correction OFF)

Network Analyzer: HP 8510B — Enhanced Model
Test Set: HP 8515A — 3.5 mm S-Parameter (45 MHz-26.5 GHz)
Source: HP 8340A/B — Synthesizer (10 MHz-26.5 GHz)
Calibration Kit: HP 85052B — 3.5 mm Slotless
Calibration Method: SL — Sliding Load Cal
Test Port Cables: HP 85131B/D — 3.5 mm pair short cables

Description Of Error Term		Eterm Symbl	Frequency (GHz) .045-2	2-8	8-20	20-26.5
Drift Source Frequency	(dB)	Dsf	0.000	0.000	0.000	0.000
Raw Fwd Directivity	(dB)	Rfd	−24.00	−24.00	−28.00	−27.00
Raw Fwd Reflection tracking	(+/−dB)	Rfr	1.0000	1.0000	.6000	1.6000
Raw Fwd Source match	(dB)	Rfs	−23.00	−23.00	−18.00	−14.00
Raw Fwd Crosstalk	(dB)	Rfc	−85.00	−85.00	−85.00	−80.00
Raw Fwd Transmission tracking	(+/−dB)	Rft	.9000	.9000	.7000	1.8000
Raw Fwd Load match	(dB)	Rfl	−23.00	−23.00	−18.00	−14.00
low Freq Cutoff Source to port1	(GHz)	Fcs1	0.000	0.000	0.000	0.000
low Freq Slope Source to port1	(dB)	Fss1	0.00	0.00	0.00	0.00
Loss/Dc Source to port1	(dB)	Lds1	−15.00	−12.00	−9.40	−10.09
Loss/sqr(F-ghz) Source to port1	(dB)	Lfs1	0.00	−2.12	−3.04	−7.40
Drift Mag/deg-c Src to port1	(+/−dB)	Dms1	0.0000	0.0000	0.0000	0.0000
Drift Ph/deg-c Src to port1	(+/−deg)	Dps1	.1000	.1000	.1000	.1000
Drift Ph/deg-c/F-ghz Src-pt1	(+/−deg)	Dpfs1	.0100	.0100	.0100	.0100
Raw Rev Directivity	(dB)	Rrd	−24.00	−24.00	−28.00	−27.00
Raw Rev Reflection tracking	(+/−dB)	Rrr	1.0000	1.0000	.6000	1.6000
Raw Rev Source match	(dB)	Rrs	−23.00	−23.00	−18.00	−14.00
Raw Rev Crosstalk	(dB)	Rrc	−85.00	−85.00	−85.00	−80.00
Raw Rev Transmission tracking	(+/−dB)	Rrt	.9000	.9000	.7000	1.8000
Raw Rev Load match	(dB)	Rr1	−23.00	−23.00	−18.00	−14.00
low Freq Cutoff Source to port2	(GHz)	Fcs2	0.000	0.000	0.000	0.000
low Freq Slope Source to port2	(dB)	Fss2	0.00	0.00	0.00	0.00
Loss/Dc Source to port2	(dB)	Lds2	−15.00	−12.00	−9.40	−10.09
Loss/sqr (F-ghz) Source to port2	(dB)	Lfs2	0.00	−2.12	−3.04	−7.40
Drift Mag/deg-c Src to port2	(+/−dB)	Dms2	0.0000	0.0000	0.0000	0.0000
Drift Ph/deg-c Src to port2	(+/−deg)	Dps2	.1000	.1000	.1000	.1000
Drift Ph/deg-c/F-ghz Src-pt2	(+/−deg)	Dpfs2	.0100	.0100	.0100	.0100
Connector Repeat Ref1 port1	(dB)	Crr1	−80.00	−70.00	−65.00	−60.00
Connector Repeat Trans port1	(dB)	Crt1	−80.00	−70.00	−65.00	−60.00
Connector Repeat Ref1 port2	(dB)	Crr2	−80.00	−70.00	−65.00	−60.00
Connector Repeat Trans port2	(dB)	Crt2	−80.00	−70.00	−65.00	−60.00
Loss/Dc port1 Cable	(dB)	Ld1c	−.20	−.20	−.20	−.20
Loss/sqr(F-ghz) port1 Cable	(dB)	Lf1c	−.30	−.30	−.30	−.30
Cable Refl Mag stab port1	(dB)	Crm1	−60.00	−60.00	−60.00	−60.00
Cable Trns Mag stab port1	(+/−dB)	Ctm1	.0100	.0100	.0100	.0100
Cable Ph/F-ghz stab pt1	+/−deg/GHz)	Cpf1	.0500	.0500	.0500	.0500
Loss/Dc port2 Cable	(dB)	Ld2c	−.20	−.20	−.20	−.20
Loss/sqr(f-ghz) port2 Cable	(dB)	Lf2c	−.30	−.30	−.30	−.30
Cable Refl Mag stab port2	(dB)	Crm2	−60.00	−60.00	−60.00	−60.00
Cable Trns Mag stab port2	(+/−dB)	Ctm2	.0100	.0100	.0100	.0100
Cable Ph/F-ghz stab pt2	(+/−deg/GHz)	Cpf2	.0500	.0500	.0500	.0500

— EXAMPLE —

System Specifications — Uncorrected B1 Signal Path

Network Analyzer:	**HP 8510B — Enhanced Model**
Test Set:	**HP 8515A — 3.5 mm S-Parameter (45 MHz-26.5 GHz)**
Source:	**HP 8340A/B — Synthesizer (10 MHz-26.5 GHz)**
Calibration Kit:	**HP 85052B — 3.5 mm Slotless**
Calibration Method:	**SL — Sliding Load Cal**
Test Port Cables:	**HP 85131B/D — 3.5 mm pair short cables**

Description Of Error Term		Eterm Symbl	Frequency (GHz) .045-2	2-8	8-20	20-26.5
low Freq Cutoff port1 to B1	(GHz)	Fc1b1	0.000	0.000	0.000	0.000
low Freq Slope port1 to B1	(dB)	Fs1b1	0.00	0.00	0.00	0.00
Drift Mag/deg-c port1 to B1	(+/−dB)	Dm1b1	.0100	.0100	.0100	.0100
Drift Ph/deg-c port1 to B1	(+/−deg)	Dp1b1	0.0000	0.0000	0.0000	0.0000
Drift Ph/deg-c/F-ghz pt1-B1	(+/−deg)	Dpf1b1	0.0000	0.0000	0.0000	0.0000
Loss/Dc port1 to convertor B1	(dB)	Ld1b1	−12.00	−12.00	−12.00	−12.00
Loss/sqr (F-ghz) port1 to conv B1	(dB)	Lf1b1	0.00	0.00	0.00	0.00
Loss/Dc conVertor to I.f. B1	(dB)	Ldvib1	−4.00	−4.00	−3.33	−1.92
Loss/sqr(F-ghz) conV to I.f. B1	(dB)	Lfvib1	0.00	0.00	−.08	−.15
Damage Level B1	(dBm)	Dlb1	+20.00	+20.00	+20.00	+20.00
Pwr at Conv for 0.1 db Comp B1	(dBm)	Pccb1	−10.00	−10.00	−10.00	−15.00
Raw rms Noise on Trace B1	(+/−dB)	Rntb1	.0060	.0060	.0090	.0190
Raw rms i.f. Noise Floor B1	(dBm)	Rnfb1	−99.00	−100.00	−102.00	−102.00
REsiduals at i.f. B1	(dBm)	Reb1	−140.00	−140.00	−140.00	−140.00
Linearity of Xtal B1	(+/−dB)	Lxb1	.0030	.0030	.0030	.0030
i.f. Gain Err1 −34>−46 dbm B1	(+/−dB)	Ge1b1	.0050	.0050	.0050	.0050
i.f. Gain Err2 −46>−58 dbm B1	(+/−dB)	Ge2b1	.0100	.0100	.0100	.0100
i.f. Gain Err3 −58>−70 dbm B1	(+/−dB)	Ge3b1	.0150	.0150	.0150	.0150
i.f. Gain Err4 −70>−00 dbm B1	(+/−dB)	Ge4b1	.0250	.0250	.0250	.0250
Mag error vs Phase shift B1	(+/−dB)	Mpb1	.0030	.0030	.0030	.0030

— EXAMPLE —

S11 Lower Uncertainty Specifications

S12=0., S21=0.. S22=0., Device Length = 10 cm.

Network Analyzer: **HP 8510B — Enhanced Model**
Test Set: **HP 8515A — 3.5 mm S-Parameter (45 MHz-26.5 GHz)**
Source: **HP 8340A/B — Synthesizer (10 MHz-26.5 GHz)**
Calibration Kit: **HP 85052B — 3.5 mm Slotless**
Calibration Method: **SL — Sliding Load Cal**
Test Port Cables: **HP 85131B/D — 3.5 mm pair short cables**

Ref1	.045-2		2-8		8-20		20-26.5	
(Lin)	(Mag Lin)	(Deg)	(Mag Lin)	(Deg)	(Mag Lin)	(Deg)	(Mag Lin)	(Deg)
0.000	.004986	180.000	.007359	180.000	.007458	180.000	.007738	180.000
.100	.005370	3.165	.007739	5.401	.007879	6.803	.008151	7.677
.200	.006023	1.797	.008638	3.423	.008957	4.838	.009230	5.637
.300	.006902	1.377	.010042	2.855	.010636	4.292	.010927	5.070
.400	.007990	1.195	.011924	2.637	.012937	4.106	.013253	4.876
.500	.009257	1.105	.014244	2.555	.015828	4.062	.016181	4.828
.600	.010583	1.061	.017029	2.545	.019302	4.089	.019702	4.853
.700	.012252	1.041	.020252	2.574	.023352	4.155	.023808	4.918
.800	.013949	1.036	.023908	2.627	.027974	4.246	.028497	5.010
.900	.015760	1.039	.027990	2.696	.033126	4.350	.033767	5.118
1.000	.017673	1.048	.032495	2.776	.038881	4.468	.039579	5.235

— EXAMPLE —

S21 Lower Uncertainty Specifications

S11=0., S12=0.. S22=0., Device Length = 10 cm.

Network Analyzer:	**HP 8510B — Enhanced Model**
Test Set:	**HP 8515A — 3.5 mm S-Parameter (45 MHz-26.5 GHz)**
Source:	**HP 8340A/B — Synthesizer (10 MHz-26.5 GHz)**
Calibration Kit:	**HP 85052B — 3.5 mm Slotless**
Calibration Method:	**SL — Sliding Load Cal**
Test Port Cables:	**HP 85131B/D — 3.5 mm pair short cables**

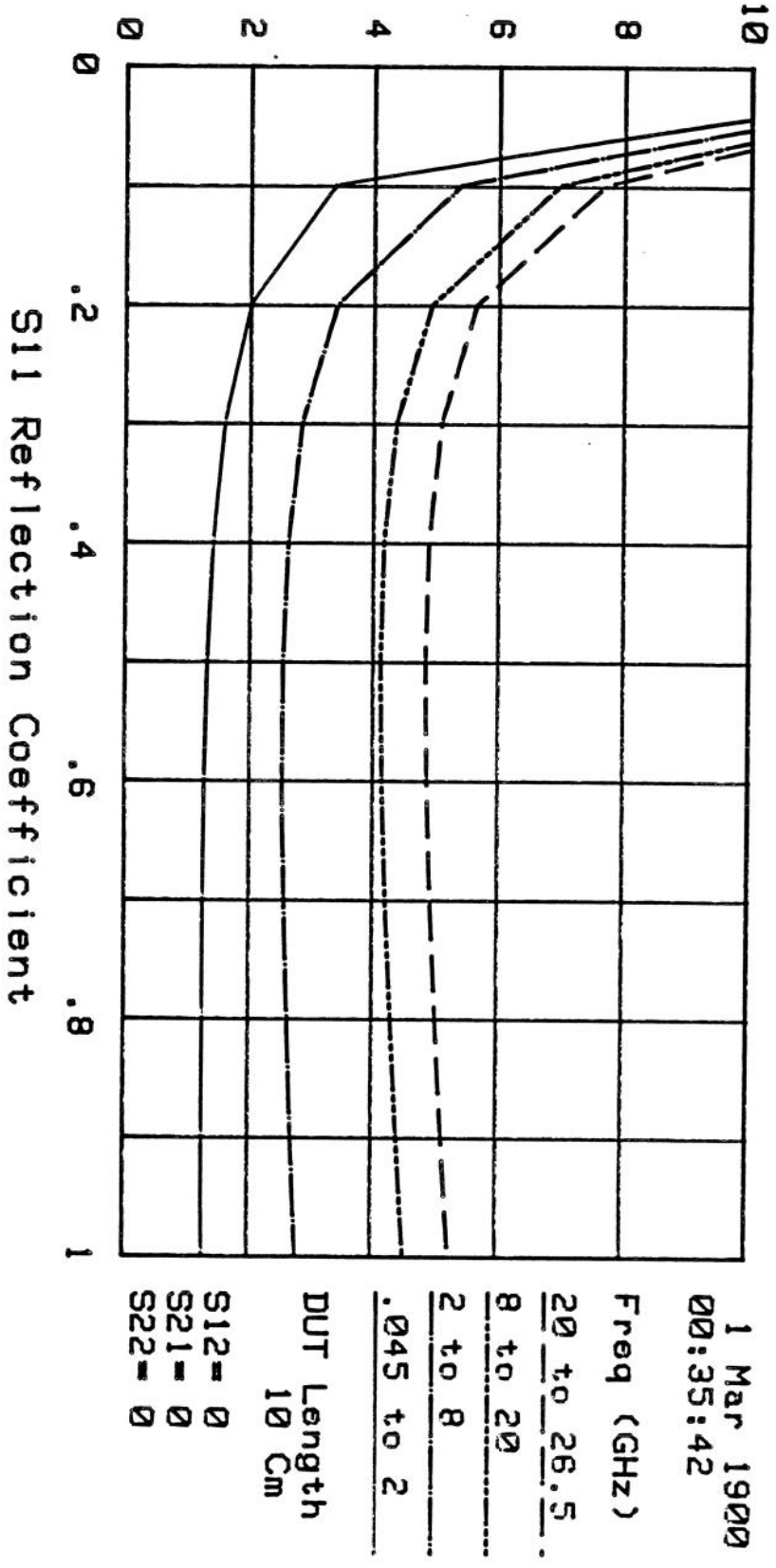
Ref1	.045-2		2-8		8-20		20-26.5	
(Lin)	(Mag Lin)	(Deg)	(Mag Lin)	(Deg)	(Mag Lin)	(Deg)	(Mag Lin)	(Deg)
10.0	.1925	1.280	.1052	1.593	.0873	2.804	.1013	3.625
0.0	.0274	.205	.0377	1.152	.0591	2.620	.0841	3.513
−10.0	.0431	.308	.0429	1.192	.0598	2.629	.0843	3.519
−20.0	.0455	.331	.0453	1.220	.0620	2.653	.0910	3.577
−30.0	.0480	.363	.0465	1.232	.0676	2.705	.1241	3.812
−40.0	.0549	.427	.0576	1.327	.0922	2.885	.2397	4.569
−50.0	.0847	.644	.1046	1.654	.1761	3.443	.6308	7.030
−60.0	.1859	1.321	.2630	2.685	.4675	5.301	2.0042	14.906
−70.0	.5316	3.507	.7970	6.008	1.4676	11.243	8.7863	42.535
−80.0	1.7326	10.523	2.7461	16.706	5.7075	31.093	800.0000	180.000
−90.0	7.2337	34.519	16.5426	59.312	800.0000	180.000	800.0000	180.000

— EXAMPLE —

S11 Uncertainty (Degrees)

S11 PHASE UNCERTAINTY SPECIFICATIONS

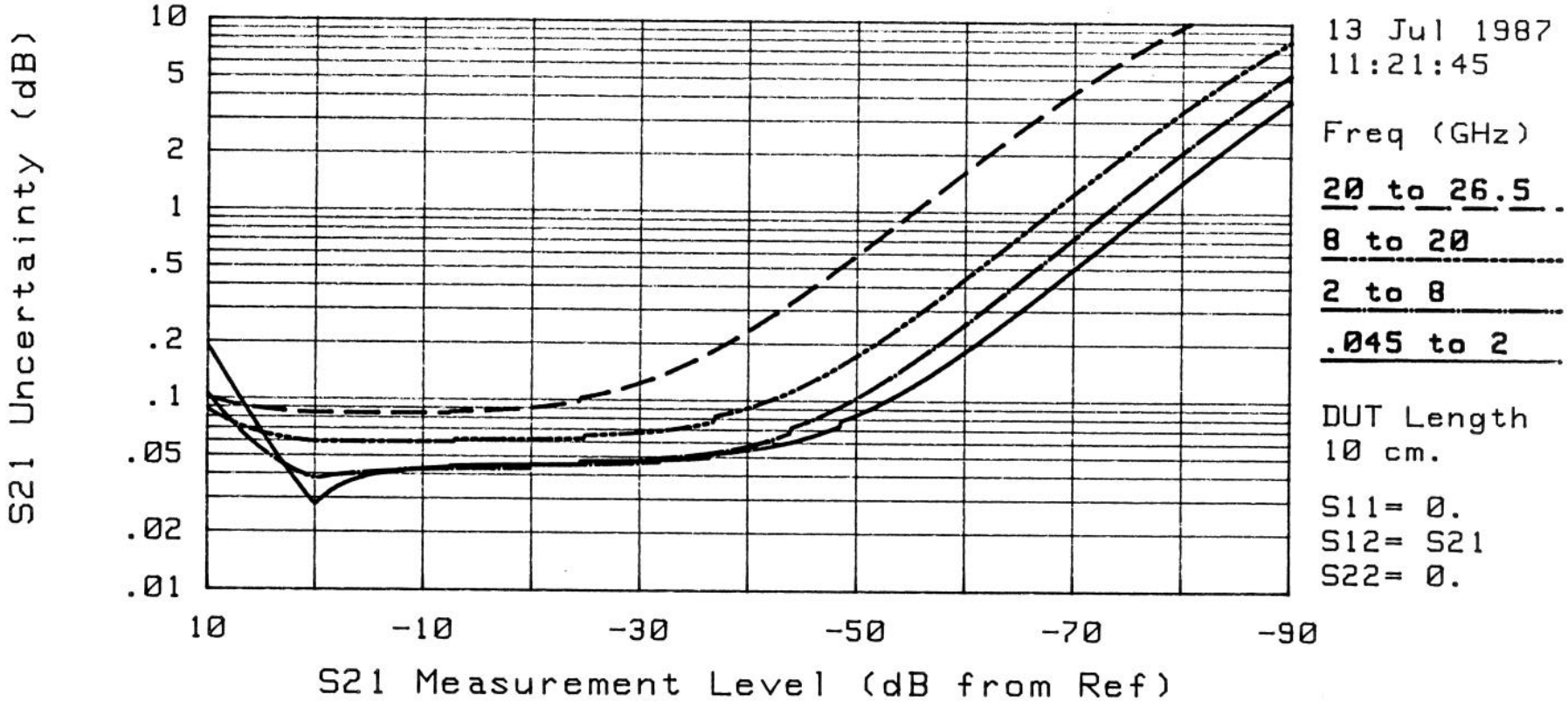
HP8510B / HP8515A / HP8340A / HP85052B / FULL / HP85131B



— EXAMPLE —

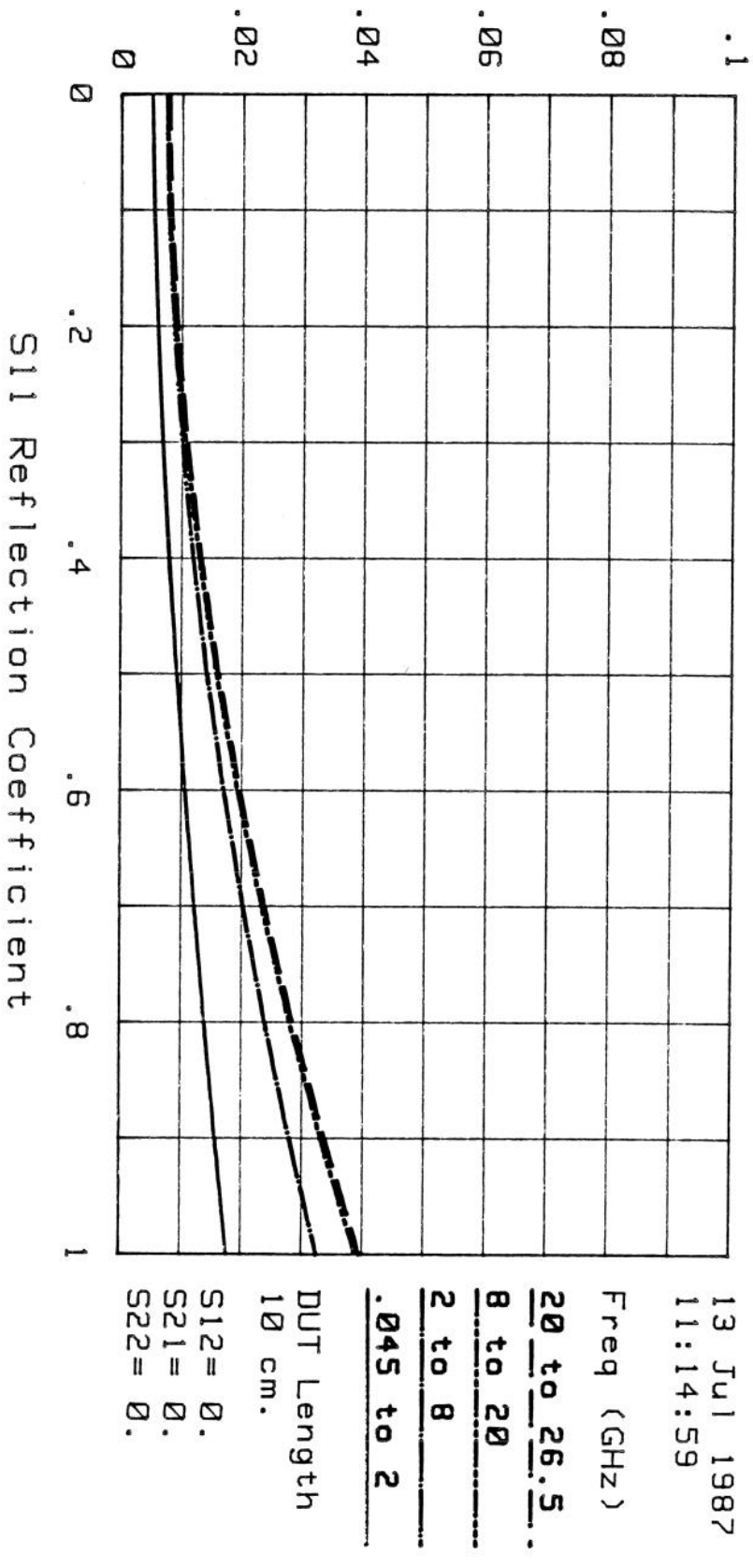
S21 MAGNITUDE UPPER UNCERTAINTY SPECIFICATIONS

HP8510B / HP8515A / HP8340A / HP85052B / SL / HP85131B



— EXAMPLE —

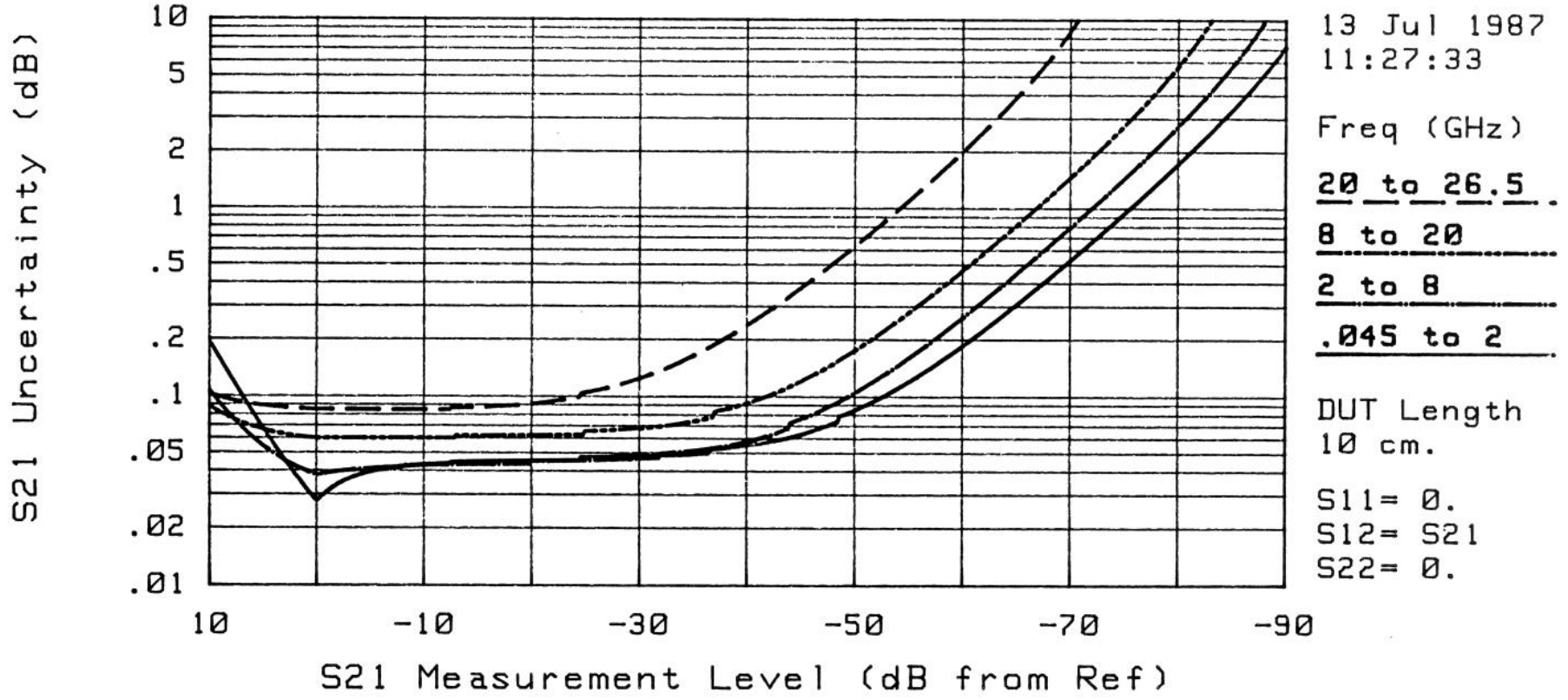
S11 Uncertainty (Linear)



— EXAMPLE —

S21 MAGNITUDE LOWER UNCERTAINTY SPECIFICATIONS

HP8510B / HP8515A / HP8340A / HP85052B / SL / HP85131B



— EXAMPLE —

REFERENCE: Important information that applies to Specifications and Performance Verification.

The listed information in this section should be used to properly generate specifications, prepare the program for performance verification and interpret any results.

1. **Calculated Error Terms**

   Some of the error terms that appear in the Specifications are calculated by the program. They are not fixed values on the data base. In both forward and reverse directions, they are:

   - Effective Forward Crosstalk
   - Effective Forward Noise on the Trace
   - Effective Forward Noise Floor
   - Effective Power Ref (out) port 1
   - Effective Power max (in) port 2
   - Effective Power min (in) port 2

2. **Calibration Method**

   For verification, you must use a FULL TWO-PORT calibration for S-Parameter test sets and a ONE-PATH TWO-PORT calibration for Reflection/Transmission test sets.

   The calibration method selected in the program is based upon the type of load that you use: Sliding Load, Offset Load, or Broadband Load. Regardless of which calibration you perform, always specify the type of load you will use.

3. **Test Set Channel Signal Path Specifications: a1, b1, a2, b2**

   These specifications refer to the errors contributed by the test set from the test port, through the coupler, and onto the sampler (down converter). These 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.

4. **HP 8510 A or B Models Both Use This Software**

   The program will generate specifications for the 8510A or the 8510B. Also, the uncertainty limits are calculated in the program and there is no need to use a written equation like the HP 8510A Specification Uncertainty equation used in the A version manual.

5. **HP 8350B Sweep Oscillators used as System Sources**

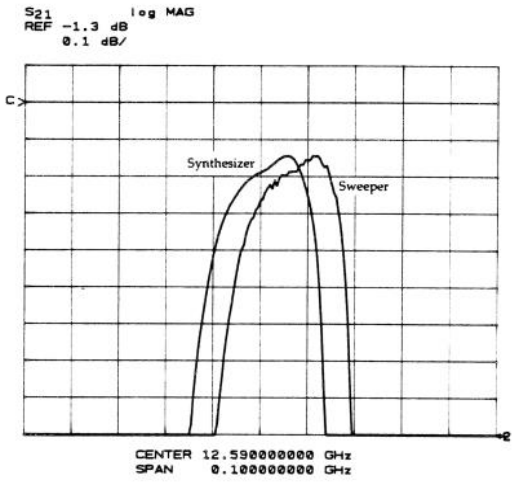
   Additional magnitude and phase errors are introduced into the system when using these sweepers. Because the sweeper signal is not synthesized, its frequency sweep will be off by about +/- 5 megahertz at any given frequency.

   The Uncertainty values shown below are for measurements of broadband (flat frequency response) zero-length devices. When devices other than this type are measured, the HP 8510 has additional uncertainties due to the sweep oscillator frequency error (due to offsets, sweep linearity, and residual FM).

Frequency accuracy of HP 8350B/83592A (25+/-5 degrees C)					
BAND:	0	1	2	3	Full Band
Frequency range (GHz)	.01-2.4	2.4-7	7-13.5	13.5-20	.01-20
Frequency accuracy (MHz)					
Ramp sweep (typical)	±5	±6	±25	±30	±50
Ramp sweep (typical, using Trim Sweep)	±5	±6	±8	±10	±15

Magnitude Errors Due to Device Frequency Response:

When measuring high frequency selective devices, HP 8350B frequency errors can cause additional magnitude uncertainty whenever the device response changes over the frequency accuracy specification of the source (for example, +/- 20 MHz in band 1). 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.

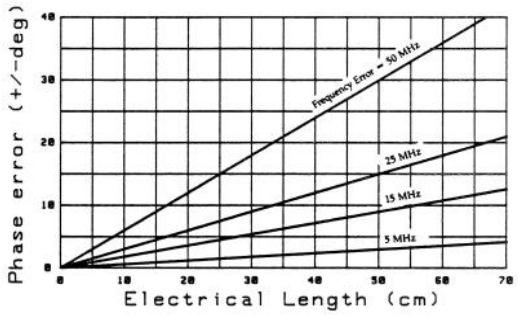


Phase Errors Due to Device Electrical Length:

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

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

where c is the propagation velocity in a vacuum (3×10^{10}cm/sec), ΔF is the frequency accuracy specification of the sweeper in ramp mode, and L is the length of the device under test. The following plot shows this uncertainty for the HP 8350B/83592A:



6. **Uncertainty and Dynamic Accuracy Limits: Upper or Lower**

The Uncertainty and Dynamic Accuracy menu allows you to select *lower* or *upper* uncertainty limits. The limits only apply to transmission measurements. If you did select the upper limit for a reflection measurement, its value would be the same as the lower limit.

For transmission measurements, the limits are the worst case values that will add to or subtract from the measurement. These limits are derived from the equations:

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

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

where U is the uncertainty and S is the measured S-parameter, and $_{ij}$ is a vector number.

Here, whenever $U_{ij}/S_{ij} = 1$, the worst case will be 20 times the log of 2 = 6 dB for the upper limit, and 20 times the log of 0 = minus infinity for the lower limit. This is due to vector numbers adding in phase and subtracting out of phase.

For example, if you were measuring a 60 dB band-stop filter, and the upper limit was 6 dB, you could add 6 dB to the measurement: −60 dB + 6 dB = −54 dB. And, if the lower limit was minus infinity, the measurement of the filter could be considered −54 dB or less.

7. **Plotters and Printers**

This program requires that the printer be connected on the HP-IB. However, the plotter can be on either the HP 8510 system bus (default state in the Software Configuration menu) or the HP-IB. When connected to the HP 8510 system bus, plots can be made from the HP 8510 CRT or from the controller's CRT. If you are in one of the program's menus where there is a [PLOT] key and you expect to plot a CRT display from the HP 8510, the program will prompt you with an error message if you have not specified the plotter's location correctly. However, remember that the HP 8510 does not have to be connected to generate specifications. Therefore, without an HP 8510 connected and running, you would connect the plotter to the HP-IB.

8. **Plot Traces on the Controller CRT**

Some traces may appear to be missing from program plots that show four frequency bands. Whenever three traces appear (instead of four), it is because the bands have the same values and are overlaid. This overlay cannot be distinguished on low resolution monitors or plotters. For example, the S11 magnitude uncertainty specifications for an HP 8510B using an HP 8340 source and an HP 8514B Test Set have the same uncertainty values for traces labeled 8 to 18 GHz and 18 to 20 GHz. Plot traces are designed for all controller/CRT combinations, however, they appear best on high resolution color monitors.

Also notice that when the program is calculating the values for plot traces, it will beep each time a trace is calculated. Therefore, if you hear four beeps, but only see three traces, it is an indication that four traces were generated but one is overlaid on the other.

9. **Plotter Pens**

The Software Configuration menu lists pen numbers (#) and colors. If your plotter has a pen wheel, the pen numbers correspond to the wheel numbers. Otherwise, plotters with only two pens use the first and second pens listed. Also, remember that the color relates to color monitors and the choice of pen colors is arbitrary. You can try making several plots using different pen colors or pen tip thicknesses...there is no rule about how you make plots. Remember that when the plotter is connected to the HP 8510 system bus, you can use the HP 8510's [COPY] key on the front panel to access its plotting capabilities for plotting HP 8510 CRT displays.

NOTE: When using plotters that only have 2 pens, be sure both pens are in place before initiating a plot.

10. **Plot Label Information**

Plots will have the date and time information in the upper right corner. If you set the date and time when you first run the program, this will be the date and time that the plot is made, based upon the time kept by the controller clock.

Plots will also be labeled with the system hardware models. However, some of the sources will not have their proper 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.

11. **Parameter Step Resolution (Software Configuration menu)**

The Software Configuration menu allows you to specify how many data points will be used to generate plot traces. This is called the *Parameter Step Resolution size*. You can increase or decrease the trace resolution on plots using this feature. However, the grid scale will always be a fixed size. Therefore, you can always select tabular data to examine exact scale values.

12. **[ABORT] key**

The program has a softkey labeled *ABORT*. You can press this key 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 the [ABORT] is pressed because data is held in an internal buffer.

NOTE: If strange characters appear on the CRT or if colors or traces are obviously wrong, turn OFF the *Enhancement* selection in the Software Configuration menu.

13. **DUT Length (N cm) and Default S-parameter Values**

A default DUT length and the values of the three other S-parameters will always appear on Uncertainty and Dynamic Accuracy plots. This length is based upon the 10 cm airline in the verification kit. The DUT length for Data Sheet values and systems using sweepers is 0 length.

For the reflection plots (S_{11} or S_{22}), the values of the other three S-parameters will be = 0. For transmission plots (S_{21} or S_{12}), S_{11} and S_{22} = 0, and $S_{21} = S_{12}$.

14. **Limited Scrolling Capabilities on the Controller CRT**

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

15. **Controller Keyboard Keys**

The program is capable of responding to many of the BASIC operating system key presses, including INSERT CHAR, DELETE CHAR, INSERT LINE, etc. You can try using any of the controller keyboard capabilities with this program.

16. **Adapters (test port)**

When you use adapters on a test set, to adapt 7mm to 3.5mm or vice-versa, 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.

17. **800 dB or 180 degree Values**

The program will not display a magnitude value greater 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.

18. **Specification Criteria (Assumptions)**

The specifications for any system are valid only when certain conditions are met. HP assumes that the list of criteria below is met for all specifications.

a. SOURCES: All sources must have a power level of +10 dBm at the RF output, or the maximum level available if it is less than +10 dBm.
Synthesizers are in step mode, not ramp mode.
Sweepers are in ramp mode.

b. 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.

c. REFLECTION/TRANSMISSION TEST SETS: Use a 10 dB pad for HP 8513A and a 20 dB pad for HP 8512A on the transmission thru path. Both pads are currently available by specifying (7 mm) HP Model No. 8492A option 20 or (3.5 mm) HP Model No. 8493C option 10. Devices are connected directly to test port 1 for reflection measurements. For transmission measurements, the pad is connected to the other end of the device and the cable is connected between the pad and port 2.

d. SYSTEM CONFIGURATIONS: Specifications are limited to those hardware items available on the HP 8510 Specifications data base disc.

e. 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.

19. **HP 8511 Frequency Converter Test Sets**

When generating specifications for systems using an HP 8511, specify the following in the Hardware Configuration menu:

No Source, No Cal Kit, and no verification kit, and use any Cal Method.

HP 8511 Performance Verification procedures and software are provided with the HP 8511 — it is not done in this program.

20. **ATTENTION messages...and "SCPP" settings**

Whenever the program exercises the HP 8510 to determine if it and its peripherals are properly addressed and responding, it will display a message if there is a problem. This message will inform you to check the HP-IB address. Be sure to check the Software Configuration menu addresses so that they corrrespond to the address switches that you set on the peripherals.

SCPP is an HP BASIC abbreviation for *Select Code Primary address*. It is possible to have an HP 8510 address of 716 or 3130, depending upon your system address configuration.

21. **Program Modifications**

It is **not** possible to modify this program.

22. **HP 8510 mm-Wave Systems**

When generating specifications for systems usings mm-wave test set kits (R, Q, U, V, W band measurements), specify the following in the Hardware Configuration menu:

No Verification kit.

Currently, Operational Verification procedures for mm-wave systems are provided with mm-wave products and documented in HP 8510 mm-wave system manuals, including the HP 85129 software and the HP 85106 racked system.

23. **Frequency Ranges on printouts**

Regardless of the frequency range of your system, the bands are inclusive as shown in the following example (in GHz):

.045 — 2: includes .045 and is equal to or less than 2.
2 — 8: greater than 2 and equal to or less than 8.
8 — 18: greater than 8 and equal to or less than 18.
18 — 20: greater than 18 and equal to 20.

24. **BASIC 5.0 and HP-UX systems (setting the time on your system)**

If you are using BASIC 5.0 which 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 TIMEZONE IS command to set the correct time and re-run the program. Refer to the *BASIC Language Reference* manual.

25. **Error Term Codes** (typical and guaranteed specifications)

The specifications generated by this software range from those guaranteed by Hewlett-Packard to those typical (not guaranteed) of most HP 8510 systems. The parameters generated by the program are listed below with codes that are intended to clarify the extent to which HP supports the specified performance of the HP 8510 system.

DEFINITION OF CODES:

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 performce of the system components and calibration stardards, 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 8510B 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.

The code for DYNAMIC ACCURACY specifications is **Factory** and the code for UNCERTAINTY specifications is **Cust. Site.**

NOTE: In all of the terms below, the forward direction =f and the reverse direction =r.

SYSTEM SPECIFICATION —-Residual Errors (Corretion ON)

Error Term	Eterm Symbol	Code
Power of Source	Ps	Condition
Averaging factor	Avg	Condition
Loss of Attenuator 1	La1	Condition
Loss of Attenuator 2	La2	Condition
Cable Flex Factor	Cff	Condition
Drift in Room Temperature	Drt	Condition
Effective Directivity	Efd, Erd	Fac. Comp.
Effective Refl tracking	Efr, Err	Fac. Comp.
Effective Source Match	Efs, Ers	Fac. Comp.
Effective Crosstalk	Efc, Erc	Fac. Comp.
Effective Trans tracking	Eft, Ert	Fac. Comp.
Effective Load Match	Efl, Erl	Fac. Comp.
Effective Noise on Trace	Efnt, Ernt	Fac. Comp.
Effective Noise Floor	Efnf, Ernf	Fac. Comp.
Effective Power Ref (out) port1,2	Epr1, Epr2	Typical
Effective Power maX (in) port1,2	Epr2, Epr1	Typical
Effective Power niN (in) port1,2	Epn2, Epn1	Typical
Effective Dny Rng (Ref-min) pt1,2	Edrr1, Edrr2	Fac. Comp.
Effective Dny Rng (maX-min) pt1,2	Edrx1, Edrx2	Fac. Comp.

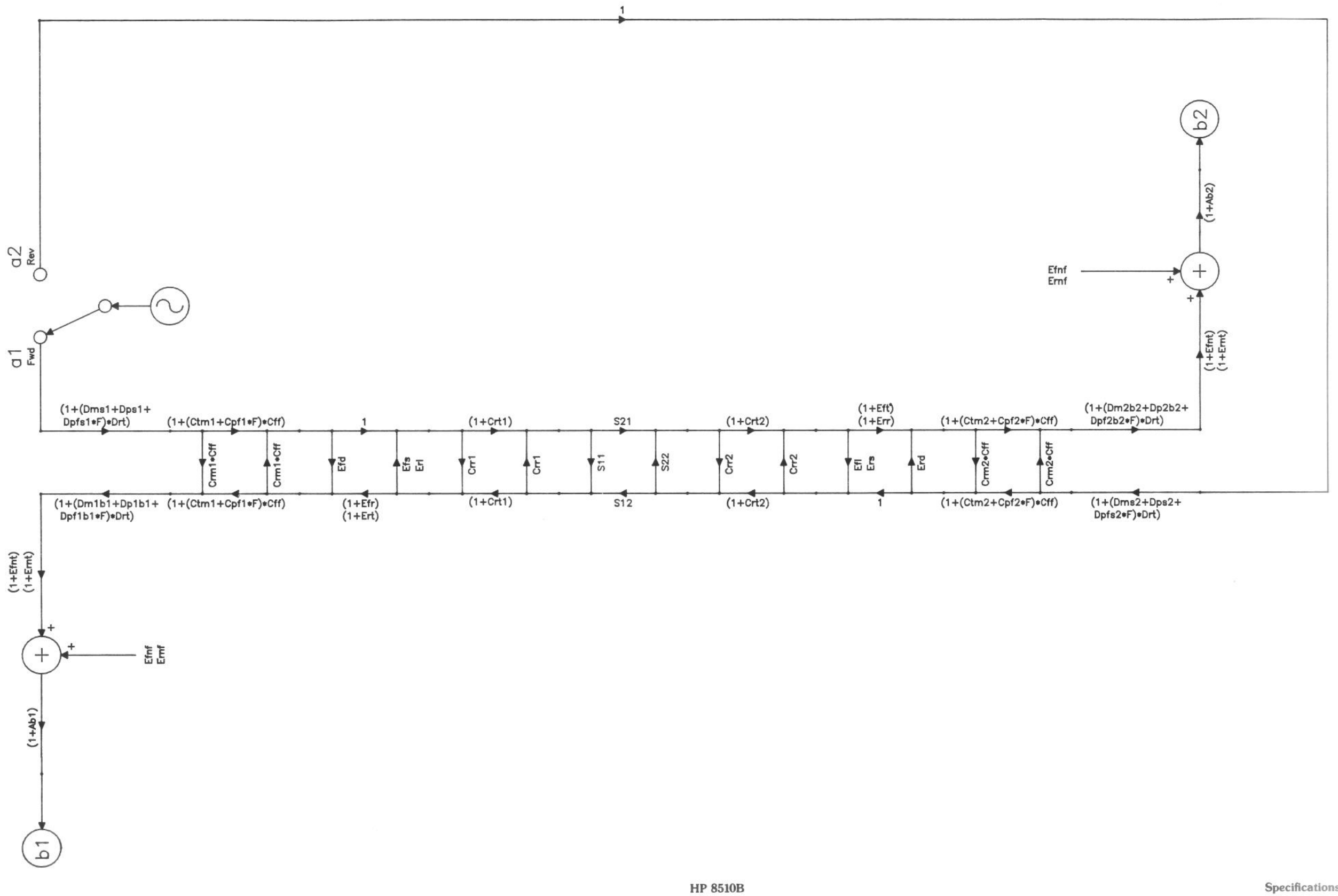
System Specifications b1,b2,a1,a2 Channel Errors (Correction OFF)

Error Term	Eterm Symbol	Code
low Freq Cutoff port1,2 to b1,b2 Source to a1, a2	Fc1b1, Fc2b2 Fcsa1, Fcsa2	Fac. Comp.
low Freq Slope port1,2 to b1,b2 Source to a1, a2	Fs1b1, Fs2b2 Fssa1, Fssa2	Fac. Comp.
Drift Mag/deg-c port1,2 to b1,b2 Source to a1, a2	Dm1b1, Dm2b2 Dmsa1, Dmsa2	Fac. Char.
Drift Ph/deg-c port1,2 to b1,b2 Source to a1, a2	Dp1b1, Dp2b2 Dpsa1, Dpsa2	Fac. Char.
Drift Ph/deg-c/F-GHz pt1,2 to b1,b2 Source to a1, a2	Dpf1b1, Dpf2b2 Dpfsa1, Dpfsa2	Fac. Char.
Loss/DC port1,2 to convertor	Ld1b1, Ld1b2 Ldsa1, Ldsa2	Typical
Loss/sqr(F-GHz) port1,2 to conv.	Lf1b1, Lf2b2 Lfsa1, Lfsa2	Typical
Loss/DC convertor to I.F.	Ldvib1, Ldvib2 Ldvia1, Ldvia2	Typical
Loss/sqr(F-GHz) conv. to I.F.	Lfvib1, Lfvib2 Lfvia1, Lfvia2	Typical
Damage Level	D1b1, D1b2 D1a1, D1a2	Fac. Char.
Power at conv. for 0.1 compress.	Pccb1, Pccb2 Pcca1, Pcca2	Factory
Raw rms Noise on Trace	Rntb1,Rntb2 Rnta1, Rnta2	Factory
Raw rms I.F. Noise Floor	Rnfb1,Rnfb2 Rnfa1, Rnfa2	Factory
Residuals at I.F.	Reb1,Reb2 Rea1, Rea2	Factory
Linearity of Xtal	Lxb1,Lxb2 Lxa1, Lxa2	Factory
I.F. Gain Err1 −34>-46 dBm	Ge1b1,Ge1b2 Ge1a1, Ge1a2	Factory
I.F. Gain Err2 −46>-58 dBm	Ge2b1,Ge2b2 Ge2a1,Ge2a2	Factory
I.F. Gain Err3 −58>-78 dBm	Ge3b1,Ge3b2 Ge3a1,Ge3a2	Factory
I.F. Gain Err4 −70>-00 dBm	Ge4b1,Ge4b2 Ge4a1,Ge4a2	Factory
Mag error vs Phase shift	Mpb1,Mpb2 Mpa1,Mpa2	Factory

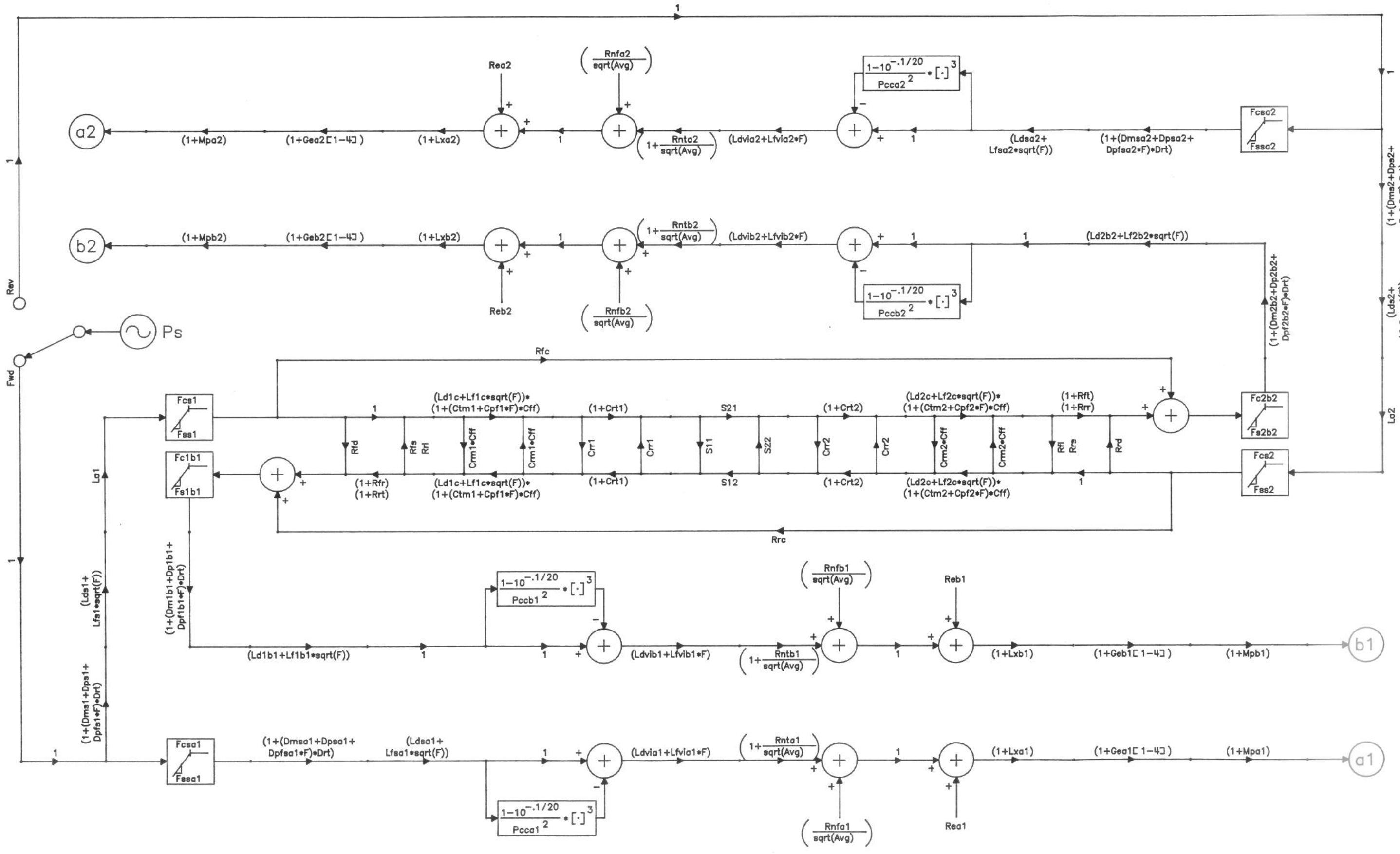
System Specifications — Test Port Errors (Correction OFF)

Error Term	Eterm Symbol	Code
Drift Source Frequency	Dsf	Typical
Raw Directivity	Rfd, Rrd	Factory
Raw Reflection tracking	Rfr, Rrr	Typical
Raw Source Match	Rfs, Rrs	Factory
Raw Crosstalk	Rfc, Rrc	Factory
Raw Transmission tracking	Rft, Rrt	Typical
Raw Load Match	Rfl, Rrl	Factory
low Freq Cutoff Source to port 1,2	Fcs1, Fcs2	Fac. Comp.
low Freq Slope Source to port 1,2	Fss1, Fss2	Fac. Comp.
Loss/Dc Source to port 1,2	Lds1, Lds2	Typical
Loss/sqr(f-ghz) Source to port 1,2	Lfs1, Lfs2	Typical
Drift Mag/deg-c Src to port 1,2	Dms1, Dms2	Fac. Char.
Drift Ph/deg-c Src to port 1,2	Dps1, Dps2	Fac. Char.
Drift Ph/deg-c/F-ghz Src-pt1,2	Dpfs1, Dpfs2	Fac. Char.
Connector Repeat Fefl port 1,2	Crr1, Crr2	Fac. Char.
Connector Repeat Trans port 1,2	Crt1, Crt2	Fac. Char.
Loss/Dc port 1,2 Cable	Ld1c, Ld2c	Cust. Site
Loss/sqr(F-ghz) port 1,2 Cable	Lf1c, Lf2c	Cust. Site
Cable Refl Mag stab port 1,2	Crm1, Crm2	Fac. Char.
Cable Trans Mag stab port 1,2	Ctm1, Ctm2	Fac. Char.
Cable Ph/F-ghz stab pt 1,2	Cpf1, Cpf2	Fac. Char.

HP8510B Corrected System Flow Graph



HP8510B Uncorrected System Flow Graph



HP 8510 Performance Tests

Before attempting to verify the system performance, read and use the section titled SPECIFICATIONS. The software, provided in the plastic holder in this manual, is used for Specifications and Performance Tests (also called Verification).

After you use the GETTING STARTED PROCEDURE in the Specifications section and this PERFORMANCE TESTS section, you should be able to generate specifications and performance test the system with little or no instruction from this manual. In fact, after you are familiar with the menu structure of this software, you should only need the MENU MAP and the REFERENCE information.

This section contains the following topic headings:

OVERVIEW: Describes, in general, what performance tests are and how to execute them using the software.

PROGRAM FEATURES: Describes the menu structure and capabilities of the verification portion of the program.

GETTING STARTED PROCEDURE: A step-by-step procedure for performance testing a typical system. It is a continuation of the Specifications: Getting Started Procedure.

MENU MAP: An illustration of the menu structure that can be used as a quick reference guide.

EXAMPLES: Printed examples of Verifications Kit printouts and test results for a typical HP 8510B system.

REFERENCE: Describes many important details about HP 8510 Performance Verification. Be sure to read this material and the *Reference* material in the Specifications section.

NOTE: In case of a revision to the software (that affects this section of the manual), any changes will be documented in a Manual Update supplement available by contacting your nearest HP office.

OVERVIEW

Verifying the Performance of Your System

Performance verification is used to verify that the HP 8510 system will make measurements within a specified total uncertainty. This total uncertainty is for each verification kit device at a specified frequency. Because it is a total value, it is the sum of the factory measured uncertainty for the device and the calculated uncertainty of the device based upon your system hardware. When you perform the verification procedure, your verification kit measurements will result in values that will be compared to the total uncertainty as follows:

> If the factory measured value for the verification kit device minus the measurement value that you make (user measured) is less than the total uncertainty, your system has passed verification performance for that device.

The method used for performance verification is based upon a comparison of measured data using standards (attenuators and airlines) in the Verification kit. The standards in your kit are measured at the factory and the magnitude and phase data, including the uncertainty calculation, is recorded on tape. This tape, an accompanying *Certificate of Calibration*, and a *Device Characterization Data Sheet* (a hard-copy of the factory measured data) is shipped with your kit. When you use this program, it will prompt you to load the Verification kit tape into your calibrated HP 8510, and then it will prompt you to connect and measure the devices in your kit. Finally, the program will calculate your system's measurement uncertainty and add it to the factory uncertainty that was read from the tape. The result is the system Total Uncertainty. The program will also printout a Performance Verification sheet that shows if the verification passed or failed.

NOTES:

> 1) Because the same software is used to generate specifications and verify the system performance, this section of the manual is a continuation of the SPECIFICATIONS section. In fact, you should read and use the information in that previous section in order to properly load the program, run it, and set the *Hardware* and *Software Configuration* menu selections so that you are ready to verify your system.
>
> 2) When performing the system verification, be sure to use only the calibration and verification kit devices that you specified in the Hardware Configuration menu. Be sure the system is properly connected, and connected on the HP-IB to the controller, and that it has warmed-up for at least one hour prior to verification. Also, be sure that you do not have any bias applied to the test set when using this Performance Test program.

3) Definition of Uncertainty: Uncertainty is the combined effect of all system errors after calibration. It is based upon modeling the system's errors using a flowgraph. All of the error terms are then put into an equation that results in a value of uncertainty for both magnitude and phase measurements. Some of the errors are based upon measurements and others are based upon mathematical calculations. Also, there are three sets of uncertainties for each measurement as follows: A) the factory system uncertainty, B) your (the users) system uncertainty, and C) the total uncertainty which is the sum the factory and the user's system uncertainty. In order for a verification measurement to pass, the difference between the factory measurement and the user measurement must be less than the total uncertainty. The following equation summarizes this:

$$|M_F - M_C| < \Delta_T = \Delta_F + \Delta_C \text{ as a function of frequency.}$$

Where:
M_F = Factory measured values on the data tape.
M_C = Your HP 8510 system's measured values.
Δ_T = Total Uncertainty
Δ_F = Factory Uncertainty values from the data tape.
Δ_C = User's Uncertainty values modeled from flowgraph.

NOTE: Do not confuse the specification error terms used in the flowgraph model with *Eterms* that are your system's raw errors prior to calibration. The calibration process results in *Eterm* values that are stored and subsequently used for error correction. The program has an [Eterm] softkey that displays these values which may be useful for diagnostic purposes.

PROGRAM FEATURES

The program has all of the features described in the *Specifications* section. In addition, the program uses the same *Hardware* and *Software* Configuration menu selections for system verification. Therefore, if your system configuration changes, you simply change the selections in the Configuration menus and the program loads and reads the data files for that selection to calculate the uncertainty data for the system.

For example, after you make the selections in the Configuration menu and the program reads the data files, the program's *Main Menu* appears on the CRT with the following softkey selections:

- SYSTEM CONFIG: Hardware and Software Configuration menus.
- SYSTEM SPECS: Generate error term Specifications.
- SYSTEM UNCERT: Generate Uncertainty values.
- VERIFY SYSTEM: Performance Test the HP 8510.

The first three selections are explained in the Specifications section. The fourth selection, is the subject of this section. When you press the [VERIFY SYSTEM] softkey, the program immediately checks the HP 8510 system to verify that it is connected to the HP-IB and responding properly. If not, the program will display an error message telling you to check the system and its address settings.

If there is no error message the program will display the SYSTEM PERFORMANCE VERIFICATION MENU with the following four selections:

SERIAL NUMBERS: *SYSTEM SERIAL NUMBER AND NBS NUMBER MENU* —Select this menu and a form will appear on the CRT that will allow you to enter the serial numbers of your system instruments: HP 85101, 85102, Test Set, etc. Also, you can enter the NBS test numbers that appear on the CERTIFICATE OF CALIBRATION that is shipped with your Verification Kit. The numbers that you enter will appear on the printouts that you generate after performing the verification. This is the menu that you should use first. However, it is not mandatory to enter these numbers unless you want them printed-out.

SYSTEM CAL: *HP 8510 SYSTEM CALIBRATION INSTRUCTIONS* —Select this menu in order to calibrate the system prior to verification. A form will appear on the controller CRT that displays the Hardware Configuration of your system and a prompt indicating that the program will set-up the HP 8510 stimulus for calibration. The program also puts the HP 8510 into *LOCAL* mode so that you can perform the Calibration using the HP 8510 front panel [CAL] key and its accompanying selections. The program will also prompt you to make a separate calibration for systems capable of making measurements at 45 MHz. In addition, if your system uses an HP 8350B as the source, the program will prompt you through a *Trim Sweep* procedure to adjust the HP 8510 to be more frequency coherent with the sweeper.

DISPLAY ETERMS: *CALIBRATION SET ERROR TERM DISPLAY MENU* —This menu is a troubleshooting tool. With a proper calibration, you can select one of the raw system errors for display on the HP 8510 CRT. These are: Directivity, Crosstalk (Isolation), Transmission Tracking, Reflection Tracking, Source Match, and Load Match. The use of this menu selection is explained in the HP 8510B SERVICE manual. In general, these Eterm displays are used to identify gross system errors or a faulty calibration.

SELECT STANDARD: *VERIFICATION KIT DEVICE SELECTION MENU* —This is the menu that allows you to verify system performance by selecting the Verification Kit standard that you want to measure. When you select this menu, you should already have entered the serial or NBS numbers and have your system properly calibrated. This menu will prompt you through the verification measurement, including the selection of the device, the Cal Set register and whether or not you will be measuring at 45 MHz.

The program will prompt you to load the Verification Kit data tape and it will even compare the device serial number on the tape to the serial number you entered in the *Serial Number menu*. It will even allow you to correct it if you entered the wrong number. Then, after the data tape values are loaded, the program will display another menu that allows you to either make the device measurement or display/print data from the tape. The program will check the system configuration prior to measurement and if anything is wrong, it will prompt you with a self-explanatory error message. If there are no problems, it will ask you to connect the device and then it will measure it. The program will also allow you to printout the data from the tape and print out the results of the verification measurement. It will even indicate if the test passes and, if not, which frequency points failed. Examples of the printouts are included in the EXAMPLE section.

Use the following GETTING STARTED PROCEDURE for step-by-step instructions, through the menus, to performance test your system with the program. Remember, you should already be familiar with the first part of the program explained in the SPECIFICATIONS section.

GETTING STARTED PROCEDURE: Verifying System Performance

The following paragraphs describe how to continue using the program after it has been run and after the *System Configuration Menu* selections have been made.

NOTE: Do not read and use this information unless you already know how to load the program, run it, and set the *Hardware* and *Software Configuration* menus. Refer to the SPECIFICATIONS section.

1. Start at the Main Menu. Do not press the [VERIFY SYSTEM] softkey yet.

   NOTE: If the program displays and error message on the controller CRT, refer to the end of the REFERENCE material, under the heading ERROR MESSAGES, for an explanation of the message.

2. Be sure that your Hardware and Software Configuration menus match the system that you are going to performance test. Also, be sure that you have the following items ready to use:

   - Calibration Kit and its tape. The model number of the calibration kit must match the one you select in the Configuration menu.
   - Verification Kit and its tape. The model number of the verification kit must match the one you select in the Configuration menu.

3. CONNECT THE HP 8510

   Be sure that the controller is connected to the HP 8510's rear panel HP-IB connector. Also, the HP 8510 must be warmed-up for one hour before verification.

4. Press **[VERIFY SYSTEM]**. If the HP 8510 is not connected or if its addresses are incorrect, the program will display an error message. If you get this message, check all connections and addresses. The *SCPP* (Select Code Primary Address) message is explained in the *Reference* portion of the SPECIFICATIONS section.

   If you do not get an error message, continue to step 5 below. If the error message is not cleared after you check connections and addresses, try pressing the recessed [TEST] button on the HP 8510 front panel and then go to the program's System Configuration menu and press the [PROGRAM RESET] softkey. After that, reset all the selections in the *Hardware* and *Software Configuration* menus, return to the Main menu and press [VERIFY SYSTEM] again. If you still get the error message, contact your HP Customer Engineer for assistance.

5. SYSTEM PERFORMANCE VERIFICATION MENU

   If the program properly acknowledges the system over the HP-IB, it will display the *System Performance Verification Menu* on the controller CRT. This menu has four selections that are typically used in this order: [SERIAL NUMBERS], [SYSTEM CAL], [SELECT STANDARD], and [DISPLAY ETERMS]. Except for the [DISPLAY ETERMS], these selections will be used and explained in the following steps.

   NOTE: The [DISPLAY ETERMS] selection is a diagnostic tool and is explained in the HP 8510 SERVICE MANUAL (Additional Tests section). However, when you first receive your system, printout the ETERMS and keep them as a reference. Later, if you ever have a service problem you can printout the ETERMS and compare them to the first ones. Thus, any great differences can be helpful in determining the problem.

6. SYSTEM SERIAL NUMBER AND NBS NUMBER SELECTION MENU

Press **[SERIAL NUMBER]**. This menu selection will display the *System Serial Numbers and NBS Number Selection Menu*. The asterisk (*) next to each entry area means only that you can enter a number in the field. Instrument serial numbers are usually located on the rear panels. NBS test numbers are on the *Certificate of Calibration* that accompanies your Verification Kit.

Enter the NBS numbers only if you want them to appear on the printout of your performance test results for each verification device (refer to item 2 in Reference for more information). If you do not enter any numbers in this menu, no numbers will appear on the printout. When you are finished with this menu, press **[DONE]**.

7. GETTING READY TO CALIBRATE THE SYSTEM

You should now be back in the System Performance Verification Menu. Press **[SYSTEM CAL]**. This selection will cause the program to display the configuration information to make sure it agrees with the system you are going to verify. If the information is correct, press **[RESUME]**, and if the information is not correct, return to the Hardware Configuration menu to correct it. The next CRT display will have instructions for connecting the test port cables. Be sure they are undamaged, clean, and properly gauged (refer to the appropriate kit manual for details). Notice that the program will prompt you to mame the proper connections. Also, notice that a [PRIOR MENU] key is usually available in all the menus so that you can return to a previous menu in case you need to change something or exit the program. Press the [RESUME] softkey after following the instructions for each of the program's display messages.

The next program CRT display will inform you about the type of calibration required and it will set the HP 8510 to the proper instrument state when you are ready to calibrate. The program will also prompt you to perform the *Trim Sweep* procedure if you have a sweeper (HP 8350B) as the system source.
If you already have the proper calibration(s) stored in an HP 8510 Cal Set register(s), the [SYSTEM CAL] menu selection is not necessary. Therefore, if you were to use a previously stored calibration(s), you would go to step 11 where the [SELECT STANDARD] is explained —that menu allows you to turn correction ON by choosing a Cal Set Register. However, because this *Getting Started* procedure is intended to show you the program's features and menu structure, it is assumed that you do not have a calibration ready to use.

NOTE: *Trim Sweep* procedures are prompted on the CRT. Follow the instructions carefully. The program will prompt you to make a *THRU* (S21) measurement in order to normalize the trace on the HP 8510. The program will then prompt you to connect the airline from the selected verification kit to make another measurement. The *Trim Sweep* value that the program asks for is a value of electrical delay or advance that adjusts the HP 8510's sweep to match more accurately source's frequency sweep. If you have already performed a manual (front panel) *Trim Sweep* procedure you can enter that *Trim Sweep* value. If not, turn the HP 8510 front panel RPG (Rotary Pulse Generator) knob in the direction that causes the trace to have the flatest and most symmetrical span across the center graticule. You can also use the HP 8510 RESPONSE [AUTO] scale key to properly view the trace on the CRT.

8. LOAD THE CAL KIT TAPE

   It is always recommended that you load the Calibration Kit tape to be sure the correct calibration standard definitions are being used. On the HP 8510, press the front panel **[CAL]** key. Then insert the tape and press the following keys: **[TAPE]**, **[LOAD]**, **[Cal Kit 1-2]**, **[Cal Kit 1]** or **[Cal Kit 2]**. Then press **[*File 1]** and if an asterisk (*) appears next to file 2 , press it after file 1 is loaded.

   NOTE: You can load the tape into either Cal Kit 1 or 2. Typically, 7mm is in Cal Kit 1 and 3.5mm is in Cal Kit 2. If you want to save the calibration definition already stored in one of these HP 8510 Cal Kits, you can save it on tape before loading the definitions you are going to use for your calibration.

   Press **[CAL]** again and verify that the proper files were loaded. The HP 8510 softkey field should display the type of calibration and the cal kit tape constants revision number. After the tape is loaded, remove it from the drive.

9. Press **[RESUME]** softkey if you are ready to calibrate. The program is designed to set-up the HP 8510 and put it into *LOCAL* operation (non-program control) so that you can calibrate the system using its front panel keys.

10. PERFORM THE CALIBRATION

    Remember that you will need a *Full 2-port* calibration for S-Parameter test sets and a *One-Path 2-port* calibration for Reflection/Transmission test sets. Also, remember that you specified a calibration method (the type of LOAD) in the *Hardware Configuration* menu. This was explained in the SPECIFICATIONS section and, in this case, it means that when the [LOADS] softkey is selected during the calibration, you will use the Sliding Load in addition to the Lowband Load.

    Perform the calibration on the HP 8510 using the front panel keys. DO NOT CHANGE ANY OF THE INSTRUMENT SETTINGS —the program will set the HP 8510 to the proper state.

    NOTE: The *HP 8510 Operating and Programming* manual and the *Calibration Kit* manual have information about HP 8510 calibration. However, here are some steps that should help you to calibrate the HP 8510 using the front panel keys:

    STEP 1: Have the proper calibration kit (specified in the Hardware Configuration menu) and its manual ready for use.

    STEP 2: Press the **[CAL]** button on the HP 8510. Then select the Cal Kit type by pressing the appropriate CRT softkey. This selection depends upon the connector type that you will be using. For example, if you are using 3.5mm connectors, you would press [CAL 1 3.5mm].

    STEP 3: Notice that the HP 8510 will display the calibration type next to each CRT softkey. For S-parameter test sets, press **[Full 2-PORT]**. For Reflection/Transmission test sets, press **[ONE-PATH 2-PORT]**.

STEP 4: The next CRT display will show softkey selections for each type of calibration measurement: [REFLECT'N], [TRANSMISSION], and [ISOLATION]. When you press one of these keys, another set of softkeys will appear. These keys represent each device to be measured. For example, when you press the [REFLECT'N] softkey, the next set of softkeys will be [OPEN], SHORT], and [LOADS] for S_{11} and, for S-Parameter test sets S_{22}. You would connect each device to the end of the cable(s) and then press the accompanying softkey to make the measurement. The HP 8510 will underline each device label when the measurement is complete. After all of the devices are measured, press the **[DONE]** softkey.

NOTE: The *LOADS* selection includes Lowband, Broadband, and Sliding (or Offset for the TRL calibration). **Do not perform the Broadband measurement.** You will always use the *Fixed* (50 Ohm) Load and perform the Lowband measurement. And, for sliding loads, be sure to set the slide to at least 5 random positions and press the [Slide is set] softkey for each one. Be sure to make all the required measurements and press the appropriate [DONE] key. Also, you can omit the *ISOLATION* measurement, if you are using an HP 8350B source.

STEP 5: After you have made all the calibration measurements, press the appropriate [DONE] softkey when the calibration is complete. Then store the calibration in a Cal Set Register (1 through 8) by pressing the accompanying softkey. If an asterisk (*) appears alongside one of the cal set registers, it means that a calibration is already stored there. If all of the registers are full, go ahead and press a key and respond to the prompts. You will delete the contents of that register and store your calibration there.

When the calibration is complete, press the program **[RESUME]** key and the program will reset the HP 8510 to *REMOTE* (program controlled) operation and return you to the *System Performance Verification Menu*.

The program will also prompt you to perform a separate 45 MHz calibration if your configuration will allow it and if your verification kit data tape has 45 MHz data (only some early kits do not have this data). Remember the registers in which you store the calibration(s) so that you can specify them in the next menu selection (explained below).

11. SELECTING THE VERIFICATION STANDARD (Getting ready to Measure the Device)

Press **[SELECT STANDARD]**. The program will display the *Verification Kit Device Selection Menu*. This menu is a form that allows you to select the standard you want to measure, enter its serial number, change the averaging factor for measurement, select the Cal Set register, and enter any comments.

VERIFY STANDARD —Remember that a complete verification requires that you measure all devices in the kit. However, you need to select the devices, one at a time, from this menu. Use the [NEXT] and [PREVIOUS] keys to change the selection. For now, you should select the 20 dB attenuator. Then use the controller keyboard UP/DOWN arrow keys or the [TAB] key to move to the next field in the displayed form.

SERIAL NUMBER —Here you can enter the serial number of the verification standard. If you do enter it, the program will compare it to the verification kit data tape in the following steps. However, you do not have to enter a number if you do not want any numbers to appear on the printout. In that case, there will be a blank space on the printout next to the NBS number heading.

NUMBER OF AVERAGES —Remember that HP requires that systems using a synthesizer (for example: HP 8340/41) as a source should always use 1024 averages and that systems using a sweeper (for example: HP 8350B) should use 128 averages. These averaging factors were chosen for verification purposes to allow optimum performance within a reasonable time. Greater averaging reduces noise on the trace but requires more time to complete. In order to verify your system properly be sure to use 1024 averages for synthesizers and 128 for sweepers. The program does allow you to select a different number by using the [NEXT] and [PREVIOUS] softkeys. However, these other averaging value selections are not recommended.

CAL SET —The broadband measurement is the primary calibration. The program has Cal Set register 1 as the default. If necessary, change it to match the proper Cal Set register where you stored your calibration. If you have a 45 MHz calibration, enter its Cal Set register number also. Select the *YES* or *NO* field that applies to your case. If you do not want a 45 MHz measurement, be sure to specify *NO*. If you do not specify *NO*, the program will expect you to make the 45 MHz measurement. Also, when performing the LOADS calibration for the 45 MHz data point, be sure that you have used the fixed (50 Ohm) load and performed only the *Lowband* measurement.

COMMENT —Here you can enter any comments by typing them in from the controller keyboard. For example, you may want to enter your name and phone number: *John Smith, ext. 333*.

12. When the form is complete, insert the Verification Kit data tape into the HP 8510 tape drive and press **[DONE]**. The program will read the tape and compare device serial numbers. If the numbers do not match, the program will change them for you by responding to the CRT prompts.

13. MEASURING THE STANDARD and DISPLAYING DATA

    The next menu will allow you to measure the verification device or display/print data from the tape or from the uncertainty calculation. Press the **[DISPLAY DATA]** softkey and you will see the *Verification Kit Tape Display Menu*. For any of the S-Parameter display softkey selections, the data will be shown on the HP 8510 CRT in graphical form. Also, you can print the data using the softkeys.

    The [PRINT FACTORY] softkey will print a table of the factory measured data for your verification kit device. This data is taken from the verification kit data tape and includes the factory measured value (in magnitude and phase) and the uncertainty of the factory system used to measure it.

    The [PRINT TOTAL] softkey will print a table of the factory measured data (magnitude and phase) for your verification kit device —this is the same measured data printed when you select [PRINT FACTORY]. However, the uncertainty column is the total uncertainty =the factory system's uncertainty and the calculated uncertainty of your system (based upon the hardware configuration you have selected). This table can be used to perform a manual performance test. To do this, you would print this table and measure each device using the HP 8510 front panel. Then you could compare the measured data with this table.

    NOTE: You can obtain your system's uncertainty calculation by subtracting the uncertainty value in the [PRINT FACTORY] selection's uncertainy column from the [PRINT TOTAL] selection's uncertainty column.

    Press any or all of the softkeys in this menu to familiarize yourself with the capabilities of this menu. Remember that the *Software Configuration Menu* has the address settings of your printer and/or plotter.

    Press **[PRIOR MENU]** when you are finished with this menu.

14. When you are ready to measure the device, press **[MEASURE DATA]** and respond to the prompts on the controller CRT. The program will initialize the system and give you instructions for making the proper connections.

    At this point, you should have the 20 dB pad ready to measure. Remember that Cal Set register you selected in the *System Performance Verification Menu* is the one that will be used.

    Follow the instructions on the CRT, making the proper connections and press the **[RESUME]** softkey as required. You can notice the HP 8510 CRT trace as the measurement is being made. When the measurement is complete, the *Verification Kit Device Measurement Display Menu* will appear on the CRT. This menu will allow you to display any of the S-Parameter measurements on the HP 8510 CRT. If you want a plot of the measurement, use the HP 8510 [COPY] key to make plots if your plotter is connected to the HP 8510 System (Interconnect) Bus. The program will automatically put the HP 8510 into *LOCAL* so that you can even change the scale or format before you plot.

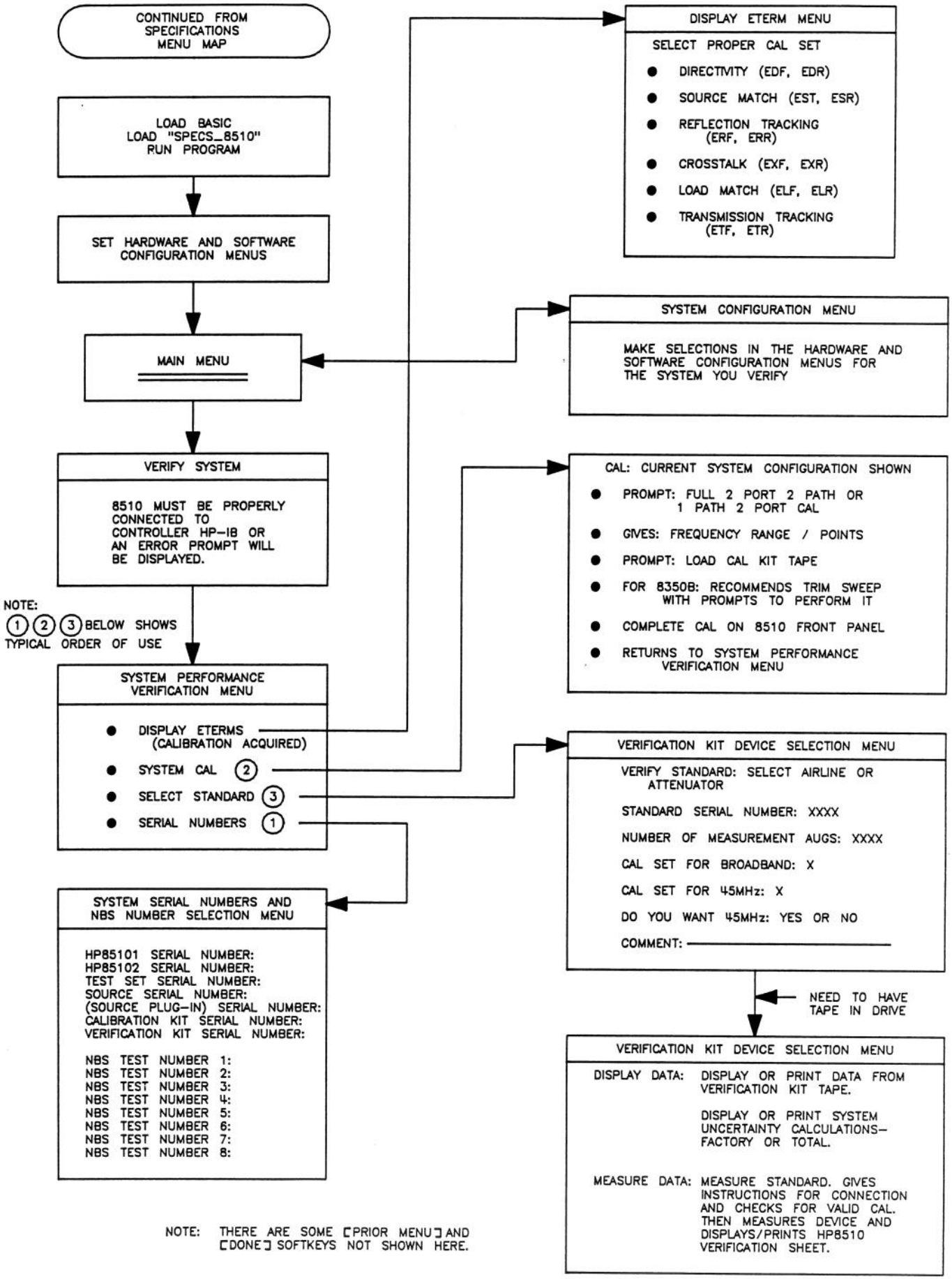
    You can repeat the measurement by using the [REPEAT MEASURE] softkey. For example, if you think the connections were loose or if you want to repeat the measurement for any reason, use this feature.

15. Press **[PRINT ALL]** and the program will printout a complete results sheet for the measurement of the device. This sheet will have all the system information on it. It will also indicate if the verification failed. If it fails at any frequency, a letter *F* will appear in the column and a failure notice will appear at the bottom of the sheet. It will not display any letters for frequency points that pass. If an *N* appears in the column, it means that the measurement is not required for verification.

16. Measure the remaining devices in your kit. You will be returning to the prior menu where you selected the standard: Verification Kit Device Selection Menu. You should now be able to refer to the examples and the Menu Map in order to continue using this program. Also, be sure to read the REFERENCE material in this section and in the SPECIFICATIONS section to fully understand how this program works.

IMPORTANT NOTE: Systems using HP 8350B sources and S-Parameter Test Sets will have to measure the *Shorted Airline* two times. The program will prompt you to connect the Shorted Airline between the cables —this cannot be done. Therefore, connect the Shorted Airline to the port 1 side and make the measurement. Select the S_{11} data and print it. Disregard any failure of S_{22} data. Then connect the Shorted Airline to the port 2 side. Re-measure it, select S_{22} and printout the results. In this manner, you will be able to get the proper results.

The MENU MAP is on the following page and examples of data follow it. All of the REFERENCE material is at the end of this section.


CONTINUED FROM SPECIFICATIONS MENU MAP
LOAD BASIC
LOAD "SPECS_8510"
RUN PROGRAM
SET HARDWARE AND SOFTWARE CONFIGURATION MENUS
MAIN MENU
VERIFY SYSTEM
8510 MUST BE PROPERLY CONNECTED TO CONTROLLER HP-IB OR AN ERROR PROMPT WILL BE DISPLAYED.
NOTE:
(1) (2) (3) BELOW SHOWS TYPICAL ORDER OF USE
SYSTEM PERFORMANCE VERIFICATION MENU
DISPLAY ETERMS (CALIBRATION ACQUIRED)
SYSTEM CAL (2)
SELECT STANDARD (3)
SERIAL NUMBERS (1)
SYSTEM SERIAL NUMBERS AND NBS NUMBER SELECTION MENU
HP85101 SERIAL NUMBER:
HP85102 SERIAL NUMBER:
TEST SET SERIAL NUMBER:
SOURCE SERIAL NUMBER:
(SOURCE PLUG-IN) SERIAL NUMBER:
CALIBRATION KIT SERIAL NUMBER:
VERIFICATION KIT SERIAL NUMBER:
NBS TEST NUMBER 1:
NBS TEST NUMBER 2:
NBS TEST NUMBER 3:
NBS TEST NUMBER 4:
NBS TEST NUMBER 5:
NBS TEST NUMBER 6:
NBS TEST NUMBER 7:
NBS TEST NUMBER 8:
NOTE: THERE ARE SOME [PRIOR MENU] AND [DONE] SOFTKEYS NOT SHOWN HERE.
DISPLAY ETERM MENU
SELECT PROPER CAL SET
DIRECTIVITY (EDF, EDR)
SOURCE MATCH (EST, ESR)
REFLECTION TRACKING (ERF, ERR)
CROSSTALK (EXF, EXR)
LOAD MATCH (ELF, ELR)
TRANSMISSION TRACKING (ETF, ETR)
SYSTEM CONFIGURATION MENU
MAKE SELECTIONS IN THE HARDWARE AND SOFTWARE CONFIGURATION MENUS FOR THE SYSTEM YOU VERIFY
CAL: CURRENT SYSTEM CONFIGURATION SHOWN
PROMPT: FULL 2 PORT 2 PATH OR 1 PATH 2 PORT CAL
GIVES: FREQUENCY RANGE / POINTS
PROMPT: LOAD CAL KIT TAPE
FOR 8350B: RECOMMENDS TRIM SWEEP WITH PROMPTS TO PERFORM IT
COMPLETE CAL ON 8510 FRONT PANEL
RETURNS TO SYSTEM PERFORMANCE VERIFICATION MENU
VERIFICATION KIT DEVICE SELECTION MENU
VERIFY STANDARD: SELECT AIRLINE OR ATTENUATOR
STANDARD SERIAL NUMBER: XXXX
NUMBER OF MEASUREMENT AUGS: XXXX
CAL SET FOR BROADBAND: X
CAL SET FOR 45MHz: X
DO YOU WANT 45MHz: YES OR NO
COMMENT:
NEED TO HAVE TAPE IN DRIVE
VERIFICATION KIT DEVICE SELECTION MENU
DISPLAY DATA: DISPLAY OR PRINT DATA FROM VERIFICATION KIT TAPE.
DISPLAY OR PRINT SYSTEM UNCERTAINTY CALCULATIONS- FACTORY OR TOTAL.
MEASURE DATA: MEASURE STANDARD. GIVES INSTRUCTIONS FOR CONNECTION AND CHECKS FOR VALID CAL. THEN MEASURES DEVICE AND DISPLAYS/PRINTS HP8510 VERIFICATION SHEET.

********* HP8510 VERIFICATION KIT DEVICE CHARACTERIZATION DATA SHEET *********

FACTORY Measured Data and TOTAL SYSTEM Uncertainties

Std: 7.5 cm 50 ohm Airline — Ser #: 00107 — Origin: 7/31/87

Kit: HP85053B -- 3.5mm — Ser #: 00135 — Origin: 7/31/87

Specified at: 23 deg. C.

PORT IDENTIFICATION: With the device label facing the user;
Port 1 (A) is on the left and Port 2 (B) is on the right.

Network Analyzer: HP8510B -- Enhanced Model

Test Set: HP8515A -- 3.5mm S-Parameter (45MHz-26.5GHz)

Source: HP8340A/B -- Synthesizer (10MHz-26.5GHz)

Calibration Kit: HP85052B -- 3.5mm Slotless

Calibration Technique: SL -- Sliding Load Cal

Test Port Cables: HP85131B/D -- 3.5mm pair short cables

	S11				S22			
Freq GHz	Mag lin	Unc +/-	Ang deg	Unc +/-	Mag lin	Unc +/-	Ang deg	Unc +/-
.045	.00126	.02076	39.57	180.00	.00143	.02077	30.74	180.00
1.500	.00286	.02067	-177.01	180.00	.00194	.02066	-168.74	180.00
2.000	.00157	.02063	-99.21	180.00	.00171	.02064	-65.76	180.00
3.000	.00038	.02526	-156.69	180.00	.00303	.02530	177.50	180.00
4.500	.00118	.02522	-16.25	180.00	.00111	.02522	-143.77	180.00
6.000	.00204	.02518	31.08	180.00	.00137	.02517	120.25	180.00
7.500	.00534	.02518	124.18	180.00	.00420	.02517	128.45	180.00
8.000	.00325	.02514	61.17	180.00	.00324	.02514	96.97	180.00
9.000	.00386	.02931	165.80	180.00	.00274	.02929	158.35	180.00
10.500	.00484	.02928	29.31	180.00	.00231	.02925	71.21	180.00
12.000	.00584	.02926	93.48	180.00	.00623	.02926	59.88	180.00
13.500	.00512	.02921	164.35	180.00	.00636	.02922	82.94	180.00
15.000	.00217	.02914	45.30	180.00	.00271	.02915	67.60	180.00
16.500	.00775	.02918	82.79	180.00	.00578	.02915	-28.00	180.00
18.000	.00428	.02912	123.03	180.00	.00424	.02912	7.69	180.00
19.500	.00354	.02907	-35.73	180.00	.00084	.02904	-77.67	180.00
20.000	.00452	.02907	105.27	180.00	.00483	.02908	12.75	180.00
21.000	.00623	.03173	-16.76	180.00	.00424	.03170	-128.69	180.00
22.500	.00798	.03171	-11.03	180.00	.00434	.03166	-14.89	180.00
24.000	.00554	.03176	45.38	180.00	.00480	.03175	41.76	180.00
25.500	.00646	.03177	123.98	180.00	.00767	.03178	103.32	180.00
26.500	.00427	.03170	13.58	180.00	.00694	.03174	-67.95	180.00

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

— EXAMPLE —

HP8510B PERFORMANCE VERIFICATION 14:54:51 20 Aug 1987

Verif Std: 20 dB Attenuator Ser #: 01034 Origin: 7/31/87
Verif Kit: HP85053B -- 3.5mm Ser #: 00135 Origin: 7/31/87

Network Analyzer:	HP8510B	S/N:
Test Set:	HP8514B	S/N:
Source:	HP83595A	S/N:
Calibration Kit:	HP85052B	S/N:
Calibration Technique:	SL	
Test Port Cables:	HP85131B	

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

Comments:

	S21 MAGNITUDE (dB)				S21 PHASE (deg)			
Freq [GHz]	Factory Meas'd [A]	User Meas'd [B]	Diff Mag [A-B]	Total Uncert +/-	Factory Meas'd [A]	User Meas'd [B]	Diff Phase [A-B]	Total Uncert +/-
1.500	-20.012	-20.015	.003	.103	-60.88	-61.20	.32	2.69
2.000	-20.020	-20.020	0.000	.103	-81.11	-81.54	.42	2.73
3.000	-20.036	-20.038	.002	.132	-121.59	-121.78	.18	3.03
4.500	-20.055	-20.066	.010	.131	177.72	177.63	.09	3.19
6.000	-20.078	-20.081	.003	.132	117.05	117.07	-.01	3.36
7.500	-20.098	-20.099	.001	.133	56.40	56.71	-.31	3.53
8.000	-20.113	-20.107	-.006	.133	36.18	36.45	-.27	3.59
9.000	-20.129	-20.116	-.013	.198	-4.27	-4.07	-.20	4.12
10.500	-20.154	-20.143	-.011	.200	-64.86	-64.79	-.07	4.30
12.000	-20.179	-20.181	.002	.204	-125.50	-125.56	.06	4.50
13.500	-20.207	-20.198	-.009	.207	173.90	173.89	.01	4.69
15.000	-20.232	-20.216	-.016	.208	113.29	113.34	-.05	4.85
16.500	-20.249	-20.237	-.012	.207	52.72	52.76	-.04	5.01
18.000	-20.252	-20.243	-.008	.202	-7.87	-7.97	.09	5.15
19.500	-20.261	-20.265	.005	.197	-68.55	-68.68	.14	5.28
20.000	-20.262	-20.250	-.012	.195	-88.78	-88.76	-.03	5.32

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

PASSED: S21 Verification Measurement of the 20 dB Attenuator.

— EXAMPLE —

HP8510B PERFORMANCE VERIFICATION 01:57:33 1 Mar 1900

Verif Std: 20 dB Attenuator Ser #: 1 Origin: 10/10/-9
Verif Kit: HP85053A -- 3.5mm Ser #: 11111 Origin: 10/10/-9

Network Analyzer:	HP8510B	S/N:
Test Set:	HP8515A	S/N:
Source:	HP83592A	S/N:
Calibration Kit:	HP85052A	S/N:
Calibration Technique:	SL	
Test Port Cables:	HP85131B	

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

Comments:

	S12 MAGNITUDE (dB)				S12 PHASE (deg)			
Freq [GHz]	Factory Meas'd [A]	User Meas'd [B]	Diff Mag [A-B]	Total Uncert +/-	Factory Meas'd [A]	User Meas'd [B]	Diff Phase [A-B]	Total Uncert +/-
1.500	-20.124	-20.133	.009	.140	-60.57	-62.03	1.47	2.92
3.000	-20.148	-20.153	.005	.138	-121.33	-123.51	2.18	3.07
4.500	-20.166	-20.174	.007	.137	178.19	174.94	3.25 F	3.23
6.000	-20.187	-20.193	.005	.137	117.69	113.44	4.25 F	3.39
7.500	-20.211	-20.233	.022	.139	57.15	52.09	5.06 F	3.58
9.000	-20.236	-20.265	.029	.193	-3.43	-9.60	6.17 F	4.10
10.500	-20.264	-20.358	.095	.197	-64.00	-70.69	6.69 F	4.29
12.000	-20.293	-20.335	.042	.202	-124.55	-132.91	8.36 F	4.49
13.500	-20.322	-20.561	.238 F	.205	174.94	164.72	10.22 F	4.67
15.000	-20.350	-20.792	.442 F	.208	114.44	106.39	8.05 F	4.86
16.500	-20.373	-20.582	.208	.209	53.95	44.18	9.77 F	5.03
18.000	-20.389	-20.608	.218 F	.205	-6.56	-14.57	8.02 F	5.17
19.500	-20.399	-20.493	.094	.200	-67.11	-76.98	9.86 F	5.31

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

Legend: F -- Parameter Verification failed.

FAILED: S12 Verification Measurement of the 20 dB Attenuator.

— EXAMPLE —

HP8510B PERFORMANCE VERIFICATION 01:57:33 1 Mar 1900

Verif Std: 20 dB Attenuator Ser #: 1 Origin: 10/10/-9
Verif Kit: HP85053A -- 3.5mm Ser #: 11111 Origin: 10/10/-9

Network Analyzer:	HP8510B	S/N:
Test Set:	HP8515A	S/N:
Source:	HP83592A	S/N:
Calibration Kit:	HP85052A	S/N:
Calibration Technique:	SL	
Test Port Cables:	HP85131B	

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

Comments:

	S11 MAGNITUDE (lin)				S11 PHASE (deg)			
Freq [GHz]	Factory Meas'd [A]	User Meas'd [B]	Diff Mag [A-B]	Total Uncert +/-	Factory Meas'd [A]	User Meas'd [B]	Diff Phase [A-B]	Total Uncert +/-
1.500	.00599	.00524	.00075 N	.01524	92.09	77.45	14.64 N	180.00
3.000	.00647	.00892	-.00245 N	.01525	53.87	42.03	11.84 N	180.00
4.500	.00892	.00876	.00016 N	.01532	13.80	15.92	-2.13 N	180.00
6.000	.01106	.00570	.00535 N	.01539	-16.76	-15.95	-.81 N	180.00
7.500	.01373	.00295	.01078 N	.01547	-48.22	14.54	-62.76 N	78.92
9.000	.01867	.00329	.01538 N	.01613	-83.97	80.79	-164.76 N	57.53
10.500	.02397	.00596	.01801 N	.01630	-122.41	84.45	153.14 N	45.28
12.000	.03005	.00917	.02087 N	.01646	-162.05	86.13	111.82 N	37.14
13.500	.03397	.01648	.01749 N	.01658	157.77	84.11	73.66 N	33.65
15.000	.03602	.02381	.01222 N	.01664	117.42	64.28	53.14 N	32.24
16.500	.03525	.03003	.00522 N	.01662	77.62	47.79	29.83 N	32.97
18.000	.03033	.02286	.00747 N	.01646	34.19	11.77	22.42 N	37.48
19.500	.02278	.01479	.00799 N	.01625	-19.12	-19.35	.23 N	48.41

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

Legend: N -- Parameter Verification Not Required.

PASSED: S11 Verification Measurement of the 20 dB Attenuator.

— EXAMPLE —

REFERENCE: **Important information that applies to Performance Verification and Specifications.**

1. **Trim Sweep procedure**

   The HP 8510 *Trim Sweep* procedure is especially designed for use with HP 8350B sources. The procedure will improve the frequency accuracy of your system. It does this by aligning more closely the HP 8510's frequencies with those of the sweeper. Refer to item 5 in the Reference material of the SPECIFICATIONS section for information on HP 8350B sources.

2. **NBS Numbers**

   The NBS measures HP standards and returns the results to HP with a test number and a date. Your kit is measured on the same system that was used to measure the devices sent to the NBS.

   NBS numbers are supplied with the Certificate of Calibration that comes with your Verification Kit. The numbers are kept on record here at Hewlett-Packard. They are used to document the traceable path of the measured kit data to the National Bureau of Standards. Below is a typical set of NBS numbers:

   738/236940-86
   738/234708-85
   738/230170-83
   731/237627-86
   233661

   NOTE: These numbers are supplied and authorized for use by the NBS. They refer to calibration procedures and standards that are traceable to the NBS. 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.

3. **Complete Performance Verification Criteria**

   A complete performance verification requires that you measure all of the devices in your kit. Do not change any of the HP 8510 parameters or stimulus settings that the program uses for your system. The averaging factor should always be 1024 for synthesizers (for example, HP 8340/41) and 128 for sweepers (for example HP 8350B). For sweepers, the program always sets the HP 8510 sweep-time to 500 milliseconds. Remember that sweep-time does not apply to synthesizers because the system is in *step* mode.

   The four devices will be slightly different for each configuration. However, every kit will have one of the following:

   a. 20 dB attenuator
   b. 40 or 50 dB attenuator
   c. Airline (length varies with kit type)
   d. 25 Ohm mismatch airline (length varies with kit type)*

   *NOTE: Systems with sweepers as sources (HP 8350B) will use a shorted airline instead of the 25 ohm mismatch airline. This is because of the sweeper's phase and magnitude errors (explained in the SPECIFICATION section (Reference material). Also, do not be concerned that the data tape does not have *shorted airline* data −the program uses the *airline* data.

4. **45 MHz Calibration and Verification**

   The verification kit data tape has 45 MHz data. Always use the *fixed load* for the LOADS portion of the calibration 45 MHz calibration and always select the LOW BAND load.

5. **Remote or Local operation**

   The program will automatically set 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 calibrate. REMOTE operation occurs whenever the program is controlling the HP 8510 over the HP-IB bus.

6. **System hang-ups or other problems**

   If the system or the controller will not respond during verification, press [LOCAL] and [PRESET] on the HP 8510 and re-run the program.

7. **Omit Isolation measurement for HP 8350B sources**

   If you are using an HP 8350B source, HP recommends that you omit the *Isolation* measurement during the calibration sequence.

8. **Test Set Rear Panel Extension Links**

   The program will prompt you to use the long or short Test Set rear panel extension links, depending upon the test set and the cables you have selected.

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

   Reflection/Transmission test sets: use SHORT links.
   S-Parameter test sets: use LONG links.

9. **Making connections and maintaining connectors**

   Always keep your connectors and cables in proper 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. A copy of HP's *Microwave Connector Care Manual* is shipped with your system's manual set. It describes how to clean and care for your connectors. If you do not have a copy, contact your nearest HP office and request it by name.

10. **Ramp mode operation for synthesizers**

    Ramp sweep is not verifiable for systems using synthesizers (HP 8340/41) as the source. Do not set the synthesizer to RAMP sweep because the program will not properly execute its commands in that mode.

11. **Explanation of the wording on Tables**

    ORIGIN = date the verification kit was certified.
    FACTORY = verification kit tape data.
    FIELD = uncertainty calculated by the program.

12. **Controller CRT Displays and High-resolution Monitors**

    Tabular data displays do not stop at the top of each page on the CRT. If the controller display memory is not capable of displaying the entire table, you can press any key (for example: space bar) 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 using the UP/DOWN arrow keys to scroll the display. Afterward, you can use the BASIC [CONTINUE] key to resume program operation (you may have to reset the BASIC softkeys to menu softkeys by pressing [USER] or [SHIFT] [USER], depending upon your keyboard.

    NOTE: High-resolution monitors should use the BASIC *Dump Graphics* command and a wide-carriage printer to print tables.

ERROR MESSAGES

The following error messages (in **bold** print) are coded into the program. Whenever you get one of these messages, refer to the information in this section. Also, when checking HP-IB addresses, check the instrument address switches and the program's Software Configuration menu address settings.

ATTENTION: The HP 8510 Network Analyzer does not respond — Check all the HP 8510 system instruments line power and HP-IB addresses. Then check line fuses and all cables.

ATTENTION: The Plotter is Inactive — Check the plotter addresses, line power, cables and fuses.

ATTENTION: The Printer is Inactive — Check the printer address, line power, cables and fuses.

Bad Selection of HP-IB Address of 8510 — Check the Software Configuration menu HP 8510 address and the HP-IB address of the HP 8510.

Bad Selection of HP-IB Address of Plotter — Check the plotter HP-IB address.

Bad Selection of HP-IB Address of Printer — Check the printer HP-IB address.

Bad Selection of HP 8510 Plotter Address — Check the plotter HP-IB address.

Bad Selection of HP 8510 System Bus Address — Check the HP 8510 System Bus (Interconnect) address.

Cal Set registers cannot be the same. Please select another register. — 45 MHz calibration and broadband calibration should not be set to the same Cal Set register in the program's SELECT STANDARD (Verification Kit Device Selection Menu).

Error during configuration: Choice selection led to invalid frequency range — Check the Hardware Configuration Menu. The source and test set frequency range may not be compatible as selected.

Error: (*Filename*) NOT Found — Check the disc and the disc drives. This message indicates that the program is trying to load or read a file that it cannot find. Be sure the proper file is in the proper drive.

Error: Cal technique NOT supported by Cal kit — Check the Hardware Configuration Menu. The type of calibration method and the type of calibration kit must be compatible. For example, a Cal Kit that does not have an *Offset Load* device should not be selected with an *Offset Load* calibration method.

Error: Tape Drive LOAD ERROR — Check the HP 8510 front panel tape drive and any tape in the drive . This message indicates that the program has commanded the HP 8510 to load a tape but it cannot.

Error: Turn CORRECTION OFF before Loading Tape File — Use the HP 8510 front panel [CAL] key to access the Cal Kit registers and turn off the active calibration. Remember that the *CORRECTION ON* message should not appear on the HP 8510 CRT if a calibration is turned OFF.

Error: Unable to load Selected Number of Points from Tape File — This message indicates that the Verification Kit tape data points do not coincide with the number of points the HP 8510 is going to measure.

Error: Unknown Error during Tape Read. Network Analyzer Error Number =xx — This type of error occurs if the HP 8510 outputs an error (to the program) that is not defined in the program. The program will use this particular message for all HP 8510 errors it does not recognize. These errors are defined in the HP 8510 Keyword Dictionary.

Error: Verification Device NOT FOUND in Verification Kit — This message indicates that a verification kit device has been selected for measurement, using the program's Verification Kit Device Selection Menu, that is not in the verificaiton kit. Remember that the verification kit is selected in the Hardware Configuration Menu.

Error: Verification form could not be properly initialized — This message indicates that the data disc file is damaged. If this message occurs, check the Data disc, use another Data disc, or contact your nearest HP office.

Error: Verification Kit Device File Load ABORTED — Please check for valid tape —This message indicates that the verification kit tape cannot be loaded. Check the tape and the tape drive.

Error: Verification Kit Device File NOT found on Tape — Please check for valid tape —This message indicates that the seleted verification kit device data is not on the tape. Check the tape and the device selection in the Verification Kit Device Selection Menu.

Note: Cannot verify at 45 MHz because 45 MHz data is not on the tape. — This message indicates that the verification kit data tape does not have any data for a 45 MHz measurement. This should only occur if an older version tape (without 45 MHz data) is used. Check the tape and the tape printout.

Program Error: System Menu (*menu name*) NOT found — This message indicates that the program cannot read or find one of the menu and that the program is reading that drive.

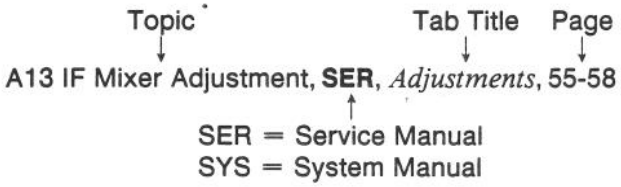
Selection of Cal Register is INVALID. Please select a different Cal Register — Check the Cal Set Register selected in the Verification Kit Device Selection Menu. This message means that the HP 8510 Cal Set Register you selected is not a proper calibration. For example, if you selected register 6, thinking that it contained a 45 MHz calibration, but it did not, you would get this message.

Selection of Error Term is INVALID for Cal Set Selected — This message indicates that the calibration stored in a particular Cal Set Register is not a valid calibration. For example, a 45 MHz verification measurement cannot be made using a Cal Set that contains a broadband calibration.

Tape Read Error — This message indicates that something is wrong with the tape, the tape drive, or the data on the tape. Check the tape, the drive, and the procedure used prior to receiving this message.

Subject Index

LEGEND



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