About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual is the best copy we could find; it may be incomplete or contain dated information. If we find a more recent copy in the future, we will add it to the Agilent website.

Support for Your Product

Agilent no longer sells or supports this product. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available. You will find any other available product information on the Agilent Test & Measurement website, www.tm.agilent.com.

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, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. In other documentation, to reduce potential confusion, the only change to product numbers and names has been in the company name prefix: where a product number/name was HP XXXX the current name/number is now Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

HP 85106D mm-Wave Network Analyzer System

Installation and Operation

HP part number: 85106-90079
Printed in USA
October 1997

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What You'll Find in This Manual…

Chapter 1
- Getting Started - provides information about installing your system

Chapter 2
- Operation - provides the system description, instructions for turning the system ON, performing system calibration, and example measurements.

Chapter 3
- Performance Verification - contains information about the system's performance verification, using a waveguide verification kit and the HP 8510C specifications and performance verification software.

Chapter 4
- Service and Troubleshooting - provides information about the troubleshooting and repair of a system.

Chapter 5
- HP 85104A Test Set Module - provides information specific to the HP 85104A test set module, such as replaceable parts, theory of operation, and the troubleshooting information.

Chapter 6
- HP 85105A mm-Wave Controller - contains information specific to the HP 85105A mm-wave controller, such as replaceable parts, theory of operation, and the troubleshooting information.

Appendix A
- HP-IB addressees and hardware states.

Appendix B
- Upgrade Path information.

Certification

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

Warranty

This Hewlett-Packard system product is warranted against defects in materials and workmanship for a period corresponding to the individual warranty periods of its component products. Instruments are warranted for a period of one year. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products that prove to be defective.

Warranty service for products installed by HP and certain other products designated by HP will be performed at Buyer's facility at no charge within HP service travel areas. Outside HP service travel areas, warranty service will be performed at Buyer's facility only upon HP's prior agreement and Buyer shall pay HP's round trip travel expenses. In all other areas, products must be returned to a service facility designated by HP.

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HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

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Assistance

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

For assistance, call your local Hewlett-Packard Sales and Service Office (refer to “Service and Support”).

Service and Support

Any adjustment, maintenance, or repair of this product must be performed by qualified personnel. Contact your customer engineer through your local HP Service Center. You can find a list of HP Service Centers on the web at `http://www.hp.com/go/tmdir`.

If you do not have access to the Internet, one of these HP centers can direct you to your nearest HP representative:

United States:	Hewlett-Packard Company Test and Measurement Call Center PO Box 4026 Englewood, CO 80155-4026 (800) 452 4844 (toll-free in US)
Canada:	Hewlett-Packard Canada Ltd. 5150 Spectrum Way Mississauga, Ontario L4W 5G1 (905) 206 4725
Europe:	Hewlett-Packard European Marketing Centre Postbox 999 1180 AZ Amstelveen The Netherlands (31 20) 547 9900
Japan:	Yokogawa-Hewlett-Packard Ltd. Measurement Assistance Center 9-1, Takakura-Cho, Hachioji-Shi Tokyo 192, Japan (81) 426 56 7832 (81) 426 56 7840 (FAX)
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Australia/New Zealand:	Hewlett-Packard Australia Ltd. 31-41 Joseph Street Blackburn, Victoria 3130 Australia 1 800 629 485 (toll-free)
Asia-Pacific:	Hewlett-Packard Asia Pacific Ltd. 17-21/F Shell Tower, Times Square 1 Matheson Street, Causeway Bay Hong Kong (852) 2599 7777 (852) 2506 9285 (FAX)

Safety and Regulatory Information

Review this product and related documentation to familiarize yourself with safety markings and instructions before you operate the instrument. This product has been designed and tested in accordance with international standards.

WARNING

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

CAUTION

The **CAUTION** notice 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 the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

Instrument Markings

	When you see this symbol on your instrument, you should refer to the instrument's instruction manual for important information.
	This symbol indicates hazardous voltages.
	The laser radiation symbol is marked on products that have a laser output.
	This symbol indicates that the instrument requires alternating current (ac) input.
	The CE mark is a registered trademark of the European Community. If it is accompanied by a year, it indicates the year the design was proven.
	The CSA mark is a registered trademark of the Canadian Standards Association.
1SM1-A	This text indicates that the instrument is an Industrial Scientific and Medical Group 1 Class A product (CISPER 11, Clause 4).
	This symbol indicates that the power line switch is ON.
	This symbol indicates that the power line switch is OFF or in STANDBY position.

Safety Earth Ground

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

Before Applying Power

Verify that the product is configured to match the available main power source as described in the input power configuration instructions in this manual. If this product is to be powered by autotransformer, make sure the common terminal is connected to the neutral (grounded) side of the ac power supply.

Typeface Conventions

Italics

- Used to emphasize important information:
  Use this software *only* with the HP 85106D system.
- Used for the title of a publication:
  Refer to the *HP85106D System-Level User's Guide*.
- Used to indicate a variable:
  Type `LOAD BIN` *filename.*

`Instrument Display`

- Used to show on-screen prompts and messages that you will see on the display of an instrument:
  The HP 85106D will display the message **`CAL1 SAVED`**.

[Keycap]

- Used for labeled keys on the front panel of an instrument or on a computer keyboard:
  Press **[Return]**.

{Softkey}

- Used for simulated keys that appear on an instrument display:
  Press ***{Prior Menu}***.

`User Entry`

- Used to indicate text that you will enter using the computer keyboard; text shown in this typeface must be typed *exactly* as printed:
  Type `LOAD PARMFILE`
- Used for examples of programming code:

```
#endif // ifndef NO_CLASS
```

`Path Name`

- Used for a subdirectory name or file path:
  Edit the file *`usr/local/bin/sample.txt`*

Computer Display

- Used to show messages, prompts, and window labels that appear on a computer monitor:
  The **Edit Parameters** window will appear on the screen.
- Used for menus, lists, dialog boxes, and button boxes on a computer monitor from which you make selections using the mouse or keyboard:
  Double-click **EXIT** to quit the program.

Contents

1 Getting Started

Introduction

The HP 85106D mm-wave S-parameter network analyzer is a banded waveguide system. Table 1-1 lists the waveguide bands available from 33 GHz to 110 GHz. You must add two HP 85104A series test set modules for each waveguide band. For fully error-corrected measurements, it is necessary to use a calibration kit in the same frequency band as the test set modules being used. Refer to "Frequency Bands and Accessories Available" on page 1-4 in this manual for the specific model numbers required for your system.

Table 1-1 HP 85106D mm-Wave System Frequency Bands

Frequency Range	45 MHz - 50 GHz	33 GHz -50 GHz	40 GHz -60 GHz	50 GHz -75 GHz	75 GHz -110 GHz
Frequency Band	Coaxial (option001)	Waveguide			
		Q-band WR-22	U-band WR-19	V-band WR-15	W-band WR-10

The HP 85106D mm-wave system arrives with one each of the following installed in a system cabinet:

- HP 8510C Network Analyzer
- HP 85105A mm-Wave Controller
- HP 83621B Synthesized Source (quantity of two)
- System Cabinet - 1600 mm Rack, all instruments noted above are mounted in this cabinet.
- An HP 85106D system configuration disk is included with your system. This disk allows you to load the mm-wave instrument and hardware states into your system. Refer to Chapter 2, "Operation" for more information about loading your system's configuration.

NOTE

To complete your mm-wave system, two test set modules must be ordered for the frequency band of interest. Refer to "Frequency Bands and Accessories Available" on page 1-4 in this manual.

Warranty

The HP 85106D mm-wave network analyzer system carries a one year on-site warranty where available, and includes installation and performance tests. If instruments are ordered separately, such as the HP 85104A, they are included in this warranty, provided they are used in an HP 8510C network analyzer system.

System Serial Numbers Supported by This Manual

A serial number label is attached to each HP 85106D system cabinet. This label is located on the front of the system cabinet, in the lower left-hand corner, and has the serial number of your system printed on it.

A typical serial number label is shown in Figure 1-1. The serial number has-two parts. The first four digits, followed by a letter, comprise the serial number prefix. The last five digits form the sequential suffix, which is unique to each instrument (or system). The contents of this manual apply directly to systems having the same serial number prefix or higher as listed on the title page of this manual under the heading Serial Numbers.

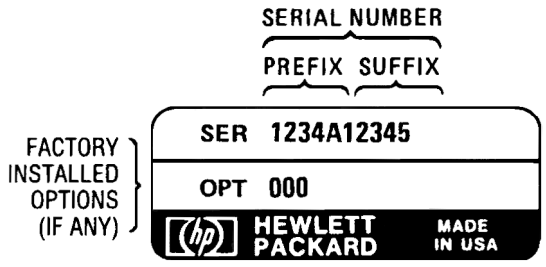


Figure 1-1 Typical Serial Number Label

Upgrading Instruments

Upgrades within the HP 8510 family are available through Hewlett-Packard. Refer to Appendix B, “Upgrade Path Information” or contact the nearest HP Sales and Service office for more information. Office listings are located in the front of this manual.

HP 85106D mm-Wave System Options

Option 001 This option adds:

- HP 8517B, 45 MHz to 50 GHz coaxial, S-parameter test set.
- HP 85133F test port return cable set.
- HP 85056A 2.4 mm calibration kit.
- Replaces one HP 83621B with 83651B and adds Option 050 to the HP 85105A.
- Cabling for switching between mm-wave operation and microwave operation.

Option 007 This option adds:

- High-power and high-dynamic range capability to the HP 8517B test set.

The HP 8517B test set is shipped when you order the HP 85106D option 001 system. Option 007 is *not available* unless the HP 85106D mm-wave system has Option 001 installed.

Option 010 This option adds time domain capability to the HP 8510C network analyzer.

Option 230 This option allows for 220/240 V line voltage operation of the system.

Frequency Bands and Accessories Available

The following items are required (or strongly recommended) to complete your HP 85106D system. Order the model numbers that correspond to the frequency range you are operating in.

33 GHz to 50 GHz (WR-22)

- HP Q85104A WR-22 test set module (2 required for S-parameter)
- HP Q11644A WR-22 calibration kit (required for error corrected measurements)
- HP Q11645A WR-22 verification kit (strongly recommended)

40 GHz to 60 GHz (WR-l9)

- HP U85104A WR-19 test set module (2 required for S-parameter)
- HP U11644A WR-19 calibration kit (required for error corrected measurements)
- HP U11645A WR-19 verification kit (strongly recommended)

50 GHz to 75 GHz (WR-16)

- HP V85104A WR-15 test set module (2 required for S-parameter)
- HP V11644A WR-15 calibration kit (required for error corrected measurements)
- HP V11645A WR-15 verification kit (strongly recommended)

75 GHz to 110 GHz (WR-10)

- HP W85104A WR-10 test set module (2 required for S-parameter)
- HP W11644A WR-10 calibration kit (required for error corrected measurements)
- HP W11645A WR-10 verification kit (strongly recommended)

Installing the System

Most of the HP 85106D system instruments are already installed in a system rack, assembled, and have most of the cabling attached upon arrival from the factory. After the system has been uncrated, an HP Customer Engineer performs the following at installation:

- Completes the system checklist.
- Assembles the work surface and connects it to the system cabinet.
- Installs the HP 85104A test set modules (shipped separately from the system cabinet).
- Verifies that the HP-IB addresses are set properly, and after the customer connects the system to a power source, verifies the powering-on of the system.
- Runs the system performance verification, which includes a measurement calibration.

System Arrival

The HP 85106D mm-wave system arrives with the work surface included in the system cabinet packaging. The HP 85104A test set modules and any optional instruments or peripherals are shipped separately. The system cabinet is shipped upright in a special crate. Refer to the *HP 85043C System Rack Installation manual* for detailed information on unpacking instructions.

Keep the shipping containers to help verify the receipt of all components ordered. Inspect all shipping containers. Keep the carton and packaging materials until the entire shipment is verified for completeness and the system has been mechanically and electrically checked. Confirm all equipment received against the receiving checklist provided in the following section.

If the shipment is damaged or incomplete, notify an HP Sales and Service office. If the shipping container is damaged, or the packaging material shows signs of stress, notify the carrier as well as the HP Customer Engineer. Keep the shipping materials for the carrier's inspection. The sales and service office will arrange for repair or replacement of damaged equipment without waiting for a claim settlement from the carrier.

Unpacking the System Cabinet

Air carrier height limitations require that the HP 85106D be shipped with the system cabinet in the up-right position. The crate may be used one more time *only* to ship the HP 85106D cabinet. Refer to the *HP 85043C System Rack Installation manual* for specific instructions about unpacking and setting up the system cabinet.

When the entire shipment has arrived, contact your nearest HP Sales and Service office to arrange for system installation, if installation is available in your area. The HP Customer Engineer performs the installation, and uses the receiving checklist in the following section.

HP 85106D Receiving Checklist

Refer to Figure 1-2 on page 1-9**,** and to your system instruments, as you complete this checklist.

HP 85106D Standard System

- ❑ HP 8510C Network Analyzer
- ❑ HP 83621B (qty 2) Synthesized Source
- ❑ HP 85105A mm-Wave Controller (documented in this manual)

HP 85106D Option 001-Adds Microwave Test Set

- ❑ HP 85106D Standard System (with one HP 83621B, and one HP 83651B)
- ❑ HP 8517B S-Parameter Test Set
- ❑ HP 85133F 2.4 mm Cable Set
- ❑ HP 85056A 2.4 mm Calibration Kit

HP 85106D Option 007[1]- Substitutes HP 8517B, Option 007 for Standard HP 8517B

- ❑ HP 8517B Opt. 007, High-Power, High-Dynamic Range Test Set

[1] Option 001 must be installed in the HP 85106D System for the HP 8517B Option 007, High-Dynamic Range, S-Parameter test set configuration to be valid.

HP 85106D Option 010 - Adds Time Domain to the HP 8510C

- ❑ HP 85106D Standard System (HP 8510C has time domain)

HP 85106D System Replaceable Parts

Table 1-2 Miscellaneous System Replaceable Parts

Description	HP Part Number
HP 8510C Standard System	
HP 8510C Network Analyzer	08510-90275
HP 83621B (qty 2) Synthesized Source	83621-90002
HP 85105A mm-Wave Controller	85106-90039
HP 85106D Installation and Operation Manual	85106-90079
HP 85106D Option 001	
HP 85106D Standard System	85106-90039
HP 8517B S-Parameter Test Set	08517-90041
HP 85133F 2.4 mm Cable Set	85133-90017
HP 85056A 2.4 mm Calibration Kit	85056-90020
HP 83651B Synthesized Source[1]	08360-90054
HP 85106D Option 007	
HP 8517B Option 007 High Power	08517-90041
HP 85106D Option 010	
HP 85106D Standard System	85106-90039

1. HP 83621B replaces the HP 83651B for Option 001 only.

Table 1-3 Troubleshooting Documentation

Description	HP Part Number
HP 8510C On-Site Service Manual	08510-90349
HP 8517B Operating and Service Manual	08517-90041
HP 8360 Series Calibration and Installation Manual (for the HP 83621B/31B/51B)	83621-90024

Table 1-4 Miscellaneous Service Parts List

Description	HP Part Number
Service Adapter	85102-60210
Service Extender Hardware Card	85102-60030

Miscellaneous Equipment Not Supplied

The following is a list of equipment that you can use but is not supplied with your HP 85106D system.

- Controller
- Plotter
- Millimeter Calibration Kits
- Millimeter Verification Kits

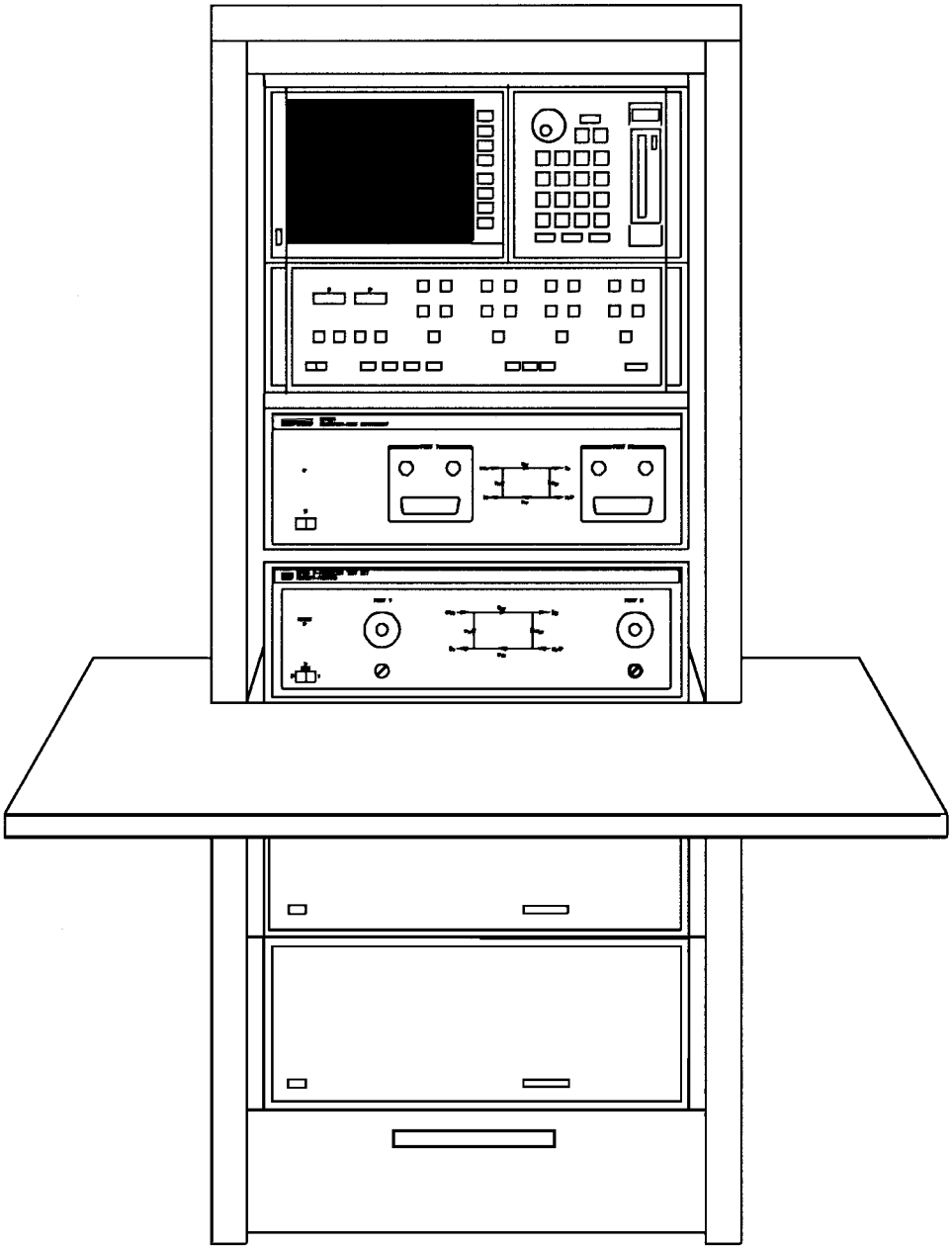


Figure 1-2 HP 85106D mm-Wave, S-Parameter Network Analyzer System (option 001)

Preparing the Site

The environmental and electrical requirements needed to operate your HP 85106D system are specified in this section. Make sure the site meets the requirements listed in Table 1-5, before you begin installation.

Environmental Requirements

Notice that the requirements for the HP 85106D are the same as for the HP 8510C network analyzer. Note the accuracy enhanced, measurement requirements that follow. Keep the environment as dust-free as possible. Clean the air filters and the system rack regularly.

Table 1-5 HP 85106D Environmental Requirements

Temperature	+5° C to 40° C (41° F to 104°F)
Relative Humidity	5% to 95% at +40°C or less (non-condensing)
Altitude	Up to 4600 meters (approximately 15,000 feet)

Accuracy Enhanced Measurement Requirements

Accuracy enhanced (error corrected), measurements require the ambient temperature of the HP 85106D system to be maintained within ±1°C of the ambient temperature at the time of calibration. The calibration temperature must be within the operating temperature range of the calibration kit (typically 20° to 26°C). See the appropriate calibration kit manual for actual operating temperature values.

Power Requirements

Install the required ac power at all necessary locations. Place air-conditioning equipment or any other motor-operated equipment on a different ac line than the one used by the system.

Only use three-wire power cables for all the instruments. These cables provide the required grounding when they are connected to a grounded power outlet. Table 1-6 on page 1-11 lists the maximum VA power ratings of the HP instruments in this system.

System Heating and Cooling

Install air conditioning and heating if required. Air conditioning requirements depend on the amount of heat produced by the instruments. Use the BTU/hour ratings from Table 1-6 on page 1-11 to determine the total rating of your system. Each VA rating is multiplied by 3.4 to determine the BTU/hour rating of each instrument.

To convert the total BTU/hour figure to “tons,” divide the total BTU/hour value by 12,000. A “ton” is the amount of heat required to melt a ton (907 kg) of ice per hour.

Table 1-6 Maximum VA Ratings and BTU/hour Ratings of HP Instruments

Instrument	Maximum VA Rating [1]	Actual VA Subtotal	Maximum BTU/hour	Actual BTU/hour Subtotal
Standard Equipment				
HP 85101 Display Processor	250	_____	850	_____
HP 85102 IF Detector	210	_____	714	_____
HP 85105 Test Set Controller	270	_____	918	_____
HP 8360 Synthesized Source (quantity of two)	400	_____	1360	_____
HP 8517 Coaxial Test Set (HP 85106D Option 001 with or without Option 007)	145	_____	323	_____
Totals:				
Standard System	1505 VA	_____	5117	_____
Option 001.002	1675 VA	_____	5525	_____

1. Values are based on 120 Vac supplied to each instrument at 60 Hz.

System Voltages Available

All HP 85106D system instruments must be set to the same voltage as the system rack; either 120 Vac or 220 Vac. The system instruments are set at the factory to 120 Vac, with the exception of the Option 230 system, which is set to 220 Vac.

CAUTION

System cabinet fans may be permanently damaged if a 120 V system is plugged into a 230 Vac power outlet. Cabinet fans are wired for either 120 V or 230 V, not both. Therefore, a system wired for 120 V operation cannot be switched to 230 V operation by changing only individual instrument voltage selection switches.

Consult individual instrument manuals to change voltages from 120 V to 100 V (120 V systems only), or from 220 V to 240 V (Option 230 system, or 230 V systems only).

Weights and Dimensions

The approximate weight of each of the HP 85106D system cabinet versions (fully loaded) are listed below:

- Standard . . . . . 267 Kg (576 lbs)
- Option 001 . . . . . 289 Kg (624 lbs)
- Option 001/007. . . . . 303 Kg (653 lbs)

The outside dimensions of the system cabinet (excluding work surface) are:

- Height . . . . . 1620 mm (64 inches)
- Width . . . . . 600 mm (24 inches)
- Depth . . . . . 905 mm (36 inches)

Installing the Work Surface

The work-surface installation procedure is described completely in the HP 85043C *System Rack Installation Manual*, included with the system cabinet. You can install the work surface by referring to Figure 1-3 on page 1-13 and using the tools listed below:

- Small flat-blade screwdriver
- Medium-sized Pozidriv screwdriver

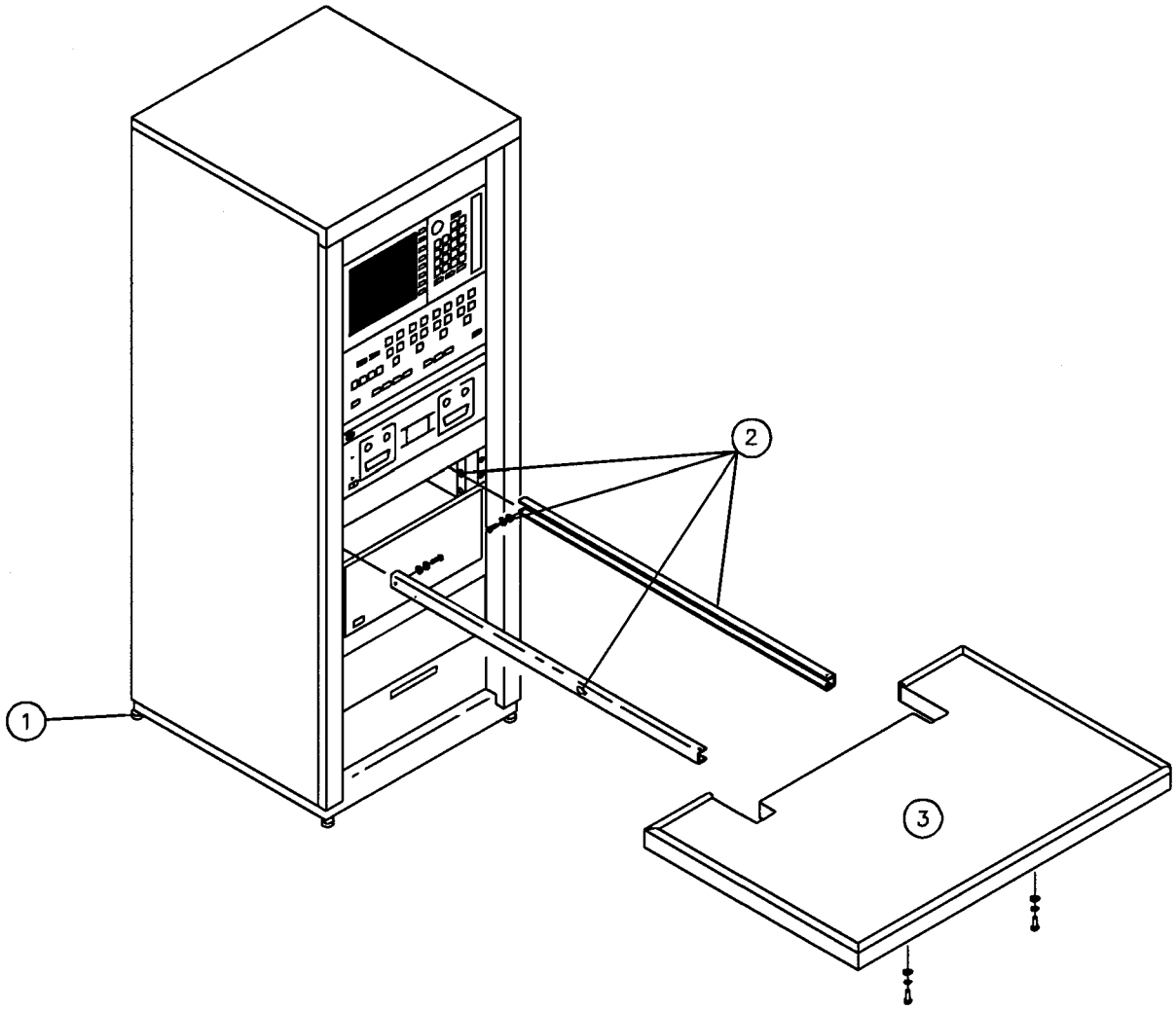


Figure 1-3 Installing the Work Surface

Procedure:

1. Extend lock feet, bottom of cabinet.
2. Attach work surface support rails to inside of cabinet.
3. Slide work surface onto support rails.

Installing the Test-Set Module Cable-Support Assembly

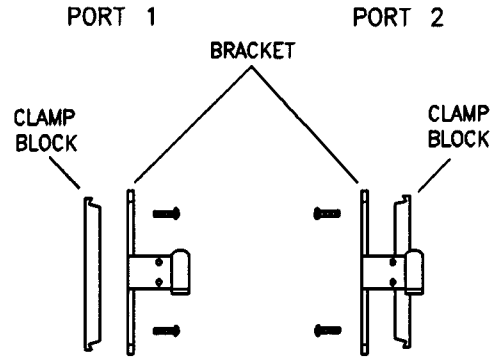
Use the cable-support assembly to support the RF, LO, and interconnect cables of the HP 85104A test-set modules. These cables connect the test set modules to the HP 85105A mm-wave controller.

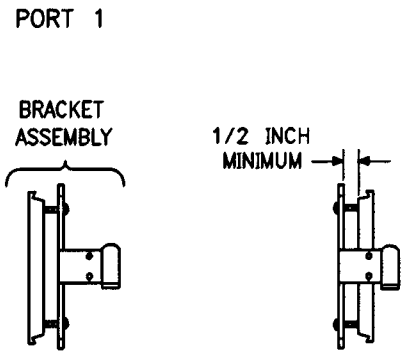
Refer to the “Cable Support Assembly” on page 1-15 for an illustration of the cable support assembly components. The barrel is attached to the test set module cable assembly, the bracket and clamp block must be attached to the barrel, then to the mm-wave controller handle. Follow the procedure below to install the cable support assembly.

NOTE

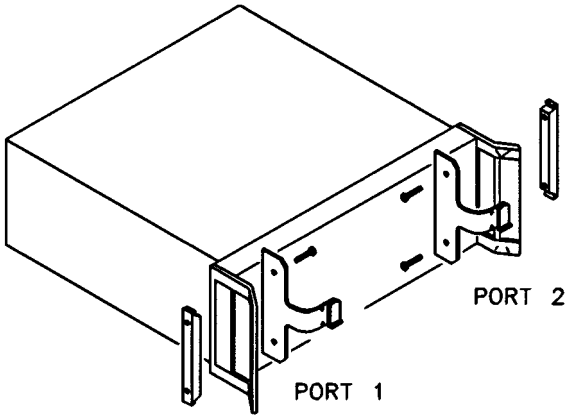
The cable support assembly orientations for port 1 and port 2 are different. Be sure to follow the instructions for the appropriate port.

Cable Support Assembly



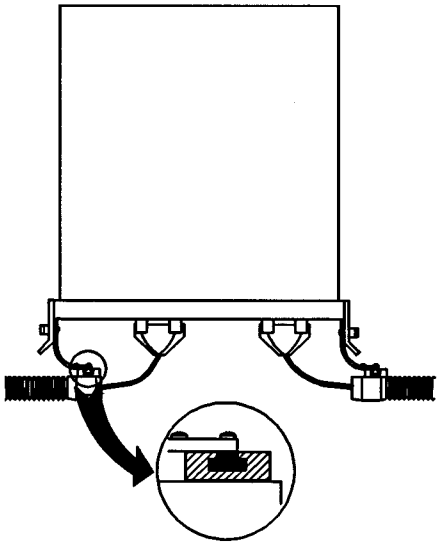


1 Attach the bracket to the clamp block leaving approximately 1/2 inch between the bracket and clamp block. Note the different orientation of the bracket and clamp block for port 1 and port 2.



2 Slide the bracket/clamp block into the HP 85105A mm-wave controller handle. Notice that port 1 and port 2 have different configuration. Hold the bracket and clamp block together and tighten the 2 screws on the bracket. Push the bracket towards the instrument front panel so the bracket is flush against the front panel.

3 Repeat this procedure for the other port if necessary.



4 Attach the barrel to the bracket assembly by sliding the barrel over the bracket.

Installing Test Set Modules

CAUTION

The test set modules are extremely sensitive to electrostatic discharge (ESD). Ground your work station before unpacking and installing test set modules in your system. Refer to Table 5-1 on page 5-8 of this manual for part numbers of ESD grounding supplies.

Installing the Test Port Extensions

Each test set module is shipped with two or three straight extensions (depending on the waveguide band), and one 90° bend. Attach these extensions to the test set module port before performing the calibration and performance verification procedure (refer to Figure 1-4 on page 1-17). The straight extension flanges are precision flanges. The 90° extension has standard flanges. Use a straight extension for the actual test port.

CAUTION

Do not use the 90° bend for the test port. Its flanges are not precision flanges.

To connect the precision flanges (the straight extensions), follow the sequence below:

1. Install the captive screws into all four of the tapped holes in one of the flanges.
2. Bring the flanges together using the guide pins for alignment.
3. Gradually tighten all four screws in an X-pattern to the final torque.

Connecting Standard Flanges

The standard flanges are designed with the mating surfaces on a plane that is different from the edges. The mating surfaces must be flush. To connect standard flanges (the 90° bend), use the following procedure.

1. Install the captive screws in each of the four tapped holes in one of the flanges.
2. Carefully bring the flanges together using the guide pins for alignment. Hold the mating surfaces in contact while engaging the first few threads of all four screws.
3. Gently tighten one top screw until there is light pressure on the mating surface, then lightly tighten the opposite bottom screw to bring the flange mating surfaces into even contact.

4. Gradually tighten all four screws in an X pattern to the same final torque. This pattern insures that equal contact pressure is applied to all four waveguide wall surfaces.
5. While tightening the screws, inspect the mating surfaces for proper alignment by placing a lamp or white paper behind the connection. If the flanges do not align without a gap, loosen all of the screws and start over.

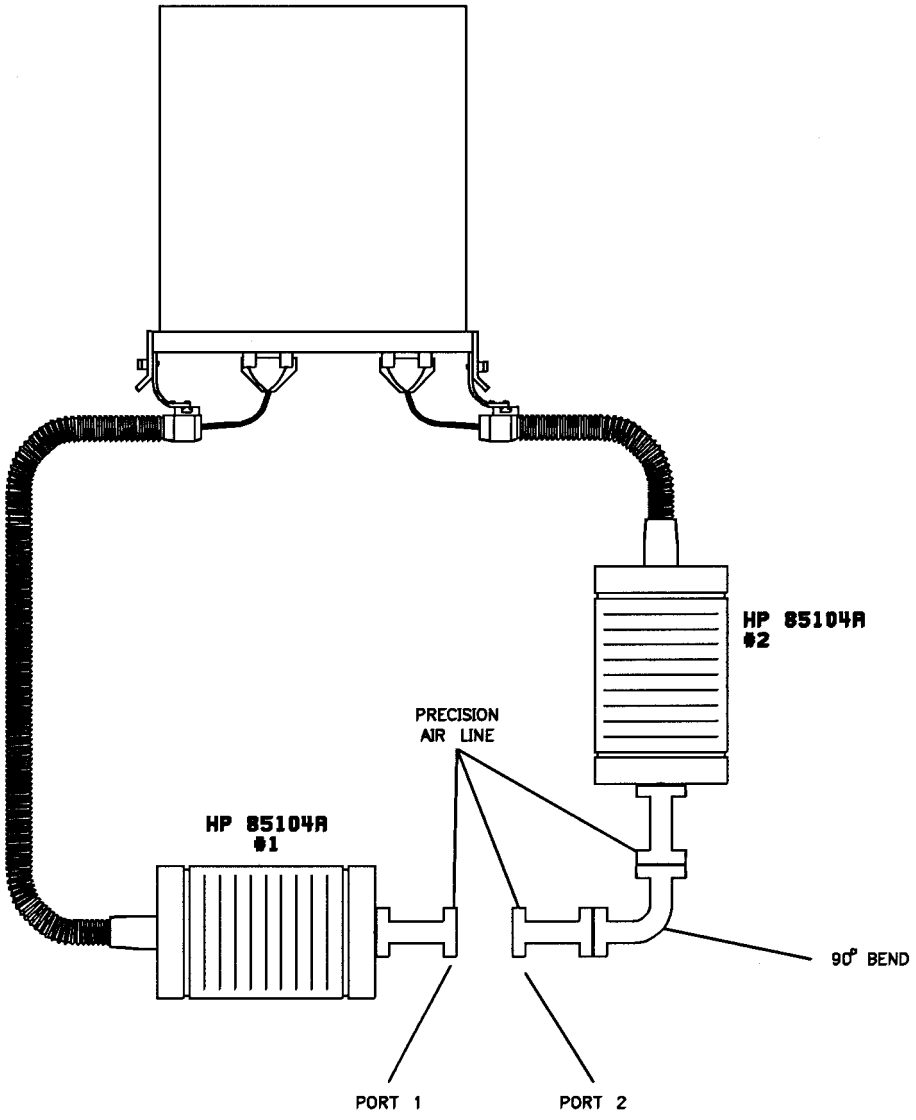


Figure 1-4 Installing Test Port Extensions

Connecting the Test Set Modules to the HP 85105A

Turn the HP 85105A mm-wave controller power OFF. Connect the test set modules to the HP 85105A as shown in Figure 1-5. Refer to Chapter 2, “Operation” for test set module operation in the HP 85106D system.

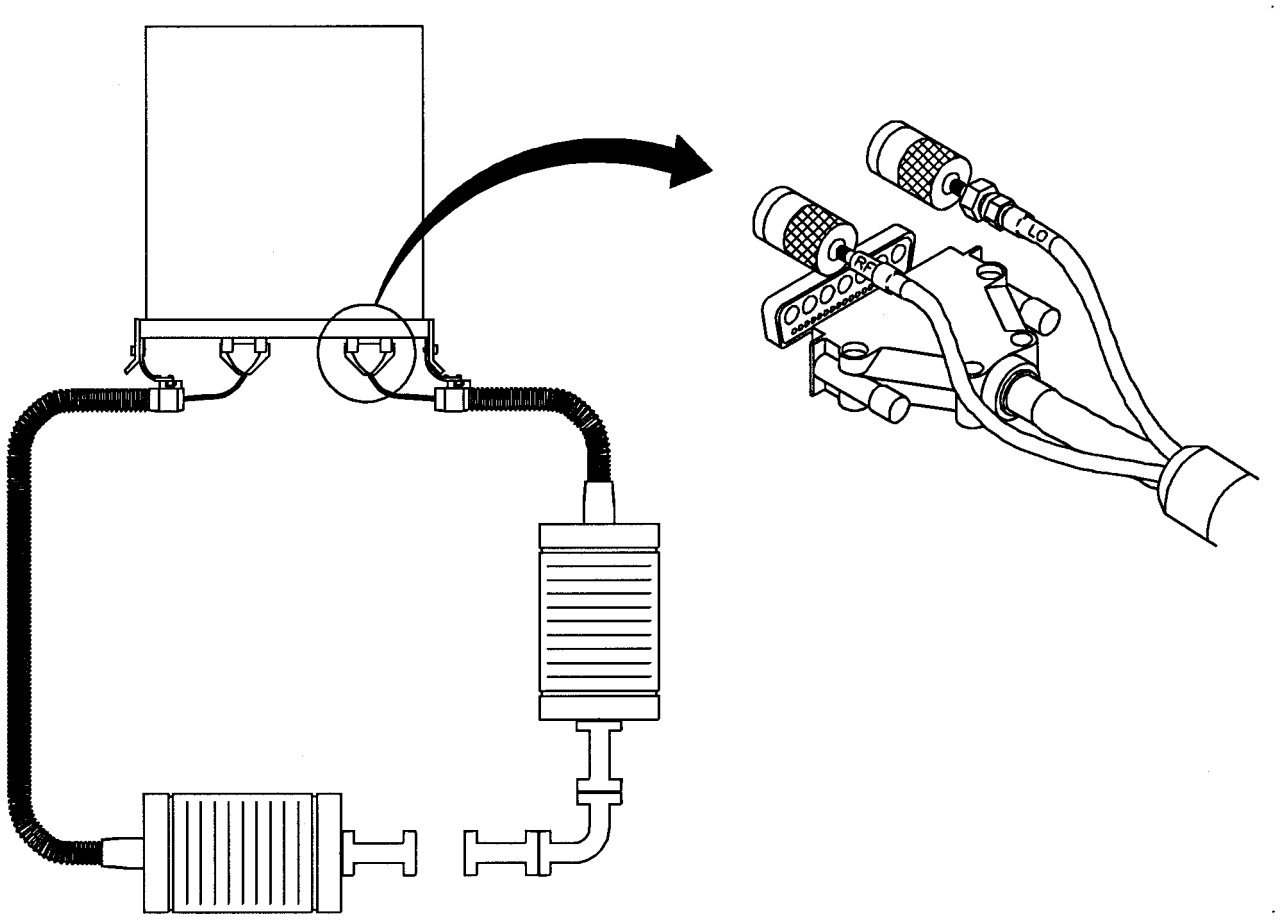


Figure 1-5 Installing the Test Set Modules

System Cabling

Figure 1-6 on page 1-19, and Figure 1-7 on page 1-20 are the cabling diagrams for the HP 85106D system (standard, and Option 001). The system is shipped from the factory with the system cables connected. The accessory cables are not connected.

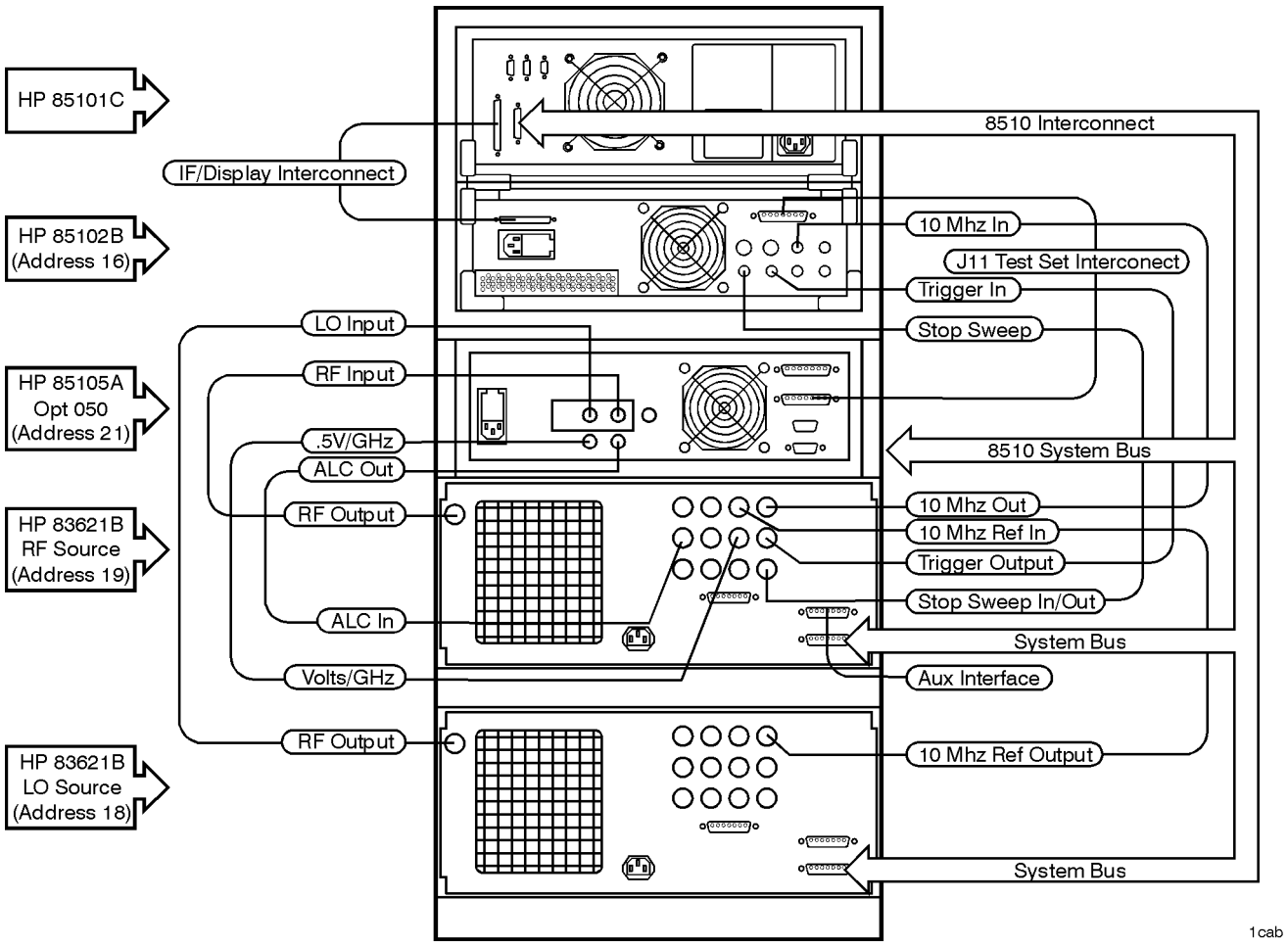


Figure 1-6 HP 85106D Cabling Diagram (standard configuration)

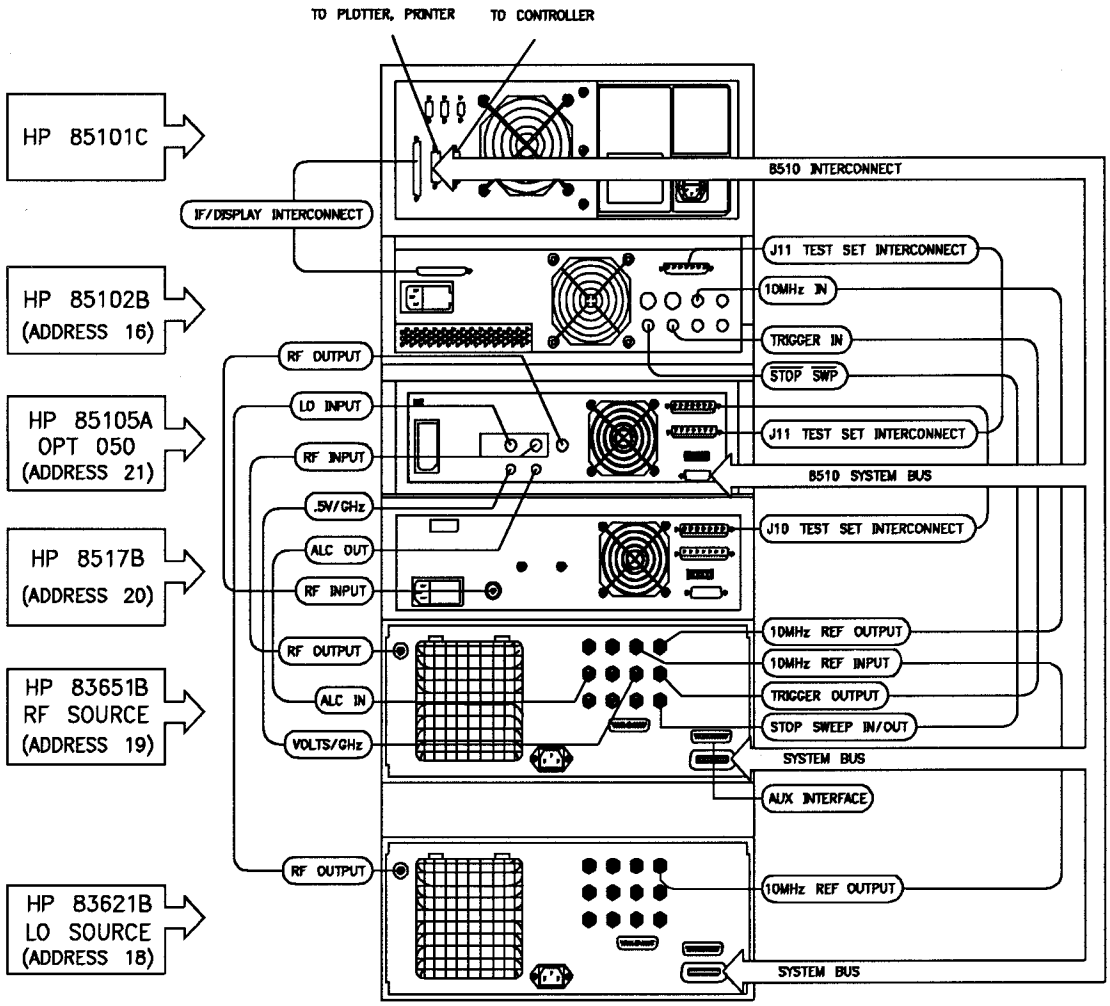


Figure 1-7 HP 85106D Cabling Diagram (option 001 configuration)

Installing a Controller

Connect a PC, or controller (HP 9000 Series 300 computer workstation) to your system to run the performance verification software.

Memory Needed

PC Controller:

- Windows 3.1, 95, or NT. There must be at least 4 megabytes of memory running HP BASIC REV 6.3.

HP 9000 Series 300 Computer Controller:

- With BASIC 5.0 or later. There must be at least 2.5 megabytes of RAM available after BASIC is loaded.

Refer to Chapter 3, “Performance Verification” in this manual for more information.

Making Connections

The HP-IB Bus

The computer retains full control of the HP-IB bus. No other device can send commands until the computer relinquishes its control. Connect any peripheral equipment to this bus if you want the equipment to be controlled by the computer only.

Connecting a Plotter

To connect a plotter to the system:

- Attach one end of the HP-IB cable to the plotter (the plotter should have its own HP-IB cable).
- Then attach the "free" end of the plotter cable to either the "HP 8510 Interconnect" (for system bus control), or to the "HP-IB Connector" (for HP-IB bus control).
- Set the plotter address to 5.
- Connect the plotter to an ac-power source and then turn it ON.

Refer to “Accessory ac Power Outlet” on page 1-22" for information about connecting the plotter to the power outlet inside the system cabinet.

Accessory ac Power Outlet

All power connections for instruments in the system are located inside the cabinet via a multiple-outlet power strip. On some systems an extra power outlet is provided on the power strip for accessories. Power cables for accessories may be routed through the hole provided in the rear of the cabinet. Special “boot” ac power cables are included with your HP 85106D system for this purpose.

CAUTION

Before connecting any equipment to the extra power outlet refer to Table 1-6 on page 1-11 for the maximum VA ratings for this outlet on your system.

Installing the HP 85106D Into a Different Cabinet

Hewlett-Packard strongly recommends that the HP 85106D system cabinet be used with the HP 85106D mm-wave system. HP is not obligated to support user-configured mm-wave rack systems. The customer takes full responsibility for instrument damage incurred due to using racks or system cabinets other than the one supplied with the HP 85106D system. Contact your nearest HP Sales and Service Office for more information about ordering a rack for your system.

HP 8510C Benchtop mm-Wave Systems

Figure 1-8 shows the Hewlett-Packard suggested benchtop configuration of the HP 8510C mm-wave system and how this system is cabled. Although other benchtop configurations are available, the required cable lengths for a different configuration may vary from what is shipped with each instrument. Table 1-7 on page 1-24 lists the cables used in this configuration.

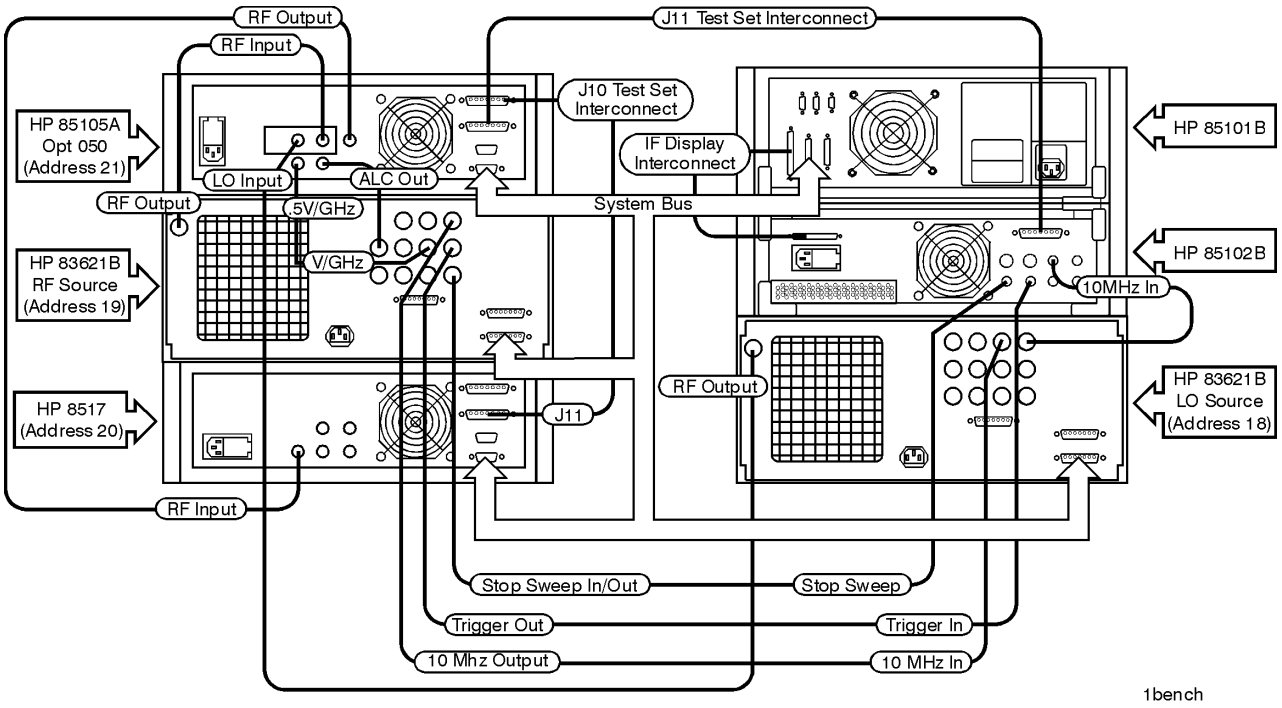


Figure 1-8 Suggested Benchtop Configuration of the HP 8510C mm-Wave System (option 001)

Table 1-7 Electrical Connections Using an HP 83621B

Description	From Instrument/Connector	To Instrument/Connector	HP Part No.
line	Display/Processor/line module		8120-1396
line	IF Detector/line module		8120-1396
line	HP 85105/line module		
line	Test Set/line module		8120-1396
line	RF Source/line module		8120-1396
line	RF Source/line module		8120-1396
line	LO Source/line module		8120-1396
IF Display Interconnect	Display/Processor/IF Display Interconnect	IF Detector/IF Display Interconnect	08510-60101
Test Set Interconnect	IF Detector/Test Set Interconnect	HP 85105/J11 Test Set Interconnect	08510-60106
Test Set Interconnect[1]	HP 85105/J10 Test Set Interconnect	Test Set/J10 Test Set Interconnect	08510-60102
BNC	RF Source/10 MHz Ref Output	IF Detector/10 MHz IN	8120-1840
T-Adapter[2]			1250-0781
BNC	RF Source/Stop Sweep In/Out	IF Detector/Stop Sweep	8120-1840
BNC	RF Source/Trigger Output	IF Detector/Trigger in	8120-1840
HP-IB	RF Source, LO Source, Disk Drive, HP 85105, Test Set[1]/HP-IB	Display/Processor/HP 8510 Interconnect	8120-3445
RF	RF Source/RF Output	HP 85105 RF Input/J7 RF Input	85105-00053
RF	LO Source/RF Output	HP 85105/LO Input	85100-60002
RF[1]	HP 85105/RF Output	Test Set/RF Input	85105-00054
BNC	IF Detector/LO Phaselock Out	LO Source/FM Input	8120-1840
Source Interconnect[1]	Test Set/J15 Source Interface	RF Source Auxiliary Interface	08516-60009

1. Used only with HP 8516A option 001.

2. Can be used to tie 10 MHz time bases together, but it is recommended that you connect the cables as shown in previous diagrams.

NOTE You can use a BNC-T adapter to tie the 10 MHz time bases together, but it is recommended that you connect the cables as shown in the cabling diagrams.

Space Requirements

To ensure enough clearance for cables and adequate cooling for reliable operation in a benchtop configuration, use the following guidelines:

- Leave all instrument feet attached. The feet maintain 12 mm (1/2 inch) vertical clearance between stacked instruments.
- Leave the instrument covers on during operation.
- Maintain 75 mm (3 inches) side separation between instruments.

Setting HP-IB Addresses

When the HP 8510C power is turned ON:

- All previously assigned HP-IB addresses are automatically recalled from memory and assigned to the various system instruments, including the HP 8510.
- Before you operate the system, check individual instrument HP-IB address switches. These must be switched to match the addresses assigned by the system. The instruments and the applicable default addresses are listed in Table 1-8.

All instrument addresses in HP 85106D systems are set at the factory prior to shipment. Instrument addresses of benchtop mm-wave systems must be checked and set according to the addresses shown in Table 1-8**.**

Table 1-8 HP 85106D System Instrument HP-IB Addresses

Address Of	HP-IB Address Standard	HP-IB Address Option 001
HP 8510	16	16
System Bus	17	17
RF Source	19	19
Coaxial Test Set (Optional)	31	20
Plotter	5	5
Printer	1	1
Disk Drive	0	0
LO Source	18	18
mm-wave Controller	21	21

NOTE All HP 8360 Series sources must have the LAN switch set to 001.

Shipping Your HP 85106D System

If you need to ship your HP 85106D system:

- Repackage the system in its original shipping crate. This crate can be reused *once*.
- Make all surface shipments via padded van with an air suspension ride.

CAUTION

Regardless of the crate style *all surface shipments must be made VIA padded van (air suspension ride).* Surface shipments in vehicles without air suspension may result in damage to the system components, cabinet, and to the shipping crate.

2 Operation

Introduction

This section describes the operation of an HP 85106D mm-wave system. The topics in this section are as follows:

- System set up and powering up the system.
- Configuring the instrument and the hardware states for dual source operation.
- Performing an operator's check.
- Performing measurement calibrations.

This section applies to all HP 8510C systems equipped with the HP 85105A mm-wave test set controller and HP 85104 series test set modules. The system instruments are configured for benchtop or rack-mounted operation. The mm-wave system functions like any HP 8510 system with an S-parameter test set as described in the standard *HP 8510 Operating and Programming* manual. This information supplements the operating information specific to the mm-wave configuration.

System Description

The HP 85106D mm-wave network analyzer is configured for wide dynamic range S-parameter measurements of waveguide components. This system allows automatic switching for all four S-parameters. This makes it unnecessary to manually disconnect and reverse the device during the measurement process. Figure 2-1 on page 2-3 shows a simplified block diagram of this system applicable to all waveguide bands. The HP 85106D system consists of:

- One HP 8510C
- Two sources (one source provides the RF (stimulus) signal and the second source provides the Local Oscillator (LO) signal)
- One band-independent HP 85105A mm-wave test set controller
- Pair of band-dependent HP 85104 Series mm-wave test set modules that cover:
  - Q-band (33 GHz to 50 GHz)
  - U-band (40 GHz to 60 GHz)
  - V-band (50 GHz to 75 GHz)
  - W-band (75 GHz to 110 GHz)

This system brings a new level of convenience to mm-wave S-parameter measurements by integrating the necessary amplifiers, frequency multipliers and signal separation devices into the test set controller and test set modules. The system then provides a large work surface to position the modules for ease of use. Precision calibration standards in the HP 11644 Series mm-wave calibration kit permit full use of all built-in HP 8510 accuracy enhancement (error corrected) models.

The HP 8510C uses its multiple source control feature over the system bus to tune both the RF and the LO sources over the entire frequency sweep. All system functions, from setting up the measurement frequencies to calibration and measurement are controlled directly from the HP 8510C front panel. The measurement results are displayed on the HP 8510 CRT.

Stimulus for the device under test is generated using the synthesized RF source followed by a power amplifier and a switch in the test set controller. This RF is routed to either port 1- test set module for forward measurements, or to port 2 test set module for reverse measurements. Components in the test set module provide frequency multiplication, and signal separation for sampling the incident, reflected, transmitted signals, and the harmonic mixers to achieve the first IF conversion to 20 MHz.

The second source provides the LO for the four harmonic mixers. This LO source is set so that the mm-wave RF test signal frequency and the appropriate LO harmonic are offset by exactly 20 MHz. The system time base obtained from one synthesized source is used by the other synthesized source in the HP 8510. The resulting 20 MHz IF signals are amplified and then applied to the HP 8510 IF/detector section for routing to either the normal or optional wideband IF section for detection, post-processing, and display.

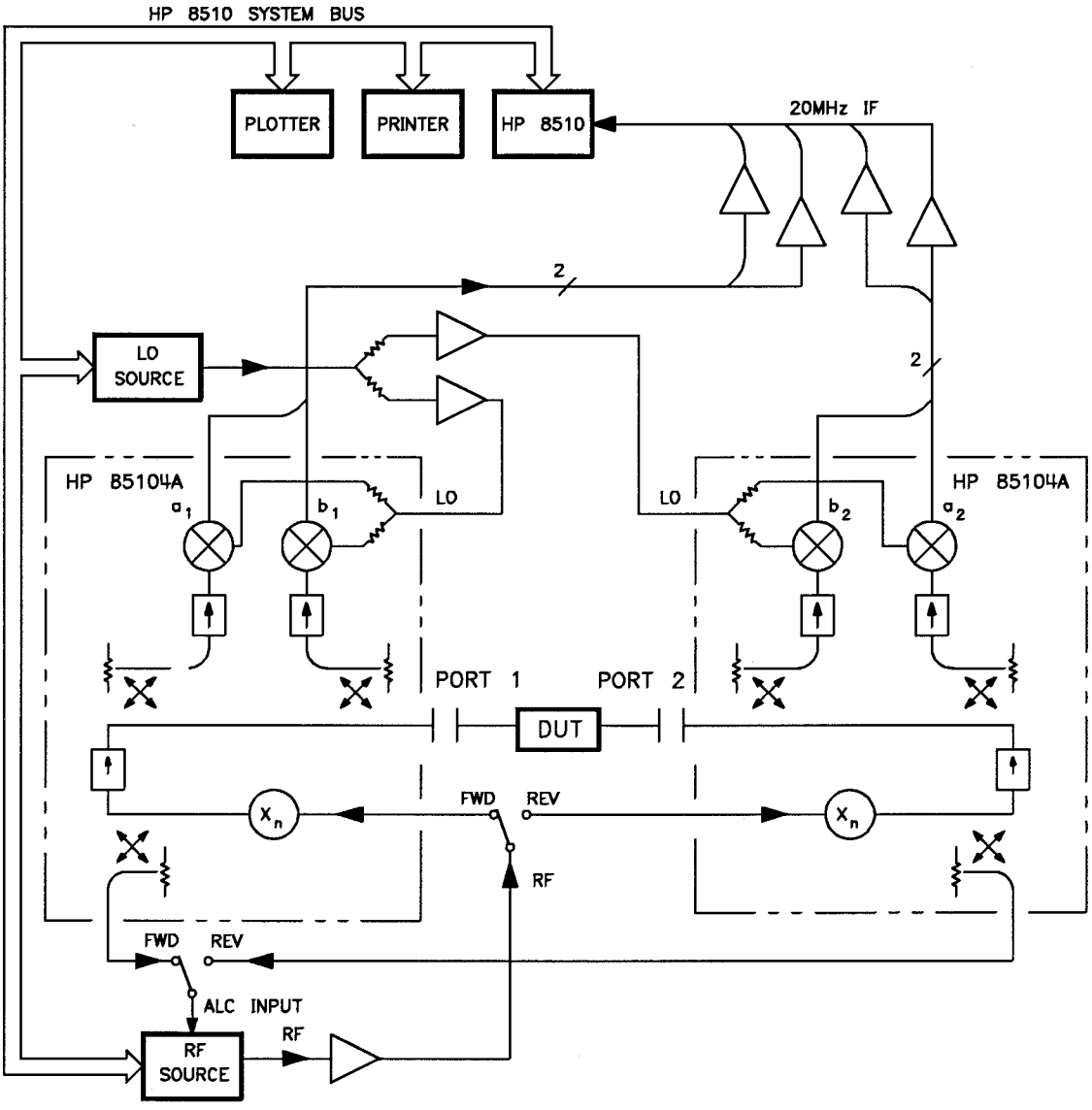


Figure 2-1 Simplified Block Diagram of the HP 85106D mm-Wave System

Since the HP 85105 mm-wave controller includes RF and IF switching hardware, the system may also be configured for coaxial measurements from 45 M Hz to 50 GHz. This is achieved by the addition of a coaxial test set that has convenient switching between coaxial and waveguide test sets. If the optional microwave test set is installed in the system, the RF signal, 20 MHz IF signals, and phaselock control signals pass through the test set controller before entering the HP 8510C IF/detector section. You can add two additional coaxial test sets to the system by adding external RF and IF switching hardware. This is described in Chapter 6, “HP 85105A mm-Wave Controller”.

System Set Up

Setting up the system includes:

- Turning on system power.
- Setting up the system hardware state and instrument state memories.
- Configuring the test set modules.
- Performing an operator's check.

Turn On System Power

1. Verify that the hardware is connected (refer to Chapter 1, “Getting Started” and Figure 2-10 on page 2-31).
2. Turn on all system instruments power, *except* the HP 8510C. Wait 10 seconds, then turn on the HP 8510C.

If the HP 8510 hardware and instrument state are *correct* for the current system configuration, the network analyzer begins making measurements according to the last HP 8510C instrument state 8. Proceed to “Configuring Port 1 and Port 2” on page 2-7".

If current HP 8510C hardware and instrument states are *incorrect*, the HP 8510C may display an error message and a beeper may sound. The HP 8510C remains in an error condition until the multiple source mode is activated and it receives a signal it can detect. Turn the beeper off by pressing [**SYSTEM**] {***BEEPER OFF***}. Configure and load the network analyzer memory as described in the following procedure:

Configure Network Analyzer Memory

The system set up procedure is greatly simplified by loading the appropriate Machine Dump file from the mm-wave system disk supplied. The system disk that is supplied contains files that define the specific hardware state and instrument state for the various millimeter-wave frequency ranges.

Each Machine Dump file on this disk describes the complete HP 8510C memory configuration including:

- Appropriate hardware state.
- Current and all eight instrument states.
- Calibration sets, and calibration kits for one of the mm-wave bands or for operation with a coaxial test set.

Procedure

The following procedure describes loading the network analyzer memory from the system disk.

1. Load the desired Machine Dump file from the system. Insert the disk into the internal drive of the HP 8510C external disk drive. Press the following keys:

   [**DISK**]

   {***STORAGE IS INTERNAL***}

   {***LOAD***}

   {***MORE***}

   {***MACHINE DUMP***}

   Use the RPG knob to select the file for the desired frequency band (see Table).

   Press: {***LOAD FILE***} to start the process.

Table 2-1 Machine Dump Files Stored On The mm-Wave System Disk

Frequency Range	45 MHz - 50 GHz	33 GHz -50 GHz	40 GHz -60 GHz	50 GHz -75 GHz	75 GHz -110 GHz
Frequency Band	Coaxial ((option001)	Waveguide			
		Q-band WR-22	U-band WR-19	V-band WR-15	W-band WR-10
Machine Dump Files	MD_COAX	MD_SYNWR22	MD_SYNWR19	MD_SYNWR15	MD_SYNWR10

NOTE

If your system contains an extra test set (HP 85106D Option 001), verify that only the desired test set is active (active light ON). If unselected test sets are active, deactivate the test set temporarily by pressing [**LOCAL**] {***TEST SET***}. Then return to the desired address.

2. When the Machine Dump file is loaded the system begins sweeping the full frequency range of the current band. Press [**CAL**] and read the {***CAL 1***} label to see whether the calibration kit for the desired band is loaded.
3. The system is ready for operation. You may change the instrument state settings for specific applications.

The initial settings in the Hardware State, Instrument State, and Calibration Kit definition are listed at the end of this section, and in Chapter , "Appendix A". These settings remain active until changed or a new file is loaded from the system disk to completely change the current instrument state.

NOTE

Instrument State 8 is recalled each time the HP 8510 line power is turned ON. The Machine Dump file loads this register with an appropriate full-band sweep. Since the hardware state is not modified at power-on, the system can be configured to power up in a particular frequency range by saving the desired instrument state into register number 8. Pressing [***USER PRESET***] on the HP 8510C recalls instrument State 8.

Creating a New Machine Dump File

You can create a new Machine Dump file to store the exact system configuration for specific applications. Refer to the steps below:

1. Configure your system for the application. The hardware state, present instrument state, and all memories are saved exactly as they are currently defined.
2. Store the Machine Dump to disk by pressing the following keys:

   [**DISC**]

   {***STORAGE IS INTERNAL***}

   [**STORE**]

   {***MACHINE DUMP***}

Enter the desired disk file label (RBAND or UWAVE), then press to store the entire system state.

Configuring Port 1 and Port 2

The test set module test port is manufactured with precise tolerances so that the system achieves the stated system specifications. Before each connection, inspect the test set flange surfaces and the flanges of the device under test for contamination or damage. In general, imperfections not visible with the unaided eye do not affect device performance.

During measurement calibration, it is very important that the calibration standards be connected using a precise, consistent method. The precision test port flanges and the calibration standards utilize precision guide pin holes and guide pins. These provide the additional stability necessary to obtain the best results from the measurement calibration.

The recommended arrangement is illustrated in Figure 2-2 on page 2-8. There are several important questions about which set up is best. Generally, adding the 90° bend makes it simpler to connect Port 1 and Port 2 to make the thru and to connect the device under test.

CAUTION

Do not exceed +27 dBm incident at Port 2 or Port 1. System specifications are determined with about 0 dBm incident at Port 2 or Port 1. Greater than + 27 dBm damages the test set making it necessary to replace expensive parts. Observe proper precautions, especially when measuring amplifiers having greater than about 20 dB of gain.

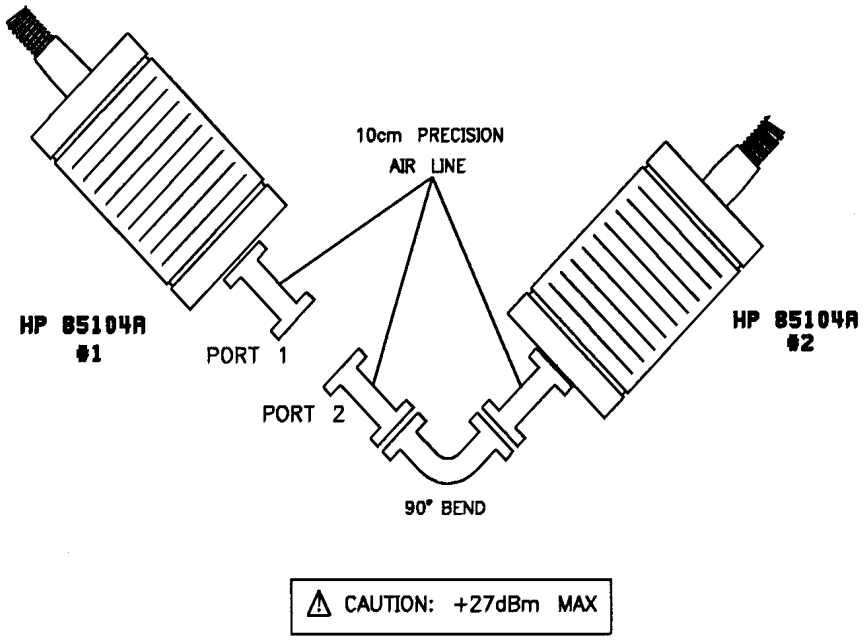


Figure 2-2 Typical Port 1 and Port 2 Configuration

1. To align the test ports for connection, raise the modules to the same height by fully extending the four feet on each stand. If the surface is level the test set modules should *not* rock. If either module is not stable make the final adjustment by changing the height of the feet using the height-adjustment screws.
2. Release the stand lock by moving the lever, then center the module within the range of motion. Lock the slider. Small movements of the test port (up to 1/2-inch) can be made by turning the small knob at the front of the stand. Typically, Port 1 is fixed in position and Port 2 is moved toward it to make the connection.

WARNING

Never look directly into the open end of a waveguide section while RF source power is on. Although the signal levels in this setup are relatively low, mm-wave energy is non-ionizing radiation that can be extremely harmful to the eye. The results may be eye damage or permanent blindness.

3. Before inspecting the test ports:
   a. Reduce the RF power by pressing [**STIMULUS MENU**]
   b. Press {***POWER MENU***} {***SOURCE POWER 1***}
   (note the RF power level)
   c. Enter [**-50**] [**x1**].
4. Inspect the test ports, then enter the RF power level, [**x1**]
(restore RF power level).

CAUTION

The IF and LO ports on the test set cables can be damaged by electrostatic discharge. Do not touch their center conductors unless proper ESD precautions have been taken.

Waveguide Connections

Figure 2-2 on page 2-8 shows the arrangement of the waveguide parts of the test set. Familiarize yourself with the specific components making up the test set before proceeding with the assembly. Detailed handling instructions are provided with the calibration kit manuals.

Inspect each flange for damage, then clean the mating surfaces using Isopropyl alcohol and a non-abrasive foam swab. Always support both components being assembled and never allow bending or twisting force to be applied to the flange connections.

For the Q, U, V, and W-band test set modules special captive screws of two different lengths are used for all of the connections. The screw threads are only halfway up the screw body. Also, guide pins are an integral part of the flange.

There are two types of flanges used as shown in Figure 2-3**.** The test ports use the precision flange and all other connections use the standard flange.

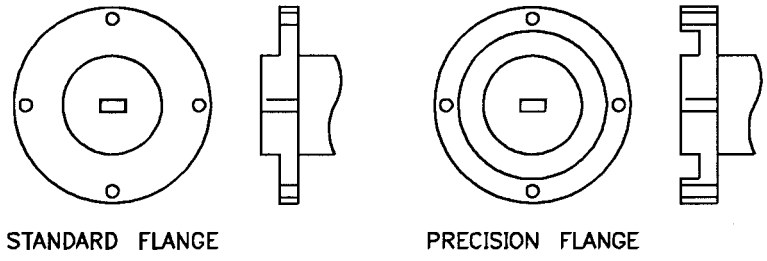


Figure 2-3 Standard and Precision Waveguide Flanges (Q, U, V, and W Bands)

Standard Flanges

The standard flanges are designed so that the mating surfaces are on a different plane than the edges. It is necessary that the mating surfaces be flush. To connect the flange, use the steps below:

1. Install the captive screws in all four tapped holes on one of the flanges.
2. Carefully bring the flanges together using the guide pins for alignment.
3. Hold the mating surfaces in contact while engaging the first few threads of each of the four screws.
4. Now gently tighten the top screw until there is light pressure on the mating surface, then lightly tighten the bottom screw to bring the flange mating surfaces into even, intimate contact.
5. Gradually tighten all four screws in an X-pattern. Continue the X-pattern through final torquing to ensure that equal contact pressure is applied to all four waveguide wall surfaces.

While making the connection you may inspect the mating surfaces for proper alignment by placing a lamp or white paper behind the connection. If the flanges cannot be aligned so that there is no gap, loosen all screws and start again.

When the top screw is tightened with the bottom screw loose, the upper surface of the mating areas are brought together first. The objective is to equalize the pressure across the entire contact surface. Tightening the top screw brings the mating surfaces together forming an angle. This angle determines the final mating force when the opposite screw is tightened. Tightening the opposite screw then brings the mating surface into complete contact. When the upper screw is holding the mating surfaces together properly (a very shallow angle), gently tighten the opposite screw and recheck flange alignment in all axes using the light or white paper behind the flange. If flange alignment is complete, evenly tighten the screws on the side and recheck the alignment.

Precision Flanges

Make these connections slowly and carefully. To connect the precision flanges, bring the flange together using the guide pins for alignment, then gradually tighten all four screws in an X-pattern. Continue the X-pattern through the final torque. The flange outer radius and the inner mating surface share the same plane making these flanges easier to connect.

Operating Notes

The system is ready for normal operation once the mm-wave system is configured according to the instructions in the previous section. The HP 8510C front panel behaves the same for microwave measurements with the following exceptions:

Frequency Control

Enter start and stop frequencies with the [**START**], [**STOP**], [**CENTER**], and [**SPAN**] keys and the numeric keypad. Due to source resolution frequency entries are sometimes modified by the HP 8510C. For example, with the U-band system an entry of 40 GHz may appear as 39.999999996 GHz.

NOTE

If you are looking at unratioed user parameters (a1, b1, a2, b2) you may see a discontinuity at the beginning and end of the trace and frequencies where source 1 is going through a band change, as an example, 0.5 GHz in Q and U-band, 54 GHz in V-band, and 81 GHz in W-band.

Use of the [USER PRESET] Key

You may press the green [**USER PRESET**] key at any time to return the network analyzer to a predefined state that has be determined by you. The preset function performs all necessary internal network analyzer initialization, then recalls instrument State 8. [**USER PRESET**] does not send an initialization signal to the other instruments on the system bus.

Factory Preset is another initialization available and is *not recommende*d. Use the factory preset softkey located under [**RECALL**] {***MORE***} and {***FACTORY PRESET***} to completely reset the instrument state to the factory setting.

Important changes caused by using “Factory Preset” to the desired mm-wave instrument state are as follows:

SWEEP MODE	Factory preset selects step sweep mode. The mm-wave system operates in Step, Single Point, or Frequency List sweep modes only.
SET Z_0	Factory preset selects 50; the mm-wave system uses 1.
WAVEGUIDE DELAY	Factory preset selects the coaxial configuration. For mm-wave measurements, select the waveguide configuration.
WAVEGUIDE CUTOFF	This function defines the waveguide cutoff frequency, f_{co} used in the electrical delay computation. Factory preset selects 0 Hz.
SOURCE #1 POWER and SOURCE #2 POWER	Power levels defined in the standard instrument state depend on the source and waveguide frequency band; the levels should be close to those listed in the sections titled "RF Signal Power Control" and "LO Signal Power Control," and Table on page 2-14.

After factory preset, the operator must recall an appropriate mm-wave instrument state previously saved. This is usually instrument State 8.

RF Signal Power Control

The RF signal source power is set to a nominal value by the system configuration software. If needed, adjust the level for your application. For maximum measurement accuracy, calibrate the system with the same source power as to be used during the measurement. RF source power is adjusted by pressing the keys in the Stimulus [**MENU**], {***POWER MENU POWER SOURCE 1***}.

WARNING

If the network analyzer displays `I.F. OVERLOAD` warning, decrease the RF source power.

If maximum dynamic range is needed to measure a device that is not sensitive to its input power, the RF power may be increased to a level just below that which causes an **IF OVERLOAD** message to appear.

If you are measuring a device and the input power is an important parameter, check to verify that the source is leveled. Do this before calibrating or setting up the analyzer for the measurement. Press [**RECALL**] Instrument State [**8**] (your current network analyzer set up is replaced).

1. Select the Parameter menu, {***USER 1 a1***}. Response menu [**AUTO**], [**DISPLAY**] {***DATA->Memory1***}. {***DISPLAY:DATA and MEMORY***}.

NOTE

When looking at user parameters, always turn Averaging OFF.

2. Increase {***POWER SOURCE 1***} slightly and verify that power increases across the band. If the power does not increase at some point, an unleveled condition exists, and the power must be reduced.
3. Once you have determined that the source has excess power across the band, return the [***POWER SOURCE 1***} setting to its original value.
4. If the incident power at Port 2 is also critical, this procedure can be repeated with {***USER 3 a2***}, leaving{***POWER SOURCE 1***} the lower value of the two.

NOTE

Although the {***POWER SOURCE 1***} is displayed on the analyzer in dBm this is the value of dBv programmed into the source. The source is operating in the EXT DET mode. Changes in this value result in the output power changing. If the actual output power is critical for the measurement application, first determine that the source is leveled (as described above) then measure the output with a power meter.

LO Signal Power Control

LO signal power is controlled using the {***SOURCE #2 POWER***} function. Refer to Table 2-2 for recommended and expected LO signal power levels.

Table 2-2 Recommended RF and LO Power Levels For All Bands

Frequency Range	45 MHz - 50 GHz	33 GHz -50 GHz	40 GHz -60 GHz	50 GHz -75 GHz	75 GHz -110 GHz
Frequency Band	**Coaxial (option001)**	**Waveguide**			
		Q-band WR-22	U-band WR-19	V-band WR-15	W-band WR-10
Source #1 (RF) Power	+10	–20	–25	–30	–20
Source #2 (RF) Power	+3	+3	+3	+3	N/A

Operator Check

To perform an operator's check, complete the following:

- Measure the power levels of the HP 8510C user parameters a1, b1, a2, and b2.
- Observe the appropriate levels (listed in Table 2-3 on page 2-16) to be certain that the system is operating properly.
- For complete system verification, refer to Chapter 3, “Performance Verification” in this manual.

CAUTION

Do not increase source #1 power level or connect a device with gain that is greater than -13 dBm as shown in these measurements. Greater than about -10 dBm can result in mixer compression errors, and greater than +27 dBm can damage the first frequency conversion stage. System specifications apply when the source #1 power is set as listed in Table 2-2 on page 2-14.

Perform the Operators Check

The following measurements show approximate RF signal levels incident at the first frequency conversion stage and given in dBm (even though the marker value read-out is in dB). During this procedure you may adjust the RF source #1 power level, this will change the available power at the test port, and thus the IF signal level.

This measurement is important for setting signal levels in preparation for measuring components. This is especially true for amplifiers. The maximum signal applied to Port 2 (or Port 1) without damage depends upon the band, exceeding +27 dBm can cause damage. If the IF signal level exceeds about -10 dBm, measurement errors due to compression result.

Procedure

1. Turn averaging OFF. (When looking at user parameters, always turn Averaging OFF).
2. Press PARAMETER [MENU] then {*USER 1 a1*}. Read the displayed forward reference signal path power level. Compare the reading with the power level listed in Table 2-3 on page 2-16, they should be about the same.
3. Connect a flush short to test-port 1. Select {*USER 4 b1*}. Read the displayed forward reflection signal path power level. Compare the reading with the power level listed in Table 2-3 on page 2-16, they should be about the same.
4. To measure the reverse reference signal path, redefine the parameter. Press PARAMETER [MENU], then press {*USER 3 a2*} then the following keys:

   {*REDEFINE PARAMETERS*}

   {*DRIVE:PORT2*}

   {*PHASE LOCK*} {*LOCK TO a2*}

   {*NUMERATOR*} {*NUMERATOR a2*}

   {*DENOMINATOR*} {*NO RATIO*}

   {*CONVERSION*} {*CONVERT TO*} {*REDEFINE DONE*}

Read the displayed reverse reference signal path signal level. Compare the reading with the power level listed in Table 2-3, they should be about the same.

5. Connect Port 1 and Port 2 together and select:

   {*USER 2 b2*}

   REDEFINE PARAMETERS}

   {*DRIVE*}

   {*DRIVE:PORT1*}

   {*PHASE LOCK*}

   {*LOCK TO a1*}.

Read the displayed forward transmission signal path power level. The power level should be approximately 2 dB less than was measured with a short at each test port.

If other than the power levels listed in Table 2-3 are observed (by about +4 dB), refer to Chapter 4, “Service and Troubleshooting” in this manual.

Table 2-3 Typical Power Levels During Operator’s Check of the mm-Wave System

Frequency Range	33 (GHz) to 50 (GHz)	40 (GHz) to 60 (GHz)	50 (GHz) to 75 (GHz)	75 (GHz) to 100 (GHz)
	Q-Band (WR-22)	U-Band (WR-19)	V-Band (WR-15)	W-Band (WR-10)
User Parameter a_1	–13	–13	–26	–27
User Parameter b_1	–15	–15	–27	–28
User Parameter a_2	–13	–13	–26	–27
User Parameter b_2	–15	–15	–27	–28

Measurement System Calibration

A perfect vector network analyzer exhibits flat frequency response, no impedance mismatches, and infinite isolation between channels. In an actual system all of these characteristics are imperfect, but are generally repeatable and predictable. To correct for these systematic errors, measurement calibration is performed using known impedance standards connected at the measurement ports. All of the required standards are supplied with the HP 11644A series calibration kits. To be sure the system is meeting measurement specifications, refer to Chapter 3, “Performance Verification”.

The HP 85106D with an HP 11644A series calibration kit can use any of the accuracy enhancement models available with the HP 8510C. For measurement of 2-port devices use, Full 2-Port, TRL 2-Port, or a combination of Transmission Response and Reflection 2-Port calibrations. Refer to the standard *HP 8510C Operating and Programming manual* and to the calibration kit manual for descriptions of the calibration types. Procedures for the TRL 2-Port, Response, Response & Isolation, and 1-Port calibration types are described in this section.

Warm-up Time

Allow at least one hour for the system to reach a stable temperature after power is turned on before trying to get highly repeatable measurements. In addition, a stable ambient temperature helps to minimize time-base variations, as well as physical dimensional changes that appear as short or long term drift in magnitude and phase measurements.

Before Starting a Measurement Calibration

Check to be certain the appropriate CAL KIT definition is installed in the HP 8510C. This definition is part of the Machine Dump file previously loaded, and is contained on the disk in each HP 11644A series calibration kit. Press [**CAL**] and read the {***CAL 1***}or {***CAL 2***} softkey label to confirm the calibration kit label.

Setting the Stimulus Values

Set all of the desired Stimulus characteristics for device measurement. These include the frequency range or frequency list, the number of points, Source #1 power level, and so forth. If the DUT must be measured using different stimulus settings, then make separate measurement calibrations for each frequency range (except where the HP 8510C Frequency Subset feature can be used).

Selecting the Averaging Factor

It is also advisable to turn averaging ON; an averaging factor of 128 is acceptable and improves the measurement results without substantially increasing measurement time.

In the RESPONSE [**MENU**] press:

{***AVERAGING ON/restart***} [**128**] [**x1**]

Checking the Instrument State

Verify that System Z_o is set to 1. This is used to normalize impedance in waveguide.

In the [CAL] {MORE} menu press:

{***SET Zo***} [**1**] [**x1**]

Entering the Exact Offset Delay

For the 1-Port and Full 2-Port calibrations, improve accuracy by entering the actual the exact length of the waveguide section instead of the nominal length as provided in the standard calibration kit definition. For TRL 2-port calibration either the actual or nominal length may be used.

NOTE

The disk file describing the calibration kit definition includes the “nominal” length of the waveguide section used to make the quarter-wave offset short and the quarter-wave offset load. The actual physical length of the waveguide section is printed on the waveguide section or can be found in the summary data sheet or calibration report. This value can be converted and entered into the Cal Kit standard definitions thereby improving the accuracy of the offset calibration. Please refer to the *HP 11644 Series Calibration Kit* manual for instructions to enter the actual offset length. You may want to store this definition onto a disk for future use. For further information on modifying the cal kit definition see the standard *HP 8510C Operating and Programming* manual and *Product Note 8510 - 5A*.

TRL 2-Port Calibration

The TRL 2-Port calibration procedure is recommended for general measurements of 2-port devices. It is required when performing the complete performance verification procedure. The procedure consists of measuring:

- A zero length thru connection.
- Short circuits at each port.
- Terminations at each port for isolation.
- A waveguide shim as the line standard.

This calibration procedure produces 12 term error correction and provides the best accuracy for 2-port devices.

1. Set the averaging factor to 128 by pressing in the RESPONSE [**MENU**] {***AVERAGING ON/restart***} [**128**] [**x1**].

Leave the AVERAGING FACTOR as the active function. This allows you to change the averaging factor for different calibration standards during the calibration procedure.

NOTE

If system performance verification is being done, the averaging factor is set to 1024 by the performance verification program and should not be changed.

2. Start the calibration procedure by pressing:

   [**CAL**]

   {***CAL KIT 1 WR-xx***}

   {***CALIBRATE:TRL 2-PORT***}

3. Connect Port 1 directly to Port 2 and press {***THRU***}. The system makes 6 measurements.
4. Connect the short to Port 1 and press {***S11 REFLECT***}. The system measures S_{11}.
5. Connect the short to Port 2 and press {***S11 REFLECT***}. The system measures S_{22}.
6. Press {***ISOLATION***}. Isolation calibration is recommended for wide dynamic range measurements, but *it is not required.* To omit the isolation part of the calibration press {***OMIT ISOLATION***} then proceed with "Performing the Optional Isolation Calibration" on page 2-20.

The isolation measurement is made with both Port 1 and Port 2 terminated in an appropriate one-port device. Since there is only one load in the standard calibration kit, the measurement is performed with a load on one port and a short circuit on the other.

Performing the Optional Isolation Calibration

To perform the isolation cal:

1. Set the averaging factor to at least 512.
2. Connect the load to Port 1 and a short circuit to Port 2.
3. Press {***FWD IOS'N ISOL'N STD***}. The HP 8510 measures S_{11} and S_{21}.
4. Connect the load to Port 2 and the short circuit to Port 2.
5. Press {***FWD IOS'N ISOL'N STD***}.
6. After the HP 8510 measures S_{22} and S_{12}.
7. Press {***ISOLATION DONE***}.
8. Set the Averaging Factor back to 128.
9. Connect the waveguide shim between Port 1 and Port 2.
10. Press {***LINE***}. The system makes 6 measurements.
11. Press {***SAVE TRL 2-PORT***}. The error coefficients are computed and the Cal Set selection menu is displayed.
12. Press a {***CAL SET***} key to store the error coefficients and turn correction on. The HP 8510 begins to measure all four S-parameters, automatically switching between forward and reverse parameters.
13. To measure a device, connect it between the test ports, and select a parameter to measure by pressing [**S11**], [**S21**], or [**S22**]. Any of the four S-parameters may now be selected and displayed. To restart the measurement, press [***MEASUREMENT RESTART***].

Response and Isolation Calibration

The Response calibration provides vector normalization of the system magnitude and phase frequency response to that of the selected calibration standard for the current selected parameter. The frequency response error is all that is removed with this calibration. This calibration type is useful for measuring a well-matched device or for a required quick check of device performance.

The Response & Isolation calibration accounts for both frequency response and isolation effects. In reflection measurements, both tracking and directivity errors are removed. In transmission measurements, tracking and crosstalk errors are removed. Two standards are required.

- The response standard is a flush short for reflection measurements or a zero length thru for transmission measurements.
- The isolation standard, for either transmission or reflection measurements, is the fixed load.

The Response/Isolation calibration is useful when measuring well matched or high loss devices.

1. Select the parameter to measure by pressing [**S11**], [**S21**], [**S12**], or [**S22**]. Set the frequency range for the measurement.
2. Begin the calibration process by pressing the following keys:

   [**CAL**] then {***CAL KIT 1 WR-xx***}

   {***CALIBRATE:RESPONSE***} or {***CALIBRATE:RESPONSE & ISOL'N***}

Proceed to step 3 for a Response calibration or proceed to step 4 for a Response & Isolation calibration.

3. For the Response calibration, connect the calibration standard:

- A thru for transmission
- A short at Port 1 or Port 2 for reflection.

   a. Press the {***SHORT***} or {***THRU***}softkey. The softkey is underlined after the standard is measured.

   b. Press {***DONE RESPONSE***}. Proceed to step 5.

4. For the Response part of the Response & Isolation calibration press {***RESPONSE***} and connect the response calibration standards:

- A thru for transmission.
- A short at Port 1or Port 2 for reflection.

    a. Press the {***SHORT***}or {***THRU***} softkey. The softkey is underlined after the standard is measured.

    b. Press {***DONE RESPONSE***}. If you plan to skip the isolation part of the calibration proceed to step 6.

5. For the Isolation part of the Response & Isolation calibration, connect a load to Port 1 and a short circuit to Port 2. Press {***ISOL'N STD***}. After the standard is measured the softkey is underlined. Press {***SAVE RESP&ISOL***}.

6. Wait for the error coefficients to be computed and the Cal Set selection menu to be displayed. Press one of the {***CAL SET***} keys to store the error coefficients and turn correction on. The corrected response is displayed.

7. Check the calibration by observing the corrected response.

1-Port Calibration

The S_{11} 1-Port or S_{22} 1-Port calibration requires three standards to quantify and remove the system frequency response, source match, and directivity errors. These calibration types provide the best accuracy for reflection measurements of 1-port devices. The standards used for this calibration are:

- Flush short
- Quarter-wave offset short
- Z_o termination

The three choices for Z_o termination are:

- Fixed load
- Sliding load
- Load/offset load combination

The load/offset load combination is preferred.

Choosing the Proper Load Standard

In the 1-Port calibration a load termination is used to determine the system directivity. (The error signal that appears in the reflected signal path and did not reach the test port). This section describes the different load standards that can be used with the HP 8510C.

A fixed load is the simplest load standard and provides adequate performance for many applications. During the calibration that uses a fixed load, the load is assumed to be perfect. The measured directivity is the combination of the actual system directivity and the actual reflection coefficient of the load. The effective system directivity is therefore dependent on the reflection coefficient of the load element (see Figure 2-4a**)**.

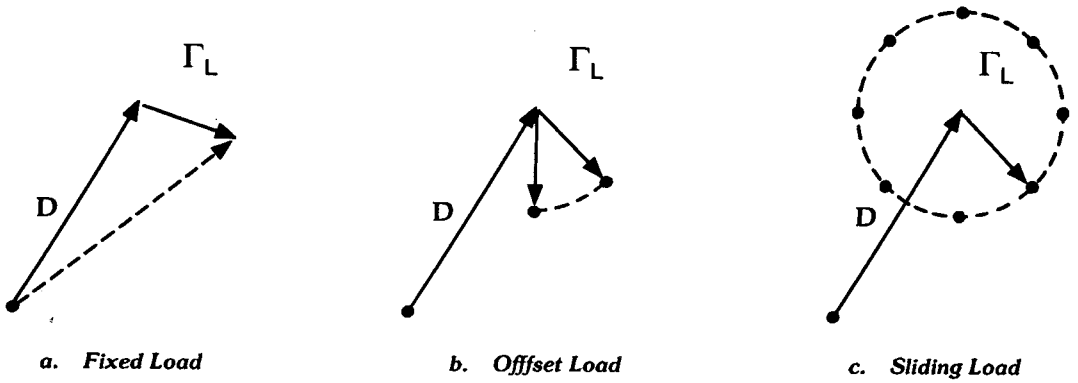


Figure 2-4 Phasor Diagram, Measuring Directivity Using Various Standards

Combining a fixed load with an offset load offers significantly better system directivity. This "offset load" technique is a two-step process. First, the fixed load is connected to the test port and measured. Then the same fixed load is offset by the shim and measured again. Since the shim offsets the load by a precisely known distance the angle of the resultant phase shift is known. Using these two measurements and the angle the HP 8510C can determine the exact directivity (Figure 2-4b). The accuracy of the offset load technique depends on how precisely the offset delay is specified in the cal kit definition (see section "Entering the Exact Offset Delay" on page 2-18).

A sliding load may also be used to determine directivity. The load element is moved to five (or more) positions determining corresponding points of the circle of Figure 2-4c. The HP 8510C then uses a circle-fitting routine to determine the center of the circle which is the actual directivity. Again, the effective directivity is determined by the dimensions of the line.

An important concern with the sliding load is the mechanical stability of the load element. This restriction has made the sliding load technique impractical in V and W bands, this is due to the small dimensions.

1-Port Reflection Calibration Procedure

1. Begin the calibration procedure by pressing the following keys:

   [**CAL**] then {***CAL KIT 1 WR-xx***}

   {***CALIBRATE:S11 1-PORT***}

   S_{11} will automatically be displayed on the screen.

2. Connect the flush short and press {***SHORT***}.

3. Connect the quarter-wave offset shim between the test port and the flush short to make a quarter-wave offset short. Press {***OFFSET***} and wait for this measurement to be completed.
4. Press {***LOADS***}, then choose either {***FIXED***}, {***OFFSET***}, or {***SLIDING***}.
   a. **Fixed Load Only** - Connect the load and select {***FIXED***}. When the measurement is complete press {***DONE LOADS***}.
   b. **Offset Load**- Select {***OFFSET***} and the two load selections appear, {***LOAD NO OFFSET***}{***LOAD OFFSET***}. Connect the fixed load directly to the test port and press {***LOAD NO OFFSET***}. After the measurement insert the quarter-wave waveguide section between the test port and the fixed load. Press {***LOAD OFFSET***}. When the measurement is complete, press {***OFFSET LOAD DONE***} {***DONE LOADS***}.
   c. **Sliding Load** - (not available for V and W bands). Select {***SLIDING***}. Connect the sliding load and move the sliding element toward the test port then press {***SLIDE IS SET***}. After the measurement, change the position of the sliding load and press {***SLIDE IS SET***} again. Change the load position at least five more times covering the full range of possible positions. Press {***SLIDING LOAD DONE***}.
5. Press {***SAVE 1-PORT CAL***}. The error coefficients are computed and the Cal Set selection menu is displayed. Press one of the {***CAL SET***} keys to store the error coefficients and turn on correction. The system is now ready for fully error-corrected reflection measurements of one-port devices.

Combining Calibration Error Models

Another technique for measuring 2-port devices is to combine an S_{11}, 1-port calibration and an S_{21} thru Response calibration for the forward parameters. Then combine an S_{22} 1-Port calibration and an S_{12} thru Response calibration for the reverse parameters. With this technique each parameter has its own cal set and is measured independently of the other parameters. This is usually the fastest way to measure a two-port device, but since this technique does not account for source and load match effects, it is only recommended for measurements of well matched or high loss devices.

Example Measurements

An HP 8510C equipped with the mm-wave test set, (its multiple source operation, waveguide line stretcher, frequency list mode, and other features), is capable of making measurements with unprecedented speed, accuracy, and convenience. The measurement examples that follow are useful for showing waveguide measurements.

Transmission Measurements

The frequency conversion technique used by the HP 85104 Series test set module allows high dynamic range measurements of mm-wave components. The transmission signal path noise floor can vary depending upon the frequency range and source RF power available at the test port. A quick check of dynamic range is performed using the Response & Isolation calibration with the test ports in the final measurement configuration. Choose the smallest averaging factor that provides the needed noise floor. Figure 2-5 illustrates the transmission response of a 44 GHz bandpass filter measured from 33 GHz to 50 GHz.

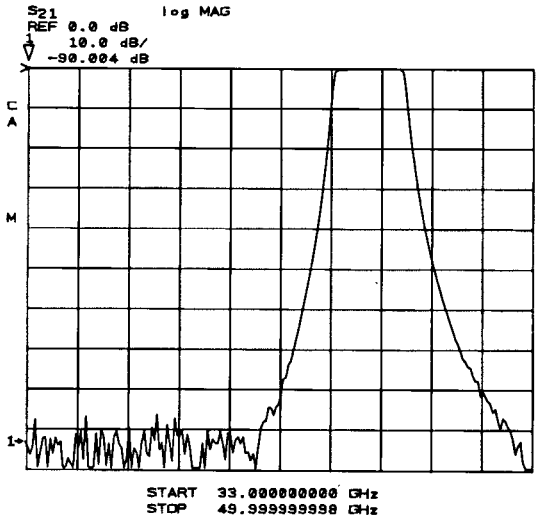


Figure 2-5 S_{21}, Bandpass Filter, 33 to 50 GHz, Showing Typical Dynamic Range

Reflection Measurements

Built in error correction provides a powerful measurement capability at mm-wave frequencies. Systematic errors are mathematically removed from the measurement system by measuring calibration standards with precisely known characteristics. Figure 2-6 compares uncorrected and corrected impedance measurements of a W-band fixed load. The slowly varying trace shows the result using an S_{11} 1-port calibration.

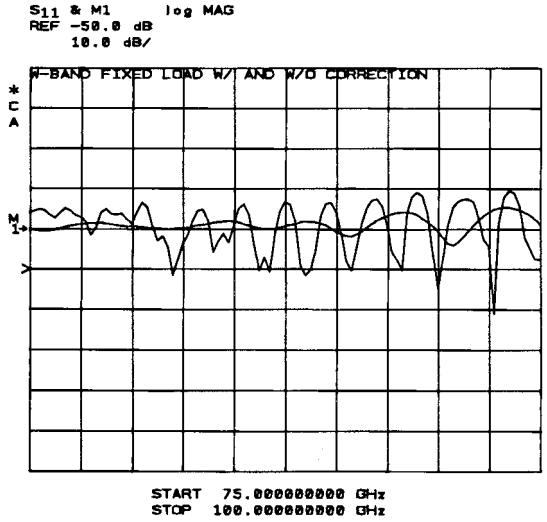


Figure 2-6 Comparing S_{11} Measurements Using Response and 1-Port Calibration

Using Frequency List

The HP 8510C frequency list mode allows the measurement of devices at specific user defined frequency points. In this measurement of a 94 GHz bandpass filter, a multi-segment frequency list is used to measure the filter transmission response from 80 GHz to 100 GHz, in 600 MHz steps, with an increased resolution of 20 MHz from 92 GHz to 96 GHz. Figure 2-7 illustrates the A11 segments selection results. Note that either of the segments can be displayed independently.

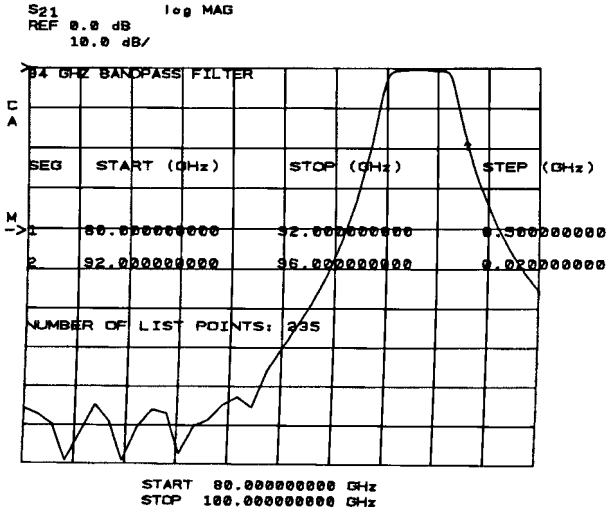


Figure 2-7 S_{21} Response, Using Frequency List to Adjust Frequency Resolution

Waveguide Electrical Delay

For phase and group delay measurements, remember that the propagation constant in waveguide and other non-TEM transmission lines is frequency dependent. Phase and group delay also exhibit this frequency dependence. Figure 2-8 illustrates the phase and group delay of a 44 GHz bandpass filter.

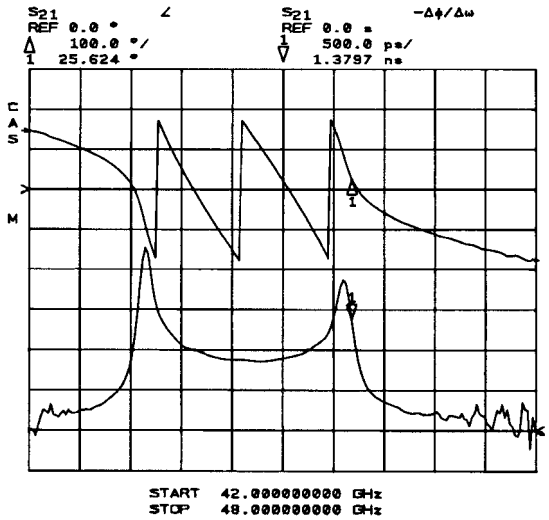


Figure 2-8 Bandpass Filter, S_{21} Phase and Group Delay

The Waveguide Delay function is used to compensate for the frequency dependent propagation constant of rectangular waveguide (dispersion). As illustrated in Figure 2-9, waveguide delay provides a display of deviation from characteristic phase.

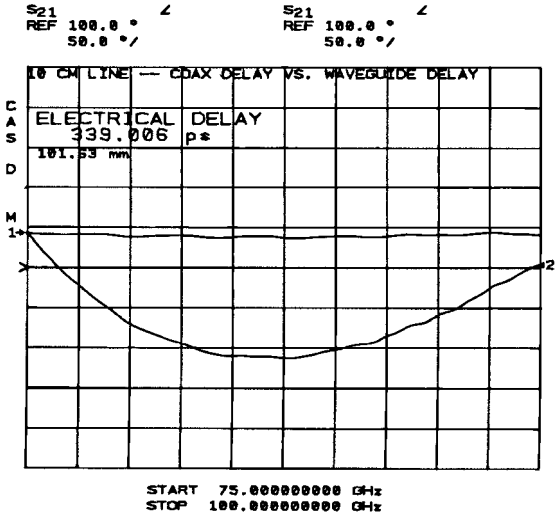


Figure 2-9 Using Waveguide Delay to View the Phase Response

To make this measurement, first enter the waveguide cutoff frequency (f_{co}) by pressing the following keys:

RESPONSE [**MENU**] {***MORE***}

{***WAVEGUIDE DELAY***}

The active function is now WAVEGUIDE CUTOFF at the waveguide cutoff frequency f_{co}. This value is a part of the instrument state that was loaded with the Machine-Dump file for the frequency band. If the value is incorrect for the band in use, enter the appropriate f_{co} for the waveguide band in use. The electrical delay then applied varies as a function of frequency to account for dispersion. Now press the keys:

PRIOR [**MENU**]

{***ELECTRICAL DELAY***}

Move the measurement marker to the center of the frequency range, then press {***AUTO DELAY***} to automatically choose a value for waveguide delay. Now use the knob to enter the appropriate electrical delay value to flatten the trace and view the deviation from characteristic waveguide phase response.

This measurement shows the phase response of the 10 cm line with electrical delay applied. Note that coaxial delay (linear) cannot flatten the phase response. With waveguide delay the phase response can be flattened so the actual device length may be measured.

Time Domain Measurements

With the HP 8510C Option 010 Time Domain feature, use {***TIME BAND PASS***} to locate impedance changes within the device under test. Figure 2-10 on page 2-31 illustrates the S_{11} time band pass response of a shorted 10 cm waveguide section with and without waveguide delay applied.

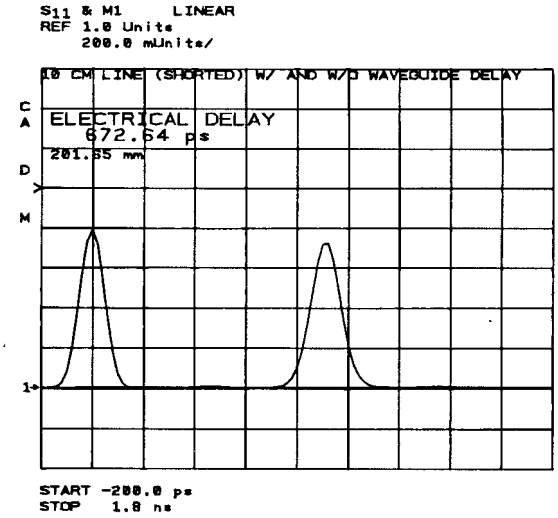


Figure 2-10 S_{11} Shorted 10 cm Waveguide Section

With no delay applied, the reflection of the short is displayed at about 900 ps. Both the magnitude and location of this time domain response are affected by the dispersive nature of the waveguide. The dispersion tends to "smear" the trace making the peak magnitude value inaccurate. To obtain a more exact measurement of the shorted line, add waveguide delay to move the response to time, t=0. The delay required is 672 ps, or 201.65 mm which is the twice the actual electrical length of the waveguide section. Twice because the signal propagates from the port to the reflection and then back to the port. Notice the change in magnitude due to the dispersion. The corrected response now displays the actual effects of the loss in the line and is unaffected by dispersion.

Operation Using A Coaxial Test Set

The system may include one of the coaxial test sets in the HP 8510 family. Figure 2-11 illustrates a simplified diagram of interconnections. The needed RF signal switch and the 20 MHz IF and control switches are included in the HP 85105 mm-wave controller. The system is easily switched from mm-wave to microwave test set operation by loading appropriate hardware and instrument states, but without changing rear panel connections.

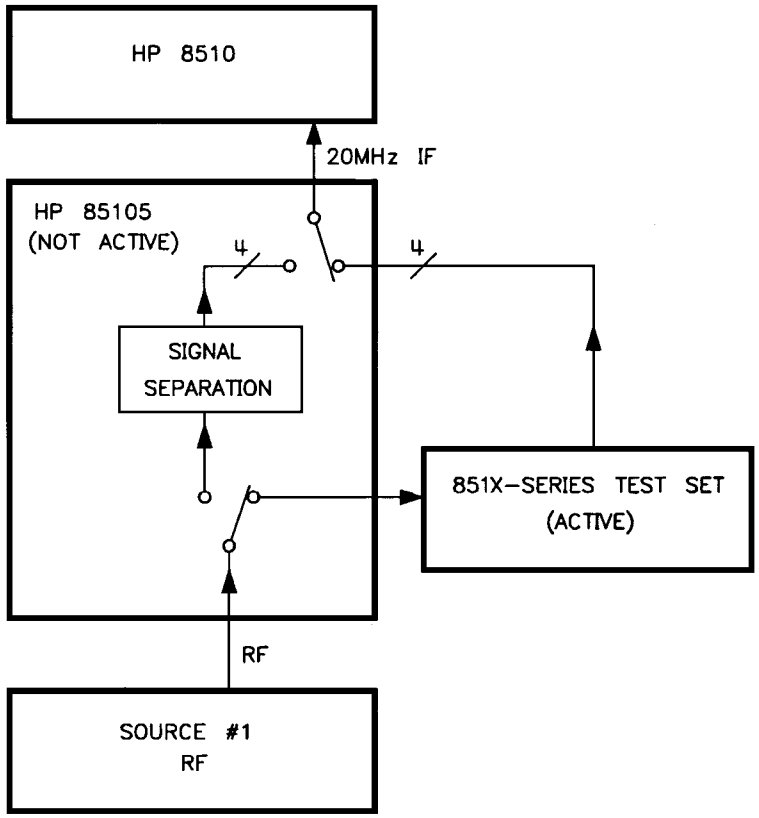


Figure 2-11 Block Diagram of System With Coaxial Test Set

Procedure

The following procedure describes configuring the mm-wave system for coaxial measurements.

1. Connect the HP 85105A and the coaxial test set as described in Chapter 1, “Getting Started”. When the coaxial test set is Active the RF signal is routed from the RF source through the HP 85105A to the coaxial test set. The IF and control signals from the coaxial test set are selected for application to the HP 8510. The HP 85106D Option 001 system includes a coaxial test set already connected this way. The HP 85105A must have power to operate in the pass-thru mode.
2. Load the coaxial Machine Dump file from the mm-wave system disk. Press:

   [**DISK**]

   {***STORAGE IS INTERNAL***}

   {***LOAD***} {***MORE***} {***MACHINE DUMP***}

Use the knob to select file {***MD_COAX***} (see Table on page 2-6), {***LOAD FILE***}.

Press [**USER PRESET**]. The key differences between the mm-wave instrument state and the coaxial test set instrument state are listed in Chapter , “Appendix A”.

The coaxial test set ACTIVE LED should go on and the HP 85105A ACTIVE LED should go off.

3. Check that the calibration kit definition is appropriate for the application. If necessary, load the appropriate calibration kit definition from the disk/tape supplied with the desired coaxial calibration kit. You may wish to store a coaxial calibration kit in CAL KIT 2 and a mm-wave cal kit in CAL KIT 1.

The system is now ready for operation using the coaxial test set.

Common Problems and Their Solutions

While preparing for mm-wave measurements you may encounter some of the following problems. Some recommended points to check are listed below:

Problem

CAUTION: NO IF FOUND displayed (or very low detected signal levels)

Possible Causes and Solutions

If a microwave test set is connected as well, verify that the test set ACTIVE LED is off. If it is on, then toggle the test set address.

1. Press [**SYSTEM**] {***HP-IB ADDRESS***} {***TEST SET***}.
2. Enter [**20**] [**x1**]
3. Enter [**21**] [**x1**]

If an RF Switch is also used, the SWITCH 0 LED should be on during mm-wave operation and off during microwave operation.

Problem

Data is grossly incorrect after calibration.

Possible Causes and Solutions

{***FACTORY PRESET***} was pressed and the {***SET Z0***} function (under the CAL menu) was reset to 50 ohms during a waveguide calibration. RECALL the correct mm-wave instrument state (Z_o=1), then calibrate again.

Problem

System locks up soon after loading a machine dump.

Possible Causes and Solutions

If the system is configured and is using a synthesizer for the LO and a machine dump expecting a sweeper LO is loaded, the system may hang while attempting to phase lock. To recover from this situation:

1. Turn all instruments off.
2. While holding down a key on the HP 8510 numerical keypad, turn the HP 8510 back on.
3. The HP 8510 starts the error diagnostic routine. Press [**=MARKER**].
4. Run the main program by pressing [**5**] [**1**].

Once the HP 8510 is sweeping, reset the phase lock by:

a. Press [**SYSTEM**] {***MORE***} {***SYSTEM PHASELOCK***} {***NONE***}.

b. Turn on the other instruments and reload the machine dump using the correct MD_SYNWRxx file.

Instrument State and Hardware State Settings

The following complete list of Hardware state and Instrument state settings is for the system when it is using the HP 85105A test set controller and the HP 85104A test set modules and for a system using a coaxial test set.

HP-IB Addresses

Source #1 (RF)	19
Source #2 (LO)	18
Test set	21 (HP 85105A)
	20 (Coaxial)
RF switch	31

System Phaselock

LOCK TYPE:	NONE (two synthesizers)
LOCK TYPE:	EXTERNAL (sweeper LO)
	not used with 85106D
LOCK TYPE:	INTERNAL (single source) with HP 8517B used in option 001

Power Leveling

(mm-wave):

POWER SWEEP	EXTERNAL
SOURCE 1:	EXTERNAL
SOURCE 2:	INTERNAL

(Coaxial):

SOURCE 1:	INTERNAL
SOURCE 2:	not used

Sweep Mode

HP 85105A with two synthesizer configuration gives you:

- FREQUENCY LIST
- SINGLE POINT
- STEP

With the coaxial configuration under 50 GHz ramp sweep is also available.

Set Z_o

1Ω (HP 85105A)

50 Ω (Coaxial)

Table 2-4 Waveguide Cutoff Frequencies

Frequency Range	**0.045 GHz to 50 GHz**	**33 GHz to 50 GHz**	**40 GHz to 60 GHz**	**50 GHz to 75 GHz**	**75 GHz to 110 GHz**
Frequency Band	**Coaxial**	Q-Band (WR-22)	U-Band (WR-19)	V-Band (WR-15)	W-Band (WR-10)
Cutoff Frequency	N/A	26.338 GHz	31.386 GHz	39.873 GHz	59.024 GHz

Multiple Source

ON for HP 85105 mm-Wave Controller

OFF for Coaxial Test Set

Multiple Source Definitions are required for each mm-wave band. Multiple source settings are shown in Figure 2-12 on page 2-40 for all the mm-wave bands. These definitions load automatically when the hardware state is loaded. Examine these by pressing:

[**SYSTEM**] {***MORE***} {***EDIT MULT.SRC.***}

QuickSTEP does not work in multiple source mode.

As an example of how multiple source control works, consider a Q band system (33 GHz to 50 GHz) set to measure from 42 GHz to 48 GHz at 201 points. For the 101st measurement point along the sweep the test signal frequency at the DUT is 45 GHz. To generate this 45 GHz signal, the test signal source is set to 15 GHz, amplified, and its frequency is tripled in the test set module (3 X 15=45). The incident, reflected, and transmitted portions of the 45 GHz signal are separated in the test set module and applied to the first frequency conversion stage. Inside each harmonic mixer the 45 GHz signal is mixed with the tenth harmonic of the LO source to produce an IF signal of 20 MHz. This means the tenth harmonic of the LO source is at 45.020 GHz. The LO source fundamental frequency is at 4.502 GHz (10 X 4.502=45.020). The same approach may be used to show that for the entire 201 point sweep, the test signal source sweeps from 14 to 16 GHz while the LO source sweeps from 4.202 to 4.802 GHz.

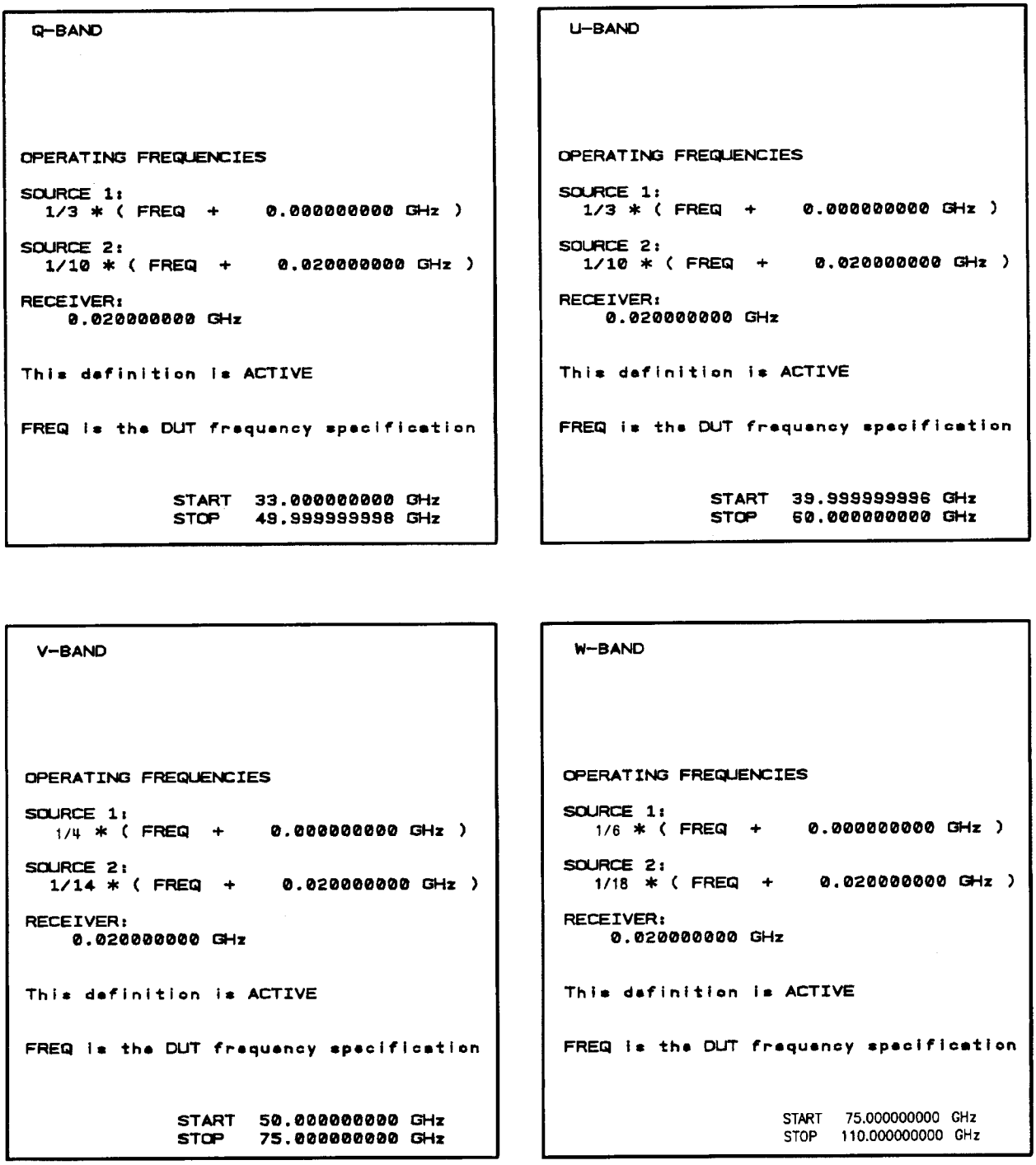


Figure 2-12 Multiple Source Settings for the mm-Wave Bands

3 Performance Verification

Introduction

After the system is completely installed and the operator's check in Chapter 2, “Operation” of this manual has passed, performance verification is needed. Performance verification assures proper system operation and is included as a part of the HP 85106D installation.

Performance verification for the mm-wave system is the same as for the standard HP 8510C system. Refer to the “Performance Verification” section in the *HP 8510C On-Site Service* manual as you calibrate and verify your system. Two frequency tests have been added to the required performance verification procedure of an HP 8510C system. These tests are outlined in the *HP 8510C On-Site Service* manual.

Installation of HP-BASIC and Performance Verification Software

NOTE Always use the highest numbered software version for performance verification.

Installing on a PC

The DOS version of the software runs on an INTEL 486 PC or higher, and must have at least four megabytes of available memory. The PC is also required to have a HP-IB card to communicate to the HP 8510 System.

NOTE Refer to the *HP BASIC for Windows, Installing and Using Guide* for the details of installing a configuring HP BASIC on a PC.

1. Install HP BASIC on PC by following the instructions on the 1st disk. The program will guide you through the installation process.
2. Install the Performance and Verification software by following the instructions on the disk lable. The installation program will lead you through the installation and create the program group which includes the specs and verification icon.
3. Click the mouse on the “Specs and Verification” icon to run the program. The first time you start the program you will get the following warning message:

   A valid HPBW GPIB (HP-IB) driver for your board (if any) has not been loaded.
   You can run the Specifications and Uncertainty portions of the HP 8510 software
   but cannot run the Verification portion as this requires GPIB or:
   To load the correct driver EDIT this program and Remove the “!” from in
   front of the LOAD statement for your GPIB board.
   After editing, type RE-STORE “AUTOST” to store the modified program . Then,
   close this window and re-select the Specifications Verification icon to
   re-run the program. The HP 8510 software should now load and run.

Follow the instructions in the above warning message to edit AUTOST file if you need to run the verification.

Installing on an HP 300 Series Controller

The performance verification software runs on most HP 200 and HP 300 series (except for HP 9826) controllers and requires at least two megabytes of memory to run the program.

1. Load HP BASIC (rev 5.0 or later), and make sure the following language extension and driver files are installed one at a time.

- ERR
- CLOCK
- GRAPH
- MAT
- IO
- HP-IB

Insert the HP 8510C Specification and Verification software disk (LIF format) into the default drive (or the drive you specify as the MSI (mass storage is).

- Load the file by typing:

  `LOAD "SPECS_8510"`, then press [**RETURN**] or [**EXECUTE**]

2. Type:

   `RUN`

This will start the program.

For Both PC and HP 300 Controller

After the program is started:

1. The display allows you to set the date and time.

At this point, you may press the controller “Y”" key to continue, or you press the controller "N" key and set the date and time. When your entries are complete, press [**RETURN**] or [**ENTER**].

2. The program loads the System Configuration file and System Hardware Configuration Menu is displayed. Use this menu to select the system equipment you want to use.

System Configuration

Select this menu to return to the Hardware Configuration menu or to use the Software Configuration menu and set the addresses of the HP 8510 or printer/plotter, or select plot trace pens/colors. Also use this menu to reset the program. All menu choices are returned to the program's default states and the program begins again at the time and date setting.

NOTE

QUIT PROGRAM --Always complete the selection with this key when you are finished using the program.

VERIFY SYSTEM--Use this menu to verify system performance. Do not choose this selection until the Hardware and Software Configuration menus are set.

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 appears.

The following example lists the equipment used in a typical mm-wave system:

- Network Analyzer: HP 8510C
- Test Set: U85105A U-Band S-Parameter (40 GHz - 60 GHz)
- Source: U85104A U-Band Synthesizer (40 GHz - 60 GHz)
- Calibration: U11644A - (40 GHz-60 GHz)
- Cal. Technique TL: Thru - Reflect - Line (TRL) Cal
- Test Port Cables - R, Q U, V, W-Band Millimeter L.O. cable
- Verification Kit HP 11645A U-band

Procedure

1. Select the equipment listed previously or select the equipment for your system. The CRT displays a highlighted field around the active selection. Use the {***NEXT***} and {***PREVIOUS***} keys to change the selection in the highlighted area as needed. Continue making selections to get the correct hardware configuration.
2. Press the {***DONE***} softkey to load the program. The MAIN menu is returned to the controller display. The program remembers the last system configuration you selected and when you run the program again (without turning the controller OFF), the same configuration appears on the display. You can reset the configuration by pressing {***PROGRAM RESET***} in the SYSTEM CONFIGURATION menu.
3. Have the following kits and disks ready to use:

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

NOTE

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

4. Press [**SYSTEM**] {***HP-IB configure***} {***HP-IB uses USR PRESET***} to send the preset command over HP-IB to USER PRESET.
5. Press {***VERIFY SYSTEM***}. If the program acknowledges the system over HP-IB, the System Performance Verification Menu is displayed on the controller.
6. Press {***SERIAL NUMBERS***}. Enter the serial numbers and the NIST numbers *only* if you want them to appear on the printout of your performance test results for each verification device. The serial numbers are usually located on the instrument rear panels. Locate NIST test numbers on the Certificate of Calibration that accompanies your verification kit.
7. When you are finished with this menu press {***DONE***}.

You are returned to the System Performance Verification Menu. Press {***SYSTEM CAL***}. The configuration information is displayed. Be sure it agrees with the system you plan to verify. If it does, press {***RESUME***}to continue. If not, go back to the Hardware Configuration Menu and edit the configuration listing to correct it.

Important Information For mm-Wave System Users

The verification program initializes the system and may change the instrument state. For mm-wave systems these values must be checked, and may need to be reset to their initial values. The prompt **`Initializing System Prior to Calibration`** appears on the HP 8510 display. Check the following instrument states before continuing with the calibration procedure. Your verification will be invalid if these states are set incorrectly.

The following conditions are recalled automatically during verification:

`SYSTEM PHASELOCK`

Press [**SYSTEM**] {***MORE***} {***SYSTEM PHASELOCK***} {***NONE***}

`POWER LEVELING`

Press [**SYSTEM**] {***MORE***} {***POWER LEVELING***} {***SOURCE 1:EXT LEVEL***}

{***SOURCE 2:INTERNAL***}.

`SOURCE POWER LEVEL`

Press STIMULUS [**MENU**] {***POWER MENU***}

{***POWER SOURCE 1}*** [**xx**]*

[**x1**} {***POWER SOURCE 2***} [**xx**]*

*Refer to the following table for the correct power level.

Table 3-1 Recommended RF and LO Source Power Levels

Band	Q (WR-22)	U (WR-19)	V (WR-15)	W (WR-10)
Power Source #1 (RF)[1]	-20	-20	-25	-30
Power Source #2 (LO)	+3	+3	+3	+3
WAVEGUIDE DELAY				
Cutoff Frequency	26.338	31.396	39.873	59.024

1. Optimum power level may vary from system to system. Adjust the power level to the maximum level without an "IF overload" message appearing. (Refer to "RF Signal Power Control" on page 2-12).

Calibration

Loading the Calibration Disk

Load the Calibration Kit disk as follows:

1. Insert the standards definition disk and press:
   a. [DISK], {*LOAD*}, {*CAL KIT *1*}.
   b. {*CAL KIT*1*}, {**file 1*}. If an asterisk (*) appears next to file 2, press {**File 2*} after file 1 is loaded.
2. Press [CAL] again and verify whether the proper files are loaded. The HP 8510C softkey field should display the calibration type and the cal kit tape constants revision number. Remove the disk after the file is loaded.
3. Press {*RESUME*} twice if you are ready to calibrate. The program sets the HP 8510C up and places it in LOCAL operation so you can calibrate the system using the front panel keys.

SYSTEM Z_o

Press [CAL] {*MORE*} {*SET Z0*} [1] [x1].

4. Perform the Calibration. You need the Pull 2-port calibration for S-parameter test sets, as in the HP 85106D System.
5. On the HP 8510 press [CAL]. Then select {*TRL 2-PORT*}.
6. Next, a series of softkey selections appear on the display: {*REFLECTION*} {*TRANSMISSION* }{*ISOLATION*} and{*LINE*}. When you press one, another set of softkeys will appear. Connect each device as directed; the HP 8510C underlines each device label when the measurement is complete.

If desired, refer to the step-by-step TRL calibration procedure in Chapter 2, “Operation” of this manual.

7. After making all calibration measurements, press the appropriate {*DONE*} softkey when the last measurement is completed.
8. 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, a calibration set is already stored there.

NOTE

If all of the registers are full, press any cal set key and respond to the displayed prompts. You delete the original contents of that register, then store your calibration there.

When the calibration is complete, press the program {***RESUME***} key. The program resets the HP 8510C for REMOTE operation and returns you to the System Performance Verification Menu.

Selecting the Verification Standard

Press {***SELECTION STANDARD***}. The program displays the Verification Kit Device Selection Menu. Use this "form" menu to select the standard you want to measure and enter its serial number. Change the averaging factor for measurement and select the Cal Set register, and to enter any comments.

A complete verification requires that you measure all devices in the kit. However, you must select the devices one-at-a-time from the Verify Standard menu. Select NO for the 45 MHz measurement and verify that the other selections are correct.

1. Press {***DONE***} after the form is completed. Insert the Verification Kit disk into the HP 8510 disk drive and press{***RESUME***}. The program reads the disk and compares device serial numbers. If the numbers do not match, change them by responding to the prompts.

Measuring the Standard and Displaying the Data

When you are ready to measure the device press {***MEASURE DATA***} and respond to the prompts on the controller display. The program initializes the system and gives you instructions about making proper connections. Measure all of the devices in your kit.

1. Press {***PRINT ALL***} and the program prints out a complete results sheet for the measurement of the device. If the device fails at any frequency, the letter F appears in the column along with a failure notice at the bottom of the sheet.
2. To quit the program press [**PRIOR MENU**] until you can select the softkey.

4 Service and Troubleshooting

Introduction

Use this section to troubleshoot an HP 85106D factory-configured system to the instrument level. When the faulty instrument is located, continue troubleshooting, following the troubleshooting procedure documentation for that product to locate the faulty instrument assembly.

WARNING

Each instrument in the HP 8510C system contains lethal voltages when the instrument has ac power applied. Refer to the safety information included in the "Safety/Licensing" section of the *HP 851OC Network Analyzer On-Site Service Manual*, which is included with each HP 85106D system. Servicing must be performed by qualified personnel only.

Troubleshooting Strategy

System troubleshooting is carried out in the following three stages:

1. Completing a pre-operational check to quickly identify selected failures. This check includes verifying that the system is cabled correctly, that the correct firmware revision is loaded, the HP-IB addresses are correct, voltages are correct, and configuration and language switch settings are correct.
2. Running the HP 8510C internal diagnostics to determine if the network analyzer is functioning.
3. Using specific procedures to find certain obvious symptomatic failures. Hardware service tools are used to emulate source and test set functions, and to identify a cause of failure outside the analyzer.

The HP 8510 network analyzer is the core instrument around which the HP 8510C system is built. The HP 8510 internal diagnostics check operation of the analyzer during initial application of ac line power and continuously while the instrument is running. The faulty system component can be isolated most effectively when these diagnostics are used to confirm or deny HP 8510C operation.

During the pre-operational check, note any failure indications before you begin troubleshooting. These indications may be self-test failure messages, running error messages (caution type), measurement errors, performance test problems, or display hang-ups. Continue following the procedure; failure indicators are discussed as they apply to the process. Refer to the system block diagrams in Figure 4-1 on page 4-2, and Figure 4-2 on page 4-3, as needed for troubleshooting.

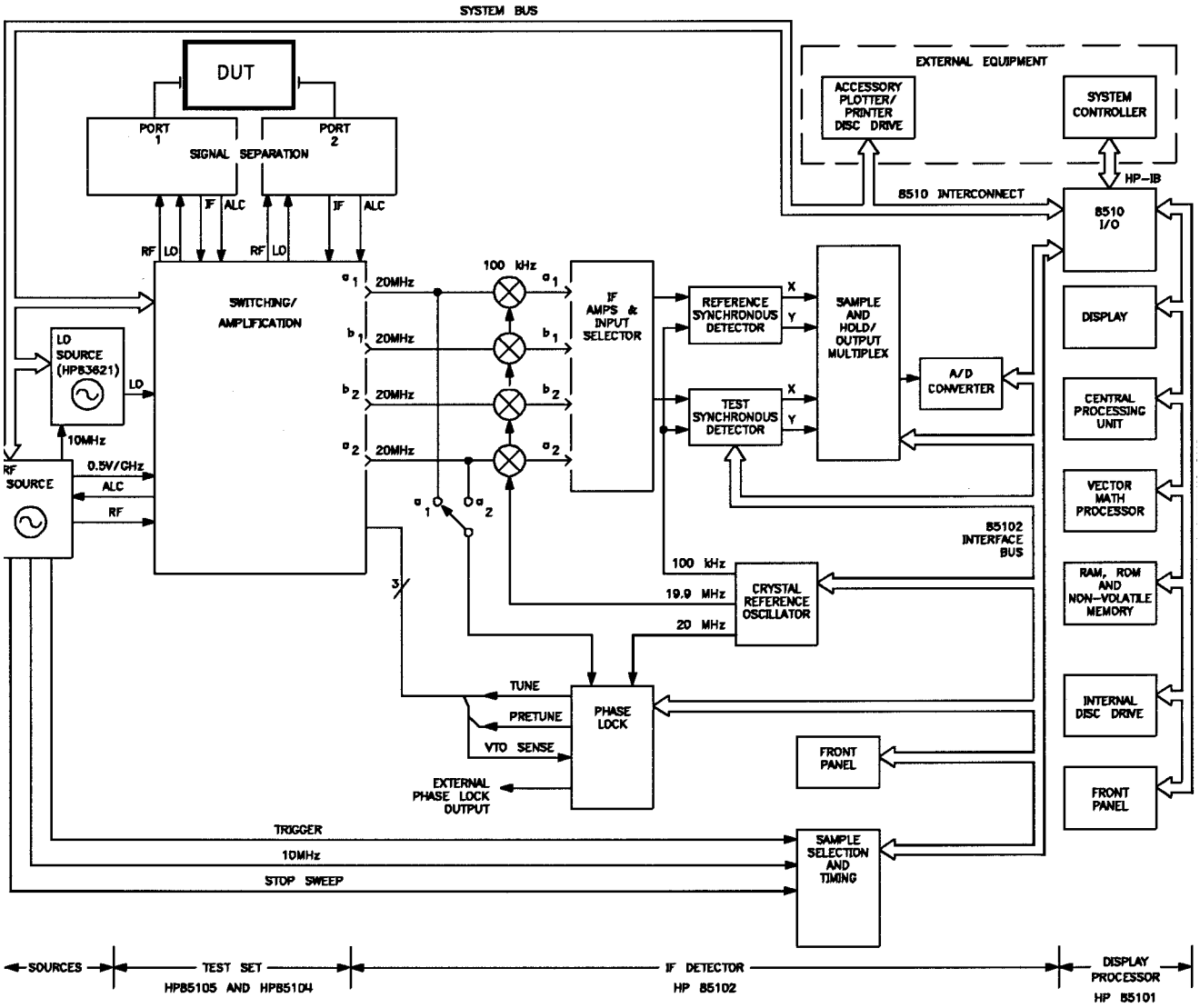


Figure 4-1 HP 85106D System Block Diagram

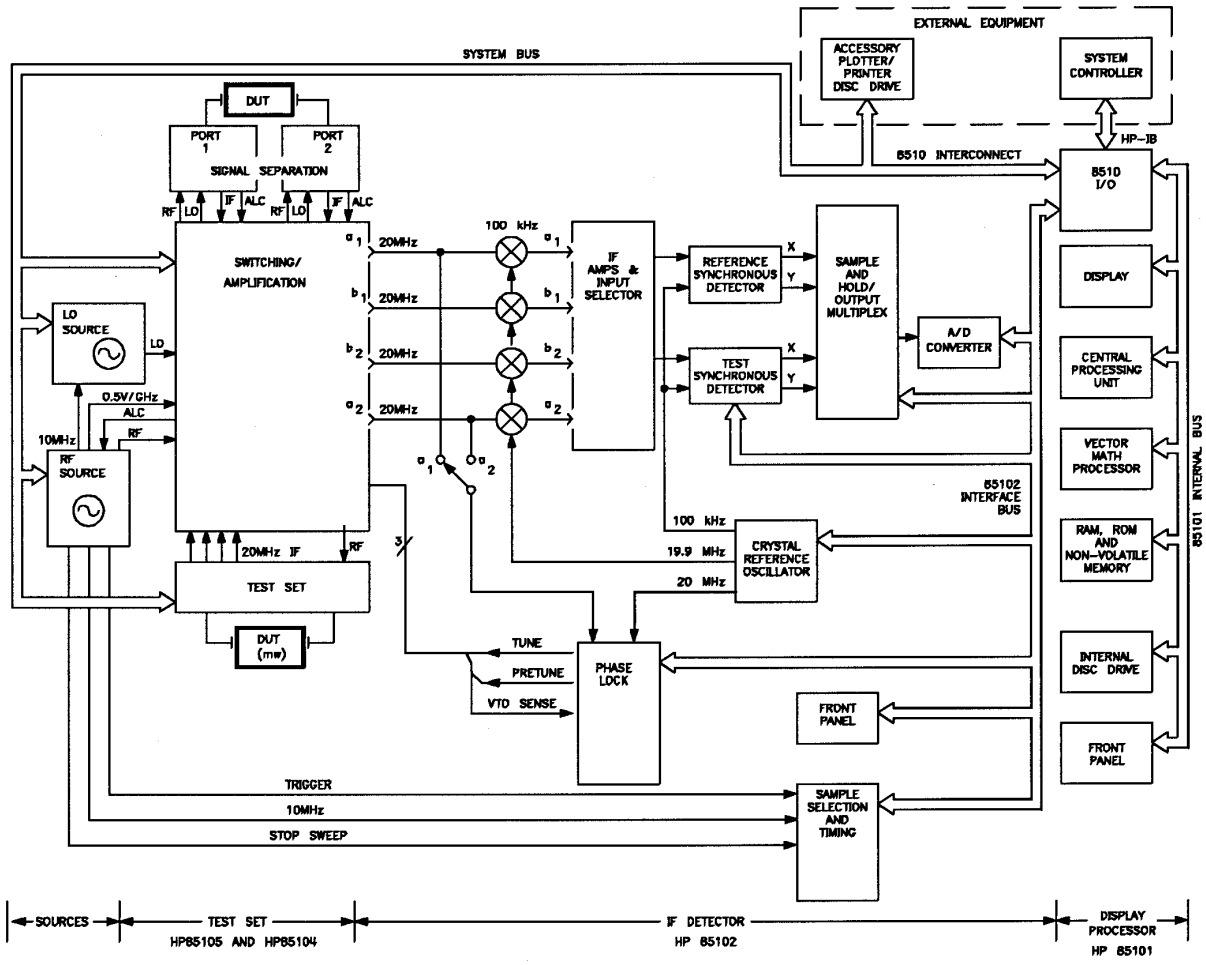


Figure 4-2 HP 85106D Option 001 System Block Diagram

Troubleshooting Documentation Required

As you troubleshoot, other manuals are mentioned that can provide information and detailed troubleshooting procedures. The following is a list of manuals that are required during troubleshooting. (See Table 1-3 on page 1-7 for HP part numbers).

- *HP 8510C On-Site Service Manual*
- *HP 8517B Operating and Service Manual*
- *HP 8360 Series Calibration and Installation Manual (used for the HP 83621B, HP 83631B and HP 83651B synthesized sweepers)*

Pre-Operational System Check

Table 4-1 Pre-Operational System Check Table

Check	Additional Information
HP 8510 front/rear panel control settings	HP 85101 and HP 85102B power switches ON
HP 8510C operating system firmware revision	Must be revision B.6.54 or later
Cabling and HP-IB addresses of all instruments in the system	See Figure 4-3 on page 4-6, Figure 4-7 on page 4-19, and Figure 4-8 on page 4-23 in this procedure
HP 8360 Series source language switch setting	See Figure 4-8 on page 4-23
HP 8360 Series source automated calibration procedure (full user cal)	HP 83621/31/51 Calibration and Installation

HP 8360 Series Source Language and HP-IB Address Selection

The HP 8360 Series synthesizers use one of the following external interface languages:

- TMSL (Test and Measurement System Language)
- Analyzer Language

HP 8510 systems require that the synthesizer be set to "Analyzer Language." Set both the language configuration and the synthesizer HP-IB address with a switch located on the rear panel of the synthesizer. The factory default settings for this switch is to "Analyzer Language" at HP-IB address 19 (address 18 for the LO).

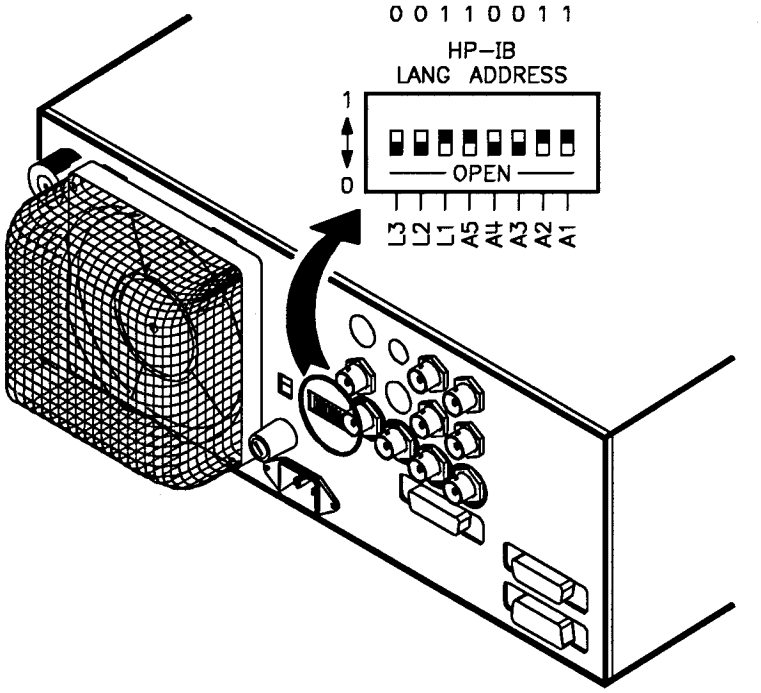


Figure 4-3 HP 8360 Series Source Rear Panel HP-IB Switch

Turn On System Power and Observe Instrument Front Panels

NOTE

In the next step, observe the preset routines for each instrument as ac line power is applied. Note any errors.

1. Switch the ac line power to all system instruments OFF.
2. Apply ac line power to the system instruments in the following order:
   a. Sources
   b. Millimeter-wave controller/source modules
   c. Test set (if included)
   d. When the system instruments finish their preset routines and are ready, apply ac line power to the HP 8510C.

NOTE

If the HP 8510 hardware state and instrument state are incorrect, or not loaded, the HP 8510 may display an error message and sound a beep. Turn the beep off by pressing [**SYSTEM**] {***BEEPER OFF***} on the front panel.

If needed, load the desired "Machine Dump" file from the HP 8510C system disk by inserting the disk into the disk drive. Press the following HP 8510C keys:

[**DISK**]

{***STORAGE IS INTERNAL***}

{***LOAD***} {***MORE***}

{***MACHINE DUMP***}

Refer to Chapter 1, "Getting Started" of this manual for more information about the contents of a "Machine Dump." Use the RPG knob on the HP 8510 to select the file for the desired frequency band and LO source (see Table on page 2-6), then press {***LOAD FILE***}. The system is ready for operation after the file is loaded.

If the system locks-up, refer to Chapter 2, "Operation" using the "Common Problems and Their Solutions" information.

Instrument State 8 is recalled each time the HP 8510 ac line power is turned ON. The Machine Dump file loads this register with an appropriate full-band sweep. Since the hardware state is not modified at power-up, the system can be configured to power up in any particular frequency range by saving the desired instrument state in register number 8. Press the green [**USER PRESET**] key on the front of the HP 8510C to recall "Instrument State 8".

Cycle the AC Line Power

Turn the HP 8510 ac power OFF, then ON. Check the RF power and sweep functions of the HP 8510 by observing the display or blinking sweep LED on the HP 836xx synthesized sweepers front panel. If used, the sweep LED on the HP 8340/41 synthesizer front panel may also be blinking.

NOTE

If the HP 85l0 locks up, refer to “Common Problems and Their Solutions” on page 2-34 for information.

If there are any self-test failure messages or running error messages (caution type), refer to the *HP 8510C On-Site Service Manual.* Follow the specific procedure associated with the type of test that failed. If there are unratioed power test failures, refer to “Check Unratioed Power Levels” on page 4-19.

Check HP 8510C Diagnostics

At turn on, the HP 8510 runs an internal self-test check of several internal assemblies. Failure messages are displayed along with messages that may indicate the failure cause. During normal operation the HP 8510 performs continuous internal diagnostics which indicate network analyzer problems during operation. Running error messages (caution type), as these are called, are displayed.

Self-Test Failure

If one or more self-test fails, as displayed on the HP 8510, refer to the "Self-Test" chapter in the H*P 8510C On-Site Service Manual.*

Running Error Messages (Beeping)

If a running error message (caution type) appears on the HP 8510 display, refer to the "Running Error Messages" chapter in the *HP 8510C On-Site Service Manual.*

Symptomatic Failure Types

Refer to the following heading listed that most closely represents the instrument problem (obvious or not). They are suggested courses of action specific to the failure symptom.

- Millimeter-Wave, Phase Lock, Power Loss, or Frequency Related Problems.

Check Unratioed Power Levels

Refer to the test titled “Check Unratioed Power Levels” on page 4-19.

- Microwave, Phase Lock, Power Loss, or Frequency Related Problems When Using the Optional HP 8517B Test Set.

When Using the Optional HP 8517B Test Set

To help locate the faulty instrument, the service adapter (HP part number 85102-60210) is used to emulate the operation of the source and test set and check unratioed power levels into the HP 85102 IF/Detector.

NOTE

When checking any unratioed power levels, turn the HP 8510 averaging OFF. Refer to “Unratioed Power Test” in the *HP 8517B Operating and Service Manual*. This procedure allows you to check individually the output power level of each test set sampler/mixer assembly and its associated IF amplifier. Depending upon the test outcome, the procedure directs you to the most likely cause of failure.

Power Supply Problems

WARNING

Each instrument in the HP 8510 system contains lethal voltages when ac power is applied. Refer to the HP 8510 safety information included in the "Safety/Licensing, section of the *HP 851OC Network Analyzer On-Site Service Manual,* included with each HP 85106D system. Servicing must be performed by qualified personnel only.

Check ac line fuses (110 V/220 V) and power switches. Remove the top covers on the following instruments:

- HP 85101 network analyzer display/processor
- HP 85102 network analyzer IF/detector
- HP 85105A millimeter-wave controller
- Sources

Check the LED power and service-indicator lights. Measure each power supply voltage with a digital voltmeter. The HP 85102C power switch LED is supplied by the +5 V supply in the HP 85101C.

Refer to "HP 8510 Power Supply Troubleshooting" in the "Additional Tests" chapter in the *HP 8510 On-Site Service Manual* for more information.

Calibration Verification Problems

Read the respective manual for the calibration kit used and review inspection, gauging, cleaning, and use of the calibration and verification devices and test port return cables.

Refer to “Performance Test Failure Troubleshooting” in the “Additional Tests” chapter of the *HP 8510 On-Site Service Manual*, or the information in Chapter 3, “Performance Verification” of this manual.

Software Problems

Try loading the standard operating system firmware into the HP 8510 from the backup copy. This operating system firmware must be revision C.0654 or later for the HP 85106D system to function properly.

There is a chance that you encountered a software “bug” that is already known. Contact HP and explain the details so that the problem can be duplicated and checked. Continue with troubleshooting using “All Other Problems” on page 4-13,

All Other Problems

The best approach to repair the HP 85106D at this point is to verify that the HP 85101 display/processor is working properly. When its operation is verified it can be used as your diagnostic controller.

From the HP 85106D mm-wave system disconnect any external controller, printer, plotter, disk drive, or other equipment and all their cables. Leave only the instruments listed below attached to the system:

- HP 8510C network analyzer
- HP 85104A mm-wave test sets
- HP 85105A mm-wave controller
- Two Sources

Run the Service Program

This group of internal diagnostics, called the Service Program, gives the fastest and most complete check of the HP 85106D system. Whenever your HP 85106D system appears to have a failure you can use this program to check the boards in the HP 8510C and HP 85105A.

In general, the Service Program is used for the following purposes:

- When there is a self-test failure, run the Service Program diagnostics for the board assembly that failed. Verify the failure.
- When there is a running error message (caution type), run the “Service Program” diagnostics for those board assemblies indicated in the “Running Error Messages” section in the *HP 8510C Service Manual.* The service program verifies whether the board has a detectable problem.
- When there is any reason to suspect a board-level problem, run the “Service Program” diagnostics.
- After a board assembly is replaced, run the appropriate service program diagnostics again to verify that the board-level failure is repaired.

Service Hardware Tools

Two service tools are designed especially for use with these diagnostics.

- The HP 85102 service extender hardware card (HP part number 85102-60030).
- The Service Adapter Test Set Emulator (HP part number 85102-60210).

These is the source emulator, and the test set emulator. Refer to Chapter 5, "Replaceable Parts," of the *HP 8510C On-Site Service Manua*l for information. In addition, you also need two BNC-to-BNC cables (not included). The HP 8510C displays a message to alert you when these tools are required in the Service Program.

Test Outcome

If a “Service Program” test fails and indicates a board is faulty, you can be reasonably certain that the board should be replaced. However, refer to the information in “Front Panel Tests” and “Additional Tests” of the *HP 8510C On-Site Service Manual*. If there is another test for the board in question, perform the test to further verify the failure.

If by running the “Service Program” tests, you cannot verify or isolate the problem, refer to the information in “Front Panel Tests” and “Additional Tests” of the *HP 8510C On Site Service Manual.* The information provided there contains more information about testing certain boards and assemblies.

Symptoms Versus Causes Failures

Be sure that you have not overlooked any fundamental problems disguised by a symptom of the real failure. Some of these fundamental problems include incorrect cabling or connections, instruments with incorrect firmware, error messages due to boards improperly seated in sockets, and so forth.

Overall Service Program Flowchart

Figure 4-4 on page 4-15 illustrates the overall Service Program flowchart including HP 8510C key presses to access all the tests included in this diagnostic.

NOTE

All tests used to generate signature-analysis patterns are for factory repair and are not intended for on-site service. Also, you can always use the front panel recessed [**TEST**] button to exit the Service Program and reset the HP 8510C. You need to use a paper clip to access this button located beneath the disk drive. Be sure to reconnect the system properly.

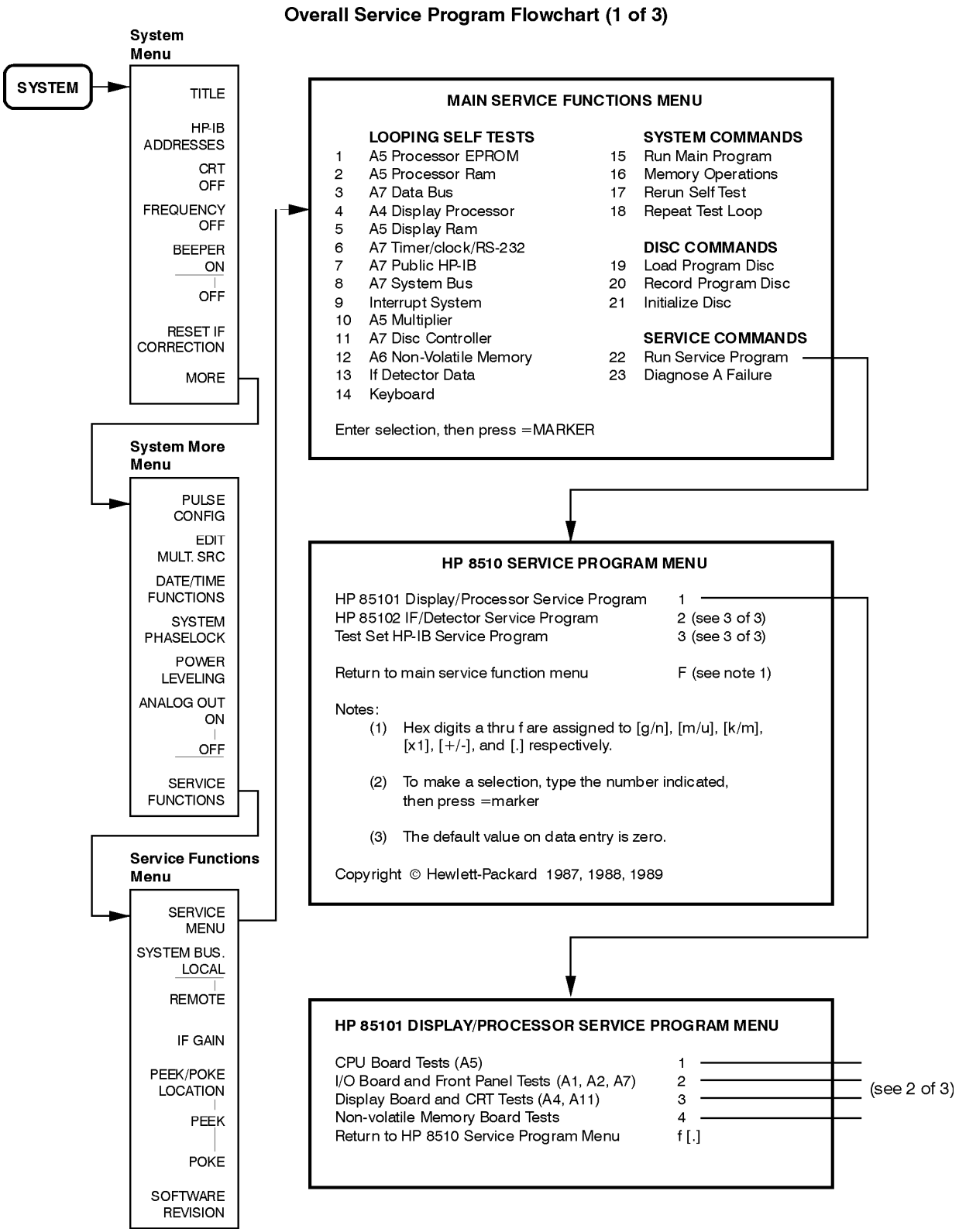


Figure 4-4 Overall Service Program Flowchart (1 of 3)

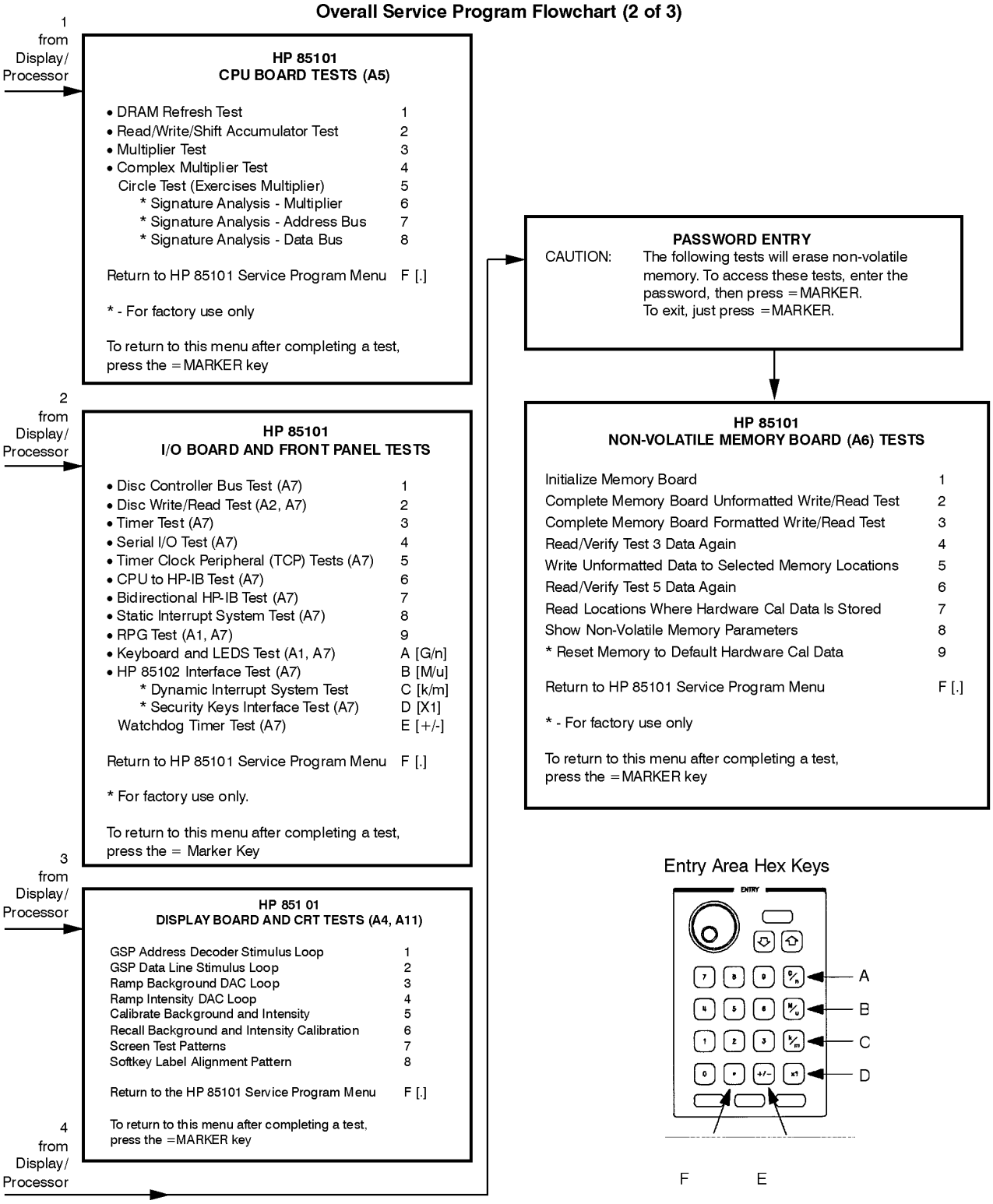


Figure 4-5 Overall Service Program Flowchart (2 of 3)

Overall Service Program Flowchart (3 of 3)

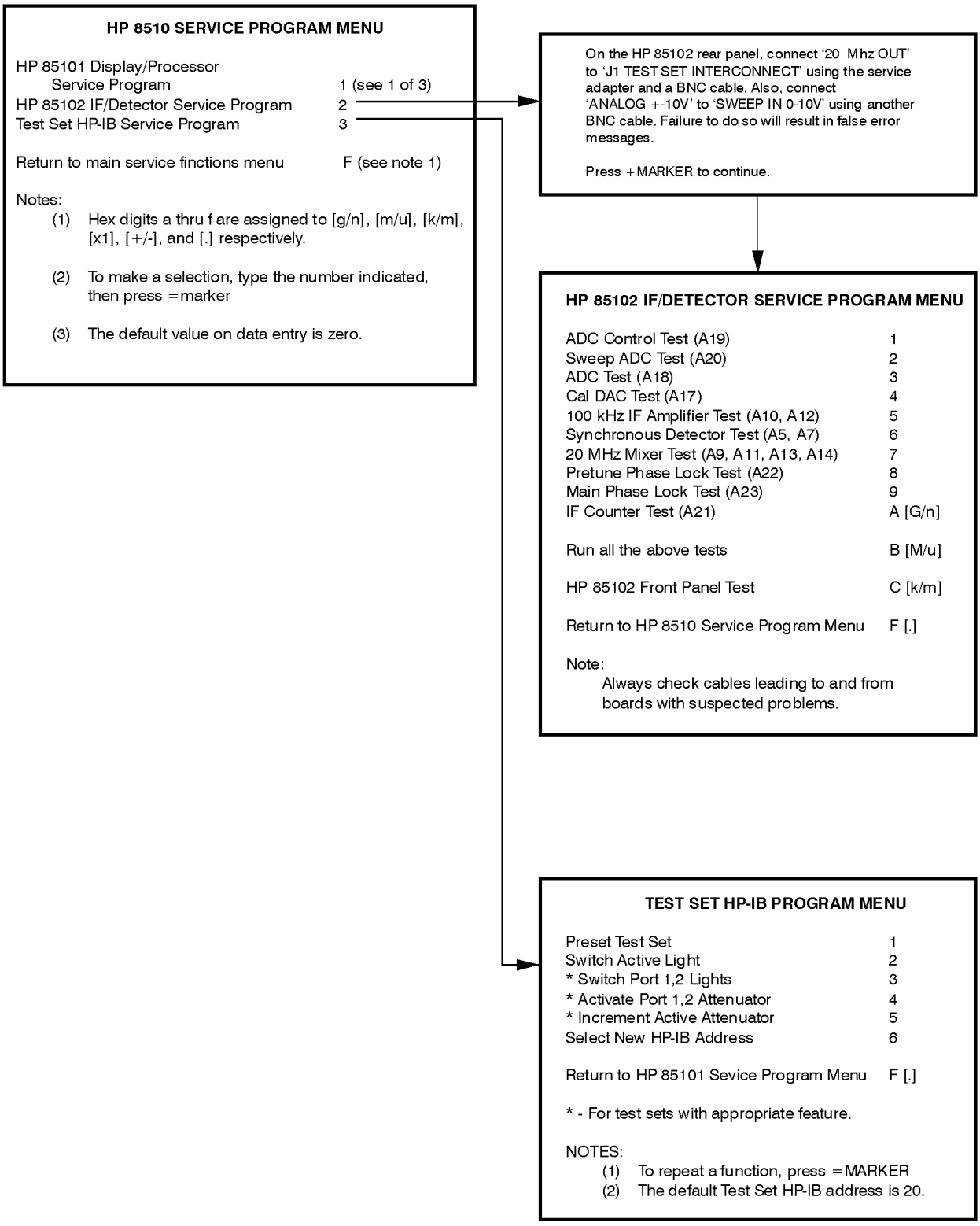


Figure 4-6 Overall Service Program Flowchart (3 of 3)

Service Program Procedure Using HP 85101 Tests

Run the program now using all the tests in the HP 85101 test menu. These tests can find 95% of all HP 85101 failures, and require approximately ten minutes to complete.

The steps in the test menu identify the most important HP 85101 tests. The tests that are not bulleted are primarily adjustments that increase troubleshooting and may require extra equipment.

Service Program Procedure Using HP 85102 Tests

If the HP 85101 is working properly, then the HP 85102, the sources, or their interfaces may be the problem. Verify the operation of the HP 85102 by running the HP 85102 Service Program tests. Refer to the test menu provided in Figure 4-4 on page 4-15. This flowchart illustrates the Service Program path to use for the HP 85102 tests. These tests help find 80% of all HP 85102 failures and require approximately one minute to complete.

Check Unratioed Power Levels

This procedure allows you to check the output power level of each sampler/mixer assembly, individually, and each associated IF amplifier.

The typical power level display (S11 as an example) is a ratio (in this case, b_1/a_1). The network analyzer automatically applies power and phase locks to a predefined port or ports to make the selected measurement. Ratioed measurements provide useful data but they can mask certain malfunctions. Assume, for example, that you need to measure the S-parameter at a specific power level of a device. If the test set has a 20 dB power hole due to a faulty RF input connector, that deficiency would be invisible (ratioed out) in a ratioed measurement, however the data would be incorrect. It would not have been taken at the specified power level. Similarly, troubleshooting system faults using the ratioed measurement mode can be deceptive.

The solution is to separately test each channel and check the power in unratioed mode. To do so requires specifying which port receives the driven power, and which channel is phaselocked.

The following procedure includes steps to redefine parameters as required. The power levels given are approximate. The assemblies that are parts of the signal path of each channel are illustrated in Figure 4-7. Knowing which assemblies are common to two, or all four channels, is a powerful troubleshooting tool.

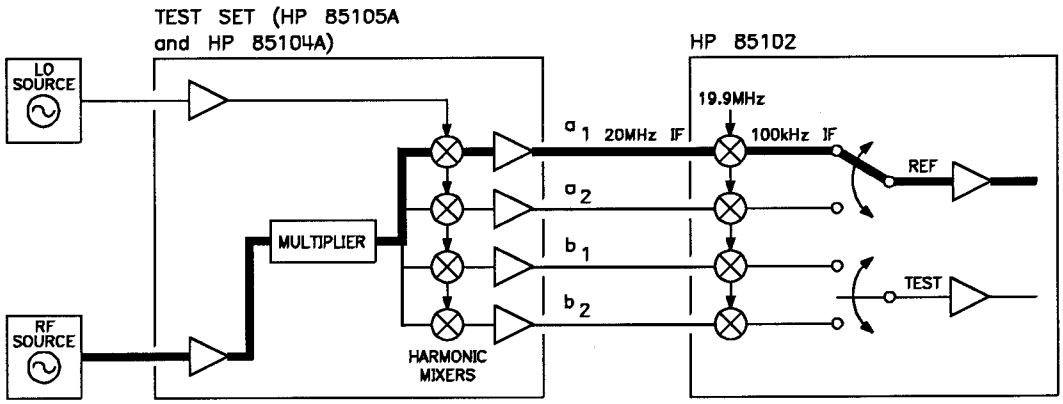


Figure 4-7 Simplified Signal Path of Unratioed Power Test

The mixers illustrated in the test set block diagram of Figure 4-7 are harmonic mixers. They mix the multiplied signal from the RF source and a harmonic of the signal from the LO source to produce a 20 MHz IF output.

NOTE All system instruments must be connected and averaging must be turned off during this test.

To check all of the IF signals in the HP 85104A mm-Wave Test Sets, the a_2 and b_2 phase lock and drive paths must be redefined. If the configuration disk has been loaded for the desired millimeter band, then the user parameters are already defined. If manual entry is needed, press the following keys on the HP 8510 to redefine a_2:

PARAMETER [**MENU**]

{***USER 3 a2***}

{***REDEFINE PARAMETERS***}

{***DRIVE***} {***PORT 2***}

{***PHASE LOCK***} {***a2***}

{***REDEFINE DONE***}

To redefine b_2, press:

{***USER 2 b2***}

{***REDEFINE PARAMETERS***}

{***DRIVE***} {***PORT 2***}

{***PHASE LOCK***} {***a2***}

{***REDEFINE DONE***}

NOTE It is very important that you connect shorts to port 1 and port 2 on the test set modules.

On the HP 8510 press the following keys to check the IF signals indicated in the following table.

{***USER 1 a1***} checks the a_1 incident IF signal

{***USER 2 b2***} checks the b_2 reflected IF signal

{***USER 3 a2***} checks the a_2 incident IF signal

{***USER 4 b1***} checks the b_1 reflected IF signal

Table 4-2 Typical Power Levels for Operational Check of the mm-Wave System

Frequency Range	33 GHz to 50 GHz	40 GHz to 60 GHz	50 GHz to 75 GHz	75 GHz to 110 GHz
Band	**Q (WR-22)**	**U (WR-19)**	**V (WR-15)**	**W (WR-10)**
a_1	-13	-13	-26	-27
b_1	-15	-15	-27	-28
a_2	-13	-13	-26	-27
b_2	-15	-15	-27	-28

NOTE The maximum power level must not activate the **IF OVERLOAD** running error message.

If Four Channels Fail the Unratioed Power Test

If the power levels on all four channels fail, the most likely cause of failure is in the RF or LO source paths from the sources.

Remove the HP-IB and RF power cables from the HP 85106D system to isolate the sources. Refer to the appropriate source manual to troubleshoot the HP 8360 series sources. Be sure to check the power levels out of the source and the RF cables from the sources to the HP 85106D system.

NOTE Do not try to measure the RF source power in source #1 of the HP 85106D system by disconnecting the RF cable. Measuring the RF from the source breaks the leveling loop and causes the source to supply maximum power output. Instead, try placing a coupler in the RF cable path then measure the power.

Consider substituting known good sources and cables for the suspected sources.

If the sources are all good, then continue with “If One, Two, or Three Channels Fail the Unratioed Power Test” on page 4-22.

If One, Two, or Three Channels Fail the Unratioed Power Test

If the power level on at least one, but not all, of the four channels fail, the most likely cause of failure is the HP 85104A mm-wave test set module or HP 85105A mm-wave controller.

To help isolate the problem to the faulty instrument, use the service adapter and service tools. These emulate the operation of the source and test set and check unratioed power levels into the HP 85102 IF/detector.

NOTE

When checking any unratioed power levels, turn averaging on the HP 8510C OFF.

Run "The Service Program" procedure **(**Figure 4-8) using the Test Set HP-IB Commands tests. These tests can find about 15% of all HP 85105A mm-wave controller failures. The test requires approximately one minute to complete. Only the digital functionality of the HP 85105 is checked by this test, not the RF paths.

NOTE

Do not perform Test Number 5 "Increment Active Attenuator" in the "Test Set HP-IB Commands" menu. The HP 85105A has no attenuators.

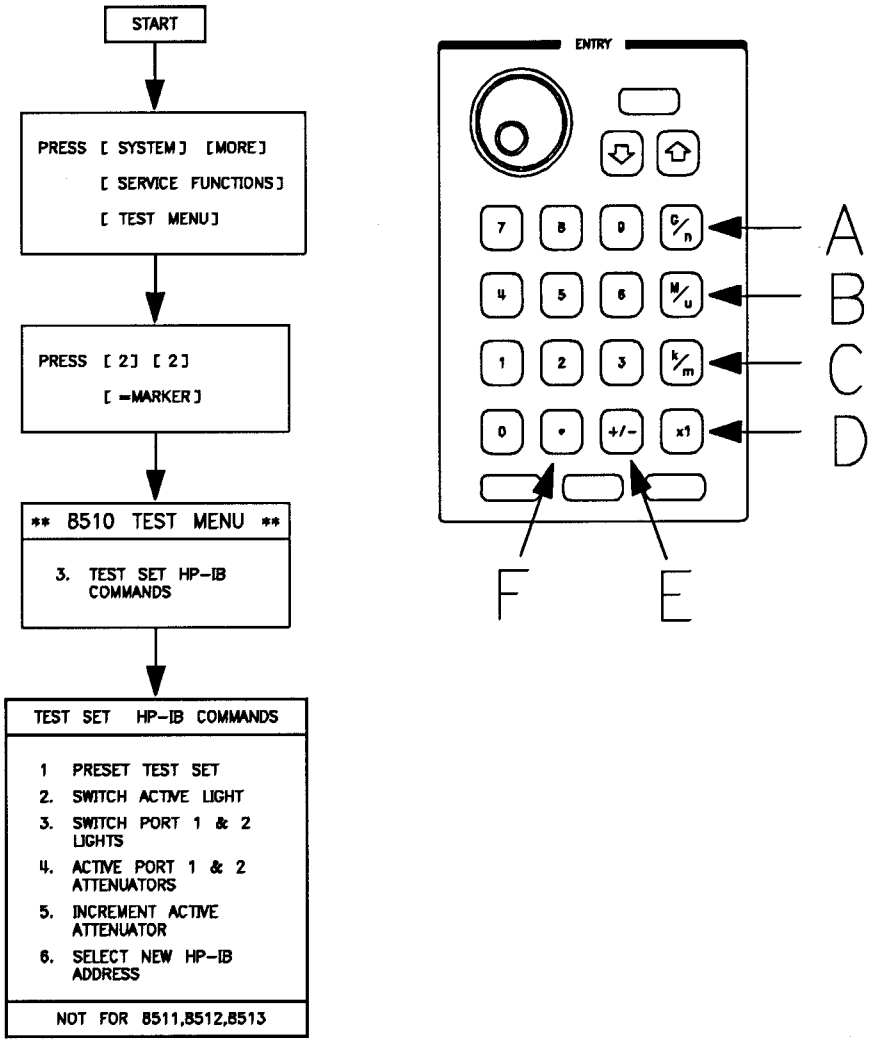


Figure 4-8 Test Set Service Program Flowchart

Troubleshoot the HP 85105A mm-wave controller using the procedure in Chapter 6, “HP 85105A mm-Wave Controller” of this *HP 85106D Operation and Service Manual.*

Troubleshoot the HP 85104A mm-wave test set module using the procedure in Chapter 5, “HP 85104A Test Set Module” of this *HP 85106D Operation and Service Manual.*

5 HP 85104A Test Set Module

Introduction

This section documents the operation, troubleshooting techniques, and replaceable parts of the HP 85104A test set module.

Theory Of Operation

A pair of HP 85104A test set modules are used to make either reflection, transmission, or S-parameter measurements at mm-wave frequencies, in conjunction with an HP 85105A mm-wave controller. The mm-wave controller routes the LO and RF signals from RF and LO sources to the test set modules. Switching from port 1 to port 2 is also performed by the mm-wave controller. The test set modules separate the incident from the reflected RF signal and then down convert those signals to a 20 MHz IF frequency.

Refer to the HP 85104A block diagrams (Figure 5-7 on page 5-23 through Figure 5-10 on page 5-29) while reading the following description. The RF is received from the mm-wave controller and input to the source module block of the test set module. The RF is then multiplied six times in the case of W-band (2 times for R-band, 8 times for Q-band, 8 times for U-band and 4 times for V-band). This multiplied RF signal then passes through a coupler/detector (only in V and W bands) where the signal is sampled for use in an ALC loop. The RF continues through an isolator and a dual directional coupler. A portion of the incident signal is coupled off, passed through an isolator, and into a harmonic mixer, A11. The signal received at the test port (either transmitted from another test set module or reflected from a device under test) is coupled off, passed through an isolator, and into a harmonic mixer, A12. The 2-8 GHz LO signal is input from the source through the mm-wave controller. The signal is then divided and input to the harmonic mixer. In the case of W-band, the sixteenth harmonic of the LO mixes with the RF so that a 20 MHz IF frequency is output. The LO harmonic product must be 20 MHz higher in frequency than the RF signal. The IF frequencies (incident and reflected) are then output to the mm-wave controller for further processing. The mixing harmonics for other bands are; R-band: 8, Q-band: 10, U-band: 10, and V-band: 14. The isolators in the test set modules are used to keep reflections from the dual directional coupler, A8, from interfering with the source, and to keep reflections from the mixers, All and A12, from interfering with the incident and reflected RF signals.

Warranty

Refer to Chapter 1, “Getting Started” in this manual for warranty information about the HP 85104A.

Checking for Complete Shipment

Along with your HP 85104A test set modules you should also receive the following:

- 2 - Waveguide straight sections (V-band and W-band contain 3 straight sections)
- 1 - 90° Waveguide bend

Front and Rear Panel Features

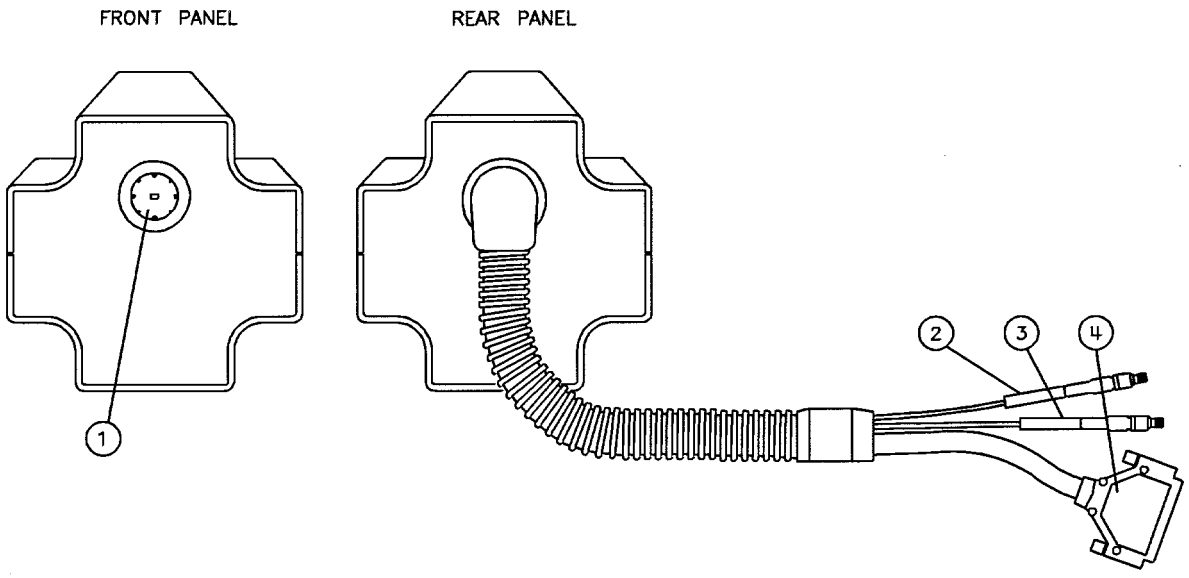


Figure 5-1 Front and Rear Panel Features of the HP 85104A (all waveguide bands)

Features and Functions

The features and functions of the test set module are described and shown below.

1. **Test Port Connector -** The RF signal enters the device-under-test through this port.
2. **LO Input Cable -** The LO signal enters the test set module from the HP 85105A through this cable.
3. **RF Input Cable -** The RF signal enters the test set module from the HP 85105A through this cable.
4. **Module Interface Cable -** The voltages and ground lines enter the test set module from the HP 85105A through this cable. Incident and reflected IF signals return to the analyzer through this cable. An ALC signal returns to the RF source through this cable.

Installing Test Set Modules and Cable Support Assembly

The test set modules and cable support assembly are configured as part of the system (see "Cable Support Assembly" on page 1-15 of this manual). Refer to "Installing Test Set Modules" on page 1-16 to configure your test set as shown in Figure 5-2.

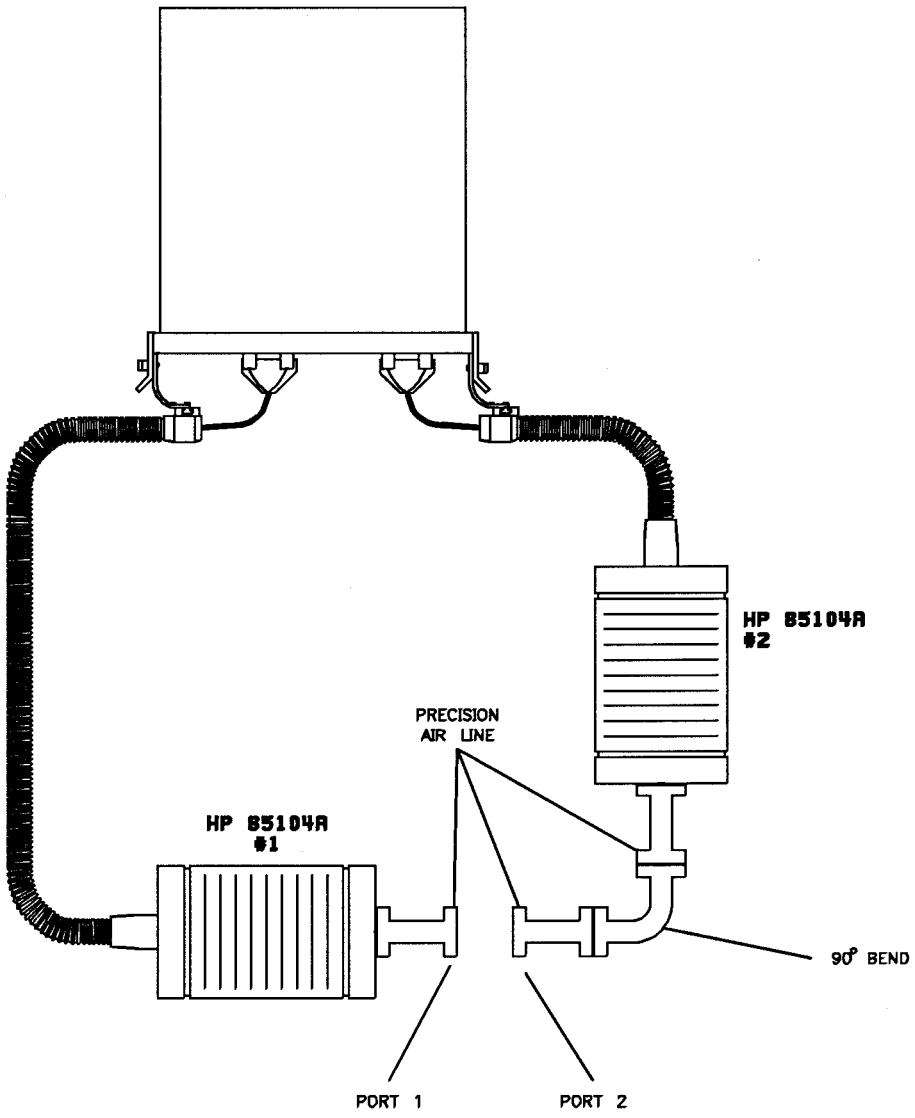


Figure 5-2 HP 85104A Test Set Module Configuration

Using the Test Set Module Stand

Attach the test set module to a stand for vertical and horizontal level adjustment. These adjustments help to align port 1 and port 2 during device testing.

Vertical Adjustment

Adjustable Feet

The adjustable feet located at each corner of the stand allow limited (approximately 13 mm (1/2 inch)) vertical adjustment. Move port 1 and port 2 together just enough to judge their relative alignment. Adjust the feet on one of the modules until both modules are aligned vertically so they can be connected together. The waveguide components must be coplanar.

Thumbwheel

The thumbwheel is on the elevator portion of the stand and allows for vertical adjustment of the module (Figure 5-3 on page 5-5**)**. The range of adjustment is approximately 31.75 mm (1.25 inch).

NOTE

Do not use the thumbwheel to raise the module beyond 38.1 mm (1 1/2 inches). The elevator assembly may disengage from the rest of the stand assembly past this dimension.

Horizontal Adjustment

Slide Lever

The slide lever locks/unlocks the test set module stands horizontal movement (see Figure 5-3 on page 5-5). The module is locked in place when the slide lever is pushed toward the rear of the module, and unlocked when the slide lever is pushed toward the front of the module. The range of horizontal adjustment is approximately 152 mm (6 inches). This adjustment is especially useful when quick setup and measurement are important and the mm-wave modules must remain stable.

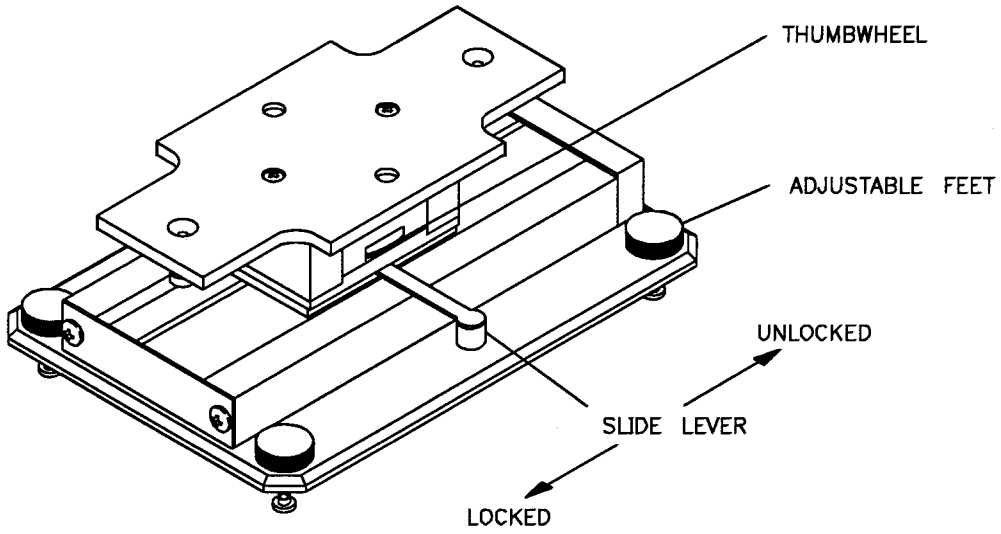


Figure 5-3 Test Set Module Stand

Removing the Test Set Module From the Stand

Follow the procedure below to remove the module from the stand:

1. Turn the power to the HP 85105A mm-wave controller OFF.
2. Disconnect the test set module from the system. Refer to Chapter 1, “Getting Started” for information about removing the cable-support assembly.
3. Turn over the module and stand. Loosen the two captive screws located on the bottom of the stand (one on each end of the stand) to disengage the module.
4. Lift the stand off the module.
5. Reverse this same procedure to attach the module to the stand.

Specifications

Specifications describe the warranted performance of the instrument. The electrical specifications of the HP 85104A when used in an HP 85106D system (rack or benchtop configuration), are defined in Chapter 3, "Performance Verification" of this manual.

Supplemental Characteristics

The supplemental characteristics listed below are intended to provide useful information by giving typical, but non-warranted, performance characteristics.

HP 85104A Supplemental Characteristics

Max RF Input Power (damage level into the test port)	>27 dBm

HP 85104A Power Requirements and Physical Characteristics

Operating Temperature:	0^{o} C to 55^{o} C
Power:	All power is supplied to the HP 85104A by the HP 85105A.
Dimensions:	
Module only	292.1 mm x 174.6 mm x 196.9 mm (11 1/2 x 7 x 13 3/4 inches) (maximum height)
Module/stand	292.1 mm x 177.8 mm x 349.3 mm (11 1/2 x 7 x 13 3/4 inches) (maximum height)
Weight (approximate):	
Module only	5.9 Kg, 13 lb
Module/stand	9.1 Kg, 20 lb

Troubleshooting Test Set Modules

The test set module troubleshooting strategy is similar to that for the HP 86106D system. Refer to Chapter 4, “Service and Troubleshooting” as necessary to determine whether your test set module is faulty.

Follow the troubleshooting flowcharts (see Figure 5-4 on page 5-9 and Figure 5-5 on page 5-10) to identify the faulty assembly. These flowcharts are keyed to numbered troubleshooting procedures. As you progress through the flowchart, perform the numbered procedure associated with each block. A block diagram of the test set module is included in this section to assist you in understanding the operation of the module.

Troubleshooting Procedures

The following troubleshooting procedures correspond to the Troubleshooting Flowcharts, (Figure 5-4 on page 5-9 and Figure 5-5 on page 5-10). The tools listed in the table below are required (but not supplied) to perform the procedures.

Table 5-1 Tools Required

Tool	Size	HP Part Number
Torx-head screwdriver	T-10	8710-1623
Torx-head screwdriver	T-8	8710-1644
Torx-head balldriver	3/32	8710-1539
Pozidriv screwdriver	1 pt	8710-0899
Open-end wrench	5/16 inch	8720-0015
ESD Grounding Supplies		
Wrist strap		9300-1383
Conductive mat		9300-0797

WARNING

Attention electrostatic discharge sensitive.
Handle only at static safe work stations.
The test set modules are extremely sensitive to electrostatic discharge (ESD).
Ground your work station and yourself before handling these instruments.

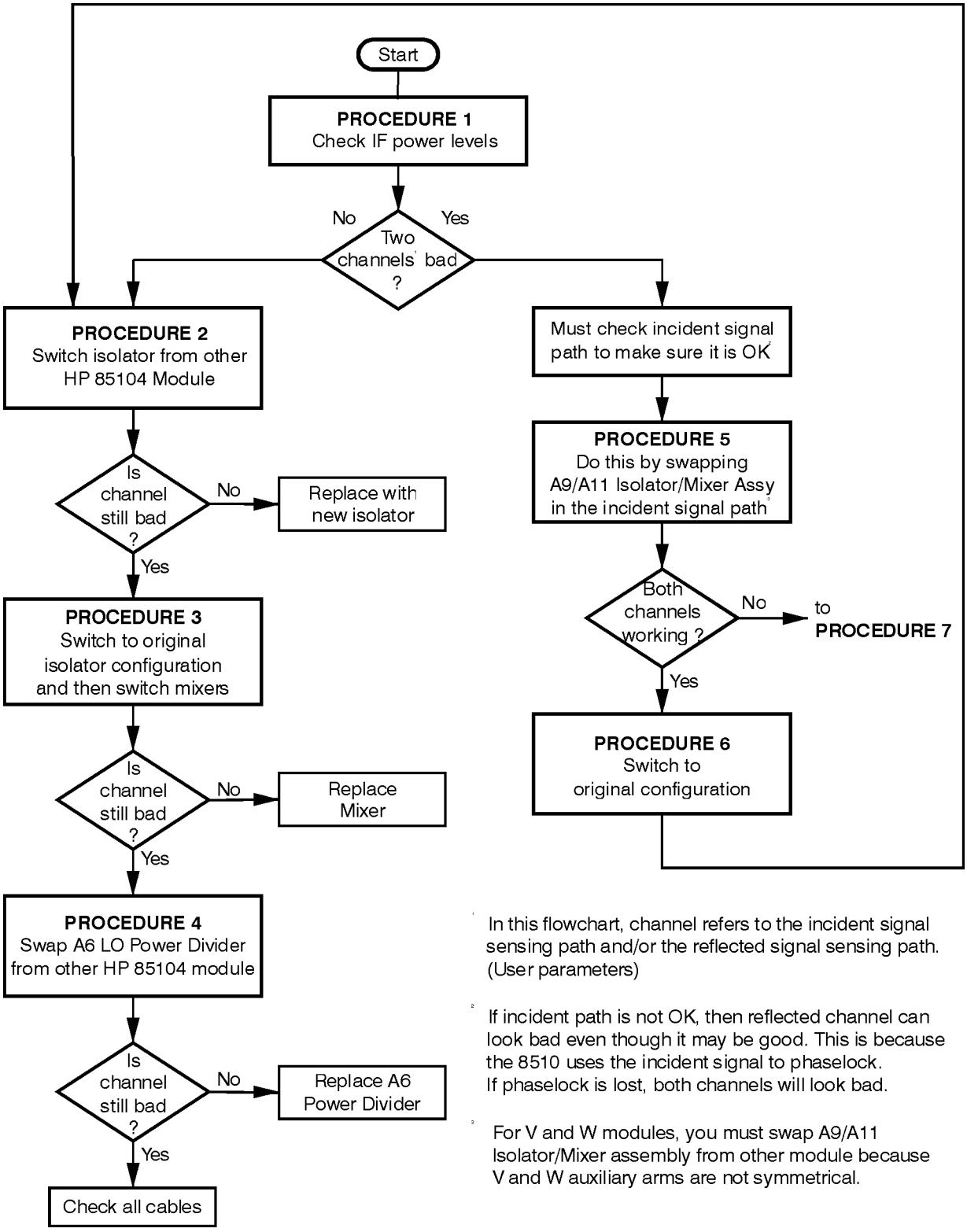


Figure 5-4 HP 85104A Troubleshooting Flowchart (1 of 2)

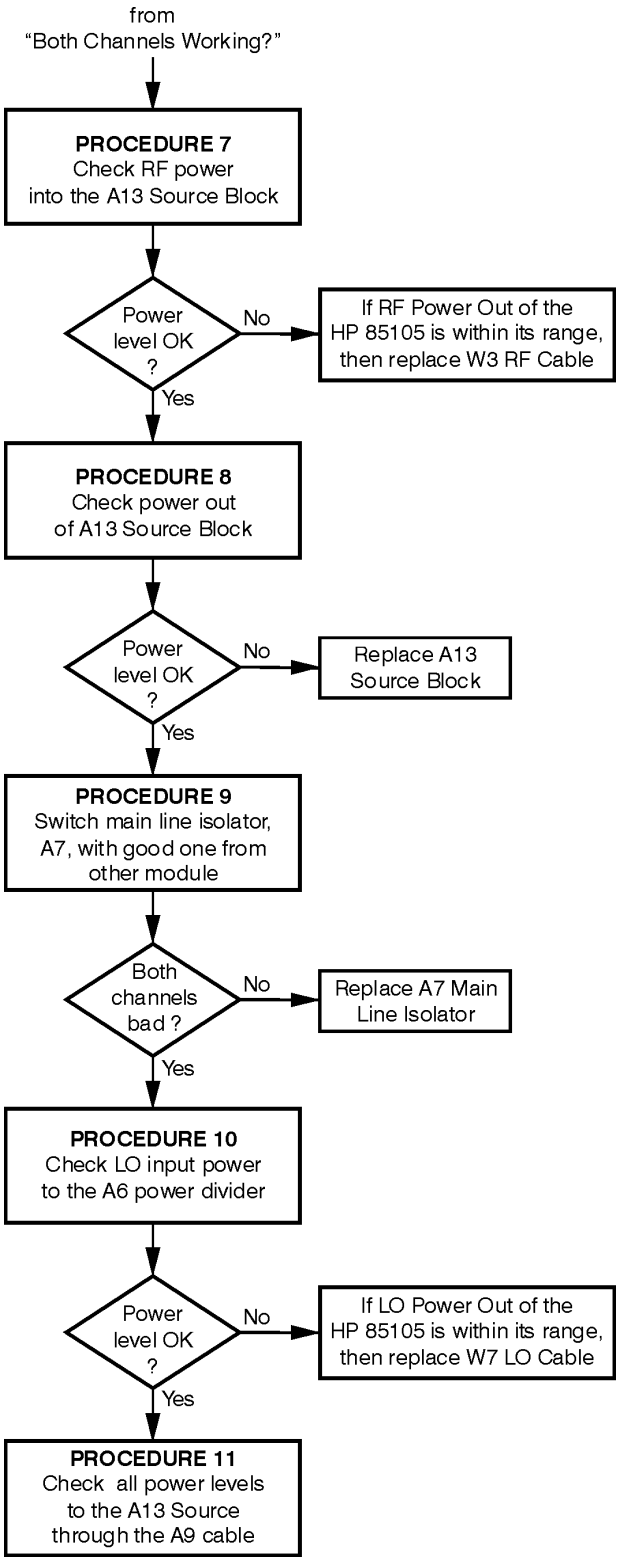


Figure 5-5 HP 85104A Troubleshooting Flowchart (2 of 2)

Check IF Power Level — Procedure 1

1. Check the unratioed power levels (user parameters) of a1, b1, a2, and b2.
2. Press PARAMETER [**MENU**]
3. Press {***USER 1***} through {***USER 4***}.

Refer to the table below for approximate power levels for the band you are using. Attach a short circuit to the module when you are checking b_1 or b_2. Power levels are measured using the configuration tape or disk RF levels.

Table 5-2 IF Power Levels

Parameter	Q-band[1] (WR-22)	U-band[1] (WR-19)	V-band[1] (WR-15)	W-band[1] (WR-10)
al USER1	-13 dB	-13 dB	-26 dB	-27 dB
b2 USER2	-15 dB	-15 dB	-27 dB	-28 dB
a2 USER3	-13 dB	-13 dB	-26 dB	-26 dB
bl USER4	-15 dB	-15 dB	-27dB	-28 dB

1. These values are approximate. The power levels may vary as much as ±4 dB across the band.

Switching Isolators (A7, A9, or A10)

Procedure 2

Before beginning this procedure, turn the power to the HP 85105A mm-wave controller OFF. Disconnect the cables from the HP 85104A to the HP 85105A.

Refer to the step references in Figure 5-11 on page 5-32**.**

1. Disassemble the test-set module beginning with the following four steps:
   a. Invert the test set module so that the bottom side is facing up. Remove the stand by loosening the two captive screws until the module and stand are disengaged.
   b. Remove all extensions from the HP 85104 test set modules.
   c. Remove the two torx-head screws from the bottom housing. Pull the bottom housing off.
   d. Slide the front panel up and out. Cut and remove any cable ties as needed.
2. Disconnect the suspect isolator (Step 15) at the coupler interface and at the mixer interface.
3. Loosen the four mixer-bracket screws (Step 14) and slide the isolator out of the assembly.
4. Replace the suspect isolator with a known good isolator (possibly from the other test set module). Be sure to use correct waveguide connection techniques (refer to “Waveguide Connections” on page 2-9 for connection procedures).

NOTE

You must exchange the suspect isolator with an isolator from the same auxiliary arm position.

5. Reconnect the cables from the HP 85104A to the HP 85105A. Turn the HP 85105A ON. Recheck the unratioed power levels (refer to “Procedure 1” on page 5-11).
6. Return to the troubleshooting flowchart.

Switching Mixers (A11, A12)

Procedure 3

Before beginning this procedure, turn power to the HP 85105A mm-wave controller OFF. Disconnect the HP 85104A from the HP 85105A. This procedure assumes that the isolators are located in their original modules.

Refer to the step references in Figure 5-11 on page 5-32**.**

1. Remove the IF and LO cables from the mixer inputs (Step 7 and Step 13).
2. Disconnect the isolator at the mixer interface (Step 15 and Step 16).
3. Remove the mixer bracket (Step 14).
4. Replace the mixer with the mixer from the opposite auxiliary arm or with a mixer from another test set module.
5. Attach the new mixer to the isolator and connect the IF and LO input cables. Be sure to use correct waveguide connection techniques (refer to "Waveguide Connections" on page 2-9 for waveguide connection information).
6. Connect the mixer clamp.
7. Reconnect the cables from the HP 85104A to the HP 86105A. Turn the HP 85105A ON. Recheck the unratioed power levels (refer to "Procedure 1" on page 5-11).
8. Return to the troubleshooting flowchart.

Swapping the Power Divider (A6)

Procedure 4

Before beginning this procedure, turn the HP 85105A mm-wave controller power OFF. Disconnect the HP 85104A from the HP 85105A.

Refer to the step references in Figure 5-11 on page 5-32**.**

1. Disassemble the test-set module using the following four steps:
   a. Invert the test set module so that the bottom side is facing up. Remove the stand by loosening the two captive screws until the module and stand are disengaged.
   b. Remove all extensions from the HP 85104 test set modules.
   c. Remove the two torx-head screws from the bottom housing. Pull the bottom housing off.
   d. Slide the front panel up and out. Cut and remove any cable ties as needed.
2. Disconnect the LO IN and LO OUT cables from the power divider (Step 18).
3. Remove the two screws from the power divider (Step 17) using the T-8 torx-head screw driver. Slide the power divider out of the assembly.
4. Replace the power divider with a known good power divider (possibly from the other test set module).
5. Reattach the LO IN and LO OUT cables to the power divider.
6. Reconnect the cables from the HP 85104A to the HP 85105A. Turn the HP 85105A ON. Recheck the unratioed power levels (refer to "Procedure 1" on page 5-11).
7. Return to the troubleshooting flowchart.

Removing the Incident or Reflected Isolator/Mixer Assemblies

Procedure 5

Before beginning this procedure, turn the power to the HP 85105A mm-wave controller OFF. Disconnect the HP 85104A from the HP 85105A.

Refer to the following step references in Figure 5-11 on page 5-32.

Disassemble the test-set module using the following four steps:

a. Invert the test set module so that the bottom side is facing up. Remove the stand by loosening the two captive screws until the module and stand are disengaged.

b. Remove all extensions from the HP 85104 test set modules.

c. Remove the two torx-head screws from the bottom housing. Pull the bottom housing off.

d. Slide the front panel up and out. Cut and remove any cable ties as needed.

1. Disconnect the LO IN and LO OUT cables from the power divider (Step 13).
2. Disconnect the mixer bracket from A11, or A12 mixer (incident signal path near left-hand Step 14; reflected signal path near right-hand Step 14).
3. Disconnect A9 or A10 isolator at the coupler interface (incident signal path near left-hand Step 15; reflected signal path near right-hand Step 15.)
4. Slide the isolator/mixer assembly out of the module and replace it with a known good incident arm assembly from another test set module.
5. Reattach the isolator to the coupler. Be sure to use correct waveguide connection techniques. Refer to Chapter 2, “Operation” of this manual.
6. Reattach the LO IN and LO OUT cables to the mixer.
7. Reconnect the cables from the HP 85104A to the HP 85105A. Turn the HP 85105A ON. Recheck the unratioed power levels (refer to “Procedure 1” on page 5-11).
8. Return to the troubleshooting flowchart.
9. Repeat Procedure 5 to return the A9/A11 or A10/A12 assembly to their original module.

Check the RF Power into A13 Source Block

Procedure 6

The following equipment is required to perform this procedure:

- Power Meter HP 463A
- Power Sensor HP 8485A

Before beginning this procedure, turn the HP 85105A mm-wave controller power OFF. Disconnect the HP 85104A from the HP 85105A. Refer to step references in Figure 5-11 on page 5-32**.**

1. Disassemble the test-set module using the following four steps:
   a. Invert the test set module so that the bottom side is facing up. Remove the stand by loosening the two captive screws until the module and stand are disengaged.
   b. Remove all extensions from the HP 85104 test set modules.
   c. Remove the two torx-head screws from the bottom housing. Pull the bottom housing off.
   d. Slide the front panel up and out. Cut and remove any cable ties as needed.
2. Remove the RF cable from the 90° coaxial bend and connect the RF cable to the power sensor.
3. Reconnect the cables from the HP 85104A to the HP 85105A. Turn the HP 85105A ON. The measured power level displayed on the power meter should be within the value listed in Table 5-3**.**
4. Return to the troubleshooting flowchart.

Table 5-3 RF Power Into the A13 Source Block

All Bands
> +13 dBm

Check the RF Power Out of A13 Source Block

Procedure 7

The following equipment is required to perform this procedure:

Equipment Required	Q-band	U-band	V-band	W-band
Power Meter	HP 436A	Anritsu ML83A	Anritsu ML83A	HP 436A HP 436B HP 438A
Power Sensor	HP Q8486A	Anritsu MP715A-004	Anritsu MP716A	HP W8486A

Before beginning this procedure, turn the HP 85105A mm-wave controller power OFF. Disconnect the HP 85104A from the HP 85105A. Refer to step references in Figure 5-11 on page 5-32.

1. Disassemble the test-set module using the following four steps:
   a. Invert the test set module so that the bottom aide is facing up. Remove the stand by loosening the two captive screws until the module and stand are disengaged.
   b. Remove all extensions from the HP 85104 test set modules.
   c. Remove the two torx-head screws from the bottom housing. Pull the bottom housing off.
2. Disconnect the LO IN and LO OUT cables from the power divider (Step 13).
3. Remove the two screws from the power divider to remove the power divider (Step 17).
4. Disconnect the main line isolator (A7, Step 18) from the source and coupler interfaces.
5. Connect the power sensor to A13 module assembly output as shown in Figure 5-6 on page 5-18.

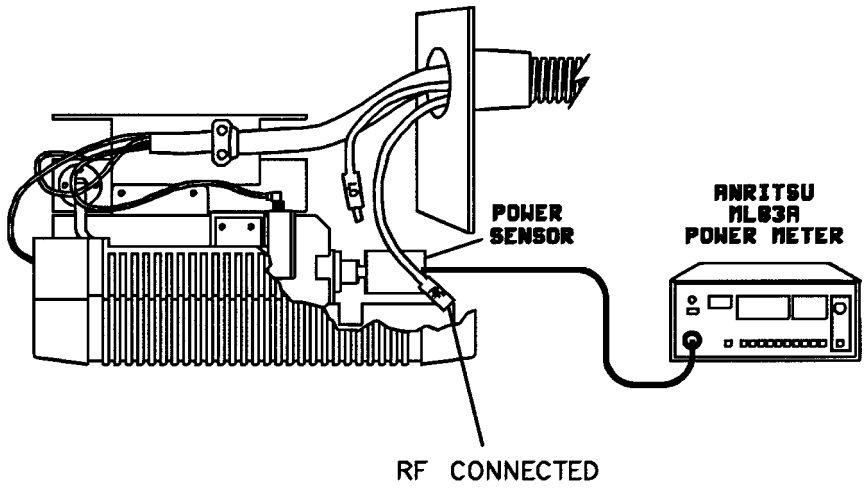


Figure 5-6 Power Level Test Setup

NOTE

It may be necessary to connect a waveguide straight section to the end of the power sensor to reach the A13 output.

6. Reconnect the cables from the HP 85104A to the HP 85105A. Turn the HP 85105A ON. Read the power level on the power meter. Refer to the Table 5-3 on page 5-16 for the correct power level of the band you are using.
7. Reverse the steps in this procedure to reassemble the test set module.
8. Return to the troubleshooting flowchart.

Table 5-4 RF Power Out of the A13 Source Block

Band (GHz)	Power Level (dBm)
33 to 50 (Q-band)	>3
40 to 60 (U-band)	>3
50 to 75 (V-band)	>3
75 to 110 (W-band)	>0

Switch the Main Line Isolator

Procedure 8

Before beginning this procedure, turn the HP 85105A mm-wave controller power OFF. Disconnect the HP 85104A from the HP 85105A.

Refer to step references in Figure 5-11 on page 5-32**.**

1. Disassemble the test set module using the following four steps:
   a. Invert the test set module so that the bottom side is facing up. Remove the stand by loosening the two captive screws until the module and stand are disengaged.
   b. Remove all extensions from the HP 85104 test set modules.
   c. Remove the two torx-head screws from the bottom housing. Pull the bottom housing off.
   d. Slide the front panel up and out. Cut and remove any cable ties as needed.
2. Disconnect the LO IN and LO OUT cables from the power divider (Step 13).
3. Disconnect the mixer bracket from A11, or A12 mixer (incident signal path near left-hand Step 14; reflected signal path near right-hand Step 14).
4. Disconnect A9 or A10 isolator at the coupler interface (incident signal path near left-hand Step 15; reflected signal path near right-hand Step 15.)
5. Slide the isolator/mixer assembly out of the module and replace it with a known good incident arm assembly from another test set module.
6. Replace the suspect isolator with a known good isolator, possibly from the other test set module.
7. Reattach the LO power divider by replacing the two screws and reconnecting the LO IN and LO OUT cables.
8. Reconnect the cables from the HP 85104A to the HP 85105A. Turn the HP 85105A ON. Recheck the unratioed power levels (refer to “Procedure 1” on page 5-11).
9. Return to the troubleshooting flowchart.

Check LO Input to Power Divider A6

Procedure 9

The following equipment is required to perform this procedure:

- Power Meter HP 436A
- Power Sensor HP 8485A

Before beginning this procedure, turn the HP 85105A mm-wave controller power OFF. Disconnect the HP 85104A from the HP 85105A.

Refer to step references in Figure 5-11 on page 5-32.

Disassemble the test set module using the following four steps:

1. Invert the test set module so that the bottom side is facing up. Remove the stand by loosening the two captive screws until the module and stand are disengaged.
2. Remove all extensions from the HP 85104 test set modules.
3. Remove the two torx-head screws from the bottom housing. Pull the bottom housing off.
4. Slide the front panel up and out. Cut and remove any cable ties as needed.
5. Disconnect W7, LO cable assembly from the 90° bend of the power divider.
6. Connect W7 to the HP 8485A power sensor.
7. Reconnect the HP 85104A to the HP 85105A. Turn the HP 85105A ON. Read the power level displayed on the power meter. Refer to Table 5-5 for the correct power level in the band you are using.
8. Return to the troubleshooting flowchart.

Table 5-5 Power Divider LO Input Level

All Bands
> 19 dBm

Check All Voltages to A13 Source Block

Procedure 10

1. Refer to “Module Interface Adapter” on page 6-8.

The voltages on the front panel of the HP 85105A mm-wave test set controller are the same ones that enter the HP 85104A, A13 source block, via the black interface connector on the A5 board assembly (part of A18 source block assembly).

2. Return to the troubleshooting flowchart.

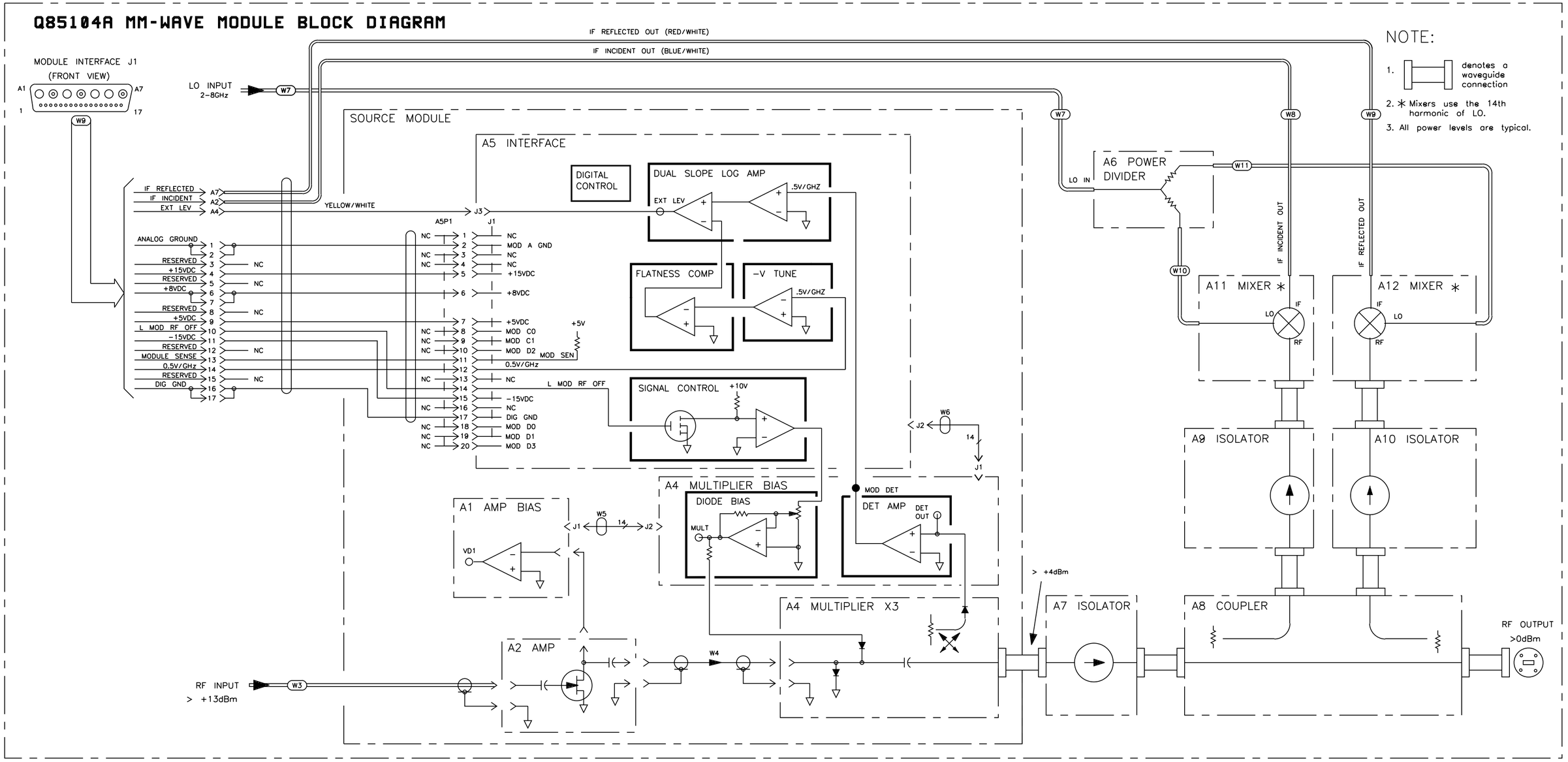


Figure 5-7. HP Q85104A Block Diagram

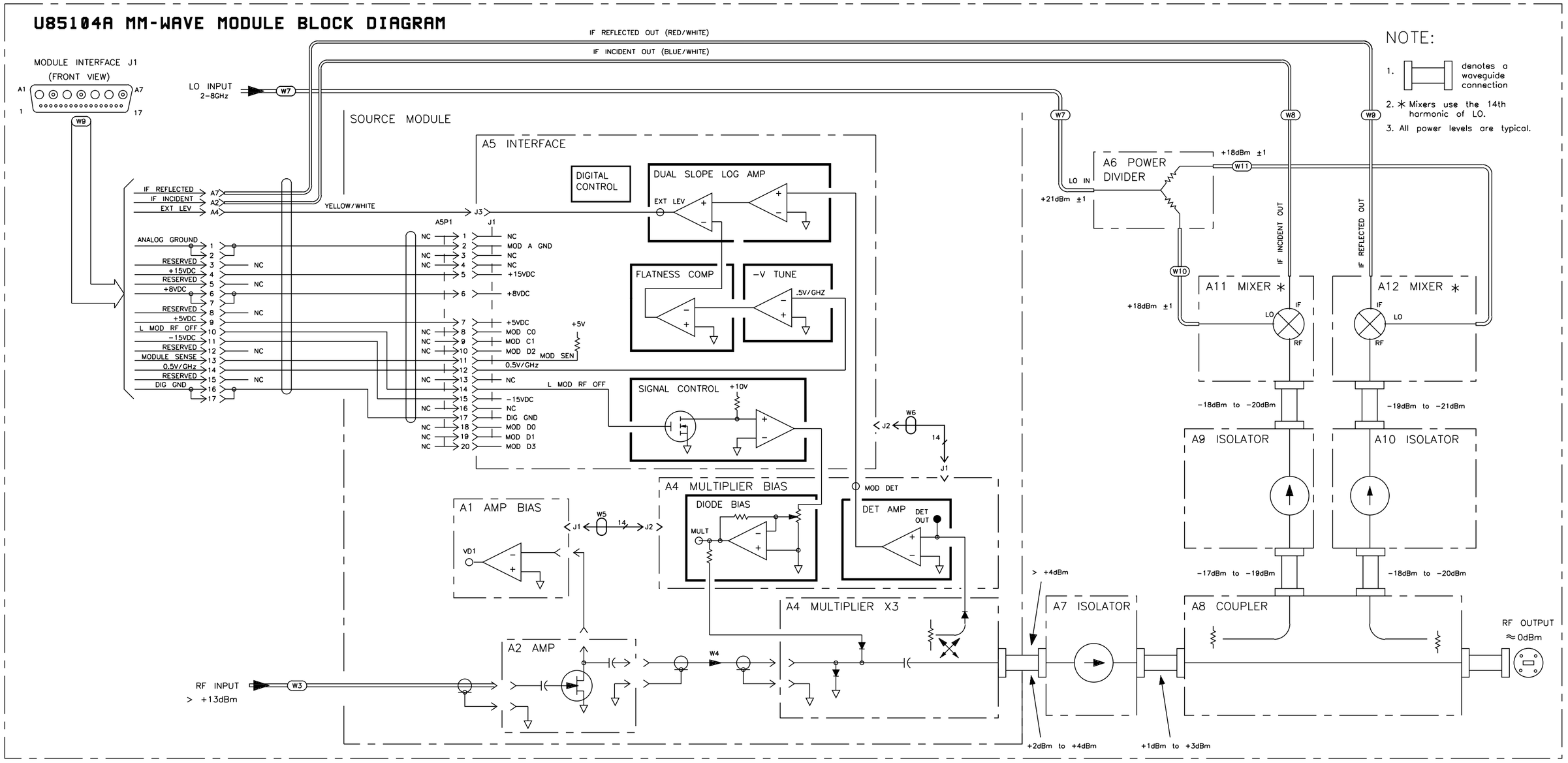


Figure 5-8. HP U85104A Block Diagram

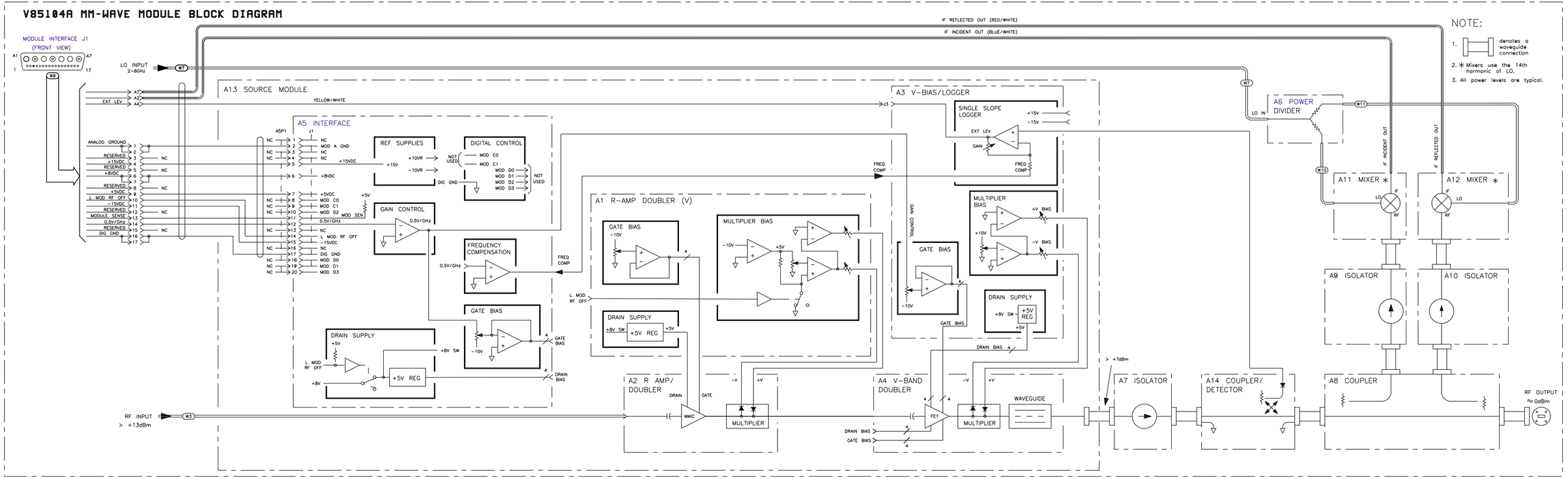


Figure 5-9. HP V85104A Block Diagram

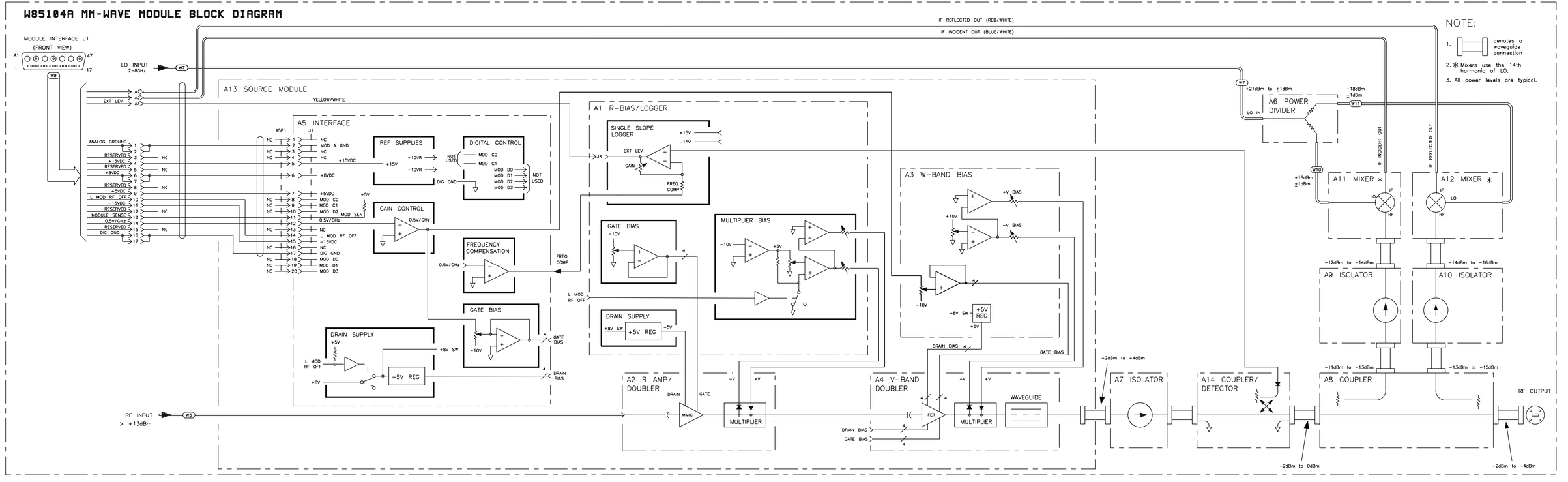


Figure 5-10. HP W85104A Block Diagram

Disassembly Procedure

Use the procedure in this section to completely disassemble a test set module. Notes are made for differences between the different frequency band modules. Follow the procedure and stop at the disassembly level needed for your repair.

The step numbers in the following procedure correspond with the STEP numbers in Figure 5-11 on page 5-32.

Table 5-6 Disassembly Tools Required

Tool	Size	HP Part Number
Torx-head screwdriver	T-10	8710-1623
Torx-head screwdriver	T-8	8710-1644
Hex-head balldriver	3/32	8710-1539
Pozidriv screwdriver	1 pt	8710-0899
Wire cutter	N/A	8710-0012
Open-end wrench	5/16	8710-0015
Wrist Strap	N/A	9300-1383
Conductive Mat	N/A	9300-0797

WARNING

Electrostatic discharge sensitive.
Handle only at static safe work stations.
The test set modules are extremely sensitive to electrostatic discharge (ESD).
Ground your work station and yourself before handling these instruments.

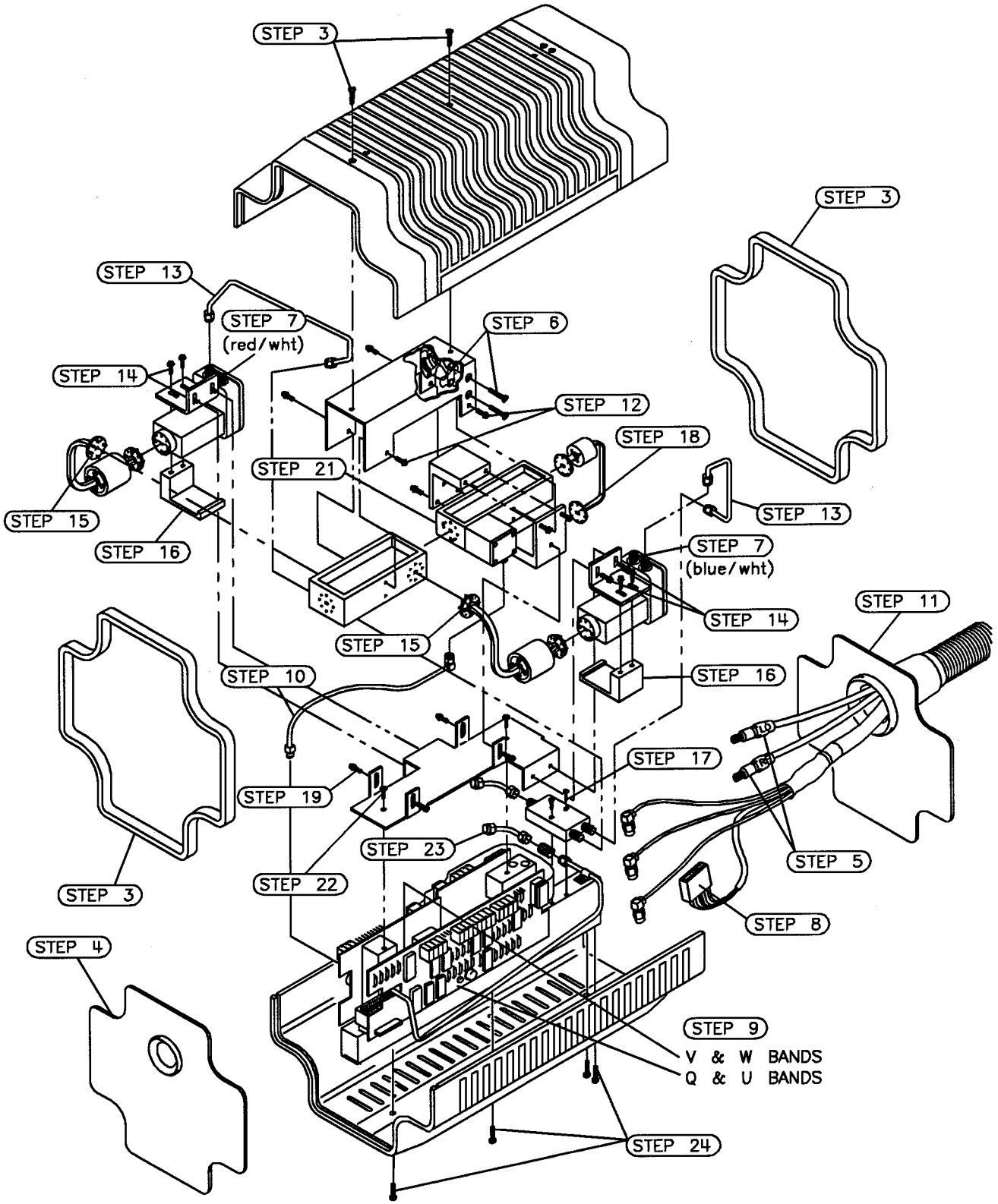


Figure 5-11 HP 85104A Disassembly Procedure

Procedure

NOTE

The disassembly procedure *must* be followed in sequence. It is not the reverse of the assembly procedure.

1. Turn the test set module over so the bottom side is facing up. Remove the stand by loosening the two captive screws until the module and stand are disengaged.
2. Remove all extensions from the HP 85104A.
3. Remove the two torx-head screws from the bottom housing and pull the bottom housing off.
4. Slide the front panel up and out. Cut and remove the cable ties.
5. Disconnect the RF and LO cables from the 90° coaxial bends that are connected to the main top mount (near the power divider).
6. Remove the cable clamp.
7. Disconnect the IF cabling (red/white and blue/white) from the mixers.
8. Disconnect the module interface connector from the A5 board, (part of A13 source block).
9. Disconnect the ALC cable yellow/white) from the A5 board.

NOTE

In some modules the ALC cable may not be accessible at this time. Remove this cable when it becomes accessible.

10. For V-or W-band modules, disconnect the detector cable from the A5 board (part of A13 source block). Leave the A5 cable connected to A14 detector.

NOTE

The coupler/detector (A14) and the source block (A13) must be returned to the factory together (attached with two screws) if either component is faulty.

11. Remove the rear panel/cable assembly.
12. Remove the hex-head screws from the bottom mount and remove the mount.
13. Remove the semi-rigid coaxial cables from the LO power divider to the mixers.
14. Remove the four mixer bracket screws and remove the mixer bracket from both sides of the source block.

15. Disconnect the isolator mixer assembly arms by removing the screws from the flange at the coupler interface.
16. Remove the mixer clamp.
17. Remove the two torx-head screws (size T-8) from the LO power divider and remove the power divider.
18. Disconnect the main line isolator arm at the source interface by removing the 4 hex-head screws from the flange.
19. Remove the hex-head screws from the coupler bracket.
20. Slide the coupler/isolator assembly to the rear of the instrument and remove it.
21. For V-or W-band modules, remove A14 coupler/detector from A8 dual directional coupler.

NOTE

The coupler/detector (A14) and the source block (A13) must be returned to the factory together (attached with two screws) if either component is faulty.

22. Remove the torx-head screws from the coupler bracket and remove the bracket.
23. Remove the 90° coaxial bend from the RF cable near the RF clamp on the source block.
24. Turn the source block over and remove the four torx-head screws from the top housing.
25. Remove the source module assembly which includes the aluminum bar mount to complete the disassembly procedure for the HP 85104A test set module. Refer to the assembly procedure that follows to reassemble the test set module.

Assembly Procedure

Use the assembly procedure in this section to completely assemble a test set module. Notes are made in the procedure for differences between the different frequency banded modules. Follow the procedure in the order given, starting at the step number needed for your repair.

The step numbers correspond to the numbers in Figure 5-12 on page 5-36**.** Refer to this figure as you assemble the test set module.

Table 5-7 Tools Required

Tool	Size	HP Part Number
Torx-head screwdriver	T-10	8710-1623
Torx-head screwdriver	T-8	8710-1644
Hex-head balldriver	3/32	85104-20035
Pozidriv screwdriver	1 pt	8710-0899
Cable Ties	N/A	1400-0249

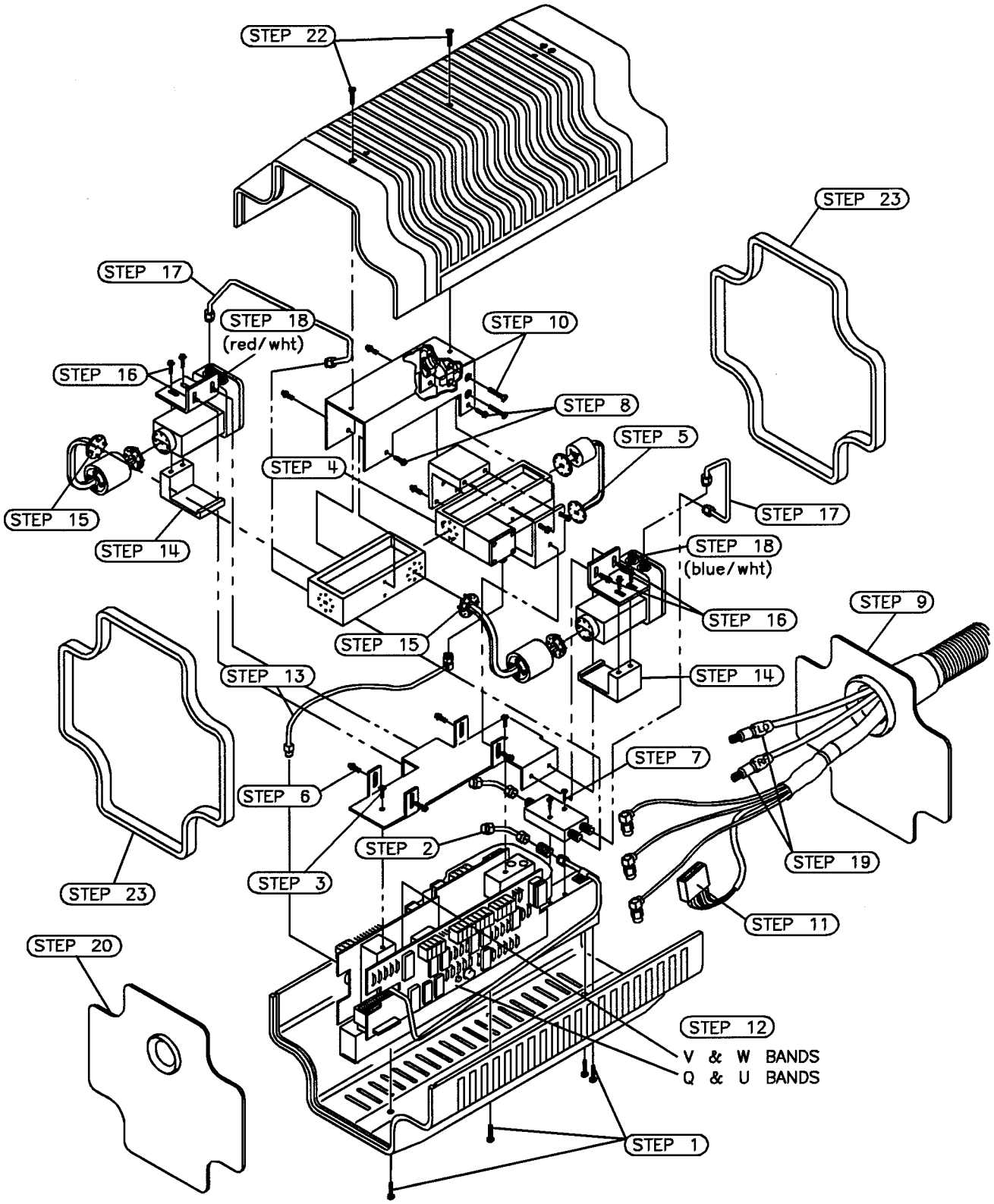


Figure 5-12 HP 85104A Assembly Procedure

Procedure

NOTE

The assembly procedure must be followed in sequence; it is not the reverse of the disassembly procedure.

1. Put the source block inside the top housing and insert four torx-head screws on the outside of the top housing.
2. Connect the 90° coaxial bend to the semi-rigid cable on the top mount of the source block.
3. Place the coupler bracket on the A13 assembly and attach it with torx-head screws.
4. Connect the coupler/detector (A14) to the dual directional coupler (A8).
5. Using the guide pins, align the flange of the coupler/isolator assembly with the flange of the source block. Hold the mating surfaces in contact while engaging the first few threads of each screw (use four long hex-head screws). Follow the standard flange connection technique as outlined in Chapter 1, “Getting Started” and Chapter 2, “Operation” of this manual.

NOTE

You may have to hold the opposite end of the coupler higher in order to mate the surfaces of the isolator and source module block.

6. Once a good connection has been made at the source/coupler interface, insert the hex-head coupler bracket screws.
7. Position the LO power divider on the source block with the input port towards the right aide of the instrument (referenced from the front of the instrument). Use the screw holes toward the right side of the instrument on the source block to attach the LO power divider.
8. Attach the bottom mount to the coupler using hex-head screws.
9. Slide the rear panel/cable assembly into the grooves of the top housing.
10. Connect the cable clamp around the main interface cable and screw the clamp to the right side of the coupler bracket.
11. Attach the module interface connector to A5.
12. Attach the ALC cable (yellow/white) to A5.
13. For V-and W-bands, attach the coupler/detector cable (W13).
14. Place a mixer clamp on each side of the housing across from the coupler bracket side mount.

15. Attach a mixer/isolator assembly to each mixer clamp by aligning the isolator flange with the coupler interface (use the guide pins). Follow the waveguide connection procedure in step 5 of this procedure to connect the flanges.
16. Attach a mixer bracket to each mixer using two screws on the mixer clamp and two screws on the coupler bracket.
17. Attach the semi-rigid coaxial cables from the LO power divider to the mixers; W10 to the left mixer and W11 to the right mixer.
18. Attach the IF cables to the mixers (red/white to the incident mixer and blue/white to the reflected mixer).
19. Attach the RF and LO cables (part of the rear panel/cable assembly) to the coaxial elbows on the top mount.
20. Slide the front panel into the groove of the top housing.

NOTE

The grommet in the front panel should move freely after the bottom housing is tightened down.

21. Attach the long flexible cables to a bracket or piece of waveguide with a cable tie.
22. Attach the bottom housing using two torx-head screws.
23. Attach the stand to the module by aligning the two captive screws with the module and tightening them. Refer to Chapter 1, “Getting Started” for the procedure to attach the stand.
24. To complete the assembly procedure, reattach the test port extensions (straight sections and bends) to the test port.

NOTE

Perform the operator's check for the HP 85106D system located in Chapter 2, “Operation” of this manual. If the unit is working, a performance verification should be done to assure that the system is operating within its specifications. Refer to Chapter 3, “Performance Verification” in this manual for information.

Replaceable Parts

This section contains information about ordering replaceable parts for the HP 85104A test set module. Figures 5-12 through 5-16 list the replaceable parts in reference designator order.

Ordering Information

To order a part listed in this section:

- Quote the Hewlett-Packard part number
- Indicate the quantity required
- Address your order to the nearest Hewlett-Packard Sales and Service Office.

Refer to the listing of the offices at the front of this manual.

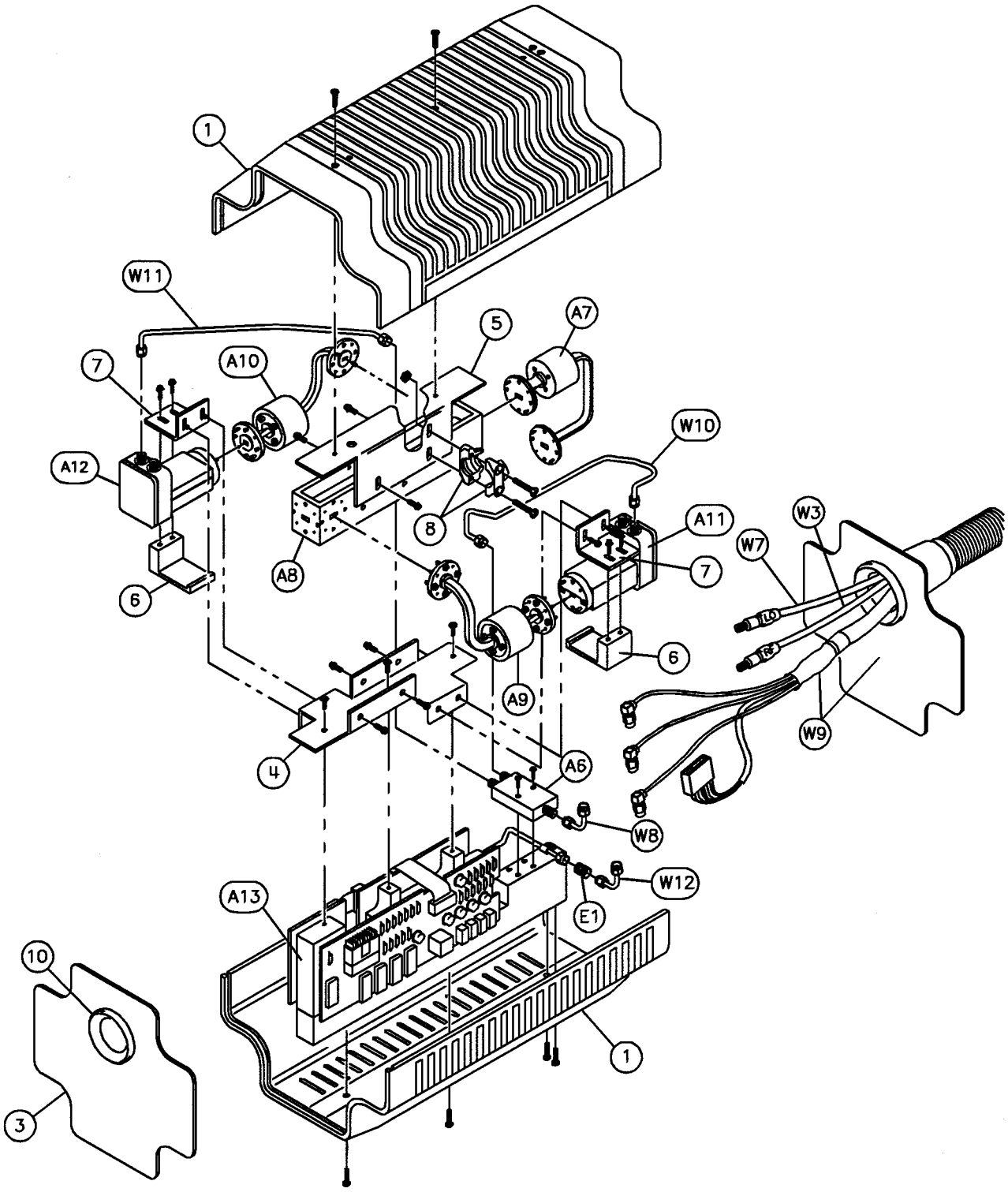


Figure 5-13 HP Q85104A Replaceable Parts

Table 5-8 HP Q85104A Replaceable Parts List

Reference Designator	Qty	Description	HP Part Number
1	2	Housing	85104-20001
3	1	Front Panel	85104-00001
4	1	Coupler Bracket	85104-00009
5	1	Bottom Mount	85104-00007
6	2	Mixer Clamp	85104-20020
7	2	Mixer Bracket	85104-00008
8	1	Cable Clamp	85104-20019
10	1	Front Panel Grommet	0400-0366
A6	1	Power Divider	0955-0264
A7	1	Isolator	85104-60022
A8	1	Dual Directional Coupler	85104-60021
A9	1	Incident Isolator	85104-60038
A10	1	Reflected Isolator	85104-60038
A11	1	Incident Mixer	11643-60028
A12	1	Reflected Mixer	11643-60028
A13	1	Q-band Module Assy	85104-60011
E1	1	ADPT F SMA F SMA	1250-1158
W3	1	RF Cable Assembly	85104-60016
W7	1	LO Cable Assembly	85104-60017
W8	1	RF Cable (90^{o} bend)	85104-20021
W9	1	Interconnect Cable Assy (rear panel)	85104-60015
W10	1	Incident LO Input Cable	85104-20004
W11	1	Reflected LO Input Cable	85104-20005
W12	1	RF Cable (90^{o} bend)	85104-20021
		CABLE SUPPORT ASSEMBLY	
	1	Bracket	85104-00018
	1	Clamp	85104-20037
	1	Barrel	85104-20038

Table 5-8 HP Q85104A Replaceable Parts List (Continued)

Reference Designator	Qty	Description	HP Part Number
	1	Dovetail - F	85104-20039
	1	Dovetail - M	85104-20040
		HARDWARE	
	10	SMM 3.0 10 PN TX	0515-0373
	2	SMM 2.5 16 PN TX	0515-2007
	3	SM 440 1.000 PNPD	2200-0155
	8	SM 632.312 PNPD	2360-0115
	23	SS 440.375	3030-0221
	27	WSHR LK.115D 4	2190-0030
	1	Nut-Hex 4-40	2260-0009
	27	WSHR FL.125D 4	3050-0105
		MISCELLANEOUS	
	2	Waveguide Straight, 5 cm (Q896B)	11644-60017
	1	90^{0} Waveguide Bend	85104-60034
	1	Ball Driver	8710-1539
		PARTS NEEDED BUT NOT SUPLIED	
	1	Pozi Screwdriver, 1	8710-0899
	1	Torx Screwdriver, 10	8710-1623
	1	Torx Screwdriver, 8	8710-1644
	1	Open-end Wrench 5/16	8720-0015
	1	Wrist Strap	9300-1383
	1	Conductive Mat	9300-0797

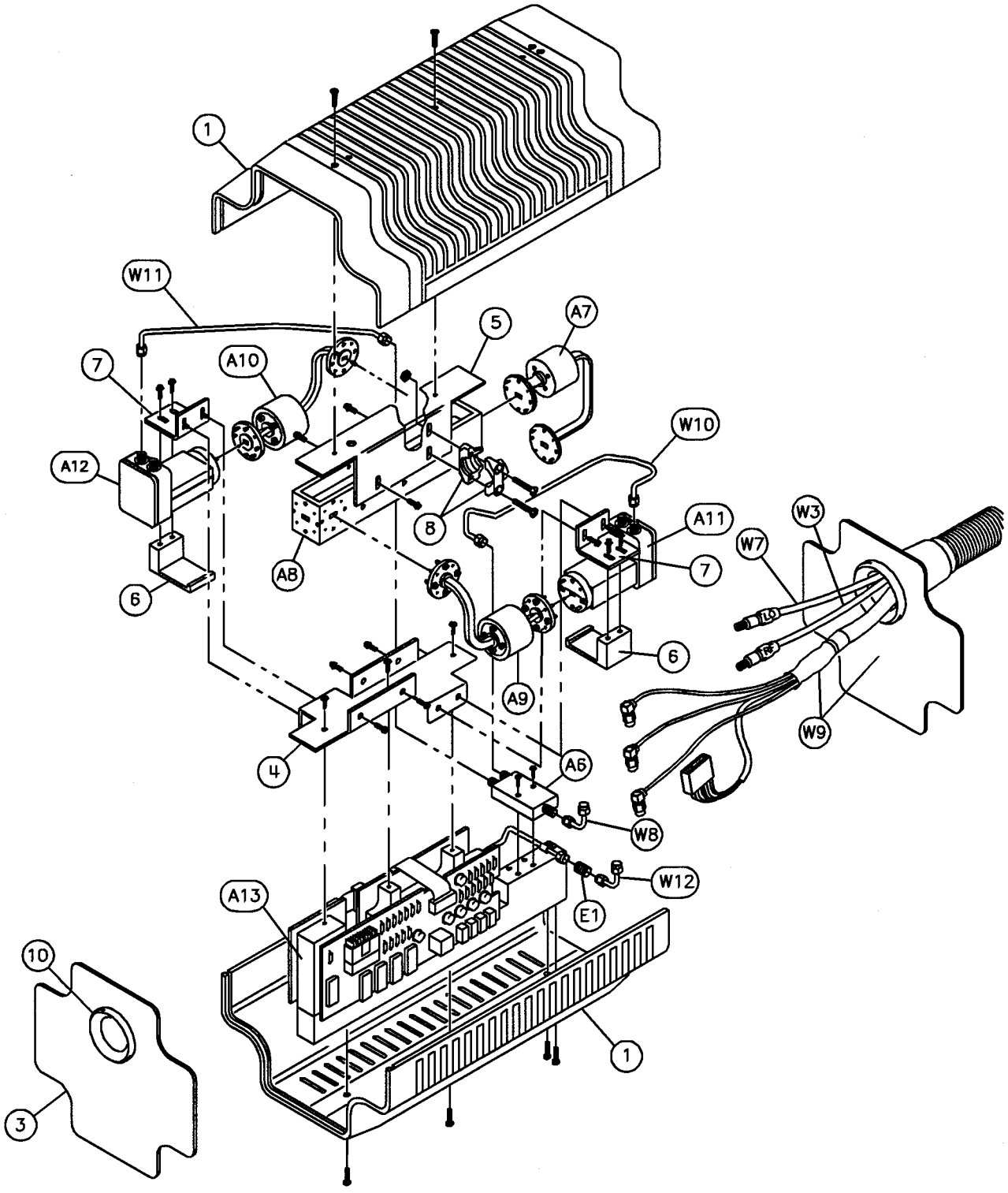


Figure 5-14 HP U85104A Replaceable Parts

Table 5-9 HP U85104A Replaceable Parts List

Reference Designator	Qty	Description	HP Part Number
1	2	Housing	85104-20001
3	1	Front Panel	85104-00002
4	1	Coupler Bracket	85104-00009
5	1	Bottom Mount	85104-00007
6	2	Mixer Clamp	85104-20020
7	2	Mixer Bracket	85104-00008
8	1	Cable Clamp	85104-20019
10	1	Front Panel Grommet	0400-0366
A6	1	Power Divider	0955-0264
A7	1	Insulator	85104-60019
A8	1	Dual Directional Coupler	85104-60018
A9	1	Incident Isolator	85104-60039
A10	1	Reflected Isolator	85104-60039
A11	1	Incident Mixer	11643-60029
A12	1	Reflected Mixer	11643-60029
A13	1	U-band Source Module Assembly	85104-60012
E1	1	ADPT F SMA F SMA	1250-1158
W3	1	RF Cable Assembly	85104-60016
W7	1	LO Cable Assembly	85104-60017
W8	1	RF Cable (90^{o} bend)	85104-20021
W9	1	Interconnect Cable Assembly (rear panel)	85104-60015
W10	1	Incident LO Input Cable	85104-20008
W11	1	Reflected LO Input Cable	85104-20009
W12		RF Cable 90^{o} Bend	85104-20021
		CABLE SUPPORT ASSEMBLY	
	1	Bracket	85104-00018
	1	Clamp	85104-20037
	1	Barrel	85104-20038

Table 5-9 HP U85104A Replaceable Parts List (Continued)

Reference Designator	Qty	Description	HP Part Number
	1	Dovetail F	85104-20039
	1	Dovetail M	85104-20040
		HARDWARE	
	10	SMM 3.0 10 PN TX	0515-0373
	2	SMM 2.5 16 PN TX	0515-2007
	2	SM 440 1.000 PNPD	2200-0155
	8	SM 632.312 [M[D	2360-0115
	23	SS 440.375	3030-0221
	27	WSHR LK.115D 4	2190-0030
	1	Nut-Hex 4-40	2260-0009
	27	WSHR FL.125D 4	3050-0105
		MISCELLANEOUS	
	2	Waveguide Straight, 5 cm (U896B)	11644-60018
	1	90^{O} Waveguide Bend	85104-60034
	1	Ball Driver	8710-1539
		PARTS NEEDED BUT NOT SUPPLIED	
	1	Pozi Screwdriver, 1	8710-0899
	1	Torx Screwdriver, 10	8710-1623
	1	Torx Screwdriver, 8	8710-1644
	1	Open-end Wrench 5/16	8720-0015
	1	Wrist Strap	9300-1383
	1	Conductive Mat	9300-0797

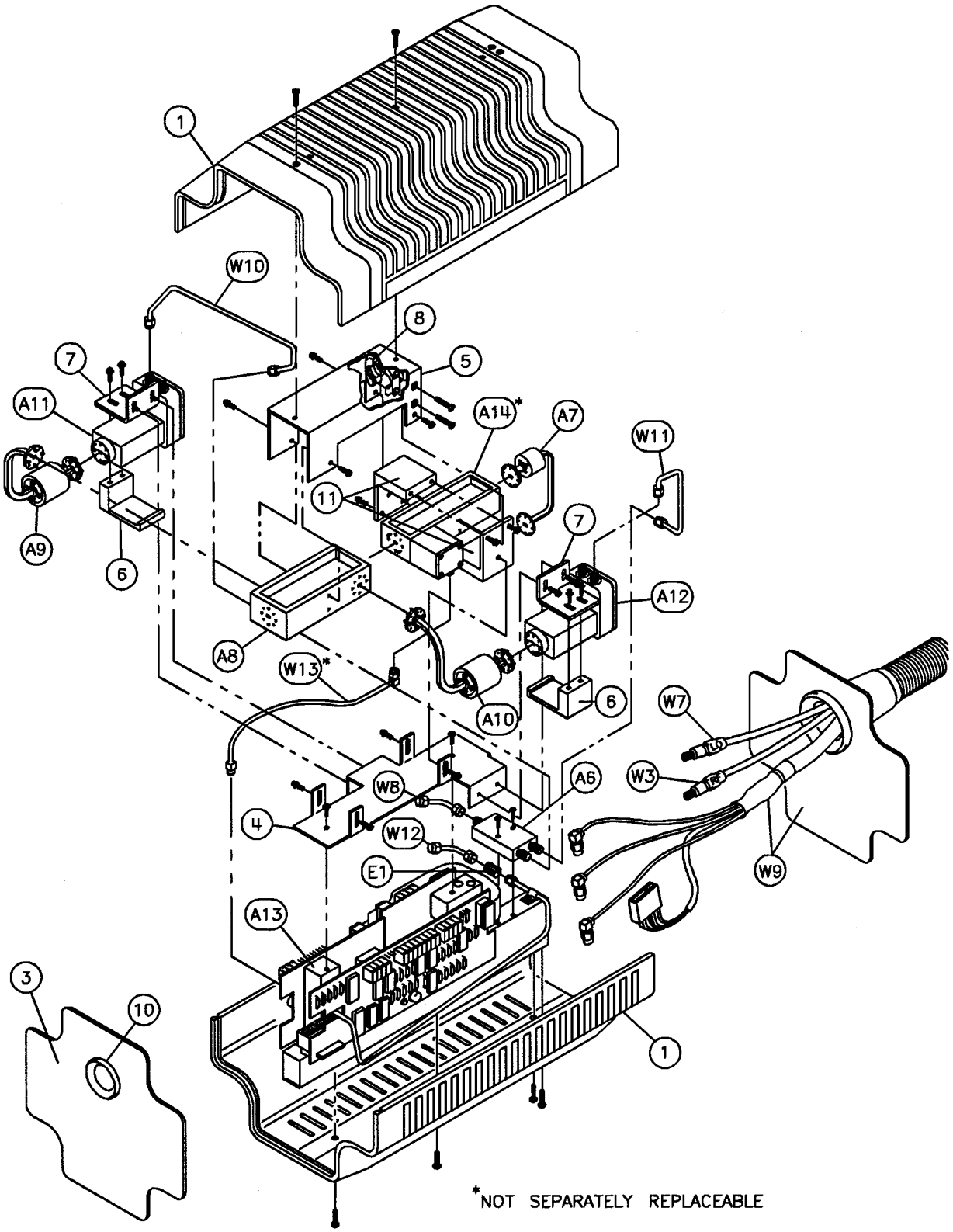


Figure 5-15 HP V85104A Replaceable Parts

Table 5-10 HP V85104A Replaceable Parts List

Reference Designator	Qty	Description	HP Part Number
1	2	Housing	85104-20001
3	1	Front Panel	85104-00003
4	1	Coupler Bracket	85104-90010
5	1	Bottom Mount	85104-00006
6	2	Mixer Clamp	85104-20020
7	2	Mixer Bracket	85104-00008
8	1	Cable Clamp	85104-20019
10	1	Front Panel Grommet	0400-0366
11	1	Detector Clamp	85104-20033
A6	1	Power Divider	0955-0264
A7	1	Insulator	85104-60025
A8	1	Dual Directional Coupler	85104-60024
A9	1	Incident Isolator	85104-60027
A10	1	Reflected Isolator	85104-60026
A11	1	Incident Mixer	11643-60030
A12	1	Reflected Mixer	11643-60030
A13	1	V-band Source Module Assembly	85104-60009
A14	1	Not Separately Replaceable; (part of A13 assembly)	N/A
E1	1	ADPT F SMA F SMA	1250-1158
W3	1	RF Cable Assembly	85104-60016
W7	1	LO Cable Assembly	85104-60017
W8	1	RF Cable (90^{o} bend)	85104-20021
W9	1	Interconnect Cable Assembly (rear panel)	85104-60015
W10	1	Incident LO Input Cable	85104-20012
W11	1	Reflected LO Input Cable	85104-20013
W12	1	RF Cable 90^{o} Bend	85104-20021

Table 5-10 HP V85104A Replaceable Parts List (Continued)

Reference Designator	Qty	Description	HP Part Number
W13	1	Coupler/detector Cable	85104-60037
		CABLE SUPPORT ASSEMBLY	
	1	Bracket	85104-00018
	1	Clamp	85104-20037
	1	Barrel	85104-20038
	1	Dovetail F	85104-20039
	1	Dovetail M	85140-20040
		HARDWARE	
	10	SMM 3.0 10 PN TX	0515-0373
	2	SMM 2.5 16 PN TX	0515-2007
	2	SM 440 1.000 PNPD	2200-0155
	8	SM 632.312 PNPD	2360-0115
	23	SS 440.375	3030-0221
	27	WSHR LK.115D 4	2190-0030
	1	Nut-Hex 4-40	2260-0009
	27	WSHR FL.125D 4	3050-0105
		MISCELLANEOUS	
	2	Waveguide Straight, 5 cm (V896B)	11644-60012
	1	90^{o} Waveguide Bend	85104-60035
	1	Ball Driver	8710-1539
		PARTS NEEDED BUT NOT SUPPLIED	
	1	Pozi Screwdriver, 1	8710-0899
	1	Torx Screwdriver, 10	8710-1623
	1	Torx Screwdriver, 8	8710-1644
	1	Open-end Wrench 5/16	8720-0015
	1	Wrist Strap	9300-1383
	1	Conductive Mat	9300-0797

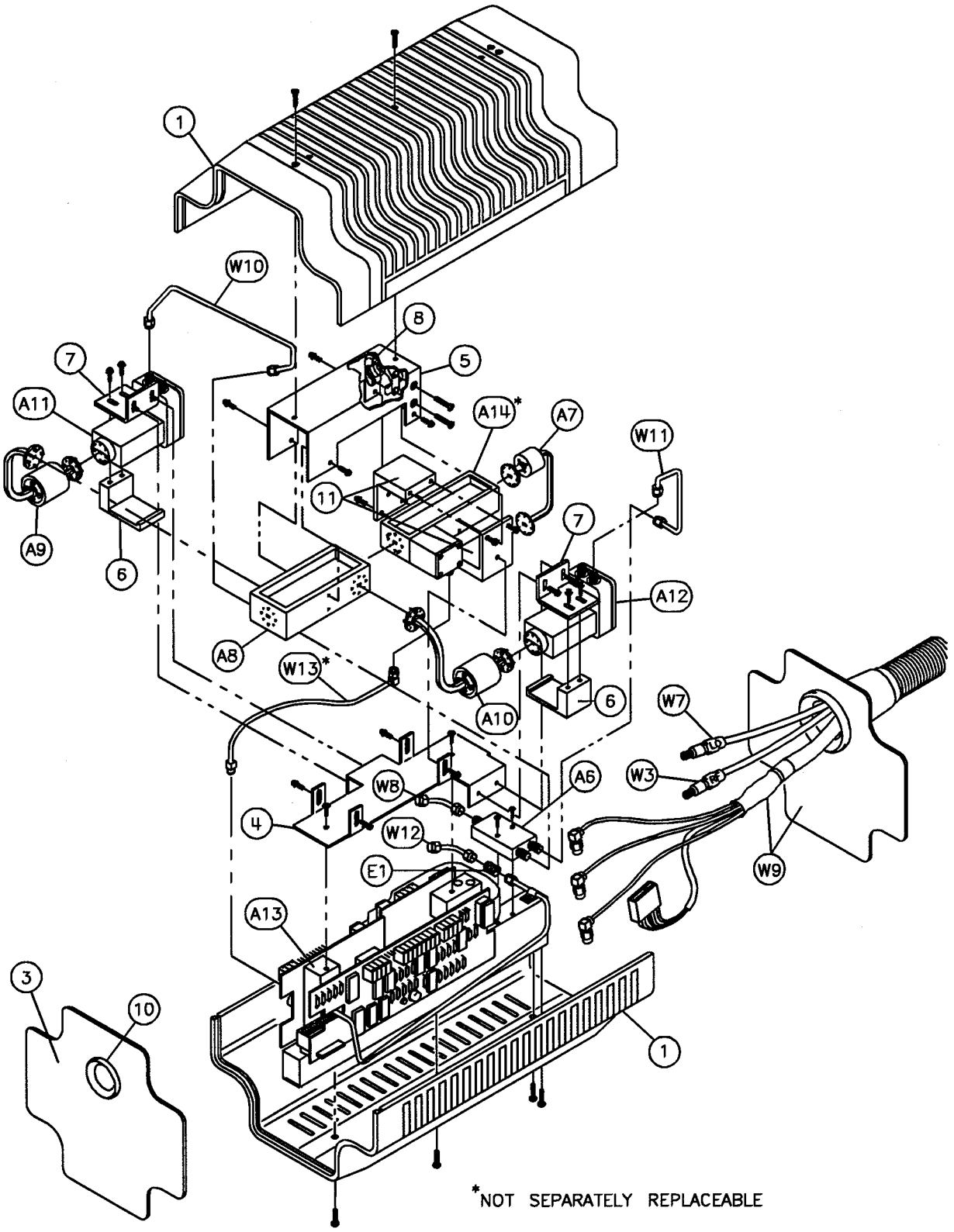


Figure 5-16 HP W85104A Replaceable Parts

Table 5-11 HP W85104A Replaceable Parts List

Reference Designator	Qty	Description	HP Part Number
1	2	Housing	85104-20001
3	1	Front Panel	85104-00004
4	1	Coupler Bracket	85104-90010
5	1	Bottom Mount	85104-00006
6	2	Mixer Clamp	85104-20020
7	2	Mixer Bracket	85104-00008
8	1	Cable Clamp	85104-20019
10	1	Front Panel Grommet	0400-0366
11	1	Detector Clamp	85104-20023
A6	1	Power Divider	0955-0264
A7	1	Insulator	85104-60029
A8	1	Dual Directional Coupler	85104-60028
A9	1	Incident Isolator	85104-60031
A10	1	Reflected Isolator	85104-60030
A11	1	Incident Mixer	11643-60031
A12	1	Reflected Mixer	11643-60031
A13	1	W-band Source Module Assembly	85104-60014
A14	1	Not Separately Replaceable; (part of A13 assembly)	N/A
E1	1	ADPT F SMA F SMA	1250-1158
W3	1	RF Cable Assembly	85104-60016
W7	1	LO Cable Assembly	85104-60017
W8	1	RF Cable (90^{o} bend)	85104-20021
W9	1	Interconnect Cable Assembly (rear panel)	85104-60015
W10	1	Incident LO Input Cable	85104-20016
W11	1	Reflected LO Input Cable	85104-20017
W12	1	RF Cable 90^{o} Bend	85104-20021
W13	1	Coupler/detector Cable	85104-60037

Table 5-11 HP W85104A Replaceable Parts List (Continued)

Reference Designator	Qty	Description	HP Part Number
		CABLE SUPPORT ASSEMBLY	
	1	Bracket	85104-00018
	1	Clamp	85104-20037
	1	Barrel	85104-20038
	1	Dovetail F	85104-20039
	1	Dovetail M	85140-20040
		HARDWARE	
	10	SMM 3.0 10 PN TX	0515-0373
	2	SMM 2.5 16 PN TX	0515-2007
	2	SM 440 1.000 PNPD	2200-0155
	8	SM 632.312 PNPD	2360-0115
	23	SS 440.375	3030-0221
	27	WSHR LK.115D 4	2190-0030
	1	Nut-Hex 4-40	2260-0009
	27	WSHR FL.125D 4	3050-0105
		MISCELLANEOUS	
	2	Wavegd Straight, 5 cm (W896B)	11644-60012
	1	90^{o} Waveguide Bend	85104-60035
	1	Ball Driver	8710-1539
		PARTS NEEDED BUT NOT SUPPLIED	
	1	Pozi Screwdriver, 1	8710-0899
	1	Torx Screwdriver, 10	8710-1623
	1	Torx Screwdriver, 8	8710-1644
	1	Open-end Wrench 5/15	8720-0015
	1	Wrist Strap	9300-1383
	1	Conductive Mat	9300-0797

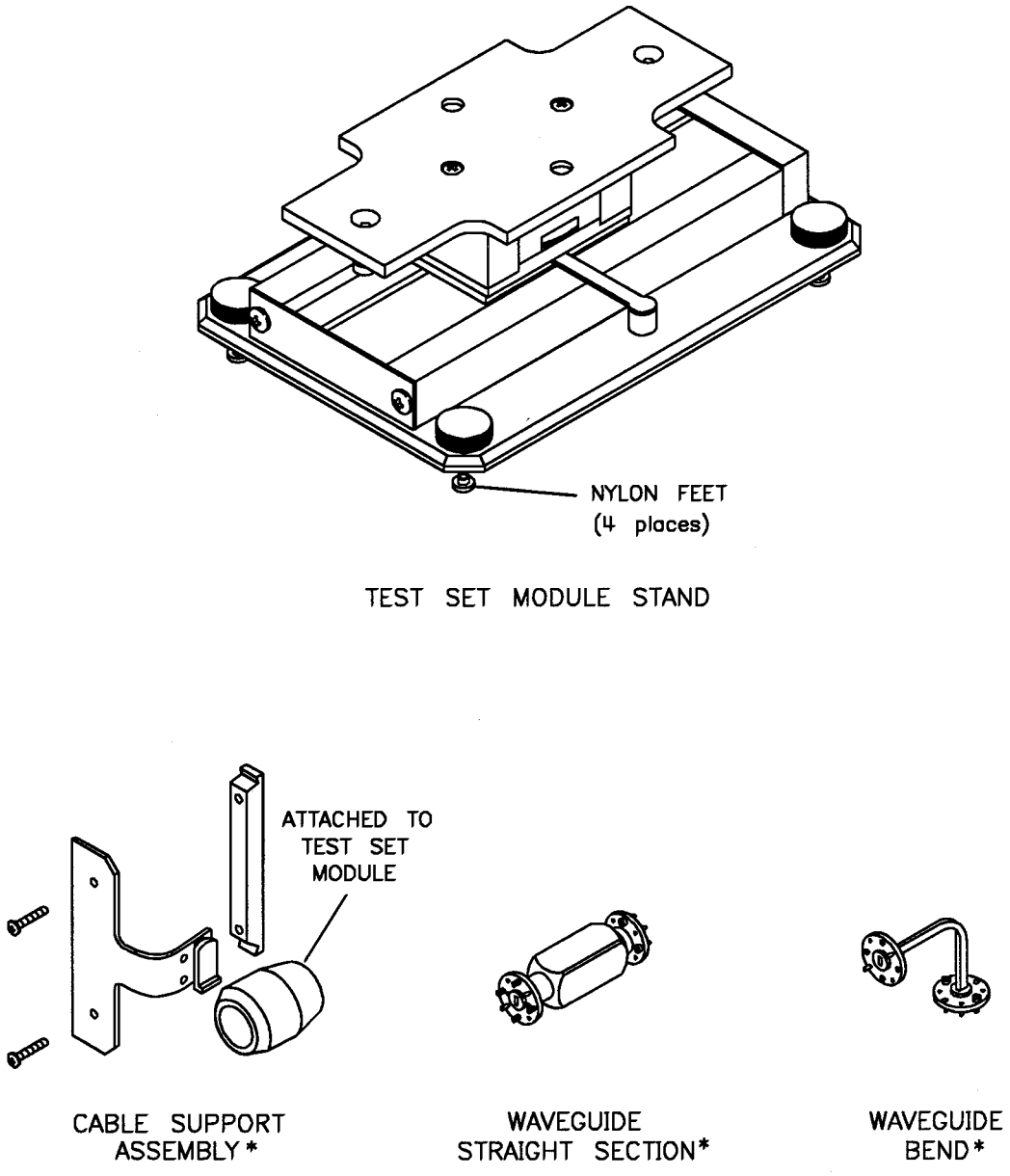


Figure 5-17 HP 85104A Replaceable Parts (supplied with different bands)

Qty	Description	HP Part Number
1	Stand Assembly	85104-60006
4	Nylon Feet	85104-20036

6 HP 85105A mm-Wave Controller

Introduction

The information in this chapter documents the operation, troubleshooting, and the replaceable parts for the HP 85105A mm-wave controller.

Description of the Instrument

The HP 85105A mm-wave controller **(**Figure 6-13 on page 6-28**)** is designed to be used in conjunction with:

- One HP 8510 network analyzer
- Two Synthesized Sources
- Two HP 85104A mm-wave test set modules
- One coaxial test set (optional)

The HP 85105A provides an amplified LO signal to each of the mm-wave modules to drive the harmonic mixers. An amplified RF signal is applied to the active test set, either port 1 or port 2 for S-parameter measurements. The incident and reflected IF signals from the test sets are returned to the HP 85105A amplified, output to the analyzer, processed and displayed. A leveling signal is passed from the test set through the controller to the RF source to provide leveled power.

Tthe coaxial test set is selected by the HP 8510 software. The HP 85105A sends a control signal to switch the RF signal to the test set and routes the IF from the test set to the analyzer. No new connections are required when switching between mm-wave and microwave operation. The HP 85105A is equipped with the IF switching and RF switch control capability for routing these signals to either the mm-wave or microwave test set.

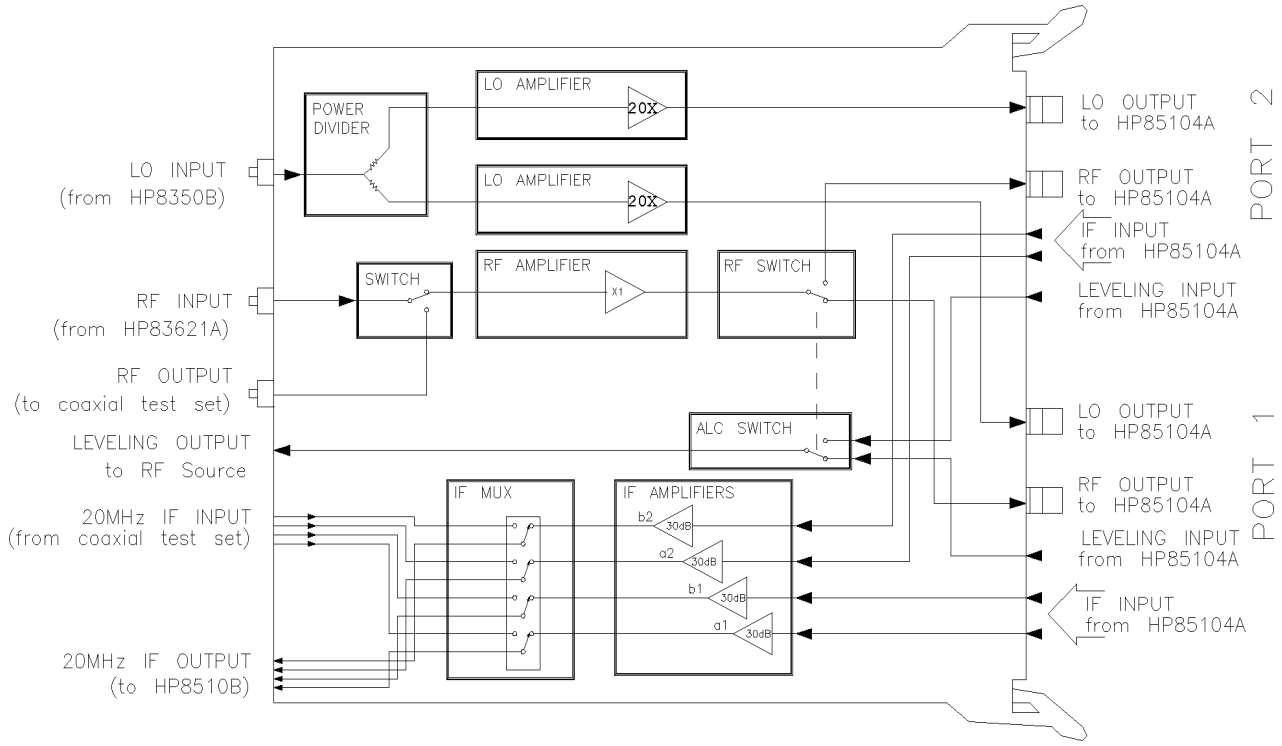


Figure 6-1 HP 85105A Simplified Block Diagram

Warranty Information and Safety

Warranty information for the HP 85105A is located in the front section of this manual.

For operator safety, the voltages in this instrument warrant normal caution. Service should be performed only by qualified personnel. Before removing the instrument covers to troubleshoot problems or replace assemblies, refer to the *HP 8510C On-Site Service Manual* "Safety/Licensing" section for information about hazardous voltage locations and general safety precautions.

Instrument Operation

The following information illustrates the features and functions of the HP 85105A mm-wave controller. Using the module interface adapter and multiple coaxial test sets are also described. Accessories supplied with the HP 85105A are listed in this chapter with part numbers and figures. See Figure 6-26 on page 6-43 through Figure 6-38 on page 6-66.

For cabling, instructions related to the HP 85105A mm-wave controller as part of an HP 85106D system refer to Chapter 1, “Getting Started” of this manual. The switching functions of the controller are performed by the HP 8510C operating system and may be accessed through the front panel push-buttons on the HP 8510C network analyzer. For additional operation information refer to Chapter 2, “Operation”.

Options

Option 004

Provides the rear panel output of port 1 and 2 RF, LO, and Module Interface connectors. This option is designed for use with the HP 85109C system configuration. The connectors are deleted from the front panel.

Option 050

Provides all functions on a standard HP 85105A, except that the RF switching is extended to 50 GHz to allow for connecting the HP 8517B test set to the HP 85106D Option 001 system.

Front Panel Features

1. Line Switch

This switch turns the instrument on and off. When the side of the switch labeled 0 is depressed, the instrument is off; when the side of the switch labeled 1 is depressed, the line power is on.

2. Line LED

This LED goes on and off with the instrument line switch to indicate the status of line voltage applied to the instrument.

3. Active LED

This LED is lit when the mm-wave test set is selected by the network analyzer.

4. a1 LED

This LED indicates that port 1 is selected and the RF source is switched to port 1. This LED lights for about 2 seconds and then goes off when power is first turned on.

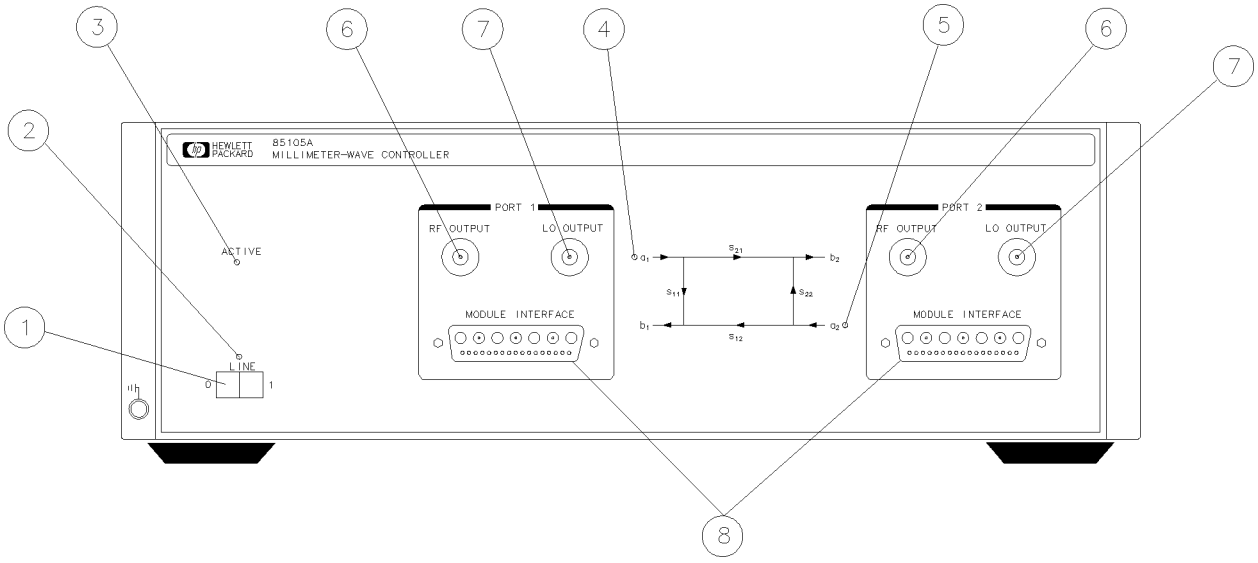


Figure 6-2 Front Panel Features of the HP 85105A

5. a2 LED

This LED indicates that port 2 is selected and the RF source is switched to port 2. This LED lights for about 2 seconds and then goes off when power is first turned on.

NOTE

The features for port 1 and port 2 are identical. The following descriptions apply equally to both ports.

6. RF Output

When the port is selected by the analyzer, an amplified RF source signal is available to an HP 85104A test set module, or to a multiplier for customer configured systems.

7. LO Output

An amplified LO signal is always available to an HP 85104A test set module, or to an harmonic mixer for customer configured systems.

8. Module Interface

The HP 85104A test set plugs into this interface. This interface supplies dc voltages and ground highband lines to the test set and returns incident and reflected IF signals and an ALC signal to the analyzer and RF source respectively.

Module Interface

The module interface connectors Figure 6-3 for port 1 and port 2 of the HP 85105A are identical. The following information may be used for troubleshooting purposes or for constructing a system without using the HP 85104A test set.

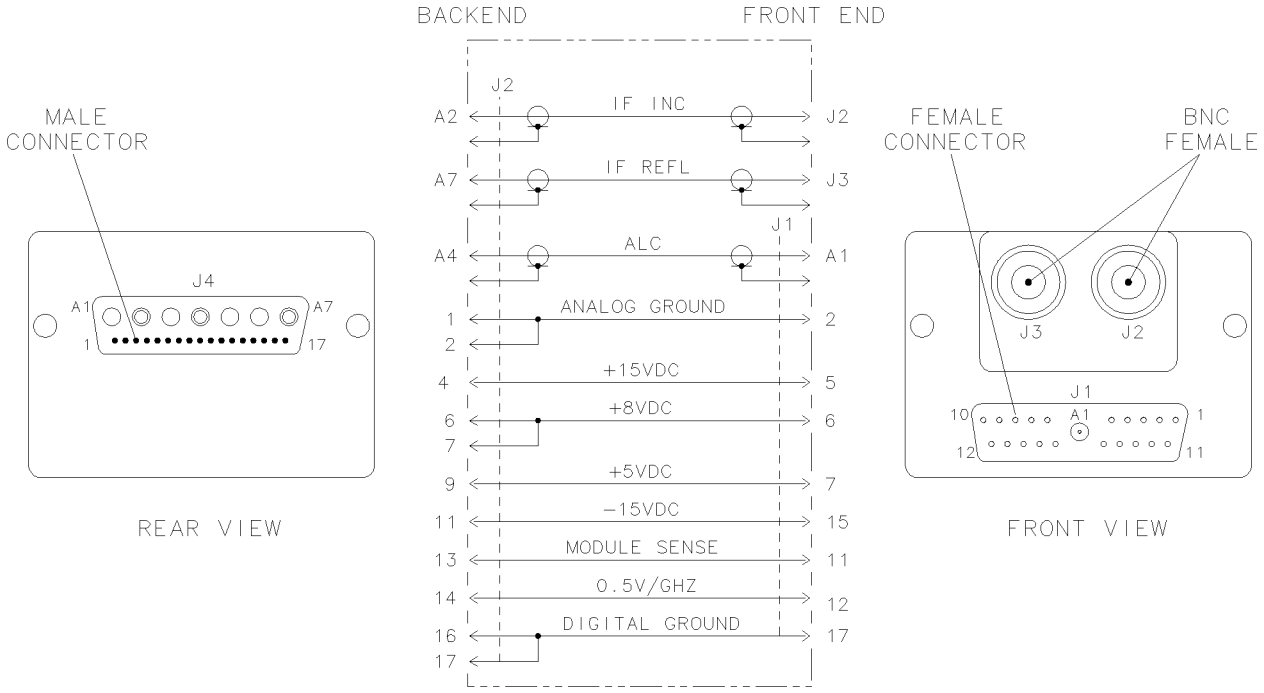


Figure 6-3 Module Interface Connections

Coaxial Wires

Jack A7 IF Input

This is the reflected IF signal input connection; b1 for port 1 and b2 for port 2.

Jack A4 ALC Input

The ALC signal input connection from the HP 85104A test set.

Jack A2 IF Input

This is the incident IF signal input connection; a1 for port 1 and a2 for port 2.

Pin Connections

The pins and jacks used on this connector are described below, any others on this connector are not used.

Pin Number 1 and 2

These two pins are the analog and dc-supply ground lines.

Pin Number 4

This pin is a +15.0 Vdc supply.

Pin Number 6 and 7

These two pins are both +8.0 Vdc supplies.

Pin Number 9

This pin is a +5.0 Vdc supply.

Pin Number 11

This pin is a -15.0 Vdc supply.

Pin Number 13

This is the Module Sense line. When a highband test set is connected to the module interface of the HP 85105A, a +5.0 Vdc level is input to this pin. The result is that the ALC from the test set is routed through the HP 85105A to the RF source. If the +5.0 Vdc is missing from this pin, the internal ALC of the HP 85105A is routed to the RF source.

Pin Number 14

This is the +0.5 Vdc/GHz line. See the description in "Rear Panel Features" of the 0.5 V/GHz line.

Pin Number 16 and 17

These two lines are digital ground.

Module Interface Adapter

The module interface adapter supplied with the HP 85105A is used to adapt the HP 85105A front panel module interface to a plug. Compatible with HP 8355X Series source modules and two BNC connectors used to receive incident and reflected IF signals. See Figure 6-4.

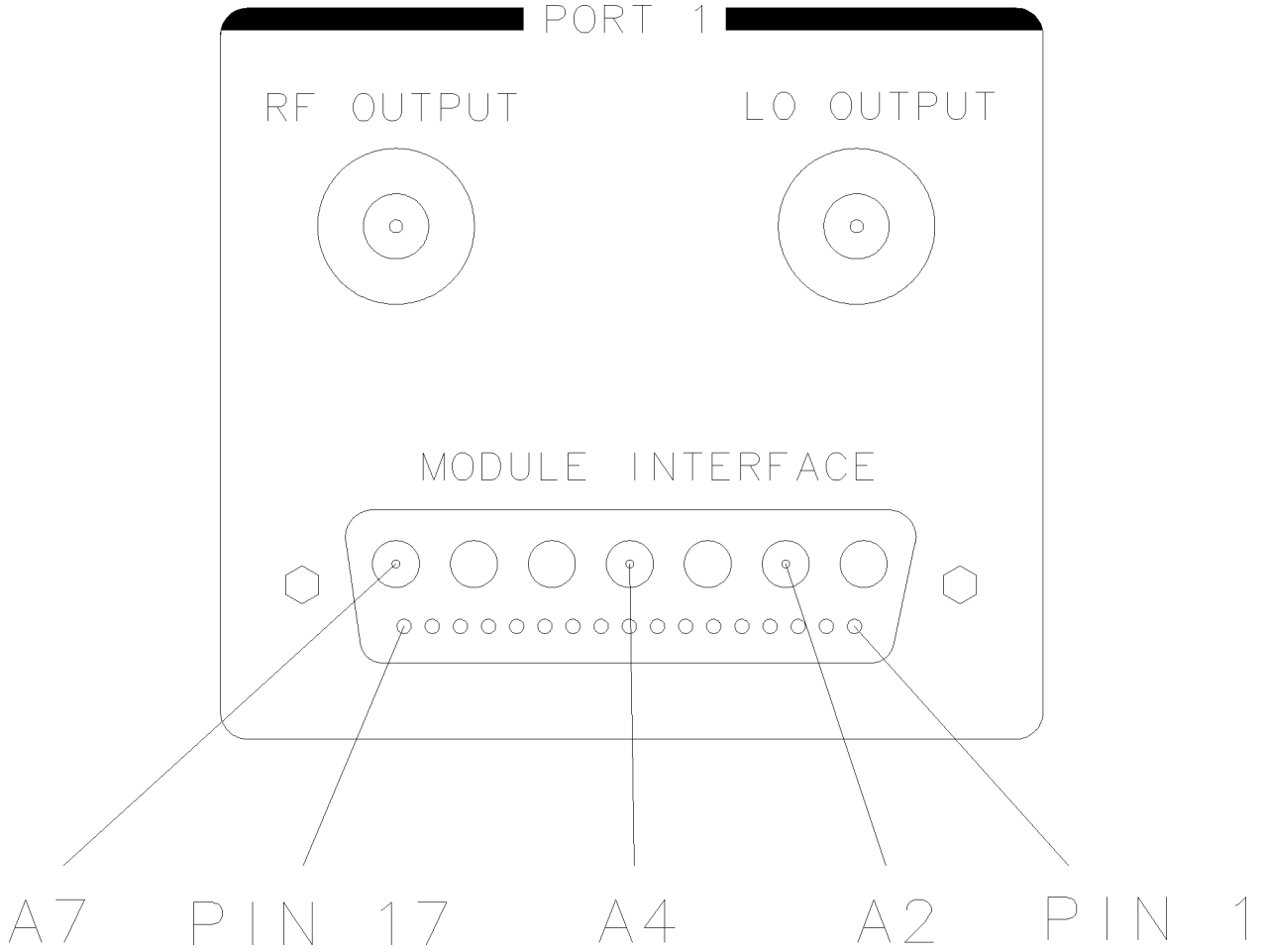


Figure 6-4 Module Interface Adapter Wiring Diagram

Rear Panel Features

1. Line Module

This assembly houses the line cord connector, line fuse and line voltage selector. Pull out the top side of the line module cover to replace or change the fuse or to change the voltage selection. Note that the voltage selector drum must be removed to rotate it to a different voltage setting. Recommended fuse values are printed on the rear panel.

2. 0.5 V/GHz

This input to the instrument comes from the RF source. A voltage level of 0.5 volt is input to this connector for every GHz of RF source frequency. Pin number 14 of the module interface on the front panel of the HP 85105A carries this voltage to the test set modules.

3. LO Input

This input to the instrument comes from the LO source. The signal is split and amplified then output to the front panel of the HP 85105A.

4. ALC Output

This dc level is applied to the RF source. The ALC signal is either generated by the highband test set or the HP 85105A. If a test set is used, the ALC signal generated by the test set is input to the HP 85105A via the front panel module interface. If a highband test set is not sensed by the HP 85105A, the internal ALC signal generated on the RF Leveling Amplifier Assembly is routed to this connector.

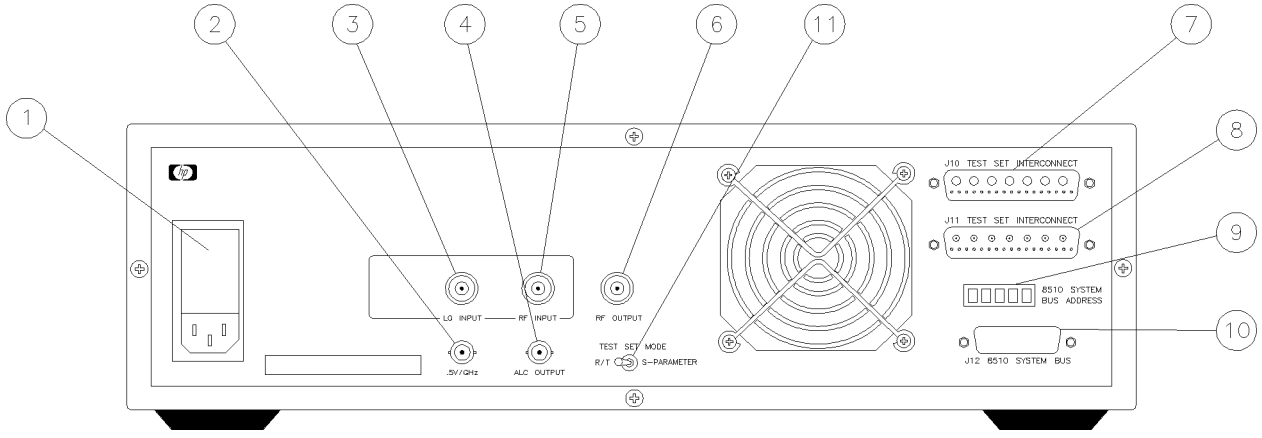


Figure 6-5 Rear Panel Features of the Standard HP 85105A

5. RF Input

This input comes from the RF source via the RF switch. When the test set module is selected by the HP 8510 the RF is amplified and then input to a switch that directs the RF to either port 1 or 2. When the coaxial test set is selected by the HP 8510 the RF is switched to the connector labeled "RF OUTPUT" located on the rear panel of the HP 85105A.

NOTE

The HP 85105A standard and Option 004 connectors, number 5 and 6, are 3.5 mm female.

The HP 85105A Option 050 connectors, number 5 and 6, are 2.4 mm female adapters to accommodate 50 GHz operation.

6. RF Output

When the port is selected by the analyzer, an amplified RF source signal is available to an HP 85104A test set module, or to a multiplier for customer configured systems.

7. J10 Test Set Interconnect

Should be connected to J11 of the coaxial test set. This connector transmits the IF signals from the test set to the HP 85105A.

8. J11 Test Set Interconnect

Should be connected to the J1 Test Set Interconnect on the HP 85102 IF/Detector. This connector transmits the IF signals from the HP 85105A to the HP 85102 IF/Detector. It also transmits control signals.

9. HP 8510 System Bus Address Switch

This five-pole binary-weighted switch sets the system bus address of the instrument. The binary weight of each pole is indicated on the rear panel as are the on and off positions. Decimal twenty one, binary 10101 (on, off, on, off, on) is the default setting.

10. J12 EP 8510 System Bus Connector

This connector is used for system HP-IB communications with the HP 85101 display/processor.

Controlling Multiple Test Sets

Because the HP 85105A has multiple test set switching (Option 001) as standard, it can control one set of HP 85104A mm-wave test set modules and one coaxial test set without the need for external switches or instruments. If it is necessary to control more than one coaxial test set, install Option 001 in each test set. When installed, the following procedures may be used.

The HP 851X Series Option 001 test sets allow an HP 8510 to alternately control up to three additional coaxial test sets (Figure on page 6-14), allowing for a total of four test sets in all. The HP 85105A must be the first test set in the series. While a measurement is proceeding on test set number 1, which is equipped with Option 001, test device connection may be completed on test set number 2, which does not need to be equipped with Option 001 (unless another test set is to be connected). When the measurement on test set number 1 is completed, then the HP 8510 can control test set number 2.

In a standard test set, the 20 MHz IF and control signals are applied directly to J11 TEST SET INTERCONNECT, which connects to the HP 8510. Option 001 adds a set of IF switches, control switches, and the J10 TEST SET INTERCONNECT connector. This allows the selection of 20 MHz test set IF signals. As shown in Figure on page 6-14**,** test set number 1 can apply its IF to the HP 8510 or it can switch to pass the IF from test set number 2 through the J10 TEST SET INTERCONNECT to the HP 8510.

Installation and Operation

Set each test set rear panel address switch to the address listed in Figure on page 6-14**,** if configuring three or four test sets. Use the supplied test set interconnect cable to connect test set number 1, J11 to the HP 8510. Use the supplied test set interconnect cable to connect test set number 2, J11 to test set number 1, J10. You may continue this test set “daisy chain” to include up to four test sets if the total length of all test set interconnect cables does not exceed 13 meters (about 40 feet). The last test set in the chain does not require Option 001.

If the RF coaxial switches are not incorporated into the system, then the RF input to the test set must be manually switched to the active test set.

Initialization at Power-up

After power-up, configure the IF switches so that only one system test set is active. Refer to the following procedure:

1. Check the active LEDs on all system test sets.
2. Check the HP 8510's expected test set address by pressing [**LOCAL**] {***TEST SET***}. The address should match the address of the test set desired. If not, change the address. See Figure on page 6-14 for recommended addresses.
3. If unselected test sets are active (active LED ON), deactivate the test set by temporarily addressing it then return to the desired address.

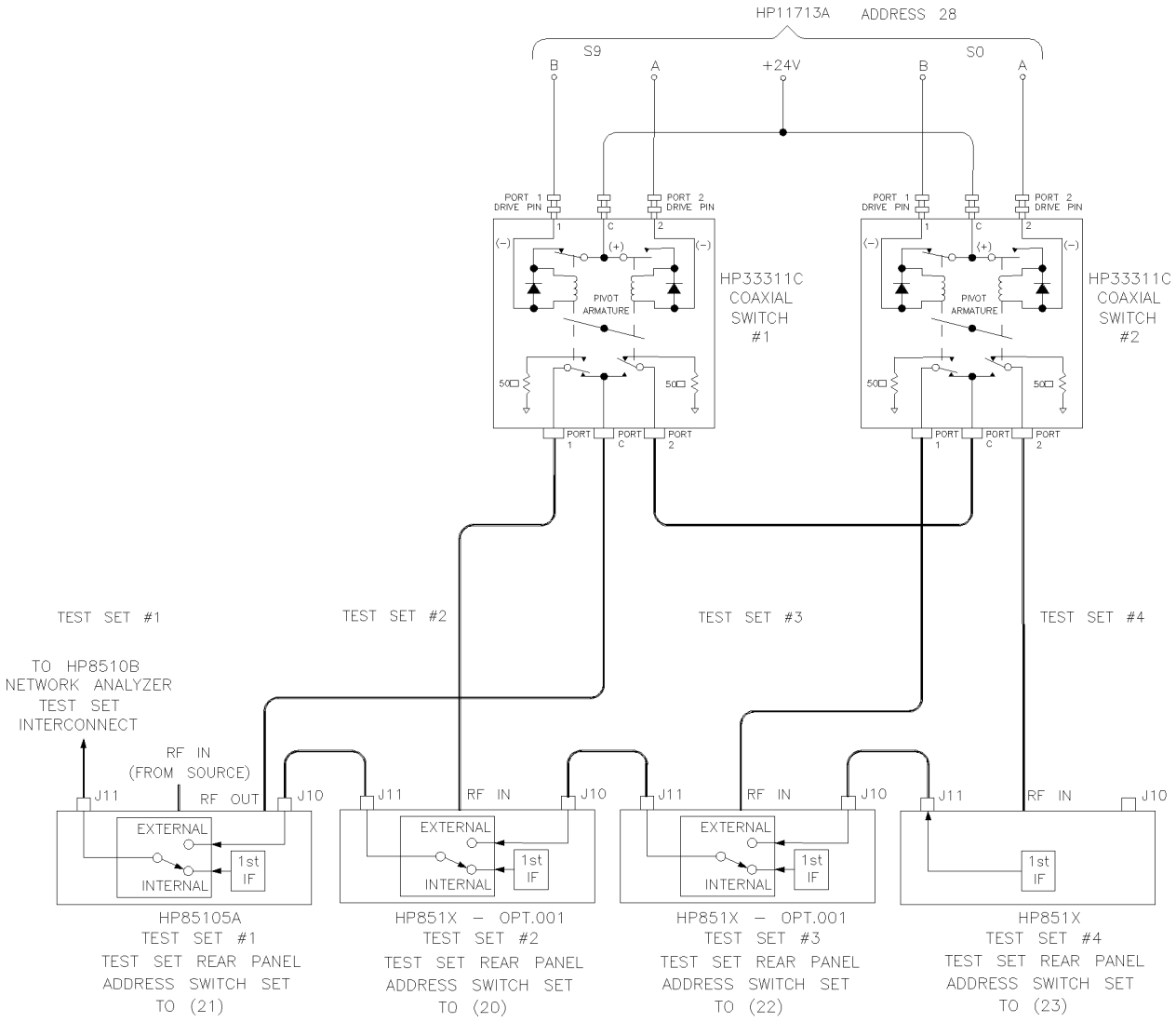


Figure 6-6 RF and IF Switching With Four Test Sets

NOTE

1. If test set #3 or #4 is a 50 GHz test set, then switch #1 and #2 must be 50 GHz coaxial switches.
2. Not all system connections are shown.
3. In dual source configurations, the second source can be multiplexed in a similar manner. If only one dual-source test set is used, the second source can be connected directly to the one test set.
4. The HP 85105A must be the first test set in the series, and if the HP 8517 test set is used, it must be second in the series.

Coaxial Switch Positions With Four Test Sets			
New ADDRESS of Test Set	Test Set Switched	Coaxial Switch Port Selected	
		Switch #1	Switch #2
21	1	Port 1	Port 2
20	2	Port 1	Port 2
22	3	Port 2	Port 1
23	4	Port 2	Port 2

Selecting a Test Set

Test Set IF Switching

The active test set is selected via the built-in ability of the HP 8510 to generate an addressed command to the test set. Each time the HP 8510 ADDRESS of TEST SET function is changed (see the HP 8510 [**LOCAL**] menu), the HP 8510 switches the previously addressed test set IF to external and the newly addressed test set IF to internal. The test set front panel active indicator shows the test set status. When the test set is active the IF signals from the test set are applied directly to J11 TEST SET INTERCONNECT. When the test set is inactive the IF signals appearing at J10 are passed through to J11 and on to the next test set or to the HP 8510.

The address of the test set can be changed manually from the HP 8510 front panel by selecting the {***ADDRESS OF TEST SET***} function. Then enter the test set address by pressing [**x1**], or it can be changed via program control using the HP 8510 HP-IB ADDRESS; command. Each test set HP-IB address is set with address switches on the test set rear panel.

RF Switch Driver Commands

A related feature of the HP 8510 is that when the HP 8510 {***ADDRESS OF TEST SET***} function is changed, a code sequence is automatically issued over the HP 8510 system bus to the device at the ADDRESS of RF SWITCH. In the recommended configuration, this device is an HP 11713A attenuator/switch driver, which in turn controls one or more HP 33311C coaxial switches. As shown in Figure on page 6-14, these switches are used to select which test sets receive the RF output from the network analyzer source. The exact command issued depends upon the new value of the {***ADDRESS OF TEST SET***} function, also shown in Figure on page 6-14.

Measurement Calibration

After selecting the active test set, perform the system calibration procedure as usual. When you select a different test set, make sure you recall the Cal Set that applies to that test set.

Since the Cal Set Limited Instrument State does not include the number of the active test set, a Cal Set which does not apply to the current test set can be turned on without any HP 8510 caution messages appearing. This will cause errors in the displayed data because incorrect error coefficients are applied to the measured data.

Operational Checks

To check the operation of a multiple test set configuration, connect a device with a known response at test set number 2. Press:

1. HP 8510 [**LOCAL**] {***test set***}
2. Enter the address of test set number 2 (this would be 20)
3. Press [**x1**]. The test set number 2 measurement should appear.
4. Press [**DISPLAY**] {***DATA-->MEMORY***} {***DISPLAY:DATA and MEMORY***} to store the trace for later comparison. Use {***ADDRESS OF TEST SET***} to select test set number 3.
5. Switch back to test set number 2. Observe any difference in the response between the stored trace and the result after switching back and forth between the test sets. Any difference in the data believed to be due to Option 001 IF switch or RF switching, must be investigated.

Performance Verification

Standard system performance verification procedures are used to verify the operation of the Option 001 test set as test set number 1. To verify the performance of another test set in the chain, select it as the active test set and proceed as usual with the HP *8510C On-Site Service Manual* performance verification procedures.

Specifications

Specifications describe the warranted performance of the instrument. The electrical specifications of the HP 85105A mm-wave controller when used in an HP 85106D system are in Chapter 3, “Performance Verification” in this manual.

Supplemental Characteristics

The supplemental characteristics provide information useful in applying the instrument by giving typical, but non-warranted, performance parameters.

Table 6-1 HP 85105A Supplemental Characteristics

Test Ports		
RF and LO Connector Type:	Precision 3.5 mm male	
Connector Torque:	90 N-cm (8 in-lb)	
Nominal Operating Power Level		
Operating Level	**Port 1**	**Port 2**
RF 8 to 20 GHz	>+ 17 dBm	>+ 17 dBm
20 GHz to 21 GHz (Option 050, or 054)	>+ 16 dBm	
LO 2 to 8 GHz	>+ 20 dBm	>+ 20 dBm

NOTE

The RF level can be adjusted more than 10 dB down from nominal by use of the Source 1 power level menu on the HP 8510.

Other Connectors (Rear Panel)

RF IN Connector type:	Precision 3.5 mm female (in Option 050 RF IN/OUT connectors are 2.4 mm female)
LO Connector type:	Precision 3.5 mm female
Connector torque:	Precision 3.5 mm, 90 N-cm (8 in-lb) SMA 56 N-cm (5 in-lb)
RF Source Power Level:	
Damage input level:	>+ 13 dBm
Maximum input level:	+ 5.0 dBm
Minimum input level:	-2.0 dBm
LO Source Power Level:	
Damage input level:	>+ 13 dBm
Maximum input level:	+ 3.0 dBm (+2 dBm recommended)
Minimum input level:	0.0 dBm

HP 85105A Power Requirements and Physical Characteristics

Operating Temperature:	0^{O} C to 55^{O} C
Power:	110, 120,220 or 240 ±10% Vac 48 to 66 Hz line frequency 270 VA maximum
Dimensions:	460 mm x 133 mm x 609 mm (18.1 x 5.25 x 24.0 in)
Weight:	15 Kg, 35 lbs

Troubleshooting

The troubleshooting strategy for the HP 85105A is systematic. This information is used after system level troubleshooting has pinpointed the HP 85105A as the problem instrument. Use the Troubleshooting Flowchart (Figure 6-7 on page 6-21**)** to identify the faulty assembly. The flowchart is keyed to numbered individual troubleshooting procedures. As you progress through the flowchart, perform the numbered procedure associated with each block. A block diagram is provided at the end of this section to assist in understanding the operation of the mm-wave controller.

Theory of Operation

The mm-wave controller when used in conjunction with the HP V85104 test set, provides all of the features and functions of a full S-parameter test set. Refer to the block diagram while reading the following description:

An LO signal is input to the rear panel of the mm-wave controller, divided and input to two identical 2 GHz to 8 GHz leveling amplifier assemblies. An RF signal is applied to the mm-wave controller rear panel, then sent to a coaxial switch. If the mm-wave controller is the test set selected by the HP 8510, the RF is routed through the coaxial switch the RF leveling amplifier assembly and to a PIN switch were the RF is routed from the active port (either port 1 or port 2) of the mm-wave controller.

If a coaxial test set is selected by the HP 8510, the RF signal is routed from the coaxial switch, then out through the mm-wave controller rear panel. Incident and reflected IF signals are applied to the mm-wave controller from the test set modules via the module interface on the mm-wave controller front panel. These signals are amplified and output to the analyzer to be processed and displayed. If the coaxial test set is selected by the HP 8510 the IF from the test set is routed through the mm-wave controller rear panel connectors, J10 and J11, then to the HP 8510.

Whenever a test set module is connected to the module interface of the mm-wave controller, a +5 Vdc level is applied to module interface pin 18. The result - the ALC from the test set module is routed through the mm-wave controller to the RF source. If the +5Vdc level is not at this pin, then the internal ALC in the mm-wave controller is routed from the RF leveling amplifier assembly to the RF source.

CAUTION

Electrostatic discharge sensitive
Handle only at static safe work stations.
The assemblies in these procedures are very susceptible to damage from electrostatic discharge, and their reliability will be impaired.

Equipment Needed But Not Supplied

You need the following equipment to troubleshoot your instrument. This equipment is not supplied as part of the system.

- 1 point Pozidriv
- 2 point Pozidriv
- Service Adapter
- 3.5 mm precision female to female adapter
- 5/16 in. Torque Wrench
- HP 436A Power Meter
- HP 8485A Power Sensor
- HP 847SC Negative Detector
- HP 1740A Oscilloscope, or equivalent
- HP 8498C 10 dB Fixed Attenuator

Troubleshooting Sequence

Figure 6-7 on page 6-21 illustrates the troubleshooting sequence that can be used to determine which assembly is faulty.

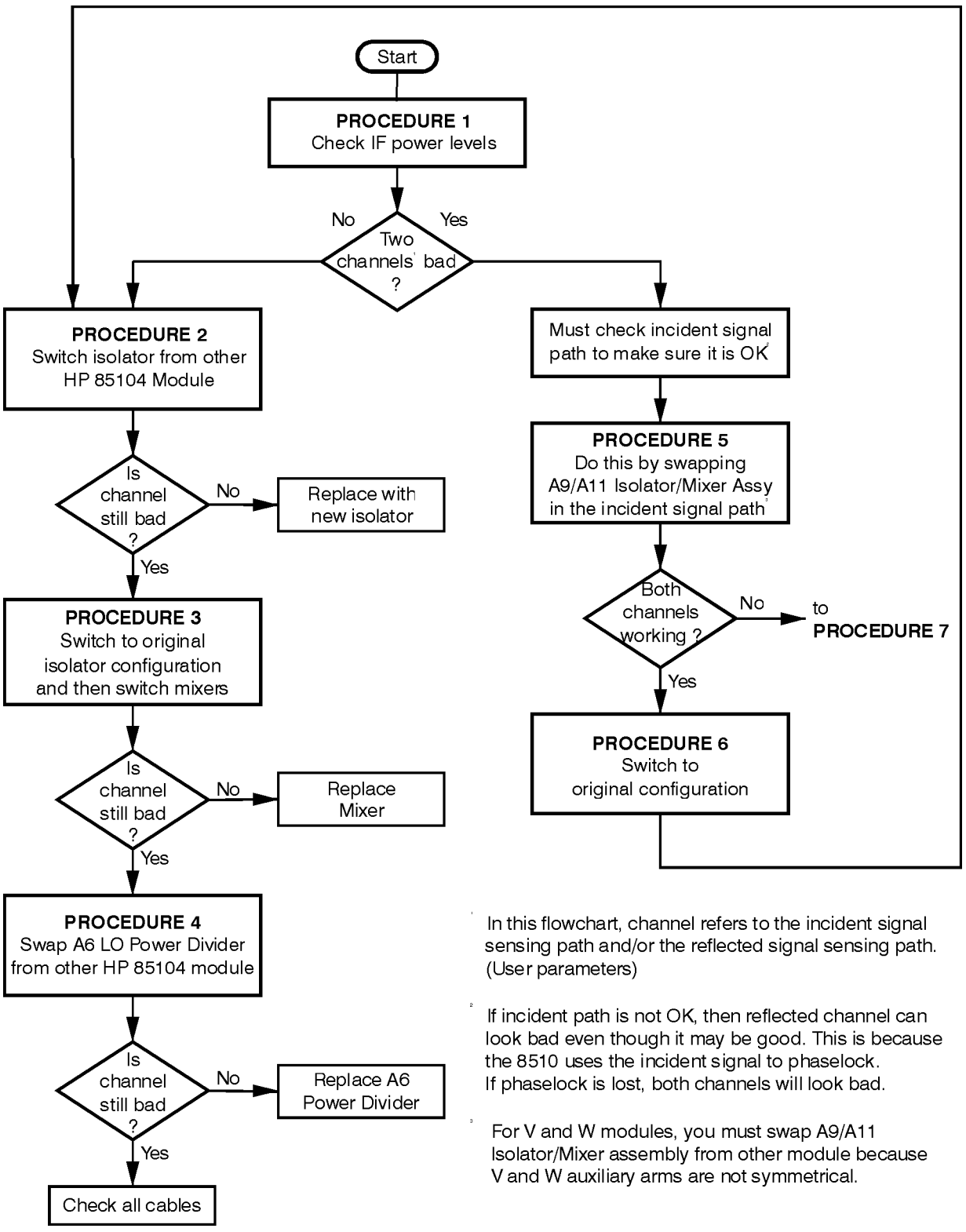


Figure 6-7 Troubleshooting Flowchart (1 of 2)

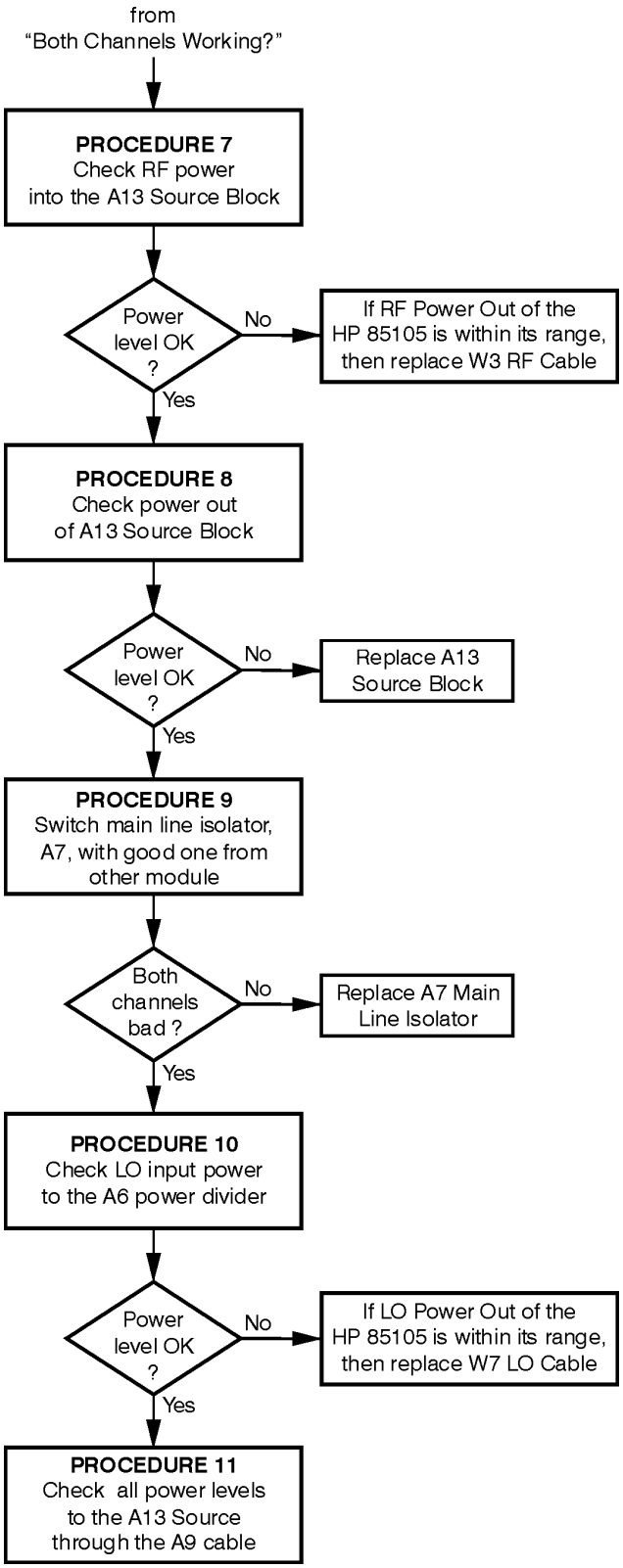


Figure 6-8 Troubleshooting Flowchart (2 of 2)

HP 85105A Troubleshooting Procedures

Procedure 1

- A15 Primary Regulator
- A6 Secondary Regulator
- HP-IB Address Switches
- Fuse Locations

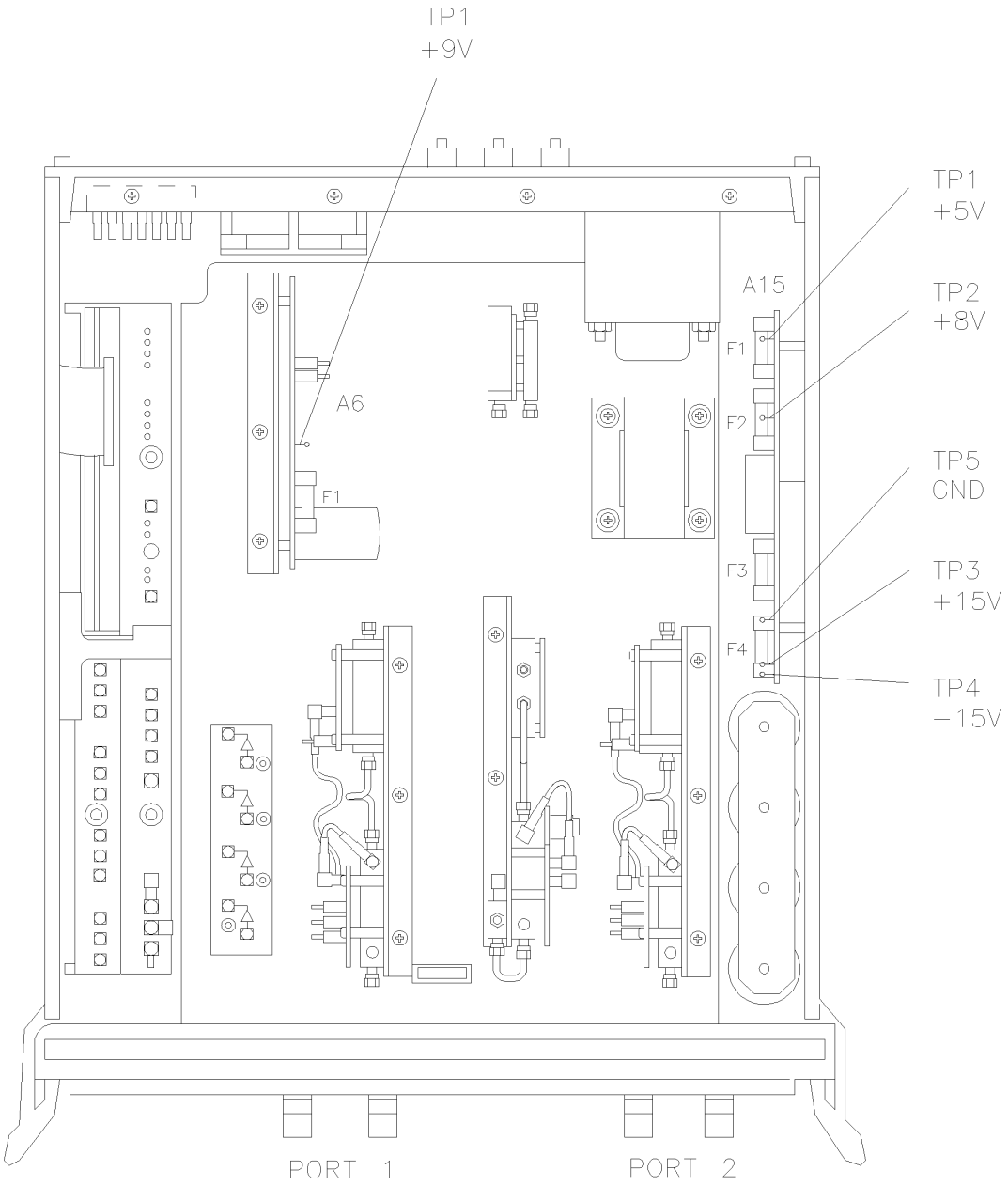


Figure 6-9 Power Supply Fuses and Test Points

A15 Primary and A6 Secondary Regulator Board Assembly

Use a digital voltmeter to check the voltages and an oscilloscope to check the ripple.

Table 6-2 Power Supply Voltages

Nominal Voltage	Test Point	Voltage Range	Maximum Ripple Peak to Peak
+ 14.85 Vdc	A15TP3	+14.10 to +15.60	2 mv
- 14.85 Vdc	A15TP4	-14.10 to -15.60	2 mv
+ 9.20 Vdc	A6TP1	+9.10 to +9.30	2 mv
+8.00 Vdc	A15TP2	+7.60 to +8.40	2 mv
+5.05 Vdc	A15TP1	+ 4.75 to 5.25	2 mv

HP-IB Address Switch

Set the switch as indicated in Figure 6-10 (the dark side of the switch is depressed). The HP-IB address switch is on the instrument rear panel. It is easy to access but need not be changed unless the error message **SYSTEM BUS ADDRESS ERROR** is displayed on the HP 8510 screen. Decimal twenty one, binary 10101 (on, off, on, off, on) is the default setting.

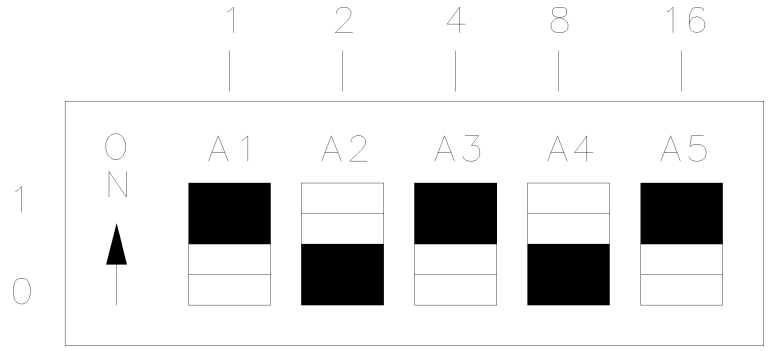


Figure 6-10 Instrument HP-IB Switch Setting

Fuses

The locations of the six fuses used in the HP 85105A are illustrated in Figure 6-9 on page 6-23 (F1 through F4). The values of these fuses and their part numbers may be found in the “Replaceable Parts” section.

Refer to Figure 6-11 for information about setting the voltage selector cam and replacing a line fuse.

NOTE

Do not attempt to rotate the voltage selector cam while it is installed in the line module or non-repairable damage will result. The cam must be completely removed from the line module, rotated to the proper position, and reinstalled. Refer to the instructions below.

Replacement of Fuse

1. Pry open line module cover door.
2. Pull out fuse carrier.
3. Insert fuse of proper rating.
4. Place carrier back into line module.

Selection of Operating Voltage

1. Pry open line module cover door.
2. Remove cam from the line module.
3. Rotate the cam to the desired voltage (when the line module cover is closed, the selected voltage will be visible through a small window).
4. Insert the cam back into the line module.
5. Close the line module cover door.

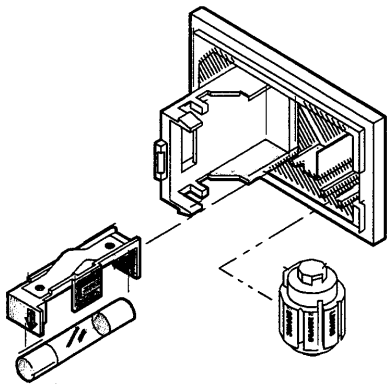


Figure 6-11 Power Line Module

Self-Test Indicators

Procedure 2

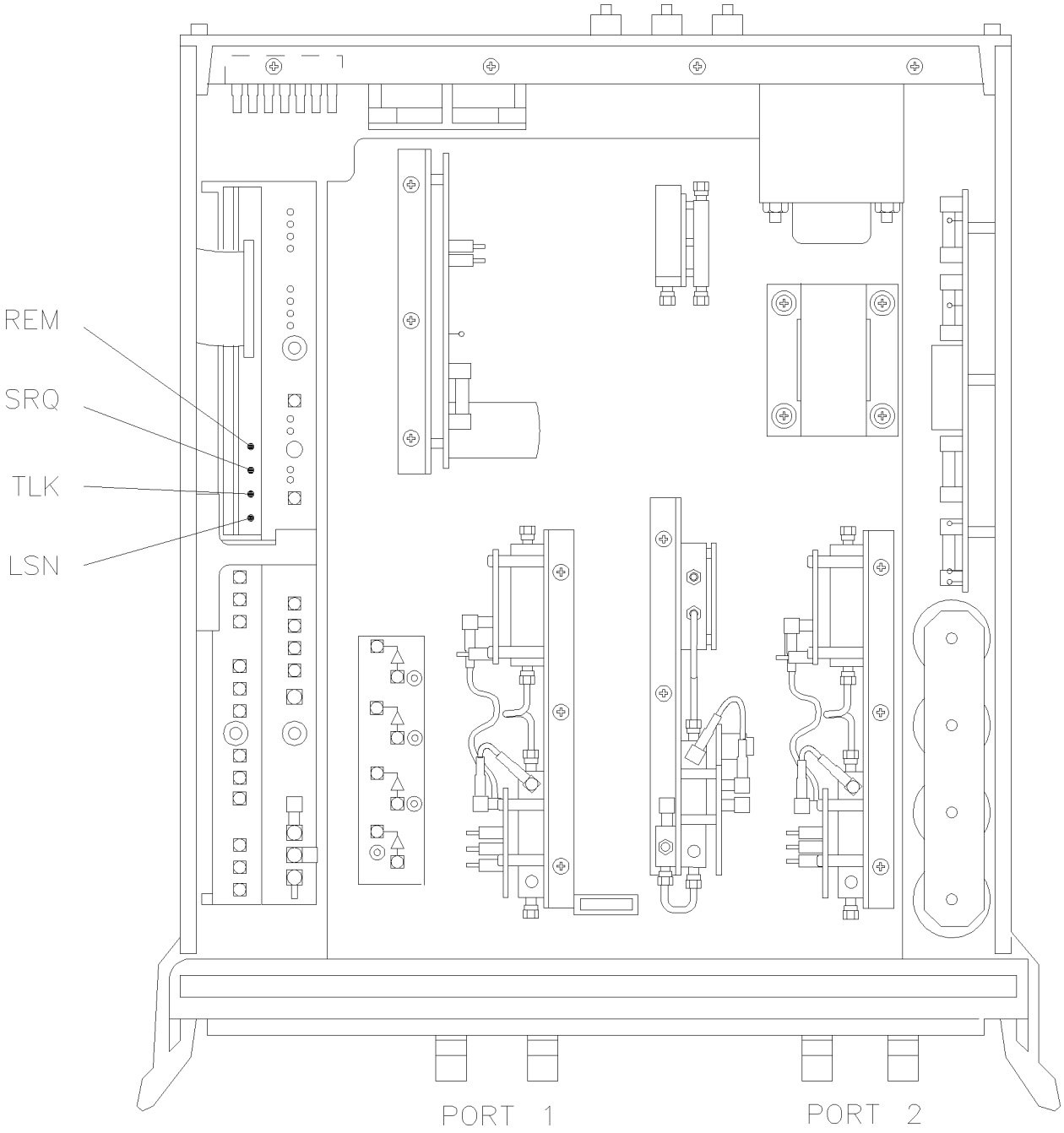


Figure 6-12 Location of Self-Test Indicators

The ACTIVE LED should always remain off until the HP 85105A is accessed by the HP 8510. Each time the test set is turned on the Port 1 and Port 2 LEDs will light for approximately 2 seconds during the self-test, and then turn off. To determine what part of the self-test has failed, note which LEDs on the A4 board are lit. Refer to Table 6-3 for failure indications.

Table 6-3 Self-Test Failure Indications

Self-Test Indication	A4 HP-IB LED's				Time (after turn-on)
	LSN	TLK	SRQ	REM	
PWON	ON	ON	ON	ON	0 to 0.5 sec
Fail ROM Test	OFF	ON	ON	ON	ON briefly
Pass ROM Test	OFF	OFFF	ON	ON	0.5 to 2.0 sec
Fail RAM Test	OFF	OFF	OFF	ON	
Pass RAM Test	OFF	OFF	OFF	OFF	after 2 sec

If the Self-test Fails to Run

If the portion of memory which contains the self-test programming is faulty, the self-test will not run properly. The following conditions indicate that the self-test ROMs are probably faulty.

- all LEDs flash briefly and go off
- all LEDs flash briefly and stay on
- ACTIVE LED goes on too soon

RF and LO Output Power at Front Panel Ports

Procedure 3

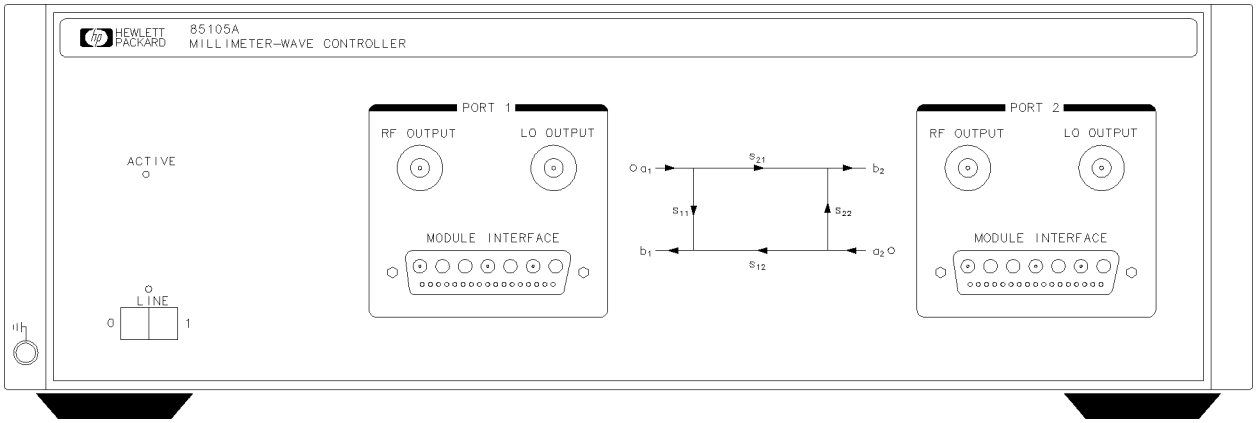


Figure 6-13 Front Panel RF and LO Ports

1. Run the system software and select {***HIGHBAND***} to make the mm-wave controller active.
2. Choose a power meter that covers the 4 to 21 GHz frequency range of interest (HP 436A Meter and HP 8485A sensor). Calibrate the power meter and attach a 3.5 mm, 10 dB fixed attenuator (HP 8493C) and a female-to-female adapter to the sensor.
3. Attach the power sensor to the LO output on both ports 1 and 2. Select {***SINGLE POINT MODE***} from the [**STIMULUS**] menu, then using the RPG knob, slowly scan over the frequency band. The power out should be +22 dBm ±2 dB.
4. Attach the power sensor to the RF output of the active port, measure the power out then select the other port and measure its RF output power. Select from the [**STIMULUS**] menu, then using the RPG knob, slowly scan over the frequency band. The RF power out should be >+17 dBm for both ports (>+16 dBm, 20 to 21 GHz).

LO Input at Rear Panel

Procedure 4

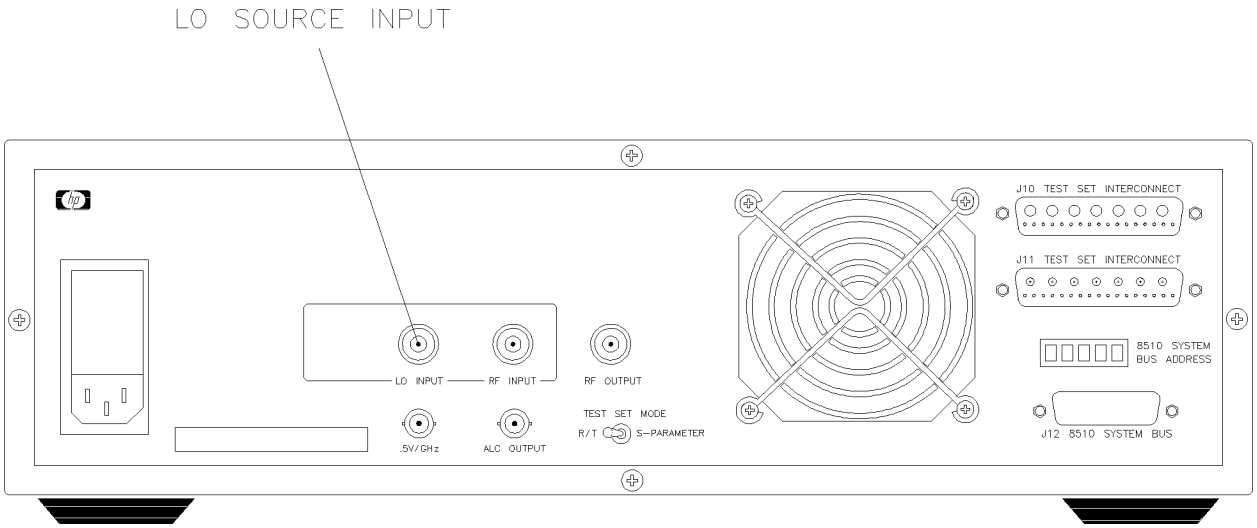


Figure 6-14 Rear Panel LO Input

1. Run the system software and select {***HIGHBAND***} to make the mm-wave controller active.
2. Choose a power meter that covers the 4 to 6 GHz frequency range (HP 436A meter and HP 8485A sensor). Calibrate the power meter and attach a 3.5 mm (female to female) adapter to the sensor.
3. Disconnect the LO source cable from the back of the instrument and attach the power sensor to the LO cable. Select {***SINGLE POINT MODE***} from the [**STIMULUS**] menu, then using the RPG knob, slowly scan over the frequency band. The power level should be 0 to +2 dBm.

LO Input to Leveling Amplifiers

Procedure 5

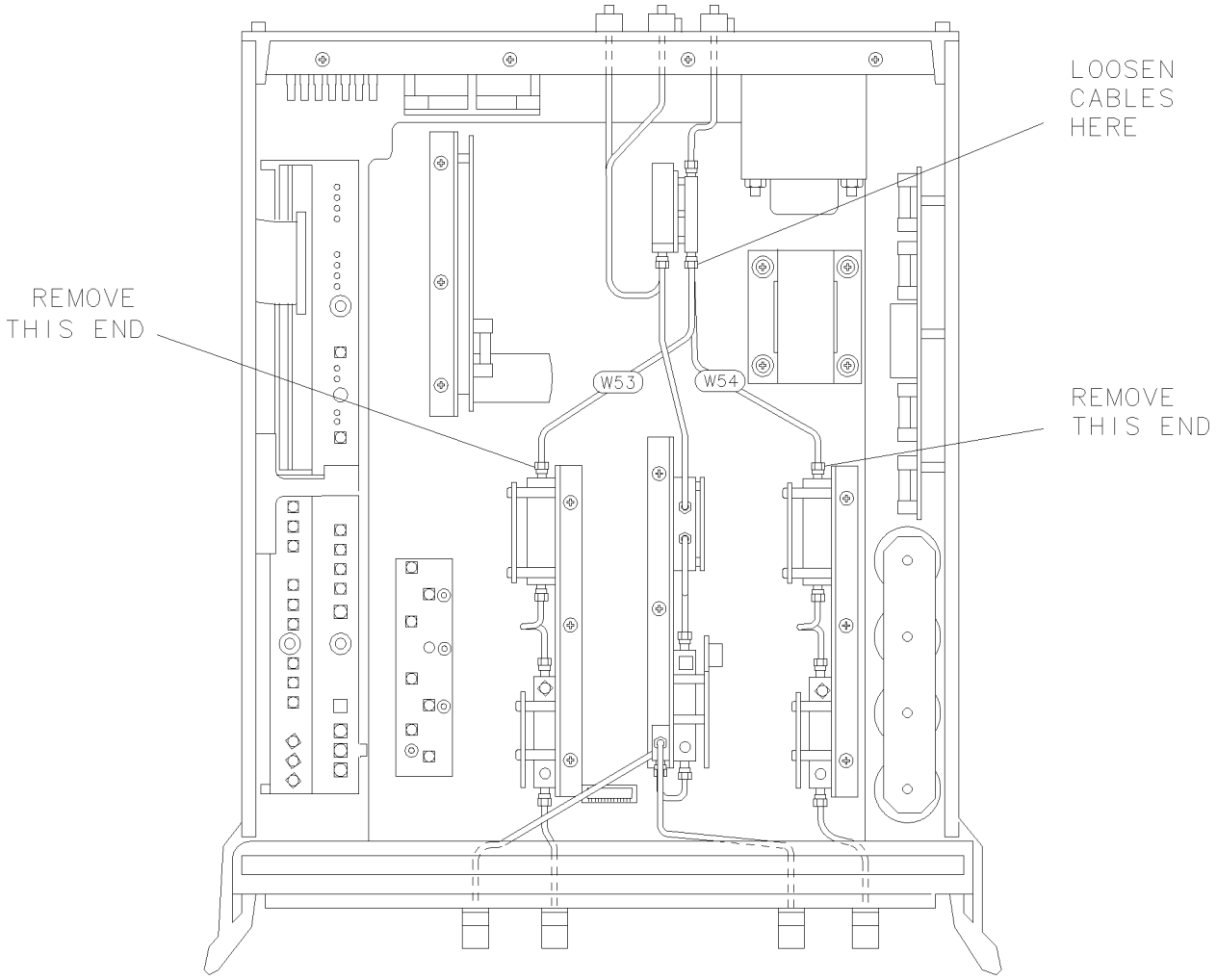


Figure 6-15 LO Input to Leveling Amplifiers

1. Run the system software. Select {***HIGHBAND***} to make the mm-wave controller active.
2. Choose a power meter that covers the 4 to 6 GHz frequency range (HP 436A meter and HP 8485A sensor). Calibrate the power meter and attach a 3.5 mm (female to female) adapter to the sensor.

3. Loosen the end of the coaxial cable attached to the power divider and detach the coaxial cable from the leveling amplifier. Rotate the amplifier end of the coaxial cable so that it is easily accessible and then tighten the power divider end. When checking the input to the port 1 leveling amplifier it will be necessary to remove the coaxial cable connecting the RF leveling amplifier to the coax switch, rotate the cable for better access and then reconnect at the coax switch. Attach the power sensor to the cable. Select {***SINGLE POINT MODE***} from the [**STIMULUS**] menu, then using the RPG knob, slowly scan the frequency band. The power level should be -3 to O dBm.

LO ALC Adjustment

Procedure 6

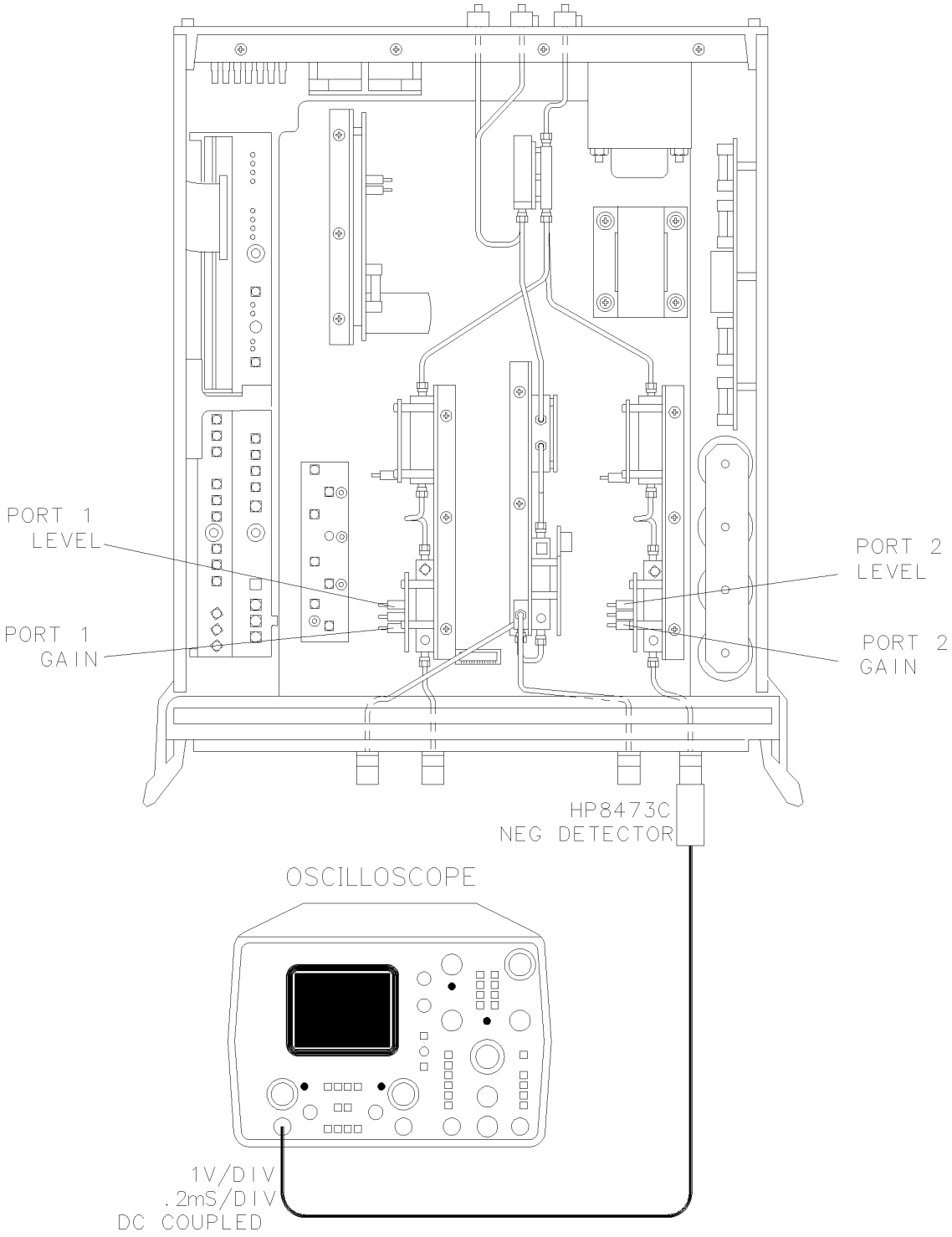


Figure 6-16 LO ALC Adjustment Points

1. Run the system software and select {***HIGHBAND***} to make the mm-wave controller active.
2. Check the user parameter (a1 or a2) for the LO port in question. The trace should be -15 ±2 dBm across the band as displayed on the HP 8510 CRT. If this is the case the LO ALC is adjusted properly. If the message **`NO IF FOUND`** is displayed and/or a trace is not observed at the level mentioned, the LO ALC adjustment needs to be made, continue with step 3.

NOTE

Step 3 should *only* be performed when an amplifier, coupler, or detector has been replaced.

3. Connect the oscilloscope and negative detector as shown in Figure 6-16 on page 6-32. Turn the gain adjustment fully clockwise. Oscillations should be visible on the oscilloscope. Turn the gain adjustment counter clockwise until the oscillations just disappear. Recheck the user parameters in step 2 and then continue with step 4.
4. Choose a power meter that covers the 4 to 6 GHz frequency range (HP 436A meter and HP 8485A sensor). Calibrate the power meter and attach a 3.5 mm 10 dB fixed attenuator (HP 8493C) and an adapter (female to female) to the sensor. Connect the sensor/attenuator to the LO output of the port in question. Turn the LO level adjustment so that +12 dBm is displayed on the power meter. The LO output is now set at +22 dBm. Select {***SINGLE POINT MODE***} from the [**STIMULUS**] menu, then using the RPG knob, slowly scan over the frequency band.
5. Adjust the LEVEL pot over the full adjustment range to make sure there are no oscillations at any power level. Then turn the GAIN pot three additional turns.

RF Amplifier Output

Procedure 7

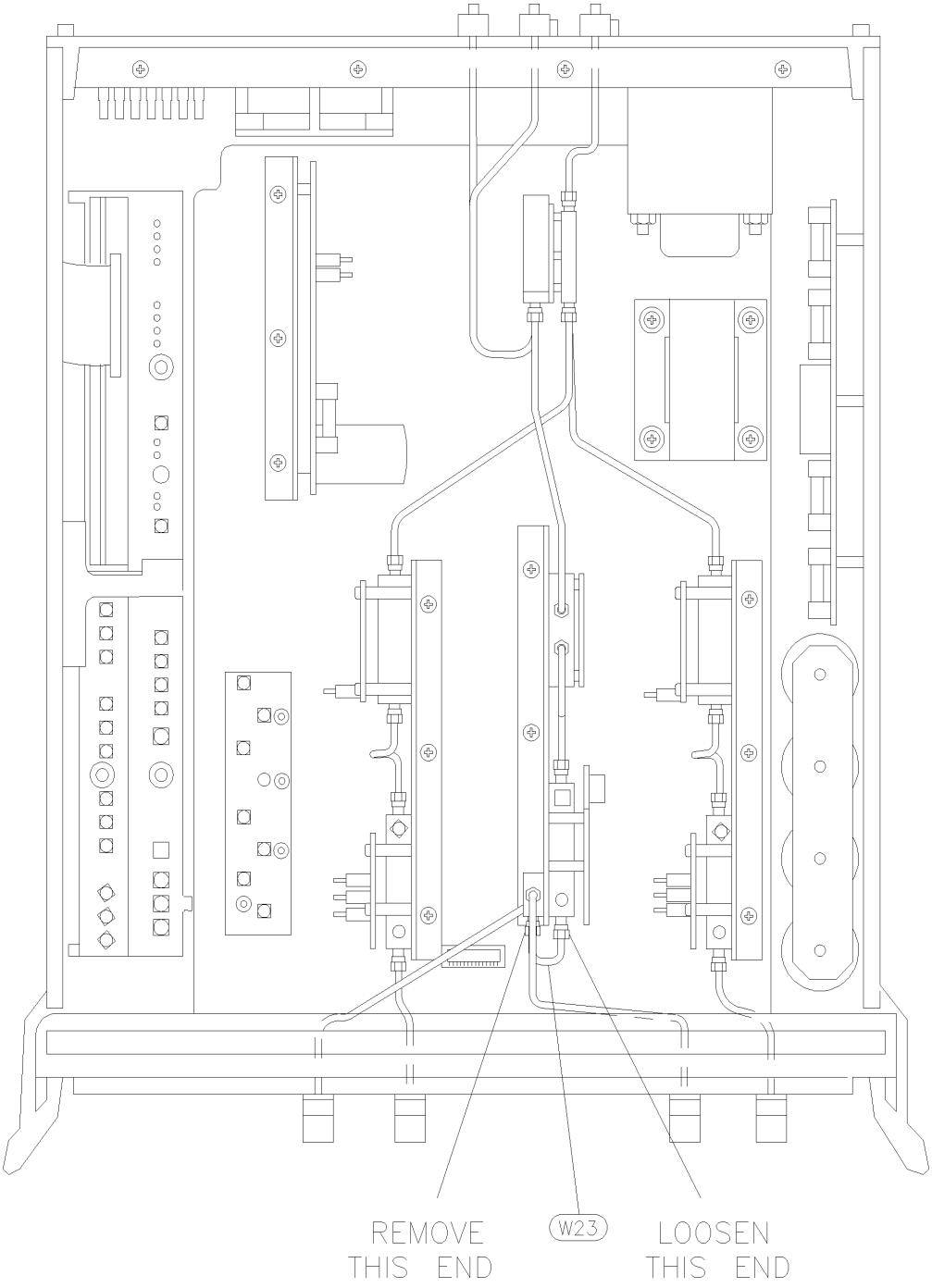


Figure 6-17 RF Amplifier Output

1. Run the system software and select {***HIGHBAND***} to make the mm-wave controller active.

NOTE

Make sure the highband test set is not connected to the module interface connectors.

2. Choose a power meter that covers the 13 GHz to 22 GHz frequency range (HP 436A meter and HP 8485A sensor). Calibrate the power meter and attach a 3.5 mm 10 dB fixed attenuator (HP 8493C) and a female to female adapter to the sensor.
3. Loosen the end of the coax cable attached to the output of the RF leveling amplifier coupler and detach the other end of the coax cable from the pin switch. Rotate the cable and attach the power meter sensor. Tighten the cable end attached to the RF leveling amplifier. Select {***SINGLE POINT MODE***} from the [**STIMULUS**] menu, then using the RPG knob, slowly scan over the frequency band. Power should be +22 dBm ±2 dB.

RF Input at Rear Panel

Procedure 8

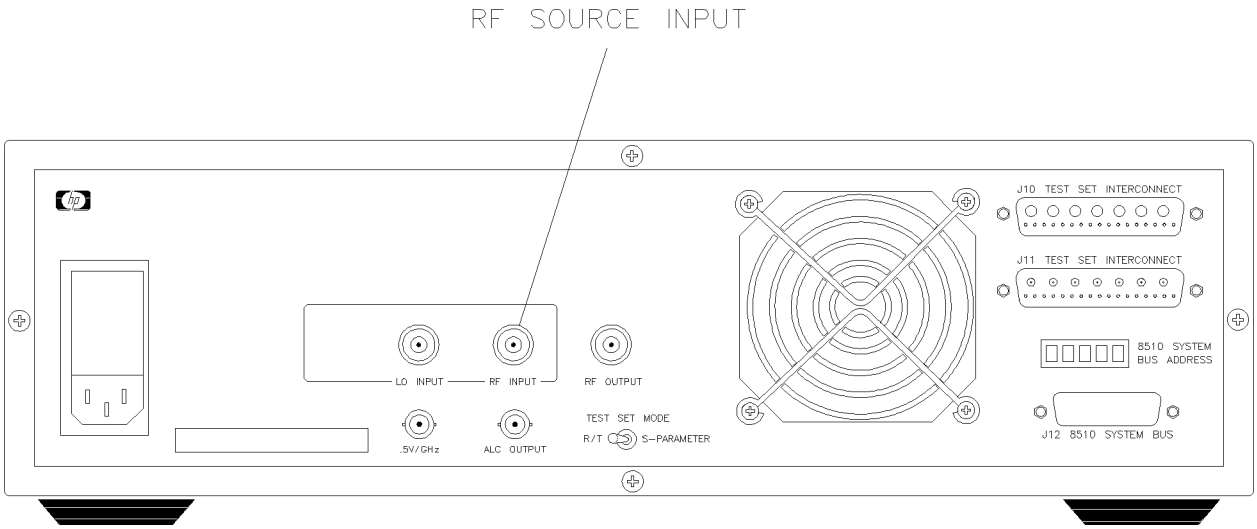


Figure 6-18 Rear Panel RF Input

1. Run the system software and select {***HIGHBAND***} to make the mm-wave controller active.
2. Choose a power meter that covers the 13 GHz to 21 GHz frequency range (HP 436A meter and HP 8485A sensor). Calibrate the power meter and attach a 3.5 mm (female) to 2.4 mm (female) adapter to the sensor.
3. Disconnect the RF source cable from the back of the instrument and attach the power sensor to the cable. Select {***SINGLE POINT MODE***} from the [**STIMULUS**] menu, then using the RPG knob, slowly scan over the frequency band. The power level should be greater than +13 dBm.

Because the RF source is externally leveled, when the RF path is broken to measure the signal level the source will output its maximum power of greater than 13 dBm.

Coax Switch Voltages

Procedure 9

Microwave Operation

The coax switch Figure 6-19 (HP part number 33311C) routes the source RF through the HP 85105A and to the optional coax test set when HP-IB test set address 20 is selected on the HP 8510. At that time the bias voltages on the coax switch are as shown in Figure 6-20 (HP part number 33311C). The HP part number for Figure 6-21 on page 6-38 is 0955-0603.

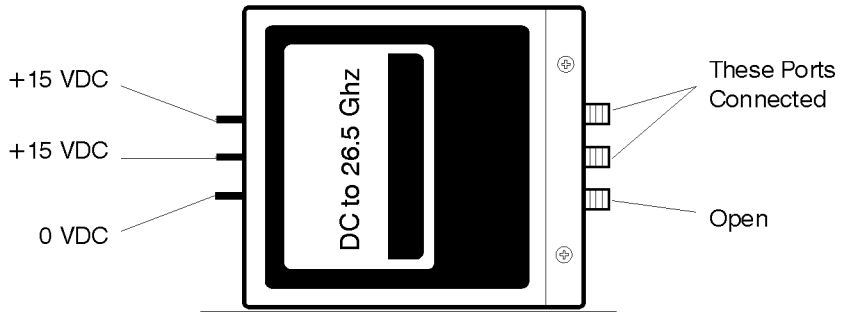


Figure 6-19 Switch Bias Voltages, Microwave Operation (HP 85105A Standard)

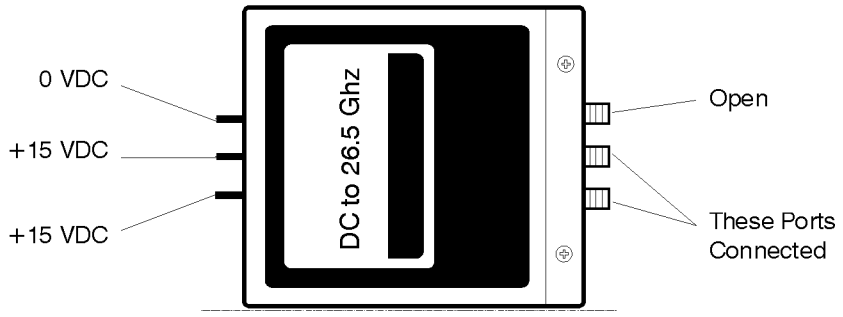


Figure 6-20 Switch Bias Voltages, mm-Wave Operation (HP 85105A Std, Opt 004)

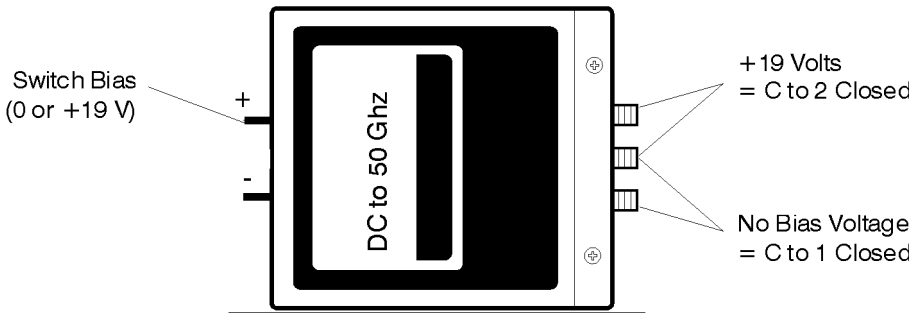


Figure 6-21 Switch Bias Voltages, (HP 85105A)

A5 Attenuator Switch Driver Board

Procedure 10

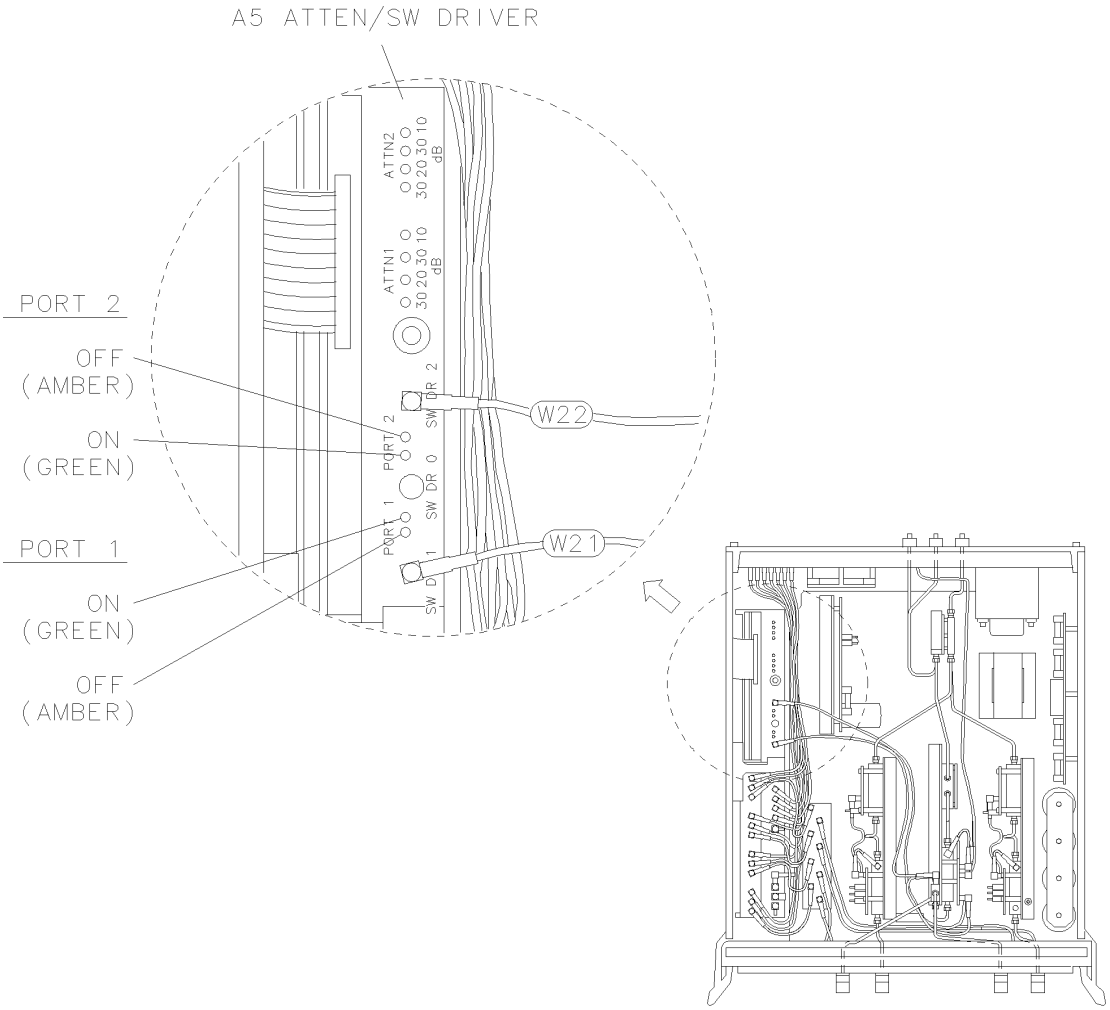


Figure 6-22 Attenuator Switch Driver Board

1. Remove cables W21 and W22 from the A5 attenuator switch driver board.
2. Switch the instrument to port 1. When port 1 is active, the port 1 indicator light on the A5 board will be green and the port 2 indicator light will be amber. The voltage measured at A5J1 is +15 ±1.5 Vdc and the voltage measured at A5J2 is -15 ±1.5 Vdc.
3. Switch the instrument to port 2. When port 2 is active, the port 2 indicator light on the A5 board will be green and the port 1 indicator light will be amber. The voltage measured at A5J1 is -15 ±1.5 Vdc and the voltage measured at A5J2 is +15 ±1.5 Vdc.

IF Path a1, a2, b1, b2

Procedure 11

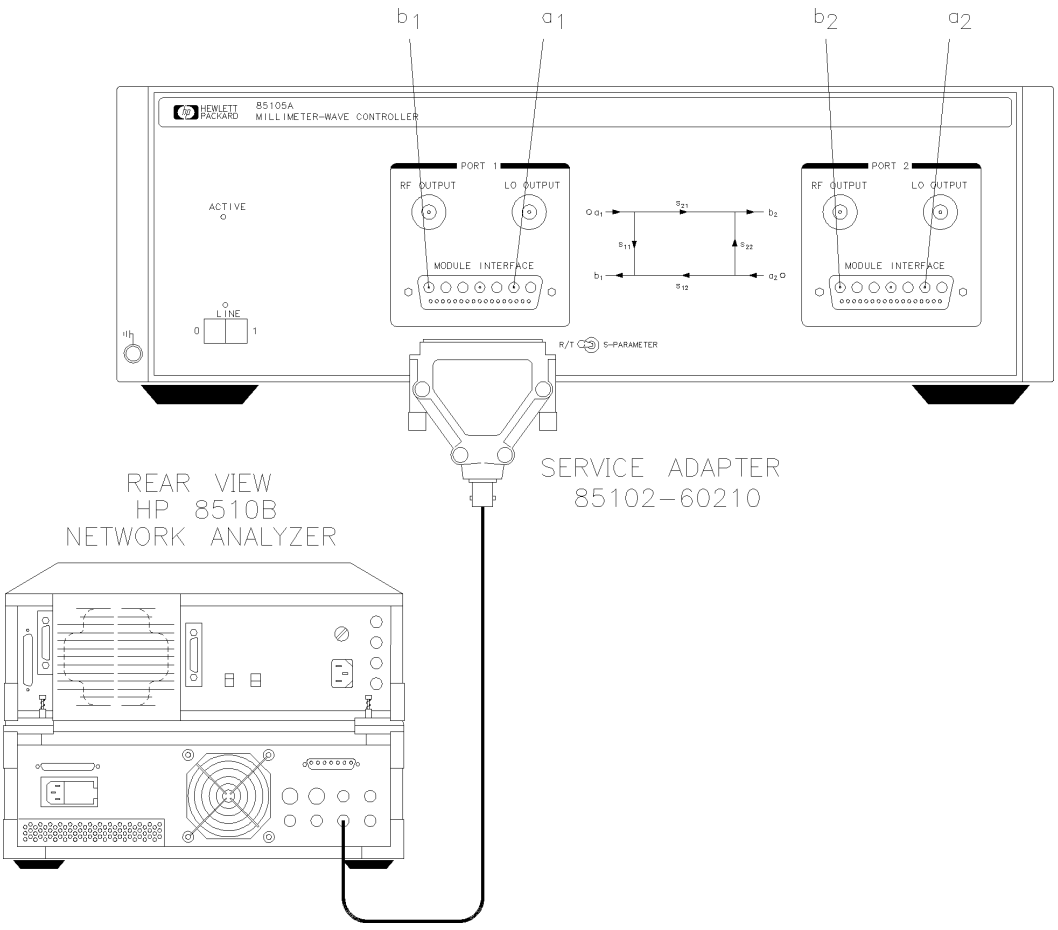


Figure 6-23 IF Inputs

1. Connect a BNC cable to the 20 MHz Out on the rear panel of the HP 85102 and to the service adapter. Connect the service adapter to the port 1 module interface.
2. A 20 MHz signal is routed from the HP 85102 through the service adapter and injected into the a1 and b1 inputs of the module interface, as shown in Figure 6-23 on page 6-40. Check the a1 and b1 user parameters for port 1. The traces should be flat lines approximately - 5 dB across the band (on the HP 8510 CRT).
3. Repeat steps 1 and 2 for the user parameters a2 and b2 at the module interface at port 2.

A2 IF Multiplexer

Procedure 12

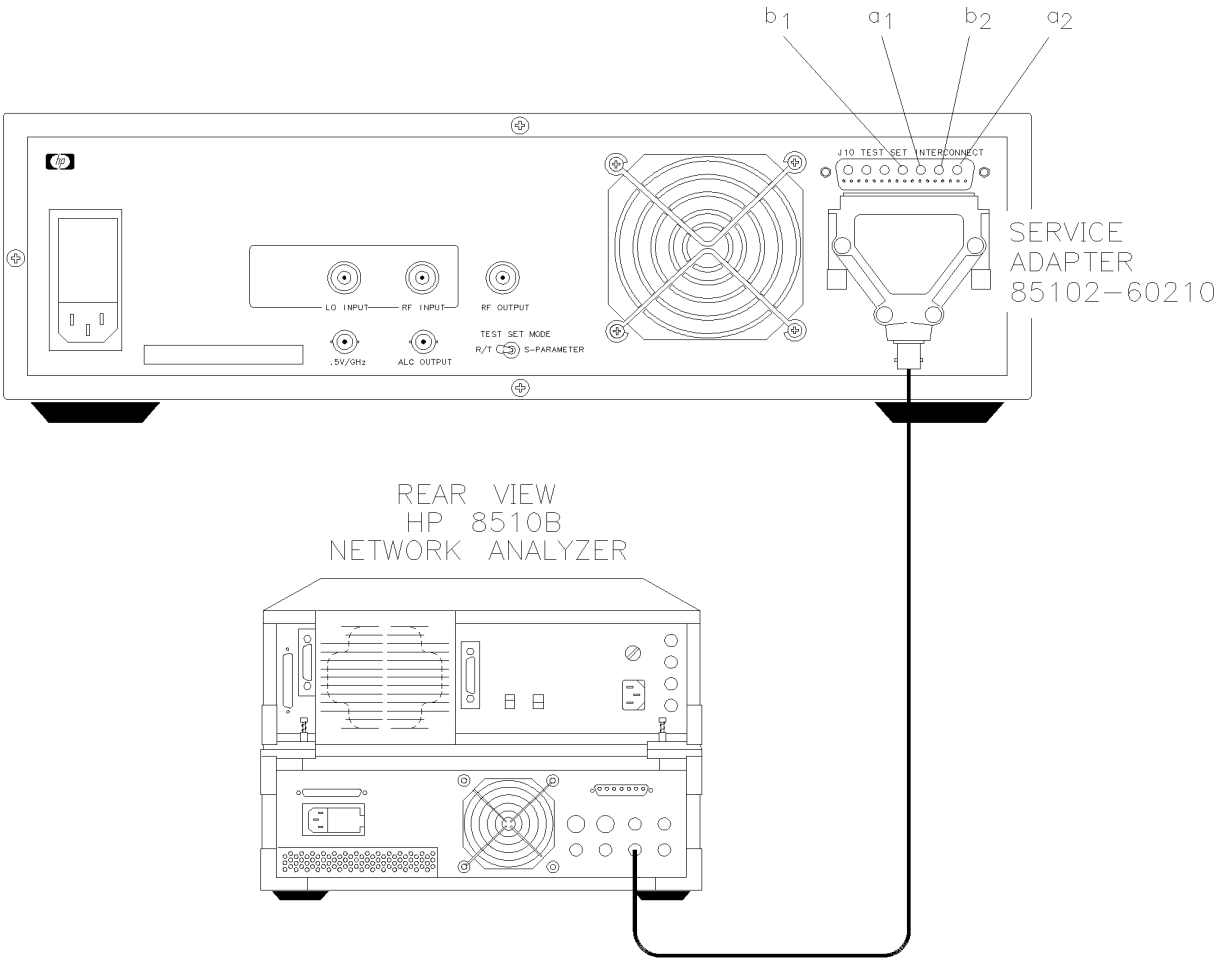


Figure 6-24 Multiplexer Inputs

1. Switch the system to microwave operation by choosing test set address 20 for the coaxial test set.
2. Connect a BNC cable to the 20 MHz Out on the rear panel of the HP 85102 and to the service adapter. Connect the service adapter to the J10 TEST SET INTERCONNECT on the rear panel of the HP 85105A. A 20 MHz signal is routed from the HP 85102 through the service adapter and injected into the a1, a2, b1, and b2 inputs of the J10 TEST SET INTERCONNECT.
3. Check the a1, a2, b1, and b2 user parameters. The traces should be flat lines approximately -28 dB across the band (on the HP 8510 CRT).

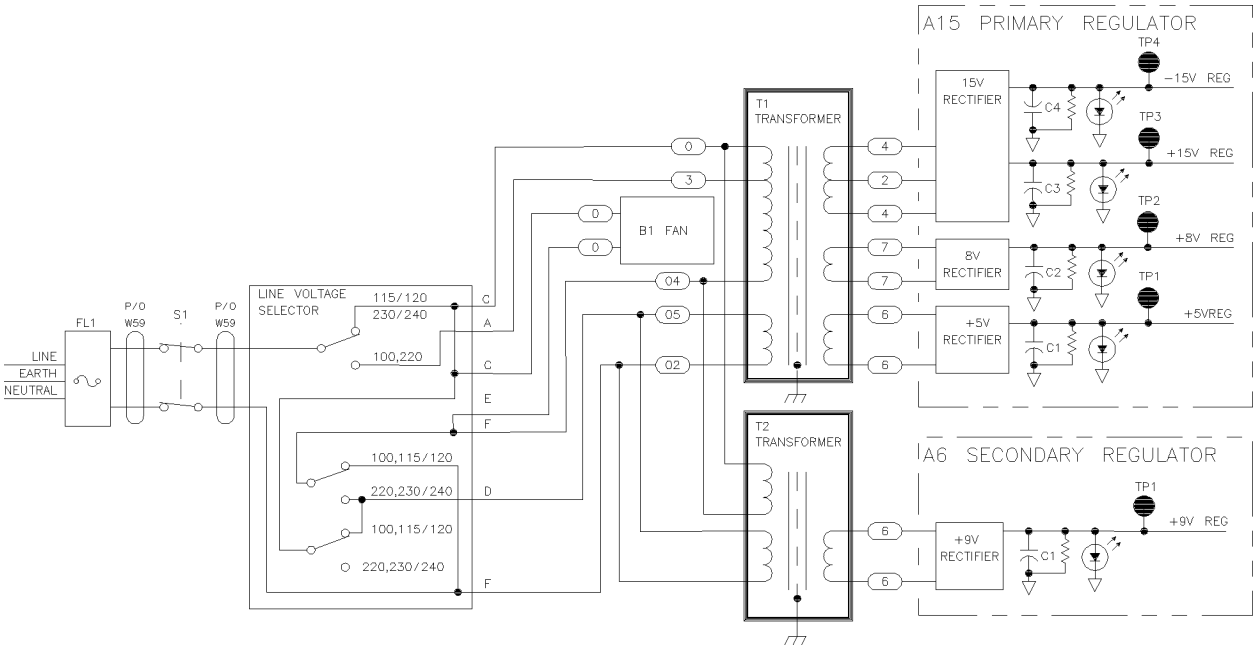


Figure 6-25 HP 85105A Power Supply Block Diagram

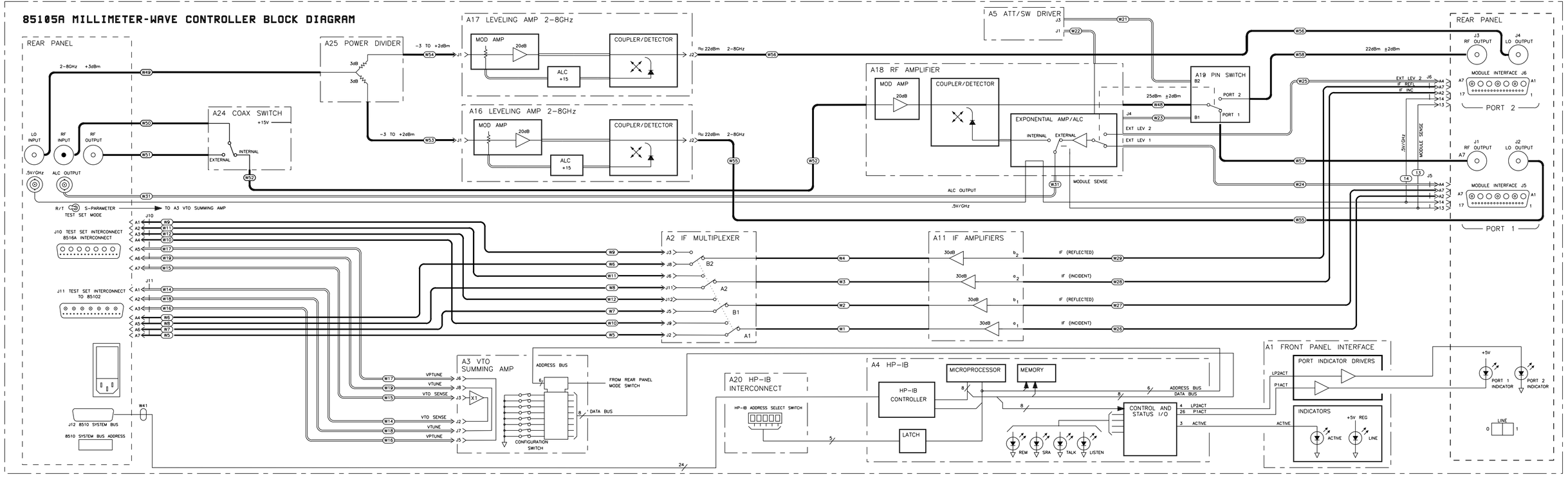


Figure 6-26. HP 85105A Controller Block Diagram

Replaceable Parts

This section contains information for ordering replaceable parts. The replaceable parts include major assemblies and chassis hardware.

R-E (Rebuilt-Exchange) Assemblies Cost Less

Some assemblies are available through the rebuilt-exchange program. These factory rebuilt (repaired and tested) assemblies meet all factory specifications required of a new assembly. They are offered on an exchange (trade-in) basis only. The defective assembly must be returned for credit. Figure 6-27 on page 6-47 illustrates the procedure. The rest of the figures provide parts information. If you have any questions, contact your HP customer engineer.

Replaceable Parts List

The following figures assist in locating and identifying all replaceable parts, including corresponding lists that provide the following information.

- Hewlett-Packard part number.
- Part quantity as shown in the figure. There may be more of the same part in the instrument.
- Part description, using abbreviations.

Ordering Information

To order a part listed in the replaceable parts lists:

- Quote the Hewlett-Packard part number.
- Indicate the quantity required.
- Address the order to the nearest Hewlett-Packard office.

To order a part that is *not* listed:

- Include the instrument model number.
- Complete serial number.
- Description and function of the part.
- Number of parts required.
- Address the order to the nearest Hewlett-Packard office.

To Order Parts.....Fast

Monday through Friday, 6 am to 5 pm (Pacific Standard Time) call:

(800) 227-8164

The parts specialists have a direct on-line access to replacement parts inventory corresponding to the replaceable parts list in this manual. There is a charge for hot-line one day delivery, but four day delivery time is standard.

After hours and holidays, call:

(415) 968-2347

This service applies to the United States Only. Outside the United States, contact your nearest HP office.

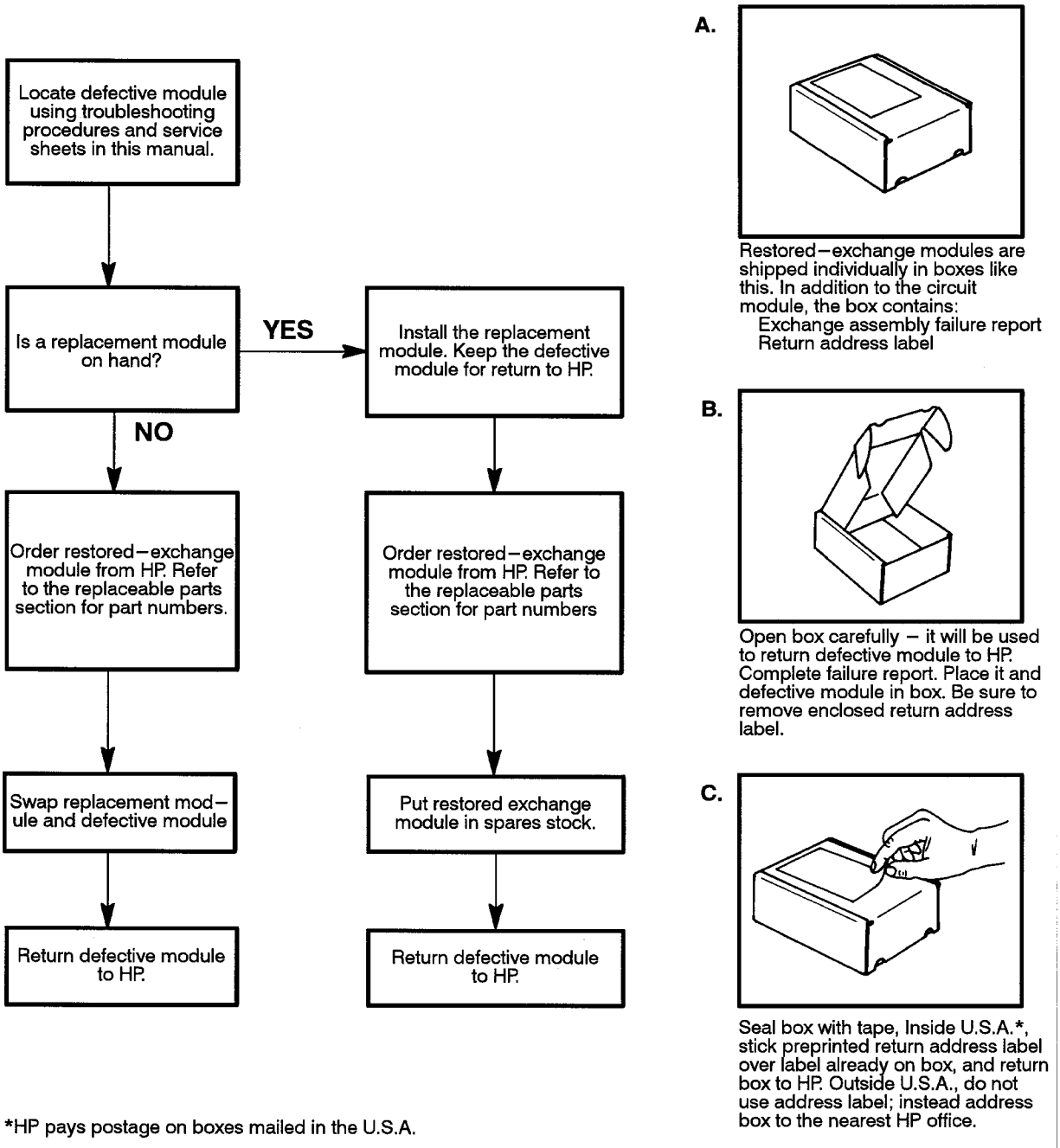


Figure 6-27 The Low Cost Rebuilt Exchange Procedure

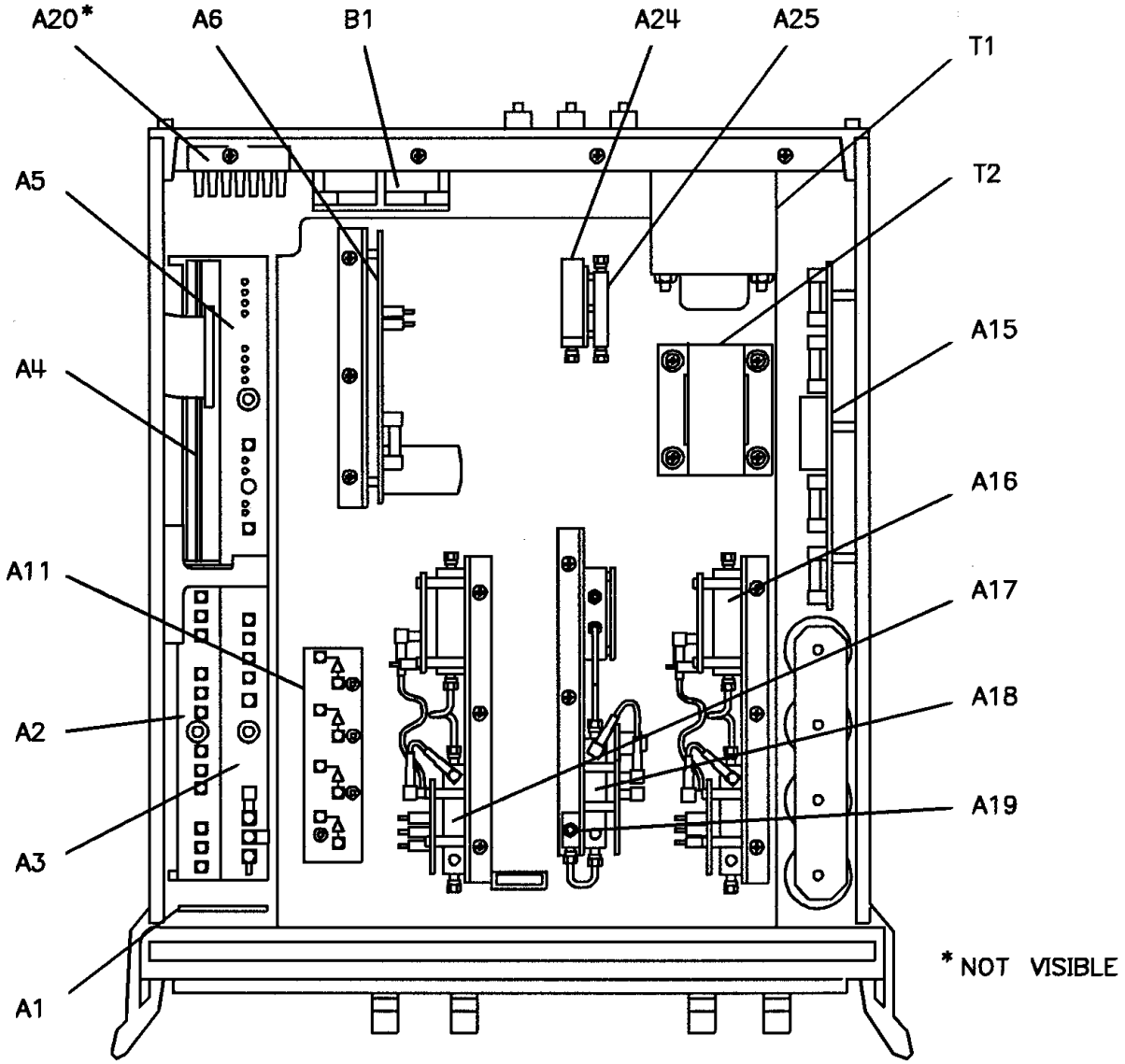


Figure 6-28 HP 85105A Major Assemblies

Table 6-4 HP 85105A Major Assembly Parts

Reference Designator	Qty	Description	HP Part Number
A1	1	Front Panel Interface Board Assembly	08513-60005
A2	1	IF Multiplexer Board Assembly	08513-69004
A2	1	IF Multiplexer Board Assembly (R-E)	08513-60004
A3	1	VTO Summing Amplifier Board Assembly	85105-60016
A4	1	HP-IB Board Assembly	85105-60014
A5	1	Attenuator/Switch Driver Board Assembly	85105-60003
A6	1	Secondary Regulator Board Assembly 9 Vdc	85105-60006
A7-10		Not Assigned	
A11	1	IF Amplifier Assembly	85105-60011
A11	1	IF Amplifier Assembly (R-E)	85105-69011
A12-14		Not Assigned	
A15	1	Primary Regulator board Assembly +5, +8, $\pm$ 15 Vdc	85105-60002
A15	1	Primary Regulator board Assembly +5, +8, $\pm$ 15 Vdc (R-E)	85105-69002
A16-A17	1	LO Leveling Amplifier Assembly Port 1 and Port 2	85105-60008
A16-A17	1	LO Leveling Amplifier Assembly Port 1 and Port 2 (R-E)	85105-69008
A18	1	RF Leveling Amplifier Assembly	85105-60009
A18	1	RF Leveling Amplifier Assembly (R-E)	85105-69009
A19	1	Pin Switch (standard)	85105-60012
A19	1	Pin Switch (standard) (R-E)	85105-69012
A20	1	HP-IB Interface Board Assembly	08513-60006
A21-A23		Not Assigned	
A24	1	Coaxial RF Switch	33311-60048
A24	1	Coaxial RF Switch, 50 GHz (Option 050)	0955-0603
A25	1	Power Divider 2 - 8 GHz	0955-0264
B1	1	FAN-TBAX34-CFM 115V 50/60 Hz 1.5KVDIEL	08513-20031
T1	1	Power Transformer	5181-0161
T2	1	Power Transformer	5181-0178

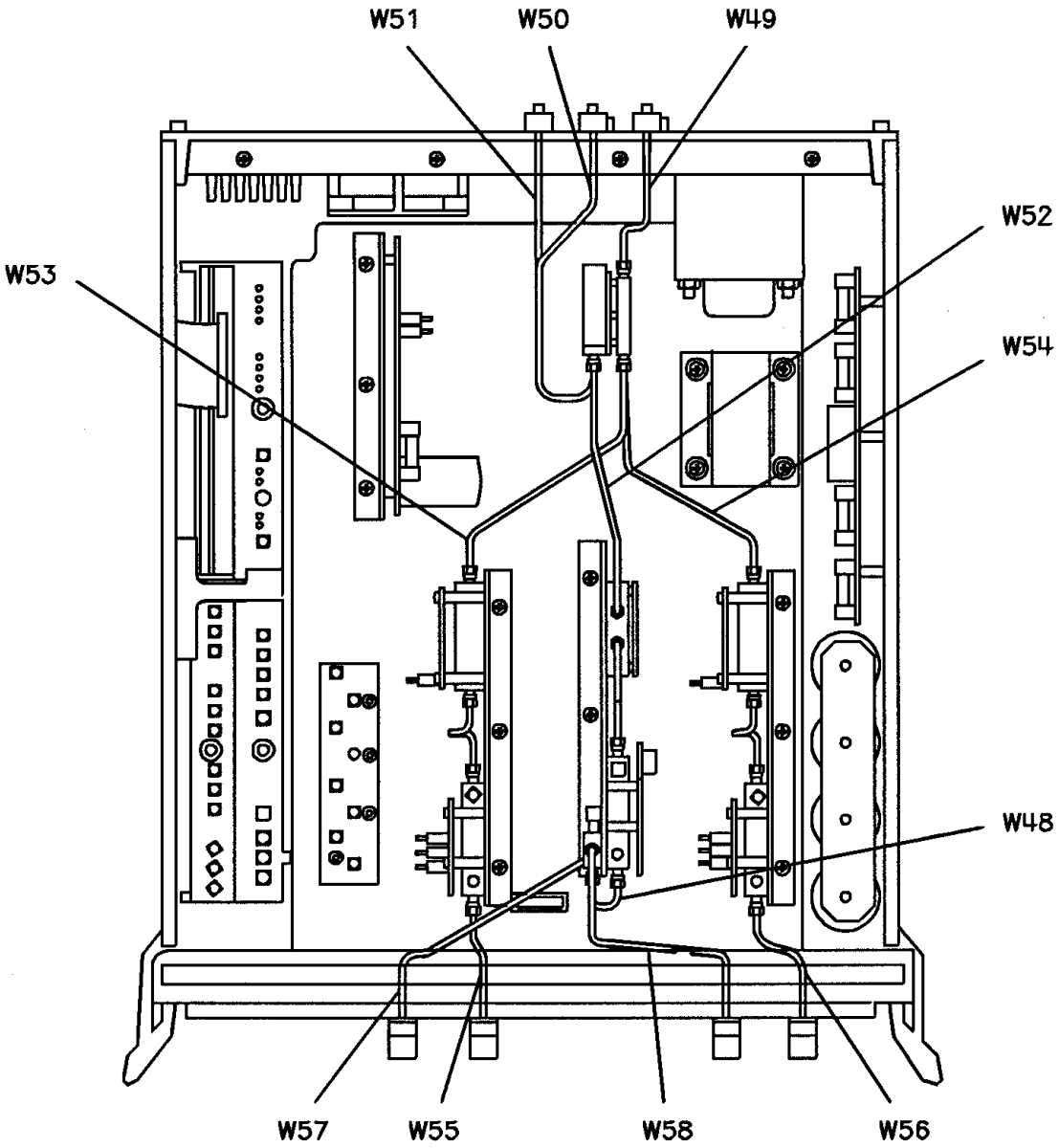


Figure 6-29 HP 85105A Semi-rigid RF Cables

Table 6-5 HP 85105A Semi-rigid RF Cable Parts

Reference Designator	Qty	Semi-Rigid RF Cable Descriptions	HP Part Number
W48	1	A19J to A18 Coupler (Standard)	85105-20032
W48	1	A19J to A18 Coupler (Option 050)	85105-20050
W49	1	A25 To Rear Panel LO Input	85105-20033
W50	1	A24 To Rear Panel RF Input	85105-20034
W50	1	A24 To Rear Panel RF Input (Option 050)	85105-20018
W51	1	A24 To Rear Panel RF Output	85105-20035
W51	1	A24 To Rear Panel RF Output (Option 050)	85105-20019
W52	1	A24 To A18 Mod Amplifier	85105-20036
W52	1	A24 To A18 Mod Amplifier (Option 050)	85105-20020
W53	1	A25 To A16 Mod Amplifier	85105-20037
W54	1	A25 To A17 Mod Amplifier	85105-20038
W55	1	A16 Coupler to Front Panel J2	85105-20039
W56	1	A17Coupler to Front Panel J4	85105-20040
W57	1	A19 to Front Panel J1 (Standard)	85105-20041
W57	1	A19 to Front Panel J1 (Option 050)	85105-20051
W58	1	A19 to Front Panel J3 (Standard)	85105-20042
W58	1	A19 to Front Panel J3 (Option 050)	85105-20052

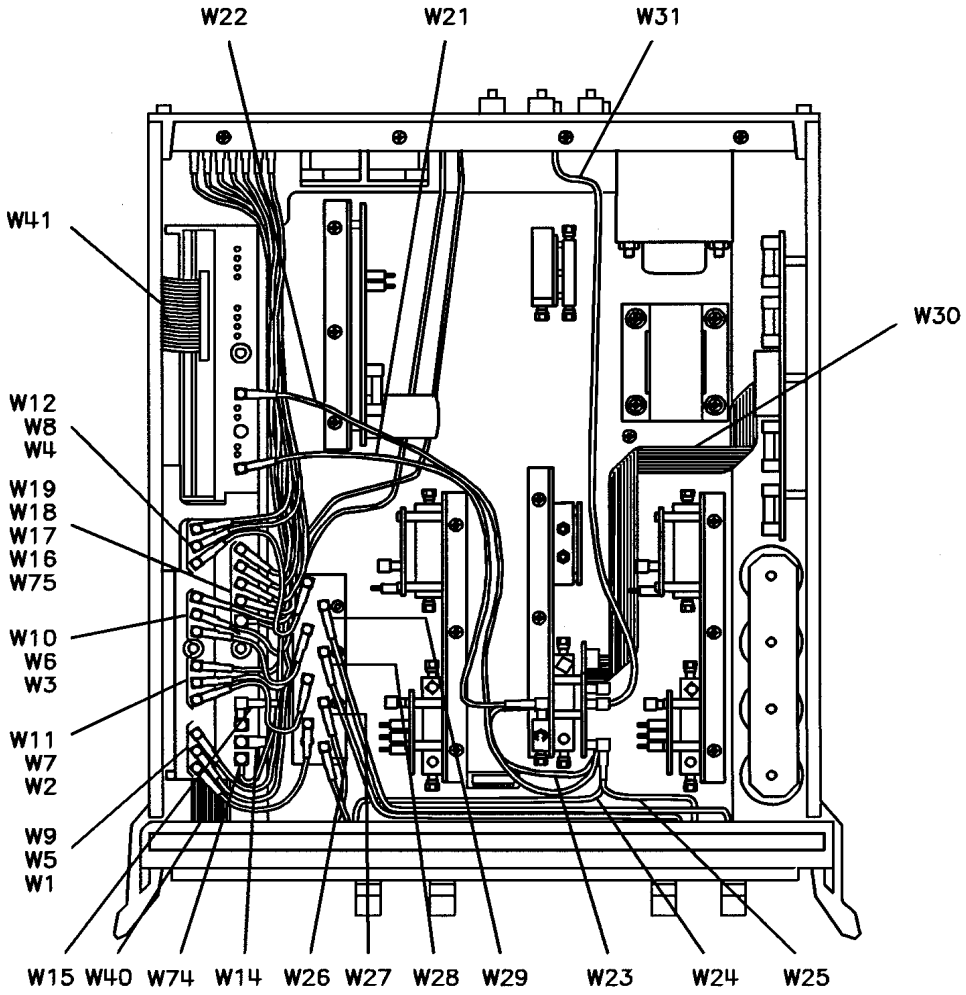


Figure 6-30 HP 85105A Flexible RF Cables

Table 6-6 Flexible RF and Ribbon Cable Parts

Reference Designator	Qty	Description	HP Part Number
W1	1	A2J1 to A11a1 Flexible RF Cable	85105-60111
W2	1	A2J4 to A11b1 Flexible RF Cable	85105-60111
W3	1	A2J7 to A11a2 Flexible RF Cable	85105-60111
W4	1	A2J10 to A11b2 Flexible RF Cable	85105-60111
W5	1	A2J2 to J11A1 Flexible RF Cable	08513-60125
W6	1	A2J8 to J11A4 Flexible RF Cable	08513-60126
W7	1	A2J5 to J11A2 Flexible RF Cable	08513-60127

Table 6-6 Flexible RF and Ribbon Cable Parts (Continued)

Reference Designator	Qty	Description	HP Part Number
W8	1	A2J11 to J11A3 Flexible RF Cable	08513-60128
W9	1	A2J3 to J10A1 Flexible RF Cable	08513-60129
W10	1	A2J9 to J10A4 Flexible RF Cable	08513-60130
W11	1	A2J6 to J10A6 Flexible RF Cable	08513-60131
W12	1	A2J2 to J10A3 Flexible RF Cable	08513-60132
W13		Not Assigned	
W14	1	A3J2 to J11A7 Flexible RF Cable	08513-60134
W15	1	A3J3 to J10A7 Flexible RF Cable	08513-60135
W16	1	A3J5 to J11A5 Flexible RF Cable	08513-60136
W17	1	A3J6 to J10A5 Flexible RF Cable	08513-60137
W18	1	A3J7 to J11A6 Flexible RF Cable	08513-60138
W19	1	A3J8 to J10A6 Flexible RF Cable	08513-60139
W20		Not Assigned	
W21	1	A5J3 to A19B2 Flexible RF Cable	85105-60101
W22	1	A5J1 to A18 Flexible RF Cable	85105-60102
W23	1	A18J4 to A19B1 Flexible RF Cable	85105-60103
W24	1	A18 to J5A4 Flexible RF Cable	85105-60104
W25	1	A18to J6A4 Flexible RF Cable	85105-60105
W26	1	A11a1 to J5A2 Flexible RF Cable	85105-60106
W27	1	A11b1 to J5A6 Flexible RF Cable	85105-60107
W28	1	A11a2 to J6A2 Flexible RF Cable	85105-60108
W29	1	A11b2 to A6J6 Flexible RF Cable	85105-60109
W30	1	A15 to A18 Ribbon Cable	85105-60121
W31	1	A18 to Rear Panel ALC Flexible RF Cable	85105-60110
W40	1	A1 to A10 Ribbon Cable	08513-60013
W41	1	A4 to A20 Ribbon Cable	08513-60036
W74	1	A3J1 to Rear Panel Test Set Mode Switch Flexible RF Cable	85105-60133
W75	1	A3J4 to Rear Panel Test Set Mode Switch Flexible RF Cable	85105-60134

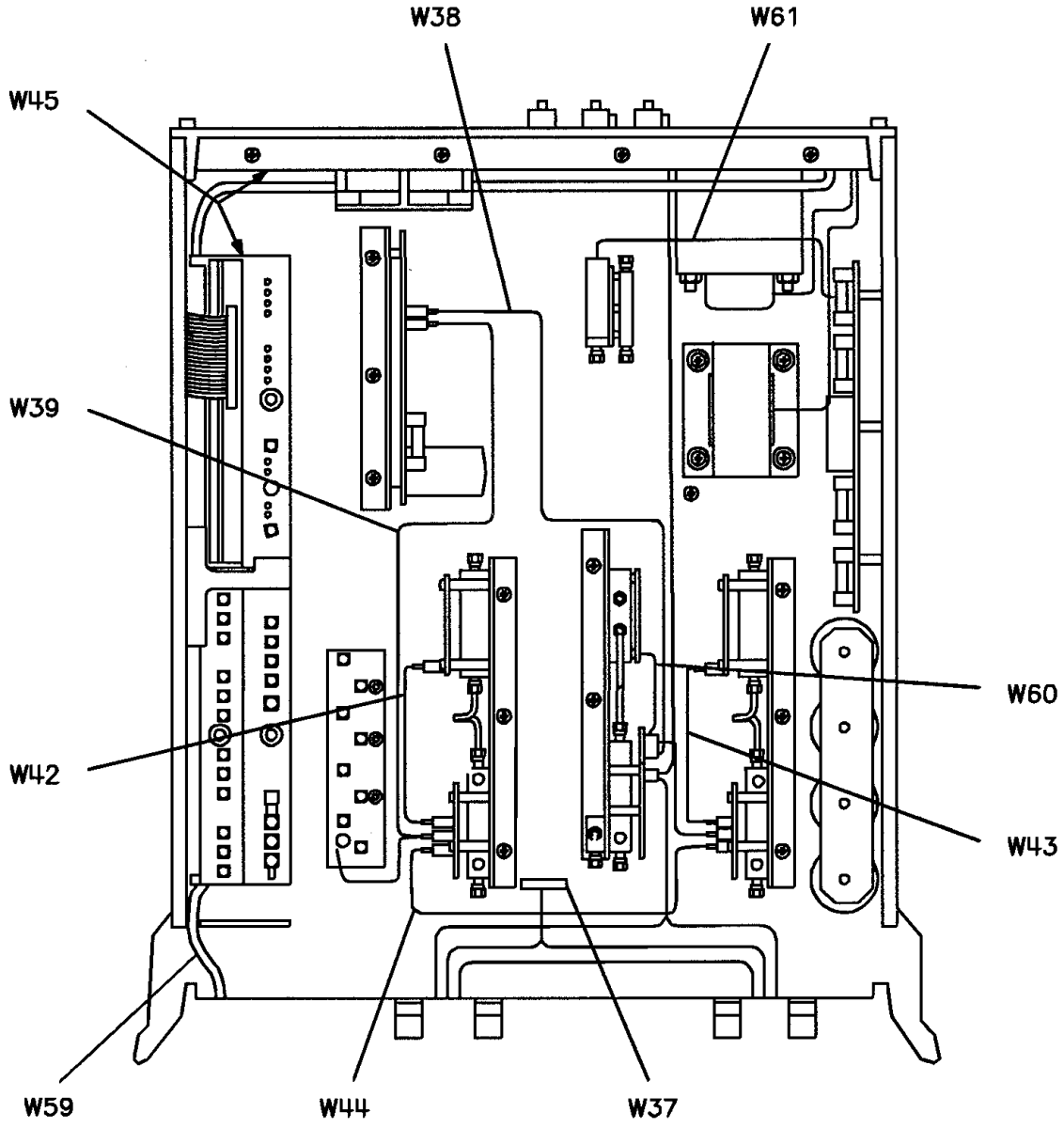


Figure 6-31 Wire Harnesses

Table 6-7 Wire Harness Parts

Reference Designator	Qty	Description	HP Part Number
W42	1	A16 ALC to Bias Board Cable Assembly	85105-60117
W43	1	A17 ALC to Bias Board Cable Assembly	85105-60117
W37	1	A10J3 to Front Panel J5 and J6, A18 and Rear Panel .5V GHz Cable Assembly	85105-60114
W38	1	A6 to A18 and A17 Cable Assembly	85105-60115
W39	1	A6 to A16 and A11 Cable Assembly	85105-60116
W44	1	A16 ALC Board to A17 ALC Board Cable Assembly	85105-60018
W45	1	J10 and J11 to J7 Motherboard Cable Assembly	08513-60014
W59	1	Line Switch Cable Assembly	85102-60226
W60	1	A18 ALC to Bias Board Cable Assembly	85105-60119
W61	1	J8 Motherboard to A24 (standard, option 004) Cable Assembly	85105-60120
W61	1	J8 Motherboard to A24 (options 050, 054) Cable Assembly	85105-60020
W62	1	Not Assigned	

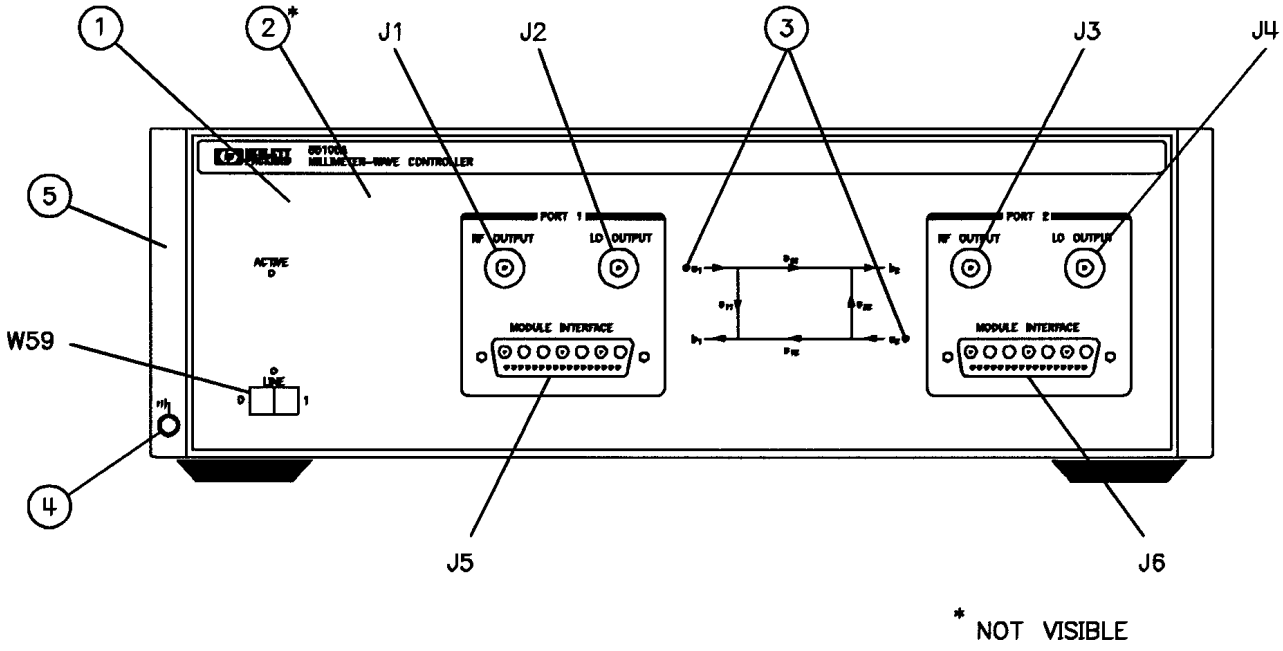


Figure 6-32 HP 85105A Front Panel

Table 6-8 HP 85105A Front Panel Miscellaneous Parts

Reference Designator	Qty	Description	HP Part Number
1	1	Front Panel Dress	85105-00001
2	1	Sub Panel	85105-00002
3	1	LED Lamp 25 MA MAX	1990-0858
	1	Retainer LED	1450-0615
	1	LED Mount	08340-40002
4	1	Binding Post Assembly	1510-0038
	1	Lock Washer .25 in	2190-0067
	1	Hex Nut Double Cham 1/4-32	2950-0006
5	1	Front Bezel	5021-8747
J1 - J4	1	3.5 mm Connector Assembly	5061-5316
	1	Lock Washer	2190-0104
	1	Hex Nut	2950-0132
J5 - J6	1	24 Pin connector Female	1251-2197
W59		(See HP 85105A Millimeter-Wave Controller Block Diagram)	

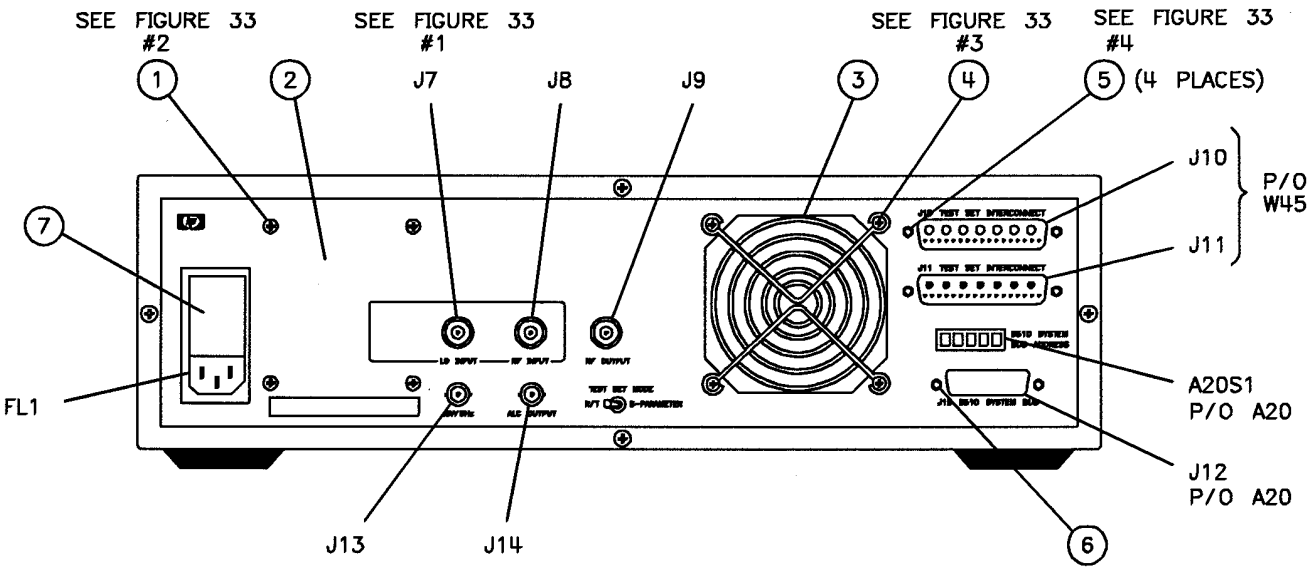
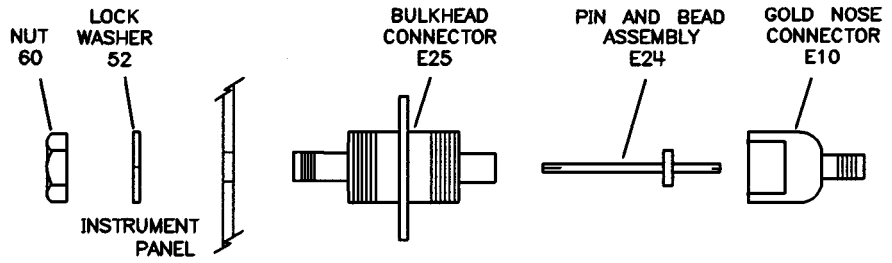


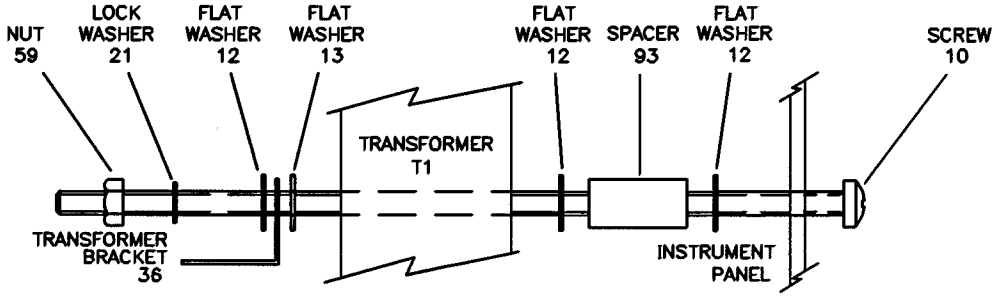
Figure 6-33 Rear Panel (Standard, Option 050)

Table 6-9 Rear Panel Miscellaneous Parts (Standard, Option 050)

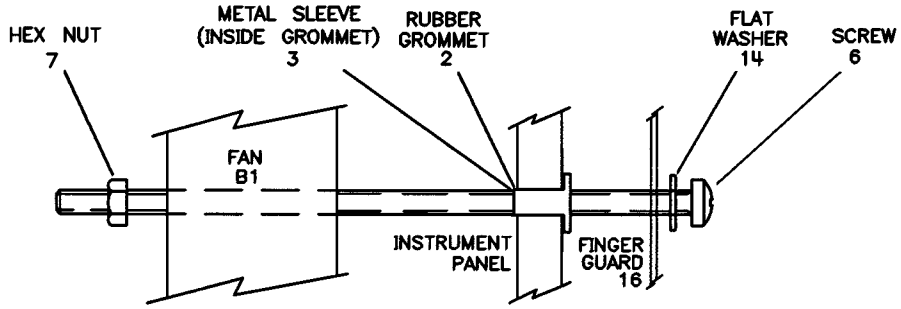
Reference Designator	Qty	Description	HP Part Number
1	1	Machine Screw 8-32 3.25 inch	2510-0270
	1	Flat Washer MTLC NO. 8	3050-0139
	1	Lock Washer NO. 10	2190-0017
	1	Hex Nut DBL-CHAM 3/8-32	2950-0001
	1	Round Spacer .625-IN-LG	0380-0010
2	1	Rear Panel (Standard)	85105-0003
2	1	Rear Panel (Option 050)	85105-0013
3	1	Finger Guard	3160-0309
4	1	Grommet-RND	0400-0002
	1	Threaded Insert Standoff	0590-0926
	1	Machine Screw 6-32	2360-0123
	1	Hex Nut 3-32	2420-0001
	1	Flat Washer NO. 6	3050-0227
5	1	Connector Jackscrew	1251-7812
	1	Hex Nut 4/40	0590-0663
6	1	Standoff Hex	0380-0643
7	1	Line Module Retainer Clips	5001-3907
J7 - 9	1	Gold Nose Connector (Standard)	08513-20016
	1	Pin and Dead Assembly (Standard)	5061-5394
	1	Bulkhead Connector (Standard)	08513-20017
	1	Lock Washer 7/16 (Standard)	2190-0104
	1	Hex Nut 7/16 (Standard)	2950-0132
J8,9	2	2.4mm (female) Bulkhead Connector (Option 050)	5062-7243
J13 -14	1	BNC Connector (female) 50 ohm	1250-0083
	1	Lock Washer 3/8 IN	2190-0016
	1	Hex Nut 3/8	2950-0001
FL1	1	Line Module-Filtered	9135-0217



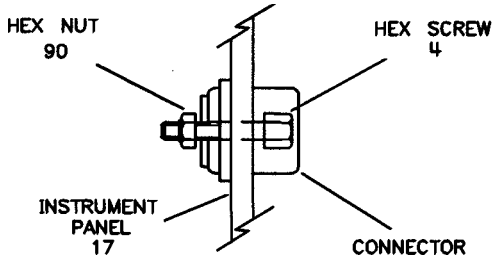
Rear-RF Input Connector (Standard)



Hardware Stack-UP-Transformer



Hardware Stack-Up Fan



Hardware Stack-Up Rear Panel Cable connectors

Figure 6-34 Detailed Views

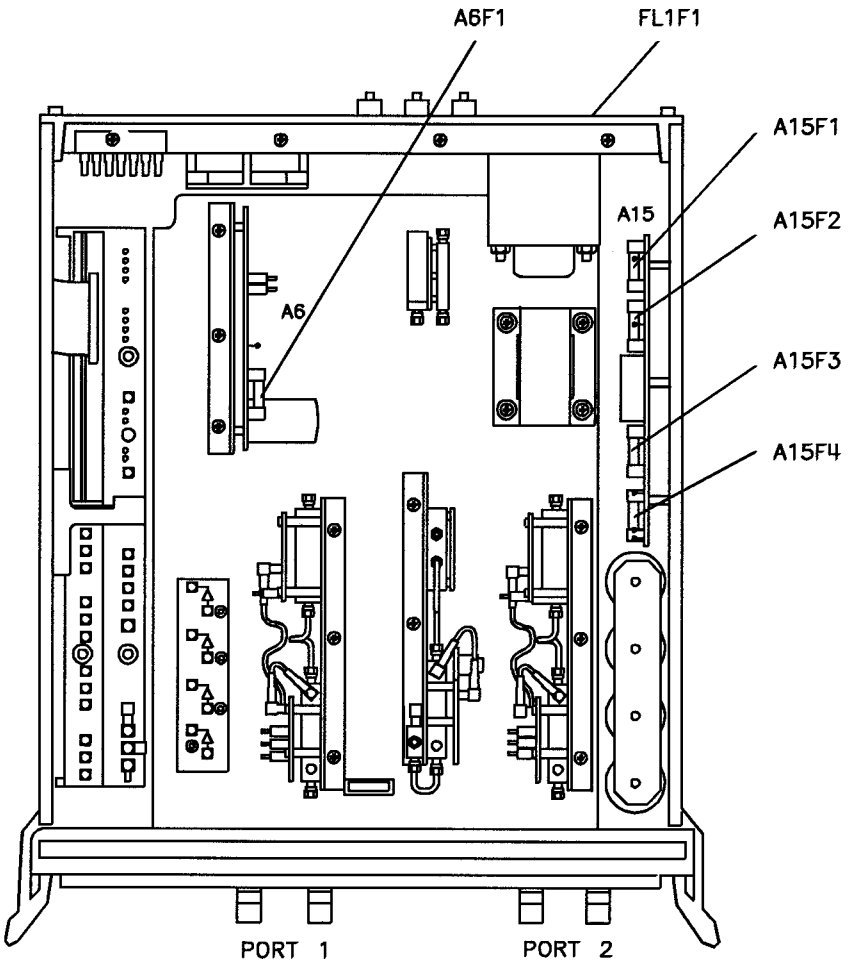


Figure 6-35 Fuse Locations and Values

Table 6-10 Fuse Locations, Values and Parts

Reference Designators	Qty	Descriptions	HP Part Number
A6F1	1	Fuse 3A 250V	2110-0003
A15F1	1	Fuse 3A 250V	2110-0003
A15F2	1	Fuse 3A 250V	2110-0003

Table 6-10 Fuse Locations, Values and Parts

Reference Designators	Qty	Descriptions	HP Part Number
A15F3	1	Fuse 1.5A 250V	2110-0043
A15F4	1	Fuse 1A 250V	2110-0001
FL1F1	1	Fuse 4A 250V Main Line	2110-0055

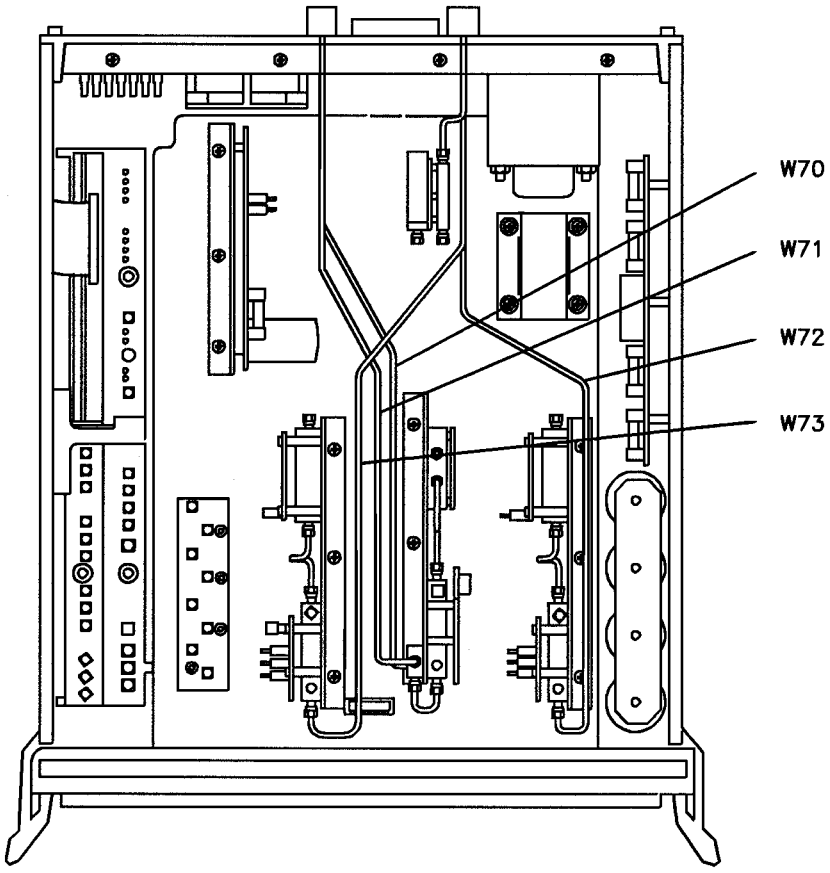


Figure 6-36 HP 85105A (Options 004 and O50) Unique Semi-Rigid Cable Assemblies

Table 6-11 HP 85105A (Options 004,050) Unique Semi-Rigid Cable Assembly Parts

Reference Designator	Qty	Descriptions	HP Part Number
W48	1	A19J1 to A18 Coupler Semi-Rigid RF Cable	85105-20050
W50	1	A24 to RF in (rear) Semi-Rigid RF Cable	85105-20018
W51	1	A24 to RF out (rear) Semi-Rigid RF Cable	85105-20019
W57	1	A19 to J1 RF out (front) Semi-Rigid RF Cable	85105-20051
W58	1	A19 to J3 RF out (front) Semi-Rigid RF Cable	85105-20052
W70	1	A19 Port 2 to Rear Panel J3 (option 004) Semi-Rigid RF Cable	85105-20043
W70	1	A19 Port 2 to Rear Panel J3 (option 050) Semi-Rigid RF Cable	85105-20043
W71	1	A19 Port 1 to Rear Panel J1 (option 004) Semi-Rigid RF Cable	85105-20044
W71	1	A19 Port 1 to Rear Panel J1 (option 050) Semi-Rigid RF Cable	85105-20044
W72	1	A17 to Rear Panel J4 (options 004,050) Semi-Rigid RF Cable	85105-20046
W73	1	A16 to Rear Panel J2 (options 004,050) Semi-Rigid RF Cable	85105-20045

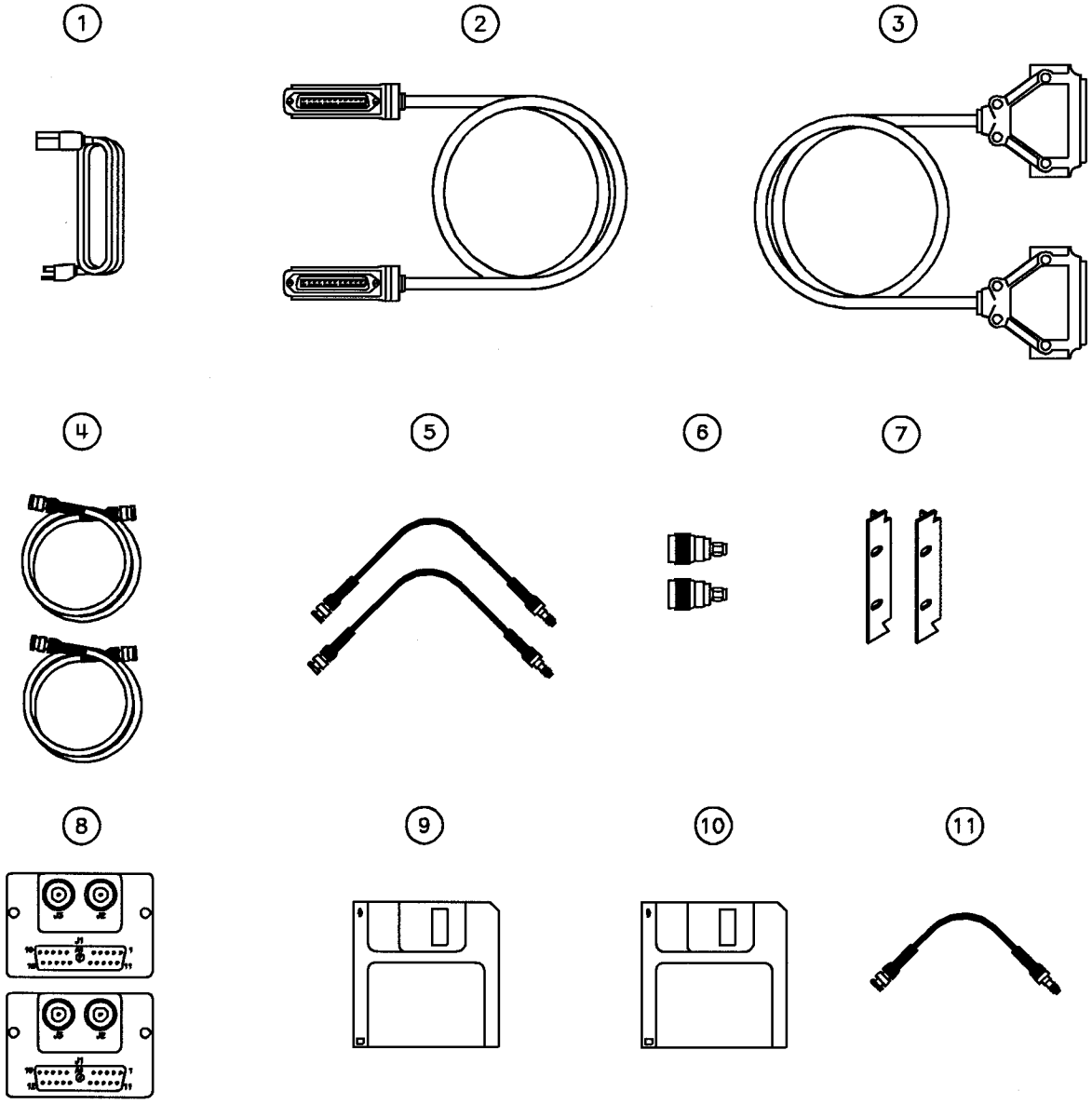


Figure 6-37 HP 85105A Accessories (Standard)

Table 6-12 HP 85105A Accessories (Standard)

Reference Designator	Qty	Descriptions	HP Part Number
1	1	Power Cord USA	8120-1348
2	1	HP-IB Cable	8120-3445
3	1	Test Set Interface Cable	08510-60106
4	2	BNC Cables	8120-1840
5	2	Flex Source Cable 30 IN	85100-60002
6	2	Adapter (male) to (male) SMA	1250-1894
7	1	Rack Mount Kit	5062-4071
8	2	Front Panel Adapter (Standard Only)	85105-60015
9	1	System Configuration Disk HP 85106 (Standard Only)	85106-10013
10	1	Specification and Performance Verification Software Program and Data Disk	08510-10033
11	1	Flexible Source Cable 18 IN	8120-4396

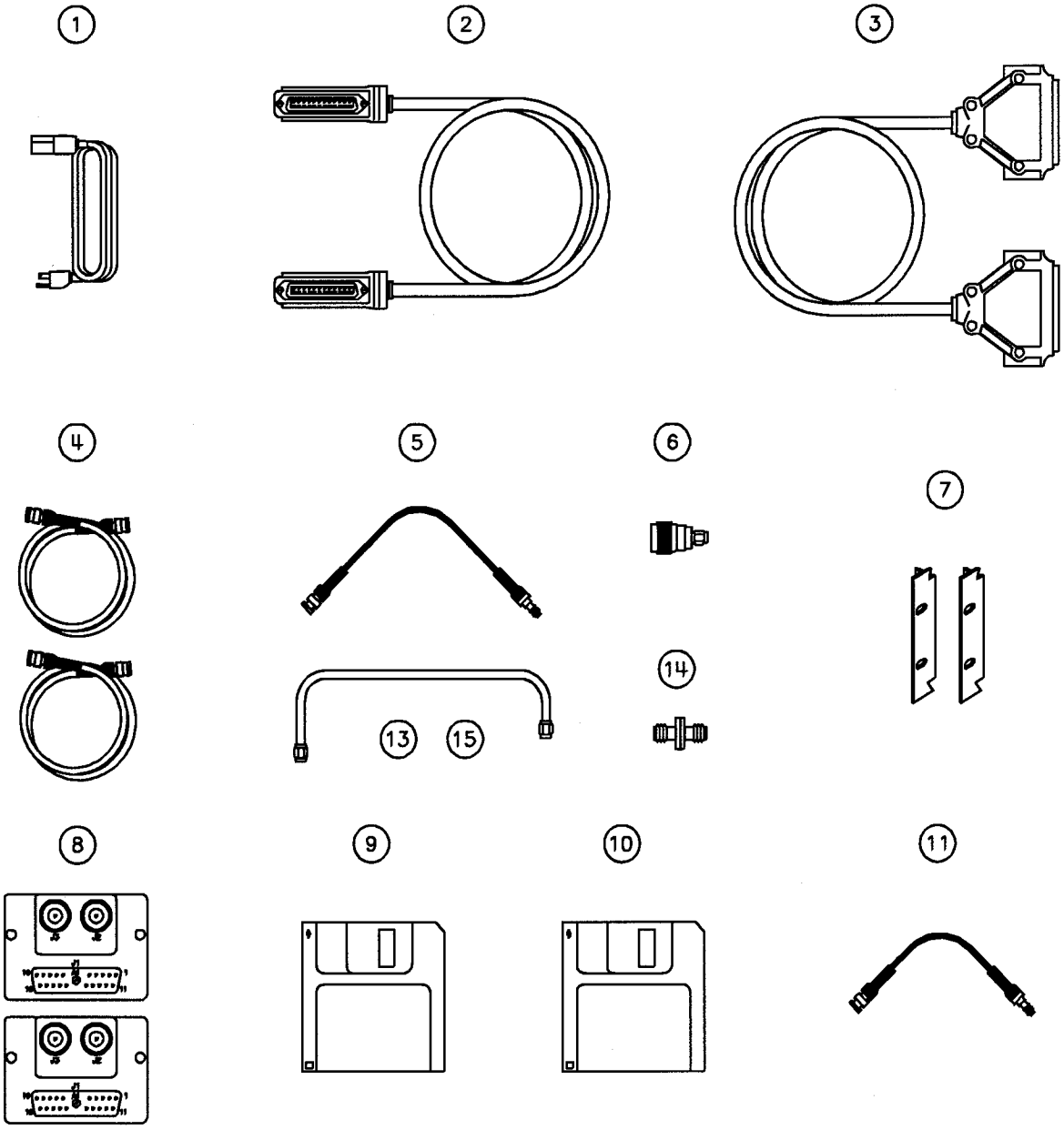


Figure 6-38 HP 85105A Accessories (Option 050)

Table 6-13 HP 85105A Accessories (Option 050)

Reference Designator	Qty	Descriptions	HP Part Number
1	1	Power Cord USA	8120-1348
2	1	HP-IB Cable	8120-3445
3	1	Test Set Interface Cable	08510-60106
4	2	BNC Cables	8120-1840
5	2	Flex Source Cable 30 IN	85100-60002
6	2	Adapter (male) to (male) SMA	1250-1894
7	1	Rack Mount Kit	5062-4071
8	2	Front Panel Adapter (Standard Only)	85105-60015
9	1	System Configuration Disk HP 85106 (Standard Only)	85106-10006
10	1	Specification and Performance Verification Software Program and Data Disk	08510-10033
11	1	Flexible Source Cable 18 IN	8120-4396
13	1	Source to 85105A (Option 050) RF Cable	85105-20053
14	1	2.4 mm (female) to (female) Adapter	1250-2188
15	1	85105A to Coax Test Set (Option 050) RF Cable	85105-20054

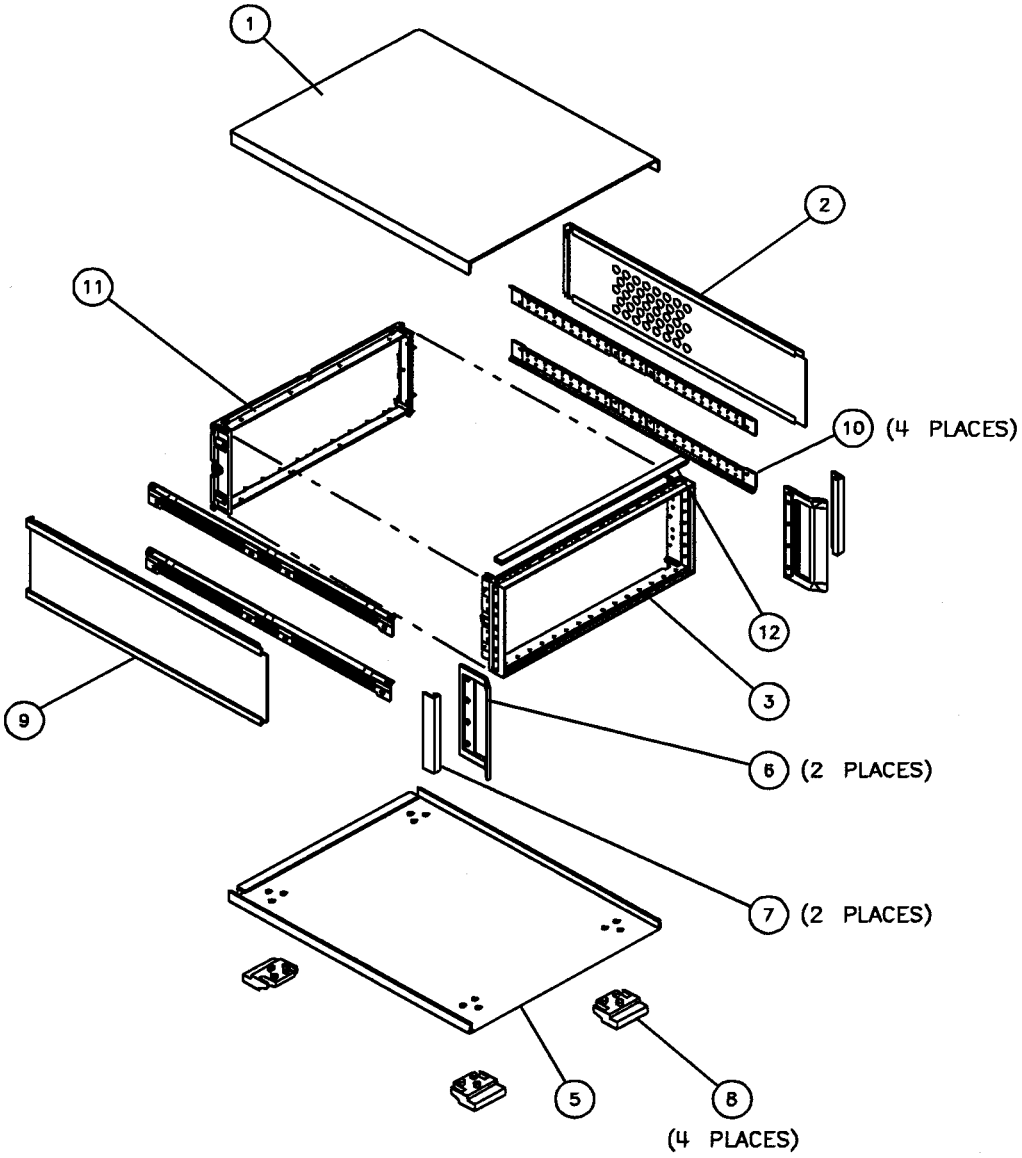
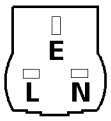
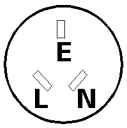
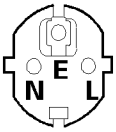
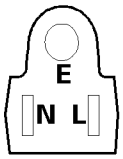
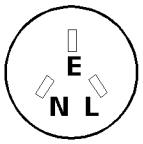


Figure 6-39 Chassis Parts, all HP 85105A Models

Table 6-14 All 85105A Model Chassis Parts

Reference Designators	Qty	Descriptions	HP Part Numbers
1	1	Top Cover	5062-3735
2	1	Side Cover Perf	08513-00041
3	1	Front Frame	5021-8403
4	1	Front Foot	5040-7201
5	1	Bottom Cover	5062-3747
6	1	Handle Assembly	5062-3799
7	1	Trim Front Handle	5020-8896
8	1	Rear Foot	5040-7221
9	1	Side Cover	5062-3757
10	1	18 inch Corner Strut	5021-5837
11	1	Rear Frame	5021-5804
12	1	Trim Strip	5040-7202
		Touch-Up Paint	
		• Dove Gray - Use around front panel and painted portions of front handles.	6010-1146
		• French Gray - Use on side, top, and bottom covers.	6010-1147
		• Parchment Gray - Use on rack mount flanges, rack support shelves and front panels.	6010-1148

PLUG TYPE **	CABLE HP PART NUMBER	PLUG DESCRIPTION	CABLE LENGTH CM (INCHES)	CABLE COLOR	FOR USE IN COUNTRY
250V 	8120-1351 8120-1703	Straight* BS1363A 90°	229 (90) 229 (90)	Mint Gray Mint Gray	Great Britain, Cyprus, Nigeria, Singapore, Zimbabwe
250V 	8120-1369 8120-0696	Straight* NZSS198/ ASC112 90°	201 (79) 221 (87)	Gray Gray	Argentina, Australia, New Zealand, Mainland China
250V 	8120-1689 8120-1692	Straight* CEE7-Y11 90°	201 (79) 201 (79)	Mint Gray Mint Gray	East and West Europe, Central African Republic, United Arab Republic (unpolarized in many nations)
125V 	8120-1348 8120-1538	Straight* NEMA5-15P 90°	203 (80) 203 (80)	Black Black	United States, Canada, Japan (100V or 200V), Brazil, Colombia, Mexico, Philippines, Saudia Arabia, Taiwan
	8120-1378 8120-4753 8120-1521 8120-4754	Straight* NEMA5-15P Straight 90° 90°	203 (80) 230 (90) 203 (80) 230 (90)	Jade Gray Jade Gray Jade Gray Jade Gray	
250V 	8120-5182 8120-5181	Straight* NEMA5-15P 90°	200 (78) 200 (78)	Jade Gray Jade Gray	Israel

* Part number for plug is industry identifier for plug only. Number shown for cable is HP Part Number for complete cable, including plug.
** E = Earth Ground: L = Line: N = Neutral.

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Figure 6-40 Power Cable and Plug Part Numbers

Appendix A

HP-IB Addresses, Hardware States, and Instrument States

This appendix contains information about HP-IB addresses, hardware states, and instrument states for microwave and mm-wave HP 8510 systems.

Table A-1 HP 85106D mm-Wave System HP-IB Addresses

HP 8510 System Bus	mm-Wave (waveguide)	microwave (coaxial)
Address of 8510	16	16
System bus	17	17
Source #1 (RF)	19	19
Source #2 (LO)	18	18
Test Set	21	20
Plotter	5	5
Printer	1	1
Disk	0	0
Pass-thru	31	31
RF switch	31	31

Table A-2 Important HP 85106D mm-Wave Hardware States

System Parameter	mm-Wave (waveguide)	microwave (coaxial)
System Phaselock	None or Ext.[1]	Int.
Mult. Source	On	Off
Leveling Source #1	Ext.	Int.
Leveling Source #2	Int.	N/A
HP-IB Config	USER DEF PRESET	USER DEF PRESET

1. System phaselock must be set to external-mode for HP 8350B source.

Table A-3 Important HP 85106D mm-Wave System Instrument States[1]

System Parameter	mm-wave (waveguide)				Microwave (coaxial)	Measurement Unit
	Q - Band (WR-22)	U - Band (WR-19)	V - Band (WR-15)	W - Band (WR-10)		
Power Source #1[2]	-20	-20	-25	-30	10	dBm
Power Source #2	+3	+3	+3	+3	N/A	dBm
Sweep Mode	any, except RAMP[3] or QuickStep				any	-
Z_0	1				50	Ω
Delay	waveguide				coaxial	-
Waveguide Cutoff	26.338	31.386	39.873	59.024	N/A	GHz

1. Instrument states may be changed by selecting the {***FACTORY PRESET***} key on the HP 8510.

2. Optimum power level for source #1 may vary from system to system. Adjust the power level to the maximum level without getting the "IF Overload" error. (Refer to "RF Signal Power Control" in the "Operation" chapter).

3. With two synthesizers cannot be used with RAMP mode.

Table A-4 HP 85106D mm-wave System Multiple Source Operating Frequencies

Waveguide Band	Start Frequency (GHz)	Stop Frequency (GHz)	Source #1		Source #2	
			Multiplier	Offset Frequency	Multiplier	Offset Frequency
R[1]	26.5	40.0	1/2	0.000000000	1/8	0.020000000
Q	33.0	50.0	1/3	0.000000000	1/10	0.020000000
U	40.0	60.0	1/3	0.000000000	1/10	0.020000000
V	50.0	75.0	1/4	0.000000000	1/14	0.020000000
W	75.0	110.0	1/6	0.000000000	1/18	0.020000000

1. R-band can be used with the HP 83554A Source Modules and R11643A Test Set Kit, *only.*

Appendix B

Upgrade Paths

Network Analyzer Upgrade Paths

- To upgrade your HP 8510A network analyzer to an HP 8510C, order upgrade kit HP 85103C.
- To upgrade your HP 8510B network analyzer to an HP 8510C, order upgrade kit HP 85103D.

Both of the upgrade kits listed include on-site installation by an Hewlett-Packard customer engineer. Contact your HP Sales and Service office for assistance.

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