Installation and Quick Start Guide

HP 8719D/20D/22D Network Analyzer

HP Part No. 08720-90291
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Regulatory Information

The regulatory information is in the *HP 8719D/20D/22D Network Analyzer User's Guide.*

Warranty

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

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

LIMITATION OF WARRANTY

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

Assistance

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products. For any assistance, contact your nearest Hewlett-Packard Sales and Service Office.

Safety Notes

The following safety notes are used throughout this manual. Familiarize yourself with each of the notes and its meaning before operating this instrument.

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

Caution Caution denotes a hazard. It calls attention to a procedure that, if not correctly performed or adhered to, would result in damage to or destruction of the instrument. Do not proceed beyond a caution sign until the indicated conditions are fully understood and met.

General Safety Considerations

Warning **For continued protection against fire hazard replace line fuse only with same type and rating (3A/250V). The use of other fuses or material is prohibited.**

Warning **This is a Safety Class I product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor, inside or outside the instrument, is likely to make the instrument dangerous. Intentional interruption is prohibited.**

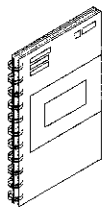
Caution **Ventilation Requirements:** When installing the instrument in a cabinet, the convection into and out of the instrument must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the instrument by 4 °C for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is greater than 800 watts, then forced convection must be used.

How to Use This Guide

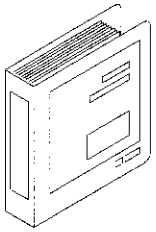
This guide uses the following conventions:

(Front-Panel Key)	This represents a key physically located on the instrument.
`Softkey`	This indicates a "softkey," a key whose label is determined by the instrument's firmware.
`Screen Text`	This indicates text displayed on the instrument's screen.

HP 8719D/20D/22D Network Analyzer Documentation Map

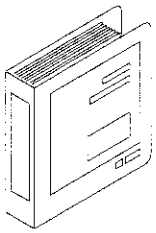


The **Installation and Quick Start Guide** familiarizes you with the network analyzer's front and rear panels, electrical and environmental operating requirements, as well as procedures for installing, configuring, and verifying the operation of the analyzer.

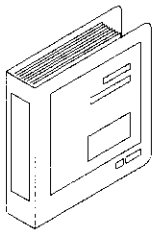


The **User's Guide** shows how to make measurements, explains commonly-used features, and tells you how to get the most performance from your analyzer.

The **Quick Reference Guide** provides a summary of all available user features.



The **Programmer's Guide** provides programming information including an HP-IB programming and command reference reference, as well as programming examples.



The **Service Guide** provides system verification and performance tests as well as the information needed to adjust, troubleshoot, and repair the instrument.

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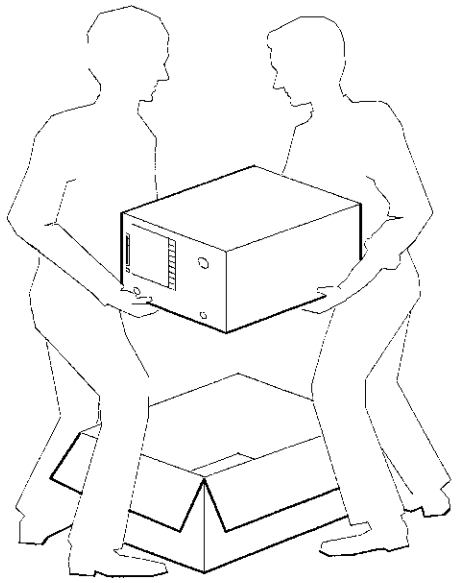
Installing Your Analyzer

This chapter shows you how to install your analyzer and confirm the correct operation, by following the steps below:

1. Verify the shipment.
2. Familiarize yourself with the front and rear panels.
3. Meet electrical and environmental requirements.
4. Configure the analyzer.
   - ☐ standard configuration
   - ☐ Option 1D5 configuration – high stability frequency reference
   - ☐ printer or plotter configuration
   - ☐ rack-mount configuration
5. Verify the analyzer operation.
   - ☐ self-test
   - ☐ installed options
   - ☐ operator's check
   - ☐ transmission mode
   - ☐ reflection mode
6. Backup the EEPROM disk.

Step 1. Verify the Shipment

1. Unpack the contents of all the shipping containers. **WARNING:** The analyzer weighs approximately 54 pounds (25 kilograms). Use correct lifting techniques.



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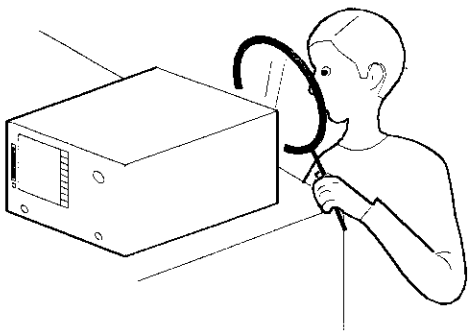
2. Carefully inspect the analyzer to ensure that it was not damaged during shipment.



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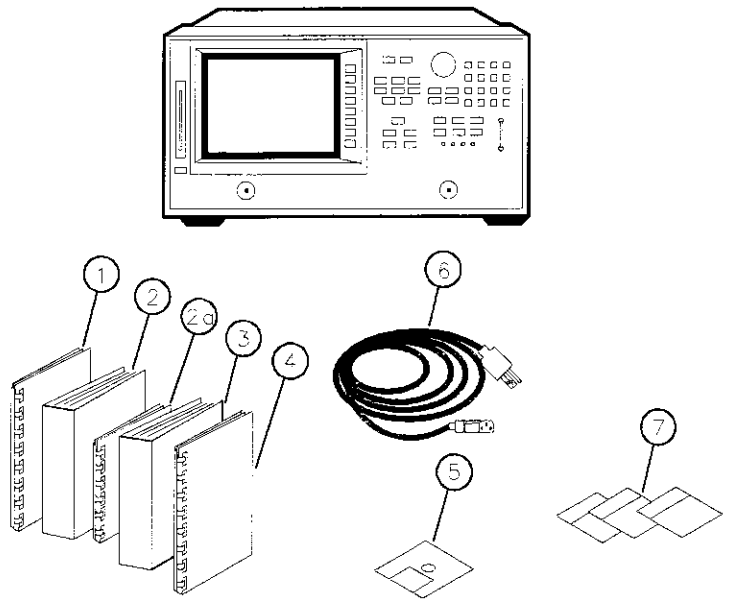
Note If your analyzer was damaged during shipment, contact your nearest Hewlett-Packard office or sales representative. A list of HP Sales and Service offices is provided at the end of this guide.

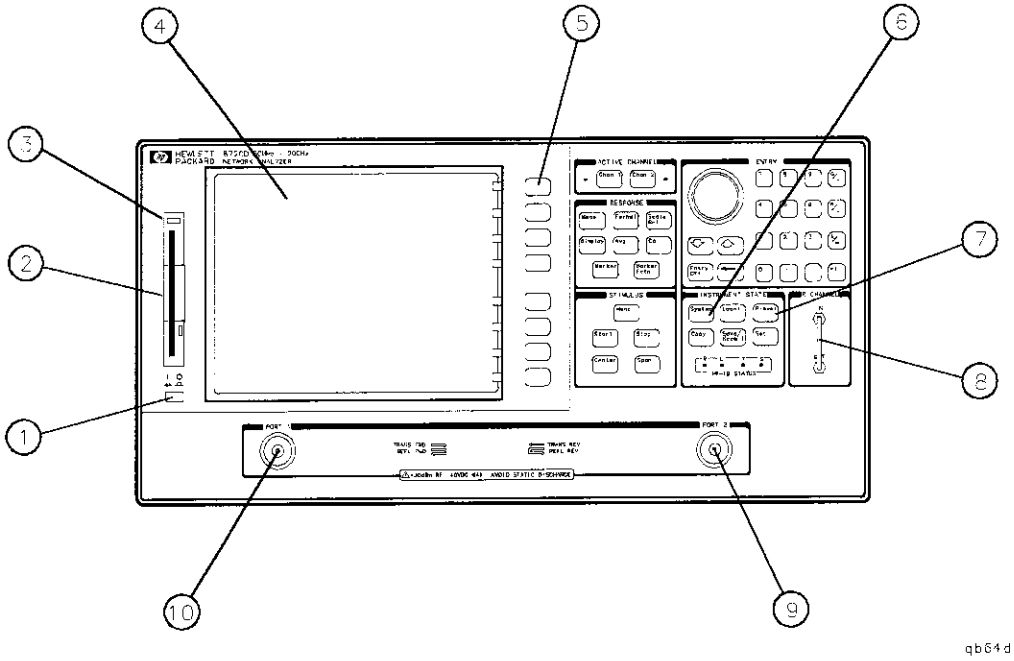
3. Verify that all the accessories have been included with the analyzer.



Received	Part Number	Item Number	Description
	08720-90291	1	Installation and Quick Start Guide
	08720-90288	2	User's Guide
	08720-90289	2a	User's Quick Reference Guide
	08720-90293	3	Programming Guide
	08720-90292	4	Service Guide
	unique to instrument	5	EEPROM Backup Disk
	unique to country	6	AC power cable
	5062-3978	7	Rack Flange Kit (Option 1CM only)
	5062-4072	7	Rack Flange Kit with Handles (Option 1CP only)
	5062-3990	7	Front Handle Kit (standard)

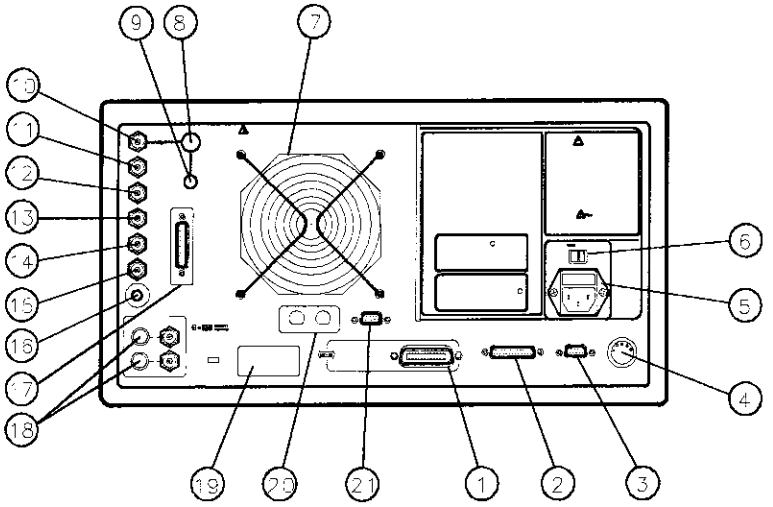
Step 2. Familiarize Yourself with the Front and Rear Panels

Front Panel



1 LINE POWER SWITCH	**6** SYSTEM KEY
2 DISK DRIVE	**7** PRESET KEY
3 DISK EJECT	**8** R CHANNEL IN/OUT JUMPER
4 ANALYZER DISPLAY	**9** PORT 2 (TRANS REV/REFL REV)
5 SOFTKEYS	**10** PORT 1 (TRANS FWD/REFL FWD)

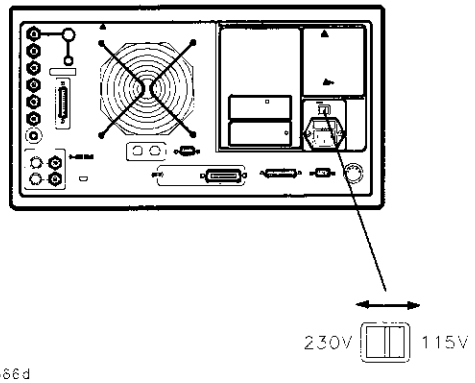
Rear Panel



1 HP-IB INTERCONNECT	**11** AUXILIARY INPUT
2 PARALLEL INTERFACE	**12** EXTERNAL AM INPUT
3 RS-232 (SERIAL) INTERFACE	**13** EXTERNAL TRIGGER INPUT
4 DIN KEYBOARD INPUT	**14** TEST SEQUENCE OUTPUT
5 AC POWER INPUT AND FUSE	**15** LIMIT TEST OUTPUT
6 LINE VOLTAGE SELECT SWITCH	**16** MEASURE RESTART
7 FAN	**17** TEST SET I/O INTERCONNECT
8 10 MHZ PRECISION REFERENCE OUTPUT (OPT. 1D5)	**18** BIAS INPUTS AND FUSES
9 10 MHZ REFERENCE ADJUST (OPT. 1D5)	**19** SERIAL NUMBER LABEL
10 EXTERNAL REFERENCE INPUT	**20** RF IN/OUT (OPT. 085)
	21 EXTERNAL MONITOR: VGA

Step 3. Meet Electrical and Environmental Requirements

1. Set the line-voltage selector to the position that corresponds to the AC power source.



2. Ensure the available AC power source meets the following requirements:

- 90 to 132 VAC
- 50 to 60 Hz / 400 Hz (single phase)

OR

- 198 to 264 VAC
- 50 to 60 Hz (single phase)

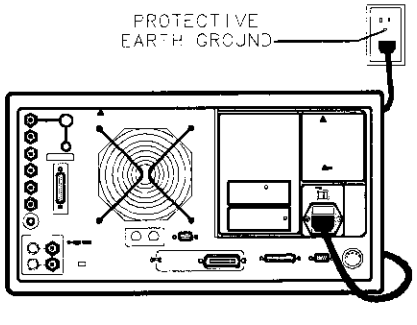
The analyzer power consumption is 280 VA max.

3. Ensure the operating environment meets the following requirements:

- 0 to 55°C
- < 95% relative humidity at 40°C (non-condensing)
- < 15,000 feet (≈4,500 meters) altitude

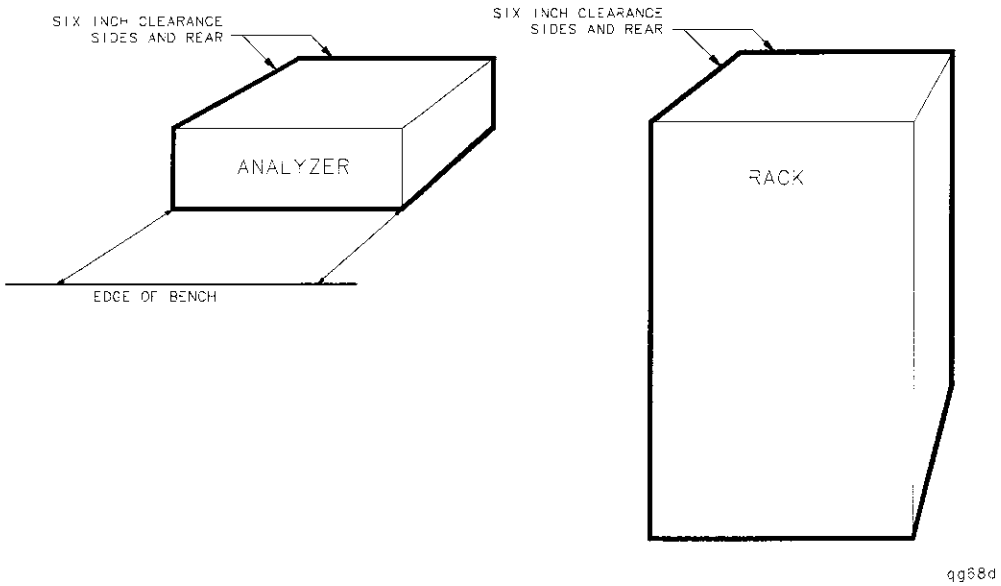
Some performance parameters are specified for 25°C ±5°C. Refer to the *HP 8719D/20D/22D Network Analyzer User's Guide* for information on the environmental compatibility of warranted performance.

4. Verify that the power cable is not damaged, and that the power-source outlet provides a protective earth contact.



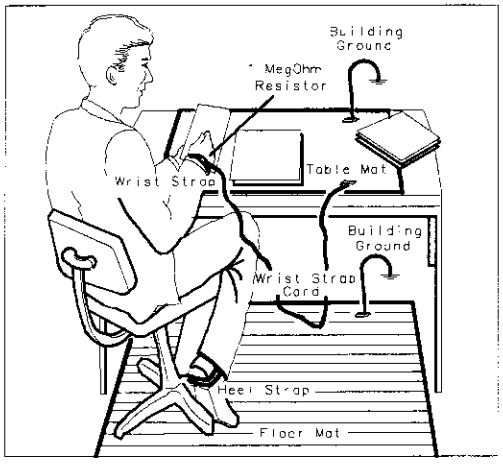
WARNING: Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal, can result in personal injury, or may damage the analyzer.

5. Ensure there are at least six inches of clearance between the sides and back of either the stand-alone analyzer or the system cabinet.



CAUTION: The environmental temperature must be 4°C less than the maximum operating temperature of the analyzer for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is >800 watts, then you must provide forced convection.

6. Set up a static-safe workstation. Electrostatic discharge (ESD) can damage or destroy electronic components.



- static-control table mat and earth ground wire: HP P/N 9300-0797
- wrist-strap cord: HP P/N 9300-0980
- wrist-strap: HP P/N 9300-1367
- heel-straps: HP P/N 9300-1308
- floor mat: not available through Hewlett-Packard

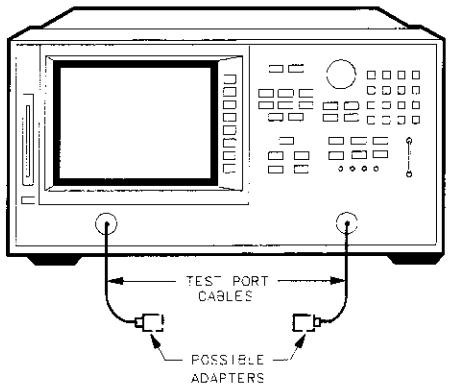
Step 4. Configure the Analyzer

This step shows you how to set up your particular analyzer configuration.

- standard configuration
- Option 1D5 configuration – high stability frequency reference
- printer or plotter configuration
- cabinet rack-mount configuration

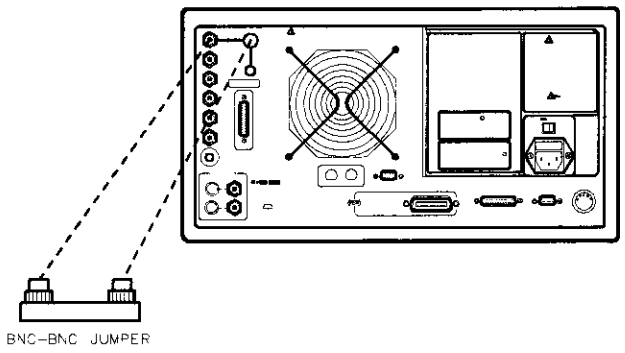
To Configure a Standard Analyzer

Connect 3.5-mm (2.4-mm, HP 8722D) cables and optional adapters if you are using other connector types.



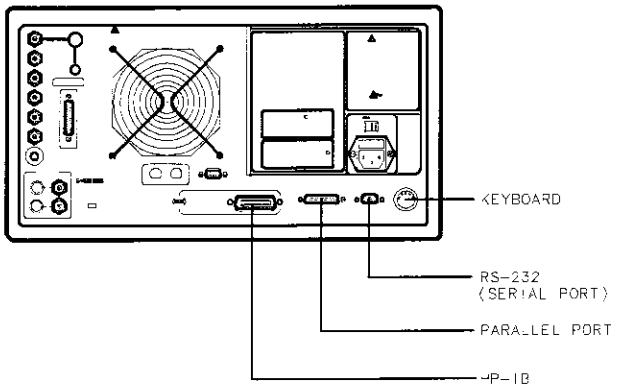
To Configure an Analyzer that has High Stability Frequency Reference (Option 1D5)

Connect the jumper cable on the analyzer rear panel as shown.

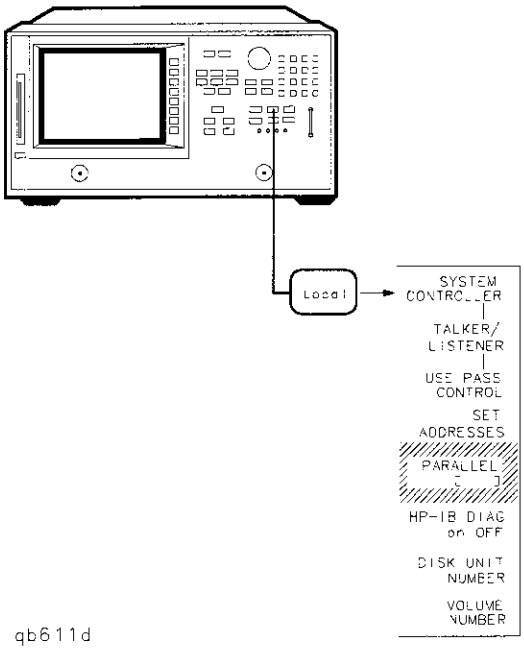


To Configure an Analyzer with Printers or Plotters

1. Connect your printer or plotter to the corresponding interface.

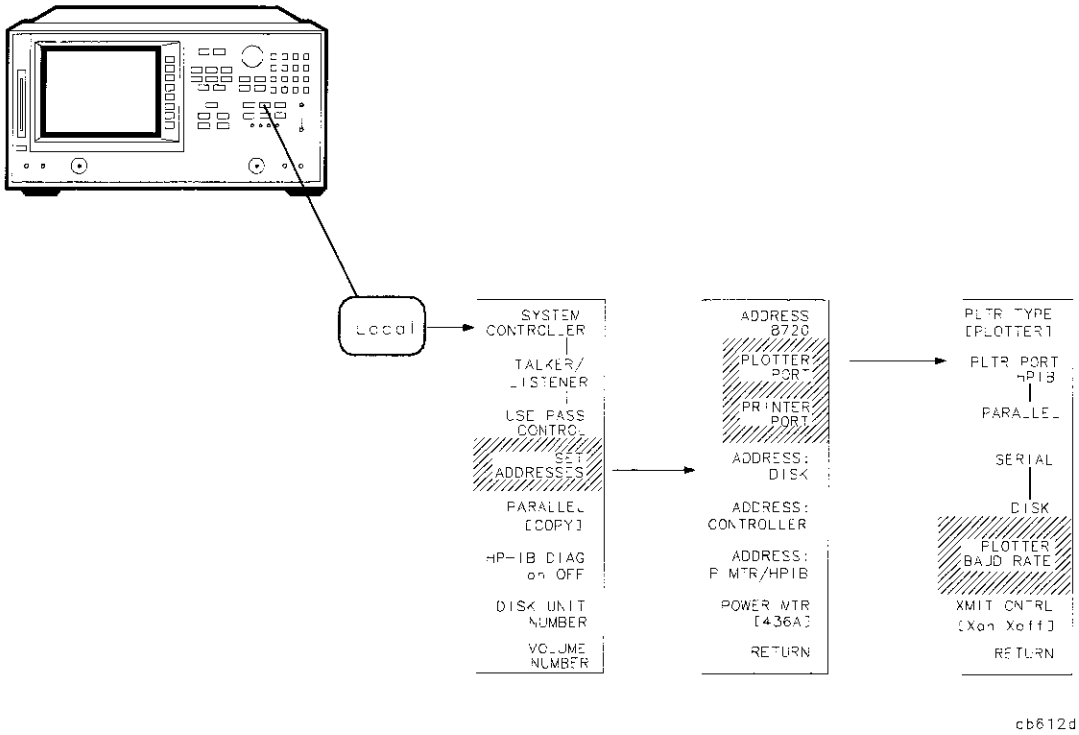


2. If you are using the parallel interface, press (Local) and PARALLEL until your choice of [GPIO] or [COPY] appears.

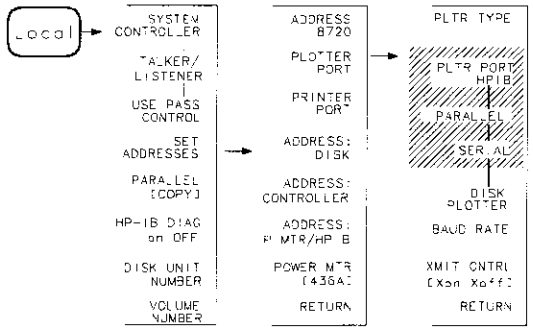


- If you choose [COPY], the parallel port is dedicated for normal copy device use (printers or plotters).
- If you choose [GPIO], the parallel port is dedicated for general purpose I/O. The analyzer controls the data input or output, through its sequencing capability.

3. Press SET ADDRESSES and then choose either PRINTER PORT or PLOTTER PORT, depending on your hardcopy device. Or, if you are plotting your files to disk, press SET ADDRESSES PLOTTER PORT DISK.

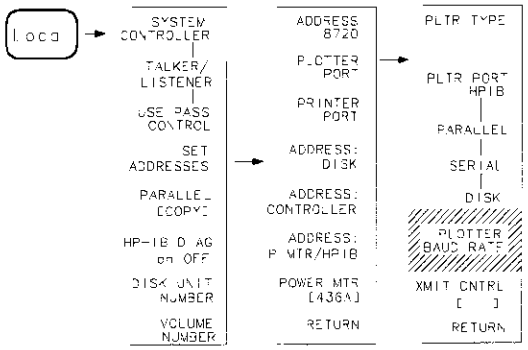


4. Press the key that corresponds to your printer or plotter interface: HPIB, PARALLEL (parallel port), or SERIAL (serial port). **NOTE:** The plotter menu is shown as an example. It will only appear if you select PLOTTER PORT. Similar interface choices will appear if you select PRINTER PORT.



- If you select HPIB, the HP-IB address is active so you can then enter the HP-IB address of your printer or plotter, followed by (x1).
- If you have already selected the PARALLEL [COPY] choice for the parallel-port configuration, you must also select PARALLEL in this menu in order to generate a hardcopy.

5. If you will be using the serial port, adjust the analyzer's baud rate until it is equal to the baud rate set on the peripheral by pressing `PLOTTER BAUD RATE` (or `PRINTER BAUD RATE`), and the ⇧ and ⇩ front panel keys. **NOTE:** The plotter menu is shown as an example. It will only appear if you select `PLOTTER PORT`.



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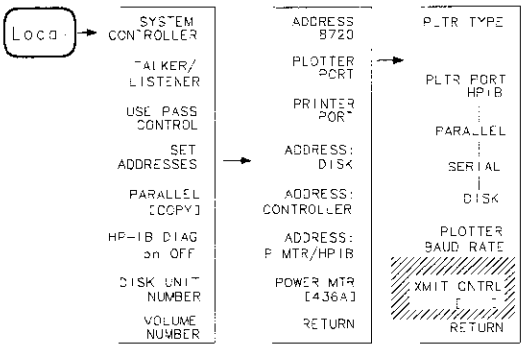
You can set the analyzer to the following rates:

- 1200
- 2400
- 4800
- 9600
- 19200

6. Also if you will be using the serial port, you must set the transmission control, `XMIT CNTRL` (handshaking protocol) to either `Xon-Xoff` or `DTS-DSR` (equal to the transmission control set on the peripheral). **NOTE:** Transmission control for plotters is set programmatically. The plotter menu is shown as an example. It will only appear if you select `PLOTTER PORT`.



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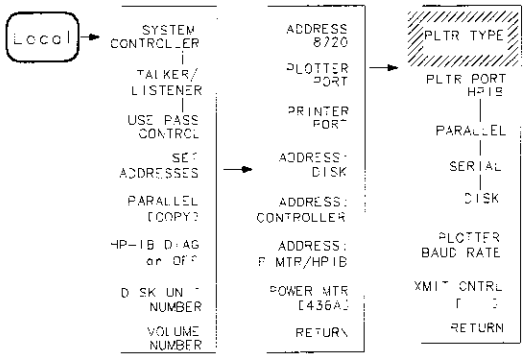
- `Xon-Xoff` sets transmission on/transmission off (software handshake).
- `DTS-DSR` sets data terminal ready/data set ready (hardware handshake).

7. If you will be using a plotter, select PLTR TYPE and keep pressing the key until the choice you want appears.



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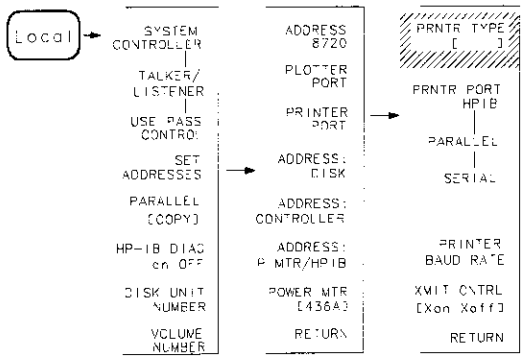
- Choose PLOTTER for a pen plotter such as the HP 7440A, 7470A, 7475A, or 7550B.
- Choose HPGL PRT for a PCL5 compatible printer, which supports HP-GL/2, such as the:
  - ☐ LaserJet III
  - ☐ LaserJet 4
  - ☐ DeskJet 1200C

8. If you will be using a printer, press PRNTR TYPE until your printer choice appears.



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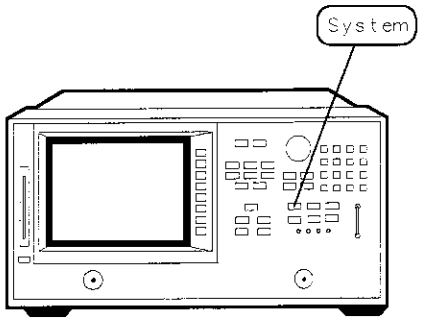
- Choose your printer type from these HP printers.
  - ☐ THINKJET
  - ☐ DESKJET (except for HP DeskJet 540 and 850)
  - ☐ LASERJET
  - ☐ PAINTJET
  - ☐ DJ 540 (converts 100 dpi raster information to 300 dpi raster format)
- Choose EPSON-P2 for Epson-compatible printers (ESC/P2 printer control language).

9. Press (System) SET CLOCK to begin setting and activating the time stamp feature so the analyzer places the time and date on your hard copies and disk directories.



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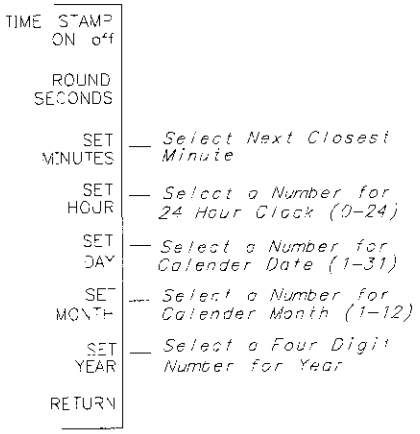
10. Press each of the following softkeys to set the date and time.



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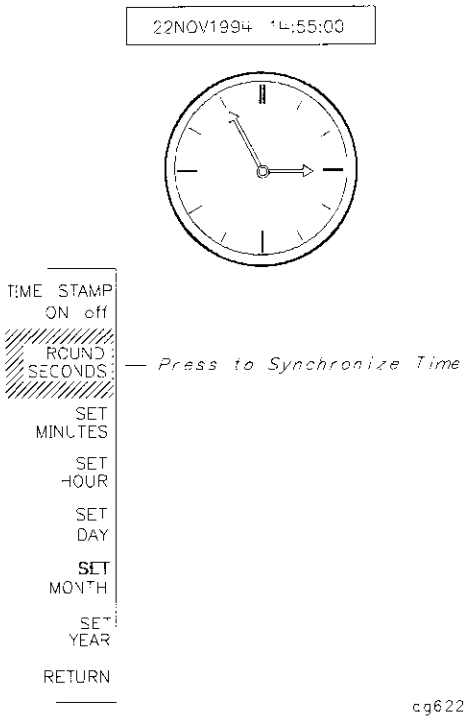
11. Press ROUND SECONDS when the time is exactly as you have set it.



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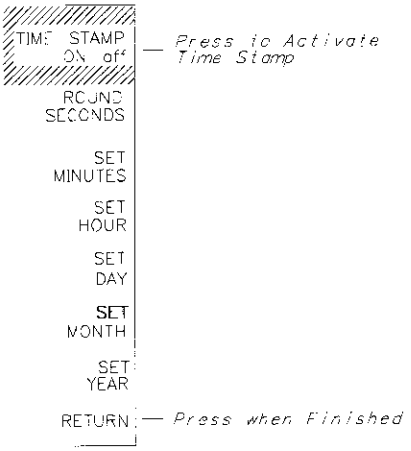
12. Press TIME STAMP so that ON is displayed on the softkey label. Then press RETURN.



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To Configure the Analyzer with Cabinet Flange Kits

There are three kits available for the analyzer:

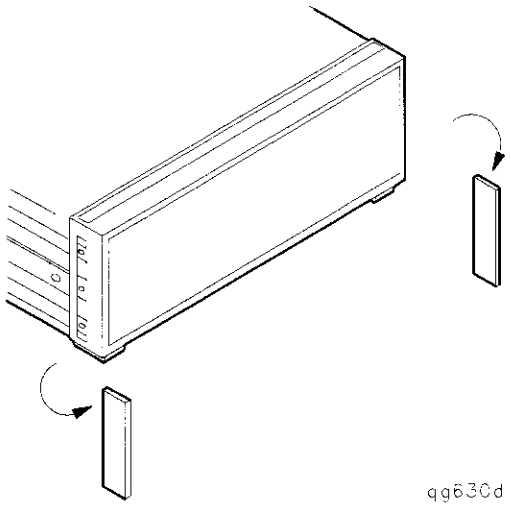
- instrument front handles kit (standard HP part number 5062-3990)
- cabinet flange kit without front handles (Option 1CM or HP part number 5062-3978)
- cabinet flange kit with front handles (Option 1CP or HP part number 5062-4072)

To Attach Handles to the Analyzer (Standard)

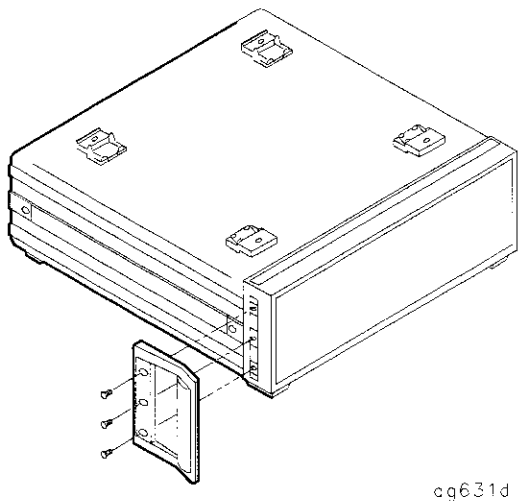
1. Ensure that the front handles kit is complete. **NOTE:** If any items are damaged or missing from the kit, contact the nearest HP sales and service office to order a replacement kit. Items within the kit (handles, flanges, screws, etc.) are not individually available.

2. Remove the side trim strips.

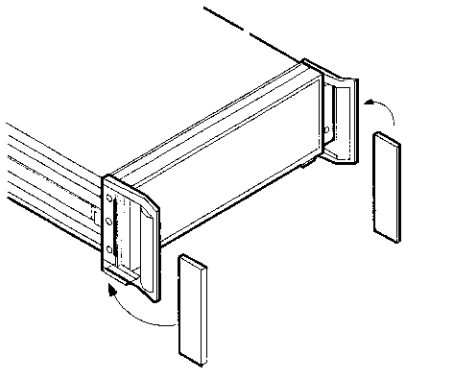
- (2) front handles
- (6) screws
- (2) trim strips



3. Attach the handles to the sides of the front panel, using three screws for each handle.



4. Place the new trim strip over the screws on the handles.



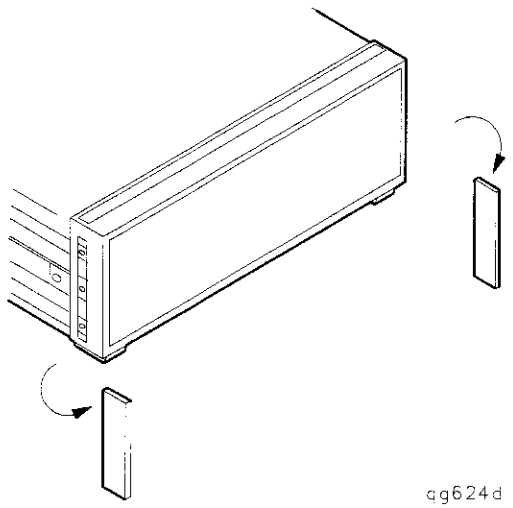
WARNING: If an instrument handle is damaged, you should replace it immediately. Damaged handles can break while you are moving or lifting the instrument and cause personal injury or damage to the instrument.

To Attach the Cabinet Flanges to an Analyzer (Option 1CM)

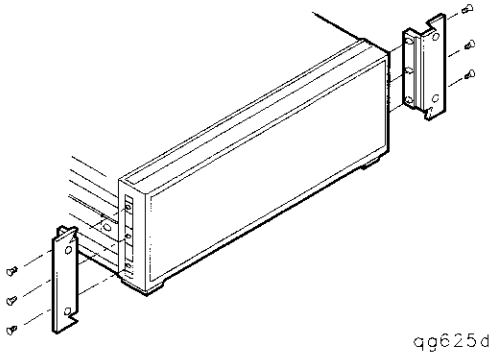
1. Ensure that the cabinet flange kit is complete.

- (2) cabinet mount flanges
- (6) screws

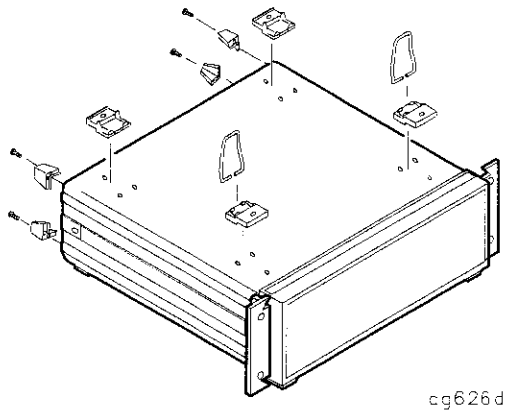
2. Remove side trim strips.



3. Attach the cabinet flanges to the sides of the front panel using three screws for each flange.



4. Remove the feet and the tilt stands before cabinet mounting the instrument.

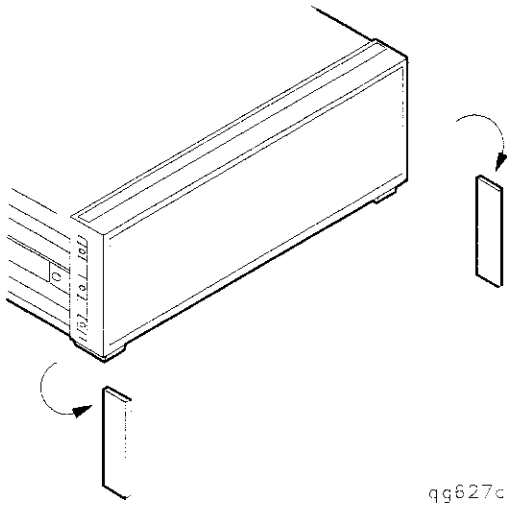


To Attach Cabinet Flanges and Front Handles to an Analyzer (Option 1CP)

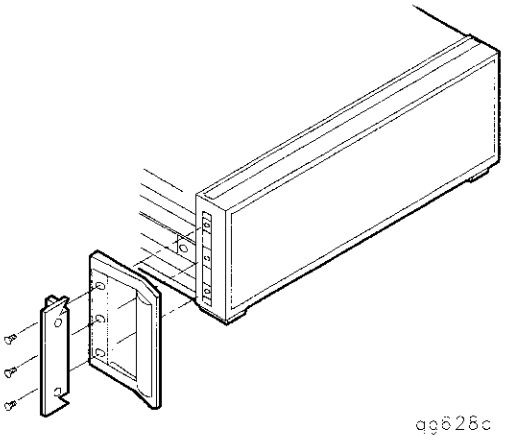
1. Ensure that the cabinet flange kit with handles is complete.

- (2) cabinet mount flanges
- (2) front handles
- (8) screws

2. Remove the side trim strips.

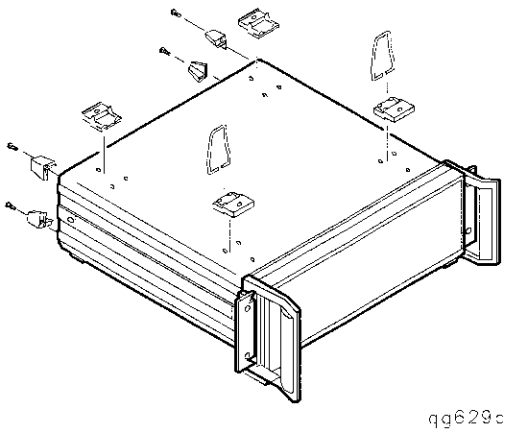


3. Attach the cabinet mount flanges and the handles to the sides of the front panel, using four screws per side. (Attach the flanges to the outside of the handles.)



WARNING: If an instrument handle is damaged, you should replace it immediately.

4. Remove the feet and the tilt stands before cabinet mounting the instrument.



Step 5. Check the Analyzer Operation

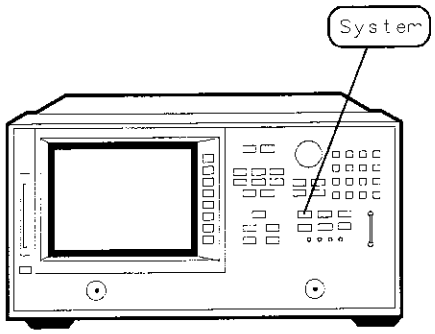
This series of procedures shows you how to check your analyzer for correct operation.

- viewing installed options
- initiating the analyzer self-test
- running operator's check
- testing transmission mode
- testing reflection mode

Note The analyzer has an on-site warranty. If the analyzer should fail any of the following tests, call your local HP sales and service office. A customer engineer will be dispatched to service your instrument on-site. If for some reason a customer engineer is not available in your area, send the analyzer to the nearest HP service center for repair, including a description of any failed test and any error message. Ship the analyzer, using the original or comparable anti-static packaging materials. A table listing of Hewlett-Packard sales and service offices is provided at the end of this guide.

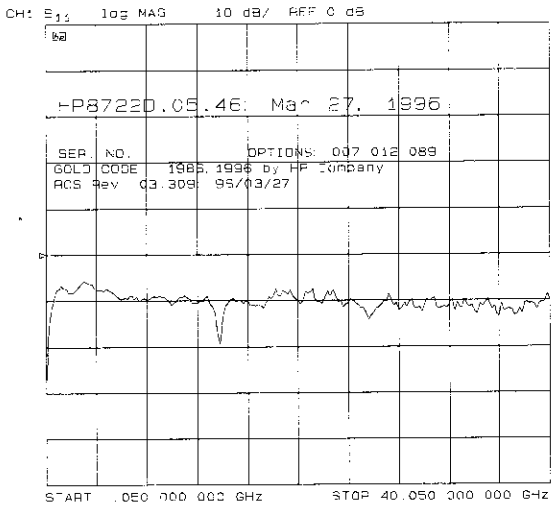
To View the Installed Options

1. Switch on the AC power supplied to the analyzer, cycle the AC power using the LINE button, or press (System) SERVICE MENU FIRMWARE REVISION.



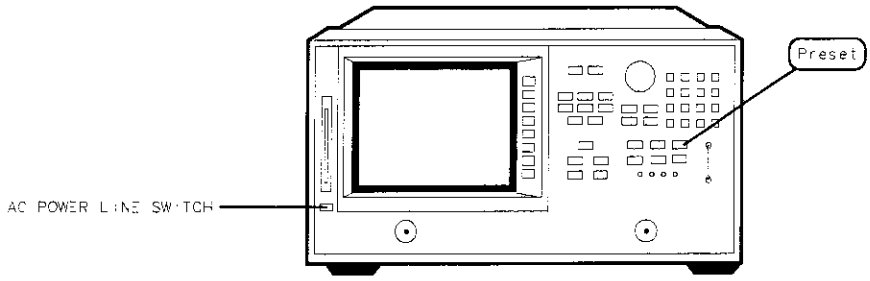
qs613d

2. Locate the serial number and configuration options. Compare them to the shipment documents.

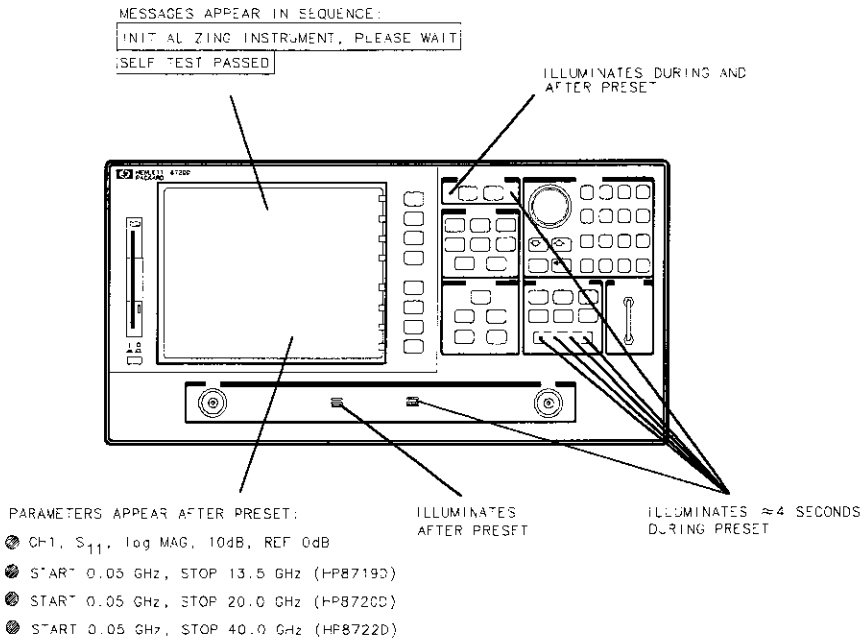


To Initiate the Analyzer Self-Test

1. Switch on the AC power supplied to the analyzer, and press (Preset).

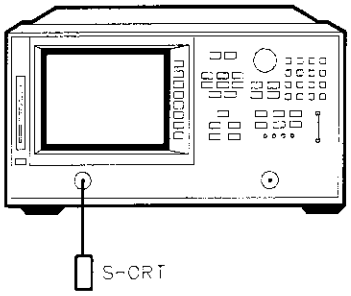


2. Watch for the following indications that the analyzer is operating correctly:

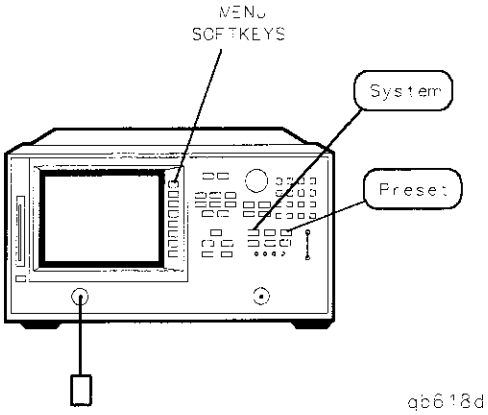


To Run the Operator's Check

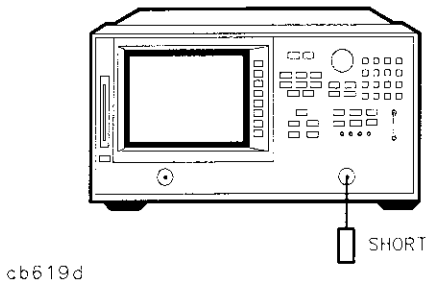
1. Connect the equipment as shown.



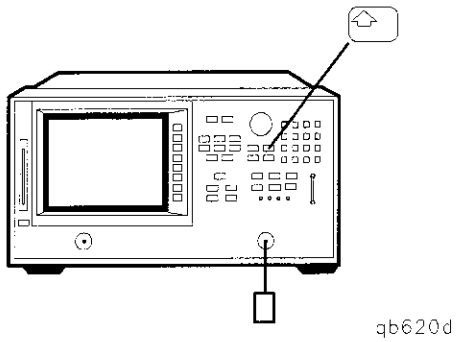
2. Press (Preset) (System) SERVICE MENU TESTS EXTERNAL TESTS EXECUTE TEST.



3. Follow the prompts shown on the analyzer display and then press CONTINUE.

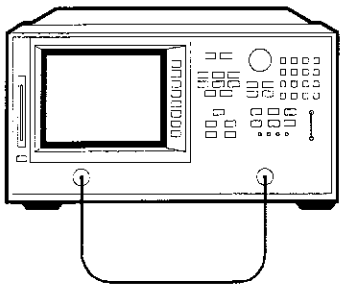


4. Press (⇧) EXECUTE TEST, follow the prompts shown on the analyzer display, and then press CONTINUE.



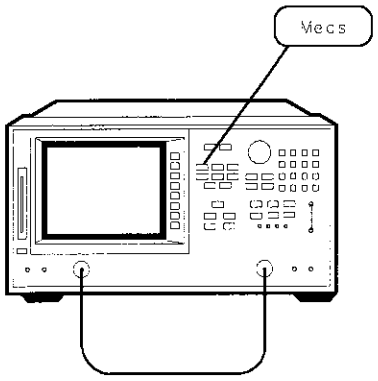
To Test the Transmission Mode

1. Connect the equipment as shown and press (Preset). **NOTE:** The test port return cable should have low-loss characteristics to avoid a degradation in frequency response at higher frequencies.



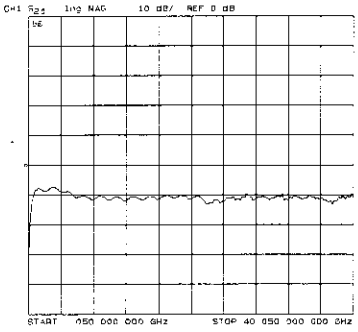
qb62'c

2. To check the forward transmission mode, press (Meas) `Trans: FWD S21 (B/R)` .

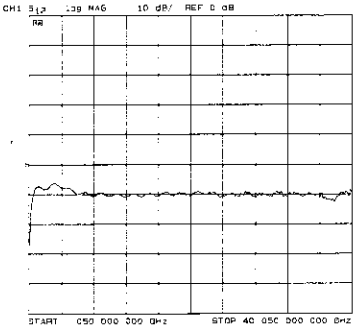


qb622d

3. Look at the measurement trace displayed on the analyzer. It should be similar to the trace below.

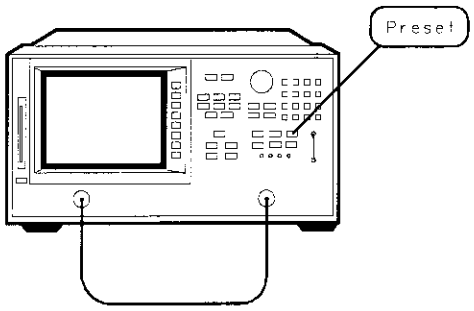


4. To check the reverse transmission mode, press (Meas) `Trans: REV S12 (A/R)` . The measurement trace should be similar to the trace below.

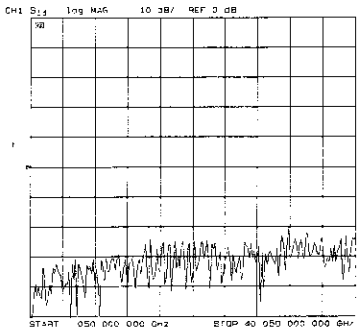


To Test the Transmission Mode's Load Match

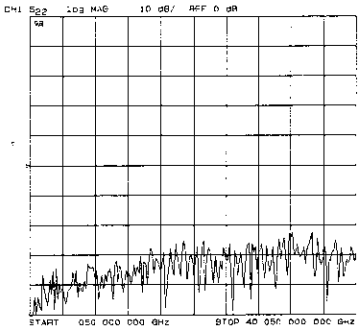
1. Connect the equipment as shown and press Preset.



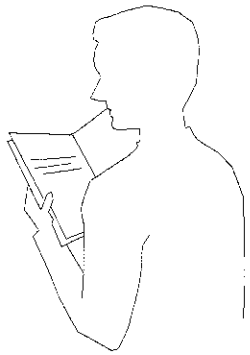
2. Look at the measurement trace displayed on the analyzer. It should be similar to the trace below.



3. To check the reverse reflection mode for channel 1, press Meas `Refl: REV S22 (B/R)`. The measurement trace should be similar to the trace shown below.



4. If you are ready to start making measurements, continue with the next chapter "Quick Start: Learning How to Make Measurements."



Step 6. To Copy the EEPROM Backup Disk

Description

Correction constants are stored in EEPROM on the A7 controller assembly. The advantage of having an EEPROM backup disk is its capacity to store all the correction-constant data to a new or repaired A7 assembly without having to rerun the correction-constant procedures. The network analyzer is shipped from the factory with an EEPROM backup disk which is unique to each instrument. It is prudent to make a copy of the EEPROM backup disk so that it can be used in case of failure or damage to the original backup disk.

Equipment

3.5-inch disk ..... HP 92192A (box of 10)

EEPROM Backup Disk Procedure

1. Insert a 3.5-inch disk into the disk drive.
2. Press (Preset).
3. If the disk is not formatted, press (Save/Recall) FILE UTILITIES FORMAT DISK.

   - To format a LIF disk, select FORMAT:LIF (The supplied EEPROM backup disk is LIF. The analyzer does not support LIF-1 format.)
   - To format a DOS disk, select FORMAT:DOS

   Press FORMAT INT DISK and answer YES at the query.

4. Press (System) SERVICE MENU SERVICE MODES MORE STORE EEPR ON

   (Save/Recall) SELECT DISK INTERNAL DISK RETURN SAVE STATE to store the correction-constants data onto floppy disk.

Note A default file "FILE0" is created. The file name appears in the upper left-hand corner of the display. The file type "ISTATE(E)" describes the file as an instrument-state with EEPROM backup.

5. Press FILE UTILITIES RENAME FILE ERASE TITLE. Use an external keyboard or the front panel knob and the SELECT LETTER softkey to rename the file "FILE0" to "N*12345*" where *12345* represents the last 5 digits of the instrument's serial number. (The first character in the file name must be a letter.) When finished, press DONE.
6. Label the disk with the serial number of the instrument and the words "EEPROM Backup Disk".

Note Whenever the network analyzer is returned to Hewlett-Packard for servicing and/or calibration, the EEPROM backup disk should be returned with the analyzer. This will significantly reduce the instrument repair time.

The EEPROM backup disk procedure is now complete.

Quick Start: Learning How to Make Measurements

2

The information and procedures in this chapter teach you how to make measurements with your analyzer.

- analyzer front panel operation
- general steps for making measurements
  - step 1. choose the measurement parameters with the test device connected
  - step 2. make a measurement error-correction (measurement calibration)
  - step 3. measure the device
  - step 4. output measurement results
- transmission measurements
  - transmission measurement error-correction (measurement calibration)
  - insertion loss
  - save/recall
  - 3 dB bandwidth
  - out-of-band rejection
  - ripple or flatness
- reflection measurements
  - reflection measurement error-correction (measurement calibration)
  - return loss
  - print output
  - reflection coefficient
  - standing wave ratio (SWR)
  - S_{11} and S_{22} in polar format
  - impedance
  - admittance

The Analyzer - At a Glance

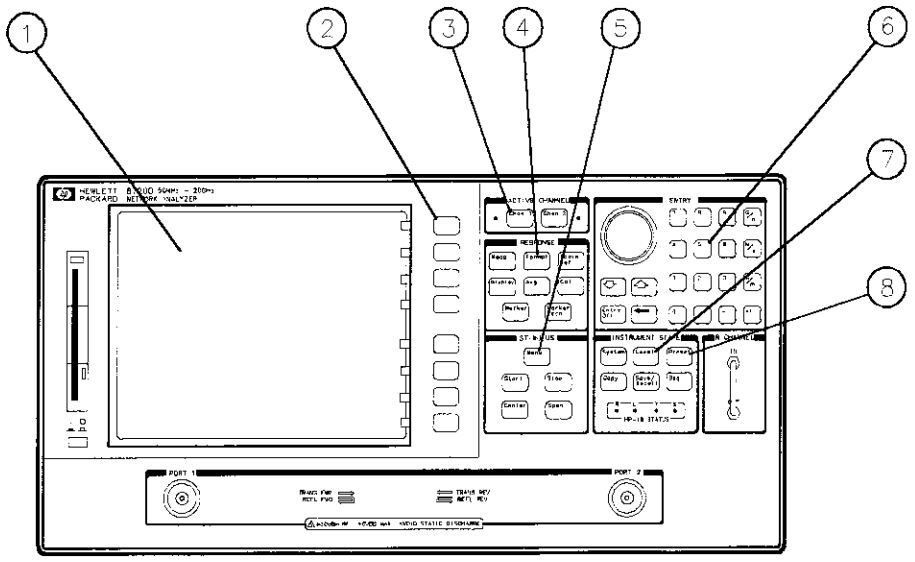


Figure 2-1. The Network Analyzer Front Panel Features

1 - The analyzer display shows the measurement trace, softkey labels, and the values of the current measurement parameters.

2 - The softkeys allow you to make choices from the "menus" that are shown on the analyzer display. The menus list the possible choices for a particular function.

3 - The channel keys allow you to choose which channel is active, and the measurement parameters for that channel. You can select many of the measurement and display functions independently for each measurement channel. To modify the measurement parameters of a particular channel, first select channel one or two, and then make the desired measurement choices. Notice that the light next to the current active channel's key is illuminated.

4 - The response keys allow you to control the analyzer's receiver. The top three keys allow you to choose the measurement parameter (Press: Meas for softkey/measurement options such as `Refl: FWD S11 (A/R)`, `Trans: FWD S21 (B/R)`, `Trans: REV S12 (A/R)`, etc.), presentation format (amplitude or phase versus frequency, Smith chart, polar coordinates, and so on), and scale and reference values for a full screen display.

The lower five keys in this section enhance the usability of the measured data. The displayed traces may be overlaid, manipulated with math function keys, averaged, normalized, or read out at specific points along the trace with up to five independent markers per channel.

5 - The stimulus keys allow you to define an appropriate test port output signal for the device under test. The output frequency may be swept over any portion of the range capable for the analyzer in use, at powers between +5 and −70 dBm (or −5 and −85 dBm for the HP 8722D). The stimulus keys also allow you to control the start and stop times in the (optional) time domain mode. The choices for sweep time and resolution, linear versus logarithmic sweep, power sweep, number of points, and others are also selected here.

6 - The numeric keypad allows you to enter a numeric value for a chosen parameter, for example frequency or amplitude. Use the keys to the right of the digit keys to terminate the data entry with the appropriate units. Use [G/n] (Giga/nano), [M/μ] (Mega/micro), [k/m] (kilo/milli), and [x1] (basic units: dB, dBm, degree, second) as applicable. You can also use the knob for making continuous adjustments to parameter values, while the [↑] and [↓] keys allow you to change values in steps.

7 - The instrument state keys allow you to control several functions, including instrument preset, save/recall, printer or plotter control, time domain transform (optional), test sequencing, and built-in diagnostic tests.

8 - The [Preset] key sets the analyzer to either a predetermined, "factory" or user-defined preset condition. See the "Preset State and Memory Allocation" chapter of the *HP 8719D/20D/22D Network Analyzer User's Guide* for the conditions at preset.

Measurement Procedure

This is a general measurement procedure that is used throughout the guide to illustrate the use of the analyzer.

Step 1. Choose the Measurement Parameters with the Test Device Connected

- Press the (Preset) key to return the analyzer to a known state.
- Connect your test device to the analyzer.
- Choose the settings that are appropriate for the intended measurement.
  - measurement type
  - frequencies
  - number of points
  - power
  - measurement trace format
- Make adjustments to the parameters while you are viewing the device response.

Step 2. Make a Measurement Error-Correction (Measurement Calibration)

Press the (Cal) key to begin to make an error-correction using a known set of standards (a calibration kit). An error-correction establishes a magnitude and phase reference for the test setup and then reduces systematic measurement errors.

Step 3. Measure the Device

- Reconnect the device under test.
- Use the markers to identify various device response values.

Step 4. Output Measurement Results

- Store the measurement file to a disk.
- Generate a hardcopy with a printer or plotter.

Learning to Make Transmission Measurements

This example procedure shows you how to measure the transmission response of a bandpass filter. The measurement parameters listed are unique to this particular test device.

For further measurement examples, refer to the "Making Measurements" chapter in the *HP 8719D/20D/22D Network Analyzer User's Guide.*

Step 1. Choose the Measurement Parameters with the Test Device Connected

1. Connect your test device to the analyzer as shown in Figure 2-2.

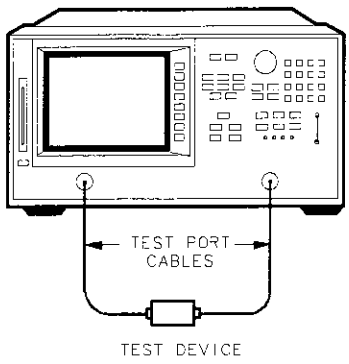


Figure 2-2. Device Connections for a Transmission Measurement

2. Press [Preset] and choose the following measurement settings:
3. [Meas] `Trans: FWD S21 (B/R)`
4. [Center] [10.24] [G/n] (Change to match the center frequency of your device.)
5. [Span] [2.5] [G/n]
6. [Menu] `POWER` [5] [x1] ([−5] [x1], HP 8722D)
7. [Scale Ref] `AUTO SCALE`
8. Look at the device response to determine if these are the parameters that you want for your device measurement. For example, if the trace is noisy you may want to increase the test port output power (which increases the analyzer input power), reduce the IF bandwidth, or add averaging. Or, to better see an area of interest you may want to change the test frequencies.

Step 2. Make a Measurement Error-Correction (Measurement Calibration)

1. Connect a "thru" between the measurement cables, as shown in Figure 2-3. Include all the adapters that you will use in your device measurement.

   If noise reduction techniques are needed for the measurement, the instrument's settings (reduced IF BW, and /or averaging) should be done prior to any measurement error-correction.

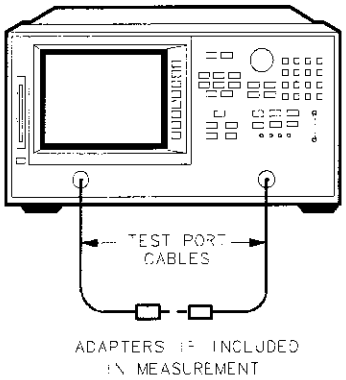


Figure 2-3. Connections for a "Thru" Calibration Standard

2. Press the following keys to make a transmission response calibration:

   (Cal) CALIBRATE MENU RESPONSE THRU

   The analyzer takes a measurement sweep.

3. To save the measurement calibration, press:

   (Save/Recall) SELECT DISK

4. Next, choose from the following options:

   - Choose INTERNAL MEMORY if you want to save the instrument state to the analyzer's internal memory.
   - Choose INTERNAL DISK if you want to save the instrument state to the analyzer's internal disk.
   - Choose EXTERNAL DISK if you want to save the instrument state to an external disk that is configured to the analyzer.

5. Press RETURN SAVE STATE to save the measurement calibration.

Note Example procedures for all types of measurement calibrations are located in the "Optimizing Measurement Results" chapter in the *HP 8719D/20D/22D Network Analyzer User's Guide*. For information on the analyzer operation during a measurement calibration, refer to the "Application and Operation Concepts" chapter in the User's Guide.

Step 3. Measure the Device

1. Connect your test device as in Figure 2-2. Use adapters where appropriate.
2. Press (Scale Ref) AUTO SCALE to reposition the measurement trace for the best view.
3. Press (Marker) and turn the front panel knob to place the marker at a frequency of interest. Read the device's insertion loss to 0.001 dB resolution as shown in Figure 2-4.

   The analyzer shows the frequency of the marker location in the active entry area (upper-left corner of display). The analyzer also shows the amplitude and frequency of the marker location in the top-right corner of the display.

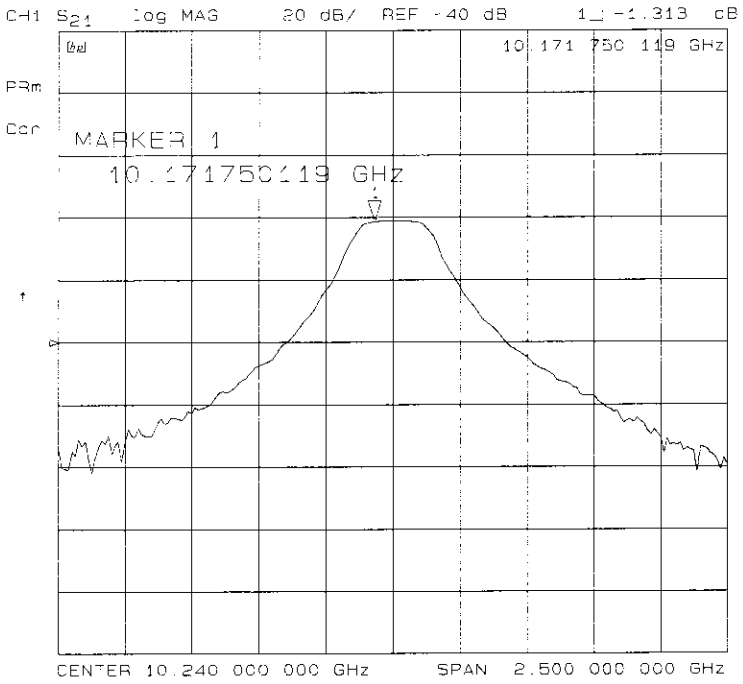


Figure 2-4. Example Measurement of Insertion Loss

Step 4. Output Measurement Results

In this example procedure you are shown how to output (store) measurement results to a disk.

For more information on creating a hardcopy of the measurement results, refer to the "Printing, Plotting, or Saving Measurement Results" chapter in the *HP 8719D/20D/22D Network Analyzer User's Guide.*

1. Insert a DOS- or LIF-formatted disk into the analyzer disk drive. The analyzer does not support LIF-1 (hierarchy file system).
2. To output the measurement results to a disk, press:

   (Save/Recall) SELECT DISK

   - Choose INTERNAL MEMORY if you want to save the measurement results to the analyzer's internal memory.
   - Choose INTERNAL DISK if you want to save the measurement results to the analyzer's internal disk drive.
   - Choose EXTERNAL DISK if you want to save the measurement results to an external disk drive that is configured to the analyzer.
3. Press RETURN DEFINE DISK-SAVE

   - Choose DATA ARRAY ON if you want to store the error-corrected data on disk with the instrument state.
   - Choose RAW ARRAY ON if you want to store the raw data (ratioed and averaged, but no error-correction) on disk with the instrument state.
   - Choose FORMAT ARY ON if you want to store the formatted data on disk with the instrument state.
   - Choose GRAPHICS ON if you want to store user graphics on disk with the instrument state.
   - Choose DATA ONLY ON if you want to only store the measurement data of the device under test. The analyzer will not store the instrument state and measurement calibration.

Note Selecting DATA ONLY ON will override all of the other save options. Because this type of data is only intended for computer manipulation, the file contents of a DATA ONLY ON save cannot be recalled and displayed on the analyzer.

   - Choose SAVE USING BINARY if you want to store data in a binary format.
   - Choose SAVE USING ASCII if you want to store data in an ASCII format, to later read on a computer.
4. Press RETURN SAVE STATE and the analyzer saves the file with a default title.

Measuring Other Aspects of Insertion Loss with Marker Functions

Using the analyzer marker functions, you can derive several important filter parameters from the measurement trace that is shown on the analyzer display.

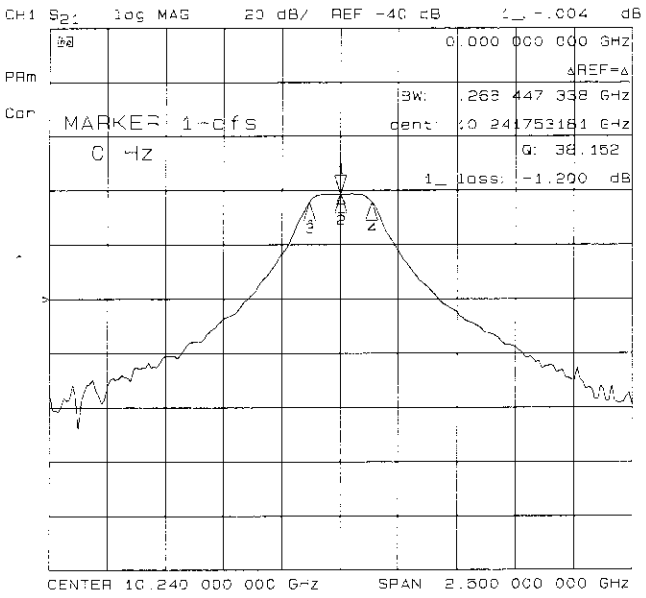


Figure 2-5. Example Measurement of 3 dB Bandwidth

3 dB Bandwidth.

The analyzer can calculate your test device bandwidth between two equal power levels. In this example procedure, the analyzer calculates the −3 dB bandwidth relative to the center frequency of the filter.

1. Press (Marker) and turn the front panel knob to move the marker to the center frequency position of the filter passband.
   - You can also position the marker by entering a frequency location: for example, press (10.24) (G/n).
2. Press MKR ZERO to zero the delta marker magnitude and frequency (this sets the delta marker reference). The −3 dB points will be relative to this marker.

   The softkey label changes to MKR ZERO Δ REF=Δ to show you that the delta reference point is the small Δ symbol.
3. Press (Marker Fctn) MKR SEARCH to enter the marker search mode.
4. Press WIDTHS ON.

   The analyzer calculates the −3 dB bandwidth, the center frequency and the Q (Quality Factor) of the test device and lists the results in the upper-right corner of the display. Markers 3 and 4 indicate the location of the −3 dB points, as shown in Figure 2-5.
5. Press WIDTH VALUE and enter (−6) (x1).

   The analyzer now calculates the bandwidth between −6 dB power levels.
6. Press (Marker) all OFF when you are finished with this measurement.

Out-of-Band Rejection.

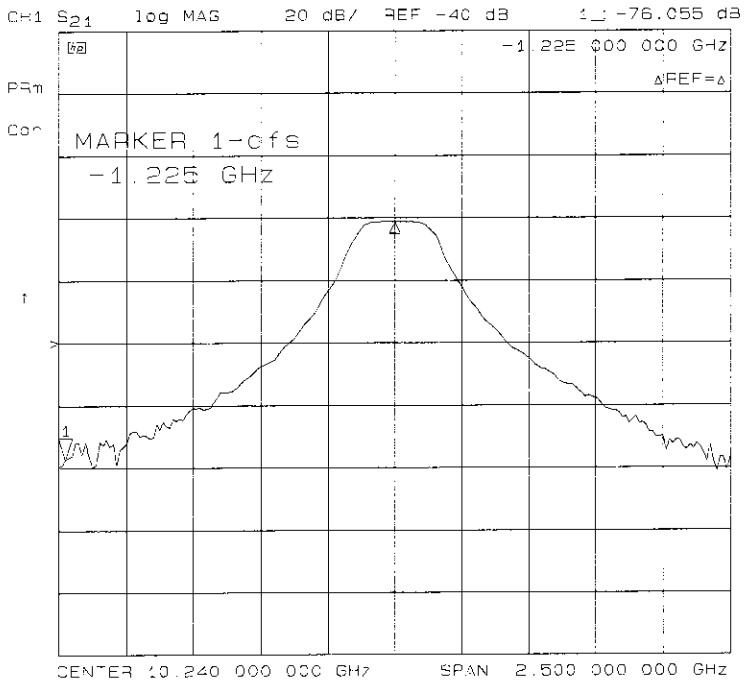


Figure 2-6. Example Measurement of Out-of-Band Rejection

1. Press MARKER 1 . The marker appears where you placed it during the bandwidth measurement.
2. Press MKR ZERO (Marker Fctn) MKR SEARCH SEARCH: MIN .

   The marker automatically searches for the minimum point on the trace. The frequency and amplitude of this point, appear in the upper-right corner of the display. This value is the difference between the maximum power in the passband and the power in the rejection band, that is, one of the peaks in the rejection band.

Note You can use the marker search mode to search the trace for the maximum point or for any target value. The target value can be an absolute level (for example, −3 dBm) or a level relative to the location of the small delta symbol (for example: −3 dB from the center of the passband).

---

3. If your measurement needs some noise reduction, you could reduce the IF bandwidth or add averaging.
   - To reduce the IF bandwidth, press (Avg) IF BW (⇩).
   - To add averaging, press (Avg) AVERAGING ON .

Passband Flatness or Ripple.

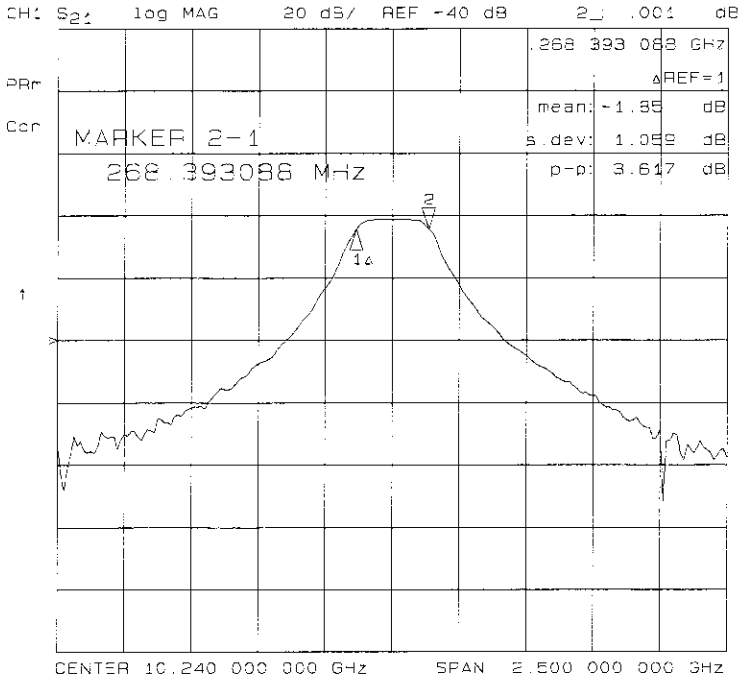


Figure 2-7. Example Measurement of Passband Flatness or Ripple

Passband flatness (or ripple) is the variation in insertion loss over a specified portion of the passband.

Continue with the following steps to measure passband flatness or ripple.

1. Press (Marker) and turn the front panel knob to move marker 1 to the left edge of the passband.
2. Press ΔMODE MENU Δ REF=1 to change the marker 1 position to the delta reference point.
3. Press MARKER 2 and turn the front panel knob to move marker 2 to the right edge of the passband.
4. Press (Marker Fctn) MKR MODE MENU STATS ON.

   The analyzer calculates the mean, standard deviation, and peak-to-peak variation between the Δ reference marker and the active marker, and lists the results in the upper-right corner of the display. The passband ripple is automatically shown as the peak-to-peak variation between the markers.

Learning to Make Reflection Measurements

This example procedure shows you how to measure the reflection response of a bandpass filter. The measurement parameter values listed are unique to this particular test device.

For further measurement examples, refer to the "Making Measurements" chapter in the *HP 8719D/20D/22D Network Analyzer User's Guide.*

Note

Reflection measurements monitor only one port of a test device. When a test device has more than one port, you must ensure that the unused port(s) are terminated in their characteristic impedance. If you do not terminate unused ports, reflections from these ports will cause measurement errors.

You can connect an unused device port to the unused analyzer test port, to act as a termination. For example: when you are measuring S_{11} or S_{22} , you can connect an unused device port to the analyzer's PORT 2 or PORT 1, respectively.

The signal reflected from the device under test is measured as a ratio of the reflected energy versus the incident energy. It can be expressed as reflection coefficient, return loss, or standing-wave-ratio (SWR). These measurements are mathematically defined as follows:

reflection coefficient (Γ) = reflected voltage / incident voltage
= S_{11} or S_{22} (magnitude and phase)

magnitude of reflection coefficient (ρ) = $|\Gamma|$

return loss (dB) = $-20 \log (\rho)$, where $\rho = |\Gamma|$

standing-wave-ratio (SWR) = V maximum / V minimum
= $(1 + \rho) / (1 - \rho)$

Step 1. Choose the Measurement Parameters with the Test Device Connected

Note For purposes of explanation, a 10.24 GHz bandpass filter was used as the test device throughout this section.

1. Connect your test device as shown in Figure 2-8.

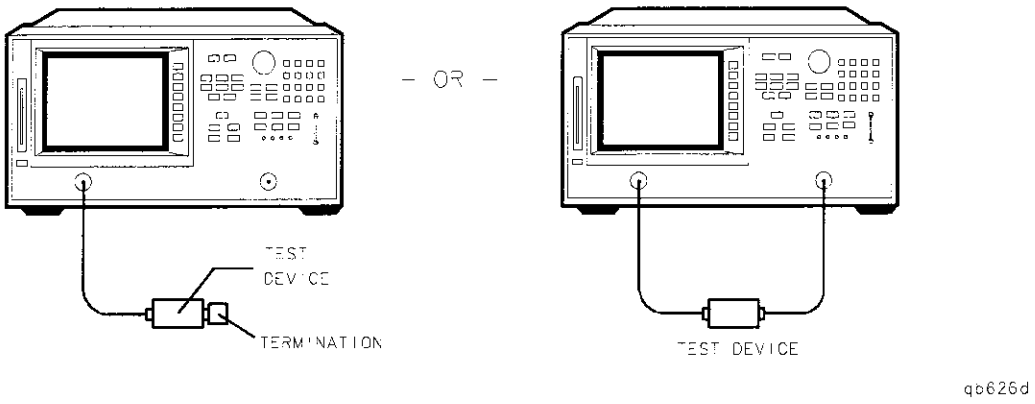


Figure 2-8. Connections for Reflection Measurements

2. Press [Preset] and choose the following measurement parameters:

   [Meas] Refl:FWD S11 (A/R)

   [Center] [10.24] [G/n]

   [Span] [2.5] [G/n]

   [Menu] POWER [5] [x1] ([−5] [x1], HP 8722D)

   [Scale Ref] AUTO SCALE

Note If you press [Start] and [Stop], the analyzer will show the frequencies at the beginning and end of the frequency span that you have set up around the center frequency. This is also another method you could use to set the analyzer's measurement frequencies.

3. Look at the device response to determine if these are the measurement parameters that you want. For example, if the trace is noisy you may want to increase the input power, reduce the IF bandwidth, or add averaging. Or, to better see an area of interest you may want to change the test frequencies.

Step 2. Make a Measurement Error-Correction (Measurement Calibration)

Follow these instructions to make an S_{11} 1-port error-correction:

1. Select a calibration kit that is appropriate to your device under test. Press (Cal) `CAL KIT`. Choose the calibration kit that is appropriate to your test device by pressing the appropriate softkey. For example, if your test device uses 3.5-mm connectors, press `3.5mmC`. If your test device uses 7-mm connectors, press `7mm`, and so on.

2. Press `RETURN CALIBRATE MENU S11 1-PORT`.

3. Follow the prompts shown on the analyzer display to connect and measure an open, short, and load on PORT 1.

   Any choice of male/female in the calibration process should always be made for the sex that represents the test port. For example, if the test port had a male, Type-N connector, you would connect the female, Type-N calibration device. But when you follow the prompts on the analyzer to measure a short calibration standard, you would select `SHORT (M)`, or the sex that represents the test port.

Caution To ensure an accurate measurement error-correction, you must connect the calibration standards to the adapters or cables that you will include in the actual device measurement.

Note If a mistake is made, standards can be measured more than once before pressing `DONE 1-PORT CAL`.

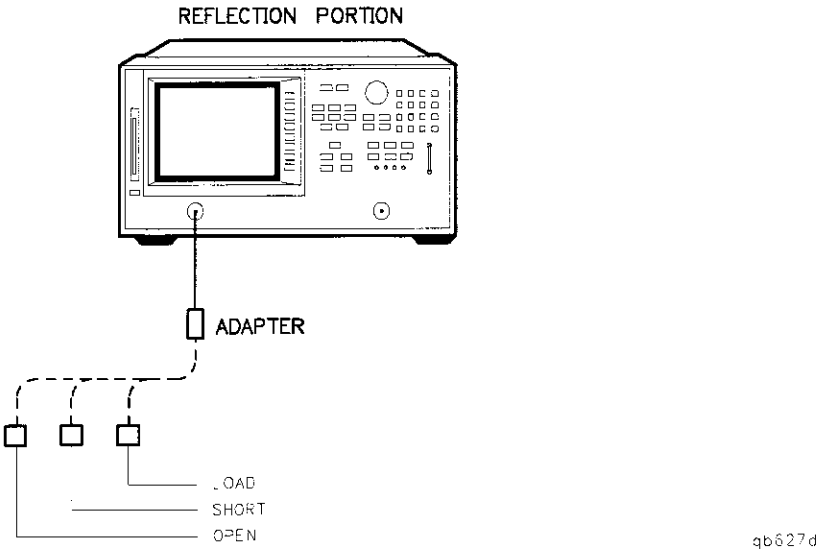


Figure 2-9. Connections for an S_{11} 1-Port Measurement Calibration

4. Press `DONE 1-PORT CAL` after measuring the three standards.

5. Press (Save/Recall) `SAVE STATE`.

Step 3. Measure the Device

Measuring Return Loss.

1. Connect your device to PORT 1.
2. Terminate any unused port on your device. You can do this by either connecting a load to the device's unused port, or by connecting the device's unused port to PORT 2 on the analyzer.
3. Press (Scale Ref) AUTO SCALE to reposition the trace.
4. Press (Marker) to read the return loss from the analyzer display as shown in Figure 2-10.

   The device response indicates that the filter and the analyzer impedances are well matched within the frequency range of the filter passband. That is, the reflected signal is smaller within the filter passband than outside the passband.

   In terms of return loss, the value within the passband is larger than outside the passband. A large value for return loss corresponds to a small reflected signal just as a large value for insertion loss corresponds to a small transmitted signal.

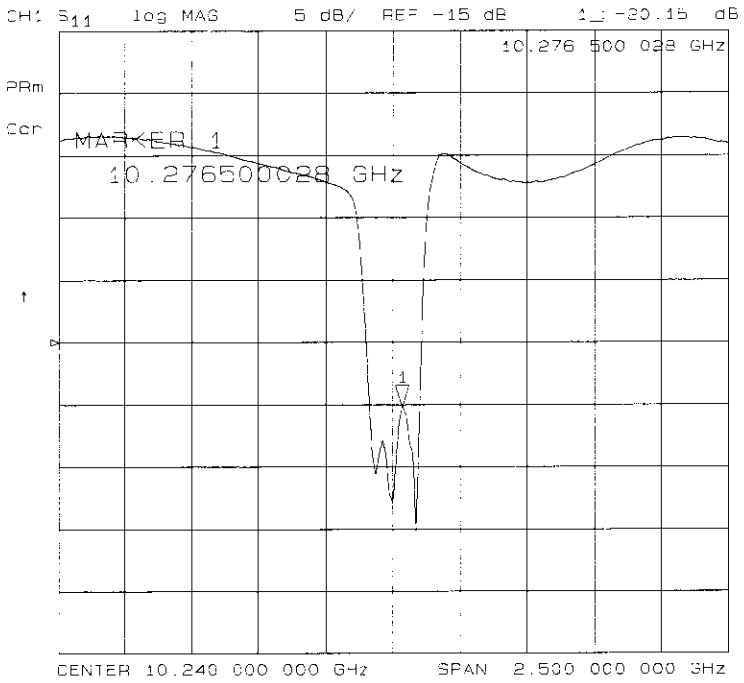


Figure 2-10. Example Return Loss Measurement Trace

Step 4. Output Measurement Results

This step in the procedure shows you how to output the measurement results to a printer.

For in-depth information on creating a hardcopy of the measurement results, refer to the "Printing, Plotting, or Saving Measurement Results" chapter in the *HP 8719D/20D/22D Network Analyzer User's Guide.*

1. Connect a printer to the analyzer as described in the "Installing Your Analyzer" chapter.
2. Press (Display) `MORE` `TITLE` and then create a title for the measurement, as shown in Figure 2-11:
   - Use an optional DIN keyboard to type the title, or
   - Use the front panel knob and the softkey menu to select each letter of the title.
3. Press `DONE` when you finish creating the measurement title. The title appears on the upper-left corner of the analyzer display.
4. Press (Local) `SYSTEM` `CONTROLLER` to set up the analyzer as the controller. If you are using an HP-IB printer, ensure that there is not another controller on the bus. (Note that this step is not required when using parallel or serial printers.)
5. Press (Copy) `PRINT` `MONOCHROME` to create a black and white hardcopy.

Note If you encounter a problem when printing a hardcopy, refer to "To Configure an Analyzer with Printers or Plotters" in the "Installing your Analyzer" chapter.

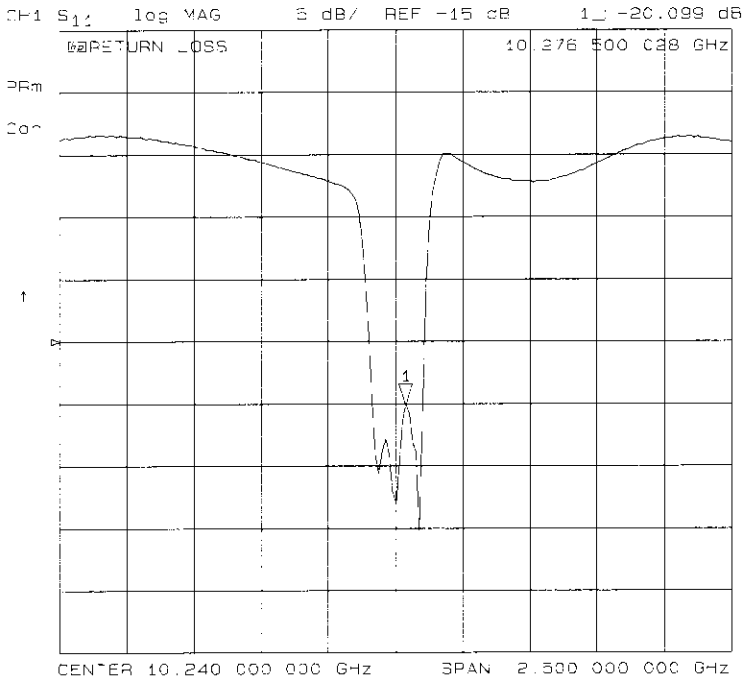


Figure 2-11. Example Measurement Title

Measuring Other Reflection Characteristics

You can derive several important filter parameters from the measurement shown on the analyzer display. The following set of procedures is a continuation of the previous reflection measurement procedure.

Measuring Reflection Coefficient.

1. Press (Save/Recall) RECALL STATE to recall the calibrated reflection measurement, that you saved earlier in this procedure..
2. Press (Format) LIN MAG (Scale Ref) AUTO SCALE so the analyzer shows the same data in terms of reflection coefficient, as shown in Figure 2-12.

   The units "mU" displayed on the analyzer are "milli-units," where "units" or "U" is used to indicate that the parameter is unitless (as opposed to having the unit "dB"). 200 mUnits = 0.2 Units.

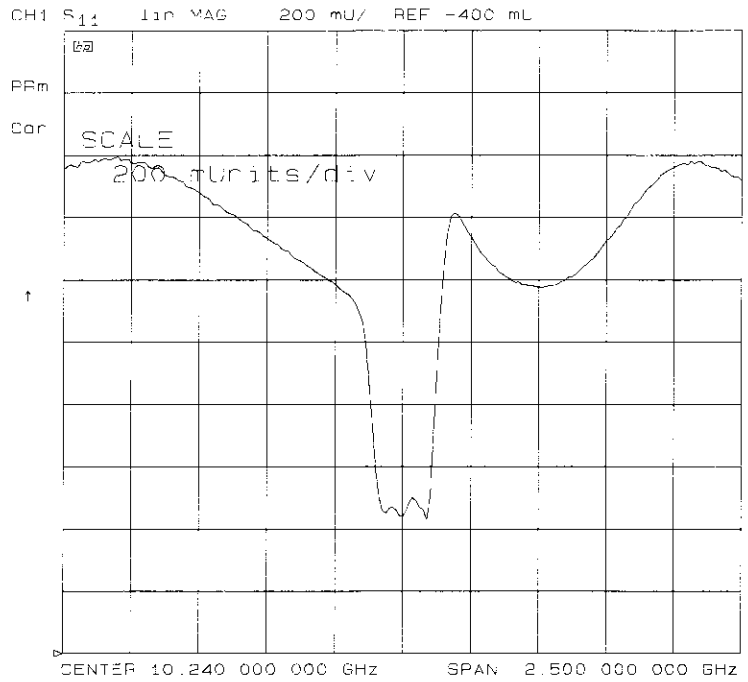


Figure 2-12. Example Reflection Coefficient Measurement Trace

Measuring Standing Wave Ratio.

Press (Format) SWR (Scale Ref) SCALE/DIV (1) (x1) REFERENCE VALUE (1) (x1) so the analyzer shows the same data in terms of standing-wave-ratio (SWR), as shown in Figure 2-13.

Now the analyzer shows the measurement data in the unitless measure of SWR where SWR = 1 (perfect match) at the bottom of the display.

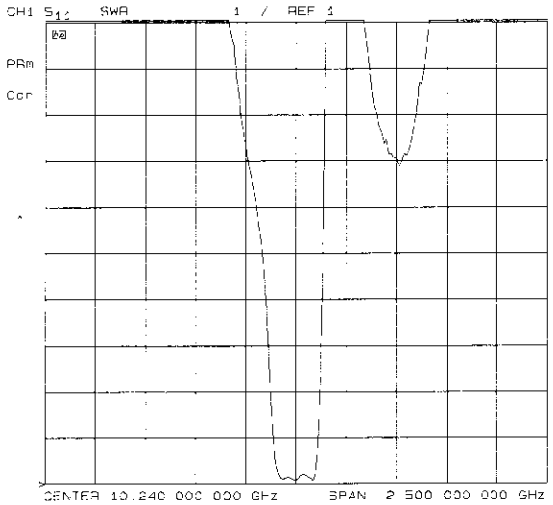


Figure 2-13. Example Standing-Wave-Ratio Measurement Trace

Measuring S_{11} and S_{22} in a Polar Format.

S_{11} is a measurement parameter used to measure the reflection coefficient of your test device input, where S_{22} is a measurement parameter used to measure the reflection coefficient of the your test device output. In both instances, you must terminate all the unused ports.

1. Press (Format) POLAR.

2. Press (Scale Ref) AUTO SCALE to reposition the trace, as shown in Figure 2-14.

   The analyzer shows the results of an S_{11} measurement with each point on the polar trace corresponding to a particular value of both magnitude and phase. The center of the circle represents a coefficient (Γ) of 0, (that is, a perfect match or no reflected signal). The outermost circumference of the scale shown in Figure 2-14 represents ρ = 2.00, or 200% reflection. The phase angle is read directly from this display. The phase angle is read directly from this display. The 3 o'clock position corresponds to zero phase angle, (that is, the reflected signal is at the same phase as the incident signal). Phase differences of 90°, 180°, and −90° correspond to the 12 o'clock, 9 o'clock, and 6 o'clock positions on the polar display, respectively.

3. Press (Marker Fctn) MARKER MODE MENU POLAR MKR MENU.

4. Turn the front panel knob to position the marker at any desired point on the trace, then read the frequency, linear magnitude and phase in the upper right hand corner of the display, as shown in Figure 2-14.

   - Choose `LIN MKR` if you want the analyzer to show the linear magnitude and the phase of the marker.
   - Choose `LOG MKR` if you want the analyzer to show the logarithmic magnitude and the phase of the active marker. This is useful as a fast method of obtaining a reading of the log-magnitude value without changing to log-magnitude format.
   - Choose `Re/Im MKR` if you want the analyzer to show the values of the marker as a real and imaginary pair.

Note You can also enter the frequency of interest, from either the attached keyboard or the numeric keyboard, and read the magnitude and phase at that point.

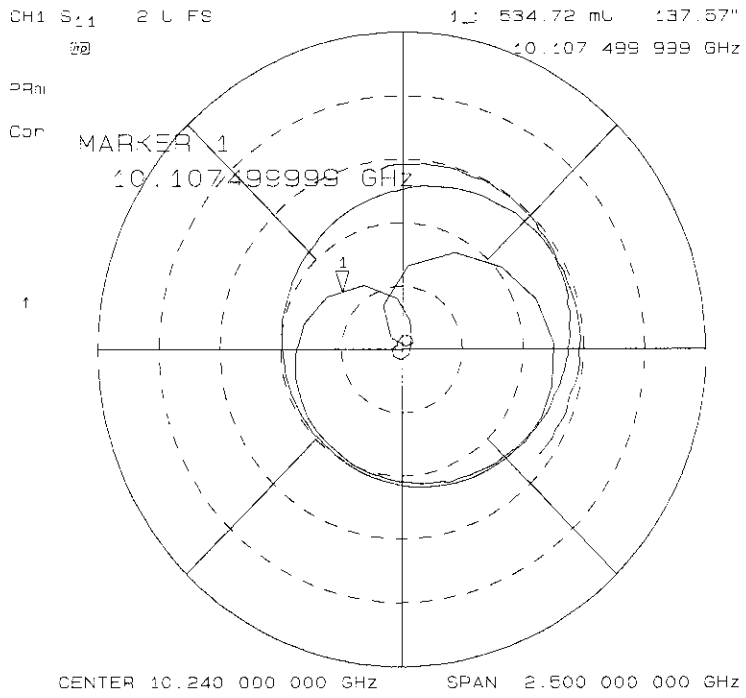


Figure 2-14.
Example S_{11} Measurement Trace in Polar Format with Markers

Measuring Impedance.

The amount of power reflected from a device is directly related to the impedance of the device and the measuring system. Each value of the reflection coefficient (Γ) uniquely defines a device impedance; $\Gamma = 0$ only occurs when the device and analyzer impedance are exactly the same. The reflection coefficient for a short circuit is: $\Gamma = 1 \angle 180°$. Every other value for Γ also corresponds uniquely to a complex device impedance, according to the equation:

$$Z_L = [(1 + \Gamma) / (1 - \Gamma)] \times Z_0$$

where Z_L is your test device impedance and Z_0 is the measuring system's characteristic impedance (50Ω or 75Ω).

1. Press (Format) SMITH CHART (Scale Ref) AUTOSCALE .

2. Press (Marker Fctn) MKR MODE MENU SMITH MKR MENU and turn the front panel knob to read the resistive and reactive components of the complex impedance at any point along the trace, as shown in Figure 2-15. This is the default Smith chart marker.

   The marker annotation tells that the complex impedance is capacitive in the bottom half of the Smith chart display and is inductive in the top half of the display.

   - Choose LIN MKR if you want the analyzer to show the linear magnitude and the phase of the reflection coefficient at the marker.
   - Choose LOG MKR if you want the analyzer to show the logarithmic magnitude and the phase of the reflection coefficient at the active marker. This is useful as a fast method of obtaining a reading of the log magnitude value without changing to log magnitude format.
   - Choose Re/Im MKR if you want the analyzer to show the values of the reflection coefficient at the marker as a real and imaginary pair.
   - Choose R+jX MKR to show the real and imaginary parts of the device impedance at the marker. Also shown is the equivalent series inductance or capacitance.

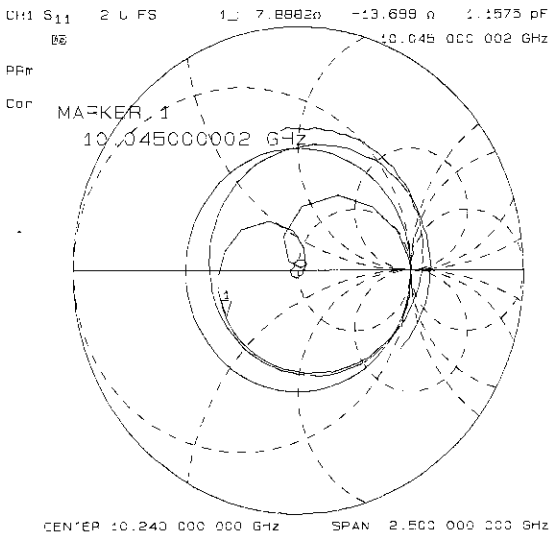


Figure 2-15. Example Impedance Measurement Trace

Measuring Admittance.

To change the display to an inverse Smith chart graticule and the marker information to read admittance, press G+jB MKR .

As shown in Figure 2-16, the marker reads admittance data in the form G+jB, where G is conductance and B is susceptance, both measured in units of Siemens (equivalent to mhos: the inverse of ohms). Also shown is the equivalent parallel capacitance or inductance.

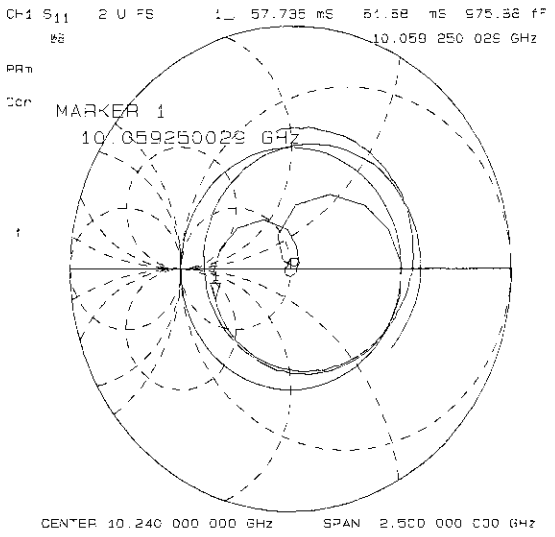


Figure 2-16. Example Admittance Measurement Trace

If You Encounter a Problem

If you have difficulty when installing or using the analyzer, check the following list of commonly encountered problems and troubleshooting procedures. If the problem that you encounter is not in the following list, refer to additional troubleshooting sections in the *HP 8719D/20D/22D Network Analyzer Service Guide.*

Power-Up Problems

If the Display Does Not Light:

- ☐ Check that the power cord is fully seated in both the main power receptacle and the analyzer power module.
- ☐ Check that the AC line voltage selector switch is in the appropriate position (230V/115V) for your available power supply.
- ☐ Check that the analyzer AC line fuse is not open.

Warning **For continued protection against fire hazard, replace the fuse with the same type and rating.**

Refer to Figure 2-17 to remove the fuse from the power module. You can use a continuity light or an ohmmeter to check the fuse. An ohmmeter should read very close to zero ohms if the fuse is good. The 3A, 250V fuse is HP part number 2110-0780.

- ☐ Contact the nearest Hewlett-Packard office for service, if necessary. A list of Hewlett-Packard sales and service offices is provided at the end of this guide.

Warning **The power cord is connected to internal capacitors that may remain live for 10 seconds after you disconnect the cord from the power supply.**

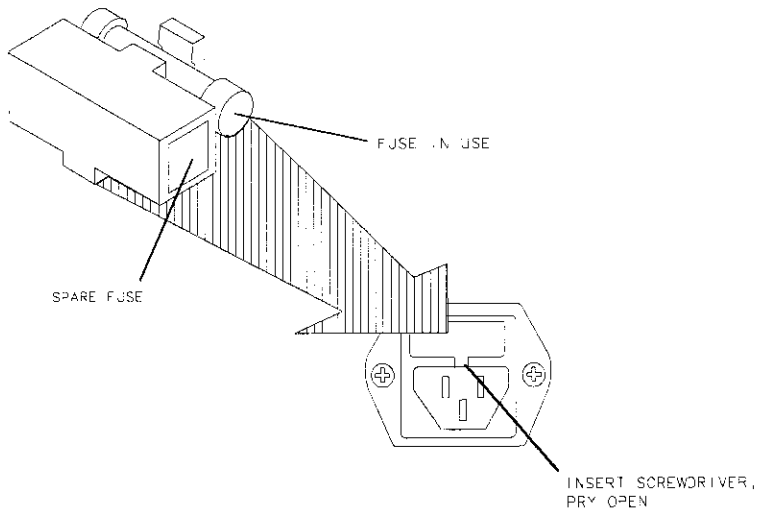


Figure 2-17. Line Fuse Removal and Replacement

If the Display Lights, but the Ventilation Fan Does Not Start:

- ☐ Check that the fan is not obstructed. To check the fan, follow these steps:
  1. Switch the LINE power to the off position.
  2. Check that the fan blades are not jammed.
- ☐ Contact the nearest Hewlett-Packard office for service, if necessary. A list of Hewlett-Packard sales and service offices is provided at the end of this guide.

Data Entry Problems

If the Data Entry Controls (keypad, knob, ⇧, ⇩, ⇦, ⇨ keys) Do Not Respond:

- ☐ Check that the ENTRY OFF function is not enabled.

  The ENTRY OFF function is enabled after you press the [Entry Off] key. To return to normal entry mode, press any function key that has a numeric parameter associated with it. For example, [Start].
- ☐ Check that none of the keys are stuck.
- ☐ Check that the selected function key accepts data.

  For example, [Scale Ref] accepts data, but [System] does not.
- ☐ Check that the analyzer's "R" HP-IB STATUS light is not illuminated.

  If the analyzer's "R" HP-IB STATUS light is illuminated, a test sequence may be running, or a connected computer controller may be sending commands or instructions to, or receiving data from, the analyzer. Press [Local] if you want to return to LOCAL control.

If the Parameter You Are Trying to Enter is Not Accepted by the Analyzer:

- ☐ Ensure that you are not attempting to set the parameter greater than or less than its limit. Refer to the *HP 8719D/20D/22D Network Analyzer User's Guide* for the parameter limits.

No RF Output

If There is No RF Signal at PORT 1 Connector:

- ☐ Check that the signal at the test ports is switched on.
  1. Press [Menu] `POWER` `SOURCE PWR` until ON appears on the `SOURCE PWR` softkey label.
- ☐ If you are applying external modulation (AM) to the analyzer, check the external modulating signal or external gate/trigger signals for problems.

Caution If the error message:

```
CAUTION: TEST PORT OVERLOAD, REDUCE POWER
```

appears on the display, too much source power is being applied at the input. In such a case, the input power will need to be reduced before the source power will remain on.

- □ Look for phase-lock error messages and then contact your nearest Hewlett-Packard office for service. A list of Hewlett-Packard Sales and Service offices is provided at the end of this guide.

Table 2-1. Hewlett-Packard Sales and Service Offices

US FIELD OPERATIONS

Headquarters
Hewlett-Packard Co.
19320 Pruneridge Avenue
Cupertino, CA 95014
(800) 752-0900

California, Northern
Hewlett-Packard Co.
301 E. Evelyn
Mountain View, CA 94041
(415) 694-2000

California, Southern
Hewlett-Packard Co.
1421 South Manhattan Ave.
Fullerton, CA 92631
(714) 999-6700

Colorado
Hewlett-Packard Co.
24 Inverness Place, East
Englewood, CO 80112
(303) 649-5512

Georgia
Hewlett-Packard Co.
2000 South Park Place
Atlanta, GA 30339
(404) 955-1500

Illinois
Hewlett-Packard Co.
5201 Tollview Drive
Rolling Meadows, IL 60008
(708) 255-9800

New Jersey
Hewlett-Packard Co.
150 Green Pond Rd.
Rockaway, NJ 07866
(201) 586-5400

Texas
Hewlett-Packard Co.
930 E. Campbell Rd.
Richardson, TX 75081
(214) 231-6101

EUROPEAN FIELD OPERATIONS

Headquarters
Hewlett-Packard S.A.
150, Route du Nant-d'Avril
1217 Meyrin 2/Geneva
Switzerland
(41 22) 780.8111

France
Hewlett-Packard France
1 Avenue Du Canada
Zone D'Activite De Courtaboeuf
F-91947 Les Ulis Cedex
France
(33 1) 69 82 60 60

Germany
Hewlett-Packard GmbH
Hewlett-Packard Strasse
61352 Bad Homburg v.d.H
Germany
(49 6172) 16-0

Great Britain
Hewlett-Packard Ltd.
Eskdale Road, Winnersh Triangle
Wokingham, Berkshire RG41 5DZ
England
(44 734) 696622

INTERCON FIELD OPERATIONS

Headquarters
Hewlett-Packard Company
3495 Deer Creek Road
Palo Alto, California, USA
94304-1316
(415) 857-5027

Australia
Hewlett-Packard Australia Ltd.
31-41 Joseph Street
Blackburn, Victoria 3130
(61 3) 895-2895

Canada
Hewlett-Packard (Canada) Ltd.
17500 South Service Road
Trans-Canada Highway
Kirkland, Quebec H9J 2X8
Canada
(514) 697-4232

China
China Hewlett-Packard Company
38 Bei San Huan X1 Road
Shuang Yu Shu
Hai Dian District
Beijing, China
(86 1) 256-6888

Japan
Hewlett-Packard Japan, Ltd.
1-27-15 Yabe, Sagamihara
Kanagawa 229, Japan
(81 427) 59-1311

Singapore
Hewlett-Packard Singapore (Pte.) Ltd.
150 Beach Road
#29-00 Gateway West
Singapore 0718
(65) 291-9088

Taiwan
Hewlett-Packard Taiwan
8th Floor, H-P Building
337 Fu Hsing North Road
Taipei, Taiwan
(886 2) 712-0404

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