

User's and Service Guide

HP 87050E and HP 87075C Multiport Test Sets



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1 Introduction and Installation

Introduction to the Multiport Test Set

- The HP 87050E is a 50-ohm multiport test set that is available with 4, 8, or 12 test ports.
- The HP 87075C is a 75-ohm multiport test set that is available with 6 or 12 test ports.

A Complete Multiport Test System

HP 87050E and HP87075C multiport test sets are designed to work with HP 8712ET/ES (1.3 GHz) and HP 8714ET/ES (3 GHz) RF network analyzers to provide complete measurement systems for 50 ohm and 75 ohm multiport devices. These test systems offer fast measurement speed, high accuracy, and productivity features that will maximize your production throughput. They feature:

- specified performance to 1.3 GHz (HP 87075C) or 2.2 GHz (HP 87050E—with typical performance to 3 GHz)
- solid-state switches for fast, repeatable, and reliable switching between measurement paths

Fully Characterize Your Devices with a Single Connection

A single connection between the multiport test set and each port of the DUT allows complete testing of all transmission paths and port reflection characteristics. HP multiport test systems eliminate time-consuming reconnections to the DUT, keeping your production costs down and your volumes up. By reducing the number of RF connections, you also:

- lower the risk of misconnections
- reduce operator fatigue
- minimize wear on cables, fixtures, connectors, and the DUT

Improve Your Competitiveness with a Fully Specified Test System

A multiport test set coupled with an HP 8712E series network analyzer offers fully specified performance at the actual test ports, whether you measure in a fixture or at the end of test cables. Specified performance means you can:

- get the same results no matter which test station you use to measure your DUT
- correlate test data from many DUTs across multiple test systems
- reduce measurement uncertainty to tighten your product specifications
- increase customer confidence in your products

Eliminate Redundant Connection of Calibration Standards with Test Set Cal

Calibrating a multiport test set using two-port error correction and a traditional network analyzer requires a unique instrument state for each measurement path, forcing many redundant connections of calibration standards. As the number of ports increases, so does the number of connections required to calibrate all possible measurement paths. Full calibration of the multiport test system is quick and simple when performing a Test Set Cal:

- connect short, open, and load standards only once to each measurement port
- minimize the number of through standards required during calibration

Reduce the Effects of Test-System Drift with SelfCal

SelfCal is an internally automated calibration technique that uses solid-state switches to measure calibration standards located inside the test set. SelfCal executes automatically in just a few seconds (at an interval you define), so the impact to your test process is minimal. Use SelfCal to:

- re-calibrate your multiport test system, returning it to the same measurement accuracy achieved immediately after performing a Test Set Cal
- reduce the effects of test-system drift, improving overall measurement accuracy between Test Set Cals

Since SelfCal does not correct for drift associated with interconnect elements between the test set and your DUT, it is essential to use high-quality test cables, adapters, and fixtures to ensure the best measurement accuracy.

Decrease Calibration Times and Increase Production Throughput

With SelfCal, a Test Set Cal needs to be performed about once per month, if within the specified temperature range. This is unlike other test systems that typically require calibration once or twice a day. Using Test Set Cal and SelfCal, you can:

- easily reduce your overall calibration times by a factor of twenty or more
- increase the amount of time a test station can be used for measuring devices—typically, by three days per month.

Improve Measurement Accuracy with Two-Port Calibration

When using a multiport test set with an HP 8712ES or HP 8714ES S-parameter network analyzer, Test Set Cal and SelfCal support full two-port calibrations. Two-port error correction greatly improves the effective load match of the test system, providing excellent measurement accuracy.

Key Conventions

This manual uses the following conventions:

FRONT-PANEL KEY: This represents a key physically located on the analyzer (a “hardkey”).

Softkey: This indicates a “softkey”: a key whose label is determined by the instrument’s firmware, and is displayed on the right side of the instrument’s screen next to the eight unlabeled keys.

If You Are Using an HP 8711C/12C/13C/14C Analyzer

This document is intended for use with HP 8712ET/ES and HP 8714ET/ES analyzers, so some of the information (for example, keypresses and calibration features) does not apply to your analyzer. The *HP 87075C Multiport Test Set User's and Service Guide* is specifically written for using the HP 87075C multiport test set with HP 8711C/12C/13C/14C analyzers. You can order a copy of this manual (HP part number 87075-90005) by contacting your nearest Hewlett-Packard sales and service office. See [Table 8-11 on page 8-38](#). The manual can be also be viewed in the following two locations:

- CD-ROM (included with your multiport test set)
- Web site <http://www.hp.com/go/manuals> or <http://www.agilent.com/find/manuals> (select "Network Analyzer Manuals Available Online")

There is also software available for an operator's check and performance tests that support the old version of the specifications for using the HP 87075C multiport test set with HP 8711C/12C/13C/14C analyzers.

Both the HP 87050E and the HP 87075C multiport test sets are compatible with HP 8711C/12C/13C/14C analyzers that contain firmware revision C.04.5.x or later. Analyzers must have 16 MBytes of DRAM and 1 MB of non-volatile RAM. For more information, refer to the *HP 87075C Multiport Test Set User's and Service Guide*.

Installation

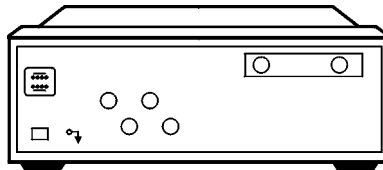
This section will guide you through the steps necessary to correctly and safely install your multiport test set. The steps are:

- “Step 1. Check the Shipment” on page 1-10
- “Step 2. Determine Network Analyzer Compatibility” on page 1-12
- “Step 3. Connect the Test Set to the Analyzer” on page 1-14
- “Step 4. Satisfy Electrical and Environmental Requirements” on page 1-16
- “Step 5. Activate the Test Set and Check the System Operation” on page 1-19
- “Step 6. Connect Peripheral Devices” on page 1-21

Figure 1-1

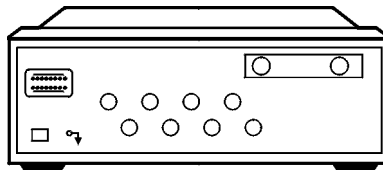
HP 87050E Multiport Test Set — Three Versions

HP 87050E Option 004 — Four Port Test Set



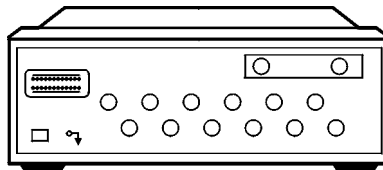
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HP 87050E Option 008 — Eight Port Test Set



pt64e

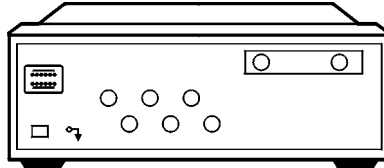
HP 87050E Option 012 — Twelve Port Test Set



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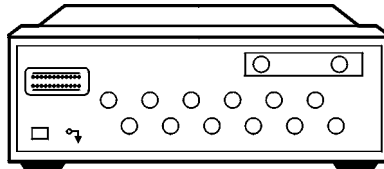
Figure 1-2 HP 87075C Multiport Test Set — Two Versions

HP 87075C Option 006 — Six Port Test Set



pt630e

HP 87075C Option 012 — Twelve Port Test Set



pt631e

Step 1. Check the Shipment

After you have unpacked your test set, keep the packaging materials to use if your instrument should need to be returned for maintenance or repair.

NOTE

The packaging material is designed to protect the test set from damage that can happen during shipping. Returning the test set in anything other than the original packaging may result in non-warranted damage.

Check the items received against [Table 1-1 on page 1-11](#) to make sure that you received everything.

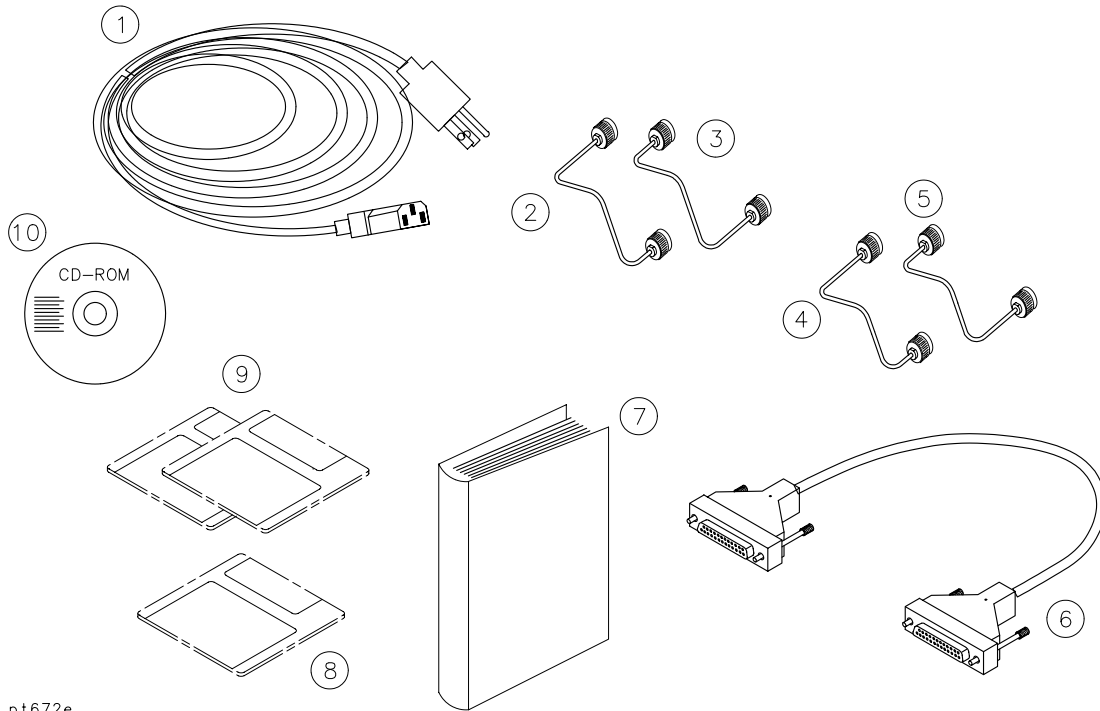
Inspect the test set and all accessories for any signs of damage that may have occurred during shipment. If your test set or any accessories appear to be damaged or missing, call your nearest Hewlett-Packard sales or service office. Refer to [Table 8-11 on page 8-38](#) for the nearest office.

Table 1-1 Test Set Accessories Supplied

Item No.	Description	Quantity	HP Part Number
1	Power Cord	1	See Figure 6-5 on page 6-9 .
2	Type-N Cable (Analyzer to test set's REFLECTION Port) ¹	1	(75 Ω) 87075-60026 (50 Ω) 87050-60058
3	Type-N Cable (Analyzer to test set's TRANSMISSION Port) ¹	1	(75 Ω) 87075-60028 (50 Ω) 87050-60060
4	Type-N Cable (Analyzer to test set's REFLECTION Port) ²	1	(75 Ω) 87075-60027 (50 Ω) 87050-60059
5	Type-N Cable (Analyzer to test set's TRANSMISSION Port) ²	1	(75 Ω) 87075-60029 (50 Ω) 87050-60061
6	Parallel Port Interface Cable	1	8120-6818
7	HP 87050E and 87075C User's and Service Guide	1	87050-90026
8	Test Set Calibration Disk	1	N/A
9	Performance Test Programs Disks (DOS and LIF formats)	1	08714-60049
10	CD-ROM	1	08714-90051

1. Not to be used with a rack-mounted system or if the analyzer has had its bottom feet removed. See [Figure 1-7 on page 1-19](#) to see how these cables are to be connected.
2. You will only receive these cables if you ordered Option 1CM (rack mount kit). Use these cables if you are rack-mounting your system, or if the bottom feet of the analyzer have been removed. See [Figure 1-7 on page 1-19](#) for information on how to connect these cables.

Figure 1-3 Test Set Accessories Supplied



.pt672e

Step 2. Determine Network Analyzer Compatibility

The HP 87050E multiport test set is designed for use with HP 8712ET/ES and HP 8714ET/ES RF network analyzers, 50 Ω impedance.

The HP 87075C multiport test set is designed for use with HP 8711C/12C/13C/14C or HP 8712ET/ES and HP 8714ET/ES RF network analyzers, 75 Ω impedance (Option 1EC).

The basic function of the HP 87050E and the HP 87075C multiport test sets is identical. However, their impedance and specifications are different.

If you are using a C-series analyzer, refer to “If You Are Using an HP 8711C/12C/13C/14C Analyzer” on page 1-6.

Check the Firmware Revision

The firmware in your E-series analyzer must be revision E.06.00 or later. The firmware revision is displayed when you first power up the analyzer, and can also be viewed by pressing (SYSTEM OPTIONS) Service Instrument Info .

If your analyzer does not have firmware revision E.06.00 or later, then you must upgrade to the latest revision of firmware. You can perform this upgrade yourself. The current firmware is available as a set of floppy disks. To order, call your nearest Hewlett-Packard sales or service office. Refer to Table 8-11 on page 8-38 for the nearest office.

The current firmware revision may also be downloaded, free of charge, through the internet. There is a link to the download site at the following URLs:

<http://www.hp.com/go/enasupport>

<http://www.agilent.com/find/enasupport>

CAUTION

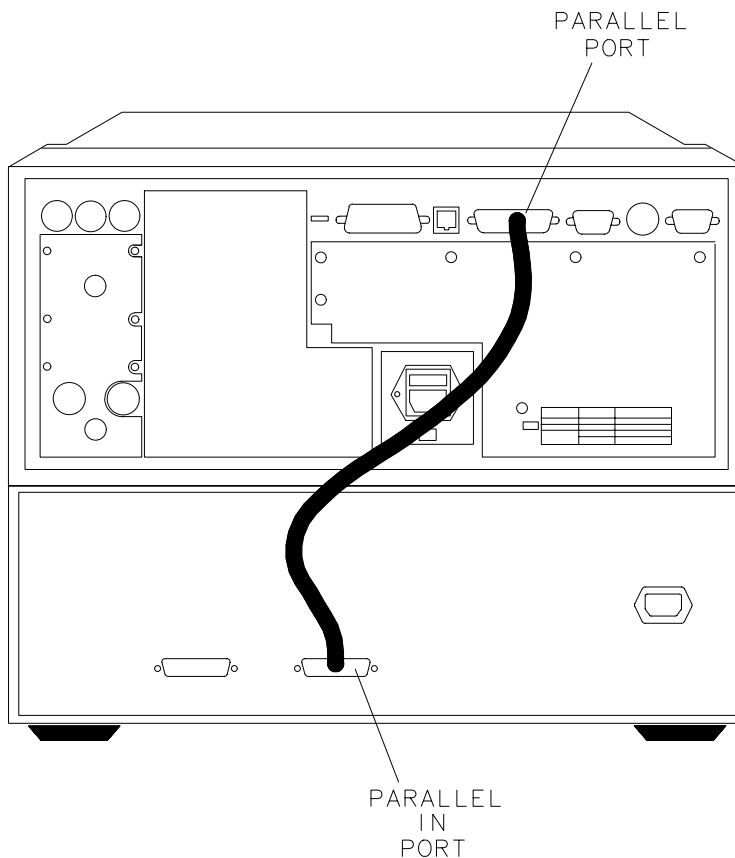
When upgrading firmware from E.05.xx to E.06.xx, it is necessary to save the correction constants on a floppy disk before loading the new version of firmware.

Step 3. Connect the Test Set to the Analyzer

For using your system on a bench, configure and connect the two instruments as shown in [Figure 1-4](#). Use the parallel cable that was shipped with the multiport test set to connect to the analyzer as shown.

If you will be installing your system in a rack, read [“Installing the System in a Rack,”](#) next in this section, before connecting the test set to the analyzer.

Figure 1-4 **System Configuration**



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Installing the System in a Rack

Use only the recommended rack mount kit for the network analyzer (Option 1CM when ordered with the analyzer, or HP part number 08712-60036 when ordered separately): it needs side support rails. *Do not attempt to mount the analyzer by the front panel (handles) only.* The recommended rack mount kit allows you to mount the analyzer with or without handles.

The rack mount kit for the test set is Option 1CM when ordered with the test set, or HP part number 5063-9214 when ordered separately.

NOTE

There are special semi-rigid cables that should be used to connect the analyzer's test ports to the test set's REFLECTION and TRANSMISSION ports when used in a rack (or a bench configuration where the analyzer's bottom feet have been removed). These cables were shipped with your analyzer if you ordered Option 1CM. If you order the rack mount kit separately, you will need to order these special cables separately also. See [Table 1-1 on page 1-11](#) for part numbers.

To install your system in an HP 85043D rack, follow the instructions in the rack manual.

CAUTION

When installing your system in other racks, improper installation may cause shock hazards, overheating, dust contamination, and inferior system performance. For support details and information about installation and warranty, call your nearest Hewlett-Packard sales or service office. Refer to [Table 8-11 on page 8-38](#) for the nearest office.

CAUTION

When installing the system in a cabinet, the convection into and out of the system must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the system 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.

Step 4. Satisfy Electrical and Environmental Requirements

NOTE

Refer to your network analyzer's *User's Guide* for information on electrical and environmental requirements for your network analyzer.

1. The line power module on your multiport test set has an autoranging input. It is designed to be used with an ac power source with a nominal voltage of either 115 V or 230 V.
2. Ensure the available ac power source meets the following requirements:

Nominal	Range
Frequency: 50/60 Hz	47–63 Hz
Line Voltage: 100/115 V or 230/240 V	90–264 V
Power	45 W max

CAUTION

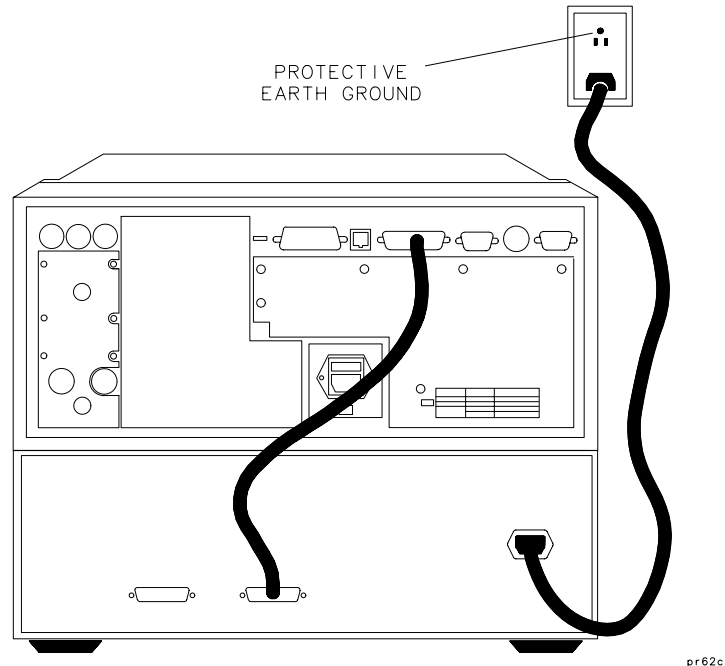
This product has an autoranging line-voltage input. Be sure the supply voltage is within the specified range.

If the ac line voltage does not fall within these ranges, an autotransformer that provides third-wire continuity to earth ground should be used.

3. Ensure the operating environment meets the following requirements for safety:
 - indoor use
 - altitude up to 15,000 feet (4,572 meters)
 - temperature 0 °C to 55 °C
 - maximum relative humidity 80% for temperatures up to 31 °C decreasing linearly to 50% relative humidity at 40 °C
 - use only in INSTALLATION CATEGORY II, and POLLUTION DEGREE 2, per IEC 1010 and 664 respectively

4. Verify that the power cable is not damaged, and that the power source outlet provides a protective earth ground contact. Note that the following illustration depicts only one type of power source outlet. Refer to [Figure 6-5 on page 6-9](#) to see the different types of power cord plugs that can be used with your test set.

Figure 1-5 Protective Earth Ground

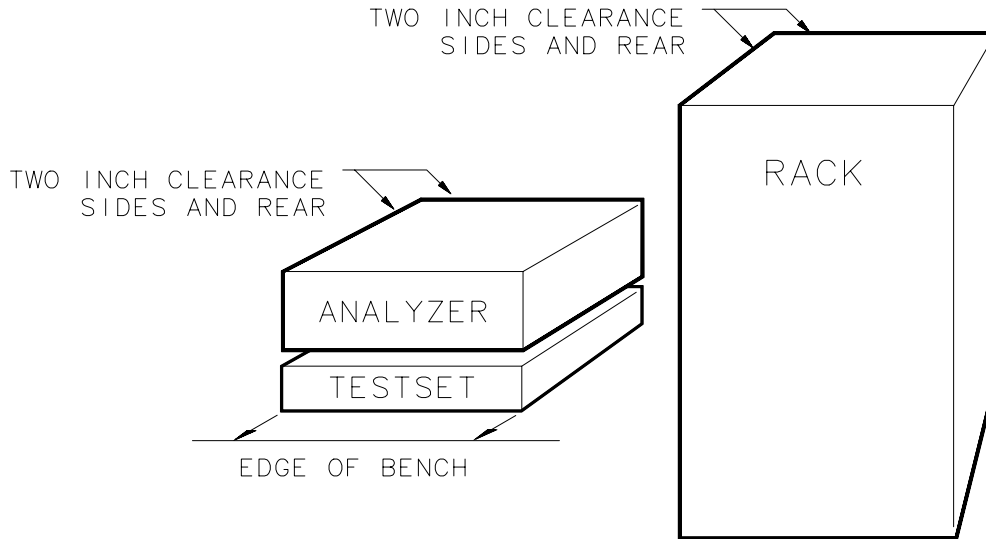


WARNING

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.

5. Ensure there are at least two inches of clearance around the sides and back of the test set or the system cabinet.

Figure 1-6 Ventilation Clearance Requirements



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

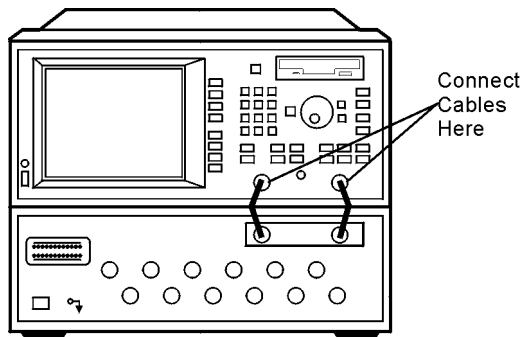
The diagram shows a person sitting at a workstation. The workstation includes a 'Table Mat' on the desk, connected to 'Building Ground' via a '1 MegOhm Resistor'. The person is wearing a 'Wrist Strap' connected to the 'Table Mat' through a 'Wrist Strap Cord' and another '1 MegOhm Resistor'. The person is also wearing 'Heel Straps' on their shoes, connected to a 'Floor Mat' which is also connected to 'Building Ground' via a '1 MegOhm Resistor'.

- table mat with earth ground wire: HP part number 9300-0797
- wrist-strap cord with 1 Meg Ohm resistor: HP part number 9300-0980
- wrist-strap: HP part number 9300-1367
- heel straps: HP part number 9300-1308
- floor mat

Step 5. Activate the Test Set and Check the System Operation

1. Connect the semi-rigid cables that were shipped with your test set as shown in [Figure 1-7](#). Check [Table 1-1 on page 1-11](#) to be sure that you are using the correct cables with your system configuration (the cables you use will be different depending on whether you are using a bench system configuration—as shown in [Figure 1-7](#)—or a rack configuration).

Figure 1-7 **Connect the Front Panel RF Cables**



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NOTE

Steps 2 and 3 *must* be performed before you can use your network analyzer to control the multiport test set.

2. Turn on the test set.
3. Turn on the analyzer and press **(SYSTEM OPTIONS)** **System Config** **Switching Test Set** . Toggle **Multiport** to ON.
4. The operator's check should be performed on the system to provide a high degree of confidence that the system is working properly. Refer to [Chapter 2, "Getting Started,"](#) for instructions on how to perform the operator's check.
5. After performing the operator's check, you should connect any peripheral devices you will be using with your system. Refer to "[Step 6. Connect Peripheral Devices,](#)" next in this chapter.

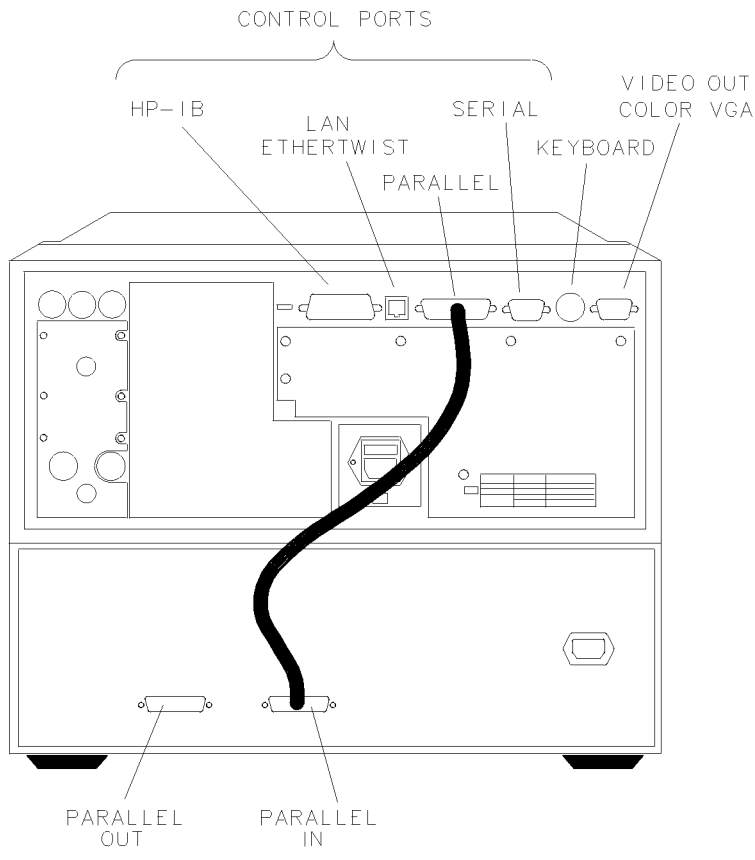
Step 6. Connect Peripheral Devices

After you've performed the operator's check to ensure that your system is working properly, connect any peripherals that you intend to use with your system.

Connecting Peripherals and Controllers

Figure 1-8

Network Analyzer and Multiport Test-Set Rear-Panel Connectors



Refer to **Figure 1-8**:

- The HP-IB port on the analyzer is for use with computers, other test instruments, and peripherals (printers, plotters, etc.).
- The PARALLEL PORT on the analyzer connects to the test set's PARALLEL IN port as shown with the interconnect cable that was shipped with your test set.
- The PARALLEL OUT port on the test set, and the analyzer's SERIAL port (RS-232) are for peripherals such as printers or plotters. The serial port can also be programmed via IBASIC for general I/O control. See your analyzer's *HP Instrument BASIC User's Handbook* for information on using IBASIC.
- The VIDEO OUT COLOR VGA port on the analyzer allows you to connect a color VGA monitor for enhanced viewing. See "Using an External VGA Monitor" in Chapter 4 of your analyzer's *User's Guide* for more information.
- The LAN ETHERTWIST connector on the analyzer is for connecting your analyzer to a local area network (LAN) for control and file access. See The LAN Interface User's Guide Supplement for information on how to use your analyzer in a LAN.
- The DIN KEYBOARD connector can be used with an optional keyboard or bar code reader. See "Using a Keyboard" in Chapter 4 of your analyzer's *User's Guide* for more information.

NOTE

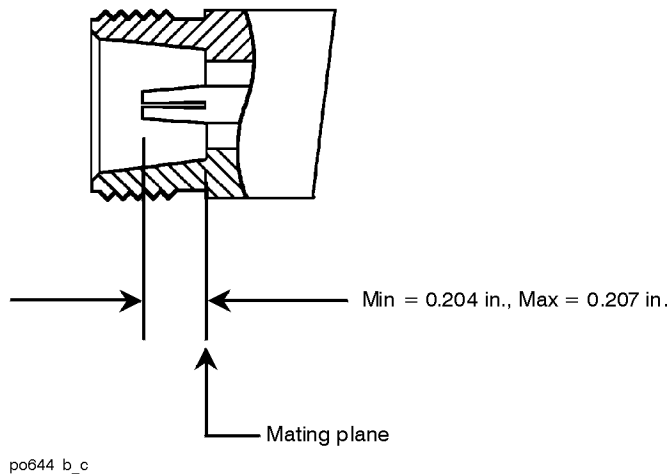
See your analyzer's *User's Guide* for more specific information on HP-IB connections, parallel and serial connections, and configuring peripheral settings.

Preventive Maintenance

Preventive maintenance consists of checking the front panel connectors. This should be done at least every six months — more often if the test set is used daily on a production line or in a harsh environment.

Visually inspect the front panel connectors. The most important connectors are those to which the DUT is connected. All connectors should be clean and the center pins centered. The fingers of female connectors should be unbroken and uniform in appearance. If you are unsure whether the connectors are good, gauge the connectors to confirm that their dimensions are correct.

Figure 1-9 Maximum and Minimum Protrusion of Center Conductor From Mating Plane



CAUTION

HP 87050E multiport test sets only:

Connecting 75 ohm cables to the front panel 50 ohm connectors of the analyzer or test set usually results in intermittent or no electrical connections.

CAUTION

HP 87075C multiport test sets only:

Never connect 50 ohm cables to the front panel 75 ohm connectors of the analyzer or test set. Otherwise, *irreparable* connector damage will occur.

Cleaning the Test Set

Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.

WARNING

To prevent electrical shock, disconnect the test set from power mains before cleaning.

This chapter provides you with a brief tour of the system and an overview of the following topics:

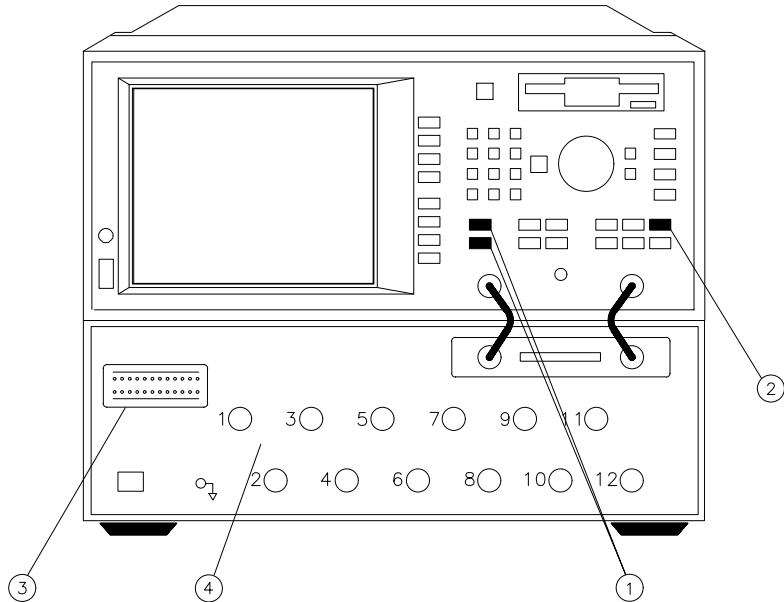
- “Port Connections” on page 2-4
- “Test Set Cal and SelfCal” on page 2-6
- “Making Measurements” on page 2-9
- “Performing the Operator's Check” on page 2-16
- “Cable and Test Fixture Considerations” on page 2-22

Brief Tour of System

On the next page, refer to the figure and descriptions of the main keys and features you'll use on your multiport system.

You should familiarize yourself with the analyzer's features by referring to its *User's Guide*.

Figure 2-1 The Multiport System



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Table 2-1 Multiport System Features

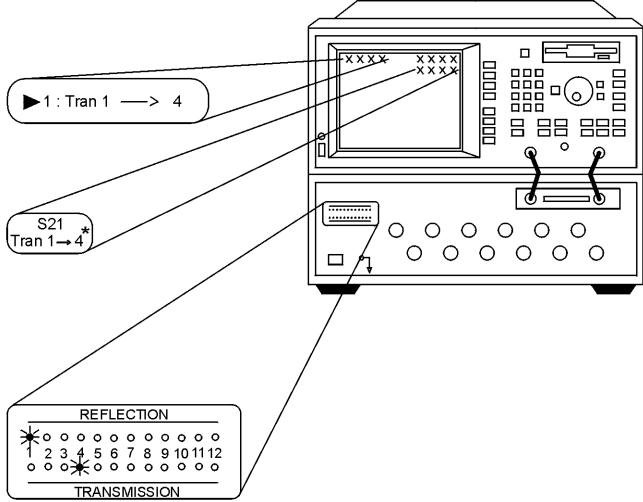
Item #	Description
1	The MEAS 1 and MEAS 2 keys: Use these keys to access measurement selection and test set port selection.
2	The CAL key: Use this key to access the Test Set Cal and SelfCal features. See Chapter 4, "Test Set Cal and SelfCal," for more information.
3	The test set port connection status display.
4	The test set ports.

Port Connections

When your multiport test system is properly connected and configured as described in [Chapter 1](#), you have the ability to switch any of the numbered ports on your test set to either the REFLECTION (or PORT 1*) or TRANSMISSION (or PORT 2*) port on the analyzer. The test set's switching mechanism is illustrated in [Figure 2-4 on page 2-10](#). The analyzer controls the test set through the rear panel parallel interface. Port connections are determined by your keypress selections, as shown in the “[Making Measurements](#)” examples later in this chapter. The port connection status is displayed on the test set's front panel and on the network analyzer's display in the upper left-hand corner (and in the softkeys, *HP 8712ES/14ES only*). See [Figure 2-2](#) and [Figure 2-3](#), which show status indicator examples for a transmission measurement and a reflection measurement.

* For HP 8712ES/14ES analyzers only.

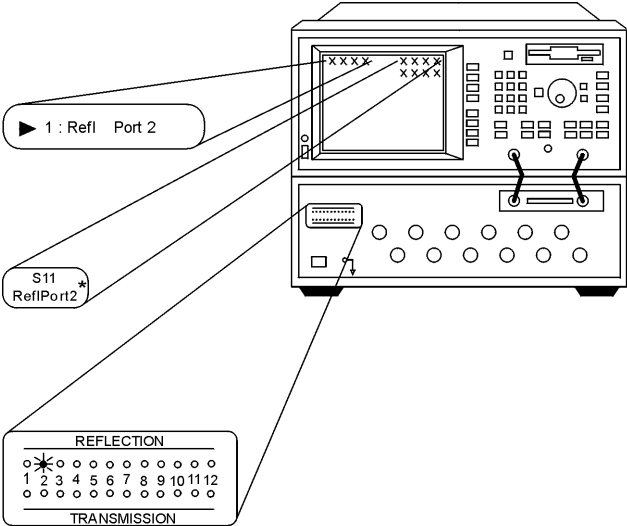
Figure 2-2 Port Connection Status: Transmission Measurement



* HP 8712ES/14ES only

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Figure 2-3 Port Connection Status: Reflection Measurement



* HP 8712ES/14ES only

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Test Set Cal and SelfCal

Before you make any measurements, you must calibrate your multiport system. By implementing the Test Set Cal and SelfCal features on your multiport system, you can increase the accuracy of your measurements *and* significantly increase the throughput of your multiport measurements by eliminating frequent and lengthy calibration procedures.

Cal Type	What is it?	How to do it?	When to do it?
Test Set Cal	A full calibration of the multiport test system. Requires connections of external calibration standards.	Press CAL Test Set Cal Create "TSET_CAL". Connect short, open, and load standards to each measurement port. Connect through-standards to each adjacent port pair. (Refer to "Test Set Cal Examples" on page 4-20.)	When you first set up your test system. Thereafter, about once a month if within the specified temperature range.
SelfCal	An internally automated calibration technique. Uses solid-state switches to measure calibration standards located inside the test set.	You do <i>not</i> have to disconnect your DUT to perform a SelfCal. Press CAL Test Set Cal (Periodic SelfCal or SelfCal Once). (Refer to "SelfCal Details" on page 4-58.)	Set SelfCal to execute automatically as often as needed (typically once an hour).

The Test Set Cal process that is best suited for your particular measurements will depend on the type of DUT you are testing. Refer to the following Test Set Cal examples for one that best matches your DUT.

- "Test Set Cal Example #1: The DUT Has Insertable Port Pairs" on page 4-21*
- "Test Set Cal Example #2: The DUT Has Noninsertable Port Pairs with Identical Connectors" on page 4-27*
- "Test Set Cal Example #3: The DUT Has a Noninsertable Port Pair with Dissimilar Connectors" on page 4-42*

****Insertable Port Pairs versus Noninsertable Port Pairs:***

During the through portion of the calibration, if an adjacent port pair (for example, 1-to-2, 3-to-4, 5-to-6, etc.) can be connected directly without using a through cable or an adapter, the port pair is insertable. If an adjacent port pair can only be connected by using a through cable or an adapter, the port pair is noninsertable.

For all the details on calibrating your test set, refer to [Chapter 4, “Test Set Cal and SelfCal.”](#)

Getting Started
Test Set Cal and SelfCal

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Making Measurements

This section will show you the basic steps in making the following measurements:

- “Transmission Measurements” on page 2-10
- “Reflection Measurements Using a 1-Port Cal” on page 2-12
- “Reflection Measurements Using a 2-Port Cal (HP 8712ES/14ES Only)” on page 2-14

NOTE

These measurement examples assume that calibration has already been performed.

IMPORTANT

HP 8712ES/14ES analyzers only:

The test set port assigned as the (S11) Port must always be the low numbered test set port while the test set port assigned as the (S22) Port must always be the high numbered port.

For more detailed information on making measurements with your multiport test set, refer to [Chapter 3, “Measurement Examples.”](#)

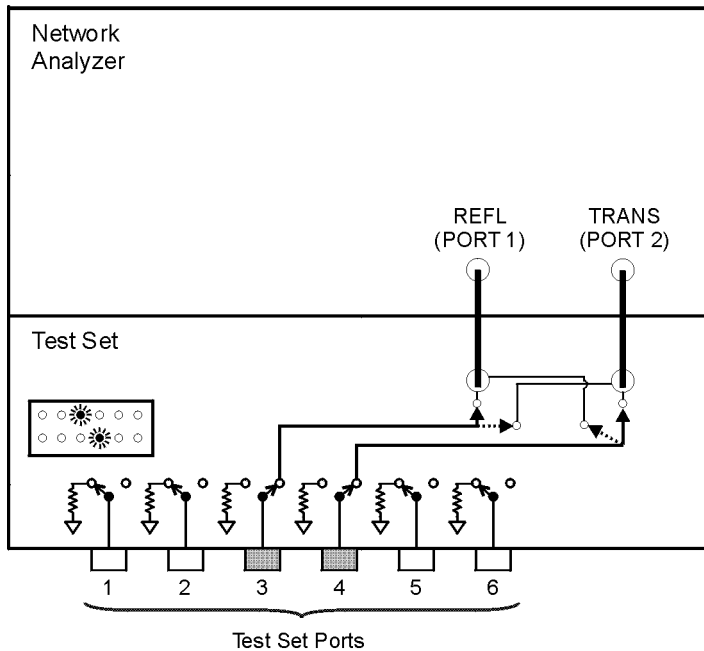
The multiport test set contains cables and line-lengths on a pc board which give it a long electrical delay. Your DUT and test cables (if any) and/or test fixture add even more electrical delay to your test setup. To maximize measurement accuracy, the effects of this electrical delay must be minimized. For a discussion of techniques to reduce the effects of electrical delay in your test setup, refer to “Measuring Devices with Long Electrical Delay,” located in Chapter 5 of your analyzer’s *User’s Guide*.

Transmission Measurements

Figure 2-4 shows:

- test set PORT 3 switched to the analyzer's REFLECTION (or PORT 1*) port
- test set PORT 4 switched to the analyzer's TRANSMISSION (or PORT 2*) port
- all other test set ports terminated with the test set impedance

Figure 2-4 **Transmission Measurement: PORT 3 to PORT 4**



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* For HP 8712ES/14ES analyzers only.

To make the connections as illustrated in [Figure 2-4](#) and perform a transmission measurement, you would press the following keys on the analyzer:

1. Press **MEAS 1**.
Selects measurement channel 1 as the active measurement channel.
2. Press **Multiport Selection**.
Displays a menu with softkeys for selecting test set ports for your measurement.
3. Press **(Reflection Port Num**
or **(S11) Port ***).
Allows you to select a test set port for your measurement.
4. Press **3** **Enter**.
Selects PORT 3 of the test set.
5. Press
(Transmissn Port Num or
(S22) Port *).
Allows you to select a test set port for your measurement.
6. Press **4** **Enter** **Done ***.
Selects PORT 4 of the test set. This completes your selection of test set ports for your measurement.
7. Press **(Transmissn** or
S21 Tran 3->4 *).
Selects the forward transmission type of measurement.

* For HP 8712ES/14ES analyzers only.

NOTE

For HP 8712ES/14ES analyzers only:

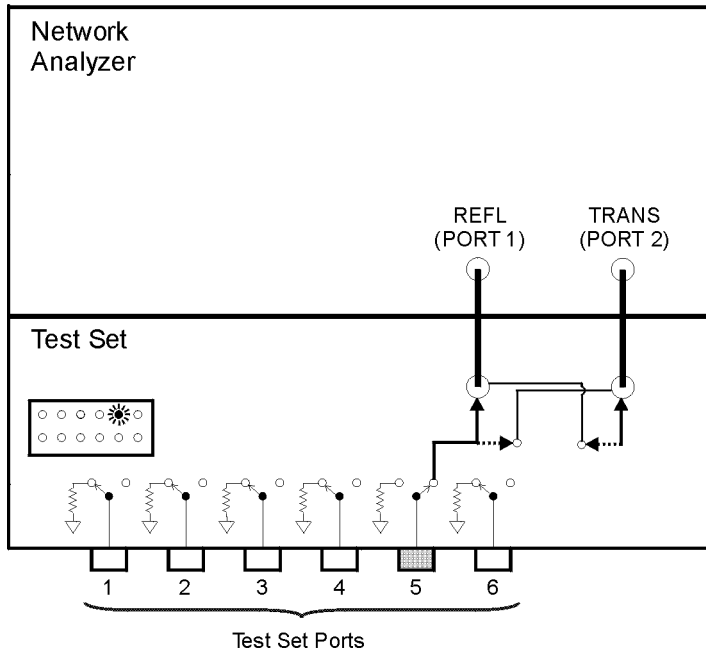
To measure transmission from test set PORT 4 to test set PORT 3, use the same port assignments as above, but press **S12 Tran 4->3** for the measurement type.

Reflection Measurements Using a 1-Port Cal

Figure 2-5 shows:

- test set PORT 5 switched to the analyzer's REFLECTION (or PORT 1*) port
- all other test set ports terminated with the test set impedance

Figure 2-5 Reflection Measurement: PORT 5



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* For HP 8712ES/14ES analyzers only.

To make the connections as illustrated in [Figure 2-5](#) and perform a reflection measurement, you would press the following keys on the analyzer:

1. Press **MEAS 1**.
Selects measurement channel 1 as the active measurement channel.
2. Press **Multiport Selection**.
Displays a menu with softkeys for selecting test set ports for your measurement.
3. Press **Reflection Port Num** or **(S11) Port ***.
Allows you to select a test set port for your measurement.
4. Press **5** **Enter** **Done ***.
Selects PORT 5 of the test set. This completes your selection of test set ports for your measurement.
5. Press **Reflection** or **S11 ReflPort5 ***.
Selects the forward reflection type of measurement.

* For HP 8712ES/14ES analyzers only.

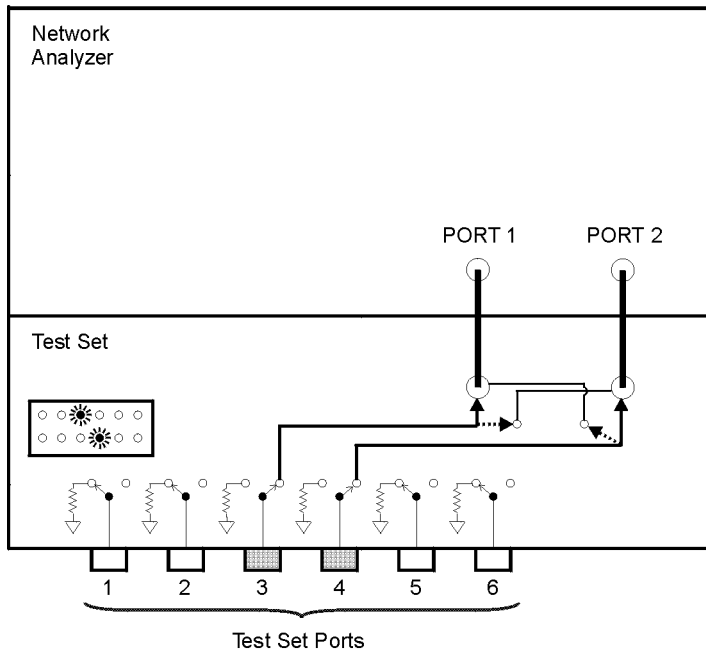
Reflection Measurements Using a 2-Port Cal (HP 8712ES/14ES Only)

In this reflection measurement it is necessary to assign both test set ports. This is because, when using a 2-port cal, the analyzer sweeps in both directions as it measures all four S-parameters. [Figure 2-6](#) shows:

- test set PORT 3 switched to the analyzer's PORT 1 port
- test set PORT 4 switched to the analyzer's PORT 2 port
- all other test set ports terminated with the test set impedance

Figure 2-6

Reflection Measurement Using a 2-Port Cal: PORT 3



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To make the connections as illustrated in [Figure 2-6](#) and perform a reflection measurement, you would press the following keys on the analyzer:

1. Press **MEAS 1**.
Selects measurement channel 1 as the active measurement channel.
2. Press **Multiport Selection**.
Displays a menu with softkeys for selecting test set ports for your measurement.
3. Press **(S11) Port**.
Allows you to select a test set port for your measurement.
4. Press **3** **Enter**.
Selects PORT 3 of the test set.
5. Press **(S22) Port**.
Allows you to select a test set port for your measurement.
6. Press **4** **Enter** **Done**.
Selects PORT 4 of the test set. This completes your selection of test set ports for your measurement.
7. Press **S11 ReflPort3**.
Selects the forward reflection type of measurement.

NOTE

For HP 8712ES/14ES analyzers only:

To measure reflection using test set PORT 4, use the same port assignments as above, but press **S22 ReflPort4** for the measurement type.

Performing the Operator's Check

Description

The operator's check should be performed when you receive your test set, and any time you wish to have confidence that your test set is functioning properly. It is *not* designed to verify specifications or to check the validity of calibrations. To verify specifications, refer to [“Performance Verification Test Results” on page 9-9](#). To check a calibration, refer to [“Verifying the Calibration” on page 4-69](#). The Operator's Check uses traditional analyzer calibrations rather than a Test Set Cal. This is because the multiport test set is treated as a DUT by the analyzer.

NOTE

The operator's check for the test set assumes that the network analyzer is functioning properly. It also assumes that the analyzer has no test fixture or DUT attached to the test set, and has a valid default calibration. Refer to your analyzer's *User's Guide* for information on performing the analyzer's operator's check.

Procedure

The quickest method for performing the operator's check is to use the “Op Verif” portion of the performance test software (see [Chapter 9](#)). This method will take approximately one minute to perform and no external connections to the test set's test ports are required. You can run this software using the IBASIC feature in your analyzer.

If you don't have access to the performance test software, the following manual procedure can be used instead.

Equipment Required

For HP 87050E multiport test sets:

- HP 8712ET/ES or HP 8714ET/ES
RF network analyzer, 50 Ω impedance
- Cables, 50 Ω type-N, (shipped with the test set—see [Table 1-1 on page 1-11](#))

- 50 Ω type-N load (part of HP 85032B calibration kit)
- 50 Ω cable such as the one that was shipped with your analyzer (HP part number 8120-6469)

For HP 87075C multiport test sets:

- HP 8712ET/ES or HP 8714ET/ES RF network analyzer, 75 Ω impedance (Option 1EC)
- Cables, 75 Ω type-N, (shipped with the test set—see [Table 1-1 on page 1-11](#))
- 75 Ω type-N load (part of HP 85036B calibration kit)
- 75 Ω cable such as the one that was shipped with your analyzer (HP part number 8120-6468)

NOTE

The following section contains illustrations depicting the analyzer display. Your display may appear different, depending on the model of your analyzer.

Process

Check Unterminated Return Loss.

1. Make sure the test set is properly connected to the analyzer using the parallel port interface cable and the front panel RF cables as described in [Chapter 1](#).
2. Make sure that both instruments are turned on, and that the analyzer is configured for use with a multiport test set as described in [“Step 5. Activate the Test Set and Check the System Operation” on page 1-19](#).
3. Press **PRESET**.
4. Press **MEAS 1** Multiport Selection (Reflection Port Num or (S11) Port *) **1** Enter Done *.
5. Press (Reflection or S11 ReflPort1 *) to configure the analyzer to make a reflection measurement.
6. Press **FREQ** Start **3** MHz Stop **1300** MHz .

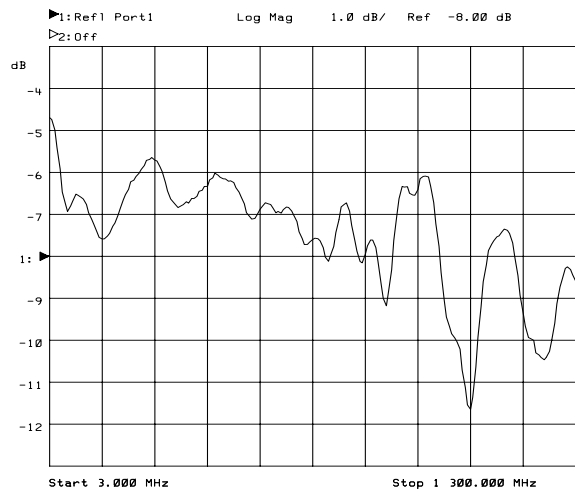
* For HP 8712ES/14ES analyzers only.

Getting Started
Performing the Operator's Check

7. Press **CAL** Default 1-Port to make sure the analyzer's default calibration is in place. (This disables the multiport Test Set Cal.)
8. Verify that the return loss of the selected port, with nothing connected, is between about 0 dB and -20 dB. See [Figure 2-7 on page 2-18](#) for an example measurement. Your results should be somewhat similar.
9. *For HP 8712ET/14ET analyzers only:* repeat steps 4 and 8 for all the remaining ports on your test set.

For HP 8712ES/14ES analyzers only: repeat steps 4 and 8 for all *but* the highest numbered port on your test set. For the highest numbered port, press **MEAS 1** Multiport Selection (S22) Port **(port number)** Enter Done S22 ReflPort . Repeat step 8.

Figure 2-7 Operator's Check: Unterminated Return Loss



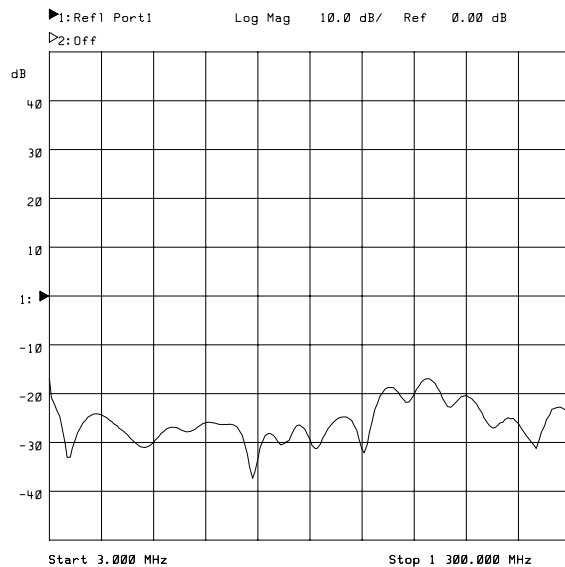
Check Terminated Return Loss.

10. Press **MEAS 1** Multiport Selection (**Reflection Port Num** or **(S11) Port ***) **1** Enter **Done ***.
11. Press (**Reflection** or **S11 ReflPort1 ***) to configure the analyzer to make a reflection measurement.
12. Connect a load (impedance must match that of your test set) to PORT 1 on the test set.
13. Verify that the return loss of the selected port is below -11 dB across the frequency range. See [Figure 2-8](#) for an example measurement. Your results should be somewhat similar.
14. *For HP 8712ET/14ET analyzers only:* Repeat steps 9–12 for all the remaining ports on your test set.

For HP 8712ES/14ES analyzers only: repeat steps 9–12 for all *but* the highest numbered port on your test set. For the highest numbered port, press **MEAS 1** Multiport Selection **(S22) Port** **(port number)** Enter **Done** **S22 ReflPort** . Repeat step 12.

Figure 2-8

Operator's Check: Terminated Return Loss

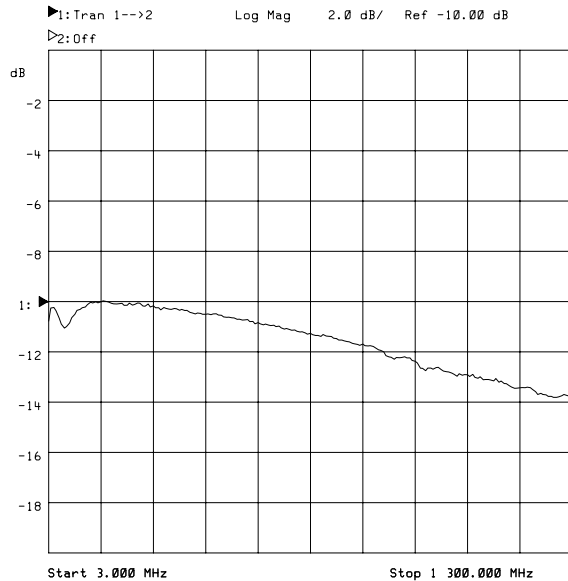


* For HP 8712ES/14ES analyzers only.

Check Transmission Measurement.

15. **CAL** (Default Response or Default 2-Port *).
16. Press **MEAS 1** Multiport Selection (Reflection Port Num or (S11) Port *) **1** Enter (Transmissn Port Num or (S22) Port *) **2** Enter Done *.
17. Press **MEAS 1** (Transmissn or S21 Tran 1-->2 *).
18. Connect a through cable between PORT 1 and PORT 2 on the test set.
19. Verify that the transmission measurement of the selected ports is between -2 dB and -19 dB across the frequency range. See [Figure 2-9](#) for an example measurement. Your results should be somewhat similar.

Figure 2-9 Operator's Check: Transmission Measurement



* For HP 8712ES/14ES analyzers only.

If the Multiport Test Set Fails the Operator's Check

If the multiport test set fails the operator's check, verify that your analyzer passes its operator's check. Refer to your analyzer's *User's Guide* for information on the analyzer's operator's check. If the analyzer passes its operator's check, your multiport test set may need adjustment or servicing. Contact any Hewlett-Packard sales or service office for assistance. Refer to [Table 8-11 on page 8-38](#) for the nearest office. Before shipping your multiport test set, fill out and attach the blue repair tag, located at the back of the analyzer's *Service Guide*.

Cable and Test Fixture Considerations

For the most accurate, repeatable measurements, it is imperative that the cables and test fixtures that you use to test devices introduce as little drift as possible. Although the system's Test Set Cal feature can effectively calibrate out the effects of external cabling and fixtures, the drift-removing SelfCal feature can only remove subsequent drift internal to the system. It cannot compensate for subsequent drift associated with any external cabling or fixturing. See [“Test Set Cal and SelfCal: Theory of Operation”](#) in [Chapter 4](#).

Drift can be minimized by using high quality connectors, semi-rigid cables (when possible), and fixturing that reduces cable movement to a minimum.

3 Measurement Examples

Your multiport system allows you to measure both forward and reverse responses of a multiport device without having to manually change connections. This chapter presents examples of making many types of measurements on a 50 ohm device and a 75 ohm device.

Although your test set may have a different number of ports, the 12-port test set (Option 012) will most often be depicted and described here.

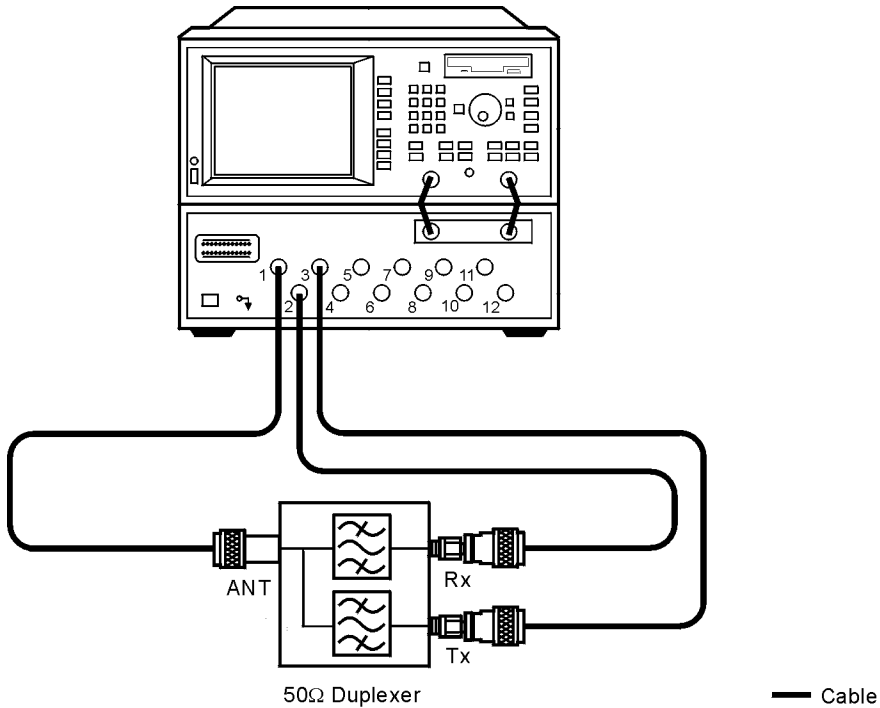
See your analyzer's *User's Guide* for example displays of various measurements. You will also find information on using the analyzer's built-in features such as markers and limit lines to help interpret your measurements quickly and easily.

Example: Measuring a 50 Ohm Duplexer

The following illustration and tables show how with one mechanical setup you can make multiple measurements on a 50 ohm duplexer simply by changing the port selections. This example will show how to make six common duplexer measurements:

- Insertion Loss: ANT port to Rx port
- Insertion Loss: Tx port to ANT port
- Isolation: Rx port to Tx port
- Return Loss: ANT port
- Return Loss: Rx port
- Return Loss: Tx port

Figure 3-1 **Measuring a 50 Ohm Duplexer— Six Measurements, One Test Setup**



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NOTE

Transmission and reflection responses of any multiport device can be affected by the load match presented to ports of the DUT that are outside of the measurement path. The effect of test set load match on the measurements is device dependent and needs to be considered.

Table 3-1 Making Measurements using an HP 8712ET/14ET Analyzer

Measurement Type	INSERTION LOSS Transmission	INSERTION LOSS Transmission	ISOLATION Transmission	RETURN LOSS Reflection	RETURN LOSS Reflection	RETURN LOSS Reflection
Measurement	ANT to Rx (Tran 1→2)	Tx to ANT (Tran 3→1)	Rx to Tx (Tran 2→3)	ANT port (Refl Port 1)	Rx port (Refl Port2)	Tx port (Refl Port 3)
Test Set Port Assigned as the Reflection Port	1	3	2	1	2	3
Test Set Port Assigned as the Transmission Port	2	1	3	–	–	–

Table 3-2 Making Measurements using an HP 8712ES/14ES Analyzer

Measurement Type	INSERTION LOSS S_{21}	INSERTION LOSS S_{12}	ISOLATION S_{21}	RETURN LOSS S_{11}	RETURN LOSS S_{22}	RETURN LOSS S_{22}
Measurement	ANT to Rx (Tran 1→2)	Tx to ANT (Tran 3→1)	Rx to Tx (Tran 2→3)	ANT port (Refl Port 1)	Rx port (Refl Port2)	Tx port (Refl Port 3)
Test Set Port Assigned as the (S11) Port	1	1	2	1	1	1
Test Set Port Assigned as the (S22) Port	2	3	3	n^*	2^*	3^*

* When using a 2-port Test Set calibration, this test set port is assigned as the (S22) Port. “n” is any test-set port in your measurement configuration that has a higher number than the port assigned as the (S11) Port.

IMPORTANT

HP 8712ES/14ES analyzers only: the test set port assigned as the (S11) Port must always be the low numbered test set port while the test set port assigned as the (S22) Port must always be the high numbered port.

Calibrating the Multiport System for Measuring a 50 Ohm Duplexer

For a complete calibration process for measuring the 50 ohm duplexer in this example, refer to [“Test Set Cal Example #3: The DUT Has a Noninsertable Port Pair with Dissimilar Connectors”](#) on page 4-42.

The Test Set Cal process that is best suited for your particular measurements will depend on the type of DUT you are testing. If your 50 ohm DUT is different from the one used in this example, refer to the following additional Test Set Cal examples for one that best matches your DUT.

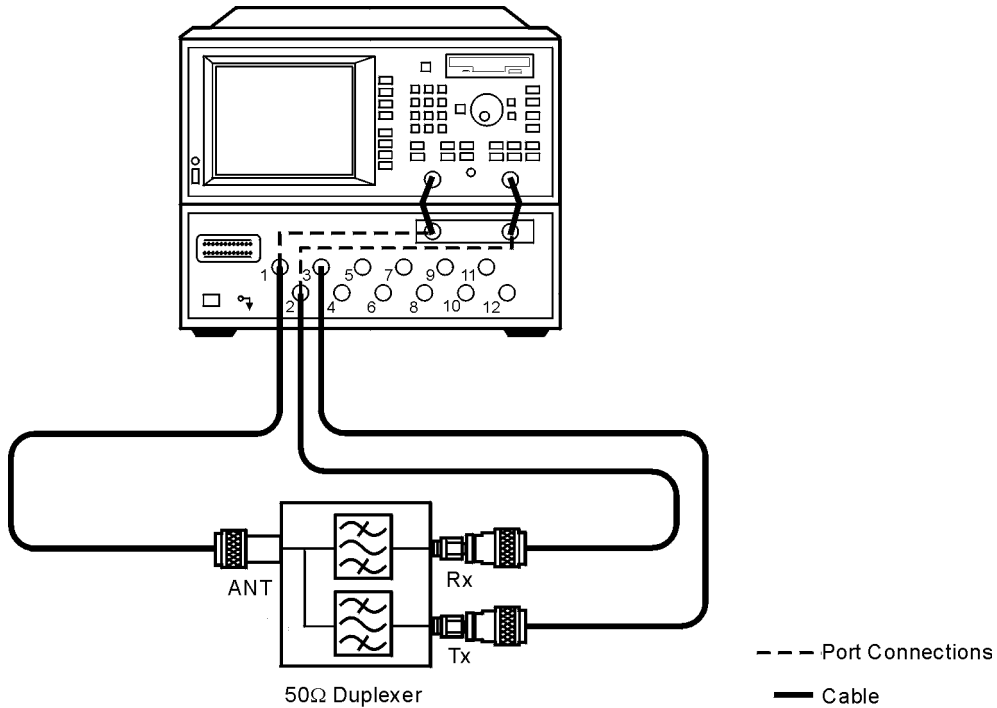
- [“Test Set Cal Example #1: The DUT Has Insertable Port Pairs”](#) on page 4-21
- [“Test Set Cal Example #2: The DUT Has Noninsertable Port Pairs with Identical Connectors”](#) on page 4-27

For all the details on calibrating your test set, refer to [Chapter 4](#), “Test Set Cal and SelfCal.”

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Measuring Insertion Loss: ANT Port to Rx Port

Figure 3-2



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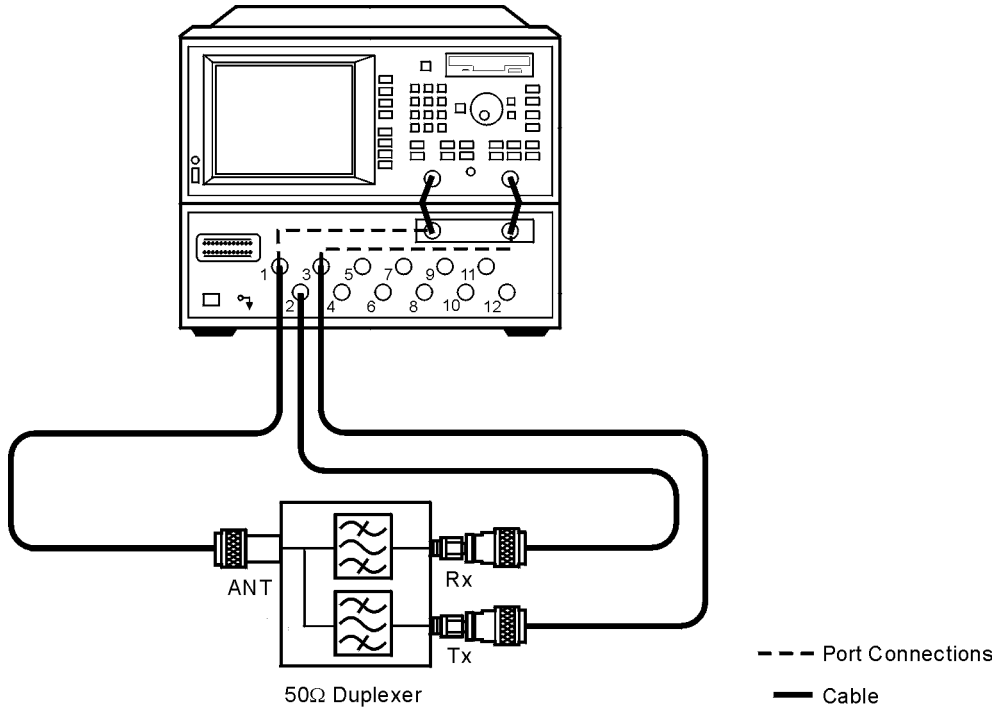
To perform the insertion loss measurement (measuring the loss from the ANT port of the DUT to the Rx port of the DUT), press the following keys on the analyzer:

1. Press **MEAS 1**.
Selects measurement channel 1 as the active measurement channel.
 2. Press **Multiport Selection**.
Displays a menu with softkeys for selecting test set ports for your measurement.
 3. Press
(**Reflection Port Num** or
(S11) Port *).
Allows you to select a test set port for your measurement.
 4. Press **1** **Enter**.
Selects PORT 1 of the test set.
 5. Press
(**Transmissn Port Num** or
(S22) Port *).
Allows you to select a test set port for your measurement.
 6. Press **2** **Enter** **Done ***.
Selects PORT 2 of the test set.
 7. Press (**Transmissn** or
S21 Tran 1->2 *).
Selects the forward transmission type of measurement.
- Optional steps—saving the instrument state:*
- These optional steps allow you to save the instrument state. Recalling an instrument state, rather than manually re-entering the analyzer parameters, can save time and improve measurement throughput.
8. Press **SAVE RECALL**.
Displays a menu with softkeys for saving and recalling analyzer data.
 9. Press **Save State**.
Saves the instrument state.

* For HP 8712ES/14ES analyzers only.

Measuring Insertion Loss: Tx Port to ANT Port

Figure 3-3



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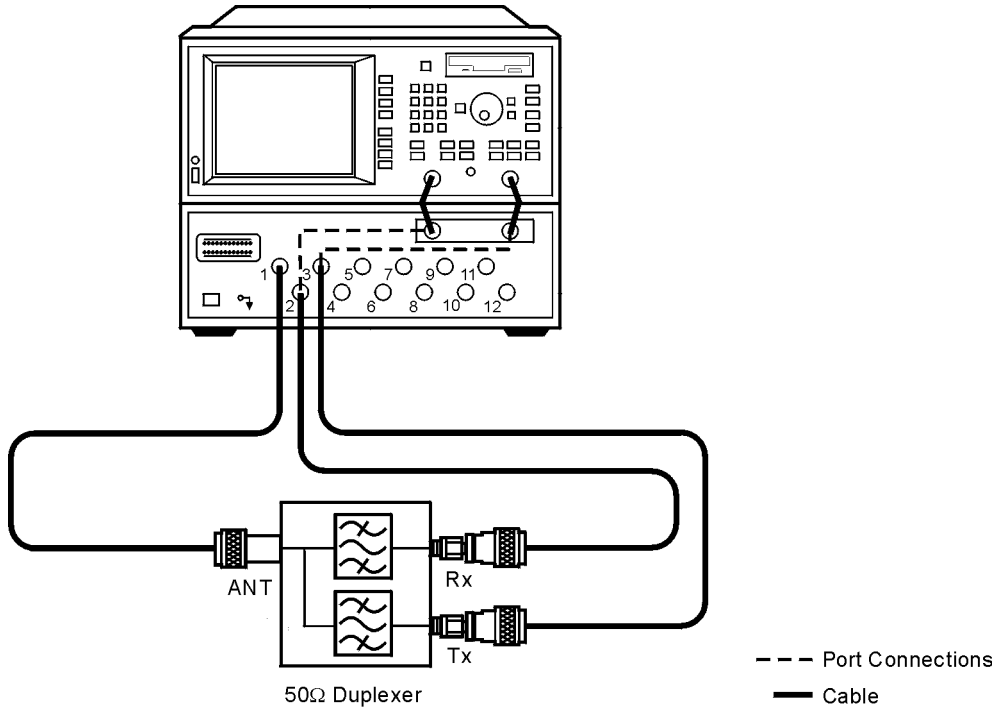
To perform the insertion loss measurement (measuring the loss from the Tx port of the DUT to the ANT port of the DUT), press the following keys on the analyzer:

1. Press **MEAS 1**.
Selects measurement channel 1 as the active measurement channel.
 2. Press **Multiport Selection**.
Displays a menu with softkeys for selecting test set ports for your measurement.
 3. Press **Transmissn Port Num** or **(S11) Port ***.
Allows you to select a test set port for your measurement.
 4. Press **1** **Enter**.
Selects PORT 1 of the test set.
 5. Press **(Reflection Port Num** or **(S22) Port ***.
Allows you to select a test set port for your measurement.
 6. Press **3** **Enter** **Done ***.
Selects PORT 3 of the test set.
 7. Press **(Transmissn** or **S12 Tran 3->1 ***.
Selects the reverse transmission type of measurement.
- Optional steps—saving the instrument state:*
- These optional steps allow you to save the instrument state. Recalling an instrument state, rather than manually re-entering the analyzer parameters, can save time and improve measurement throughput.
8. Press **SAVE RECALL**.
Displays a menu with softkeys for saving and recalling analyzer data.
 9. Press **Save State**.
Saves the instrument state.

* For HP 8712ES/14ES analyzers only.

Measuring Isolation: Rx Port to Tx Port

Figure 3-4



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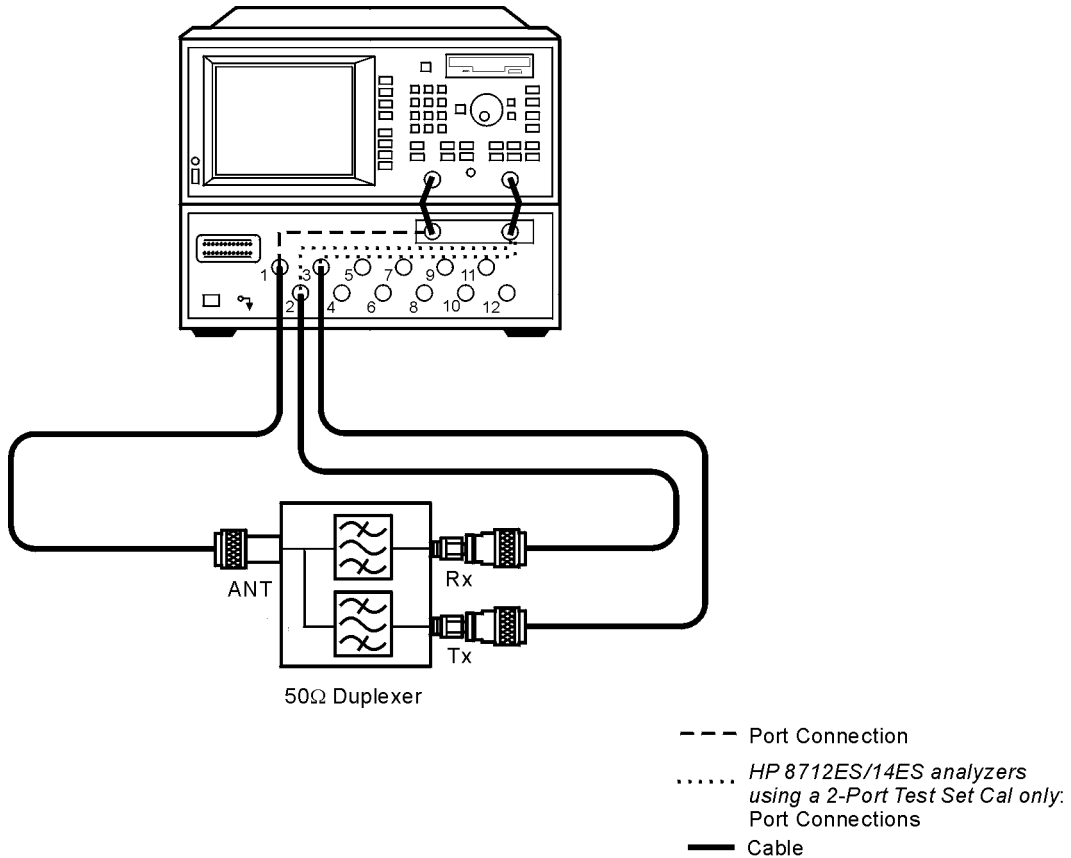
To perform the isolation measurement (a transmission measurement from the Rx port to the Tx port on the DUT), press the following keys on the analyzer:

1. Press **MEAS 1**.
Selects measurement channel 1 as the active measurement channel.
 2. Press **Multiport Selection**.
Displays a menu with softkeys for selecting test set ports for your measurement.
 3. Press **(Reflection Port Num** or **(S11) Port ***).
Allows you to select a test set port for your measurement.
 4. Press **2** **Enter**.
Selects PORT 2 of the test set.
 5. Press **(Transmissn Port Num** or **(S22) Port ***).
Allows you to select a test set port for your measurement.
 6. Press **3** **Enter** **Done ***.
Selects PORT 3 of the test set.
 7. Press **(Transmissn** or **S21 Tran 2->3 ***).
Selects the forward transmission type of measurement.
- Optional steps—saving the instrument state:*
- These optional steps allow you to save the instrument state. Recalling an instrument state, rather than manually re-entering the analyzer parameters, can save time and improve measurement throughput.
8. Press **SAVE RECALL**.
Displays a menu with softkeys for saving and recalling analyzer data.
 9. Press **Save State**.
Saves the instrument state.

* For HP 8712ES/14ES analyzers only.

Measuring Return Loss: ANT Port

Figure 3-5



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To perform the return loss measurement on the ANT port of the DUT, press the following keys on the analyzer:

1. Press **MEAS 1**.
Selects measurement channel 1 as the active measurement channel.
 2. Press **Multiport Selection**.
Displays a menu with softkeys for selecting test set ports for your measurement.
 3. Press
(**Reflection Port Num** or
(S11) Port *).
Allows you to select a test set port for your measurement.
 4. Press **1** **Enter**.
Selects PORT 1 of the test set.
 5. Press (**Reflection** or
S11 ReflPort1 *).
Selects the forward reflection type of measurement.
- Optional steps—saving the instrument state:*
- These optional steps allow you to save the instrument state. Recalling an instrument state, rather than manually re-entering the analyzer parameters, can save time and improve measurement throughput.
6. Press **SAVE RECALL**.
Displays a menu with softkeys for saving and recalling analyzer data.
 7. Press **Save State**.
Saves the instrument state.

* For HP 8712ES/14ES analyzers only.

IMPORTANT

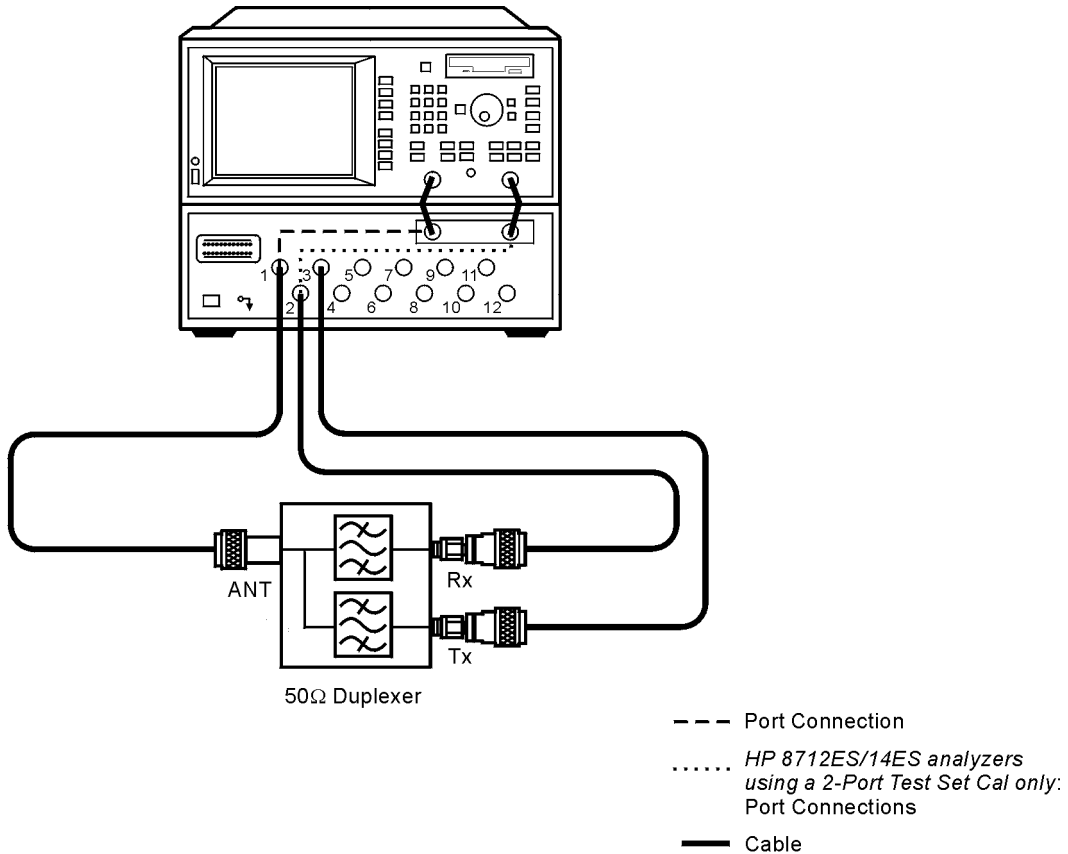
For HP 8712ES/14ES analyzers using a 2-port Test Set cal only. Measuring the return loss of the ANT port is best done using two separate measurements in order to obtain the highest measurement accuracy. The following table explains the two measurements.

	Test Set Port Assigned as the (S11) Port	Test Set Port Assigned as the (S22) Port	Measurement Explanation
First Measurement	PORT 1 (ANT port)	PORT 2 (Rx port)	When test set PORT 2 is assigned as the (S22) Port, the DUT's Rx port is terminated with an error-corrected load, while the DUT's Tx port is terminated with the uncorrected internal load of the test set. Since the error-corrected load match of the test system is considerably better than the uncorrected terminations, the portion of the trace corresponding to the ANT-to-Rx path will be more accurate than the portion of the trace corresponding to the ANT-to-Tx path. For the first measurement, verify the ANT-port return loss by using a limit-line on the portion of the trace corresponding to the ANT-to-Rx path. The ANT-port return loss corresponding to the ANT-to-Tx path will be tested in the second measurement.
Second Measurement	PORT 1 (ANT port)	PORT 3 (Tx port)	When test set PORT 3 is assigned as the (S22) Port, the DUT's Tx port is terminated with an error-corrected load, while the DUT's Rx port is terminated with the uncorrected internal load of the test set. Since the error-corrected load match of the test system is considerably better than the uncorrected terminations, the portion of the trace corresponding to the ANT-to-Tx path will be more accurate than the portion of the trace corresponding to the ANT-to-Rx path. For the second measurement, verify the ANT-port return loss by using a limit-line on the portion of the trace corresponding to the ANT-to-Tx path. The ANT-port return loss corresponding to the ANT-to-Rx path was tested in the first measurement.

To set up your test system to perform the two measurements in the previous table, it is fastest and easiest to use both of the analyzer measurement channels. For instructions on using both measurement channels, refer to [“Using Different Test Set Port Assignments for Both Measurement Channels”](#) on page 3-45.

Measuring Return Loss: Rx Port

Figure 3-6



pt661e

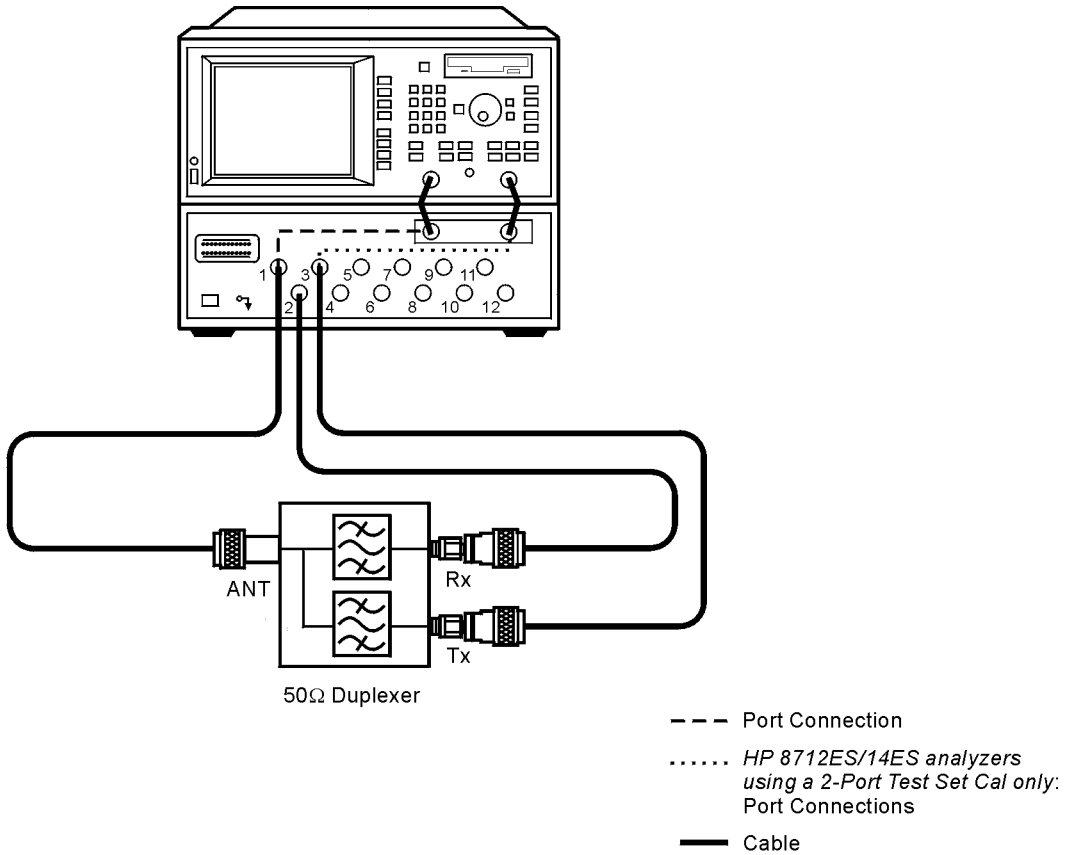
To perform the return loss measurement on the Rx port of the DUT, press the following keys on the analyzer:

1. Press **MEAS 1**.
Selects measurement channel 1 as the active measurement channel.
 2. Press **Multiport Selection**.
Displays a menu with softkeys for selecting test set ports for your measurement.
 3. Press
(**Reflection Port Num** or
(S22) Port *).
Allows you to select a test set port for your measurement.
 4. Press **2** **Enter** **Done**.
Selects PORT 2 of the test set.
For HP 8712ES/14ES analyzers:
PORT 1 is automatically selected as the **(S11) Port**.
 5. Press (**Reflection** or
S22 ReflPort2 *).
Selects the reflection measurement.
- Optional steps—saving the instrument state:*
- These optional steps allow you to save the instrument state. Recalling an instrument state, rather than manually re-entering the analyzer parameters, can save time and improve measurement throughput.
6. Press **SAVE RECALL**.
Displays a menu with softkeys for saving and recalling analyzer data.
 7. Press **Save State**.
Saves the instrument state.

* For HP 8712ES/14ES analyzers only.

Measuring Return Loss: Tx Port

Figure 3-7



pt662e

To perform the return loss measurement on the Tx port of the DUT, press the following keys on the analyzer:

1. Press **MEAS 1**.
Selects measurement channel 1 as the active measurement channel.
2. Press **Multiport Selection**.
Displays a menu with softkeys for selecting test set ports for your measurement.
3. Press
(**Reflection Port Num** or
(S11) Port *).
Allows you to select a test set port for your measurement.
4. Press **1** **Enter**.
Selects PORT 1 of the test set.
For HP 8712ES/14ES analyzers using a 2-port Test Set cal only:
(In this step, you select a second test set port. This is necessary because when using a 2-port cal, the analyzer sweeps in both directions as it measures all S-parameters.)
5. Press **(S22) Port**.
Allows you to select a test set port for your measurement.
6. Press **3** **Enter** **Done**.
Selects PORT 3 of the test set.
For all analyzers:
7. Press (**Reflection** or
S22 ReflPort3 *).
Selects the reflection measurement.
Optional steps—saving the instrument state:
These optional steps allow you to save the instrument state. Recalling an instrument state, rather than manually re-entering the analyzer parameters, can save time and improve measurement throughput.
8. Press **SAVE RECALL**.
Displays a menu with softkeys for saving and recalling analyzer data.
9. Press **Save State**.
Saves the instrument state.

* For HP 8712ES/14ES analyzers only.

Measurement Examples

Example: Measuring a 50 Ohm Duplexer

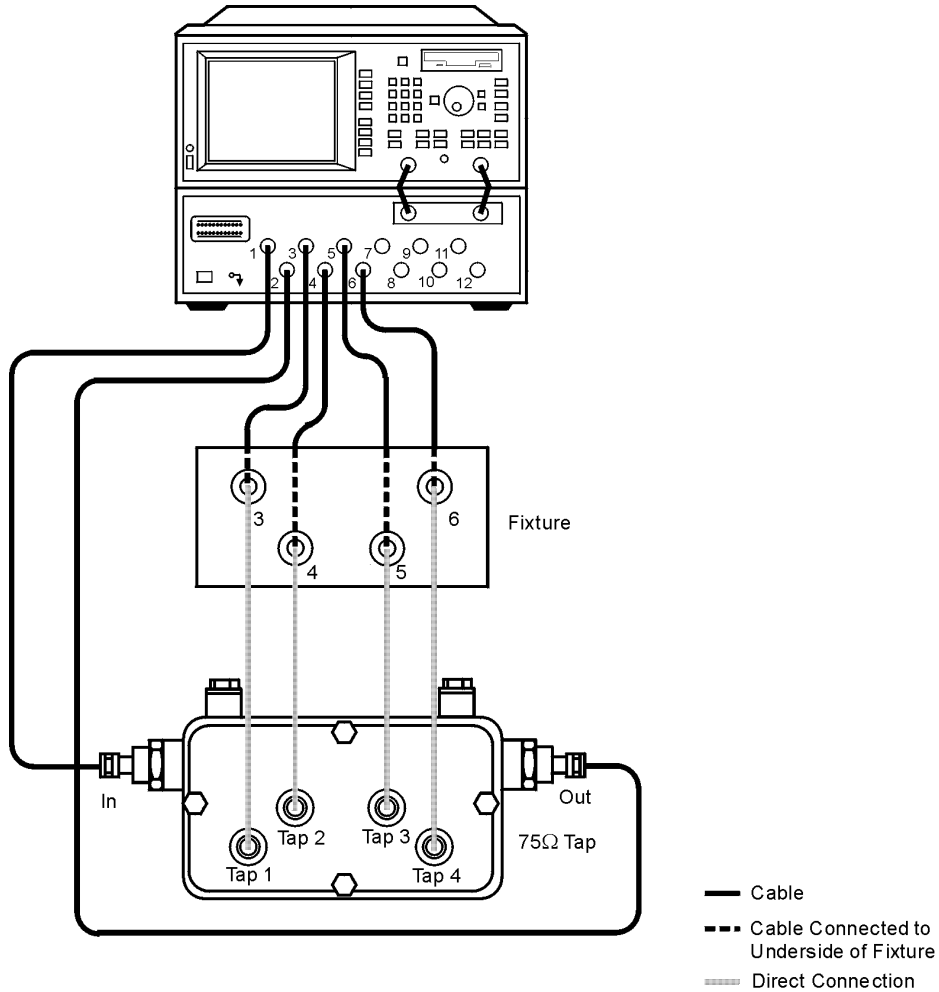
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Example: Measuring a 75 Ohm Tap

The following illustration and tables show how with one mechanical setup you can make multiple measurements on a 75 ohm tap simply by changing the port selections. This example will show how to make six common tap measurements:

- Insertion Loss: In port to Out port
- Reverse Isolation: Out port to In port
- Insertion Loss: In port to Tap1
- Isolation: Tap3 to Tap4
- Return Loss: In port
- Return Loss: Out port

Figure 3-8 **Measuring a 75 Ohm Tap — Six Measurements, One Test Setup**



pt646e

NOTE

Transmission and reflection responses of any multiport device can be affected by the load match presented to ports of the DUT that are outside of the measurement path. The effect of the test set load match on the measurements is device dependent and needs to be considered.

Table 3-3 Making Measurements using an HP 8712ET/14ET Analyzer

Measurement Type	INSERTION LOSS Transmission	REVERSE ISOLATION Transmission	INSERTION LOSS Transmission	ISOLATION Transmission	RETURN LOSS Reflection	RETURN LOSS Reflection
Measurement	In to Out (Tran 1->2)	Out to In (Tran 2->1)	In to Tap1 (Tran 1->3)	Tap3 to Tap4 (Tran 5->6)	In port (Refl Port 1)	Out port (Refl Port 2)
Test Set Port Assigned as the Reflection Port	1	2	1	5	1	2
Test Set Port Assigned as the Transmission Port	2	1	3	6	-	-

Table 3-4 Making Measurements using an HP 8712ES/14ES Analyzer

Measurement Type	INSERTION LOSS S_{21}	REVERSE ISOLATION S_{12}	INSERTION LOSS S_{21}	ISOLATION S_{21}	RETURN LOSS S_{11}	RETURN LOSS S_{22}
Measurement	In to Out (Tran 1->2)	Out to In (Tran 2->1)	In to Tap1 (Tran 1->3)	Tap3 to Tap4 (Tran 5->6)	In port (Refl Port 1)	Out port (Refl Port 2)
Test Set Port Assigned as the (S11) Port	1	1	1	5	1	1
Test Set Port Assigned as the (S22) Port	2	2	3	6	2*	2*

* When using a 2-port Test Set calibration, this test set port is assigned as the (S22) Port .

IMPORTANT

HP 8712ES/14ES analyzers only: the test set port assigned as the (S11) Port must always be the low numbered test set port while the test set port assigned as the (S22) Port must always be the high numbered port.

Calibrating the Multiport System for Measuring a 75 Ohm Tap

For a complete calibration process for measuring the 75 ohm tap in this example, refer to [“Test Set Cal Example #2: The DUT Has Noninsertable Port Pairs with Identical Connectors”](#) on page 4-27.

The Test Set Cal process that is best suited for your particular measurements will depend on the type of DUT you are testing. If your 75 ohm DUT is different from the one used in this example, refer to the following additional Test Set Cal examples for one that best matches your DUT.

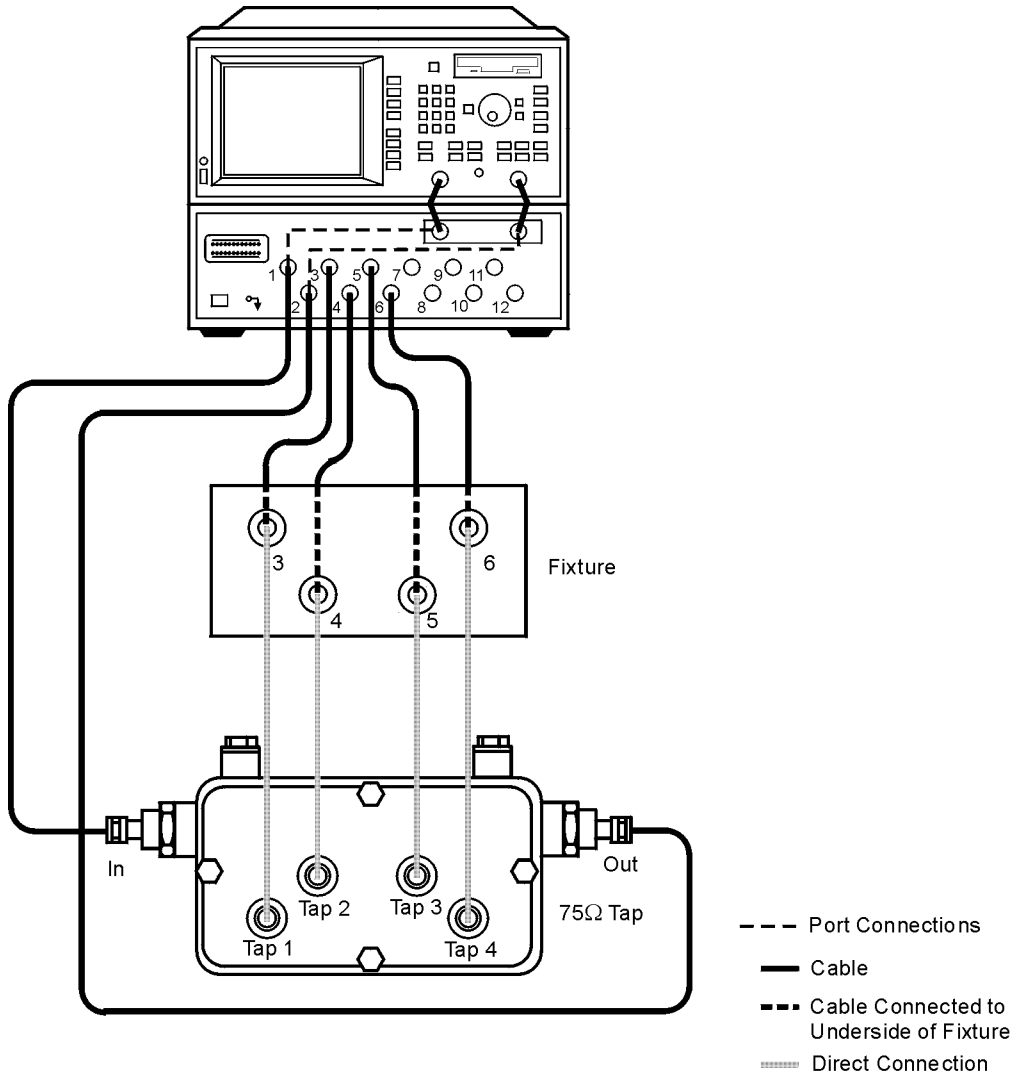
- [“Test Set Cal Example #1: The DUT Has Insertable Port Pairs”](#) on page 4-21
- [“Test Set Cal Example #3: The DUT Has a Noninsertable Port Pair with Dissimilar Connectors”](#) on page 4-42

For all the details on calibrating your test set, refer to [Chapter 4](#), “Test Set Cal and SelfCal.”

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Measuring Insertion Loss: In Port to Out Port

Figure 3-9



pt663e

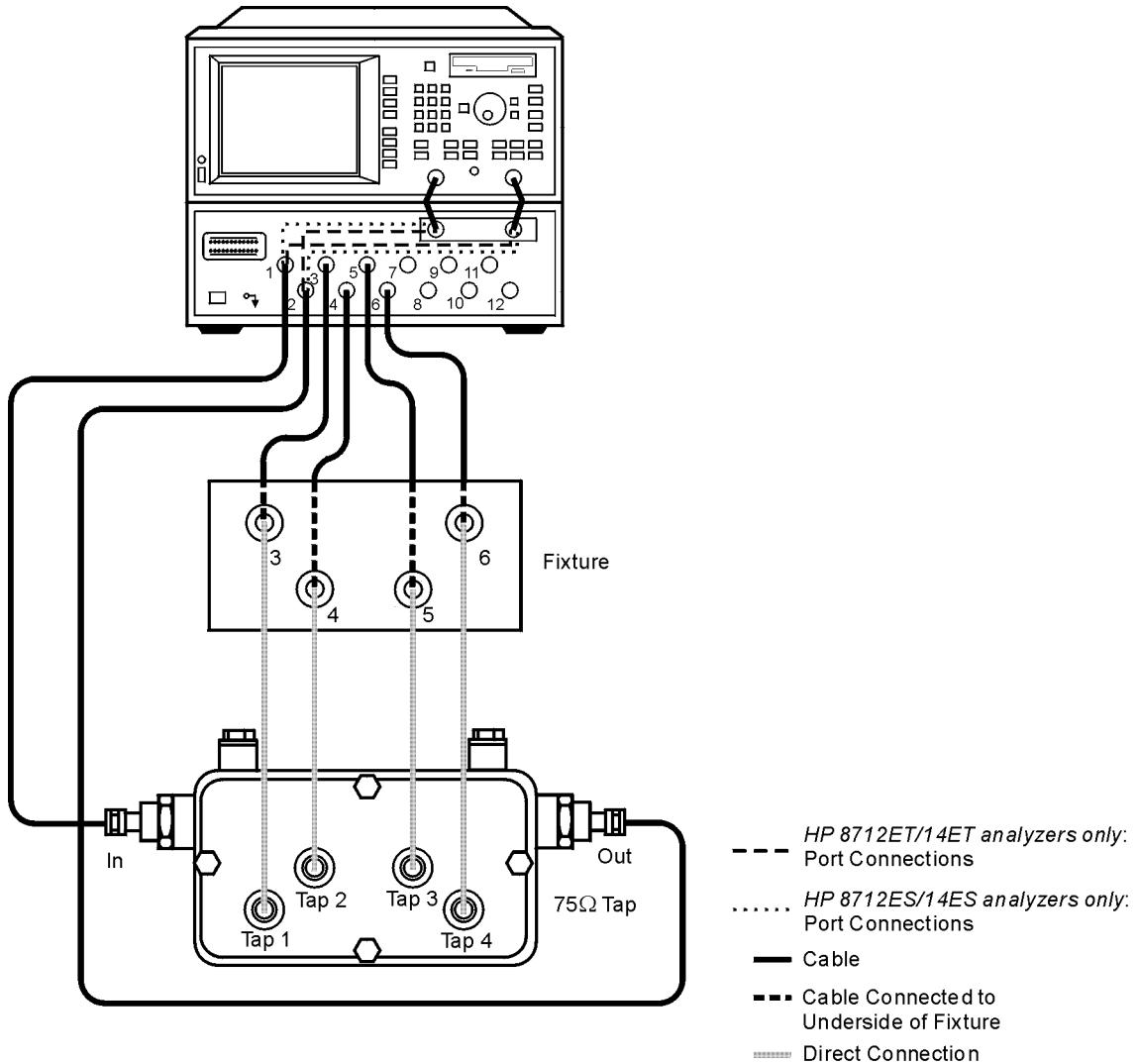
To perform the insertion loss measurement (measuring the loss from the In port of the DUT to the Out port of the DUT), press the following keys on the analyzer:

1. Press **MEAS 1**.
Selects measurement channel 1 as the active measurement channel.
 2. Press **Multiport Selection**.
Displays a menu with softkeys for selecting test set ports for your measurement.
 3. Press **(Reflection Port Num or (S11) Port *)**.
Allows you to select a test set port for your measurement.
 4. Press **1 Enter**.
Selects PORT 1 of the test set.
 5. Press **(Transmissn Port Num or (S22) Port *)**.
Allows you to select a test set port for your measurement.
 6. Press **2 Enter Done ***.
Selects PORT 2 of the test set.
 7. Press **(Transmissn or S21 Tran 1->2 *)**.
Selects the forward transmission type of measurement.
- Optional steps—saving the instrument state:*
- These optional steps allow you to save the instrument state. Recalling an instrument state, rather than manually re-entering the analyzer parameters, can save time and improve measurement throughput.
8. Press **SAVE RECALL**.
Displays a menu with softkeys for saving and recalling analyzer data.
 9. Press **Save State**.
Saves the instrument state.

* For HP 8712ES/14ES analyzers only.

Measuring Reverse Isolation: Out Port to In Port

Figure 3-10



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To perform the reverse isolation measurement (measuring the loss from the Out port of the DUT to the In port of the DUT), press the following keys on the analyzer:

NOTE

For HP 8712ES/14ES analyzers only:

If you already selected test set ports (PORT 1 and PORT 2) for the previous insertion loss measurement (In to Out), it is *not* necessary to reselect ports as described in steps 3–6. When you press **S12 Tran 2->1**, the analyzer automatically displays the reverse isolation measurement.

1. Press **(MEAS 1)**.
Selects measurement channel 1 as the active measurement channel.
2. Press **Multiport Selection**.
Displays a menu with softkeys for selecting test set ports for your measurement.
3. Press **(Reflection Port Num**
or **(S11) Port ***).
Allows you to select a test set port for your measurement.
4. Press **(2)** or **(1)*** **Enter**.
Selects PORT 2 (or PORT 1*) of the test set.
5. Press **(Transmissn Port Num**
or **(S22) Port ***).
Allows you to select a test set port for your measurement.
6. Press **(1)** or **(2)*** **Enter**
Done *.
Selects PORT 1 (or PORT 2*) of the test set.
7. Press **(Transmissn** or
S12 Tran 2->1 *).
Selects the forward transmission (or reverse transmission*) type of measurement.

Optional steps—saving the instrument state:

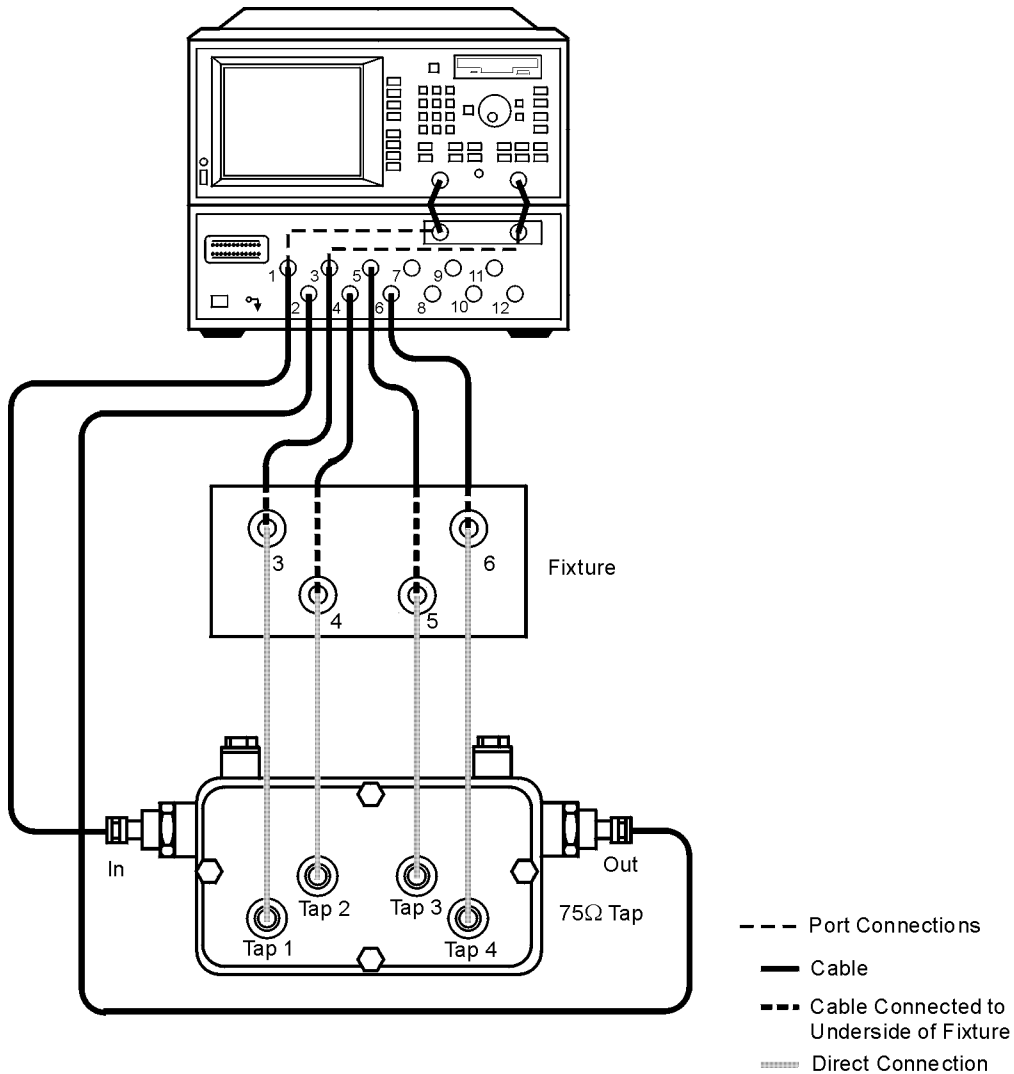
These optional steps allow you to save the instrument state. Recalling an instrument state, rather than manually re-entering the analyzer parameters, can save time and improve measurement throughput.

8. Press **(SAVE RECALL)**.
Displays a menu with softkeys for saving and recalling analyzer data.
9. Press **Save State**.
Saves the instrument state.

* For HP 8712ES/14ES analyzers only.

Measuring Insertion Loss: In Port to Tap1

Figure 3-11



pt665e

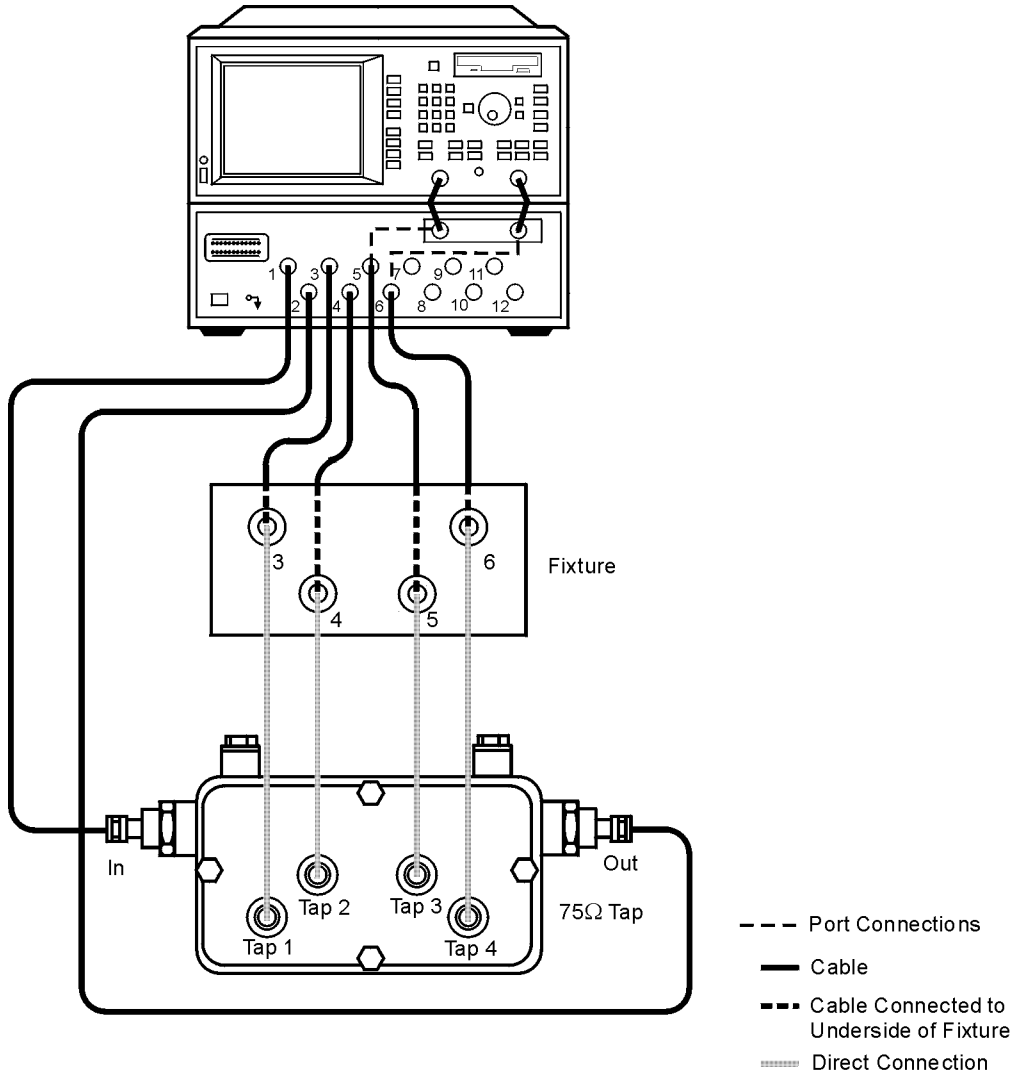
To perform the isolation measurement (a transmission measurement from the In port to the Tap1 port on the DUT), press the following keys on the analyzer:

1. Press **MEAS 1**.
Selects measurement channel 1 as the active measurement channel.
 2. Press **Multiport Selection**.
Displays a menu with softkeys for selecting test set ports for your measurement.
 3. Press
(**Reflection Port Num** or
(S11) Port *).
Allows you to select a test set port for your measurement.
 4. Press **1** **Enter**.
Selects PORT 1 of the test set.
 5. Press
(**Transmissn Port Num** or
(S22) Port *).
Allows you to select a test set port for your measurement.
 6. Press **3** **Enter** **Done ***.
Selects PORT 3 of the test set.
 7. Press (**Transmissn** or
S21 Tran 1->3 *).
Selects the forward transmission type of measurement.
- Optional steps—saving the instrument state:*
- These optional steps allow you to save the instrument state. Recalling an instrument state, rather than manually re-entering the analyzer parameters, can save time and improve measurement throughput.
8. Press **SAVE RECALL**.
Displays a menu with softkeys for saving and recalling analyzer data.
 9. Press **Save State**.
Saves the instrument state.

* For HP 8712ES/14ES analyzers only.

Measuring Isolation: Tap3 to Tap4

Figure 3-12



pt666e

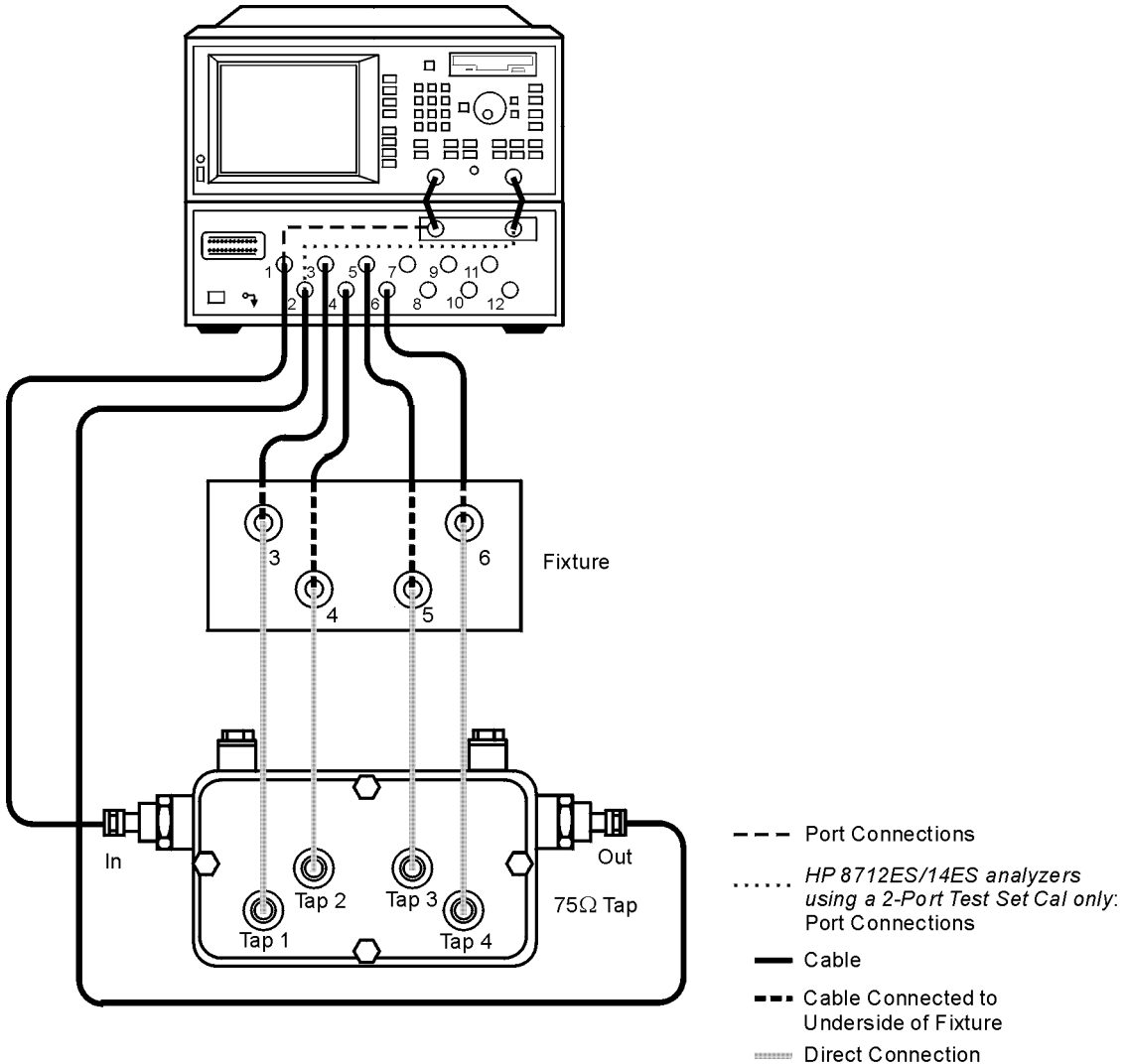
To perform the isolation measurement (a transmission measurement from the Tap3 port to the Tap4 port on the DUT), press the following keys on the analyzer:

1. Press **MEAS 1**.
Selects measurement channel 1 as the active measurement channel.
 2. Press **Multiport Selection**.
Displays a menu with softkeys for selecting test set ports for your measurement.
 3. Press
(**Reflection Port Num** or **(S11) Port ***).
Allows you to select a test set port for your measurement.
 4. Press **5** **Enter**.
Selects PORT 5 of the test set.
 5. Press
(**Transmissn Port Num** or **(S22) Port ***).
Allows you to select a test set port for your measurement.
 6. Press **6** **Enter** **Done ***.
Selects PORT 6 of the test set.
 7. Press (**Transmissn** or **S21 Tran 5->6 ***).
Selects the forward transmission type of measurement.
- Optional steps—saving the instrument state:*
- These optional steps allow you to save the instrument state. Recalling an instrument state, rather than manually re-entering the analyzer parameters, can save time and improve measurement throughput.
8. Press **SAVE RECALL**.
Displays a menu with softkeys for saving and recalling analyzer data.
 9. Press **Save State**.
Saves the instrument state.

* For HP 8712ES/14ES analyzers only.

Measuring Return Loss: In Port

Figure 3-13



pt667e

To perform the return loss measurement on the input port of the DUT using a 1-port cal, press the following keys on the analyzer:

1. Press **MEAS 1**.
Selects measurement channel 1 as the active measurement channel.
2. Press **Multiport Selection**.
Displays a menu with softkeys for selecting test set ports for your measurement.
3. Press
(**Reflection Port Num** or
(S11) Port *).
Allows you to select a test set port for your measurement.
4. Press **1** **Enter**.
Selects PORT 1 of the test set.

For HP 8712ES/14ES analyzers using a 2-port Test Set cal only:
(In this step, you select a second test set port. This is necessary because, when using a 2-port cal, the analyzer sweeps in both directions as it measures all S-parameters.)
5. Press **(S22) Port**.
Allows you to select a test set port for your measurement.
6. Press **2** **Enter** **Done**.
Selects PORT 2 of the test set.

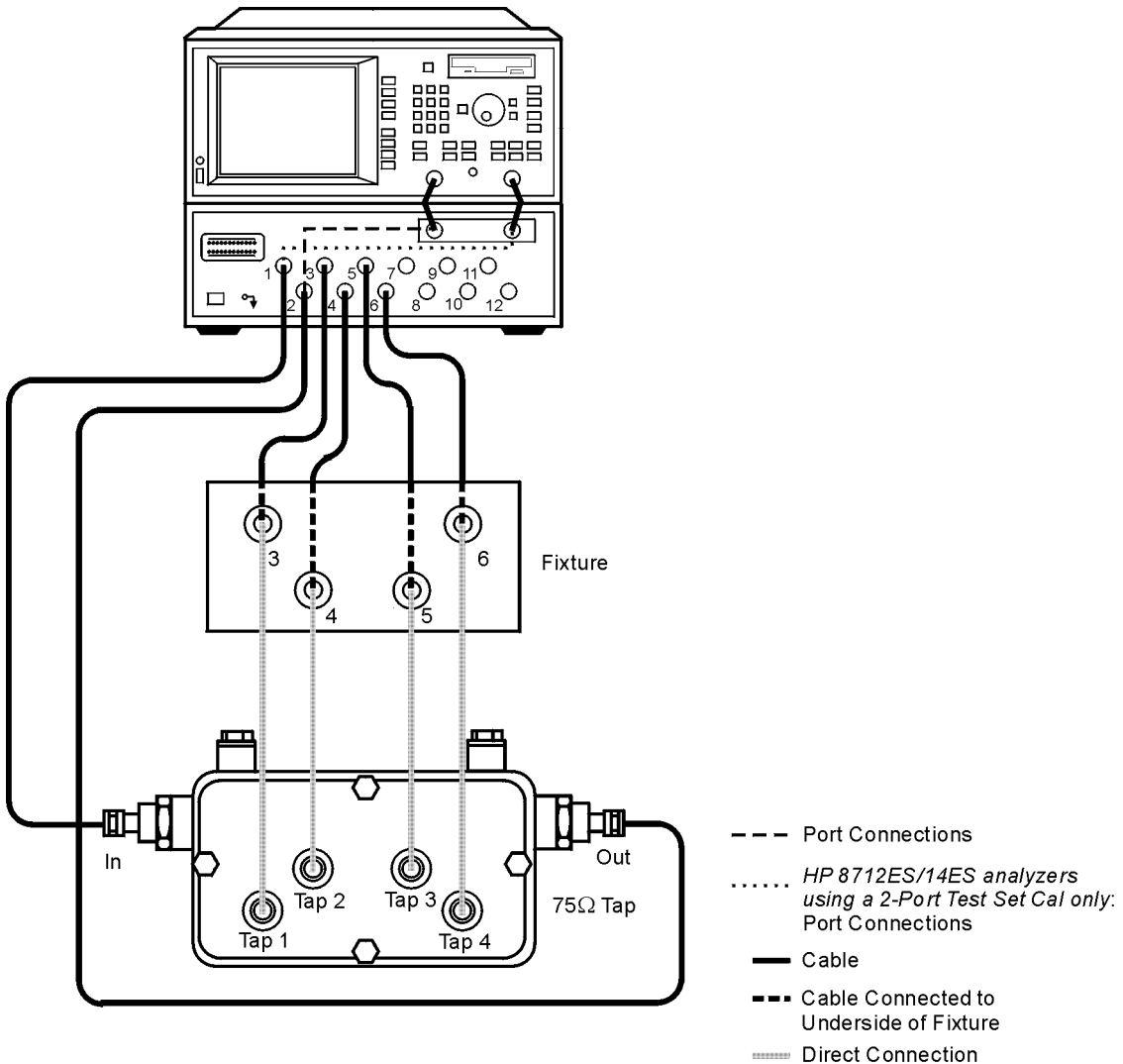
For all analyzers:
7. Press (**Reflection** or
S11 ReflPort1 *).
Selects the reflection measurement.

Optional steps—saving the instrument state:
These optional steps allow you to save the instrument state. Recalling an instrument state, rather than manually re-entering the analyzer parameters, can save time and improve measurement throughput.
8. Press **SAVE RECALL**.
Displays a menu with softkeys for saving and recalling analyzer data.
9. Press **Save State**.
Saves the instrument state.

* For HP 8712ES/14ES analyzers only.

Measuring Return Loss: Out Port

Figure 3-14



pt668e

To perform the return loss measurement on the output port of the DUT using a 1-port cal, press the following keys on the analyzer:

NOTE

For HP 8712ES/14ES analyzers only:

If you already assigned test set PORT 2 as the (S22) Port for the previous return loss measurement (In port), it is *not* necessary to reselect ports as described in steps 2–4. When you press S22 ReflPort2 , the analyzer automatically displays the PORT 2 return loss measurement.

1. Press **MEAS 1**.
Selects measurement channel 1 as the active measurement channel.
 2. Press **Multiport Selection** .
Displays a menu with softkeys for selecting test set ports for your measurement.
 3. Press
(**Reflection Port Num** or
(S22) Port *).
Allows you to select a test set port for your measurement.
 4. Press **2** **Enter** .
Selects PORT 2 of the test set.
For HP 8712ES/14ES analyzers:
PORT 1 is automatically selected as the **(S11) Port** .
 5. Press (**Reflection** or
S22 ReflPort2 *).
Selects the reflection measurement.
- Optional steps—saving the instrument state:*
6. Press **SAVE RECALL** .
Displays a menu with softkeys for saving and recalling analyzer data.
 7. Press **Save State** .
Saves the instrument state.

* For HP 8712ES/14ES analyzers only.

Measurement Examples

Example: Measuring a 75 Ohm Tap

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Using Two Measurement Channels Simultaneously

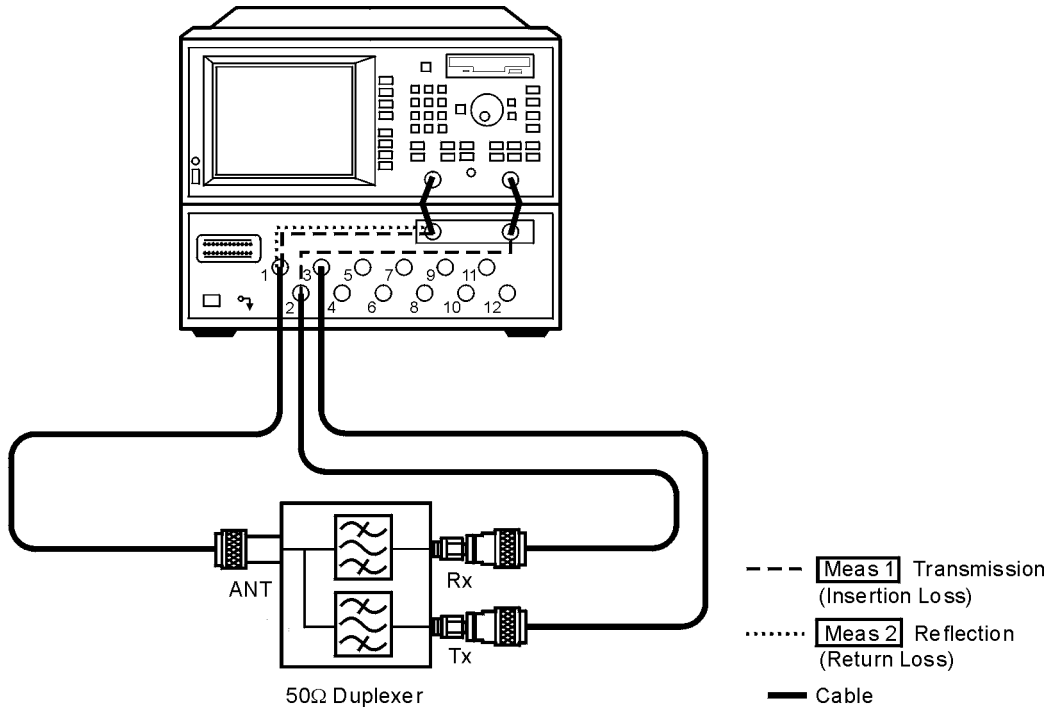
You can use each measurement channel on the analyzer to view two different measurements simultaneously. This can be done using the same or different test set port assignments for each measurement channel.

Using the Same Test Set Port Assignments for Both Measurement Channels

You can assign test set ports once and use both measurement channels on the analyzer to view two different measurements simultaneously. This saves the time of having to assign test set ports twice (once for each measurement channel).

For example, you can make a transmission measurement between two ports on your DUT and make a reflection measurement on one of those ports at the same time. Refer to [Figure 3-15 on page 3-42](#).

Figure 3-15 Simultaneous Measurements Using the Same Test Set Port Assignments for Both Measurement Channels



pt636e

To set up the analyzer to use the same test set port assignments for both measurement channels, press the following keys on the analyzer:

1. Press **MEAS 1**.
Selects measurement channel 1 as the active measurement channel that will display the transmission measurement.
 2. Press **Multiport Selection**.
Displays a menu with softkeys for selecting test set ports for your measurement.
 3. Press
(**Reflection Port Num** or
(S11) Port *).
Allows you to select a test set port for your measurement.
 4. Press **1** **Enter**.
Selects PORT 1 of the test set.
 5. Press
(**Transmissn Port Num** or
(S22) Port *).
Allows you to select a test set port for your measurement.
 6. Press **2** **Enter** **Done ***.
Selects PORT 2 of the test set.
 7. Press (**Transmissn** or
S21 Tran 1->2 *).
Selects the forward transmission type of measurement.
 8. Press **MEAS 2**.
Selects measurement channel 2 as the active measurement channel that will display the reflection measurement.
 9. Press (**Reflection** or
S11 ReflPort1 *).
Selects the reflection measurement.
- Optional steps—saving the instrument state:*
- These optional steps allow you to save the instrument state. Recalling an instrument state, rather than manually re-entering the analyzer parameters, can save time and improve measurement throughput.
10. Press **SAVE RECALL**.
Displays a menu with softkeys for saving and recalling analyzer data.
 11. Press **Save State**.
Saves the instrument state.

* For HP 8712ES/14ES analyzers only.

NOTE

For analyzers using an Enhanced Response/1-Port Test Set Calibration: When making dual measurements with alternate sweep off—the default mode for most types of measurements—both measurement channels are sweeping simultaneously. It is important to note that the test set's assigned transmission (or S_{22}^*) port (PORT 2 in this example) is terminated with the test set transmission path and network analyzer transmission input for both the transmission and the reflection measurement. It is *not* connected to the internal load. This means that during the reflection measurement, test set PORT 2 is not terminated with the internal load. To obtain the most accurate reflection measurements, test set PORT 2 *should* be terminated with the internal load. This can be accomplished by turning alternate sweep on (press **SWEEP**, toggle **Alt Sweep** to ON). The analyzer will now sweep one measurement channel, then the other, which allows the port to be properly terminated internally during the reflection measurement. You can observe the transmission port LED (PORT 2 in this example) turning on and off with each sweep.

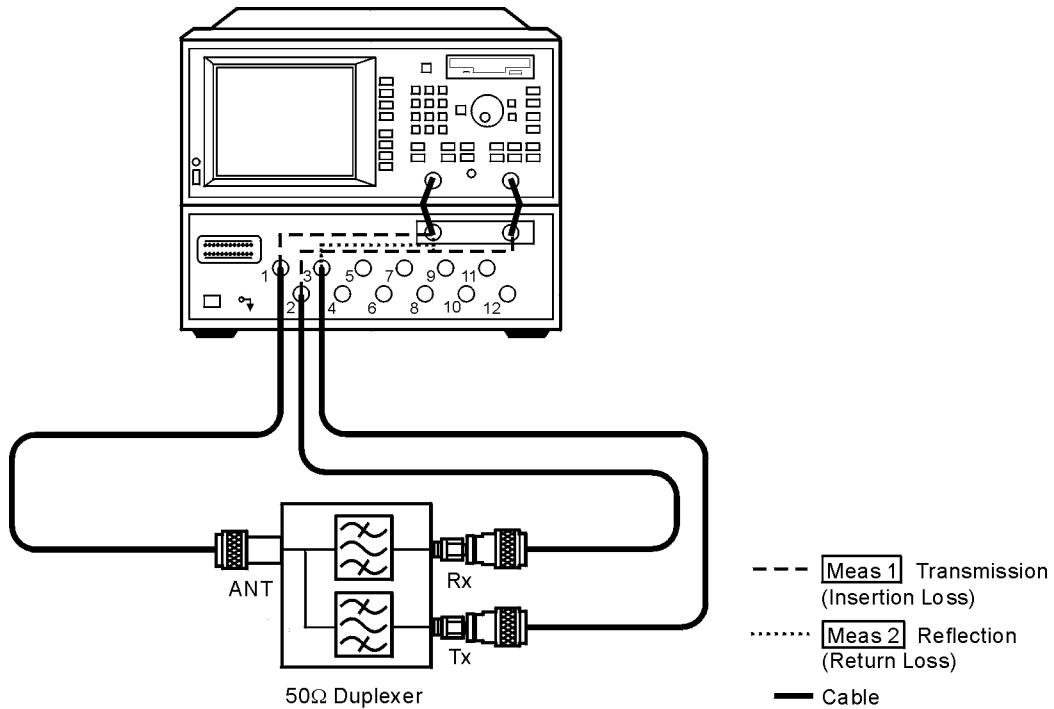
* For HP 8712ES/14ES analyzers only.

Using Different Test Set Port Assignments for Both Measurement Channels

With alternate sweep turned on, you can assign test set ports independently on both measurement channels on the analyzer to view two different measurements simultaneously. This requires the time for you to assign test set ports twice (once for each measurement channel), but gives you the flexibility of using different test set port numbers on each measurement channel.

For example, you can make a transmission measurement between two test set ports on your DUT and make a reflection measurement on a different port at the same time. Refer to [Figure 3-16](#).

Figure 3-16 Simultaneous Measurements Using Different Test Set Port Assignments for Both Measurement Channels



pt637e

To set up the analyzer to use different test set port assignments for both measurement channels, press the following keys on the analyzer:

1. Press **(SWEEP)**. Displays a menu with softkeys for selecting sweep parameters for your measurement.
2. Toggle **Alt Sweep** to ON. Sets the analyzer to show the operation of different instrument states on its two displayed measurement channels.
3. Press **(MEAS 1)**. Selects measurement channel 1 as the active measurement channel that will display the transmission measurement.
4. Press **Multiport Selection**. Displays a menu with softkeys for selecting test set ports for your measurement.
5. Press **(Reflection Port Num** or **(S11) Port ***). Allows you to select a test set port for your measurement.
6. Press **(1) Enter**. Selects PORT 1 of the test set.
7. Press **(Transmissn Port Num** or **(S22) Port ***). Allows you to select a test set port for your measurement.
8. Press **(2) Enter Done ***. Selects PORT 2 of the test set.
9. Press **(Transmissn** or **S21 Tran 1->2 ***). Selects the forward transmission type of measurement.
10. Press **(MEAS 2)**. Selects measurement channel 2 as the active measurement channel that will display the reflection measurement.
11. Press **Multiport Selection**. Displays a menu with softkeys for selecting test set ports for your measurement.
12. Press **(Reflection Port Num** or **(S22) Port ***). Allows you to select a test set port for your measurement.
13. Press **(3) Enter**. Selects PORT 3 of the test set.

* For HP 8712ES/14ES analyzers only.

Measurement Examples
Using Two Measurement Channels Simultaneously

For HP 8712ES/14ES analyzers using a 2-port Test Set cal only:

(In this step, you select a second test set port. This is necessary because, when using a 2-port cal, the analyzer sweeps in both directions as it measures all S-parameters.)

14. Press (S11) Port .

Allows you to select a test set port for your measurement.

15. Press (1) Enter Done .

Selects PORT 1 of the test set.

For all analyzers:

16. Press (Reflection or S22 ReflPort3 *).

Selects the reflection measurement.

Optional steps—saving the instrument state:

These optional steps allow you to save the instrument state. Recalling an instrument state, rather than manually re-entering the analyzer parameters, can save time and improve measurement throughput.

17. Press (SAVE RECALL).

Displays a menu with softkeys for saving and recalling analyzer data.

18. Press Save State .

Saves the instrument state.

* For HP 8712ES/14ES analyzers only.

4 Test Set Cal and SelfCal

Introduction

This chapter presents information on the following topics:

- Test Set Cal: An Overview
- Test Set Cal Examples
- Test Set Cal and SelfCal: The Details
- Verifying the Calibration
- Calibration Kits

Measurement calibration is a process that improves measurement accuracy by using error correction arrays to remove systematic measurement errors. By implementing the Test Set Cal and SelfCal features on your multiport system, you can increase the accuracy of your measurements *and* increase the throughput of your multiport measurements by eliminating frequent and lengthy calibration procedures.

Cal Type	What is it?	How to do it?	When to do it?
Test Set Cal	A full calibration of the multiport test system. Requires connections of external calibration standards.	Press CAL Test Set Cal Create "TSET_CAL". Connect short, open, and load standards to each measurement port. Connect through-standards to each adjacent port pair. (Refer to "Test Set Cal Examples" on page 4-20.)	When you first set up your test system. Thereafter, about once a month if within the specified temperature range.
SelfCal	An internally automated calibration technique. Uses solid-state switches to measure calibration standards located inside the test set.	You do <i>not</i> have to disconnect your DUT to perform a SelfCal. Press CAL Test Set Cal (Periodic SelfCal or SelfCal Once). (Refer to "SelfCal Details" on page 4-58.)	Set SelfCal to execute automatically as often as needed (typically once an hour).

Test Set Cal

A Test Set Cal is a calibration that should be performed when you first set up your test system and thereafter on a regular, but relatively infrequent basis. The time interval between Test Set Cals is dependent mainly on temperature. If the operating temperature of the analyzer and test set is within the specified range (refer to [Chapter 8](#)), the recommended time interval is about once a month. A Test Set Cal requires you to connect mechanical calibration standards to all of the ports you will be using for your measurements. The results of a completed Test Set Cal are always stored in the analyzer's non-volatile memory in a file called "TSET_CAL.CAL".

During the analyzer's power-up sequence, it searches for the "TSET_CAL.CAL" file in non-volatile memory. If it is not found, a message will be displayed indicating that the file was not found. If this happens you must either perform a new Test Set Cal or load one that has been saved on another disk.

See "[Test Set Cal: An Overview](#)" on page 4-5 to learn how to perform a Test Set Cal.

Factory Test Set Cal

A factory Test Set Cal is stored on a floppy disk and shipped with the test set. It is intended to be used when your test doesn't require the best accuracy possible, and when your test device is connected directly to the test set ports with no adapters or intervening cables. For more information, refer to "[Factory Test Set Cal](#)" on page 4-66.

SelfCal

A SelfCal is an automated internal system calibration that should be performed on a regular, frequent basis. If the operating temperature of the analyzer and test set is within the specified range (refer to [Chapter 8](#)), the recommended time interval is about once an hour. A SelfCal does not require removal of the DUT or external connections of calibration standards. The SelfCal uses the results of the most recent Test Set Cal along with measurements of internal, electronically switched open, short, load, and through transfer standards to remove the drift of the network analyzer and multiport test set due to environmental variations.

See “[Test Set Cal and SelfCal: Theory of Operation](#)” on page 4-55 for detailed information on how the Test Set Cal and SelfCal work together.

NOTE

HP recommends that you use the Test Set Cal and SelfCal features whenever you are using your multiport system. If you prefer, you can select from traditional analyzer calibrations, although in doing so the Test Set Cal and SelfCal features will not be available. Refer to your analyzer’s *User’s Guide* for information on these traditional calibrations.

Test Set Cal: An Overview

To perform a Test Set Cal the following steps are required and are explained in detail in this section:

1. Set up measurement parameters, such as frequency range, power level, number of measurements points, etc.
2. Determine the best position for the calibration reference plane.
3. Determine the type of calibration kit you will need to match the connectors at your calibration reference plane.
4. Determine the number of test set ports to be used.
5. Perform the Test Set Cal.

The following optional steps are also explained in detail in this section:

6. Save the Test Set Cal.
7. Recall the Test Set Cal.
8. Set up the SelfCal timer.
9. *For HP 8712ES/14ES analyzers only:* Select the SelfCal Method

Setting Up the Measurement Parameters

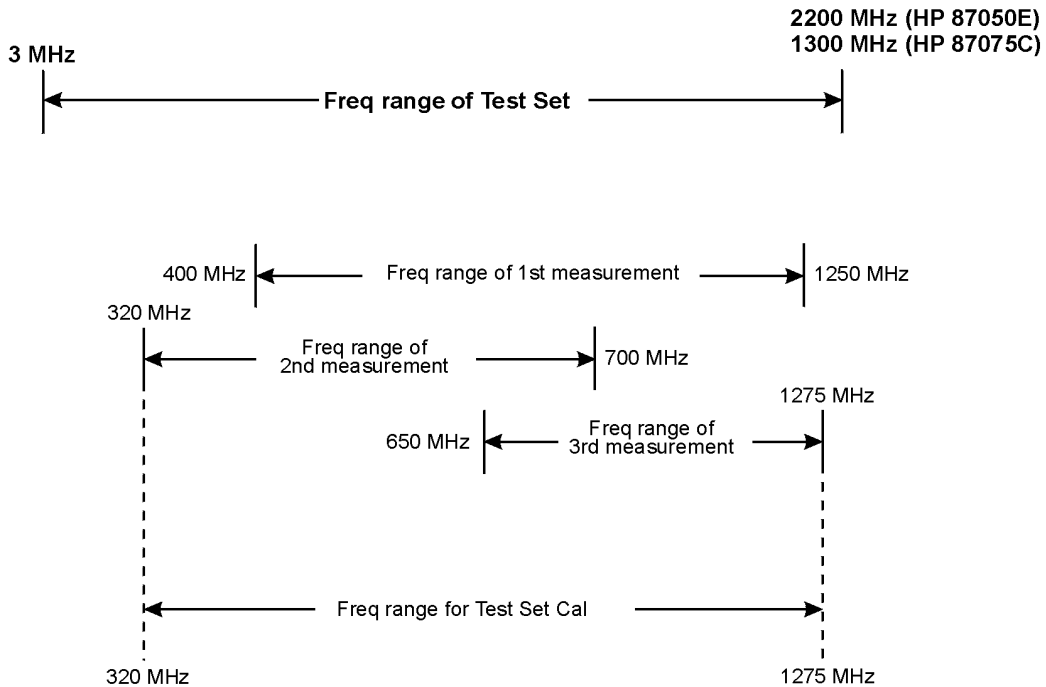
You will need to determine the measurement parameters for your Test Set Cal by determining all the measurements you will be making on a particular device and setting your parameters accordingly. The analyzer will be able to accurately interpolate between error-correction data points when most parameters are changed. However, some special considerations are discussed below.

Frequency Range

You should set your frequency range to the narrowest span possible that will cover all of the measurements you will be making. The analyzer uses a fixed number of frequency points during a calibration and interpolates as the frequency span is narrowed. Setting the analyzer to the narrowest span possible for your measurements will ensure the most accurate calibration. For example, if you will be measuring a device that requires three different measurements, set your start frequency to the lowest

frequency used among the measurements and your stop frequency to the highest frequency used among the measurements. See [Figure 4-1 on page 4-6](#). The analyzer will interpolate between calibrated measurement points when the frequency span is narrowed. However, you should be aware that best measurement accuracy is compromised with this interpolation. *After the Test Set Cal has been performed, widening the frequency span will invalidate the Test Set Cal and restore the analyzer's default factory calibration.* You can recover the previous Test Set Cal by returning to the original frequency span.

Figure 4-1 Frequency Range Example



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NOTE

HP 87075C only:

If you are using an HP 8714ET/ES analyzer with your test set, it is recommended that you set your stop frequency to ≤ 1300 MHz. The performance of the test set is *not* specified above 1300 MHz.

Using this method of calibration will yield accurate measurements with optimum throughput. If your accuracy requirements are more important than your throughput requirements, you may want to perform a separate Test Set Cal for each measurement setup. This will eliminate the need for the analyzer to use interpolation, but will increase the amount of time needed for each measurement as you switch between Test Set Cals. See [“Using Multiple Test Set Cals” on page 4-67](#) for information on using more than one Test Set Cal.

Other Parameters to Consider

Changing the status of spur avoid options (**MENU** Spur Avoid Options) after calibrating will invalidate the calibration and restore the analyzer’s default calibration. It is not recommended that the analyzer’s default calibration be used for multiport measurements. If you want to use any spur avoid options with your measurements, be sure to select them *before* you calibrate.

The following

parameters, if changed after calibrating, will not invalidate the calibration, but will cause the “C?” notation to appear at the top of the display:

- Sweep time
- Number of points
- Power level
- System bandwidth

The “C?” notation indicates that a measurement parameter has changed after a calibration was performed. For best accuracy, avoid measurements which cause the “C?” notation to appear. To avoid sweep time errors during calibrations and measurements, use step sweep mode. To do so, press (**SWEEP**) and toggle Step Sweep to ON.

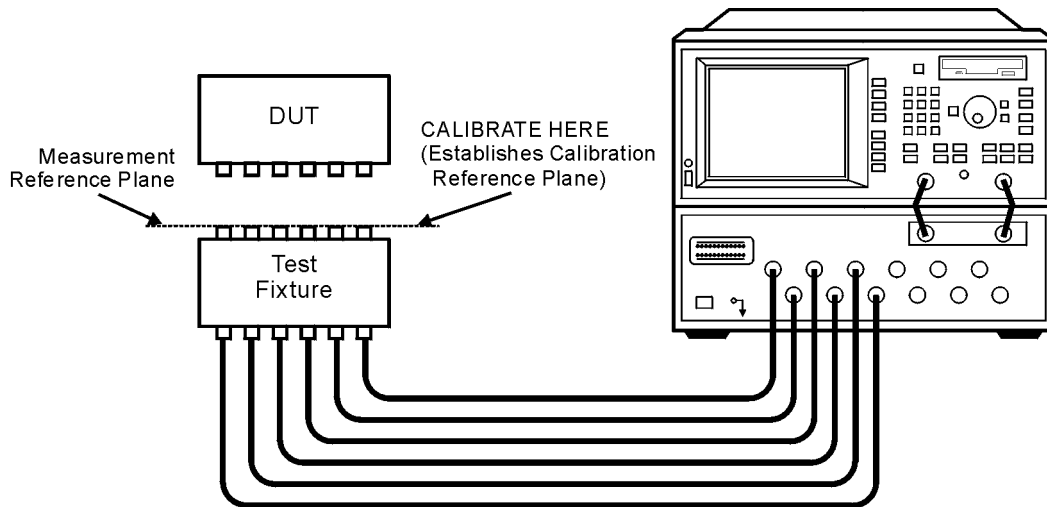
There is a trade-off between selecting the parameters for best measurement accuracy and the resulting time required for the SelfCal routine. Generally, as your parameters are modified for the greatest accuracy, the time required for a SelfCal increases. For example, selecting a large number of points and a narrow system bandwidth will improve measurement accuracy but will increase the time needed for

SelfCal. Therefore, when choosing parameters, you will have to weigh the importance of measurement accuracy versus throughput. For more details, see [Table 4-1 on page 4-62](#) and [Table 4-3 on page 4-64](#).

Determining the Best Position for the Calibration Reference Plane

Most often you will not be connecting your DUT directly to the test set front panel. More likely, you will be connecting your DUT to a test fixture or test cables that are connected to the test set. See [Figure 4-2](#) for an example. The *calibration reference plane* is where you connect your calibration standards, and the *measurement reference plane* is where you connect your DUT. Best measurement results occur when these reference planes are aligned so that you calibrate out the effects of the test fixture and its associated cables and hardware. [Figure 4-2](#) illustrates how to align the reference planes by connecting your calibration standards at the same point that you connect your DUT.

Figure 4-2 **The Calibration Reference Plane**



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CAUTION

Although the Test Set Cal can calibrate out the effects of your external hardware, the drift-removing features of the SelfCal cannot remove drift associated with any external fixtures or cabling. See [Figure 4-10 on page 4-57](#).

Be sure that all external fixtures and cables are extremely stable. HP recommends the use of semi-rigid cabling external to your multiport test set. Design fixturing such that movement of all cables and connectors is minimized.

Determining the Type of Calibration Kit to Use



For the most accurate calibrations and measurements, you should select a calibration kit to match each connector of your DUT. This will ensure that no adapters are needed after a calibration has been performed. For more information on calibration kits, refer to [“Calibration Kits” on page 4-77](#).

To perform a Test Set Cal, you will need to select one of the following calibration kits for each connector of your DUT:

Cal Kit Model Number	Impedance	Connector Type	For Use with Male Test Ports	For Use with Female Test Ports
HP 85039B	75 Ω	type-F	✓	✓
HP 85036B	75 Ω	type-N	✓	✓
HP 85036E	75 Ω	type-N		✓
HP 85032B	50 Ω	type-N	✓	✓
HP 85032E	50 Ω	type-N		✓
HP 85031B	50 Ω	APC-7	N/A	N/A
HP 85033D	50 Ω	3.5 mm	✓	✓
HP 85038A	50 Ω	7-16	✓	✓
HP 85038F	50 Ω	7-16	✓	
HP 85038M	50 Ω	7-16		✓

By convention, calibration kit labels in the analyzer indicate the sex of the *port* with which they are used. For example, the default calibration kit for the test set is type-N *female* because the front panel ports are female (the calibration standards, in turn, have male connectors).

Often, multiport devices have more than one connector type. To perform the Test Set Cal, you must select a calibration kit from the calibration kit menu to match each connector.

1. Press **CAL** More Cal Cal Kit .
2. Use the front panel knob or the   keys to highlight a port number in the on-screen table and then press the key that matches the connector type of the port. Repeat this step for each port you'll be using.

If your port has a connector type which is not one of the selections under the Cal-Kit menu (TNC for example), you may want to select APC-7 as your port since it has nearly ideal characteristics. Then do the following:

- Modify the calibration-kit characteristics so they match those of the TNC standards that you will use.
- Store the user-defined calibration kit.

Your analyzer allows you to create and store up to ten user-defined calibration kits. For details on user-defined calibration kits, refer to [“Test Set Cal Examples” on page 4-20](#) and [“Calibration Kits” on page 4-77](#).

If you must sacrifice throughput for accuracy and use multiple Test Set Cals, see [“Using Multiple Test Set Cals” on page 4-67](#).

Determine the Number of Test Set Ports to Be Used

When performing a Test Set Cal, you must decide how many of the ports you will be using on your multiport test set and select the number using the softkeys on the analyzer. If you need to use an odd number of ports, be sure to round *up* to the next even number.

The number you select will determine the highest port number that gets calibrated. In other words, if you will be using 4 ports and want to just use ports 1 through 4, then select **4 Ports**. But if you are using 4 of the ports, and want to use ports 1, 2, 4 and 6, you must choose **6 Ports** so that ports 1 through 6 get calibrated. Additionally, if you want to use ports 1, 2, and 3, you must “round up” and select **4 Ports**.

To save time, calibrate the lowest number of ports necessary for your test setup. For example, if your test setup requires the use of only 6 of the available twelve ports, calibrate for 6 ports; there is no need to spend the time to calibrate all twelve ports.

The selection of the number of ports is necessary, in part, in order to perform the minimum-through portion of the Test Set Cal. This portion occurs during the calibration when measuring through standards for a transmission measurement (S_{21} or S_{12}) or measurements using 2-port calibration. Suppose that you have a 6-port DUT and that you have selected **6 Ports** to calibrate on your test set. A traditional network analyzer calibration would require (in addition to connecting opens, shorts, and loads to all connectors) that you connect a through standard

between every possible pairing of the 6 test set ports in order to measure all possible transmission paths. This would mean 15 different connections of through standards, each needing its own separate calibration file. The Test Set Cal simplifies this process by only requiring a through-standard connection between 3 adjacent port pairs of the 6 test set ports:

- Port 1 to Port 2
- Port 3 to Port 4
- Port 5 to Port 6

The analyzer calculates the remainder of the test set port combinations and saves the data as only one calibration file. This results in significant calibration-time savings, which improves your measurement throughput.

Performing the Test Set Cal

Refer to the following Test Set Cal examples for step-by-step instructions on performing a Test Set Cal:

- [“Test Set Cal Example #1: The DUT Has Insertable Port Pairs” on page 4-21](#)
- [“Test Set Cal Example #2: The DUT Has Noninsertable Port Pairs with Identical Connectors” on page 4-27](#)
- [“Test Set Cal Example #3: The DUT Has a Noninsertable Port Pair with Dissimilar Connectors” on page 4-42](#)

HP recommends that you perform a Test Set Cal on a regular basis—about once a month if the operating temperature is within the specified range (refer to [Chapter 8](#)). Your environmental conditions and accuracy requirements may dictate either a shorter interval or allow a longer interval. Note that after you have performed a Test Set Cal a "C" appears in the upper right hand corner of the display. This "C" indicates that a user-defined calibration is in use. If you change to a narrower span, note that the "C" changes to "C?", indicating the analyzer is now interpolating between calibrated measurement points. The "C?" notation also appears

* Adjacent ports are those which share an internal through calibration standard. Adjacent ports are: [1, 2], [3, 4], [5, 6], [7, 8], [9, 10], [11, 12].

when other system parameters, such as power, number of points, or sweep time, have changed. For best accuracy, avoid measurements which cause the “C?” notation to appear.

Widening the frequency span will invalidate the Test Set Cal, and the analyzer will automatically restore the *analyzer’s* default factory calibration (not a Test Set Cal). The Test Set Cal will automatically be retrieved again when you narrow the instrument’s frequency span to be compatible with that of the calibration.

Test Set Cal for the HP 8712ET and HP 8714ET Analyzers

During a Test Set Cal, you will be prompted to connect calibration standards (opens, shorts, loads, and throughs) to the selected test set ports. The data collected by the analyzer during a Test Set Cal always includes both transmission (enhanced response) calibration data and reflection (1-port) calibration data. After calibration, when making measurements, the analyzer automatically recalls and uses the correct set of calibration data for the type of measurement you have chosen. The following table shows how measurement selection affects the type of calibration the analyzer utilizes, as well as the systematic errors that are removed:

Type of Measurement	Cal Type Automatically Selected	Systematic Errors Removed
Transmission	Enhanced Response Cal	Transmission Tracking, Source Match
Reflection	1-Port Cal	Reflection Tracking, Source Match, Directivity

CAUTION

Every time you perform a Test Set Cal, the analyzer automatically stores the results in a file called “TSET_CAL.CAL” in the analyzer non-volatile memory.

This file will be overwritten every time you perform a Test Set Cal. If you want to save the results of the current Test Set Cal, you must copy the current “TSET_CAL.CAL” file to another file. See [“Saving the Test Set Cal” on page 4-15](#).

Test Set Cal for the HP 8712ES and HP 8714ES Analyzers

During a Test Set Cal, you will be prompted to select a Test Set Cal choice before connecting the calibration standards (opens, shorts, loads, and throughs) to the selected test set ports. The following table shows the Test Set Cal choices available for each measurement type, as well as the systematic errors that each calibration will remove.

Type of Measurement	Test Set Cal Choices	Systematic Errors Removed
Transmission (S_{21} , S_{12})	Enh Resp, 1-Port	Transmission Tracking, Source Match
	2-Port	Transmission Tracking, Source Match, Load Match, Crosstalk (with Isolation toggled ON)
Reflection (S_{11} , S_{22})	Enh Resp, 1-Port	Reflection Tracking, Source Match, Directivity
	2-Port	Reflection Tracking, Source Match, Load Match, Directivity

CAUTION

Every time you perform a Test Set Cal, the analyzer automatically stores the results in a file called "TSET_CAL.CAL" in the analyzer non-volatile memory.

This file will be overwritten every time you perform a Test Set Cal. If you want to save the results of the current Test Set Cal, you must copy the current "TSET_CAL.CAL" file to another file. See ["Saving the Test Set Cal" on page 4-15](#).

As shown in the table above, choosing a two-port calibration for the Test Set Cal removes the most systematic errors, giving you the greatest measurement accuracy. However, choosing the enhanced response/1-port calibration for the Test Set Cal, though not as accurate as a two-port calibration, allows faster measurement speeds. Therefore, if

measurement speed is more important than the highest accuracy, you may want to choose the enhanced response/1-port calibration for the Test Set Cal.

Calibrating: Insertable Port Pairs versus Noninsertable Port Pairs

During the through portion of the calibration, if an adjacent port pair (for example, 1-to-2, 3-to-4, 5-to-6, etc.) can be connected directly without using a cable or an adapter, the port pair is insertable (refer to [Figure 4-3 on page 4-21](#)). If an adjacent port pair can only be connected by using a through cable or an adapter, the port pair is noninsertable (refer to [Figure 4-5 on page 4-28](#) and [Figure 4-7 on page 4-43](#)). If the port pair is noninsertable, the through cable or adapter is not used when the DUT is measured, so its electrical delay must be subtracted out. This is done by modifying the definition of the through-standard in the calibration kit for each port. Most test fixtures have fixed-location connectors, so their port pairs can only be connected by using a through cable. During the calibration you will be prompted to connect a through cable between specific port pairs. If you can connect your cables to the test set so that the cables' adjacent port pairs are male-to-female, all of your port pairs will be insertable. Configuring your test setup this way saves calibration time and improves your measurement throughput.

Saving the Test Set Cal

Every time you perform a Test Set Cal, the analyzer automatically stores the results in a file called "TSET_CAL.CAL" in the analyzer non-volatile memory. If there isn't enough memory, the file will not be created successfully and the analyzer will display the following error message: `Save file \TSET_CAL.CAL\ failed`. If this happens, save your calibration by following the directions in the pop-up message window.

It is a good idea to manually save the results of your Test Set Cal to a unique file. You can save the Test Set Cal to a floppy disk or to a unique filename in the analyzer internal non-volatile memory. The following examples describe how to save the file to a floppy disk and how to save it to a unique filename in the analyzer's non-volatile memory. See your analyzer's *User's Guide* for more detailed information on copying, saving, and recalling files.

Save TSET_CAL.CAL to a floppy disk

Insert a DOS-formatted 3.5" floppy disk into the analyzer's disk drive. (If your disk is not formatted, you can use the **SAVE RECALL** File Utilities menu to format your disk. See your analyzer's *User's Guide* for more information.)

There are two procedures to choose from when saving a TSET_CAL.CAL file. Both procedures are described in the following sections.





NOTE

When you use the **Tset Cal** key or the **Copy File** key to save the contents of the TSET_CAL.CAL file, the instrument state is *not* saved. Only the calibration data is saved. It is a good idea to also save the instrument state under which the calibration was performed. See Chapter 4 in your analyzer's *User's Guide* for more information on saving and recalling instrument states.

Procedure #1: Saving a TSET_CAL.CAL file.



1. Press **SAVE RECALL** Define Save . Toggle **Tset Cal** to ON.
2. Press **Prior Menu** Select Disk Internal 3.5" Disk .
3. Press **Prior Menu** Save State .
4. You now have a copy of the TSET_CAL.CAL file on the floppy disk.

Procedure #2: Saving a TSET_CAL.CAL file using a new filename.

1. Press **SAVE RECALL** File Utilities .
2. Use the front panel knob or the   keys to highlight the TSET_CAL.CAL file in the display table. Press **Copy File** .
3. Press **Copy to 3.5" Disk** .
4. Use a keyboard connected to the analyzer's DIN KEYBOARD connector to enter the new filename (there are no filename restrictions). If you don't have a keyboard, you can use the analyzer's   keys or the front panel knob and the **Select Char** key to select and enter characters from the top of the analyzer's display. Press **Enter** when done.
5. You now have a copy of the TSET_CAL.CAL file (renamed) on the floppy disk.

Save TSET_CAL.CAL to a new filename in the analyzer's non-volatile memory

This procedure demonstrates how to save a copy of TSET_CAL.CAL with a unique filename in the analyzer's non-volatile memory. For an alternate procedure, refer to [“Procedure #2: Saving a TSET_CAL.CAL file using a new filename” on page 4-16](#) (in step 3, press **Copy to NonVol RAM**).

1. Press **SAVE RECALL** **Define Save** . Toggle **Tset Cal** to ON.
2. Press **Prior Menu** **Select Disk** **Non-Vol RAM Disk** .
3. Press **Prior Menu** **Re-Save State** .
4. Use a keyboard connected to the analyzer's DIN KEYBOARD connector to enter the new filename. (If you don't have a keyboard, you can use the analyzer's   keys or the front panel knob and the **Select Char** key to select and enter characters from the top of the analyzer's display. Press **Enter** when done.)

Recalling the Test Set Cal

Measurement calibration information is linked to the instrument state and measurement parameters for which the calibration was done. Therefore, a saved Test Set Cal can be recalled and used for multiple instrument states as long as the measurement parameters, such as frequency range and number of points, are compatible. To recall your Test Set Cal from the analyzer's internal non-volatile memory or a floppy disk in the built-in disk drive:

1. Press **SAVE RECALL** **Select Disk** and press the key that corresponds to the location where your desired file exists.
2. If necessary, change to the directory that contains the desired file as described in “To Use Directory Utilities” in Chapter 4 of your analyzer's *User's Guide*.
3. Press **Prior Menu** and turn the front panel knob to move the highlighted bar to the file you want to recall.
4. Press **Recall State** to recall the desired file to the network analyzer.

When you recall the Test Set Cal, the instrument state is *not* recalled. Only the calibration data is recalled. For best measurement accuracy, it is a good idea to also recall the instrument state used when the calibration was performed. See Chapter 4 in your analyzer's *User's Guide* for more information on saving and recalling instrument states.

Note that after you have recalled both the Test Set Cal *and* its instrument state (this requires two separate recalls), a "C" appears in the upper right hand corner of the display. This "C" indicates that a user-defined calibration is in use. If you change to a narrower span, note that the "C" changes to "C?", indicating the analyzer is now interpolating between calibrated measurement points. The "C?" notation also appears when other system parameters, such as power, number of points, or sweep time, have changed. For best accuracy, avoid measurements which cause the "C?" notation to appear.

Widening the frequency span will invalidate the Test Set Cal, and the analyzer will automatically restore the *analyzer's* default factory calibration (not a Test Set Cal). The Test Set Cal will automatically be retrieved again when you narrow the instrument's frequency span to be compatible with that of the calibration.

Setting the SelfCal Timer

The SelfCal timer feature allows you to set up your multiport system to automatically perform a SelfCal at a user-defined interval. The default interval is 60 minutes. Your environmental conditions and accuracy requirements may dictate either a shorter interval or allow a longer interval.

To set up the SelfCal timer:

1. Press  Test Set Cal .
2. Select an interval by using the front panel keypad,   keys or the front panel knob.
3. Press .

Once you have done this, the system will perform a SelfCal and automatically calibrate itself at the interval you have chosen.

See ["SelfCal Details" on page 4-58](#) for more information on the timing of SelfCals.

Selecting the SelfCal Method (For HP 8712ES/14ES Analyzers Only)

If the Test Set Cal was done using a two-port calibration, you can select the type of SelfCal to be performed. Pressing **CAL** **Test Set Cal** gives you access to the following two SelfCal choices:

- Enhanced Response/1-Port
- 2-Port Cal

Note that by default, **2-Port Cal** is toggled to ON. This automatically selects the 2-Port SelfCal. If you want the 2-Port SelfCal to remove systematic errors caused by crosstalk, toggle **Isolation** to ON. To select an Enhanced Response/1-Port SelfCal, toggle **2-Port Cal** to OFF. The enhanced response/1-port calibration is faster with less accuracy. The two-port calibration is slower with greater accuracy.

Test Set Cal Examples

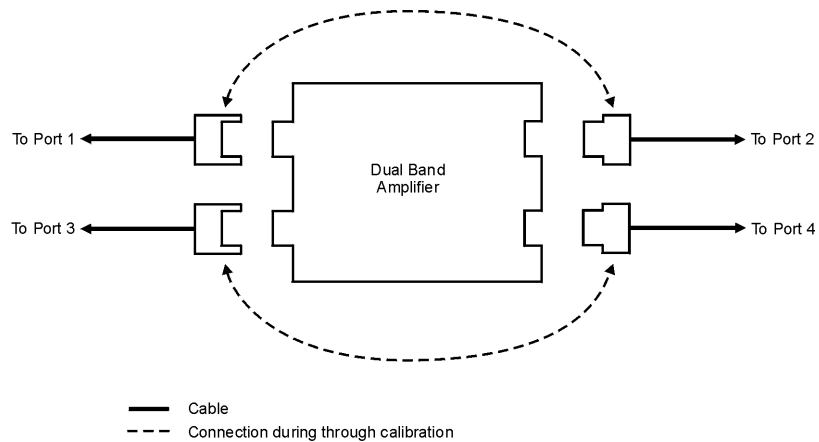
Before you proceed with the following Test Set Cal examples, be sure you have set up the analyzer with the required measurement parameters, determined the best position for your calibration reference plane, and determined which calibration kit(s) will be used for your connectors as described earlier in this chapter. For your measurement application, pick the Test Set Cal example whose DUT is most similar to your DUT.

- “Test Set Cal Example #1: The DUT Has Insertable Port Pairs” on page 4-21
- “Test Set Cal Example #2: The DUT Has Noninsertable Port Pairs with Identical Connectors” on page 4-27
- “Test Set Cal Example #3: The DUT Has a Noninsertable Port Pair with Dissimilar Connectors” on page 4-42

Test Set Cal Example #1: The DUT Has Insertable Port Pairs

As shown in [Figure 4-3](#), this test setup allows the test cables to be connected directly together as port pairs during the through portion of the calibration.

Figure 4-3 **Test Set Cal Example #1: Insertable Port Pairs**



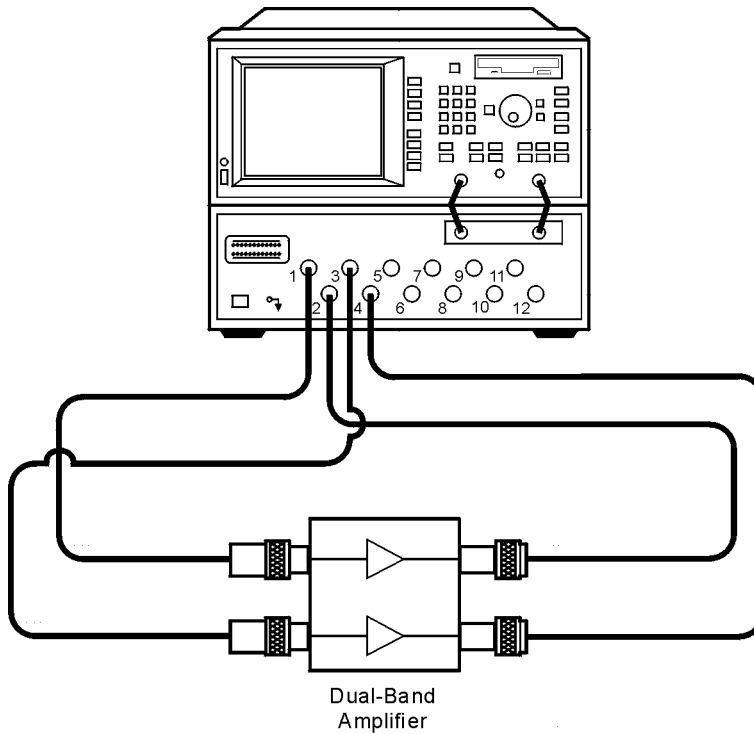
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Test Set Cal and SelfCal
Test Set Cal Examples

The DUT is a four-port dual-band amplifier which has two type-N(m) input connectors and two type-N(f) output connectors. Flexible test cables are used between the test set and the DUT.

If your DUT or test setup is different from the example, you'll need to modify the procedure.

Figure 4-4 **Test Set Cal Example #1: Test Setup**



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Test Set Cal Example #1: Procedure

NOTE

By convention, calibration kit labels in the analyzer indicate the sex of the *port* with which they are used. For example, the default calibration kit for the test set is type-N *female* because the front panel ports are female (the calibration standards, in turn, have male connectors).

Selecting Calibration Kits

- | | |
|--|---|
| | Steps 1–6 select the proper calibration kit for each of the ports at your calibration reference plane (in this example, the open ends of the flexible test cables). |
| 1. Press CAL . | Displays a menu with softkeys for selecting a calibration for your measurement. |
| 2. Press More Cal . | Displays more softkeys from the calibration menu. |
| 3. Press Cal Kit . | Displays a menu with softkeys for selecting and modifying a calibration kit. |
| 4. Highlight PORT 1 and press Type-N(f) . | Selects the type-N(f) calibration kit for PORT 1. |
| 4. Highlight PORT 3 and press Type-N(f) . | Selects the type-N(f) calibration kit for PORT 3. |
| 6. Highlight PORT 2 and press Type-N(m) . | Selects the type-N(m) calibration kit for PORT 2. |
| 6. Highlight PORT 4 and press Type-N(m) . | Selects the type-N(m) calibration kit for PORT 4. |

Performing the Test Set Cal

- Steps 7–13 perform the Test Set Cal.
- Press **CAL**.
 - Press **Test Set Cal**.
 - Press **Create "TSET_CAL"**.
 - Press **4 Ports** to select the number of test set ports (four in this example) you'll be using to make your measurements.
 - For HP 8712ES/14ES analyzers only:* press (**2-Port** or **Enh Resp, 1-Port**).
 - Press **2-Port** if you want to select a two-port Test Set Cal. This calibration provides the greatest measurement accuracy and can be used with all S-parameter measurements.
 - Press **Enh Resp, 1-Port** if you want to select an enhanced response calibration (for S_{21} and S_{12} measurements) or a one-port calibration (for S_{11} and S_{22} measurements).
 - Follow the onscreen instructions for connecting the mechanical standards from the calibration kit. When prompted to connect a through between ports, connect the test cables directly together.
 - Press **All Stds Done** when you have finished measuring all the opens, shorts, loads, and throughs.
- Displays a menu with softkeys for selecting a calibration for your measurement.
- Displays a menu with softkeys for selecting a Test Set calibration and a SelfCal for your measurements.
- Displays a menu with softkeys for selecting the number of test-set ports you will use in the Test Set Calibration.
- Selects four as the number of test-set ports that will be used in the Test Set Cal.
- Completes the Test Set Cal process. Displays a menu with softkeys for selecting a SelfCal for your measurements.

Selecting the SelfCal Routine

For HP 8712ES/14ES analyzers using a 2-Port calibration only:

14. Note that by default, **2-Port Cal** is toggled to ON. This automatically selects the 2-Port SelfCal. If you want to select an Enhanced Response/1-Port SelfCal, go to step 16.

15. If you want the 2-Port SelfCal to remove systematic errors caused by crosstalk, toggle **Isolation** to ON.

16. To select an Enhanced Response/1-Port SelfCal, toggle **2-Port Cal** to OFF.

For all analyzers:

17. Press **SelfCal Timer** and set the SelfCal time interval to the desired amount of time (the default interval is 60 minutes).

18. Press **Periodic SelfCal** .

Steps 14–18 select the SelfCal routine.

For HP 8712ES/14ES analyzers only:

If the Test Set Cal was done using a two-port calibration, you have two choices for the type of SelfCal to be performed:

- Enhanced Response/1-Port
- 2-Port

The enhanced response/1-port calibration is faster with less accuracy. The two-port calibration is slower (requires extra measurement steps) with greater accuracy.

For more information about the 2-Port calibration and the enhanced response/1-port calibration, refer to “[Test Set Cal for the HP 8712ES and HP 8714ES Analyzers](#)” on [page 4-14](#) and the analyzer’s *User’s Guide*.

For more information about the **Isolation** key, refer to Chapter 6 in the analyzer’s *User’s Guide*.

When **2-Port Cal** is toggled to OFF, an Enhanced Response/1-Port SelfCal is automatically selected.

Allows you to input the interval of time desired between automatic SelfCals.

Initiates a SelfCal on the currently selected ports and turns on the automatic SelfCal feature.

NOTE

Changing sweep frequencies (and other source parameters) may affect your calibration, reducing measurement accuracy. Refer to [“Setting Up the Measurement Parameters”](#) on page 4-5 for more information.

Test Set Cal Example #2: The DUT Has Noninsertable Port Pairs with Identical Connectors

As shown in [Figure 4-5](#), this test setup requires a through adapter and a semi-rigid through cable to connect port pairs during the through portion of the calibration:

- PORT 1 and PORT 2 flexible test cables are connected with a through adapter: type-F(f)-to-type-F(f)
- test fixture port pairs are connected with a type-F(f) semi-rigid through cable (the same through cable can be used to connect both port pairs)

Since the adapter and semi-rigid through cable are not used when the DUT is measured, the electrical delay of each must be subtracted out with the following steps, which are explained later in detail:

1. Modify the calibration kit definition of the through standard.
2. Save the modified definition in a user-defined calibration kit.
3. Assign each user-defined calibration kit to the appropriate port.

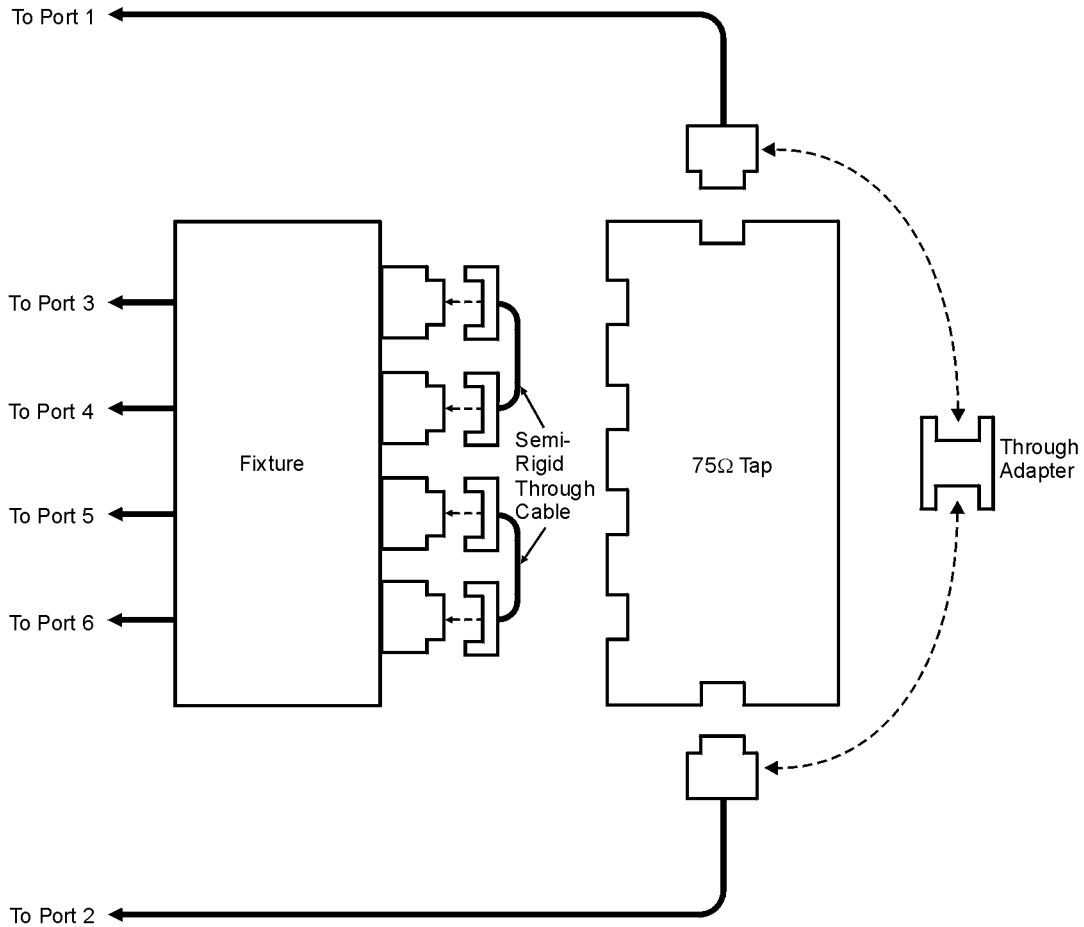
NOTE

See the example program titled “KIT_THRU.” This IBASIC program requires an HP 8712ET/ES or HP 8714ET/ES analyzer. The program develops the measurements needed to characterize a through-cable so that its loss and delay characterization can be stored into a user-defined calibration kit.

Example programs can be found in the following four locations:

- Example Programs Disk, HP 8712ET/ES and HP 8714ET/ES (DOS format): HP part number 08714-10003
- Example Programs Disk, HP 8712ET/ES and HP 8714ET/ES (LIF format): HP part number 08714-10004
- *Example Programs Guide, HP 8712ET/ES and HP 8714ET/ES*: HP part number 08714-90016
- Web site <http://www.hp.com> or <http://www.agilent.com>. Use the search function to find Web pages related to 8712 example programs.

Figure 4-5 Test Set Cal Example #2: Noninsertable Port Pairs with Identical Connectors



— Cable

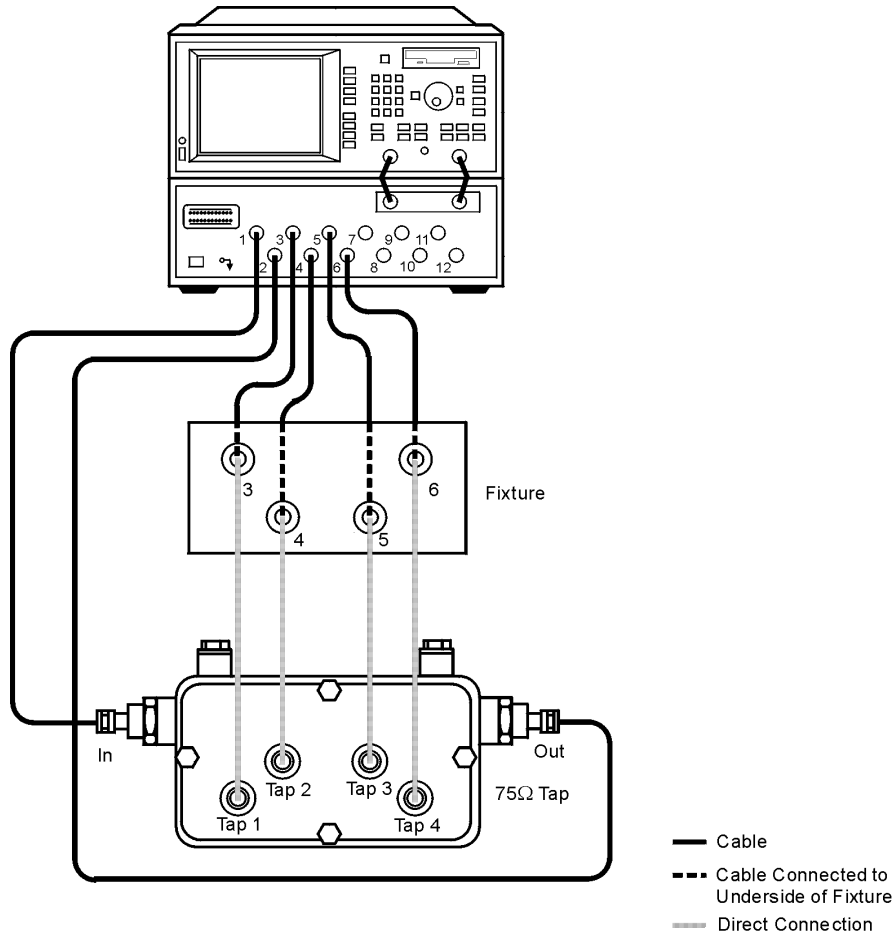
--- Connection during through calibration

Note: All fixture connectors are Type-F(m).
Test-cable connectors are type-N(m)-to-type-F(m).

The DUT is a six-port, 75 ohm CATV tap which has type-F(f) connectors. Flexible test cables are used between the test set and the DUT's input and output ports. Semi-rigid test cables are used between the test set and the custom test fixture. The test fixture ports connect directly to the DUT's four tap connectors.

If your DUT or test setup is different from the example, you'll need to modify the procedure.

Figure 4-6 Test Set Cal Example #2: Test Setup for a 75 Ohm Tap



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Test Set Cal Example #2: Procedure

NOTE

By convention, calibration kit labels in the analyzer indicate the sex of the *port* with which they are used. For example, the default calibration kit for the test set is type-N *female* because the front panel ports are female (the calibration standards, in turn, have male connectors).

Performing a One-Port Calibration

1. Locate the flexible test cable that will be used between the test set and the DUT input. Connect one end of the cable to PORT 1 of the test set and leave the other end open.

2. Press **MEAS 1**.

3. Press **Multiport Selection**.

4. Press (**Reflection Port Num** or **(S11) Port ***).

5. Press **1** **Enter** **Done ***.

6. Press (**Reflection** or **S11 Refl Port1 ***).

7. Press **AVG**.

Steps 1–15 prepare for and perform a one-port reflection calibration on the open end of the flexible test cable. This is done in order to measure the electrical delay of the adapter and the semi-rigid through cable.

For the one-port calibration, the flexible test cable is connected to the test-set port.

Selects measurement channel 1 as the active measurement channel that will display the measurement.

Displays a menu with softkeys for selecting test set ports for your measurement.

Allows you to select a test set port for your measurement.

Selects PORT 1 of the test set.

Selects the reflection measurement.

Displays a menu with softkeys for selecting averaging parameters as well as system bandwidth and delay aperture selections.

* For HP 8712ES/14ES analyzers only

8. Press **System Bandwidth**.
Displays a menu with softkeys for selecting a bandwidth for the IF filter in the receiver section of the analyzer.
9. Press **Fine 15 Hz**.
Selects the Fine (15 Hz) system bandwidth for your measurement.
10. Press **CAL**.
Displays a menu with softkeys for selecting a calibration for your measurement.
11. Press **More Cal**.
Displays more softkeys from the calibration menu.
12. Press **Cal Kit**.
Displays a menu with softkeys for selecting and modifying a calibration kit.
13. Highlight **PORT 1** in the display table and press **Type-F**.
Selects the type-F calibration kit.
14. Press **CAL**.
Displays a menu with softkeys for selecting a calibration for your measurement.
15. Press (**1-Port** or **User 1-Port ***).
Perform a calibration using type-F(f) standards.
Selects a one-port calibration.

Determining the Electrical Delay of the Calibration Short

- Steps 16–18 determine the electrical delay of the type-F short. This delay value will be used later in this procedure.
16. Press **SYSTEM OPTIONS**.
Displays a menu with softkeys for selecting system options for your analyzer.
 17. Press **Operating Parameters**.
Displays several screens of measurement channel settings, cal kit definitions, instrument settings, and instrument configuration.

** For HP 8712ES/14ES analyzers only*

18. Press **Next Screen** until the Cal Kit screen is displayed. In the “CAL KIT: Port 1” display, find the numerical value for the delay of the short. Record this value for use later in the procedure.

Displays the screens of the operating parameters information.

Determining the Electrical Delay of the Through Adapter for PORT 1 and PORT 2 of the Test Set

19. Connect a type-F(f)-to-type-F(f) through adapter to the open end of the flexible test cable.

Steps 19–32 determine the electrical delay of the through adapter. This delay value will be used later in this procedure.

The through adapter will be used again later to join PORT 1 and PORT 2 flexible test cables during the through portion of the Test Set Cal.

20. Add a type-F(m) short to the open end of the adapter.

The short is part of the test setup for measuring the electrical delay of the through adapter.

21. Press **FORMAT**.

Displays a menu with softkeys for selecting the display format for your measurement.

22. Press **Delay**.

Selects the delay display-format for your measurement.

23. Press **MARKER**.

Displays a menu with softkeys to set markers, use marker functions, and marker search. Selects marker 1 as the active marker.

24. Position marker 1 to the left edge of the measurement trace.

Adds a marker to the data trace. This marker can be moved as part of the process of identifying a user-defined segment of the measurement trace.

25. Press **2**.

Selects Marker 2 as the active marker.

26. Position marker 2 to the right edge of the measurement trace.

Adds a marker to the data trace. This marker can be moved as part of the process of identifying a user-defined segment of the measurement trace.

27. Press **Marker Functions**.

Displays a menu with softkeys for selecting various marker functions, such as marker math.

28. Press **Marker Math**.

Displays a menu with softkeys for selecting various calculations (statistics, for example) to be performed on a user-defined segment of the measurement trace.

29. Press **Statistics**.

Measures a user-defined segment of the measurement trace. Displays the mean and other calculations.

30. Record the mean value, located in the upper right corner of the display.

The mean value is the “round-trip” electrical delay of the through adapter.

31. Divide the mean value by 2.

Calculates the “one-way trip” electrical delay of the through adapter.

32. Subtract the electrical delay of the calibration short (recorded earlier). The difference is the electrical delay of the adapter. Record this value for use later in the procedure.

The calibration short electrical delay is subtracted because the short is not used with the through adapter during the Test Set Cal.

33. Remove the short from the adapter.

Determining the Electrical Delay of the Semi-Rigid Through Cable for the Test Fixture Ports

Steps 34–47 determine the electrical delay of the semi-rigid through cable. This delay value will be used later in this procedure.

34. Locate a semi-rigid through cable that will connect fixture PORTS 3–4 and PORTS 5–6. Connect it to the end of the flexible test cable.

The semi-rigid through cable will be used again later to join test-fixture PORTS 3–4 and PORTS 5–6 during the through portion of the Test Set Cal.

35. Add a type-F(m) short to the open end of the semi-rigid through cable.

The short is part of the test setup for measuring the electrical delay of the semi-rigid through cable.

36. Press **FORMAT**.

Displays a menu with softkeys for selecting the display format for your measurement.

- 37.** Press **Delay** .
Measures the “round-trip” electrical delay of the through adapter.
- 38.** Press **MARKER** .
Displays a menu with softkeys to set markers, use marker functions, and marker search. Selects marker 1 as the active marker.
- 39.** Position marker 1 to the left edge of the measurement trace.
Adds a marker to the data trace. This marker can be moved as part of the process of identifying a user-defined segment of the measurement trace.
- 40.** Press **2:** .
Selects Marker 2 as the active marker.
- 41.** Position marker 2 to the right edge of the measurement trace.
Adds a marker to the data trace. This marker can be moved as part of the process of identifying a user-defined segment of the measurement trace.
- 42.** Press **Marker Functions** .
Displays a menu with softkeys for selecting various marker functions, such as marker math.
- 43.** Press **Marker Math** .
Displays a menu with softkeys for selecting various calculations (statistics, for example) to be performed on a user-defined segment of the measurement trace.
- 44.** Press **Statistics** .
Measures a user-defined segment of the measurement trace. Displays the mean and other calculations.
- 45.** Record the mean value, located in the upper right corner of the display.
The mean value is the “round-trip” electrical delay of the through adapter.
- 46.** Divide the mean value by 2.
Calculates the “one-way trip” electrical delay of the through adapter.
- 47.** Subtract the electrical delay of the calibration short (recorded earlier). The difference is the electrical delay of the semi-rigid through cable. Record this value for use later in the procedure.
The calibration short's electrical delay is subtracted because the short is not used with the semi-rigid through cable during the Test Set Cal.

48. Remove the short and semi-rigid through cable.



49. Connect the flexible test cable between test set PORT 1 and the DUT input.

To view the test setup, refer to [Figure 4-6 on page 4-29](#).

Creating a Modified Cal Kit Buffer for the Through Adapter

- | | |
|--|---|
| <p>50. Press CAL.</p> | Steps 50–56 modify the PORT 1 calibration kit definition of the through-standard. This is done by entering the electrical delay of the through adapter. |
| <p>51. Press More Cal.</p> | Displays a menu with softkeys for selecting a calibration for your measurement. |
| <p>52. Press Cal Kit.</p> | Displays more softkeys from the calibration menu. |
| <p>53. Highlight PORT 1 in the display table and press Modify Type-F.</p> | Displays a menu with softkeys for selecting and modifying a calibration kit. |
| <p>54. Press Thru.</p> | Selects the type-F calibration kit for modifying. |
| <p>55. Press Delay.</p> | Allows you to modify the characteristics of the through calibration standard in your calibration kit. |
| <p>56. Enter the electrical delay of the adapter (recorded earlier in step 32).</p> | Allows you to modify the delay characteristic of the through calibration standard in your calibration kit. |
| | Use the keypad and softkeys to enter the numerical value of the electrical delay of the adapter. |

Saving, Defining, and Assigning User Cal Kit A

- Steps 57–59 save (and automatically assign) the modified calibration kit buffer as a user-defined calibration kit for PORT 1.
- 57.** Press **Prior Menu** .
- Displays the previous menu on the analyzer display.
- 58.** Press **Mod Kit SaveRecall** .
- Displays a menu with softkeys for saving, recalling, presetting, and describing a user calibration kit.
- 59.** Highlight Cal Kit A and press **Save** .
- Saves the modified cal kit buffer for the through adapter as Cal Kit A.
- 60.** *Optional:* press **Add Kit Description** and enter your calibration kit description.
- To enter the cal kit description, it is fastest and easiest to use a keyboard connected to the analyzer's DIN KEYBOARD connector. (If you don't have a keyboard, you can use the analyzer's   keys or the front panel knob and the **Select Char** key to select and enter characters from the top of the analyzer's display. Press **Enter** when done.)
- Steps 61–63 assign User Cal Kit A to PORT 2. (This User Cal Kit is assigned to both PORT 1 and PORT 2 since the test cables connected to these test set ports are joined with the same adapter during the Test Set Cal.)
- 61.** Press **Prior Menu** twice.
- Displays the previous menu on the analyzer display.
- 62.** Highlight PORT 2 and press **More Cal Kits** .
- Displays a menu with softkeys for selecting more calibration kits.
- 63.** Press **User Cal Kit A** .
- Assigns User Cal Kit A to PORT 2.

Creating a Modified Cal Kit Buffer for the Semi-Rigid Through Cable

- Steps 64–71 modify the PORT 3 calibration kit definition of the through-standard. This is done by entering the electrical delay of the semi-rigid through cable.
- 64.** Press **CAL** .
Displays a menu with softkeys for selecting a calibration for your measurement.
- 65.** Press **More Cal** .
Displays more softkeys from the calibration menu.
- 66.** Press **Cal Kit** .
Displays a menu with softkeys for selecting and modifying a calibration kit.
- 67.** Highlight PORT 3 in the display table and press **Type-F** .
Selects the type-F calibration kit.
- 68.** Press **Modify Type-F** .
Selects the type-F calibration kit for modifying.
- 69.** Press **Thru** .
Allows you to modify the characteristics of the through calibration standard in your calibration kit.
- 70.** Press **Delay** .
Allows you to modify the delay characteristic of the through calibration standard in your calibration kit.
- 71.** Enter the electrical delay of the semi-rigid through cable (recorded earlier in step 47).
Use the keypad and softkeys to enter the numerical value of the electrical delay of the adapter.



Saving, Defining, and Assigning User Cal Kit B

- Steps 72–74 save (and automatically assign) the modified calibration kit buffer as a user-defined calibration kit for PORT 3.
- 72.** Press **Prior Menu** .
Displays the previous menu on the analyzer display.
- 73.** Press **Mod Kit SaveRecall** .
Displays a menu with softkeys for saving, recalling, presetting, and describing a user calibration kit.

74. Highlight Cal Kit B and press **Save** .

Saves the modified cal kit buffer for the through adapter as Cal Kit B.

75. Optional: press **Add Kit Description** and enter your calibration kit description.

To enter the cal kit description, it is fastest and easiest to use a keyboard connected to the analyzer's DIN KEYBOARD connector. (If you don't have a keyboard, you can use the analyzer's   keys or the front panel knob and the **Select Char** key to select and enter characters from the top of the analyzer's display. Press **Enter** when done.)

Steps 76–79 assign User Cal Kit B to PORTS 4–6. (This User Cal Kit is assigned to PORTS 4–6 since these test set ports are joined with the same semi-rigid through-cable during the Test Set Cal.)

76. Press **Prior Menu** twice.

Displays the previous menu on the analyzer display.

77. Highlight PORT 4 and press **More Cal Kits** .

Displays a menu with softkeys for selecting more calibration kits.

78. Press **User Cal Kit B** .

Assigns User Cal Kit B to PORT 4.

79. Repeat steps 77 and 78 for PORTS 5–6.

Assigns User Cal Kit B to PORTS 5–6.

Performing the Test Set Cal

Steps 80–86 perform the Test Set Cal.

80. Press  .

Displays a menu with softkeys for selecting a calibration for your measurement.

81. Press **Test Set Cal** .

Displays a menu with softkeys for selecting a Test Set calibration and a SelfCal for your measurements.

82. Press **Create "TSET_CAL"** .

Displays a menu with softkeys for selecting the number of test-set ports you will use in the Test Set Calibration.

83. Press **6 Ports** to select the number of test set ports you'll be using to make your measurements in this example.

84. For HP 8712ES/14ES analyzers only: press (**2-Port** or **Enh Resp, 1-Port**).

85. Follow the onscreen instructions for connecting the mechanical standards from the calibration kit. When prompted to connect a through between PORTS 1 and 2, use the adapter to connect the two flexible test cables. When prompted to connect a through between PORTS 3 and 4 and PORTS 5 and 6, use the semi-rigid through cable

86. Press **All Stds Done** when you have finished measuring all the opens, shorts, loads, and throughs.

Selects six as the number of test-set ports that will be used in the Test Set Cal.

Press **2-Port** if you want to select a two-port Test Set Cal. This calibration provides the greatest measurement accuracy and can be used with all S-parameter measurements.

Press **Enh Resp, 1-Port** if you want to select an enhanced response calibration (for S_{21} and S_{12} measurements) or a one-port calibration (for S_{11} and S_{22} measurements).

Completes the Test Set Cal process. Displays a menu with softkeys for selecting a SelfCal for your measurements.

Selecting the SelfCal Routine

For HP 8712ES/14ES analyzers using a 2-Port calibration only:

Steps 87–91 select the SelfCal routine.

For HP 8712ES/14ES analyzers only:

If the Test Set Cal was done using a two-port calibration, you have two choices for the type of SelfCal to be performed:

- Enhanced Response/1-Port
- 2-Port

The enhanced response/1-port calibration is faster with less accuracy. The two-port calibration is slower (requires extra measurement steps) with greater accuracy.

Test Set Cal and SelfCal
Test Set Cal Examples

87. Note that by default, **2-Port Cal** is toggled to ON. This automatically selects the 2-Port SelfCal. If you want to select an Enhanced Response/1-Port SelfCal, go to step 89.

88. If you want the 2-Port SelfCal to remove systematic errors caused by crosstalk, toggle **Isolation** to ON.

89. To select an Enhanced Response/1-Port SelfCal, toggle **2-Port Cal** to OFF.

For all analyzers:

90. Press **SelfCal Timer** and set the SelfCal time interval to the desired amount of time (the default interval is 60 minutes).

91. Press **Periodic SelfCal** .

For more information about the 2-Port calibration and the enhanced response/1-port calibration, refer to “[Test Set Cal for the HP 8712ES and HP 8714ES Analyzers](#)” on [page 4-14](#) and the analyzer’s *User’s Guide*.

For more information about the **Isolation** key, refer to Chapter 6 in the analyzer’s *User’s Guide*.

When **2-Port Cal** is toggled to OFF, an Enhanced Response/1-Port SelfCal is automatically selected.

Allows you to input the interval of time desired between automatic SelfCals.

Initiates a SelfCal on the currently selected ports and turns on the automatic SelfCal feature.

*For HP 8712ES/14ES analyzers only.

NOTE

Changing sweep frequencies (and other source parameters) may affect your calibration, reducing measurement accuracy. Refer to “[Setting Up the Measurement Parameters](#)” on [page 4-5](#) for more information.

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Test Set Cal Example #3: The DUT Has a Noninsertable Port Pair with Dissimilar Connectors

As shown in [Figure 4-7](#), this test setup requires a through adapter to connect a port pair during the through portion of the calibration:

- PORT 1 and PORT 2 test cables are connected with a through adapter: type-N(f)-to-3.5 mm(f).
- The PORT 3 test cable is connected directly to the adapter on PORT 4 of the test set.

Since the through adapter is not used when the DUT is measured, its electrical delay must be subtracted out with the following steps, which are explained later in detail:

1. Modify the calibration kit definition of the through standard.
2. Save the modified definition in two user-defined calibration kits (one for each port's connector type).
3. Assign each user-defined calibration kit to the appropriate port.

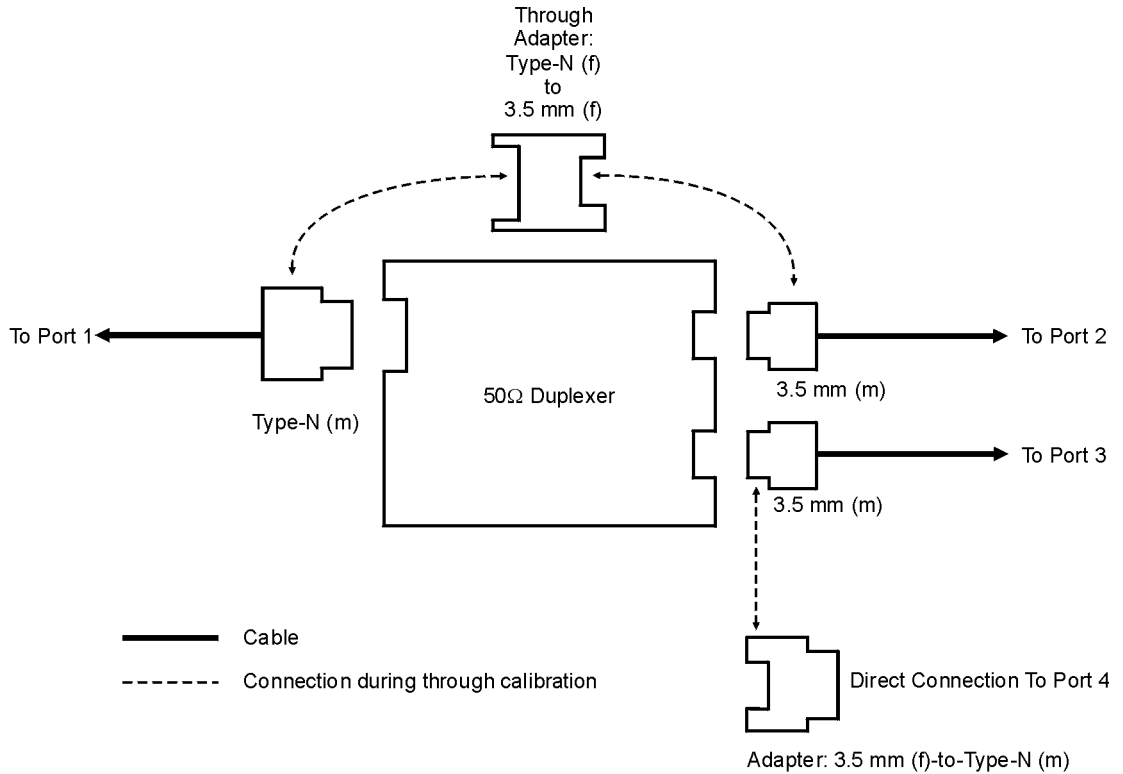
NOTE

See the example program titled "KIT_THRU." This IBASIC program requires an HP 8712ET/ES or HP 8714ET/ES analyzer. The program develops the measurements needed to characterize a through-cable so that its loss and delay characterization can be stored into a user-defined calibration kit.

Example programs can be found in the following four locations:

- Example Programs Disk, HP 8712ET/ES and HP 8714ET/ES (DOS format): HP part number 08714-10003
 - Example Programs Disk, HP 8712ET/ES and HP 8714ET/ES (LIF format): HP part number 08714-10004
 - *Example Programs Guide, HP 8712ET/ES and HP 8714ET/ES*: HP part number 08714-90016
 - Web site <http://www.hp.com> or <http://www.agilent.com>. Use the search function to find Web pages related to 8712 example programs.
-

Figure 4-7 Test Set Cal Example #3: Noninsertable Port Pair with Dissimilar Connectors



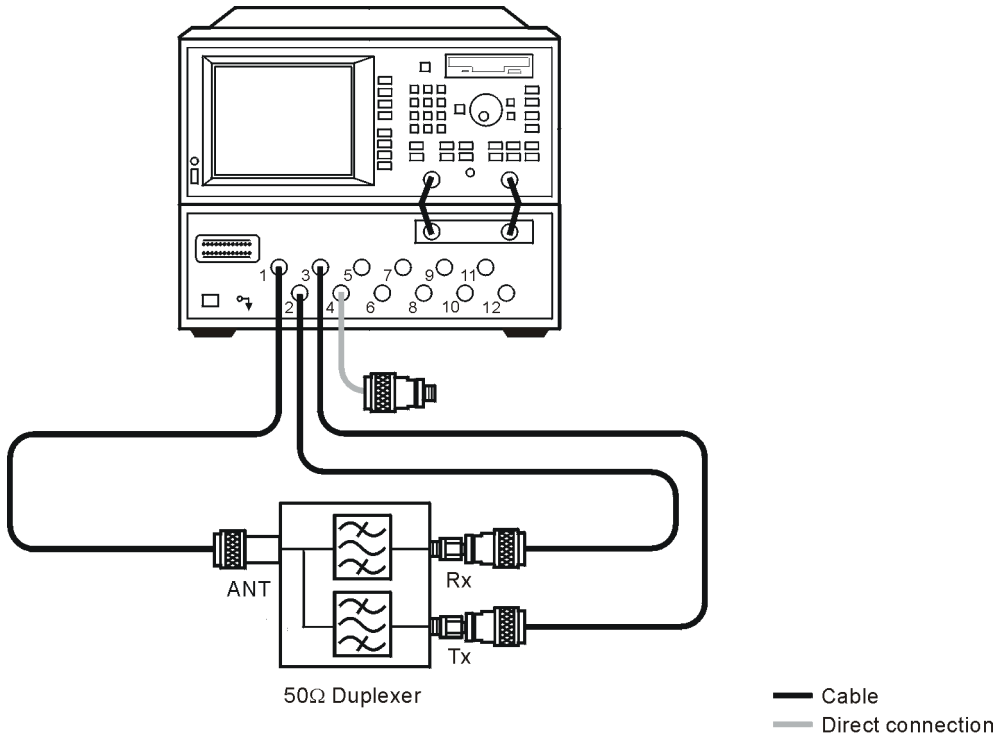
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Test Set Cal and SelfCal
Test Set Cal Examples

The DUT is a three-port, 50 ohm duplexer which has a type-N(f) input connector and two 3.5 mm(f) output connectors. Three flexible test cables are used to test the DUT and an adapter on PORT 4 is used only during the through portion of the calibration. (It is necessary to use PORT 4 because the Test Set Cal requires that you use an *even* number of ports.)

If your DUT or test setup is different from the example, you'll need to modify the procedure.

Figure 4-8 Test Set Cal Example #3: Test Setup for a 50 Ohm Duplexer



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Test Set Cal Example #3: Procedure

NOTE

By convention, calibration kit labels in the analyzer indicate the sex of the *port* with which they are used. For example, the default calibration kit for the test set is type-N *female* because the front panel ports are female (the calibration standards, in turn, have male connectors).

Performing a One-Port Calibration

1. Connect a 3.5 mm(f)-to-type-N(m) adapter directly to test set PORT 4.

Test set PORT 4 is used because, in this example, the DUT has an odd number of ports (three), so it's necessary to round *up* to the next even number (four) for the Test Set Cal. This adapter is used so that PORT 4 can be directly connected to the PORT 3 test cable, which has a 3.5 mm(m) connector.

2. Locate the flexible test cable that will be used between the test set and the ANT port of the DUT. Connect one end of the cable to PORT 1 of the test set and leave the other end open.

Steps 2–16 prepare for and perform a one-port reflection calibration on the open end of the flexible test cable. This is done in order to measure the electrical delay of the through adapter.

3. Press **MEAS 1**.

For the one-port calibration, the flexible test cable is connected to the test-set port.

Selects measurement channel 1 as the active measurement channel that will display the measurement.

4. Press **Multiport Selection**.

Displays a menu with softkeys for selecting test set ports for your measurement.

5. Press (**Reflection Port Num** or **(S11) Port ***).

Allows you to select a test set port for your measurement.

* For HP 8712ES/14ES analyzers only

Test Set Cal and SelfCal
Test Set Cal Examples

6. Press **1** **Enter** **Done** *.
Selects PORT 1 of the test set.
7. Press (**Reflection** or **S11 Refl Port1** *).
Selects the reflection measurement.
8. Press **AVG**.
Displays a menu with softkeys for selecting averaging parameters as well as system bandwidth and delay aperture selections.
9. Press **System Bandwidth**.
Displays a menu with softkeys for selecting a bandwidth for the IF filter in the receiver section of the analyzer.
10. Press **Fine 15 Hz**.
Selects the Fine (15 Hz) system bandwidth for your measurement.
11. Press **CAL**.
Displays a menu with softkeys for selecting a calibration for your measurement.
12. Press **More Cal** .
Displays more softkeys from the calibration menu.
13. Press **Cal Kit** .
Displays a menu with softkeys for selecting and modifying a calibration kit.
14. Highlight PORT 1 in the display table and press **Type-N(m)** .
Selects the type-N(m) calibration kit.
15. Press **CAL**.
Displays a menu with softkeys for selecting a calibration for your measurement.
16. Press (**1-Port** or **User 1-Port** *).
Perform a calibration using type-N(f) standards.
Selects a one-port calibration.

* For HP 8712ES/14ES analyzers only

Determining the Electrical Delay of the Calibration Short

- Steps 17–21 select the calibration kit for each of test set PORTS 2–4 at your calibration reference plane.
- Displays a menu with softkeys for selecting a calibration for your measurement.
- Displays more softkeys from the calibration menu.
- Displays a menu with softkeys for selecting and modifying a calibration kit.
- Selects the 3.5 mm calibration kit for PORT 2.
- Selects the 3.5 mm calibration kit for PORTS 3–4.
- Steps 22–24 determine the electrical delay of the 3.5 mm short. This delay value will be used later in this procedure.
- Displays a menu with softkeys for selecting system options for your analyzer.
- Displays several screens of measurement channel settings, cal kit definitions, instrument settings, and instrument configuration.
- Displays the screens of the operating parameters information.
- 17.** Press **CAL**.
 - 18.** Press **More Cal**.
 - 19.** Press **Cal Kit**.
 - 20.** Highlight **PORT 2** in the display table and press **3.5 mm**.
 - 21.** Repeat step 20 for PORTS 3–4.
 - 22.** Press **SYSTEM OPTIONS**.
 - 23.** Press **Operating Parameters**.
 - 24.** Press **Next Screen** until the Cal Kit screen is displayed. In the “CAL KIT: Port 2” display, find the numerical value for the delay of the short. Record this value for use later in the procedure.

Determining the Electrical Delay of the Through Adapter for PORT 1 and PORT 2 of the Test Set

- Steps 25–38 determine the electrical delay of the through adapter. This delay value will be used later in this procedure.
- The through adapter will be used again later to join PORT 1 and PORT 2 flexible test cables during the through portion of the Test Set Cal.
- The short is part of the test setup for measuring the electrical delay of the through adapter.
- Displays a menu with softkeys for selecting the display format for your measurement.
- Measures the “round-trip” electrical delay of the through adapter.
- Displays a menu with softkeys to set markers, use marker functions, and marker search. Selects marker 1 as the active marker.
- Adds a marker to the data trace. This marker can be moved as part of the process of identifying a user-defined segment of the measurement trace.
- Selects Marker 2 as the active marker.
- Adds a marker to the data trace. This marker can be moved as part of the process of identifying a user-defined segment of the measurement trace.
- Displays a menu with softkeys for selecting various marker functions, such as marker math.
- Displays a menu with softkeys for selecting various calculations (statistics, for example) to be performed on a user-defined segment of the measurement trace.
- 25.** Connect a type-N(f)-to-3.5 mm(f) through adapter to the open end of the flexible test cable.
 - 26.** Add a 3.5 mm(m) short to the open end of the adapter.
 - 27.** Press **FORMAT**.
 - 28.** Press **Delay**.
 - 29.** Press **MARKER**.
 - 30.** Position marker 1 to the left edge of the measurement trace.
 - 31.** Press **2:**.
 - 32.** Position marker 2 to the right edge of the measurement trace.
 - 33.** Press **Marker Functions**.
 - 34.** Press **Marker Math**.

35. Press **Statistics**.

Measures a user-defined segment of the measurement trace. Displays the mean and other calculations.

36. Record the mean value, located in the upper right corner of the display.

The mean value is the “round-trip” electrical delay of the through adapter.

37. Divide the mean value by 2.

Calculates the “one-way trip” electrical delay of the through adapter.

38. Subtract the electrical delay of the calibration short (recorded earlier). The difference is the electrical delay of the adapter. Record this value for use later in the procedure.

The calibration short electrical delay is subtracted because the short is not used with the through adapter during the Test Set Cal.

39. Remove the short from the adapter.

40. Connect the flexible test cable between test set PORT 1 and the ANT port of the DUT.

To view the test setup, refer to [Figure 4-8 on page 4-44](#).

Creating a Modified Cal Kit Buffer for the Through Adapter

41. Press **CAL**.

Steps 41–47 modify the PORT 1 calibration kit definition of the through-standard. This is done by entering the electrical delay of the through adapter.

Displays a menu with softkeys for selecting a calibration for your measurement.

42. Press **More Cal**.

Displays more softkeys from the calibration menu.

43. Press **Cal Kit**.

Displays a menu with softkeys for selecting and modifying a calibration kit.

44. Highlight PORT 1 and press **Modify Type-N(m)**.



Selects the type-N(m) calibration kit for modifying.

45. Press **Thru**.

Allows you to modify the characteristics of the through calibration standard in your calibration kit.

- 46.** Press **Delay**.
Allows you to modify the delay characteristic of the through calibration standard in your calibration kit.
- 47.** Enter the electrical delay of the adapter (recorded earlier in step 38).
Use the keypad and softkeys to enter the numerical value of the electrical delay of the adapter.

Saving, Defining, and Assigning User Cal Kit A

- 48.** Press **Prior Menu**.
Displays the previous menu on the analyzer display.
- 49.** Press **Mod Kit SaveRecall**.
Displays a menu with softkeys for saving, recalling, presetting, and describing a user calibration kit.
- 50.** Highlight Cal Kit A and press **Save**.
Saves the modified cal kit buffer for the through adapter as Cal Kit A.
- 51. Optional:** press **Add Kit Description** and enter your calibration kit description.
To enter the cal kit description, it is fastest and easiest to use a keyboard connected to the analyzer's DIN KEYBOARD connector. (If you don't have a keyboard, you can use the analyzer's   keys or the front panel knob and the **Select Char** key to select and enter characters from the top of the analyzer's display. Press **Enter** when done.)

Creating Another Modified Cal Kit Buffer for the Through Adapter



- 52.** Press **CAL**.
Displays a menu with softkeys for selecting a calibration for your measurement.

- 53.** Press **More Cal** .
Displays more softkeys from the calibration menu.
- 54.** Press **Cal Kit** .
Displays a menu with softkeys for selecting and modifying a calibration kit.
- 55.** Highlight PORT 2 and press **Modify 3.5 mm** .
Selects the 3.5 mm calibration kit for modifying.
- 56.** Press **Thru** .
Allows you to modify the characteristics of the through calibration standard in your calibration kit.
- 57.** Press **Delay** .
Allows you to modify the delay characteristic of the through calibration standard in your calibration kit.
- 58.** Enter the electrical delay of the through adapter (recorded earlier in step 38).
Use the keypad and softkeys to enter the numerical value of the electrical delay of the through adapter.

Saving, Defining, and Assigning User Cal Kit B

- Steps 59–61 save (and automatically assign) the modified calibration kit buffer as a user-defined calibration kit for PORT 2.
- 59.** Press **Prior Menu** .
Displays the previous menu on the analyzer display.
- 60.** Press **Mod Kit SaveRecall** .
Displays a menu with softkeys for saving, recalling, presetting, and describing a user calibration kit.
- 61.** Highlight Cal Kit B and press **Save** .
Saves the modified cal kit buffer for the through adapter as Cal Kit B.

62. Optional: press **Add Kit Description** and enter your calibration kit description.

To enter the cal kit description, it is fastest and easiest to use a keyboard connected to the analyzer's DIN KEYBOARD connector. (If you don't have a keyboard, you can use the analyzer's   keys or the front panel knob and the **Select Char** key to select and enter characters from the top of the analyzer's display. Press **Enter** when done.)

Performing the Test Set Cal

63. Press **CAL**.

Steps 63–69 perform the Test Set Cal.

Displays a menu with softkeys for selecting a calibration for your measurement.

64. Press **Test Set Cal**.

Displays a menu with softkeys for selecting a Test Set calibration and a SelfCal for your measurements.

65. Press **Create "TSET_CAL"**.

Displays a menu with softkeys for selecting the number of test-set ports you will use in the Test Set Calibration.

66. Press **4 Ports** to select the number of test set ports you'll be using to make your measurements in this example.

Selects four as the number of test-set ports that will be used in the Test Set Cal.

67. For HP 8712ES/14ES analyzers only: press (**2-Port** or **Enh Resp, 1-Port**).

Press **2-Port** if you want to select a two-port Test Set Cal. This calibration provides the greatest measurement accuracy and can be used with all S-parameter measurements.

Press **Enh Resp, 1-Port** if you want to select an enhanced response calibration (for S_{21} and S_{12} measurements) or a one-port calibration (for S_{11} and S_{22} measurements).

68. Follow the onscreen instructions for connecting the mechanical standards from the calibration kit. When prompted to connect a through between PORTS 1 and 2, use the type-N(f)-to-3.5 mm(f) adapter between the PORT 1 test cable and the PORT 2 test cable. When prompted to connect a through between PORTS 3 and 4, connect the PORT 3 test cable directly to PORT 4.

69. Press **All Stds Done** when you have finished measuring all the opens, shorts, loads, and throughs.

Completes the Test Set Cal process. Displays a menu with softkeys for selecting a SelfCal for your measurements.

Selecting the SelfCal Routine

For HP 8712ES/14ES analyzers using a 2-Port calibration only:

70. Note that by default, **2-Port Cal** is toggled to ON. This automatically selects the 2-Port SelfCal. If you want to select an Enhanced Response/1-Port SelfCal, go to step 72.

71. If you want the 2-Port SelfCal to remove systematic errors caused by crosstalk, toggle **Isolation** to ON.

72. To select an Enhanced Response/1-Port SelfCal, toggle **2-Port Cal** to OFF.

Steps 70–74 select the SelfCal routine.

For HP 8712ES/14ES analyzers only:
If the Test Set Cal was done using a two-port calibration, you have two choices for the type of SelfCal to be performed:

- Enhanced Response/1-Port
- 2-Port

The enhanced response/1-port calibration is faster with less accuracy. The two-port calibration is slower (requires extra measurement steps) with greater accuracy.

For more information about the 2-Port calibration and the enhanced response/1-port calibration, refer to [“Test Set Cal for the HP 8712ES and HP 8714ES Analyzers”](#) on page 4-14 and the analyzer’s *User’s Guide*.

For more information about the **Isolation** key, refer to Chapter 6 in the analyzer’s *User’s Guide*.

When **2-Port Cal** is toggled to OFF, an Enhanced Response/1-Port SelfCal is automatically selected.

Test Set Cal and SelfCal
Test Set Cal Examples

For all analyzers:

73. Press **SelfCal Timer** and set the SelfCal time interval to the desired amount of time (the default interval is 60 minutes).

Allows you to input the interval of time desired between automatic SelfCals.

74. Press **Periodic SelfCal** .

Initiates a SelfCal on the currently selected ports and turns on the automatic SelfCal feature.

*For HP 8712ES/14ES analyzers only.

NOTE

Changing sweep frequencies (and other source parameters) may affect your calibration, reducing measurement accuracy. Refer to [“Setting Up the Measurement Parameters” on page 4-5](#) for more information.

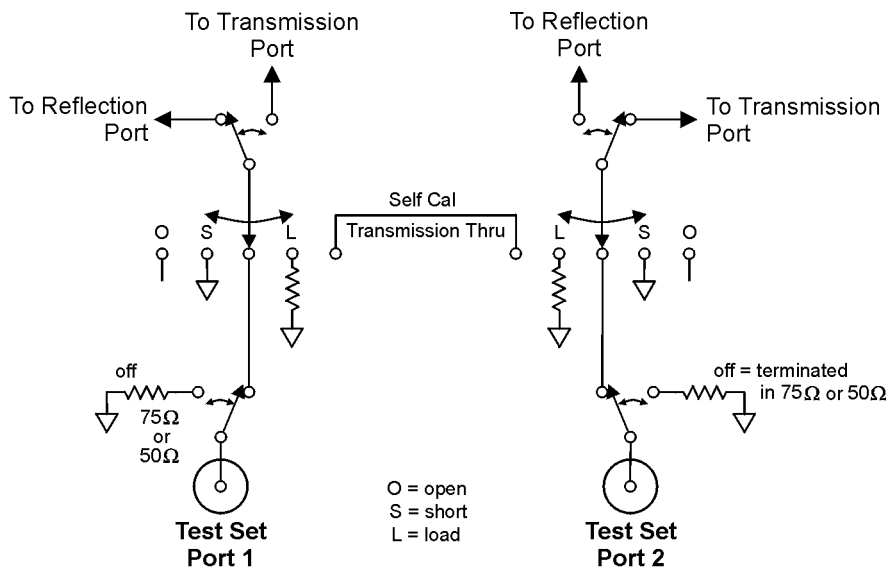
Test Set Cal and SelfCal: Theory of Operation

Adding a multiport test set to the analyzer degrades raw performance of the test system as well as introduces drift. Test Set Cal provides the vector error correction that allows the system to achieve good performance. A Test Set Cal is a calibration that is performed on a regular, but infrequent basis. The results of the Test Set Cal are used by the SelfCal feature to remove the drift associated with the hardware of the test set and analyzer to return the multiport system to an accurately calibrated state.

There are two steps to the Test Set Cal:

- The first step requires you to connect mechanical calibration standards (from a calibration kit) and your own through-cables to the calibration reference plane. This step is initiated by pressing **CAL** **Test Set Cal** **Create "TSET_CAL"** on the analyzer. Onscreen instructions lead you through this first part of the Test Set Cal. The analyzer measures the known mechanical reference standards and uses those measurements to compute error correction coefficients.
- The second step occurs once you are done connecting the mechanical calibration standards and have pressed the **All Stds Done** key. The multiport test set contains electronically switched open, short, load, and through standards behind each port. (See [Figure 4-9 on page 4-56](#). This illustration depicts a two-port test set. The same internal standards are also included behind *every* port of your test set.) These standards are very stable, yet their calibration definitions are not known like the mechanical standards. During this second step, the analyzer makes a measurement of each internal standard and then, using the error coefficients that were computed from the measurements of the mechanical standards, derives a very accurate calibration definition for each internal standard. The results of the Test Set Cal are stored in a file called "TSET_CAL.CAL" on the analyzer's non-volatile RAM disk. Once this has been done, the internal standards act as "transfer standards" for future automatic calibrations called SelfCals.

Figure 4-9 Internal Transfer Standards



pr618c

A SelfCal is an automatic measurement of the test set internal standards that allows the system to remove system drift that occurs due to environmental changes such as temperature. SelfCal allows the multiport system to recalibrate itself without having to disconnect the DUT or connect any additional external standards or cables to the system.

A SelfCal can be initiated by pressing **CAL** Test Set Cal

SelfCal Once, but it is recommended that you use the Periodic SelfCal and SelfCal Timer keys to set up the analyzer to automatically perform a SelfCal at regular, frequent time intervals. If the operating temperature of the analyzer and test set is within the specified range (refer to Chapter 8), the recommended time interval is about once an hour. See “SelfCal Details” on page 4-58 for more information on this subject.

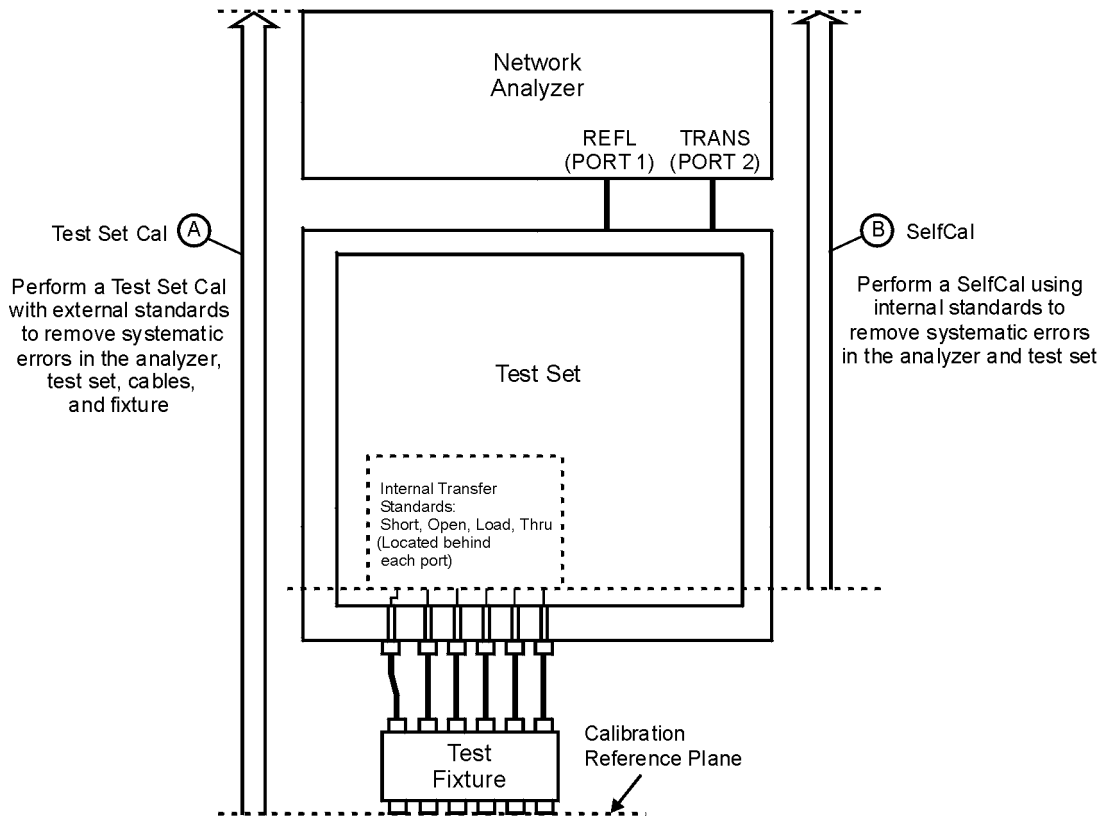
CAUTION

Performing a Test Set Cal will effectively calibrate out the initial effects of any external cabling and/or test fixtures. However, it must be noted that although the SelfCal can remove drift internal to the measurement system, it *cannot* remove any drift associated with cables, test fixtures and connections beyond the internal transfer standards.

As shown in Figure 4-10, the Test Set Cal initially removes the effects of drift associated with hardware in the area designated by arrow “A.” SelfCal can only remove the effects of drift from the area designated by arrow “B.”

Drift can be minimized by controlling the environmental temperature and humidity, and by using high quality connectors, semi-rigid cables, and fixturing that reduces cable movement to a minimum.

Figure 4-10 **Drift Removal: Test Set Cal and SelfCal**



pt65e

SelfCal Details

NOTE

For HP 8712ES/14ES analyzers only:

If the Test Set Cal was done using a two-port calibration, you can select the type of SelfCal to be performed. Pressing **CAL** **Test Set Cal** gives you access to the following two SelfCal choices:

- Enhanced Response/1-Port
- 2-Port Cal

Note that by default, **2-Port Cal** is toggled to ON. This automatically selects the 2-Port SelfCal. If you want the 2-Port SelfCal to remove systematic errors caused by crosstalk, toggle **Isolation** to ON. To select an Enhanced Response/1-Port SelfCal, toggle **2-Port Cal** to OFF.

Choosing a two-port calibration for the SelfCal gives you the greatest measurement accuracy. However, choosing the enhanced response/1-port calibration for the SelfCal, though not as accurate as a two-port calibration, allows faster measurement speeds. Therefore, if measurement speed is of more importance than highest accuracy, you may want to choose the enhanced response/1-port calibration for the SelfCal.

Whenever a Test Set Cal is performed, SelfCal arrays are automatically updated every time you change your port selection to a port that has been calibrated with a Test Set Cal. In order to further minimize the small delay in measurements that a SelfCal can introduce, the SelfCal arrays can be updated by one of the four processes listed below.

- SelfCal arrays are recalled from memory: when returning to a previously selected measurement configuration, the analyzer finds that the master calibration (a previously performed SelfCal, specified by the measurement type and ports selected) for that configuration has been saved. It also finds that the measurements of the test set internal standards, used to compute the master calibration, occurred less than one SelfCal Timer interval ago. The master calibration is retrieved from memory, allowing measurements to begin immediately.

Stored SelfCal data is not accessible by the user. It is valid only for the time interval set by the SelfCal Timer and is thus not appropriate for long-term (disk) storage.

- A “compute-only” SelfCal: when using a newly selected measurement configuration, the analyzer finds the corresponding internal standards in the test set were measured (during other SelfCals) less than one SelfCal Timer interval ago. A new master calibration is computed and then interpolated to current sweep conditions.
- A “quick” SelfCal: when returning to a previously selected measurement configuration, the analyzer finds one or more (but not all) of the corresponding internal standards in the test set were measured too long ago for best accuracy (more than one SelfCal Timer interval ago). The analyzer remeasures one or more (but not all) of the test set internal standards. Master cals are recomputed and then interpolated to current sweep conditions.
- A “full” SelfCal: when using a newly selected measurement configuration or when returning to a previously selected configuration, the analyzer finds that the corresponding internal standards in the test set were measured too long ago for best accuracy (more than one SelfCal Timer interval ago). The analyzer remeasures all of the test set internal standards for the ports selected in the current measurement. Master cals are recomputed and then interpolated to current sweep conditions.

The analyzer will automatically determine which of the above processes is necessary to update the SelfCal arrays whenever SelfCal is invoked. The following sections, “[Periodic SelfCal](#)” and “[User-Initiated SelfCals](#),” describe when and how SelfCal is initiated.

NOTE

When the analyzer measures the test set internal standards during a “full” SelfCal or a “quick” SelfCal, the data from the measurements and an associated time stamp are stored within the analyzer.

Periodic SelfCal

The following discussion describes how and when SelfCals are performed when you have enabled the SelfCal timer function using the `Periodic SelfCal` key.

Once you have set your SelfCal timer to the desired interval with the `SelfCal Timer` key and pressed the `Periodic SelfCal` key, the timer clock starts. For the following discussion, assume that you have successfully performed a Test Set Cal on ports 1 through 6, that you have set the timer to 60 minutes, and have just pressed the `Periodic SelfCal` key.

During the next 60 minutes, anytime you switch to a new port (1 through 6), the analyzer checks the time stamp for the port you have just switched to and determines if *all* of the internal standard measurements associated with this port were made within the timer interval of 60 minutes. If so, one of the following may occur:

- if a master calibration of the same configuration resides in memory, it is automatically retrieved. No message appears on the analyzer's display.
- the analyzer performs a “compute-only” SelfCal and the message `SelfCal: calculating correction coefficients...` appears briefly on the analyzer's display.

If one or more (but not all) of the internal standard measurements associated with this port were made within the timer interval of 60 minutes, the analyzer performs a “quick” SelfCal and the message `SelfCal: calculating correction coefficients...` appears briefly on the analyzer's display.

When the 60 minute interval has lapsed, and a port is selected whose internal standard measurements were not remeasured during the time interval, the analyzer will automatically initiate a full SelfCal, indicated by an onscreen message similar to `SelfCal in progress...`, on the currently selected ports.

NOTE

SelfCals are *not* automatically initiated on currently unused ports. A port is never automatically calibrated unless it is selected— even if the time interval has been exceeded.

NOTE

During a “full” SelfCal and a “quick” SelfCal, the analyzer temporarily restores the instrument parameters that were set at the time of the Test Set Cal. The analyzer returns to the current measurement parameters as soon as the SelfCal is complete.

User-Initiated SelfCals

A full SelfCal on the currently selected ports is immediately initiated when either of the following keys are pressed:

- Periodic SelfCal
- SelfCal Once

A full SelfCal of *all* ports that were calibrated for the current Test Set Cal is initiated with the SelfCal All Ports key. Using this key minimizes interruptions each time you select a port.

Pressing the SelfCal Once key initiates a full SelfCal on the currently selected ports and turns off the SelfCal timer function until you press the Periodic SelfCal key.

NOTE

See the example program titled “MPCALSRQ.” This IBASIC/RMB program requires an HP 8712ET/ES or HP 8714ET/ES analyzer. The program configures the analyzer’s status reporting so that an SRQ is issued whenever a SelfCal is initiated.

Example programs can be found in the following four locations:

- Example Programs Disk, HP 8712ET/ES and HP 8714ET/ES (DOS format): HP part number 08714-10003
- Example Programs Disk, HP 8712ET/ES and HP 8714ET/ES (LIF format): HP part number 08714-10004
- *Example Programs Guide, HP 8712ET/ES and HP 8714ET/ES*: HP part number 08714-90016
- Web site <http://www.hp.com> or <http://www.agilent.com>. Use the search function to find Web pages related to 8712 example programs.

SelfCal Lockouts

Keys pressed while a SelfCal is in progress are queued so that they will execute later, after the SelfCal is completed. The HP-IB bus is also held off during SelfCal. System integrators may want to enable the analyzer “calibrating” SRQ to manage support software. The “calibrating” SRQ may be set on rising edge or trailing edge to indicate the beginning or end of SelfCals.

To abort a SelfCal once it begins, cycle the analyzer power.

Typical SelfCal Time Requirements

The following table shows typical SelfCal times required for a transmission measurement using various port combinations and instrument settings. In general, a SelfCal may be needed once an hour for each port combination being measured.

Table 4-1 Typical SelfCal Times For a Transmission Measurement When Using One Measurement Channel

Number of Measurement Points	Sweep Time	Calibration Type			
		Enhanced Response		2-Port	
		Adjacent Port Pairs *	Nonadjacent Port Pairs **	Adjacent Port Pairs *	Nonadjacent Port Pairs **
101	95 ms	1.65 s	2.95 s	4.5 s	7.05 s
201	108 ms	1.9 s	3.5 s	5.5 s	8.5 s
201	1400 ms	9.5 s	16.5 s	20.5 s	34.5 s
401	195 ms	3.0 s	5.2 s	8.2 s	12.8 s
801	369 ms	5.0 s	8.6 s	13.6 s	21.4 s
1601	716 ms	8.8 s	15.4 s	24.2 s	38.2 s

* Adjacent port pairs are any of these pairs: [1, 2], [3, 4], [5, 6], [7, 8], [9, 10], [11, 12].

** Nonadjacent port pairs are any other pairs not in the list above.

The SelfCal time generally depends on the number of measurement points involved and the sweep time. Sweep time may be manually selected or can be set automatically by the analyzer. For example, a 201 point measurement with a narrow (250 Hz) system bandwidth automatically sets sweep time to 1400 ms. With these settings on pair ports, an enhanced response SelfCal requires 9.5 seconds while a 2-port SelfCal requires 20.5 seconds. Typically, for the most accurate SelfCal, more measurement points and slower sweep times are necessary, increasing the time required.

SelfCal Behavior When Saving and Recalling Instrument States

The following table shows if a SelfCal will automatically occur when an instrument state is recalled.

Table 4-2 SelfCal Behavior When Recalling Instrument States

Recalled Instrument-State Settings				Will SelfCal Occur at Instrument State Recall?
Calibration Choice	SelfCal Once Enabled	Periodic SelfCal Enabled	SelfCal Arrays Stale ¹ ?	
<i>Traditional Analyzer Calibrations:</i> <ul style="list-style-type: none"> • Default 1-Port • Default 2-Port² • Default Response • User 1-Port • User 2-Port² • User Response 	Don't Care	Don't Care	Don't Care	No
Test Set Cal	On ³	Off	Don't Care	No
Test Set Cal	Off	On	No (and previous SelfCal arrays exist)	No
Test Set Cal	Off	On	No (and previous SelfCal arrays do <i>not</i> exist)	Yes
Test Set Cal	Off	On	Yes	Yes

¹ SelfCal arrays are “stale” when the analyzer finds that the corresponding internal standards in the test set were measured too long ago for best accuracy (more than one SelfCal-timer interval ago).

² HP 8712ES/14ES analyzers only.

³ Toggling **SelfCal Once** to ON ensures that a SelfCal will not occur after an instrument state is recalled. This is useful if you want to manually control when full SelfCals occur. See [“SelfCal Details” on page 4-58](#) for the different types of SelfCals.

To ensure that valid SelfCal arrays exist after recalling an instrument state, you can define the state by pressing **(SAVE RECALL)** **Define Save**, and toggling **Cal** to ON. In this case, the SelfCal arrays are saved along with the instrument-state settings. If the instrument state is then recalled within the time interval set by the SelfCal timer, valid SelfCal arrays are available without further computations or measurements. This may result in a faster instrument-state recall than if one of the SelfCals occurs. See [“SelfCal Details” on page 4-58](#) for the different types of SelfCals.

Calibrated-Port Switching Speed

After SelfCal has been performed on all port combinations in your measurement configuration, the analyzer is ready to switch quickly between different multipoint measurements. The following table shows how fast the analyzer can switch between measurements when using the Fast Recall feature (press **(SAVE RECALL)** and toggle **Fast Recall** to ON). A requirement for these switch speeds is that SelfCal for the recalled state has occurred less than one SelfCal Timer interval ago or that the Periodic SelfCal feature is off.

Table 4-3 **Calibrated-Port Switching Speed**

Number of Measurement Points	Calibration Type	
	1-Port/Enhanced Response	2-Port
101	0.55 s	0.65 s
201	0.65 s	0.80 s
401	0.75 s	1.05 s
801	1.05 s	1.20 s
1601	1.55 s	1.80 s

NOTE

See the example program titled “MPSVRCL.” This IBASIC/RMB program requires an HP 8712ET/ES or HP 8714ET/ES analyzer. The program saves three instrument states, each measuring various ports in ALT sweep mode. Fast recall is enabled so that subsequent recalls require only a single keypress.

Example programs can be found in the following four locations:

- Example Programs Disk, HP 8712ET/ES and HP 8714ET/ES (DOS format): HP part number 08714-10003
 - Example Programs Disk, HP 8712ET/ES and HP 8714ET/ES (LIF format): HP part number 08714-10004
 - *Example Programs Guide, HP 8712ET/ES and HP 8714ET/ES*: HP part number 08714-90016
 - Web site <http://www.hp.com> or <http://www.agilent.com>. Use the search function to find Web pages related to 8712 example programs.
-

Factory Test Set Cal

A Test Set Cal is performed at the factory just prior to shipment of your multiport test set. The factory Test Set Cal is performed on all ports of your test set using the analyzer's preset condition over the full frequency range of the test set:

- 3 MHz to 2200 MHz (HP 87050E)
- 3 MHz to 1300 MHz (HP 87075C)

This calibration and its associated instrument state are stored on a floppy disk and shipped with the test set.

CAUTION

This calibration should only be used if you will be connecting test devices directly to the front panel connectors of the test set. Since most test setups consist of cables and/or test fixtures that are connected between the DUT and the test set, you should perform your own calibration using your specific operating parameters, mechanical standard type, and the appropriate calibration reference plane.

To use the Test Set Cal that was shipped with your test set:

1. Insert the Test Set Cal floppy disk into the analyzer's disk drive and press **SAVE RECALL** **Select Disk** **Internal 3.5" Disk**.
2. Use the front panel knob to highlight the file called "DEFAULT.CAL".
3. Press **Prior Menu** **Recall State**. The analyzer will copy the file into the analyzer's non-volatile memory. A message will appear that says the recalled Test Set Cal does not match current settings. This will be remedied by recalling the instrument state file from the disk as described in the next step.
4. Press **SAVE RECALL** and highlight the file called "DEFAULT.STA", and then press **Recall State**.

NOTE

The DEFAULT.STA file was created in the factory on a network analyzer using firmware revision E06.00 or later. If your analyzer has an earlier firmware revision, a message will appear warning you that some features are not available. However, there is nothing in the DEFAULT.STA file that will cause any problems on any analyzer.

5. Press **CAL** **Test Set Cal** to invoke the calibration.

Using Multiple Test Set Cals

For speed and convenience, it is desirable to use only one Test Set Cal, and you should be aware that using multiple Test Set Cals will degrade your throughput. However, there may be situations where it is desired or necessary to do so. For example, you may want to have both a wide frequency span and a narrow frequency span Test Set Cal, both made using 201 or more measurement points. The wide frequency span Test Set Cal could be your general-purpose calibration, helping to maximize throughput when testing devices over a wide frequency range. However, narrowing your measurement's frequency span while using this Test Set Cal might result in too few calibration points to achieve the desired accuracy. This is when a narrow frequency span Test Set Cal, also made using 201 or more measurement points, would be valuable. It would help to maximize accuracy when used for testing devices over a narrow frequency range.

The following example describes the steps you would take to use two different Test Set Cals during a measurement sequence.

1. Set up the analyzer's parameters and select the calibration kit for the first Test Set Cal.
2. Perform the first Test Set Cal. The results of the calibration will be stored in the analyzer on the non-volatile RAM disk as a file called "TSET_CAL.CAL".
3. You must now make a copy of this calibration *before* performing your second Test Set Cal. You should copy this file to a uniquely-named file on either a floppy disk or the analyzer's internal non-volatile RAM disk. See "[Saving the Test Set Cal](#)" on page 4-15.

For example, store this calibration as a file called FIRST.CAL in the analyzer's non-volatile memory.

NOTE

It is not recommended that you use the analyzer internal volatile memory for storing this file. If you do, be aware that if you cycle the power on the analyzer, your file will be erased. If you do choose to use volatile memory, you should also make a copy of the file on either the non-volatile memory, or a 3.5" floppy disk.

4. It is a good idea to save the instrument state associated with your FIRST.CAL file as well. Press **SAVE RECALL** Define Save . Toggle **Inst State** to ON. Press **Save State** . Rename the file FIRST.STA.

5. Now set up the analyzer's parameters and select the calibration kit for the second Test Set Cal.
6. Perform the second Test Set Cal and save the new "TSET_CAL.CAL" file to another unique file such as SECOND.CAL. Also, save the instrument state associated with SECOND.CAL in SECOND.STA.
7. When making measurements that require the first Test Set Cal, you will need to recall the contents of the file FIRST.CAL to the TSET_CAL.CAL file before proceeding. And similarly, before making measurements that require the second Test Set Cal, you will need to recall the contents of the file SECOND.CAL to the TSET_CAL.CAL file.

For example, to recall FIRST.CAL into the TSET_CAL.CAL file, press **SAVE RECALL** **Select Disk** **Non-Vol RAM Disk** **Prior Menu** .

Now use the analyzer's front panel knob to highlight the FIRST.CAL file. Press **Recall State** . The contents of FIRST.CAL will be written into the TSET_CAL.CAL file. To ensure you are using the same parameters under which the calibration was performed, you should also restore the instrument state associated with the FIRST.CAL file.

Verifying the Calibration

To verify your Test Set Calibration, you can choose from any of the following methods:

[“Method #1: Calibration Check \(HP 8712ET/14ET only\)” on page 4-70](#)

[“Method #2: Measure an Alternate Set of Calibration Standards” on page 4-71](#)

[“Method #3: Measure a “Golden DUT”” on page 4-73](#)

Using any one of these calibration verification methods can be very useful for determining:

- the validity of your current measurements
- the correct SelfCal timer interval for your measurements
- the correct Test Set Cal interval for your measurements
- the stability of your external cabling and fixturing

For the best indication on whether your calibration is still valid, it is a good idea to perform a calibration verification immediately after you perform a Test Set Cal. Save the results from this initial calibration verification by plotting them to a printer or plotter. Compare these plots against future calibration verifications. Or, you may want to create your own numeric specification based on the calibration verification results. This specification can be used to evaluate subsequent calibration verification results. Comparing your own calibration verifications against each other will give you a more accurate view of any drift that may be occurring, and can help you determine the best SelfCal timing interval, as well as the best Test Set Cal interval.

CAUTION

Be aware that periodic SelfCals may affect the results of a calibration verification. For example, if your system performs an automatic full SelfCal just prior to a “good” calibration verification, it is possible that measurements made before the SelfCal was triggered were “bad” if your SelfCal timer interval is set too high. See [“Using Calibration Verification to Determine Calibration Intervals” on page 4-73](#).

Method #1: Calibration Check (HP 8712ET/14ET only)

The HP 8712ET/14ET analyzers have a calibration check feature that can compute and display corrected measurement residual errors that apply to your current instrument settings and calibrations. Your analyzer's *User's Guide* describes this feature in detail in Chapter 6, in the section titled "Checking the Calibration."

This method of verifying the calibration consists of following the analyzer prompts to connect mechanical standards to the currently used ports on the test set.

1. To initiate a calibration check, press **CAL** **Cal Check**
Do Cal Check.

CAUTION

It is recommended that you use a *different* set of calibration standards for the calibration check than the ones you used to perform the initial calibration. Be sure to connect the standards at the same calibration reference plane you used for the Test Set Cal.

2. Connect the standards as prompted.
3. After you have connected all the required standards, the analyzer computes the residual errors for the measurement.
4. Now you can use the selections under the **View Cal Check** key to view the residual errors.
5. To interpret the results of the Calibration Check, refer to your analyzer's *User's Guide* for illustrations of some typical error plots, or refer to the following table for typical values.

Error Term	HP 8712ET/14ET Typical Value*
Directivity	< -40 dB
Source Match (corrected)	< -30 dB
Source Match (uncorrected)	< -15 dB
Load Match	< -10 dB
Transmission Tracking	+ 0.1 to -0.1 dB
Isolation	< -70 dB (using Fine [15 Hz] system bandwidth)
Reflection Tracking	+ 0.1 to -0.1 dB

*Typical values include cables and fixtures. Your results will vary depending upon your cables, fixturing, and connector type.

If your error plots are similar to those in the analyzer's *User's Guide* and/or they fall into the typical values noted above, your calibration is probably valid. If your data looks bad or questionable, refer to ["If the Calibration Verification Data Is Bad"](#) on page 4-75.

Method #2: Measure an Alternate Set of Calibration Standards

This method of verifying the calibration consists of connecting an alternate set of mechanical standards to a currently-used port on the test set and performing the appropriate measurements. Use the analyzer's default format (Log Mag) —if necessary, press **FORMAT** **Log Mag**).

1. Perform (or recall) a Test Set Calibration for the currently used ports on the test set.

CAUTION

For this calibration verification method you must use a *different* set of calibration standards than the ones you used to perform the initial calibration. Be sure to connect the standards at the same calibration reference plane you used for the Test Set Cal.

2. Connect the open calibration-standard to the test set port.
3. Perform a reflection (S_{11} or S_{22}) measurement on the open calibration-standard. Your measurement result should be approximately 0.0 dB*.
4. Connect the short calibration-standard to the test set port.
5. Perform a reflection (S_{11} or S_{22}) measurement on the short calibration-standard. Your measurement result should be approximately 0.0 dB*.
6. Connect the load calibration-standard to the test set port.
7. Perform a reflection (S_{11} or S_{22}) measurement on the load calibration-standard. Your measurement result should be < -40 dB.
8. Connect the through cable between the test set ports.
9. Perform a transmission (S_{21} or S_{12}) measurement on the through cable. Your measurement result should be approximately 0.0 dB*.

If your measurement results fall into the typical values noted above, your calibration is probably valid. If your measurement results look bad or questionable, refer to [“If the Calibration Verification Data Is Bad” on page 4-75](#).

* Plus or minus the residual trace noise for your selected measurement parameters. The residual trace noise depends primarily on the analyzer resolution bandwidth. For example, typical trace noise through a test set is ± 0.04 dB for a narrow resolution bandwidth and ± 0.1 dB for a medium-wide resolution bandwidth. Other factors that influence measurement accuracy include measurement uncertainties and connector repeatability.

Method #3: Measure a “Golden DUT”

This method of verifying the calibration consists of connecting a “golden DUT” to the test set and performing the appropriate measurements. A “golden DUT” is a device whose performance characteristics are known to be good. It is recommended that the performance of the “golden DUT” be verified on an independent measurement system or systems. It is also recommended that the performance of the “golden DUT” be verified when it is installed in the target application for which it is designed.

1. Perform (or recall) a Test Set Calibration for the currently used ports on the test set.
2. Connect your “golden DUT” to your test setup.
3. Perform the appropriate measurements on the “golden DUT.”
4. Compare your actual measurement results to the expected measurement results of the “golden DUT.”
5. Make a decision about the validity of the calibration based on the comparison of the measurement results.

If your actual measurement results compare well with the expected measurement results of the “golden DUT”, your calibration is probably valid. If your measurement results look bad or questionable, refer to [“If the Calibration Verification Data Is Bad” on page 4-75](#).

Using Calibration Verification to Determine Calibration Intervals

A calibration verification can help you determine the best SelfCal and Test Set Cal intervals for your measurement environment.

Determine the Best SelfCal Interval

The default and recommended SelfCal timer interval is 60 minutes. However, your test setup and environment may dictate a shorter interval or allow a longer one. To determine the best SelfCal interval for your measurements:

1. Perform a Test Set Cal and then a calibration verification. Plot the results from the calibration verification for future comparisons.
2. Turn the SelfCal timer off by pressing **CAL** Test Set Cal SelfCal Once .

3. Periodically perform a calibration verification and compare the results to those obtained in [step 1](#). Keep track of the time that elapsed from the SelfCal performed in [step 2](#).
4. Note the time when the calibration verification results have drifted beyond what is acceptable for your measurements.
5. To verify that a SelfCal will remove the drift noted in [step 4](#), do a `SelfCal Once` or `SelfCal All Ports` and then do another calibration verification. The SelfCal should have removed the unacceptable drift. If it didn't, refer to "[If the Calibration Verification Data Is Bad](#)" on [page 4-75](#). Otherwise, continue with [step 6](#).
6. Use the `(CAL)` `Test Set Cal` `SelfCal Timer` keys to set your SelfCal interval to a value less than the time noted here.
7. Now turn the SelfCal timer on by pressing `(CAL)` `Test Set Cal` `Periodic SelfCal` to enable the automatic SelfCal at the best interval for your measurements. It is a good idea to check your calibrations periodically to ensure that you are making good measurements.

Determine the Best Test Set Cal Interval

The default and recommended Test Set Cal interval is 1 month, maximum. However, your test setup and environment may dictate a shorter interval or allow a longer one. To determine the best Test Set Cal interval for your measurements:

1. Perform a Test Set Cal and then a calibration verification. Plot the results from the calibration verification for future comparisons.
2. Periodically perform a calibration verification and compare the results to those obtained in [step 1](#). Keep track of the time that elapsed from the Test Set Cal performed in [step 1](#).
 - a. When performing a calibration verification in this case, always do a `SelfCal Once` first to ensure that just the accuracy of the Test Set Cal is being observed.
 - b. Be sure to select `Periodic SelfCal` again after performing the calibration verification.
3. If the data is bad, it may be an indication of what the proper Test Set Cal interval is for your measurement environment. See "[If the Calibration Verification Data Is Bad](#)" on [page 4-75](#) for other reasons that the calibration verification data may be bad.

If the Calibration Verification Data Is Bad

CAUTION

When you encounter a calibration verification with bad results, you should note that the accuracy of measurements made prior to the verification is questionable. There is no way to tell exactly when a calibration drifted from the last good calibration verification.

When you perform a calibration verification and the results are bad, use the following troubleshooting procedure to help you identify the problem.

1. Initiate a SelfCal by pressing the `SelfCal Once` key.
2. Perform the calibration verification again. If the results are now good, then the SelfCal timer may not have been on, or the interval may have been set too long. See [“Determine the Best SelfCal Interval” on page 4-73](#) for more information.
3. If the results from step 2 are still bad, then it probably means that the Test Set Cal was either originally bad, has drifted because of time or temperature, or has drifted due to external hardware that has been moved or flexed or has worn out.
4. Redo the Test Set Cal and then redo the calibration verification. If the results are good, then:
 - You may need to redetermine your Test Set Cal interval. See [“Determine the Best Test Set Cal Interval” on page 4-74](#) for more information.
 - Your external hardware, such as cables and fixturing, may not be stable enough. You can check this by performing a Test Set Cal, doing a calibration verification, flexing or moving your external hardware, and then performing another calibration verification for comparison.
 - Environmental parameters such as temperature and humidity may have affected your calibration. These parameters can have a detrimental effect on the stability of your calibrations. The SelfCal feature can remove drift due to temperature and humidity changes within the multiport system (analyzer + test set), but SelfCal cannot remove drift of any external hardware, such as cables and fixtures. See [Figure 4-10 on page 4-57](#).

Test Set Cal and SelfCal
Verifying the Calibration

5. If the results from step 4 are still bad, then:
 - Have your calibration standards checked. If you are using the recommended procedure of using a different set of standards for the Test Set Cal and the calibration verification, and the calibration verification is always bad, you may have some faulty standards.
 - If you continue to experience calibration verification problems, you should perform the operator's checks on both the analyzer and test set to see if they are performing as expected.
 - Contact the nearest Hewlett-Packard sales or service office for assistance if you are unable to identify the problem. (See [Table 8-11 on page 8-38.](#))

Calibration Kits

When performing a Test Set Cal, you must select calibration kits to match the ports at your calibration reference plane. The following section describes how to select calibration kits stored in the analyzer and how to create user-defined calibration kits.

Selecting a Calibration Kit Stored in the Analyzer

To select a calibration kit, press **CAL** **More Cal** **Cal Kit** and use the front panel knob or the up and down keys to highlight the desired port in the display table. Next, select the softkey for the connector type of your port, or press **More Cal Kits** and select the softkey for one of ten user-defined calibration kits (User Cal Kit A–J).

Test Set Cal and SelfCal
Calibration Kits

The following table shows the calibration kits that are stored in the analyzer.

Cal Kit Model Number	Impedance	Connector Type	For Use with Male Test Ports	For Use with Female Test Ports
HP 85039B	75 Ω	type-F	✓	✓
HP 85036B	75 Ω	type-N	✓	✓
HP 85036E	75 Ω	type-N		✓
HP 85032B	50 Ω	type-N	✓	✓
HP 85032E	50 Ω	type-N		✓
HP 85031B	50 Ω	APC-7	N/A	N/A
HP 85033D	50 Ω	3.5 mm	✓	✓
HP 85038A	50 Ω	7-16	✓	✓
HP 85038F	50 Ω	7-16	✓	
HP 85038M	50 Ω	7-16		✓

NOTE

By convention, calibration kits indicate the sex of the *port* with which they are used. For example, the default calibration kit for the analyzer is type-N *female* because the front panel RF ports are female (the calibration standards, in turn, have male connectors).

Creating a User-Defined Calibration Kit

A user-defined calibration kit is created by modifying a kit that is already listed under the Cal Kit menu and saving this modified kit as one of ten User Cal Kits (User Cal Kit A–J). (The original kit remains unchanged.) There are several situations that may require you to create a user-defined calibration kit:

- Your port has a connector type listed under the Cal Kit menu, but your calibration standards (such as a short) have different characteristics than the standard HP calibration kits.
- Your port has a connector type which does not correspond to one of the standard HP calibration kits.
- You are calibrating for a multiport device that has one or more noninsertable port pairs. Refer to [“Test Set Cal Examples” on page 4-20](#).

NOTE

If your port has a connector type which is not one of the selections under the Cal-Kit menu (TNC for example), you may want to select APC-7 as your port since it has nearly ideal characteristics. Next, modify the calibration-kit characteristics so they match those of the TNC standards that you will use, and store the user-defined kit as one of ten User Cal Kits (User Cal Kit A–J).

The following steps (explained later in detail) should be performed when creating a user-defined calibration kit file:

1. Determine the characteristics of the calibration standards you plan to use.
2. Create a user-defined calibration kit in either of the following ways:
 - Use the softkeys under the Modify Kit menu and store the calibration kit as one of ten User Cal Kits (User Cal Kit A–J).
 - Edit the ASCII file provided on the *Example Programs Disk* or create your own ASCII file, and download it into the analyzer as one of ten User Cal Kits (User Cal Kit A (default) or User Cal Kit B–J).

NOTE

Calibration kit definitions *must* be in DOS format. LIF format is not supported for calibration kit definitions.

3. Verify performance.

Step 1: Determine the Characteristics of the Calibration Standards

Determine the characteristics of the calibration standards you plan to use. In particular, these are the characteristic impedance (Z_0), the delay, and the loss. These characteristics are common for the four supported standard types used by the analyzer. Additionally, the capacitive model parameters, C_0 , C_1 , C_2 , and C_3 are necessary for fully defining the open. These electrical characteristics can be mathematically derived from the physical dimensions and material of each calibration standard or from its actual measured response.

About Calibration Standards. A calibration **standard** is a specific, well-defined, physical device used to determine systematic errors. Each standard has a precisely known or predictable magnitude and phase response as a function of frequency. The response of each standard is mathematically defined in the error models used by the network analyzer.

A standard **type** is one of four basic types that define the form or structure of the model to be used with that standard (i.e., short, open, load, and through).

Standard **characteristics** are the numerical, physical characteristics of the standards used in the model selected.

Typical calibration standards are throughs, opens, shorts, and loads. All of these standards offer the advantage of broadband frequency coverage. They are used singly or in combination, depending on the type of calibration.

Open	defines the standard type of an open circuit.
Short	defines the standard type of a short circuit.
Load	defines the standard type of a load.
Through	defines the standard type as a transmission line of specified length. The through has zero length when the two test ports can be connected directly together.

For all four standard types, the **Z_0** (characteristic impedance), **Delay**, and **Loss** must be set. For an open, **C_0** , **C_1** , **C_2** , and **C_3** , the capacitive model parameters, must also be set.

NOTE

When creating a user-defined calibration kit, if a standard is not defined, the currently defined values for that standard will be retained. The best practice is to define all of your standards and characteristics when creating a user-defined calibration kit.

Z₀ Z₀ is usually set to the system characteristic impedance (usually either 50 or 75 ohms).

Delay Delay is equivalent to a uniform length of transmission line between the standard being defined and the actual measurement plane. For an open, short, and load, the DELAY is entered as the one-way travel time from the measurement plane to the standard in seconds. For a through, the DELAY is entered as the one-way travel time between the measurement planes in seconds. Delay can be measured or determined from the precise physical length of the standard, divided by the velocity factor.

CAUTION

If two ports will be connected with a through during calibration, the calibration kits for each of these ports must be modified using the identical delay value for the through.

Loss Loss is used to specify energy loss, due to skin effect, along a one-way length of coaxial delay. The value of loss is entered as ohms/second at 1 GHz. For many applications, the loss value can be set to zero without noticeable degradation. To compute the loss of your device, measure the delay in seconds and the loss in dB at 1 GHz. Then, compute:

$$\text{Loss}\left(\frac{\Omega}{s}\right) = \frac{\text{loss (dB)} \times Z_0(\Omega)}{4.3429(\text{dB}) \times \text{delay}(s)}$$

C₀, C₁, C₂, C₃ At high frequencies, an open rarely has perfect reflection characteristics because fringing capacitance causes phase shift that varies with frequency.

These effects are impossible to eliminate, but the calculation built into the analyzer includes an open-circuit capacitance model. This capacitance model is a third-order polynomial as a function of frequency, where the polynomial coefficients are user-definable.

The capacitance model equation is:

$$C(f) = (C_0) + (C_1 * f) + (C_2 * f^2) + (C_3 * f^3)$$

where f is the measurement frequency.

The terms in the equation are defined when specifying the open as follows:

- C₀ is used to enter the C₀ term, which is the constant term of the third-order polynomial and is expressed in Farads.
- C₁ is used to enter the C₁ term, expressed in F/Hz (Farads/Hz).
- C₂ is used to enter the C₂ term, expressed in F/Hz².
- C₃ is used to enter the C₃ term, expressed in F/Hz³.

For further information on calibration kits and determining standard characteristics, refer to HP Product Note 8510-5A (HP Publication No. 5956-4352). To view this product note on the Web, go to <http://www.tmo.hp.com> and select "Application Note Library."

Step 2: Create a User-Defined Calibration Kit

A user-defined calibration kit can be created by either of these two methods:







- Method A: use the softkeys under the Modify Kit menu.

This method provides a convenient and quick way to modify calibration kit standards. Use this method during the development of new calibration kit standards.

- Method B: use an ASCII file.

This method provides a way to manage calibration kit descriptions in separate files. Use this method to keep permanently filed descriptions of your calibration kits.

Method A: Use the softkeys under the Modify Kit menu.

Press **CAL** **More Cal** **Cal Kit** and use the front panel knob or the   keys to highlight the desired port in the display table. Select the softkey that matches the connector type of your port. Next, press **Modify (connector type)**, select the softkey of the appropriate calibration standard, select the softkey of the characteristic you want to modify, and enter the data using the keypad and softkeys. When you're done modifying all of the appropriate calibration standards and characteristics, press **Prior Menu**, **Mod Kit SaveRecall**. Use the front panel knob or the   keys to highlight the desired User Kit in the display table and press **Save**. The display table will now indicate that your user-defined calibration kit applies to the port you highlighted earlier. If you want to enter a calibration kit description in the display table, press **Add Kit Description**. Use a keyboard connected to the analyzer's DIN KEYBOARD connector to enter the description. (If you don't have a keyboard, you can use the analyzer's   keys or the front panel knob and the **Select Char** key to select and enter characters from the top of the analyzer's display. Press **Enter** when done.) User Cal Kits A–J are saved in nonvolatile memory in the method just described. Saving the instrument state also saves the Cal Kit.

Method B: Use an ASCII file. You can edit the ASCII file provided on the *Example Programs Disk* or create your own ASCII file. (Remember that these files are compatible with MS-DOS, and thus, you could use any IBM-compatible PC and a text editor that can modify ASCII files. Just be sure to include the line numbers as if it were an IBASIC program.) You can't read calibration kit data from the analyzer as an ASCII file.

Test Set Cal and SelfCal Calibration Kits

ASCII file example. The example program, "CALKIT," provided on the *Example Programs Disk*, is listed below. Please note that the program allows you to specify storing the downloaded file as one of ten User Cal Kits (User Cal Kit A–J) in the analyzer. If not specified, however, the file is stored in Cal Kit A. When reading the calibration kit file, the analyzer recognizes only the information after the "!" and ignores everything after a "\$". You can add comments after a "\$". The first line of a calibration kit file *must* contain a "!" with a "\$" directly after it. No characters are allowed between the "!" and the "\$" on the first line of a calibration kit file.

```
10  !$ Standard Definitions for HP 85054B Precision Type-N Cal
Kit.
20  !
30  !$ Definitions for 50 Ohm jack (FEMALE center contact) test
40  ! NAME: Load this file into the User Cal Kit selected in the
next line.
50  ! Kit B $ Select Cal Kit B
60  !$ ports, plug (MALE center contact) standards.
70  !
80  ! OPEN: $ HP 85054-60027 Open Circuit Plug
90  !     Z0 50.0 $ Ohms
100 !     DELAY 57.993E-12 $ Sec
110 !     LOSS 0.8E+9 $ Ohms/Sec
120 !     C0 88.308E-15 $ Farads
130 !     C1 1667.2E-27 $ Farads/Hz
140 !     C2 -146.61E-36 $ Farads/Hz^2
150 !     C3 9.7531E-45 $ Farads/Hz^3
160 !
170 ! SHORT: $ HP 85054-60025 Short Circuit Plug
180 !     Z0 50.0 $ Ohms
190 !     DELAY 63.078E-12 $ Sec
200 !     LOSS 8.E+8 $ Ohms/Sec
210 !
220 ! LOAD: $ HP 00909-60011 Broadband Load Plug
230 !     Z0 50.0 $ Ohms
240 !     DELAY 0.0 $ Sec
250 !     LOSS 0.0 $ Ohms/Sec
260 !
270 ! through: $ HP 85054-60038 Plug to Plug Adapter
280 !     Z0 50.0 Ohms
290 !     DELAY 196.0E-12 $ Sec
300 !     LOSS 2.2E+9 $ Ohms/Sec
310 !
320 END
```

How to download a calibration kit ASCII file. After creating a calibration kit ASCII file, you can download the program by following these steps:

NOTE

Calibration kit definitions *must* be in DOS format. LIF format is not supported for calibration kit definitions.

1. Insert the disk with the calibration standard definitions into the analyzer's built-in disk drive.
2. Press **SAVE RECALL** and note the first word of the second line on the screen. If it is not "INT:\\" (for internal disk), press **Select Disk** **Internal 3.5" Disk** **Prior Menu** .
3. Highlight the file (CALKIT, in the case of the *Example Programs Disk*).
4. Press **Recall State** and wait for the prompt:

```
Loaded cal kit information for 4 calibration standards  
Recall of cal kit from CALKIT complete
```
5. Press **CAL** **More Cal** **Cal Kit** **More Cal Kits** , and use the front panel knob or the **↑** **↓** keys to highlight the desired port in the display table. Next, select the softkey that corresponds to the User Cal Kit where the ASCII program stored the calibration kit (default is User Cal Kit A).

NOTE

Cal kit coefficients are displayed in the calibration kit block of the operating parameters screen; press **SYSTEM OPTIONS** **Operating Parameters** ; press **Next Screen** until the Cal Kit screen is displayed.



Step 3: Verify Performance



Once a measurement calibration has been generated with a user-defined calibration kit, its performance should be checked before making device measurements. To check the accuracy that can be obtained with the user-defined calibration kit, a device with a well-defined frequency response (preferably unlike any of the standards used) should be measured. The verification device must not be one of the calibration standards: measurement of one of these standards is merely a measure of repeatability.

To achieve more complete verification of a particular measurement calibration, accurately known verification standards with a diverse magnitude and phase response should be used. NIST-traceable standards (such as HP verification standards) are recommended to achieve verifiable measurement accuracy.

CAUTION

The published specifications for your analyzer system include accuracy enhancement with compatible calibration kits. Measurement calibrations made with user-defined calibration kits are not subject to those analyzer specifications.

To preset one of the ten User Cal Kits (User Cal Kit A–J) to a type-N(f) calibration kit, press **CAL** **More Cal** **Cal Kit** . Use the   keys or the front panel knob to highlight the User Cal Kit you wish to preset. Press **Modify (connector type)** **Mod Kit SaveRecall** **Preset User Kit** .

To preset *all* of the ten User Cal Kits (User Cal Kit A–J) to type-N(f) calibration kits, press **CAL** **More Cal** **Cal Kit** . Use the   keys or the front panel knob to highlight one of the User Cal Kits. Press **Modify (connector type)** **Mod Kit SaveRecall** **Preset All User Kits** .

When this preset is done, the size of your saved instrument state becomes slightly smaller since the instrument doesn't save the user-defined calibration kit. The instrument state can be saved by pressing **SAVE RECALL** **Save State** . Refer to “Saving and Recalling Measurement Results” in Chapter 4 of your analyzer's *User's Guide*.

5 Automating Measurements

This chapter contains a table of SCPI commands that are specifically related to the multiport test set. These commands, as well as the commands for controlling the network analyzer functions, are fully documented in your analyzer's Programmer's Guide.

NOTE

Example programs can be found in the following four locations:

- Example Programs Disk, HP 8712ET/ES and HP 8714ET/ES (DOS format): HP part number 08714-10003
 - Example Programs Disk, HP 8712ET/ES and HP 8714ET/ES (LIF format): HP part number 08714-10004
 - *Example Programs Guide, HP 8712ET/ES and HP 8714ET/ES*: HP part number 08714-90016
 - Web site **<http://www.hp.com>** or **<http://www.agilent.com>**. Use the search function to find Web pages related to 8712 example programs.
-

Introduction

The multiport test set is controlled by the network analyzer via the rear panel parallel interface. You can control the system (including the test set) by using the analyzer's internal IBASIC, by sending commands over a LAN to the analyzer, or by using an external controller connected to the analyzer's HP-IB port.

For detailed information on automating measurements and programming for the analyzer, refer to the documents listed in the following table:

Table 5-1 Programming Reference Materials

Title of Document	HP Part Number	Print Date
HP 8712ET/8714ET RF Network Analyzers User's Guide	08714-90011	October 1999 or later ¹
HP 8712ES/8714ES RF Network Analyzers User's Guide	08714-90012	October 1999 or later ¹
HP 8712ET/ES and HP 8714ET/ES RF Network Analyzers The LAN Interface User's Guide Supplement	08714-90013	October 1999 or later ¹
HP 8712ET/ES and HP 8714ET/ES RF Network Analyzers Automating Measurements User's Guide Supplement	08714-90014	October 1999 or later ¹
HP 8712ET/ES and HP 8714ET/ES RF Network Analyzers Programmer's Guide	08714-90015	October 1999 or later ¹
HP 8712ET/ES and HP 8714ET/ES RF Network Analyzers Example Programs Guide	08714-90016	October 1999 or later ¹
HP Instrument BASIC User's Handbook	E2083-90005	1992
HP 8712ET/ES and HP 8714ET/ES RF Network Analyzers HP Instrument BASIC User's Handbook Supplement	08714-90019	Oct 1998 or later

1. Earlier versions of this manual may be sufficient to help you successfully program your system. However, they will not contain all of the information related to the multiport test set or the most recent revision of analyzer firmware.

Multiport Test Set SCPI Commands

The test set is controlled remotely by sending the appropriate commands to the analyzer. [Table 5-2 on page 5-6](#) lists the commands that are associated specifically with the test set.

Throughout this chapter, the following conventions are used:

- **Square brackets** ([]) are used to enclose a keyword that is optional or implied when programming the command; that is, the instrument will process the command to have the same effect whether the option node is omitted or not.
- **Parameter types** (< >) are distinguished by enclosing the type name in angle brackets.
- **A vertical bar** (|) can be read as “or” and is used to separate alternative parameter options.
- **UPPER**-case letters (as found in the command `MODiFY`, for example) are used to indicate the short form of a given mnemonic. The remaining lower-case letters are the rest of the long form mnemonic.

NOTE

The brackets and vertical bars are not part of the SCPI command string, and should be omitted when sending commands to the analyzer.

Table 5-2 Multiport Test Set SCPI Command

SCPI Command	Description
CALibration:SELF <ON OFF ONCE> ¹	Initiates a SelfCal on the currently selected ports and selects Periodic SelfCal (ON) or SelfCal Once (OFF or ONCE).
CALibration:SELF:ALL ¹	Initiates a SelfCal on all ports that were calibrated during the Test Set Cal.
CALibration:SELF:METHOD <ONEPort TWOPort>	Selects the type of SelfCal to be performed. Choose ONEPort for an enhanced response/1-port SelfCal, or (<i>HP 8712ES/14ES analyzers only</i>) TWOPort for a 2-port SelfCal.
CALibration:SELF:TIMER <num>	Sets the time interval for automatic SelfCals.
CONTRol[1 2]:MULTiport:STATE <ON OFF>	When on, configures analyzer for use with a multiport test set.
MMEMory:STORE:STATE:TSCal <ON OFF>	When ON, saved state will be test set cal only.
ROUTE[1 2]:PATH:DEFine:PORT <num1>, <num2> ¹	Selects the measurement ports on the test set. num1 is the test set port assigned as the Reflection Port, and num2 is the test set port assigned as the Transmission Port.
ROUTE[1 2]:PATH:DEFine:PORT? ¹	Returns the currently selected port pair, num1, num2.
ROUTE[1 2]:REFlection:PATH:DEFine:PORT <num> ¹	Selects which port of the test set is assigned as the Reflection Port.
ROUTE[1 2]:REFlection:PATH:DEFine:PORT? ¹	Returns which port of the test set is currently assigned as the Reflection Port.

SCPI Command	Description
<code>ROUTE[1 2]:TRANsmission:PATH:DEFine:PORT <num>¹</code>	Selects which port of the test set is assigned as the Transmission Port.
<code>ROUTE[1 2]:TRANsmission:PATH:DEFine:PORT?¹</code>	Returns which port of the test set is currently assigned as the Transmission Port.
<code>SENSE[1 2]:CORRection:COLLect:CKIT:PORT[1 ... 12][:SELECT]<string></code>	Selects which port of the analyzer or multiport test set will be assigned a Cal Kit. Also, selects a Cal Kit— choose from one of the following strings: `USER USER1 USER2, IMPLIED, IMPLIED, IMPLIED, IMPLIED` `COAX, 7MM, TYPE-F, 75, IMPLIED` `COAX, 7MM, TYPE-N, 75, FEMALE` `COAX, 7MM, TYPE-N, 75, MALE`
<code>SENSE[1 2]:CORRection:COLLect:METHod TESTset</code>	Selects the type of calibration to be Test Set Cal.
<code>SENSE[1 2]:CORRection:COLLect:MP:LOAD <STANdard1 STANdard2 ... STANdard12></code>	For the test set cal process, measures a load on the port selected with <code>STANdard1</code> through <code>STANdard12</code>
<code>SENSE[1 2]:CORRection:COLLect:MP:OPEN <STANdard1 STANdard2 ... STANdard12></code>	For the test set cal process, measures an open on the port selected with <code>STANdard1</code> through <code>STANdard12</code>
<code>SENSE[1 2]:CORRection:COLLect:MP:SHORT <STANdard1 STANdard2 ... STANdard12></code>	For the test set cal process, measures a short on the port selected with <code>STANdard1</code> through <code>STANdard12</code>
<code>SENSE[1 2]:CORRection:COLLect:MP:THRU <STANdard1 STANdard2 ... STANdard6></code>	For the test set cal process, measures a thru on the ports selected with <code>STANdard1</code> through <code>STANdard6</code>

SCPI Command	Description
<code>SENSE[1 2]:CORREction:COLLect:PORTs</code> <2 4 6 8 10 12>	Selects the number of ports to perform the Test Set Cal on.
<code>SENSE[1 2]:CORREction:COLLect:VERify:REFLectioN</code> <STANdard1 STANdard2 ... STANdard12>	For Cal Check measurement of standards (reflection measurements).
<code>SENSE[1 2]:CORREction:COLLect:VERify:TRANsmisSion</code> <STANdard1 STANdard2 ... STANdard12>	For Cal Check measurement of standards (transmission measurements).
<code>SENSE[1 2]:CORREction:TESTset</code>	Sets cal to Test Set Cal if a valid Test Set Cal file exists.

1. Use *OPC synchronization with this command. See “Usage of *OPC?” below.

Usage of *OPC?

The *OPC? query and command should be used whenever you send a command that initiates a SelfCal. A SelfCal is initiated with any of the following commands:

```
CAL:SELF <ON|OFF|ONCE>
CAL:SELF:ALL
ROUTE[1|2]:PATH:DEF:PORT <num1>, <num2>
ROUTE[1|2]:REFL:DEF:PORT <num>
ROUTE[1|2]:TRAN:DEF:PORT <num>
```

Using the *OPC? query and command will ensure synchronization of overlapped and sequential commands.

```
10  !
20  ! Example shows port pair selection with selfcal
30  ASSIGN @Rfna TO 800
40  !
50  !Enable Periodic SELF CAL and selfcal with new
    port selection
60  OUTPUT @Rfna;"CAL:SELF ON;*OPC?"
70  ENTER  @Rfna;Opc_done
80  !
90  ! Select calibrated port 3 as reflection and
    port 5 as transmission
```

```
100 OUTPUT @Rfna;"ROUT:PATH:DEF:PORT 3,5;*OPC?"
110 ENTER @Rfna;Opc_done
120 !
130 END
```

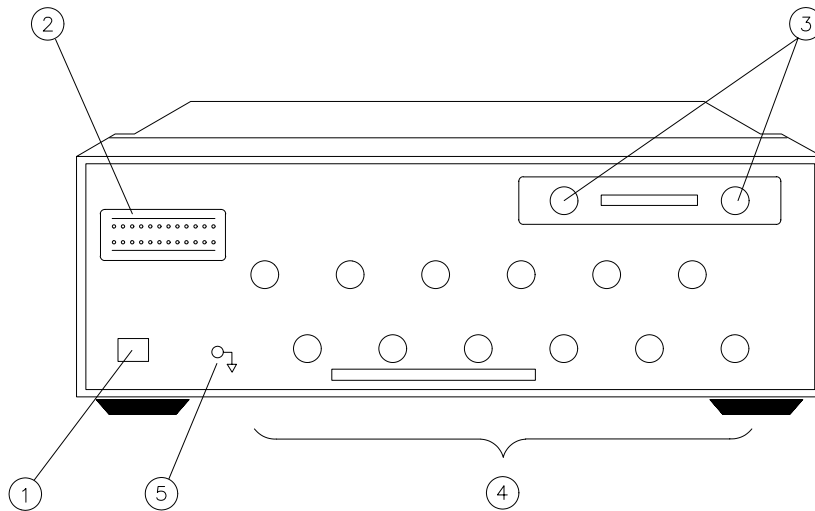
```
10 !
20 ! Example use of port pair selection without selfcal
30 ASSIGN @Rfna TO 800
40 !
50 ! Disable Periodic SELF CAL. Delay Port
calibrations until requested.
60 OUTPUT @Rfna;"CAL:SELF OFF;*OPC?"
70 ENTER @Rfna;Opc_done
80 !
90 ! Select port 3 as reflection and port 5 as
transmission
100 OUTPUT @Rfna;"ROUT:PATH:DEF:PORT 3,5;*OPC?"
110 ENTER @Rfna;Opc_done
120 !
130 ! Initiate port calibrations for all ports now.
140 OUTPUT @Rfna;"CAL:SELF ALL;*OPC?"
150 ENTER @Rfna;Opc_done
160 !
170 END
```

6 **Front/Rear Panel**

This chapter contains information on the ports and switches found on the front and rear panels of the test set.

Front Panel

Figure 6-1 Front Panel Features



pr619c

Item	Description
1	Line Power Switch
2	Port Connection Status LEDs
3	Reflection and Transmission Connectors
4	Test Ports
5	Chassis Ground Connector

Line Power Switch

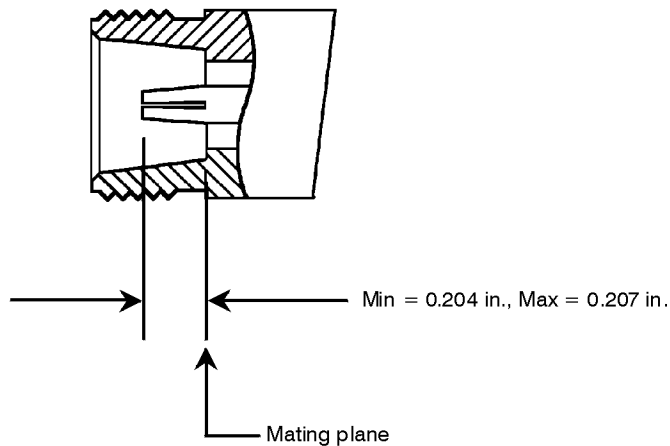
The test set line POWER switch is located at the bottom left corner of the front panel. See [Figure 6-1](#). The line POWER switch turns the power to the test set to either on or off.

The front panel LINE switch disconnects the mains circuits from the mains supply after the EMC filters and before others parts of the instrument.

Test Ports

The front panel test ports are female connectors (50 ohm for the HP 87050E; 75 ohm for the HP 87075C) that are used to connect to the device under test.

Figure 6-2 Physical Description of Type-N Connector



po644 b_c

CAUTION

HP 87050E multiport test sets only:
Connecting 75 ohm cables to the front panel 50 ohm connectors of the analyzer or test set usually results in intermittent or no electrical connections.

CAUTION

HP 87075C multiport test sets only:
Never connect 50 ohm cables to the front panel 75 ohm connectors of the analyzer or test set. Otherwise, *irreparable* connector damage will occur.

The REFLECTION Connector

The REFLECTION connector is a female type-N connector (50 ohm for the HP 87050E; 75 ohm for the HP 87075C) that connects directly to the REFLECTION (PORT 1^{*}) port of the network analyzer using a semi-rigid cable that was shipped with your test set.

CAUTION

Check your analyzer's documentation for damage limits to the REFLECTION (PORT 1^{*}) port. Make sure that your test setup will not cause those limits to be exceeded.

The TRANSMISSION Connector

The TRANSMISSION connector is a female type-N connector (50 ohm for the HP 87050E; 75 ohm for the HP 87075C) that connects directly to the TRANSMISSION (PORT 2^{*}) port of the network analyzer using a semi-rigid cable that was shipped with your test set.

CAUTION

Check your analyzer's documentation for damage limits to the TRANSMISSION (PORT 2^{*}) port. Make sure that your test setup will not cause those limits to be exceeded.

The Chassis Ground Connector

The chassis ground connector provides a convenient front panel ground connection for a standard banana plug.

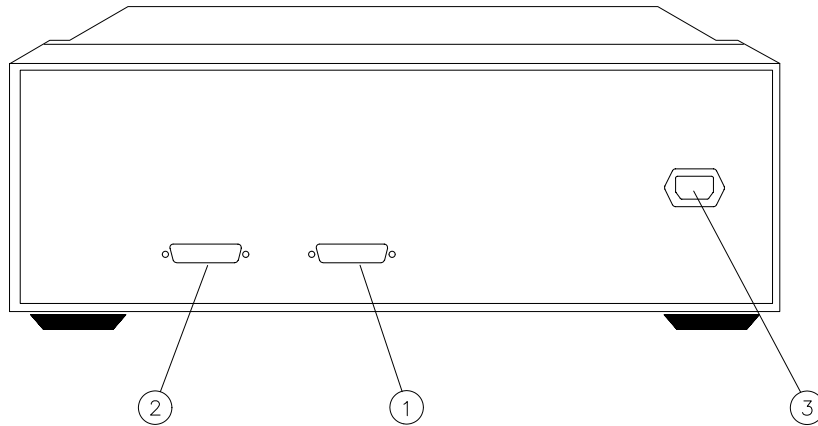
The PORT CONNECTION Status LEDs

The PORT CONNECTION status LEDs provide visual feedback of which test set port(s) are connected to the REFLECTION and TRANSMISSION connectors of the test set. When neither LED is lit for a particular test set port, the test set port is terminated with the internal load.

* For HP 8712ES/14ES analyzers only.

Rear Panel

Figure 6-3 **Rear Panel Features**



pr620c

Item	Description
1	Parallel In Connector
2	Parallel Out Connector
3	Line Module

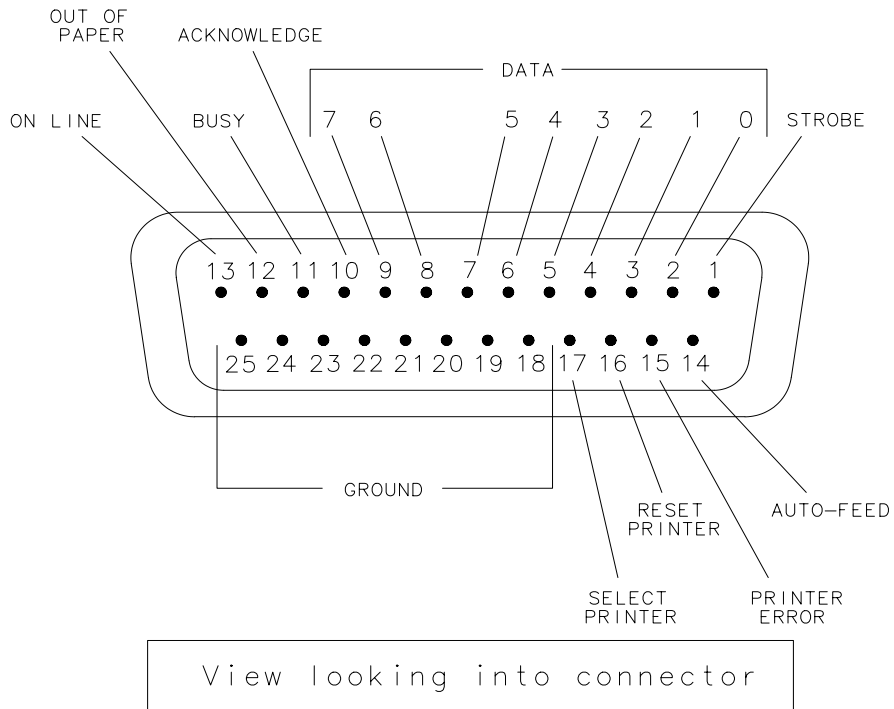
The PARALLEL IN Connector

This female DB-25 connector input is always connected to the network analyzer. The analyzer provides control of the test set through this cable as well as passing through any printer control signals to the test set's PARALLEL OUT connector.

The PARALLEL OUT Connector

This rear panel connector is used with peripherals with a parallel interface such as printers and plotters. The pin-out is standard IBM PC compatible Centronics interface, using a female DB-25 connector, as shown in [Figure 6-4](#).

Figure 6-4 Parallel Port Pinouts



.po622b

Line Module

The line module contains the power cable receptacle. See [“Step 4. Satisfy Electrical and Environmental Requirements”](#) on page 1-16 for power supply requirements.

Power Cables






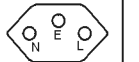

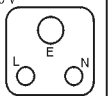

The line power cable is supplied in one of several configurations, depending on the destination of the original shipment.

Each instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument chassis. The type of power cable shipped with each instrument depends on the country of destination. See [Figure 6-5 on page 6-9](#) for the part numbers of these power cables. Cables are available in different lengths. Check with your nearest Hewlett-Packard service center for descriptions and part numbers of cables other than those described in [Figure 6-5](#).

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.

Figure 6-5 Power Cable and Line (Mains) Plug Part Numbers

Plug Type ^a	HP Cable Part Number	Plug ^b Description	Length cm (in.)	Cable Color	For Use in Country
250V 	8120-8705	Straight BS 1363 A	229 (90)	Mint Gray	Option 900 United Kingdom, Hong Kong, Cyprus, Nigeria, Singapore, Zimbabwe
	8120-8709	90°	229 (90)	Mint Gray	
250V 	8120-1369	Straight AS 3112	210 (79)	Gray	Option 901 Argentina, Australia, New Zealand, Mainland China
	8120-0696	90°	200 (78)	Gray	
125V 	8120-1378	Straight NEMA 5-15P	203 (80)	Jade Gray	Option 903 United States, Canada, Brazil, Colombia, Mexico, Philippines, Saudi Arabia, Taiwan
	8120-1521	90°	203 (80)	Jade Gray	
125V 	8120-4753	Straight NEMA 5-15P	229 (90)	Gray	Option 918 Japan
	8120-4754	90°	229 (90)	Gray	
250V 	8120-1689	Straight CEE 7/VII	200 (78)	Mint Gray	Option 902 Continental Europe, Central African Republic, United Arab Republic
	8120-1692	90°	200 (78)	Mint Gray	
230V 	8120-2104	Straight SEV Type 12	200 (78)	Gray	Option 906 Switzerland
	8120-2296	90°	200 (78)	Gray	
220V 	8120-2956	Straight SR 107-2-D	200 (78)	Gray	Option 912 Denmark
	8120-2957	90°	200 (78)	Gray	
250V 	8120-4211	Straight IEC 83-B1	200 (78)	Mint Gray	Option 917 South Africa, India
	8120-4600	90°	200 (78)	Mint Gray	
250V 	8120-5182	Straight SI 32	200 (78)	Jade Gray	Option 919 Israel
	8120-5181	90°	200 (78)	Jade Gray	

a. E = earth ground, L = line, and N = neutral.

b. Plug identifier numbers describe the plug only. The HP part number is for the complete cable assembly.

formt119

Front/Rear Panel

Rear Panel

7

Key Reference

Key Reference

This chapter contains an alphabetical reference of the network analyzer keys that are used exclusively for the multiport test set. It also contains entries for some of the network analyzer keys that are likely to be used while making measurements with your multiport test set. For a complete reference of network analyzer keys, see your analyzer's *User's Guide*.

Alphabetical Key Reference

2-Port *(HP 8712ES/14ES analyzers only)* Softkey in the Testset Cal Type menu. Use this key to select the 2-port Test Set Cal.

See [“Test Set Cal for the HP 8712ES and HP 8714ES Analyzers” on page 4-14](#) for more information.

Access Keys: **CAL** Test Set Cal Create “TSET_CAL” *n* Ports

2-Port Cal on OFF *(HP 8712ES/14ES analyzers only)* Softkey in the Test Set Cal menu. When toggled ON, this key selects the 2-port SelfCal. When toggled OFF, this key selects the Enhanced Response/1-Port SelfCal.

See [“SelfCal Details” on page 4-58](#) for more information.

Access Keys: **CAL** Test Set Cal

2 Ports Softkey in the Number of Ports to Cal menu. Use this key to select the number of ports to include in a Test Set Cal.

See [“Determine the Number of Test Set Ports to Be Used” on page 4-11](#) for more information.

Access Keys: **CAL** Test Set Cal Create “TSET_CAL”

4 Ports Softkey in the Number of Ports to Cal menu. Use this key to select the number of ports to include in a Test Set Cal.

See [“Determine the Number of Test Set Ports to Be Used” on page 4-11](#) for more information.

Access Keys: **CAL** Test Set Cal Create “TSET_CAL”

Key Reference
Alphabetical Key Reference

6 Ports (Options 006^a, 008^b, and 012 only) Softkey in the Number of Ports to Cal menu. Use this key to select the number of ports to include in a Test Set Cal.

See [“Determine the Number of Test Set Ports to Be Used” on page 4-11](#) for more information.

Access Keys: **CAL** Test Set Cal Create “TSET_CAL”

8 Ports (Options 008^b and 012 only) Softkey in the Number of Ports to Cal menu. Use this key to select the number of ports to include in a Test Set Cal.

See [“Determine the Number of Test Set Ports to Be Used” on page 4-11](#) for more information.

Access Keys: **CAL** Test Set Cal Create “TSET_CAL”

10 Ports (Option 012 only) Softkey in the Number of Ports to Cal menu. Use this key to select the number of ports to include in a Test Set Cal.

See [“Determine the Number of Test Set Ports to Be Used” on page 4-11](#) for more information.

Access Keys: **CAL** Test Set Cal Create “TSET_CAL”

12 Ports (Option 012 only) Softkey in the Number of Ports to Cal menu. Use this key to select the number of ports to include in a Test Set Cal.

See [“Determine the Number of Test Set Ports to Be Used” on page 4-11](#) for more information.

Access Keys: **CAL** Test Set Cal Create “TSET_CAL”

^a For HP 87075C multiport test sets only.

^b For HP 87050E multiport test sets only.

Add Kit
Description Softkey in Mod Kit SaveRecall menu. Allows you to enter a description of a modified calibration kit.

See [“Test Set Cal Examples” on page 4-20](#) for use of this key.

Access Keys: **CAL** More Cal Cal Kit Modify (*cal kit*)
Mod Kit SaveRecall

All Std's
Done Softkey in Create “TSET_CAL” menu. This key is pressed after all mechanical standards have been connected and measured.

See [“Test Set Cal Examples” on page 4-20](#) for more information.

Access Keys: **CAL** Test Set Cal Create “TSET_CAL”

AVG Front panel hardkey. Displays the menu that allows selection of the averaging feature as well as system bandwidth options.

See your analyzer's *User's Guide* for more information.

CAL Front panel hardkey. Displays the calibration menu options for the current measurement mode.

See [Chapter 4, “Test Set Cal and SelfCal,”](#) for information on Test Set Cal, and see your analyzer's *User's Guide* for information on other calibrations.

Create
“TSET_CAL” Softkey in Test Set Cal menu. Use this key to start the Test Set Cal process. After pressing this key, you will need to select the number of ports to calibrate.

See [“Test Set Cal Examples” on page 4-20](#) for more information.

Access Keys: **CAL** Test Set Cal

Define
Save Softkey in **SAVE RECALL** menu. Displays the menu to define the contents of a saved state.

See your analyzer's *User's Guide* for more information.

DISPLAY

Front panel hardkey. Displays menu with selections concerning type of data to be displayed, split or full screen, title and limit lines.

See your analyzer's *User's Guide* for more information.

Enh Resp

1-Port

(*HP 8712ES/14ES analyzers only*) Softkey in the Testset Cal Type menu. Use this key to select the Enhanced Response/1-Port Test Set Cal.

See "[Test Set Cal for the HP 8712ES and HP 8714ES Analyzers](#)" on page 4-14 for more information.

Access Keys: **CAL** Test Set Cal Create "TSET_CAL" *n* Ports

FastRecall

on OFF

Softkey in the **SAVE RECALL** menu. Toggle to ON if you want to enable the fast recall feature. Allows any one of up to seven instrument states to be recalled with a single key press.

See your analyzer's *User's Guide* for more information.

FORMAT

Front panel hardkey. Pressing this key displays a menus of choices for the display format of your measurement.

See your analyzer's *User's Guide* for more information.

FREQ

Front panel hardkey. Displays the frequency menu which allows you to enter the frequency range for your measurements.

See your analyzer's *User's Guide* for more information.

HARD COPY

Front panel hardkey. Displays the menu to initiate prints or plots, set up printers and plotters, and define the appearance of the output.

See your analyzer's *User's Guide* for more information.

Isolation (HP 8712ES/14ES analyzers only) Softkey in Test Set Cal menu.
on OFF Toggle to ON if you want the 2-port calibration to remove systematic errors caused by crosstalk.

See your analyzer's *User's Guide* for more information.

Access Keys: **CAL** Test Set Cal

MARKER Front panel hardkey. Pressing this key turns on marker 1 and displays the main marker menu. There are many marker features that can help you quickly interpret your measurement results.

See your analyzer's *User's Guide* for more information.

MEAS 1 Front panel hardkeys. Selecting **MEAS 1** makes measurement
MEAS 2 channel 1 the active measurement channel and also displays the menu where measurement type and port selections are made.

Selecting **MEAS 2** turns on measurement channel 2 (it is off in the default condition) and allows you to select the measurement type for that channel.

See [Chapter 3, "Measurement Examples,"](#) and your analyzer's *User's Guide* for more information.

Measure Softkey in Create "TSET_CAL" menu. Press this key when you are
Loads ready to measure the mechanical loads as part of the Test Set Cal process.

See ["Performing the Test Set Cal" on page 4-12](#) for more information on Test Set Cal.

Access Keys: **CAL** Test Set Cal Create "TSET_CAL" *n* Ports
(HP 8712ES/14ES analyzers only: **Enh Resp/1-Port** or **2-Port**)

Measure
Opens

Softkey in Create “TSET_CAL” menu. Press this key when you are ready to measure the mechanical opens as part of the Test Set Cal process.

See [“Performing the Test Set Cal” on page 4-12](#) for more information on performing a Test Set Cal.

Access Keys: **CAL** Test Set Cal Create “TSET_CAL” *n* Ports
(*HP 8712ES/14ES analyzers only:* Enh Resp/1-Port or 2-Port)

Measure
Shorts

Softkey in Create “TSET_CAL” menu. Press this key when you are ready to measure the mechanical shorts as part of the Test Set Cal process.

See [“Performing the Test Set Cal” on page 4-12](#) for more information on performing a Test Set Cal.

Access Keys: **CAL** Test Set Cal Create “TSET_CAL” *n* Ports
(*HP 8712ES/14ES analyzers only:* Enh Resp/1-Port or 2-Port)

Measure
Thrus

Softkey in Create “TSET_CAL” menu. Press this key when you are ready to measure the mechanical throughs as part of the Test Set Cal process. You must have completed measuring the opens, shorts and loads before pressing this key.

See [“Performing the Test Set Cal” on page 4-12](#) for more information on performing a Test Set Cal.

Access Keys: **CAL** Test Set Cal Create “TSET_CAL” *n* Ports
(*HP 8712ES/14ES analyzers only:* Enh Resp/1-Port or 2-Port)

MENU

Front panel hardkey. Displays menu with source settings selections: trigger functions, number of measurement points, external reference, and spur avoid features.

See your analyzer’s *User’s Guide* for more information.

Mod Kit
SaveRecall Softkey in Modify Kit Menu. Accesses menu where you can save, recall, preset, and describe user-defined calibration kits.

See your analyzer's *User's Guide* for more information.

Access Keys: **CAL** More Cal Cal Kit Modify (*cal kit*)

Modify (*cal kit*) Softkey in Cal Kit menu. Allows you to modify the values of the open, short, load, and through calibration-kit standards.

Access Keys: **CAL** More Cal Cal Kit

Multiport Softkey in Switching Test Set menu. When toggled ON, configures the analyzer for use with the multiport test set.

See “[Step 5. Activate the Test Set and Check the System Operation](#)” on [page 1-19](#) for an example of using this softkey.

Access Keys: **SYSTEM OPTIONS** System Config Switching Test Set

Multiport
Selection Softkey in **MEAS 1**/**MEAS 2** menus. Accesses the multiport selection menu where you can select testset ports to be measured.

See “[Port Connections](#)” on [page 2-4](#) for more information.

Periodic
SelfCal Softkey in Test Set Cal menu. Pressing this key initiates a SelfCal on the currently selected ports and turns on the automatic SelfCal feature.

See “[SelfCal Details](#)” on [page 4-58](#) for more information.

Access Keys: **CAL** Test Set Cal

POWER Front panel hardkey. Displays menu to set the power level of the internal RF source and turn it on or off. Also allows you to choose what power level will be in effect after the **PRESET** key is pressed.

See your analyzer's *User's Guide* for more information.

PRESET Front panel hardkey. Pressing this key returns the analyzer to a predetermined state. Chapter 12 in your analyzer's *User's Guide* contains the complete listing of preset state default parameters.

Pressing **PRESET** will not change your current multiport test set port selections.

NOTE **PRESET** can also be used in the event that your system locks up, or you receive an “unrecoverable error.” If this should happen, cycle the power on the analyzer, and press the **PRESET** key several times while the analyzer is booting up. (You must press it at least twice after you hear the double beep.) Then follow the onscreen instructions.

Re-measure Loads Softkey in Create “TSET_CAL” menu. This key appears after you have connected and measured the loads on all the ports requested for your Test Set Cal. Use this key if you want to remeasure the loads before finishing the calibration process.

If you remeasure the loads after you have already measured the throughs, you will also have to remeasure the throughs.

Access Keys: **CAL** Test Set Cal Create “TSET_CAL” *n* Ports
(*HP 8712ES/14ES analyzers only*: Enh Resp/1-Port or 2-Port)
Measure Loads

Re-measure Opens Softkey in Create “TSET_CAL” menu. This key appears after you have connected and measured the opens on all the ports requested for your Test Set Cal. Use this key if you want to remeasure the opens before finishing the calibration process.

If you remeasure the opens after you have already measured the throughs, you will also have to remeasure the throughs.

Access Keys: **CAL** Test Set Cal Create “TSET_CAL” *n* Ports
(*HP 8712ES/14ES analyzers only*: Enh Resp/1-Port or 2-Port)
Measure Opens

Re-measure

Shorts

Softkey in Create “TSET_CAL” menu. This key appears after you have connected and measured the shorts on all the ports requested for your Test Set Cal. Use this key if you want to remeasure the shorts before finishing the calibration process.

If you remeasure the shorts after you have already measured the throughs, you will also have to remeasure the throughs.

Access Keys: **CAL** Test Set Cal Create “TSET_CAL” *n* Ports
(*HP 8712ES/14ES analyzers only*: Enh Resp/1-Port or 2-Port)
Measure Shorts

Re-measure

Thrus

Softkey in Create “TSET_CAL” menu. This key appears after you have connected and measured the throughs on all the ports requested for your Test Set Cal. Use this key if you want to remeasure the throughs before finishing the calibration process.

Access Keys: **CAL** Test Set Cal Create “TSET_CAL” *n* Ports
(*HP 8712ES/14ES analyzers only*: Enh Resp/1-Port or 2-Port)
Measure Thrus

Reflection

Port Num

(*HP 8712ET/14ET analyzers only*) Softkey in Multiport Selection menu. Use this key to designate which numbered port on your test set will be connected to the REFLECTION port on your analyzer.

See “[Port Connections](#)” on page 2-4 for more information.

Access Keys: **MEAS 1** or **MEAS 2** Multiport Selection

S11 ReflPort

(*HP 8712ES/14ES analyzers only*) Softkey in the **MEAS 1** and **MEAS 2** menus. Selects the S₁₁ (forward reflection) type of measurement. Power is output from the analyzer’s PORT 1 and also measured there.

See [Chapter 3, “Measurement Examples”](#) for using this softkey.

S21 Tran

(HP 8712ES/14ES analyzers only) Softkey in the **MEAS 1** and **MEAS 2** menus. Selects the S_{21} (forward transmission) type of measurement. Power is output from the analyzer's PORT 1 and measured at the analyzer's PORT 2.

See [Chapter 3, "Measurement Examples"](#) for using this softkey.

S12 Tran

(HP 8712ES/14ES analyzers only) Softkey in the **MEAS 1** and **MEAS 2** menus. Selects the S_{12} (reverse transmission) type of measurement. Power is output from the analyzer's PORT 2 and measured at the analyzer's PORT 1.

See [Chapter 3, "Measurement Examples"](#) for using this softkey.

S22 ReflPort

(HP 8712ES/14ES analyzers only) Softkey in the **MEAS 1** and **MEAS 2** menus. Selects the S_{22} (reverse reflection) type of measurement. Power is output from the analyzer's PORT 2 and also measured there.

See [Chapter 3, "Measurement Examples"](#) for using this softkey.

(S11) Port

(HP 8712ES/14ES analyzers only) Softkey in multiport selection menu. Use this key to designate which numbered port on your test set will be referred to as S_{11} in the **MEAS 1** and **MEAS 2** menus.

See ["Port Connections" on page 2-4](#) for more information.

Access Keys: **MEAS 1** or **MEAS 2** Multiport Selection

(S22) Port

(HP 8712ES/14ES analyzers only) Softkey in multiport selection menu. Use this key to designate which numbered port on your test set will be referred to as S_{22} in the **MEAS 1** and **MEAS 2** menus.

See ["Port Connections" on page 2-4](#) for more information.

Access Keys: **MEAS 1** or **MEAS 2** Multiport Selection

SAVE RECALL

Front panel hardkey. Displays menus to save, title, define, and recall states, calibrations, and programs; rename, delete, and copy files; and select, configure, and format disks.

See [“Saving the Test Set Cal” on page 4-15](#) for information on saving a Test Set Cal, and see your analyzer’s *User’s Guide* for detailed information on the other save/recall features of your system.

SCALE

Front panel hardkey. Allows changing of scale per division, and reference level and position for optimum viewing of measurement results. Also accesses reference tracking function.

See your analyzer’s *User’s Guide* for more information.

**SelfCal
All Ports**

Softkey in Test Set Cal menu. Initiates a full SelfCal on all ports that were calibrated during the currently active Test Set Cal.

See [“SelfCal Details” on page 4-58](#) for more information.

Access Keys: **CAL** Test Set Cal

**SelfCal
Once**

Softkey in Test Set Cal menu. Initiates a full SelfCal on the currently selected ports and disables automatic SelfCals until **Periodic SelfCal** is pressed.

See [“SelfCal Details” on page 4-58](#) for more information.

Access Keys: **CAL** Test Set Cal

**SelfCal
Timer**

Softkey in Test Set Cal menu. Use this key to input the interval of time desired between automatic SelfCals.

See [“SelfCal Details” on page 4-58](#) for more information.

Access Keys: **CAL** Test Set Cal

SWEEP Front panel hardkey. Displays menu to select automatic sweep time (fastest possible), manual sweep time, alternate sweep, or power sweep.

See [“Using Two Measurement Channels Simultaneously” on page 3-41](#) for information about using alternate sweep mode. Also, refer to your analyzer’s *User’s Guide* for more information on alternate sweep and other sweep functions.

Switching

Test Set

Softkey in System Config menu. Displays the menu where you configure the analyzer for use with your multiport test set.

See [“Step 5. Activate the Test Set and Check the System Operation” on page 1-19](#) for an example of using this softkey.

Access Keys: **SYSTEM OPTIONS** System Config

SYSTEM OPTIONS Front panel hardkey. Displays menu with system configuration options such as IBASIC, LAN, and HP-IB. Use this key to access the menu to configure the analyzer for operation with the multiport test set.

See your analyzer’s *User’s Guide* for more information.

Test Set

Cal

Softkey in **CAL** menu. Displays menu of Test Set Cal and SelfCal functions and features.

See [Chapter 4, “Test Set Cal and SelfCal,”](#) for more information.

Transmissn (HP 8712ET/14ET analyzers only) Softkey in Multiport Selection menu. Use this key to designate which numbered port on your test set will be connected to the TRANSMISSION port on your analyzer.

Port Num

See “[Port Connections](#)” on page 2-4 for more information.

Access Keys: **MEAS 1** or **MEAS 2** Multiport Selection

Tset Cal

on OFF

Softkey in Define Save menu. When this key is toggled ON and you use the **Save State** or **Re-Save State** keys, you can save the currently active Test Set Cal to a file. Note that the instrument state is *not* saved along with the calibration data.

See “[Saving the Test Set Cal](#)” in [Chapter 4](#) for more information.

Access Keys: **SAVE RECALL** Define Save

- a For HP 87075C multiport test sets only.
- b For HP 87050E multiport test sets only.

Key Reference
Alphabetical Key Reference

8 **Specifications**

About This Chapter

This chapter describes the performance and features of the HP 87050E and HP 87075C multiport test sets. The performance of a test set is formally described in this chapter under the categories *Specifications* and *Supplemental Information*. Performance of the test set to specifications is covered by the Hewlett-Packard warranty¹. Supplemental information may be useful in the application of the test set, but this performance is not covered by the Hewlett-Packard warranty. Supplemental information includes characteristics, typical, and nominal values.

-
1. During the warranty period, Hewlett-Packard repairs or adjusts products, at no cost, that do not meet the specifications. (This statement does not constitute the actual warranty. See [“Warranty” on page 8-35.](#))

Definitions

All specifications and characteristics apply over a $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ range (unless otherwise stated) and thirty minutes after the instrument has been turned on.

Specification (spec.): Warranted performance. Specifications include guardbands to account for the expected statistical distribution, measurement uncertainties, and changes in performance due to environmental conditions.

Characteristic (char.): A performance parameter that the product is expected to meet before it leaves the factory, but is not verified in the field and is not covered by the product warranty. A characteristic includes the same guardbands as a specification.

Typical (typ.): Expected performance of an average unit which does not include guardbands. It is not covered by the product warranty.

Nominal (nom.): A general descriptive term that does not imply a level of performance. It is not covered by the product warranty.

Calibration: The process of measuring known standards from a calibration kit to characterize the systematic (repeatable) errors of a network analyzer.

Corrected (residual) Performance: Indicates performance after error correction (calibration). It is determined by the quality of calibration standards and how well “known” they are, plus system repeatability, stability, and noise.

Uncorrected (raw) Performance: Indicates instrument performance without error correction. The uncorrected performance affects the stability of a calibration.

System Performance: Performance of a complete multiport test system, which includes a test set (HP 87075C or HP 87050E) and a network analyzer (HP 8712ET, HP 8712ES, HP 8714ET, or HP 8714ES).

Test Set Cal: The calibration of a multiport test system requiring the connection of known calibration standards to all of the test ports that will be used for measurements.

SelfCal: An automated system calibration that uses calibration standards internal to the test set and the most recent Test Set Cal data to calibrate the test system.

Environmental Specifications: Environmental specifications bound the external conditions for which the specifications are valid. The environmental specifications also bound the external conditions the test set may be subject to, without permanently affecting performance or causing physical damage.

System Performance, Corrected, 2-Port Calibration

The following equipment conditions and environmental specifications are applicable to all corrected 2-port test set calibration specifications and typicals listed in Tables 8-1 and 8-2.

- Measurements use the fine (15 Hz) bandwidth, no averaging, and isolation calibration toggled ON.
- Test set calibrations use the fine (15 Hz) bandwidth, 16 averages, and assume an isolation calibration has been performed.
- The test set must be used with an HP 8712ES or HP 8714ES network analyzer, with firmware revision E.06.00 or later.
- The network analyzer and multiport test set must warm up for more than 30 minutes.
- The performance of the test set and the analyzer must have been verified within the last year.
- The current temperature must be within the $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ operating temperature range, and within $\pm 1\text{ }^{\circ}\text{C}$ of the last valid test set calibration using mechanical standards.

When the current temperature has drifted beyond $\pm 1\text{ }^{\circ}\text{C}$ of the last valid test set calibration using mechanical standards, system performance (corrected) specifications are changed from specifications to typicals. Typicals are valid only when the current temperature is within the $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ operating temperature range, and within $\pm 1\text{ }^{\circ}\text{C}$ of the most recent SelfCal. It is recommended that a test set calibration be performed at least once a month and a SelfCal be performed at least once an hour.

Table 8-1 System Performance, Corrected, 50Ω, 2-Port Calibration

HP 87050E HP 85032B/E (Type-N, 50 Ω) Cal Kit, 2-Port Test Set Calibration			
Description	Specification, dB		Typical, dB
	3 MHz to 1.3 GHz	1.3 GHz to 2.2 GHz	2.2 GHz to 3 GHz
Directivity	47	40	37
Source Match	37	35	30
Load Match	47	40	37
Reflection Tracking	±0.1	±0.1	±0.2
Transmission Tracking	±0.1	±0.1	±0.2
Transmission Uncertainty (Typical)			
<p>Magnitude</p> <p>HP 8714ES/HP 87050E with HP85032B</p>		<p>Phase</p> <p>HP 8714ES/HP 87050E with HP85032B</p>	
Reflection Uncertainty (Typical)			
<p>Magnitude</p> <p>HP 8714ES/HP 87050E with HP 85032B</p>		<p>Phase</p> <p>HP 8714ES/HP 87050E with HP 85032B</p>	

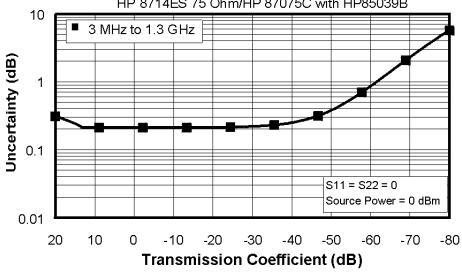
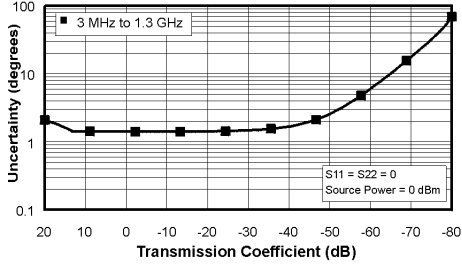
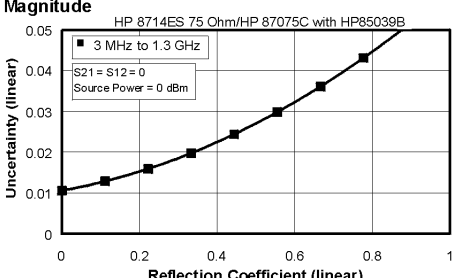
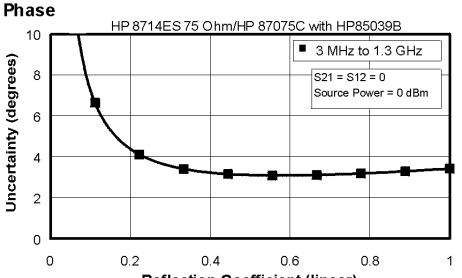
Table 8-1 System Performance, Corrected, 50Ω, 2-Port Calibration (continued)

HP 87050E HP 85033D (3.5 mm, 50 Ω) Cal Kit, 2-Port Test Set Calibration			
Description	Specification, dB		Typical, dB
	3 MHz to 1.3 GHz	1.3 GHz to 2.2 GHz	2.2 GHz to 3 GHz
Directivity	40	38	35
Source Match	38	35	30
Load Match	40	38	35
Reflection Tracking	±0.1	±0.1	±0.2
Transmission Tracking	±0.1	±0.1	±0.2
Transmission Uncertainty (Typical)			
<p>Magnitude</p> <p>HP 8714ES/HP 87050E with HP 85033D</p>		<p>Phase</p> <p>HP 8714ES/HP 87050E with HP 85033D</p>	
Reflection Uncertainty (Typical)			
<p>Magnitude</p> <p>HP 8714ES/HP 87050E with HP 85033D</p>		<p>Phase</p> <p>HP 8714ES/HP 87050E with HP 85033D</p>	

Table 8-2 System Performance, Corrected, 75Ω, 2-Port Calibration

HP 87075C HP 85036B/E (Type-N, 75 Ω) Cal Kit, 2-Port Test Set Calibration	
Description	Specification, dB
	3 MHz to 1.3 GHz
Directivity	47
Source Match	37
Load Match	47
Reflection Tracking	±0.1
Transmission Tracking	±0.1
Transmission Uncertainty (Typical)	
<p>Magnitude</p> <p>HP 8714ES 75 Ohm/HP 87075C with HP 85036B ■ 3 MHz to 1.3 GHz S11 = S22 = 0 Source Power = 0 dBm</p>	<p>Phase</p> <p>HP 8714ES 75 Ohm/HP 87075C with HP 85036B ■ 3 MHz to 1.3 GHz S11 = S22 = 0 Source Power = 0 dBm</p>
Reflection Uncertainty (Typical)	
<p>Magnitude</p> <p>HP 8714ES 75 Ohm/HP 87075C with HP 85036B ■ 3 MHz to 1.3 GHz S21 = S12 = 0 Source Power = 0 dBm</p>	<p>Phase</p> <p>HP 8714ES 75 Ohm/HP 87075C with HP 85036B ■ 3 MHz to 1.3 GHz S21 = S12 = 0 Source Power = 0 dBm</p>

Table 8-2 System Performance, Corrected, 75Ω, 2-Port Calibration (continued)

HP 87075C HP 85039B (Type-F, 75 Ω) Cal Kit, 2-Port Test Set Calibration	
Description	Specification, dB
	3 MHz to 1.3 GHz
Directivity	35
Source Match	28
Load Match	35
Reflection Tracking ¹	±0.1
Transmission Tracking ¹	±0.2
Transmission Uncertainty (Typical)	
Magnitude HP 8714ES 75 Ohm/HP 87075C with HP85039B  ■ 3 MHz to 1.3 GHz S11 = S22 = 0 Source Power = 0 dBm	Phase HP 8714ES 75 Ohm/HP 87075C with HP85039B  ■ 3 MHz to 1.3 GHz S11 = S22 = 0 Source Power = 0 dBm
Reflection Uncertainty (Typical)	
Magnitude HP 8714ES 75 Ohm/HP 87075C with HP85039B  ■ 3 MHz to 1.3 GHz S21 = S12 = 0 Source Power = 0 dBm	Phase HP 8714ES 75 Ohm/HP 87075C with HP85039B  ■ 3 MHz to 1.3 GHz S21 = S12 = 0 Source Power = 0 dBm

1. Measurements made using an HP 85039B calibration kit and a DUT with a center pin meeting the 0.77-0.86 mm limits.

System Performance, Corrected, T/R Calibration

The corrected transmission/reflection (T/R) calibration specifications and typicals are valid for both reflection (1-port) test set calibration and transmission enhanced-response test set calibration. Transmission response calibration is not specified for the HP 87050E and HP 87075C multiport test sets.

The following equipment conditions and environmental specifications are applicable to all corrected T/R calibration specifications and typicals listed in Tables 8-3 and 8-4.

- Measurements use the fine (15 Hz) bandwidth, no averaging, and isolation calibration toggled ON.
- Test set calibrations use the fine (15 Hz) bandwidth, 16 averages, and assume an isolation calibration has been performed.
- The test set must be used with an HP 8712ET, HP 8712ES, HP 8714ET or HP 8714ES network analyzer, with firmware revision E.06.00 or later.
- The network analyzer and multiport test set must warm up for more than 30 minutes.
- The performance of the test set and the analyzer must have been verified within the last year.
- The current temperature must be within the $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ operating temperature range, and within $\pm 1\text{ }^{\circ}\text{C}$ of the last valid test set calibration using mechanical standards.

When the current temperature has drifted beyond $\pm 1\text{ }^{\circ}\text{C}$ of the last valid test set calibration using mechanical standards, system performance (corrected) specifications are changed from specifications to typicals. Typicals are valid only when the current temperature is within the $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ operating temperature range, and within $\pm 1\text{ }^{\circ}\text{C}$ of the most recent SelfCal. It is recommended that a test set calibration be performed at least once a month and a SelfCal be performed at least once an hour.

Table 8-3 System Performance, Corrected, 50 Ω , T/R Calibration

HP 87050E HP 85032B/E (Type-N, 50 Ω) Cal Kit, Enhanced Response Test Set Calibration					
Description	Specification, dB		Typical, dB		
	3 MHz to 1.3 GHz	1.3 GHz to 2.2 GHz	3 MHz to 1.3 GHz	1.3 GHz to 2.2 GHz	2.2 GHz to 3 GHz
Directivity	47	40	—	—	40
Source Match	37	32	—	—	30
Load Match (refl. cal.)	18	18	23	24	20
Load Match (trans. cal.)	14	14	18	18	14
Reflection Tracking	± 0.1	± 0.1	—	—	± 0.2
Transmission Tracking	± 0.1	± 0.1	—	—	± 0.2

Table 8-3 System Performance, Corrected, 50Ω, T/R Calibration (continued)

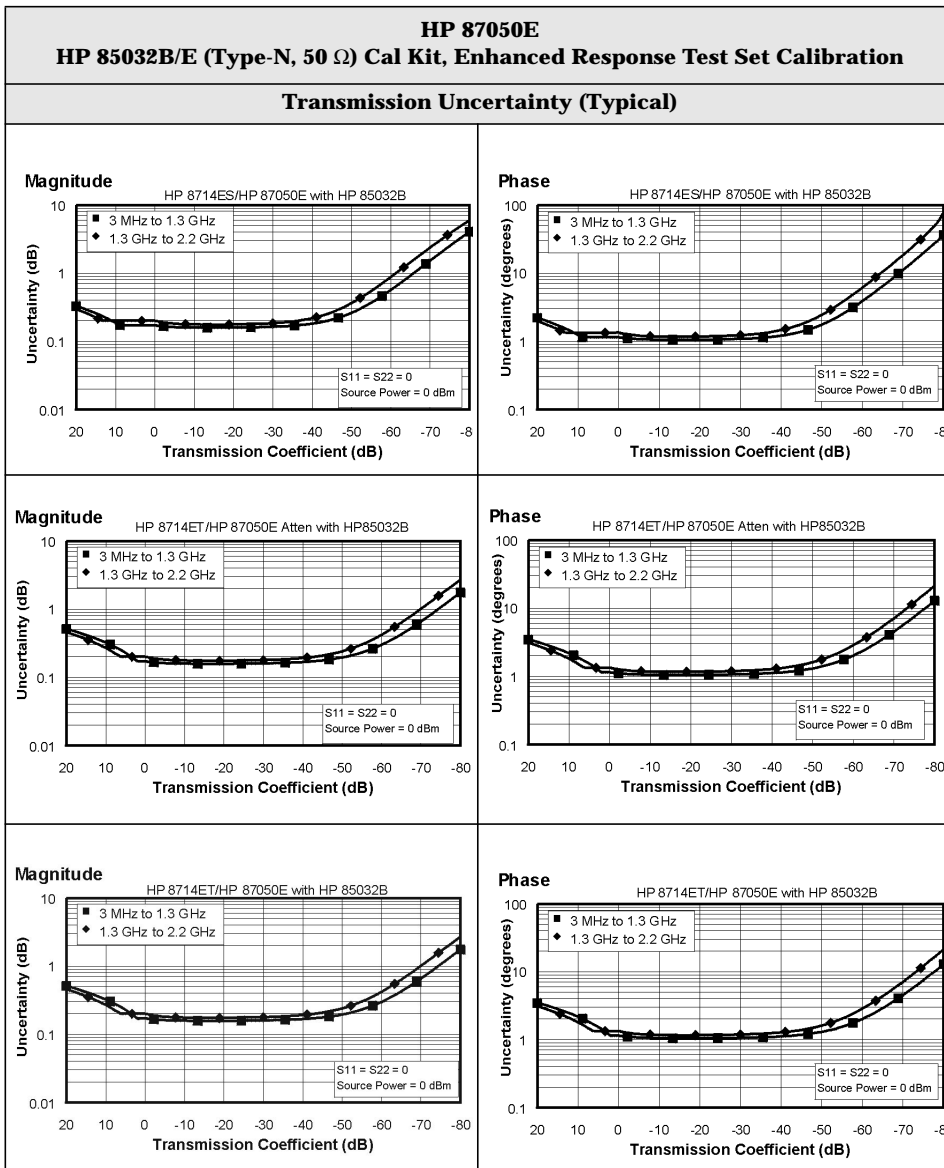


Table 8-3 System Performance, Corrected, 50Ω, T/R Calibration (continued)

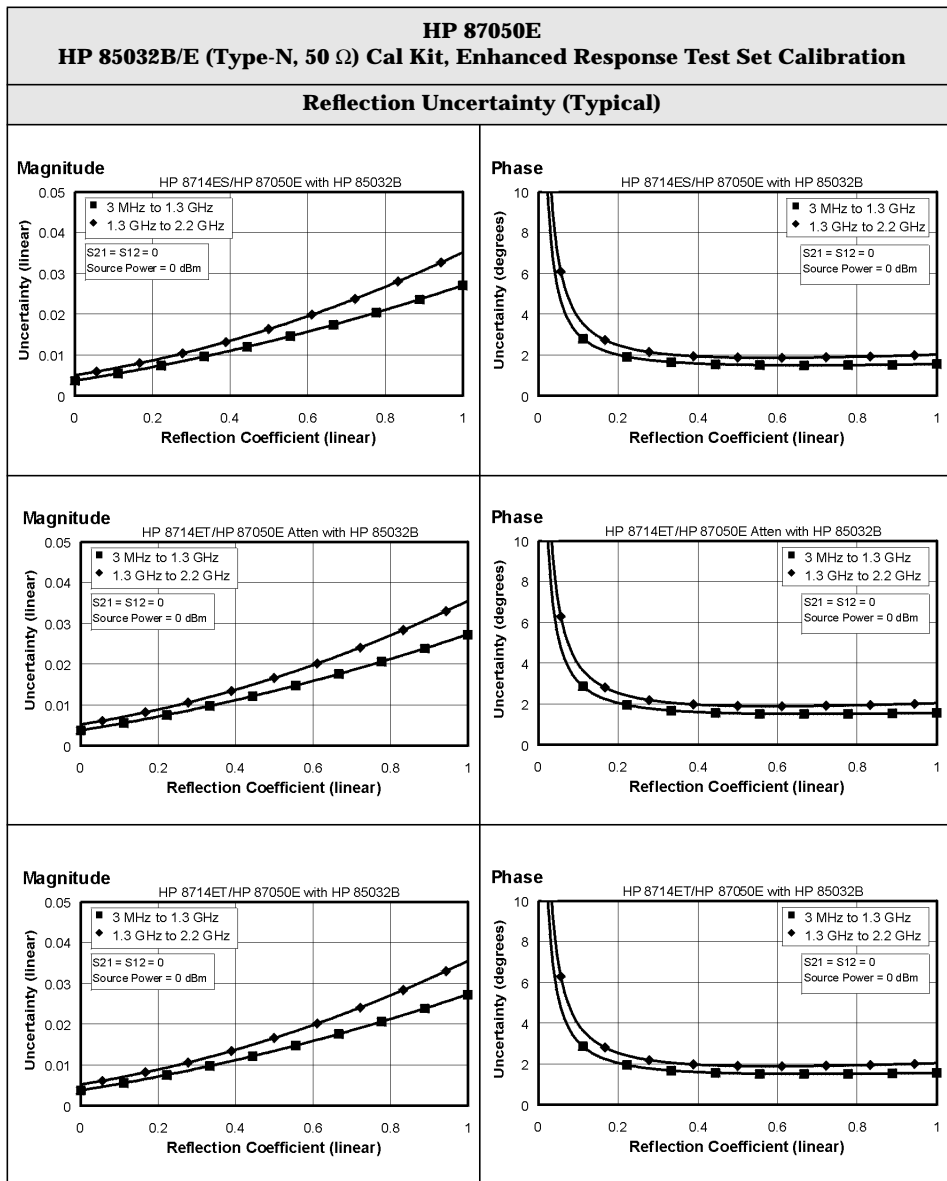


Table 8-4 System Performance, Corrected, 75 Ω , T/R Calibration

HP 87075C HP 85036B/E (Type-N, 75 Ω) Cal Kit, Enhanced Response Test Set Calibration		
Description	Specification, dB	Typical, dB
	3 MHz to 1.3 GHz	3 MHz to 1.3 GHz
Directivity	40	—
Source Match	35	—
Load Match (refl. cal.)	20	25
Load Match (trans. cal.)	15	20
Reflection Tracking	± 0.1	—
Transmission Tracking	± 0.1	—

Table 8-4 System Performance, Corrected, 75Ω, T/R Calibration (continued)

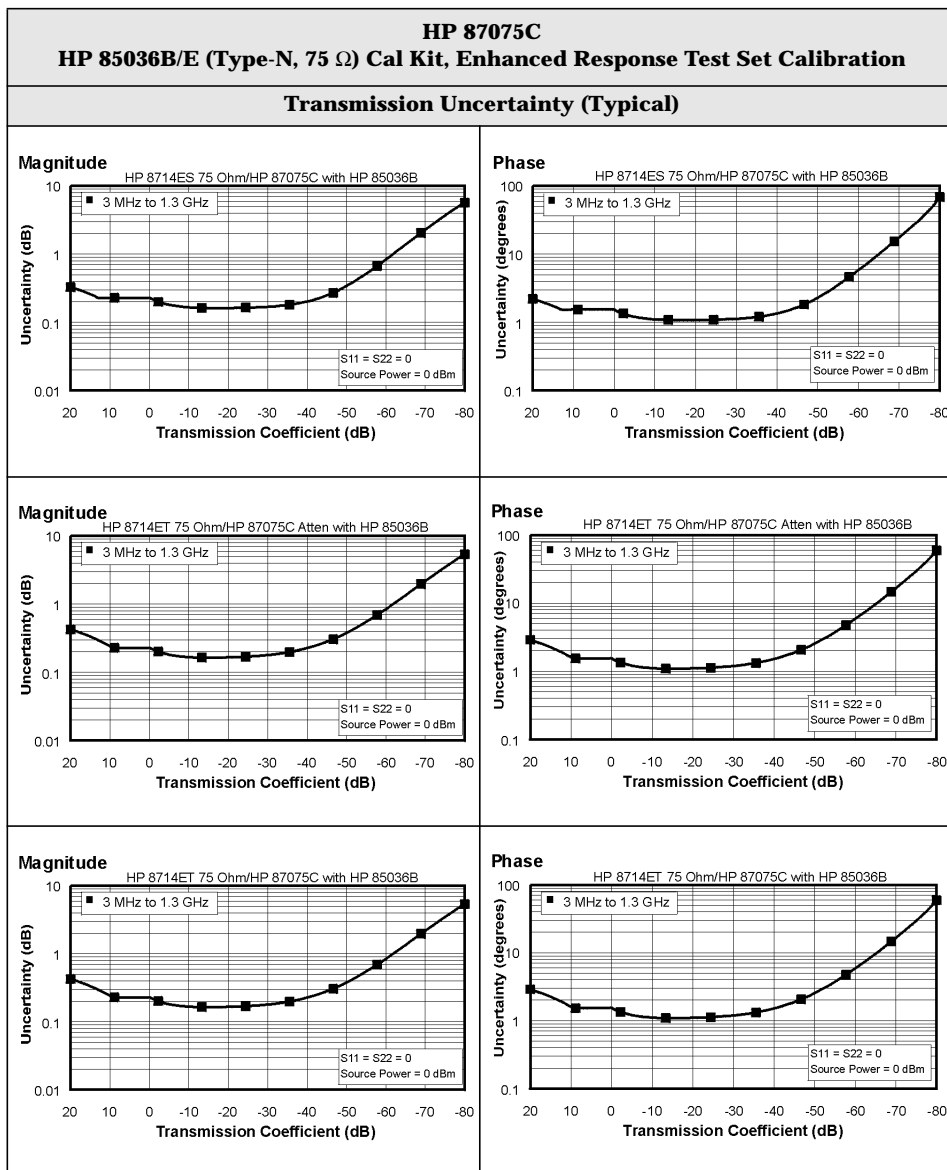
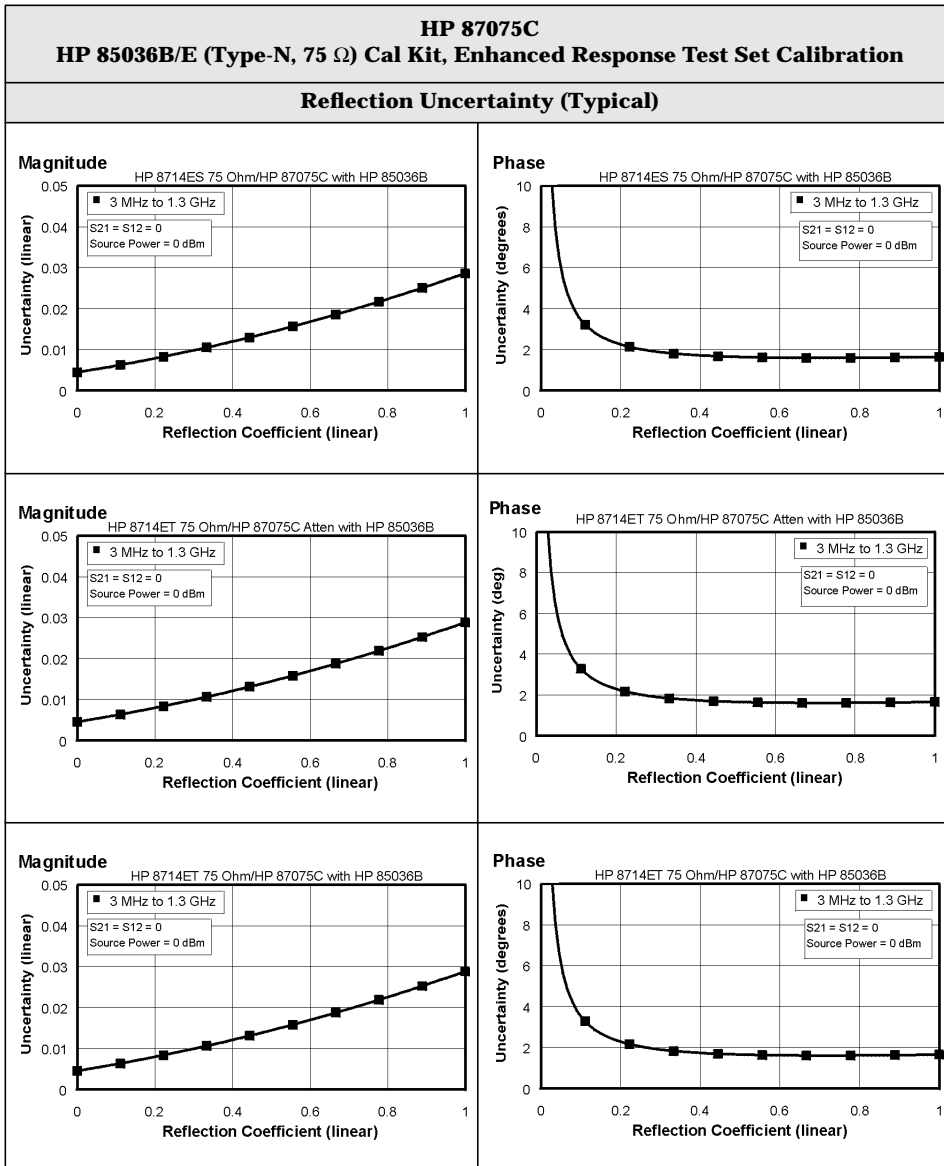


Table 8-4 System Performance, Corrected, 75Ω, T/R Calibration (continued)



System Performance, Uncorrected

Unless otherwise noted, the following equipment conditions and environmental specifications are applicable to all uncorrected specifications and typicals listed in Tables 8-5 and 8-6.

- Measurements use the fine (15 Hz) bandwidth with narrowband detection mode and no averaging.
- The test set must be used with an HP 8712ET, HP 8712ES, HP 8714ET or HP 8714ES network analyzer, with firmware revision E.06.00 or later.
- The network analyzer and the multiport test set must warm up for more than 30 minutes.
- The test set and the analyzer must have had their performance verified within the last year.

Table 8-5 System Performance, 50Ω, Uncorrected

HP 87050E (Type-N, 50 Ω) Uncorrected					
Description	Specification, dB		Typical, dB		
	3 MHz to 1.3 GHz	1.3 GHz to 2.2 GHz	3 MHz to 1.3 GHz	1.3 GHz to 2.2 GHz	2.2 GHz to 3 GHz
Source Match, ratioed	12	10	17	14	11
Load Match, test port unselected ¹	18	18	23	24	20
Load Match, test port selected ²	12	12	16	17	13
Transmission Tracking ³	—	—	±3.0	±2.5	±3.0
Reflection Tracking ³	—	—	±3.0	±2.5	±3.0
Crosstalk ⁴ , HP 8712/14ET	—	—	93	89	81
Crosstalk ⁴ , HP 8712/14ES	—	—	83	79	71

1. This is the match of any test port that is unselected (not in the measurement path). If the network analyzer is performing a reflection measurement with 1-port calibration, then only one port on the test set is selected (the source port). If the network analyzer is performing a transmission measurement or a reflection measurement with 2-port calibration, then only two ports on the test set are selected (the source and load ports).
2. This is the match of the test set port which has been selected as the load port. The network analyzer must be making a transmission measurement or a reflection measurement with two-port calibration for a test port to be selected as the load port.
3. The uncorrected tracking terms are defined as the deviation over the defined frequency band, ignoring offset loss.
4. Crosstalk is computed by normalizing the result of an isolation measurement to a through measurement between the two ports such that the path losses are taken into account. Isolation is defined as the transmission signal measured between any two ports of the test system when these two ports are terminated with shorts.

Table 8-6 **System Performance, 75Ω, Uncorrected**

HP 87075C (Type-N, 75 Ω) Uncorrected		
Description	Specification, dB	Typical, dB
	3 MHz to 1.3 GHz	3 MHz to 1.3 GHz
Source Match, ratioed	10	15
Load Match, test port unselected ¹	20	25
Load Match, test port selected ²	13	18
Transmission Tracking ³	—	±3.0
Reflection Tracking ³	—	±3.0
Crosstalk ⁴ , HP 8712/14ET	—	72
Crosstalk ⁴ , HP 8712/14ES	—	72

1. This is the match of any test port that is unselected (not in the measurement path). If the network analyzer is performing a reflection measurement with 1-port calibration, then only one port on the test set is selected (the source port). If the network analyzer is performing a transmission measurement or a reflection measurement with 2-port calibration, then only two ports on the test set are selected (the source and load ports).
2. This is the match of the test set port which has been selected as the load port. The network analyzer must be making a transmission measurement or a reflection measurement with two-port calibration for a test port to be selected as the load port.
3. The uncorrected tracking terms are defined as the deviation over the defined frequency band, ignoring offset loss.
4. Crosstalk is computed by normalizing the result of an isolation measurement to a through measurement between the two ports such that the path losses are taken into account. Isolation is defined as the transmission signal measured between any two ports of the test system when these two ports are terminated with shorts.

System Performance, General

Table 8-7 System Performance, General

System Performance, General								
Description	Specification		Typical					
	System Bandwidth							
	3MHz to 1.3GHz	1.3GHz to 2.2GHz	Fine 15Hz		MedWide 4000 Hz		Wide 6500Hz	
			3MHz to 1.3GHz	1.3GHz to 2.2GHz	3MHz to 1.3GHz	1.3GHz to 2.2GHz	3MHz to 1.3GHz	1.3GHz to 2.2GHz
System Noise Floor ¹ , dBm								
HP 8712/14 ET, 50 Ω	-97	-95	-106	-103	-82	-79	-42	-39
HP 8712/14 ET, 75 Ω	-96	—	-104	—	-79	—	-40	—
HP 8712/14 ES, 50 Ω	-88	-86	-100	-97	-75	-72	-42	-39
HP 8712/14 ES, 75 Ω	-87	—	-99	—	-75	—	-42	—
System Dynamic Range ² , dB								
HP 8712ET, 50 Ω , no atten.	101	97	112	108	87	83	49	45
HP 8712ET, 75 Ω , no atten.	65	—	82	—	82	—	44	—
HP 8712ET, 50 Ω , with atten.	100	96	111	107	86	82	48	44
HP 8712ET, 75 Ω , with atten.	63	—	81	—	81	—	43	—
HP 8712ES, 50 Ω	89	85	103	99	78	74	45	41
HP 8712ES, 75 Ω	61	—	79	—	75	—	42	—
HP 8714ET, 50 Ω , no atten.	99	95	109	105	84	80	46	42
HP 8714ET, 75 Ω , no atten.	65	—	79	—	79	—	41	—
HP 8714ET, 50 Ω , with atten.	97	93	108	104	83	79	45	41
HP 8714ET, 75 Ω , with atten.	60	—	78	—	78	—	40	—
HP 8714ES, 50 Ω	86	82	100	96	81	77	42	38
HP 8714ES, 75 Ω	58	—	76	—	72	—	39	—

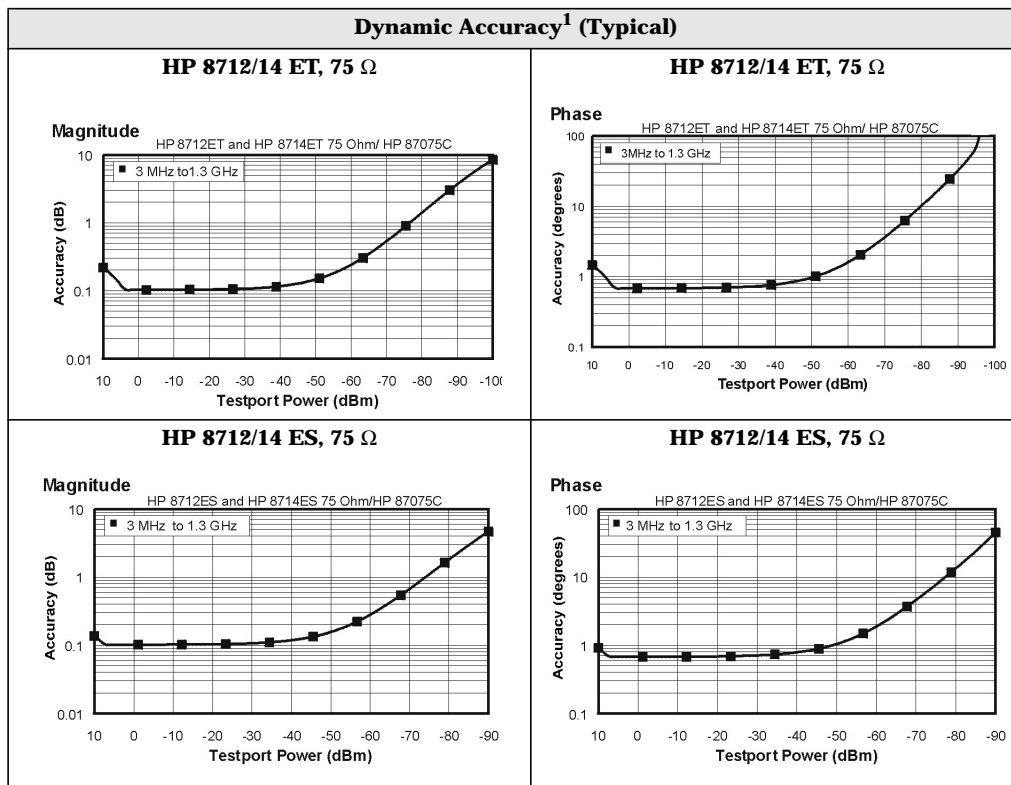
- Noise floor is defined as the rms value of the trace (in linear format) for a transmission measurement in CW mode, using the fine bandwidth (15 Hz), the test ports terminated in loads, 0 dBm at the test set source port, and no averaging. This measurement ignores the effects of crosstalk. This is a system specification (the system is an HP 8712ET/ES or an HP 8714ET/ES plus test set)—the test set increases the network analyzer noise floor by adding loss to the network analyzer measurement.
- The system dynamic range is calculated as the difference between the receiver minimum input (noise floor plus calibrated crosstalk) and the system's maximum output power (the system is an HP 8712ET/ES or an HP 8714ET/ES plus a test set). System dynamic range applies to transmission measurements only, since reflection measurements are limited by directivity.

Table 8-7 System Performance, General (continued)

System Performance, General					
Description	Specification	Supplemental Information			
		System Bandwidth			
		Fine 15 Hz	Fine 15 Hz	MedWide 4000 Hz	Wide 6500 Hz
Receiver Dynamic Range¹, dB					
HP 8712/8714 ET, 50 Ω	115	121	96	58	
HP 8712/8714 ET, 75 Ω	114	119	94	56	
HP 8712/8714 ES, 50 Ω	106	115	90	57	
HP 8712/8714 ES, 75 Ω	105	114	90	57	
Dynamic Accuracy² (Typical)					
HP 8712/14 ET, 50 Ω		HP 8712/14 ET, 50 Ω			
<p>Magnitude</p>		<p>Phase</p>			
HP 8712/14 ES, 50 Ω		HP 8712/14 ES, 50 Ω			
<p>Magnitude</p>		<p>Phase</p>			

1. The receiver dynamic range is calculated as the difference between the receiver minimum input (noise floor) and the receiver maximum input. Receiver Dynamic Range applies to transmission measurements only, since reflection measurements are limited by directivity.
2. The reference power for dynamic accuracy is -20 dBm.

Table 8-7 System Performance, General (continued)



1. The reference power for dynamic accuracy is -20 dBm.

Table 8-7 System Performance, General (continued)

System Performance, General			
Description	Specification	Characteristic, dBm	
Output Power (system maximum)			
		<1 GHz	>1GHz
HP 8712ET, 50 Ω , no attenuator	—	10.5	7
HP 8712ET, 75 Ω , no attenuator	—	7	3.5
HP 8712ET, 50 Ω , with attenuator	—	9.5	6
HP 8712ET, 75 Ω , with attenuator	—	6	2.5
HP 8712ES, 50 Ω	—	7.5	4
HP 8712ES, 75 Ω	—	4	0.5
HP 8714ET, 50 Ω , no attenuator	—	5.5	2
HP 8714ET, 75 Ω , no attenuator	—	2	0.5
HP 8714ET, 50 Ω , with attenuator	—	4.5	1
HP 8714ET, 75 Ω , with attenuator	—	1	-0.5
HP 8714ES, 50 Ω	—	3.5	-1
HP 8714ES, 75 Ω	—	0	-2.5

Table 8-7 System Performance, General (continued)

System Performance, General		
Description	Specification	Supplemental Information
Port Switching Time ¹		
Reflection Cal	—	0.5 s (typical)
Transmission Enhanced Cal	—	0.5 s (typical)
2-Port Cal	—	0.5 s (typical)
SelfCal Cal Time ²		
Reflection Cal	—	1 s (typical)
Transmission Enhanced Cal	—	3 s (typical)
2-Port Cal	—	8 s (typical)

1. This is the time required to switch to any new port configuration, and requires that the Test Set Cal has been performed for 201 points, the new measurement configuration is 201 points, and that no new SelfCal occurs during switching.
2. This is the time required to perform the SelfCal for any single port configuration, assuming that the Test Set Cal was performed for 201 points, the new measurement configuration is 201 points, and that the measurement bandwidth is medium-wide (4000 Hz). SelfCal times for other settings can be found in [Table 4-1 on page 4-62](#).

Test Set Performance

Table 8-8 Test Set Input/Output Performance, 50 Ω

HP 87050E Test Set Input/Output		
Description	Specification	Supplemental
Frequency Range		
HP 87050E	3 MHz–2.2 GHz	—
RF Input Power		
Maximum Input Power at 0.1 dB compression	—	16 dBm (typical)
Input Damage Power	—	20 dBm (characteristic)

Table 8-8 Test Set Input/Output Performance, 50 Ω (continued)

HP 87050E (50 Ω) Test Set Input/Output					
Description	Specification, dB		Typical, dB		
	3 MHz to 1.3 GHz	1.3 GHz to 2.2 GHz	3 MHz to 1.3 GHz	1.3 GHz to 2.2 GHz	2.2 GHz to 3 GHz
Source Match, test port ¹	14	11	18	15	12
Load Match, test port unselected ²	18	18	23	24	20
Load Match, test port selected ³	14	14	18	18	14
Interconnect Match, reflection port ⁴	12	10	17	15	10
Interconnect Match, transmission port ⁴	11	8	14	13	11
Insertion Loss, reflection port to port-n	7.5	9.5	6	8	12
Insertion Loss, transmission port to port-n	7.5	9.5	6	8	12
Tracking, reflection port to port-n	—	—	1.5	1.2	1.5
Tracking, transmission port to port-n	—	—	1.5	1.2	1.5
Crosstalk, uncalibrated, adjacent ports ⁵	90	90	100	95	85
Crosstalk, uncalibrated, non-adjacent ports ⁵	90	90	105	100	90

1. This is the match of the test set port which has been selected as the source port. The test set interconnect reflection port must be terminated with a load standard from either the HP 85036B/E calibration kit (for the HP 87075C) or the HP 85032B/E calibration kit (for the HP 87050E).
2. This is the match of any test port that is unselected (not in the measurement path). Only the source port of the test set is selected when you make a reflection measurement with 1-port calibration. Only the source and load ports of the test set are selected when you make a transmission or reflection measurement with 2-port calibration.
3. This is the match of the test set port which has been selected as the load port. A transmission or 2-port measurement is required for a test port to be selected as the load port. The test set interconnect transmission port must be terminated with a load standard from either the HP 85036B/E calibration kit (for the HP 87075C) or the HP 85032B/E calibration kit (for the HP 87050E).
4. This is the match of the test set interconnect ports (transmission and reflection ports) with the test set in transmission, or 2-port mode. The selected test set test ports must be terminated with load standards from either the HP 85036B/E calibration kit (for the HP 87075C) or the HP 85032B/E calibration kit (for the HP 87050E).
5. This is crosstalk of the test set measured between the test set's interconnect ports, with shorts on the selected test ports. Crosstalk is computed by normalizing the result of an isolation measurement to a through measurement between the two ports such that the path losses are taken into account. Isolation is defined as the transmission signal measured between any two ports of the test system when these two ports are terminated with shorts. The specification assumes that the test set crosstalk *has not been calibrated*. Adjacent ports are defined as: 1&2, 3&4, 5&6, 7&8, 9&10, and 11&12.

Table 8-9 **Test Set Input/Output Performance, 75 Ω**

HP 87075C Test Set Input/Output		
Description	Specification	Supplemental
Frequency Range		
HP 87075C	3 MHz–1.3 GHz	—
RF Input Power		
Maximum Input Power at 0.1 dB compression	—	16 dBm (typical)
Input Damage Power	—	20 dBm (characteristic)

Table 8-9 Test Set Input/Output Performance, 75 Ω (continued)

HP 87075C (75 Ω) Test Set Input/Output		
Description	Specification, dB	Typical, dB
	3 MHz to 1.3 GHz	3 MHz to 1.3 GHz
Source Match, test port ¹	12	16
Load Match, test port unselected ²	20	25
Load Match, test port selected ³	15	20
Interconnect Match, reflection port ⁴	12	18
Interconnect Match, transmission port ⁴	12	18
Insertion Loss, reflection port to port-n	7.5	6.5
Insertion Loss, transmission port to port-n	11.5	10.5
Tracking, reflection port to port-n	—	1.5
Tracking, transmission port to port-n	—	1.5
Crosstalk, uncalibrated, adjacent ports ⁵	57	72
Crosstalk, uncalibrated, non-adjacent ports ⁵	57	72

1. This is the match of the test set port which has been selected as the source port. The test set interconnect reflection port must be terminated with a load standard from either the HP 85036B/E calibration kit (for the HP 87075C) or the HP 85032B/E calibration kit (for the HP 87050E).
2. This is the match of any test port that is unselected (not in the measurement path). Only the source port of the test set is selected when you make a reflection measurement with 1-port calibration. Only the source and load ports of the test set are selected when you make a transmission or reflection measurement with 2-port calibration.
3. This is the match of the test set port which has been selected as the load port. A transmission or 2-port measurement is required for a test port to be selected as the load port. The test set interconnect transmission port must be terminated with a load standard from either the HP 85036B/E calibration kit (for the HP 87075C) or the HP 85032B/E calibration kit (for the HP 87050E).
4. This is the match of the test set interconnect ports (transmission and reflection ports) with the test set in transmission, or 2-port mode. The selected test set test ports must be terminated with load standards from either the HP 85036B/E calibration kit (for the HP 87075C) or the HP 85032B/E calibration kit (for the HP 87050E).
5. This is crosstalk of the test set measured between the test set's interconnect ports, with shorts on the selected test ports. Crosstalk is computed by normalizing the result of an isolation measurement to a through measurement between the two ports such that the path losses are taken into account. Isolation is defined as the transmission signal measured between any two ports of the test system when these two ports are terminated with shorts. The specification assumes that the test set crosstalk *has not been calibrated*. Adjacent ports are defined as: 1&2, 3&4, 5&6, 7&8, 9&10, and 11&12.

Table 8-10 Test Set General Information

HP 87050E and HP 87075C General Information		
Description	Specification	Supplemental Information
Port Connectors		
HP 87050E	—	Type-N, Female 50 Ω (nominal)
HP 87075C	—	Type-N, Female 75 Ω (nominal)
Front Panel Ports		
HP 87050E, 50 Ω , Opt. 004	4	—
HP 87050E, 50 Ω , Opt. 008	8	—
HP 87050E, 50 Ω , Opt. 012	12	—
HP 87075C, 75 Ω , Opt.006	6	—
HP 87075C, 75 Ω , Opt.012	12	—
Rear Panel		
Parallel In: Connector	—	25-pin D-subminiature Female (DB-25)
Parallel Out: Connector	—	25-pin D-subminiature Female (DB-25)
Line Power¹		
Frequency	47 to 63 Hz	—
Input Voltage, Operating	90 to 264 V	—
Input Power	—	<45 W, typical

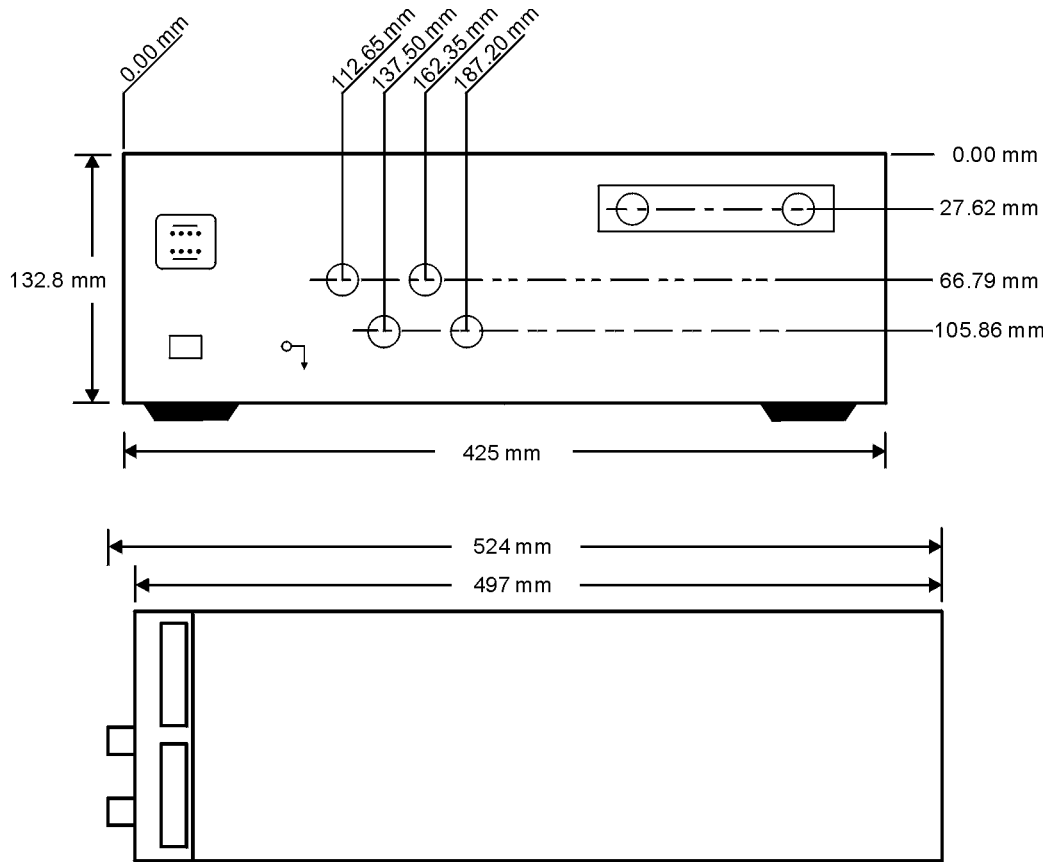
1. A third-wire ground is required.

Table 8-10 Test Set General Information (continued)

HP 87050E and HP 87075C General Information		
Description	Specification	Supplemental Information
General Environmental		
ESD	—	Minimize using static-safe work procedures and an antistatic bench mat (HP part number 9300-0797).
Dust	—	Minimize for optimum reliability.
Operating Environment		
General	Indoor Use Only	—
Temperature	0 °C to +55 °C	—
Humidity (relative)	less than 80% RH up to 31 °C, decreasing linearly to 50% RH at 40 °C	—
Altitude	0 to 4.5 km (15,000 ft)	—
Storage Conditions		
Temperature	–40 °C to +70 °C	—
Humidity (relative)	0% to 90% RH at +65 °C (noncondensing)	—
Altitude	0 to 15 km (50,000 ft)	—
Cabinet Dimensions		
Height × Width × Depth	—	132.8 x 425 x 497 mm (nominal) 5.2 x 16.7 x 19.6 in (nominal) Cabinet dimensions exclude front and rear protrusions.
Weight		
Net	—	8 kg (18 lb) (nominal)
Shipping	—	11 kg (24 lb), (nominal)

Physical Dimensions

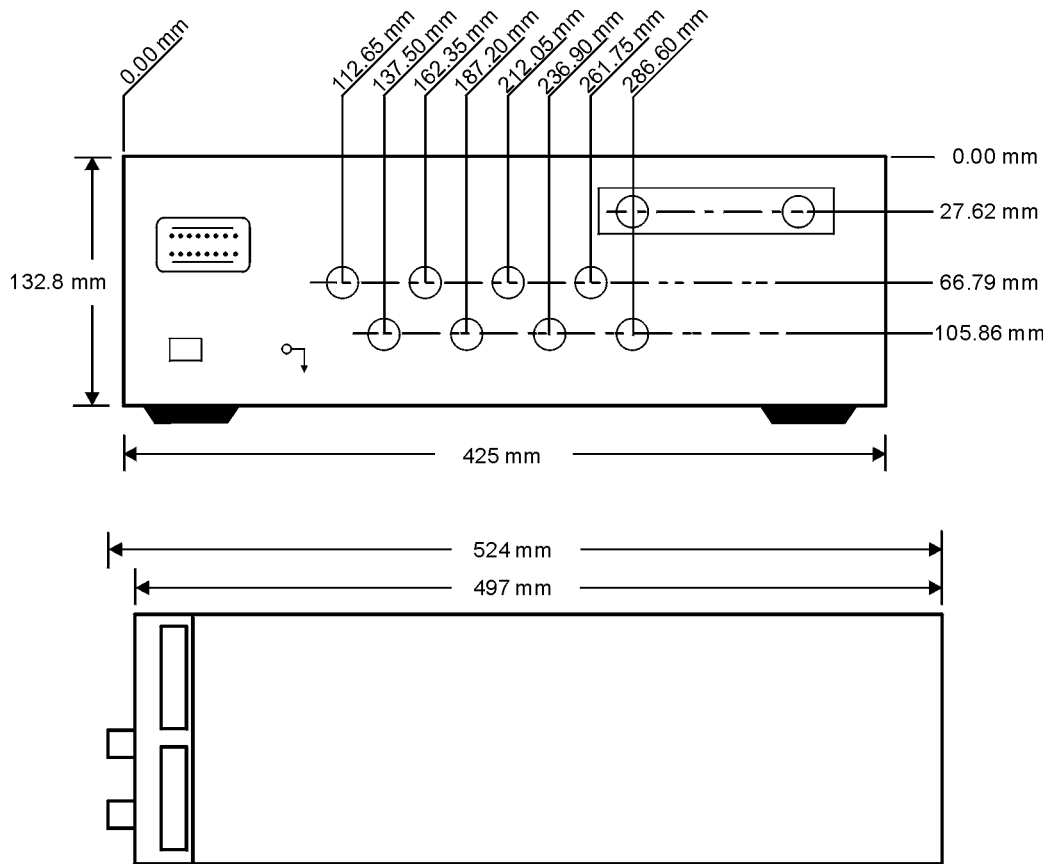
Figure 8-1 Physical Dimensions of the HP 87050E Option 004 Multiport Test Set¹



pt632e

1. These dimensions exclude rear protrusions.

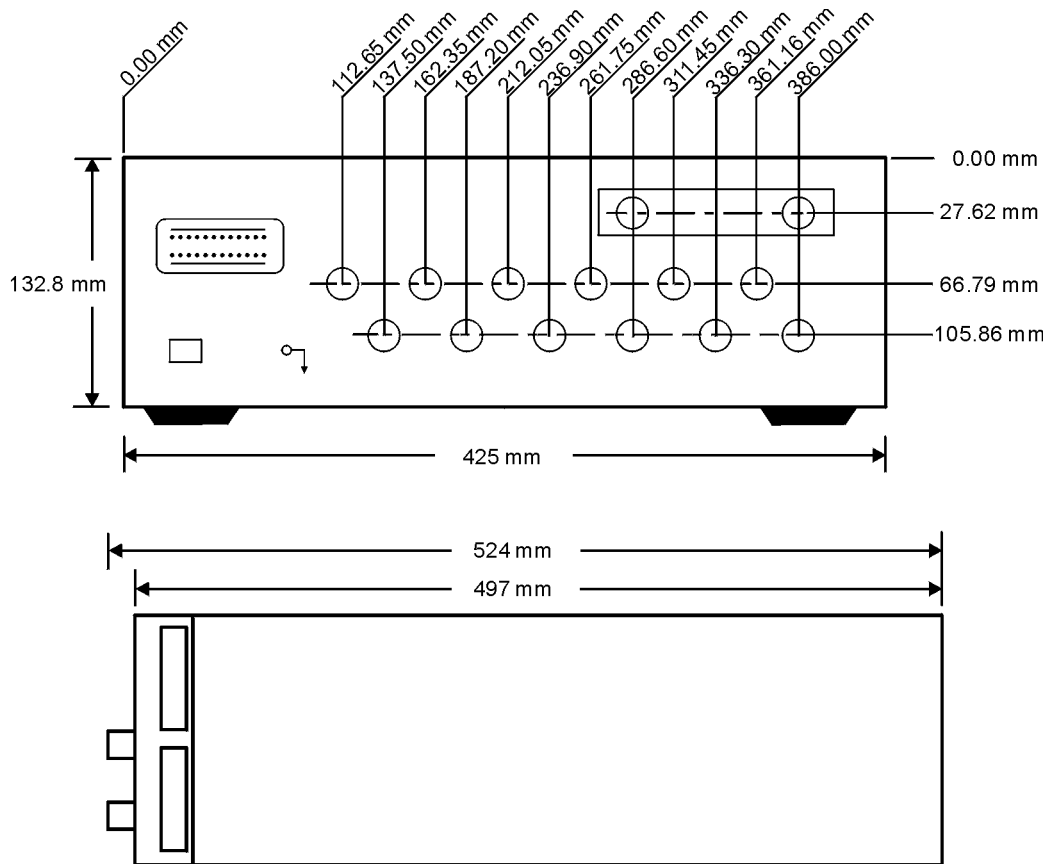
Figure 8-2 Physical Dimensions of the HP 87050E Option 008 Multiport Test Set¹



pt633e

1. These dimensions exclude rear protrusions.

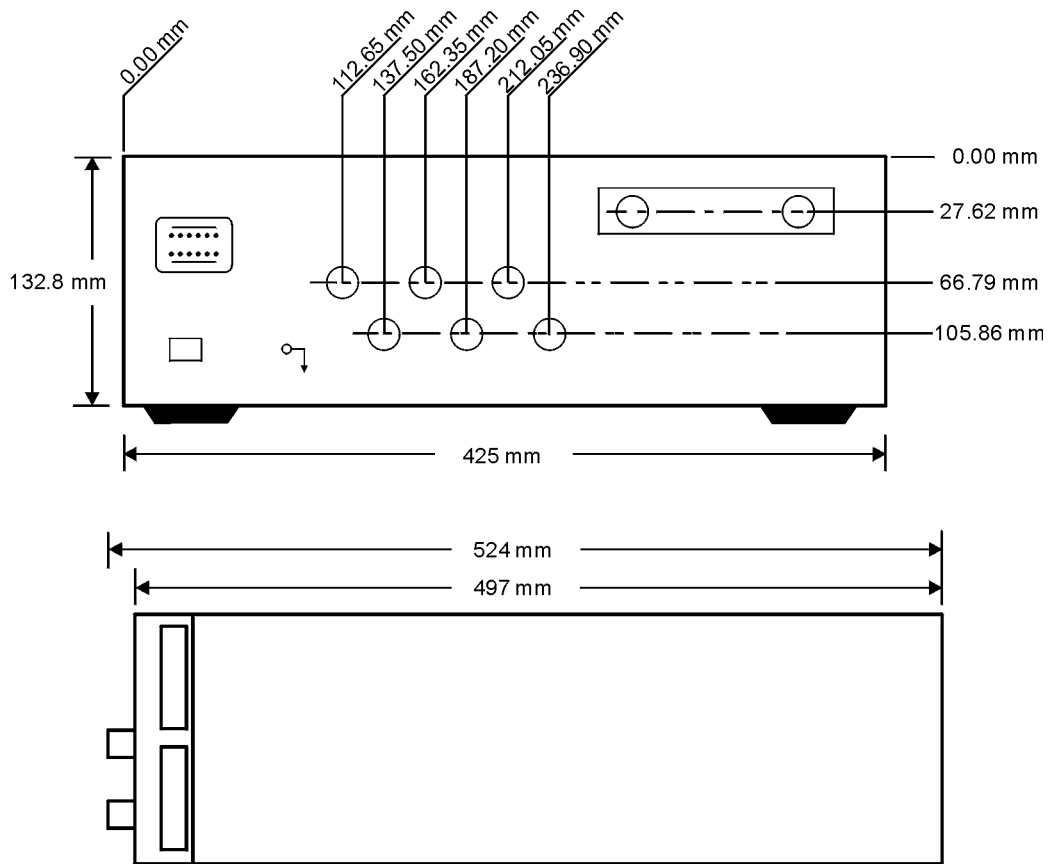
Figure 8-3 Physical Dimensions of the HP 87050E Option 012 Multiport Test Set¹



pt634e

1. These dimensions exclude rear protrusions.

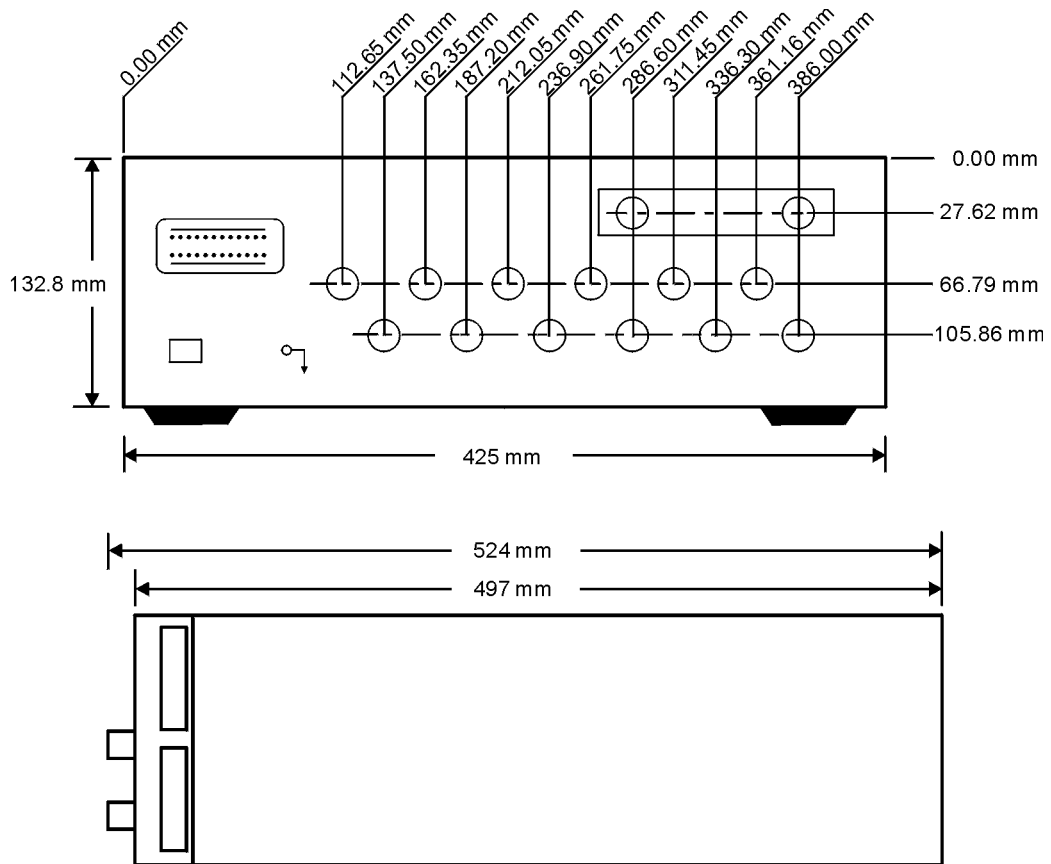
Figure 8-4 Physical Dimensions of the HP 87075C Option 006 Multiport Test Set¹



pt635e

1. These dimensions exclude rear protrusions.

Figure 8-5 Physical Dimensions of the HP 87075C Option 012 Multiport Test Set¹



pt634e

1. These dimensions exclude rear protrusions.

Warranty

NOTE

The actual warranty on your instrument depends on the date it was ordered as well as whether or not any warranty options were purchased at that time. To determine the exact warranty on your instrument, contact the nearest Hewlett-Packard sales or service office with the model and serial number of your instrument. See [Table 8-11 on page 8-38](#) for a list of sales and service offices.

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

If the warranty covers repair or service to be performed at the Buyer's facility, then the service or repair will be performed at the 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.

If the product is to be returned to Hewlett-Packard for service or repair, it must be returned to a service facility designated by Hewlett-Packard. Buyer shall prepay shipping charges to Hewlett-Packard and Hewlett-Packard shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to Hewlett-Packard from another country.

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

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

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

Exclusive Remedies

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. 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.

Hewlett-Packard Sales and Service Offices

If you should need technical assistance, contact the nearest Hewlett-Packard sales or service office. See [Table 8-11](#) on the next page.

Table 8-11 Hewlett-Packard Sales and Service Offices

UNITED STATES		
Instrument Support Center Hewlett-Packard Company (800) 403-0801		
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 (44 118) 9696622		
INTERCON FIELD OPERATIONS		
Headquarters Hewlett-Packard Company 3495 Deer Creek Rd. Palo Alto, CA 94304-1316 USA (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
Japan Hewlett-Packard Japan, Ltd. Measurement Assistance Center 9-1, Takakura-Cho, Hachioji-Shi Tokyo 192-8510, Japan TEL (81)- 426-56-7832 FAX (81)- 426-56-7840	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
China China Hewlett-Packard Co. 38 Bei San Huan X1 Road Shuang Yu Shu Hai Dian District Beijing, China (86 1) 256-6888		

9 **Service**

WARNING

These servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing unless you are qualified to do so.

WARNING

The opening of covers or removal of parts is likely to expose dangerous voltages. Disconnect the product from all voltage sources while it is being opened.

WARNING

The power cord is connected to internal capacitors that may remain live for 5 seconds after disconnecting the plug from its power supply.

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.

Automated Performance Tests

The operator's check and the performance verification tests make up the IBASIC performance test software program (for the HP part number see [Table 9-7 on page 9-36](#)). Your network analyzer is required to execute an IBASIC program to perform an operator's check or to verify test set performance.

The operator's check requires minimum user interaction and is designed to provide you with greater than 85% confidence that your test set is functioning properly. It is *not* designed to verify specifications nor to check the validity of calibrations.

NOTE

If you don't have access to the performance test software, the manual procedure for the Operator's Check can be used instead, although it is not as complete as the automated version. See ["Performing the Operator's Check" on page 2-16](#).

The performance verification tests are designed to verify specifications for the test set as listed in [Table 8-9 on page 8-26](#) and [Table 8-8 on page 8-25](#). Other specifications in [Chapter 8](#) apply to a complete test system, which is comprised of a test set *and* a network analyzer.

The performance test software uses traditional analyzer calibrations rather than a Test Set Cal. This is because the multiport test set is treated as a DUT by the analyzer.

The program file name is "PVT_TSET". To load the program for execution, insert the disk and press **SAVE RECALL** **Select Disk** . If necessary, press **Internal 3.5" Disk** . Scroll the highlight bar to the program file name and press **Programs** **Recall Program** . When finished, press **RUN** . (Load the program from the DOS-formatted disk.)

Test Equipment Required

For HP 87050E multiport test sets:

- HP 8712ET/ES or HP 8714ET/ES
RF network analyzer, 50 Ω impedance
- HP 85032B 50 Ω type-N calibration kit
- three high-quality 50 Ω cables (such as HP part number 8120-4781)

For HP 87075C multiport test sets:

- HP 8712ET/ES or HP 8714ET/ES
RF network analyzer, 75 Ω impedance (Option 1EC)
- HP 85036B 75 Ω type-N calibration kit
- two high-quality 75 Ω cables (such as HP part number 8120-2408)

Program Overview

IMPORTANT

For full performance verification, both the operator's check (Op Verif) and the performance tests (PerfTest) must be done.

An informational screen is presented when you start the program. Press **RESUME** to reach the main menu. The choices in the main menu are:

Op Verif

Pressing this key will run the automated operator's check. These tests check general operating characteristics, not specifications. Each test result is categorized as "PASS" or "WARNING."

Assuming the test mode has remained as "Standard" (see "CONFIG"), this test takes less than one minute to perform on a full 12-port system and provides greater than 85% confidence that the test set hardware is functioning normally. Follow the simple instructions on the screen.

If the "Enhanced" mode of operation is chosen, some standards, adapters, and flexible cables will be needed. The test times will still be less than a few minutes. While the standard test method is acceptable in most cases, the enhanced method is more accurate and should be used if there is any doubt about the accuracy of the measurement.

PerfTest

Pressing this key will run the performance tests, which check specifications. Each test result is categorized as "PASS" or "FAIL." The performance tests will check the following specified parameters:

- Source match
- Load match
- Interconnect match
- Insertion Loss
- Crosstalk

The performance tests may be run in either the enhanced or standard mode (see **f4 Test method** on the following page).

PRINT	Displays or prints the test results. (Printer configuration is done in the “CONFIG” area.)
Rd Info	Displays the current configuration of the test set.
HELP	Displays additional information that may be helpful when doing performance testing.
CONFIG	This selection allows you to specify several user and hardware options. Selection is via the softkeys. See “Configure for Performance Testing,” next, in this section.

Configure for Performance Testing

f2 Type of printer used specifies what type printer is to be used for data output. The three choices are HP-IB, Parallel, or Serial. The default selection is parallel.

f3 Printer HP-IB address specifies the printer’s HP-IB address. This value is only used if an HP-IB printer is selected. The default address is 01.

f4 Test method specifies the program’s mode of operation: standard or enhanced. In standard mode the default calibration of the analyzer is assumed to be accurate and the use of the provided interconnect cables is assumed. The standard method is much faster and simpler to perform and is usually sufficient.

If there is any question about the performance of the test set, then the enhanced mode should be used. User calibrations are performed in the enhanced mode. This will take more time but will compensate for many sources of error such as cable loss and match. This is the definitive test, and the uncertainties listed assume this mode of operation. In general, assuming the use of good cables, the difference between the two methods should be well under 1 dB. The default mode is Standard.

f5 Display messages allows you to turn on/off error and prompting messages on the screen of the analyzer. The display messages are most useful during troubleshooting. The use of display messages during a normal verification (where no problems are anticipated) may be distracting. The default is OFF.

Op Check Test Results

The operator's check tests are designed to provide you with greater than 85% confidence that your test set is functioning properly. They are *not* designed to verify specifications nor to check the validity of calibrations. They are implemented using special diagnostic SCPI commands. These tests check the values of:

- power supply voltages
- test set operating temperature
- internal, open, short, load, and through standards, located behind each port of the test set

Each test result is categorized as PASS or WARNING. The measured values are verified to be within acceptable ranges. If a measured value is outside of an acceptable range, a WARNING is indicated. When a WARNING occurs on one of these tests, it usually means the main printed circuit board (PCB) should be replaced.

Test results are displayed and printed with a very short description due to screen and space limitations. This section lists the test names along with more descriptive information.

Voltages/Temperature

AGND	Measured voltage of ground
P5VF	Measured voltage of the +5 volt supply
P15VF	Measured voltage of the +15 volt supply
N15VF	Measured voltage of the -15 volt supply
TEMP	Measured temperature of the main board in °C

RF Path Tests

MIN RL PORT X	These display the measured minimum and maximum return loss (in dB) of each port when left unterminated. Leaving a cable or device connected to any port will make this test fail.
MAX RL PORT X	
RL IntLoad P X	This displays the measured minimum (worst case) return loss of the internal load (the SelfCal load) for port X.
INT THRU P X-X	This displays the maximum insertion loss of adjacent port pairs (in dB) when using the internal through path. Adjacent port pairs are ports [1, 2], [3, 4], [5, 6], etc. Normally, maximum insertion loss occurs at the highest frequency.
O/S DEG Diff P X	This displays the difference, in phase degrees, of the measured reflection from the internal short versus the internal open. The nominal difference should equal 180 degrees, but in practice, the exact difference is not important; stability over time is more important than the exact difference.

NOTE

The accuracy of the RF Path Tests listed above depends on the quality of the analyzer's calibration. The standard test mode uses the default calibration and the enhanced test mode requires a user-defined calibration. When a WARNING occurs on one of these tests, repeat the test using the enhanced test mode to insure the analyzer's measurements are accurate.

Performance Verification Test Results

The performance verification tests are designed to verify specifications for the test set. This section lists the test names along with some descriptive information and the general steps involved in each test.

Each test result is categorized as PASS or FAIL. A FAIL indicates a specification has not been met. If a FAIL occurs when using the standard test mode, repeat the test using the enhanced test mode to insure the analyzer's measurements are accurate. If the failure is confirmed, refer to [“Troubleshooting” on page 9-16](#).

Some of the tests require simultaneous use of two precision female loads. This requires the use of the female-to-female adapter in the calibration kit.

SRC MATCH XX

Measures reflection at port XX when the port is switched to the test set's REFLECTION port, which is terminated with a precision load. Tests the specified performance of "Source Match," listed in [Table 8-8](#) and [Table 8-9](#) in [Chapter 8](#), "Specifications."

Steps:

- Perform reflection 1-port (User 1-port¹) calibration at end of cable (using short, open, and load).
- Connect precision load to test set's REFLECTION port.
- Measure reflection (S_{11}^1) at each port XX connected to test set's REFLECTION port.
- If spec is 16 dB, trace must be below -16 dB.

LD MATCH INT XX

Measures reflection at port XX when the port is terminated with the internal load (port XX is *not* switched to either the test set's REFLECTION port or TRANSMISSION port). Tests the specified performance of "Load Match, Test Port Unselected," listed in [Table 8-8](#) and [Table 8-9](#) in [Chapter 8](#), "Specifications."

Steps:

- Perform reflection 1-port (User 1-port¹) calibration at end of cable (using short, open, and load).
- Measure reflection (S_{11}^1) at each port XX when not connected to test set's REFLECTION port or TRANSMISSION port.
- If spec is 16 dB, trace must be below -16 dB.

LD MATCH XX

Measures reflection at port XX when the port is switched to the test set's TRANSMISSION port, which is terminated with a precision load. Tests the specified performance of "Load Match, Test Port Selected," listed in [Table 8-8](#) and [Table 8-9](#) in [Chapter 8, "Specifications."](#)

Steps:

- Perform reflection 1-port (User 1-port¹) calibration at end of cable (using short, open, and load).
- Connect precision load to test set's TRANSMISSION port.
- Measure reflection (S_{11}^1) at each port XX connected to test set's TRANSMISSION port.
- If spec is 16 dB, trace must be below -16 dB.

IC MATCH R->XX and IC MATCH T->XX

Measures reflection at the test set's REFLECTION port or TRANSMISSION port when the port is switched to port XX. Port XX is terminated with a precision load. Tests the specified performance of "Interconnect Match," listed in [Table 8-8](#) and [Table 8-9](#) in [Chapter 8, "Specifications."](#)

Steps:

- Perform reflection 1-port (User 1-port¹) calibration at end of cable (using short, open, and load).
- Connect test cable to test set's REFLECTION port or TRANSMISSION port.
- Measure reflection (S_{11}^1) at test set's REFLECTION port or TRANSMISSION port for each port XX when terminated with a precision load.
- If spec is 16 dB, trace must be below -16 dB.

INSERT LOSS R->XX
and
INSERT LOSS T->XX

Measures worst-case insertion loss between the test set's REFLECTION port or TRANSMISSION port and port XX when the test set is switched to port XX. Tests the specified performance of "Insertion Loss," listed in [Table 8-8](#) and [Table 8-9](#) in [Chapter 8](#), "Specifications."

Steps:²

- Perform transmission Enhanced Response calibration with two test cables (using short, open, load and through). The calibration reference plane should be between the two cables.
- Measure insertion loss from each port XX to test set's REFLECTION port or TRANSMISSION port.
- If spec is 16 dB, trace must be above -16 dB.

XTALK XX->YY

Measures crosstalk resulting from worst-case mismatch (shorts) between the selected ports of the test set. Tests the specified performance of “Crosstalk,” listed in [Table 8-8](#) and [Table 8-9](#) in [Chapter 8](#), “Specifications.”

Steps:³

- Set measurement parameters: system bandwidth Fine (15 Hz), Average Factor=8, and Power Level=10.
- Perform transmission Response & Isolation calibration (using two loads and a through cable at the ends of the test cables connected to the analyzer).
- Connect a load at the end of each test cable, then measure the noise floor. The transmission trace must be at least 19 dB below the crosstalk specification to be measured (for example, if the specification is 90 dB, then the trace must be below -109 dB).⁴
- Connect the analyzer to the test set using the test cables.
Repeat the following steps for each pair of ports to be tested:
 - Connect a through cable between ports XX and YY, and turn Normalize ON.
 - Remove the through cable and connect shorts to ports XX and YY.
 - Measure transmission (S_{21}).
 - If the specification is 90 dB, the trace must be below -90 dB.
 - Turn Normalize OFF.

1. For HP 8712ES/14ES analyzers only.
2. Direction of measurement does not matter.
3. Crosstalk measurements done on 11 pairs: port 1 to port 2, port 2 to port 3... port 11 to port 12. Pairs that begin with odd numbers are adjacent pairs. The five pairs that begin with even numbers are considered the worst-case nonadjacent pairs. Other nonadjacent pairs are *not* tested (for example, port 2 to port 4). This test measures the crosstalk within the testset with worst-case DUT port matches.
4. If the transmission trace is not below the required level, start the test again using a larger average factor and/or a higher power level (ignore the warnings about performance not specified).

Manual Performance Tests

There are no manual Performance Verification Tests for this instrument. It is not necessary to manually perform the Performance Verification Tests since they are available in an IBASIC program that is included with the performance test software. See [“Performance Verification Test Results” on page 9-9](#) for more information on each Performance Verification Test.

If it is necessary to manually control the instrument for performance testing or troubleshooting, refer to [“Manual Control of the Multiport Test Set” on page 9-19](#).

Adjustments

There are no adjustments for this instrument. Any drift in components can be compensated for with the SelfCal feature. Any failure will require the replacement of an assembly.

Troubleshooting

Refer to Chapter 1, “Introduction and Installation,” to make sure the test set is connected properly to the analyzer and that the analyzer has been configured for use with the multiport test set.

Troubleshooting consists of isolating the cause of any problem to an individual assembly. The multiport test set has three main assemblies:

- power supply
- LED display board
- main switch board assembly

WARNING

Line voltage may be present on exposed metal heat-sinks and other components contained on the power supply. Observe all safety precautions.

The Power Supply

WARNING

For continued protection against fire hazard, replace fuse only with same type and ratings (H 3.15 A, 250 VAC). The use of other fuses or materials is prohibited.

The line fuse is located on the power supply assembly. See the parts list (later in this chapter) for the fuse part number. The power supply is autoranging and will accept from 90 to 254 volts AC. The power supply provides ± 15 volts and +5 volts to the main board assembly via a four wire cable assembly. The pin-out is as follows:

Pin #	Voltage	Wire Color	LED Ref. Designator
1	+15 volts	brown	DS701
3	+5 volts	orange	DS700
4	ground	yellow	N/A
6	-15 volts	blue	DS702

If the power supply voltage is measured while the cable is disconnected from the main board assembly, the +5 volt supply may not function. It requires a load of at least 0.5 amps to operate properly. This can be simulated with any 10 ohm, 5 watt resistor.

The LEDs on the main board assembly indicate that power is being received. The fan operates from +12 volts and has its own regulator derived from the +15 volt supply. If the fan does not operate, check the +12 volt supply at test point TP706.

The LED Display Board

If all performance tests pass, but the LED indicators on the front panel do not operate, then the most likely cause of failure is the LED display board assembly or its associated ribbon cable.

The Main Switch Board Assembly

If any of the performance tests fail and the cause is not obvious, such as a bad power supply, damaged or loose connector, etc., then the recommended course of action is to replace the main board assembly.

IMPORTANT

Do not remove or adjust the shields on the main switch board assembly. The placement of shields and gaskets on the assembly is critical to the performance of the test set. Changes should only be made at the factory.

IMPORTANT

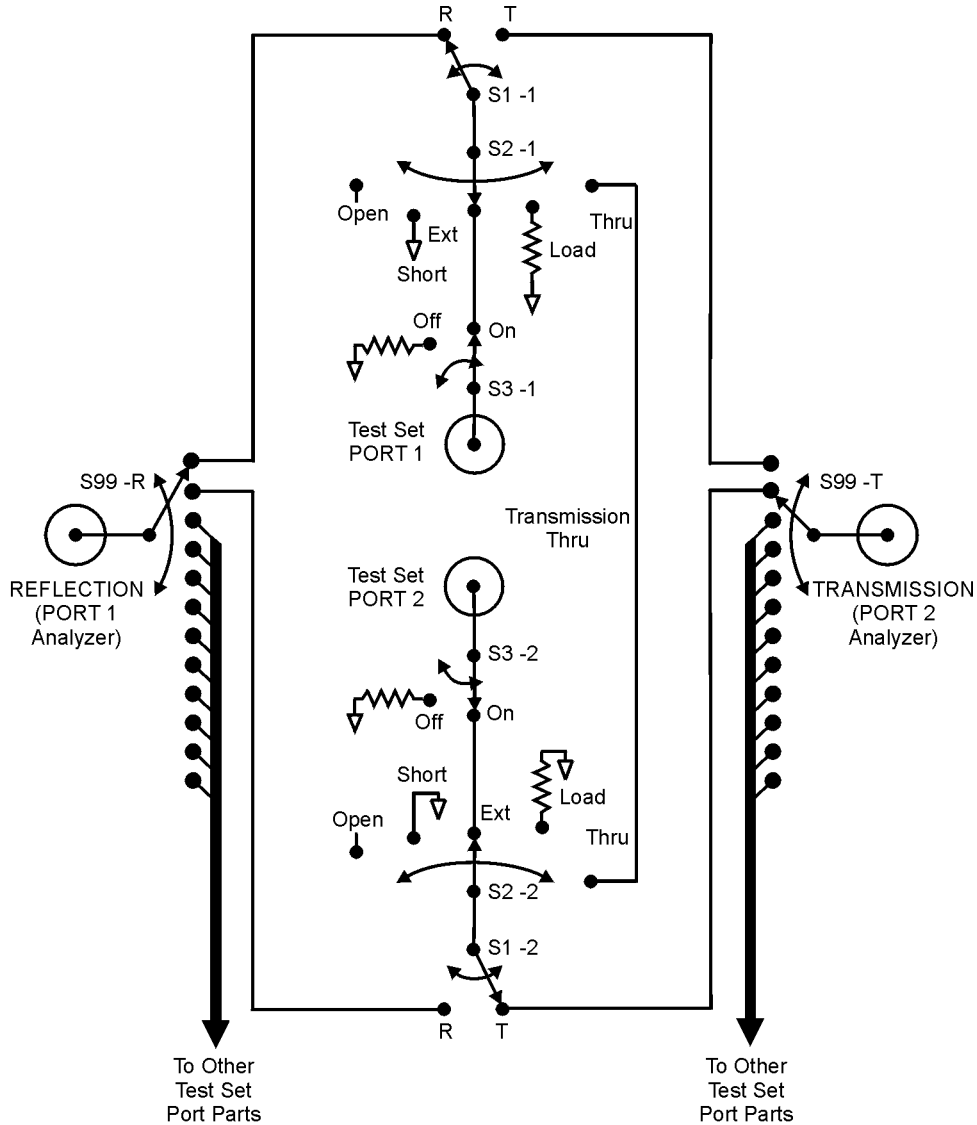
If the main board assembly is replaced, it is critical that the socketed ID ROM (U801) be transferred from the old board assembly to the new one. The replacement board assembly will *not* contain an ID ROM when purchased, and will not function properly without this ROM. In the unlikely case that this ROM should fail, contact the nearest HP office for instructions. See [Table 8-11 on page 8-38](#) for a list of Hewlett-Packard sales and service offices.

Post-Repair Procedure

If the main board assembly or power supply is replaced, a complete performance test should be performed. A Test Set Cal should be performed also (see [“Test Set Cal: An Overview” on page 4-5](#)) and stored on a disk for access by the end user.

Block Diagram

Figure 9-1 Block Diagram



pt66a

Manual Control of the Multiport Test Set

When troubleshooting or using the performance tests, most often you use traditional analyzer calibrations rather than a test set calibration. This is because the multiport test set is treated as the DUT, so the test set calibration feature is turned off. The test set calibration feature is turned off when the multiport test set is disabled or when you use traditional analyzer calibrations rather than a test set calibration. To disable the analyzer's multiport test set feature, press **(SYSTEM OPTIONS)** **System Config** **Switching Test Set** . **Toggle** **Multiport** to OFF. Disabling the multiport test set feature turns off the Test Set Cal function. When disabled, the test set may be controlled by special service-function softkeys. When the test set is enabled during troubleshooting, the analyzer's default calibration should generally be used. With the test set enabled, selecting the analyzer's default calibration or any other traditional analyzer calibration turns off the Test Set Cal function.

The remainder of this section explains how to use the special service-function softkeys to manipulate the settings of the multiport test set for manual performance testing and troubleshooting.

Before the special service-function softkeys are used, the necessary control tables must exist in the analyzer memory. To insure that these control tables exist, press **(SYSTEM OPTIONS)** **System Config** **Switching Test Set** . **Toggle** **Multiport** to ON and then to OFF.

To do manual performance testing and troubleshooting, the multiport function is disabled so that the test set acts as the DUT. (**Toggle** **Multiport** to OFF if not already done.) With the multiport function disabled, the measurement mode of the analyzer does *not* influence switch settings of the test set and the Test Set Cal is ignored.

The following paragraphs explain how the service menu softkeys control the switches in [Figure 9-1](#). To view the softkeys, press **(SYSTEM OPTIONS)** **Service** **Service Utilities** . Press **Next Menu** twice, then press **Multiport Tset Ctrl** .

[Figure 9-1](#) shows all of the switches related to test set PORT 1 and PORT 2. Switches specific to test set PORTS 3–12 are not shown.





The **Test Set Refl Port** softkey controls the REFLECTION switch (S99-R) and the **Test Set Tran Port** softkey controls the TRANSMISSION switch (S99-T). Generally, the position of these switches is indicated by the LEDs on the front panel of the test set. Switch positions are also shown at the bottom of the table on the analyzer display. To view the table,

toggle **Disp Table** to ON. The **Test Set Refl Port** softkey and the **Test Set Tran Port** softkey also control the position of each S1-*n* switch (*n* is the test set port number).

Pressing the softkey **PORT *n*** displays the Multiport Attribute menu associated with **PORT *n*** (press **More** until the port you want is displayed). This menu contains softkeys that control the positions of switches S3-*n* and S2-*n* (*n* is the test set port number). For example, if you selected **PORT 1 Ext**, this would place switch S2-1 in the EXT position and S3-1 in the ON position. (All of the other softkeys choices place S3-1 in the OFF position.) To place switch S2-1 in other positions, press **Open**, **Short**, **Load**, or **Thru**. Press **Off** to place switch S2-1 in the OPEN position.

As an example, to set up the test set switches for a measurement involving test set PORT 5 and PORT 6, use the following procedure.

Setting up the Test Set Switches for a Measurement

1. Press **Test Set Refl Port** .
Allows you to select a test set port to be connected to the Reflection switch (S99-R) for your measurement.
2. Use the analyzer's   keys, the keypad, or the front panel knob to select the port number, then press **Enter** . (In this example, press **5** **Enter** .)
Selects the test set port number (PORT 5 in this example). This port is now designated as the Reflection port.
3. Press **Test Set Tran Port** .
Allows you to select a test set port to be connected to the Transmission switch (S99-T) for your measurement.
4. Use the analyzer's   keys, the keypad, or the front panel knob to select the port number, then press **Enter** . (In this example, press **6** **Enter** .)
Selects the test set port number (PORT 6 in this example). This port is now designated as the Transmission port.
5. Press **Reset All Ports** .
Sets all ports to the OFF condition.

- 6.** Press **More** .

Displays the next menu on the analyzer display.
- 7.** Press the softkey of the port number designated as the Reflection port. (In this example, press **PORT 5** .)

Selects the port designated as the Reflection port (PORT 5 in this example).
- 8.** Press **Ext** .

Places switch S2-5 in the EXT position and switch S3-5 in the ON position.
- 9.** Press **Prior Menu**

Displays the previous menu on the analyzer display.
- 10.** Press the softkey of the port number designated as the Transmission port. (In this example, press **PORT 6** .)

Selects the port designated as the Transmission port (PORT 6 in this example).
- 11.** Press **Ext** .

Places switch S2-6 in the EXT position and switch S3-6 in the ON position.

Parts List

This section provides ordering information and lists the part numbers for the various replaceable parts, kits, and accessories for your multiport test set.

Ordering Information

To order a part listed in the replaceable parts lists:

1. Determine the part number and quantity required.
2. Mail the information to the nearest Hewlett-Packard office or, in the U.S., call the hotline number listed in the following section.

To order a part *not* listed in the replaceable parts lists:

1. Note the instrument model number, serial number and options (see the rear panel of the test set).
2. Describe the part and its function.
3. Determine the quantity required.
4. Mail the information to the nearest Hewlett-Packard office or, in the U.S., call the hotline number listed in the following section.

Call (800) 227-8164 to Order Parts Fast (U.S. Only)

When you have gathered the information required to place an order, contact Hewlett-Packard's direct ordering team by calling the toll-free hotline number shown above. Orders may be placed Monday through Friday, 6 AM to 5 PM (Pacific Standard Time).

The parts specialists have direct online access to replacement parts inventory corresponding to the replaceable parts lists in this manual. Four day delivery time is standard; there is a charge for hotline one-day delivery.

This information applies to the United States only. Outside the United States, you must contact the nearest HP sales and service office. (Refer to [Table 8-11 on page 8-38.](#))

Rebuilt-Exchange Assemblies

Under the rebuilt-exchange assembly program, certain factory-repaired and tested assemblies are available on a trade-in basis. These assemblies cost less than a new assembly, and meet all factory specifications required of a new assembly.

The defective assembly must be returned for credit under the terms of the rebuilt-exchange assembly program.

Shipping the Defective Assembly Back to Hewlett-Packard

1. When the rebuilt assembly is received, be careful not to damage the box in which it was shipped. You will use that box to return the defective assembly. The box you receive will contain the following:
 - The rebuilt assembly
 - An exchange assembly failure report
 - A return address label
2. Complete the failure report.
3. Place the failure report and the defective assembly in the box. Be sure to remove the enclosed return address label.
4. Seal the box with tape.

If you are inside the United States, stick the preprinted return address label over the label that is already on the box and return box to HP. (HP pays postage on boxes mailed within the United States.)

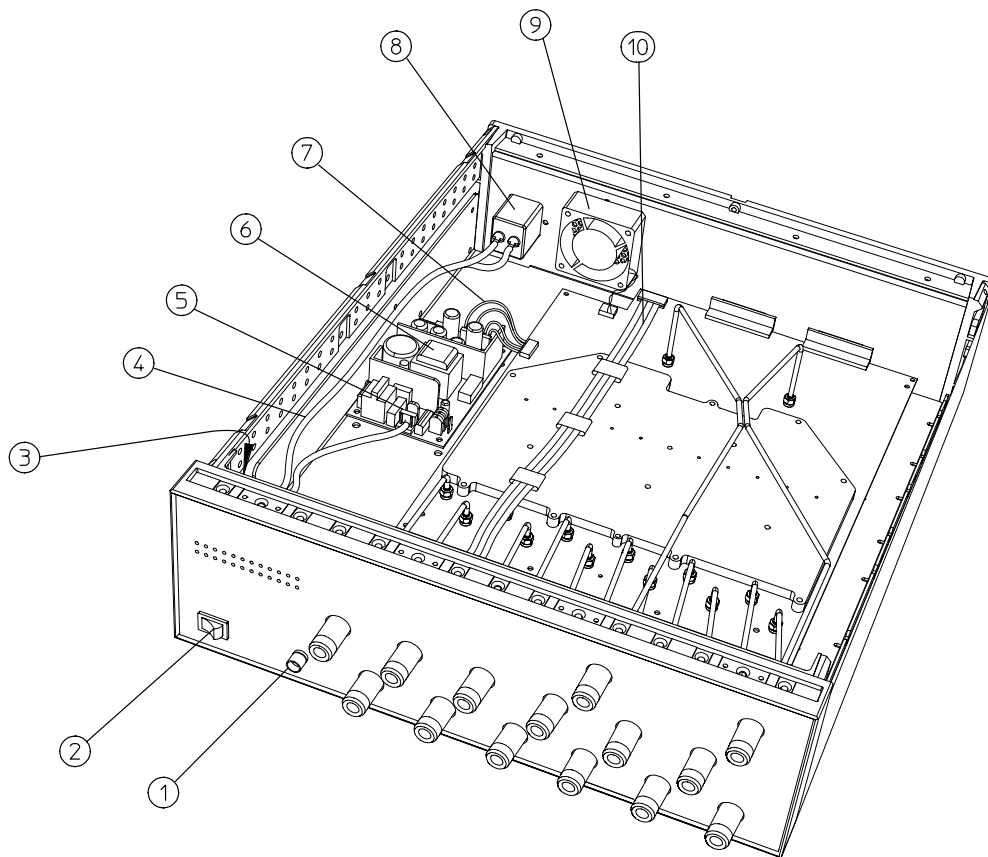
If you are outside the United States, do not use the return address label; instead, address box to the nearest HP sales or service office. (Refer to [Table 8-11 on page 8-38.](#))

Major Parts and Assemblies

Table 9-1

Item #	HP Part Number	Qty	Description
1	1510-0038	1	Ground connector
2	3101-3008	1	Line switch
3	87075-60014	1	Board assembly, LED display
4	87075-60018	1	Line module cable assembly
5	2110-0957	1	Fuse H 3.15 A, 250 VAC
6	0950-2023	1	Power supply assembly
7	87075-60019	1	Power supply cable assembly
8	87075-60018	1	Line module
9	87075-60021	1	Fan assembly
10	87075-60020	1	Ribbon cable

Figure 9-2 Major Parts and Assemblies

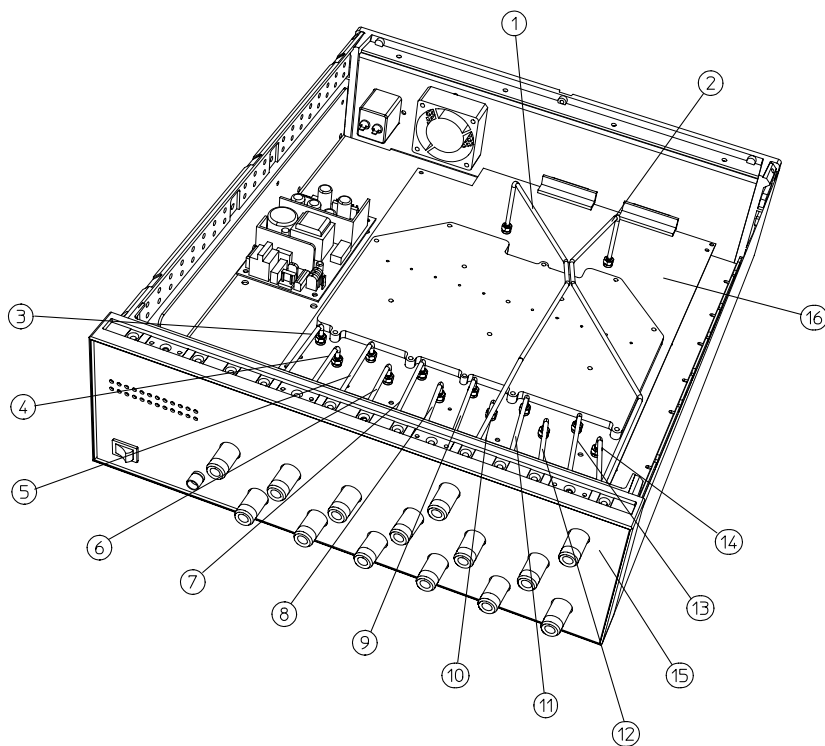


Cables, Front Panel, and Main Board Assembly — Option 012 (75 Ω and 50 Ω)

Table 9-2

Item #	HP Part Number	Qty	Description
1	(75 Ω) 87075-20034 (50 Ω) 87050-20124	1	Semi-rigid cable, REFLECTION port
2	(75 Ω) 87075-20035 (50 Ω) 87050-20125	1	Semi-rigid cable, TRANSMISSION port
3	(75 Ω) 87075-20036 (50 Ω) 87050-20112	1	Semi-rigid cable, test set PORT 1
4	(75 Ω) 87075-20037 (50 Ω) 87050-20113	1	Semi-rigid cable, test set PORT 2
5	(75 Ω) 87075-20038 (50 Ω) 87050-20114	1	Semi-rigid cable, test set PORT 3
6	(75 Ω) 87075-20039 (50 Ω) 87050-20115	1	Semi-rigid cable, test set PORT 4
7	(75 Ω) 87075-20040 (50 Ω) 87050-20016	1	Semi-rigid cable, test set PORT 5
8	(75 Ω) 87075-20041 (50 Ω) 87050-20117	1	Semi-rigid cable, test set PORT 6
9	(75 Ω) 87075-20042 (50 Ω) 87050-20118	1	Semi-rigid cable, test set PORT 7
10	(75 Ω) 87075-20043 (50 Ω) 87050-20119	1	Semi-rigid cable, test set PORT 8
11	(75 Ω) 87075-20044 (50 Ω) 87050-20120	1	Semi-rigid cable, test set PORT 9
12	(75 Ω) 87075-20045 (50 Ω) 87050-20121	1	Semi-rigid cable, test set PORT 10
13	(75 Ω) 87075-20046 (50 Ω) 87050-20122	1	Semi-rigid cable, test set PORT 11
14	(75 Ω) 87075-20047 (50 Ω) 87050-20123	1	Semi-rigid cable, test set PORT 12
15	(75 Ω) 87075-60017 (50 Ω) 87050-60064	1	Front panel assembly
16	(75 Ω) 87075-60013 (50 Ω) 87050-60069	1	Main board assembly
16	(75 Ω) 87075-69013 (50 Ω) 87050-69069	1	Rebuilt-exchange, main board assembly

Figure 9-3 Cables, Front Panel, and Main Board Assembly— Option 012



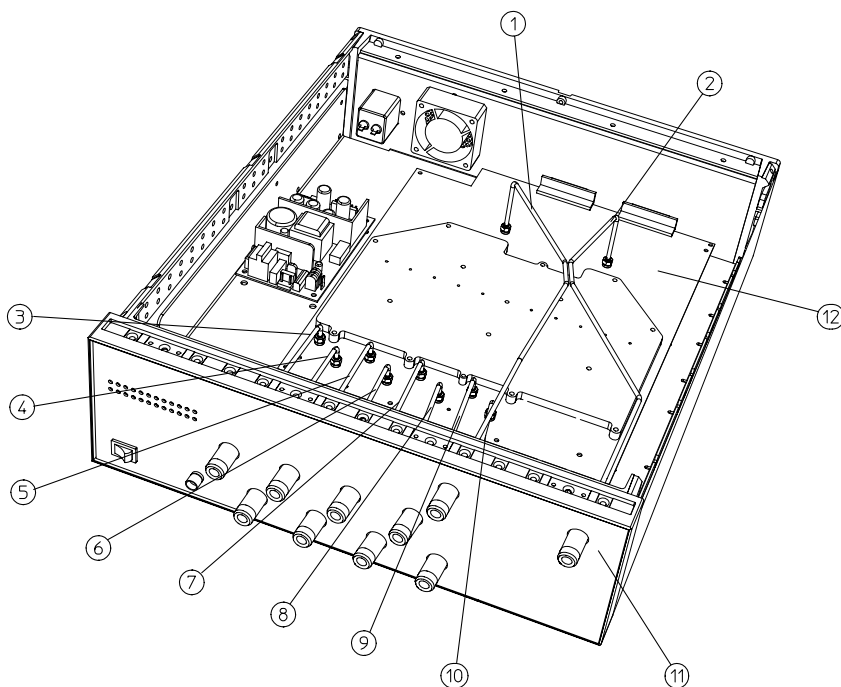
pt641e

Cables, Front Panel, and Main Board Assembly — Option 008 (50 Ω only)

Table 9-3

Item #	HP Part Number	Qty	Description
1	87050-20124	1	Semi-rigid cable, REFLECTION port
2	87050-20125	1	Semi-rigid cable, TRANSMISSION port
3	87050-20112	1	Semi-rigid cable, test set PORT 1
4	87050-20113	1	Semi-rigid cable, test set PORT 2
5	87050-20114	1	Semi-rigid cable, test set PORT 3
6	87050-20115	1	Semi-rigid cable, test set PORT 4
7	87050-20016	1	Semi-rigid cable, test set PORT 5
8	87050-20117	1	Semi-rigid cable, test set PORT 6
9	87050-20118	1	Semi-rigid cable, test set PORT 7
10	87050-20119	1	Semi-rigid cable, test set PORT 8
11	87050-60075	1	Front panel assembly
12	87050-60253	1	Main board assembly
12	87050-69253	1	Rebuilt-exchange, main board assembly

Figure 9-4 **Cables, Front Panel, and Main Board Assembly— Option 008**



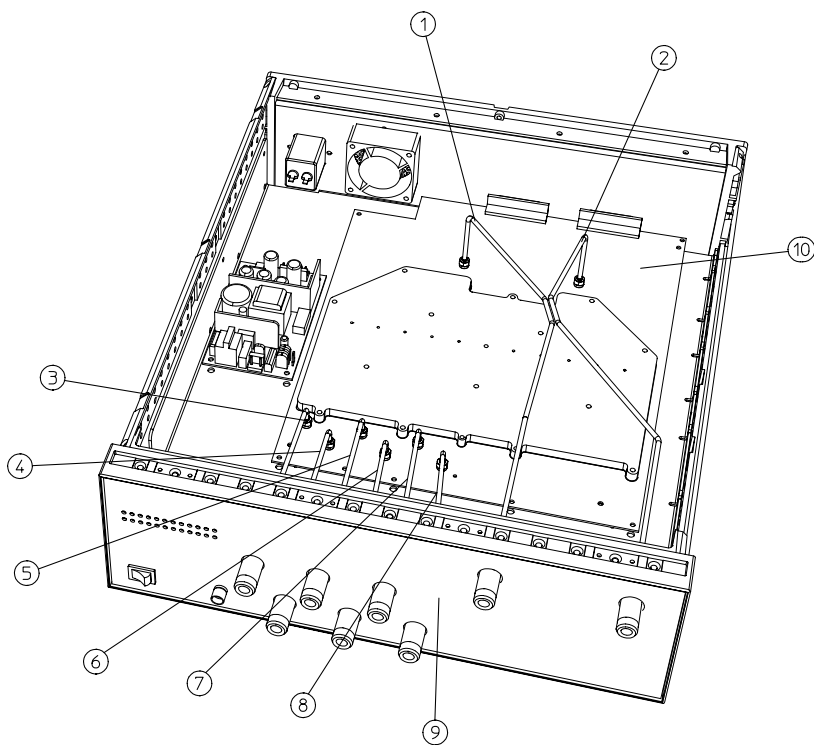
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**Cables, Front Panel, and Main Board Assembly—
Option 006 (75 Ω only)**

Table 9-4

Item #	HP Part Number	Qty	Description
1	87075-20034	1	Semi-rigid cable, reflection port
2	87075-20035	1	Semi-rigid cable, transmission port
3	87075-20036	1	Semi-rigid cable, test port 1
4	87075-20037	1	Semi-rigid cable, test port 2
5	87075-20038	1	Semi-rigid cable, test port 3
6	87075-20039	1	Semi-rigid cable, test port 4
7	87075-20040	1	Semi-rigid cable, test port 5
8	87075-20041	1	Semi-rigid cable, test port 6
9	87075-60015	1	Front panel assembly
10	87050-60013	1	Main board assembly
10	87050-69013	1	Rebuilt-exchange, main board assembly

Figure 9-5 **Cables, Front Panel, and Main Board Assembly— Option 006**



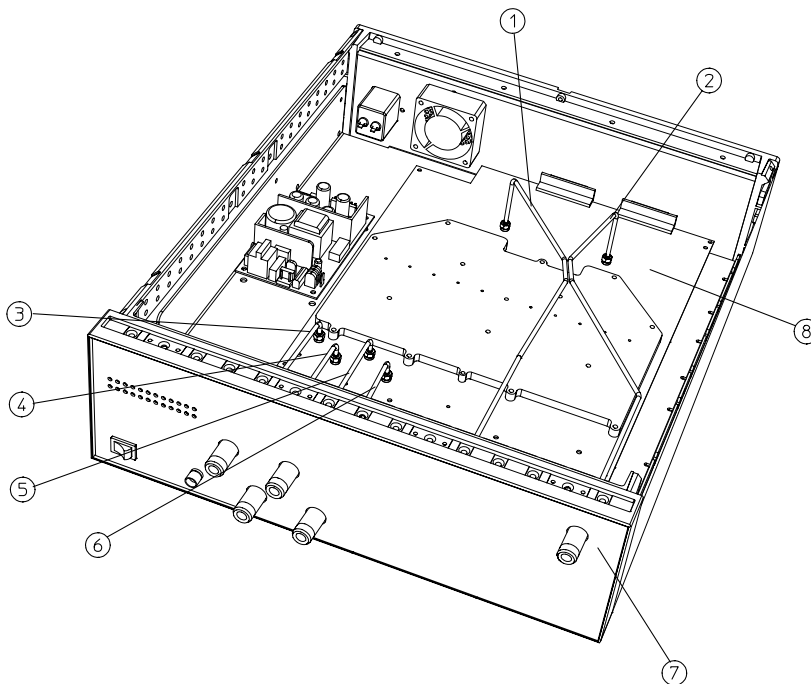
pt643e

**Cables, Front Panel, and Main Board Assembly —
Option 004 (50 Ω only)**

Table 9-5

Item #	HP Part Number	Qty	Description
1	87050-20124	1	Semi-rigid cable, REFLECTION port
2	87050-20125	1	Semi-rigid cable, TRANSMISSION port
3	87050-20112	1	Semi-rigid cable, test set PORT 1
4	87050-20113	1	Semi-rigid cable, test set PORT 2
5	87050-20114	1	Semi-rigid cable, test set PORT 3
6	87050-20115	1	Semi-rigid cable, test set PORT 4
7	87050-60073	1	Front panel assembly
8	87050-60252	1	Main board assembly
8	87050-69252	1	Rebuilt-exchange, main board assembly

Figure 9-6 **Cables, Front Panel, and Main Board Assembly— Option 004**



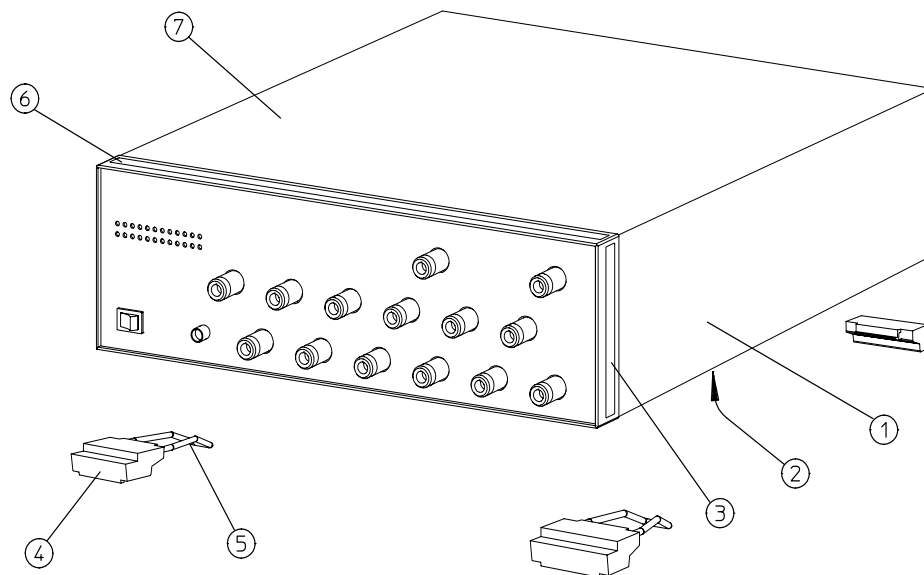
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Instrument Covers and Associated Parts

Table 9-6

Item #	HP Part Number	Qty	Description
1	5002-3964	2	Side cover
2	5002-1088	1	Bottom cover
3	5041-9171	2	Side trim
4	5041-9167	4	Feet
5	1460-1345	2	Tilt-up foot wire
6	5041-9176	1	Top trim
7	5002-1047	1	Top cover

Figure 9-7 Instrument Covers and Associated Parts



pr628

Accessories

Table 9-7

HP Part or Model Number	Description
HP 85036B/E	Type-N 75 Ω calibration kit
HP 85039B	Type-F calibration kit
HP 85032B/E	Type-N 50 Ω calibration kit
HP 85033D	3.5 mm calibration kit
HP 85031B	APC-7 calibration kit
HP 85038A/F/M	7-16 calibration kit
8120-6818	Parallel port interface cable ¹
(75 Ω) 87075-60026 (50 Ω) 87050-60058	Type-N front panel interconnect cable (REFL) ^{1,2}
(75 Ω) 87075-60027 (50 Ω) 87050-60059	Type-N front panel interconnect cable (REFL) ^{1,2}
(75 Ω) 87075-60028 (50 Ω) 87050-60060	Type-N front panel interconnect cable (TRANS) ^{1,2}
(75 Ω) 87075-60029 (50 Ω) 87050-60061	Type-N front panel interconnect cable (TRANS) ^{1,2}
08714-60049	Performance test programs disks (DOS and LIF formats) ¹

1. Supplied with your multiport test set.
2. See [Table 1-1 on page 1-11](#) for more information on these cables.

Documentation

Table 9-8

HP Part Number	Description
08714-90051	HP 8712ET/ES and HP 8714ET/ES CD-ROM (provides the contents of all of the documents listed below) ¹
87050-90026	HP 87050E and HP 87075C User's and Service Guide ¹
08714-90011	HP 8712ET/8714ET User's Guide
08714-90012	HP 8712ES/8714ES User's Guide
08714-90013	HP 8712ET/ES and HP 8714ET/ES The LAN Interface User's Guide Supplement
08714-90014	HP 8712ET/ES and HP 8714ET/ES Automating Measurements User's Guide Supplement
08714-90015	HP 8712ET/ES and HP 8714ET/ES Programmer's Guide
08714-90016	HP 8712ET/ES and HP 8714ET/ES Example Programs Guide
08714-90017	HP 8712ET/ES and HP 8714ET/ES Service Guide
E2083-90005	HP Instrument BASIC User's Handbook
08714-90019	HP 8712ET/ES and HP 8714ET/ES HP Instrument BASIC User's Handbook Supplement

1. Supplied with your multiport test set.

Service
Parts List

10 **Safety and Regulatory
Information**

Safety and Regulatory Information

This section contains required safety and regulatory information that is not included elsewhere in this manual.

Safety Information

Much of the required safety information is distributed throughout this manual in appropriate places. This section contains all required safety information that is not included elsewhere in this manual.

Warnings

IMPORTANT

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.

Warnings applicable to this instrument are:

WARNING

No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock, do not remove covers.

WARNING

If this instrument is not used as specified, the protection provided by the equipment could be impaired. This instrument must be used in a normal condition (in which all means for protection are intact) only.

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.

WARNING

The power cord is connected to internal capacitors that may remain live for 5 seconds after disconnecting the plug from its power supply.

WARNING

These servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing unless you are qualified to do so.

WARNING

The opening of covers or removal of parts is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.

Cautions

IMPORTANT

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.

Cautions applicable to this instrument are:

CAUTION

Always use the three-prong ac power cord supplied with this instrument. Failure to ensure adequate earth grounding by not using this cord may cause instrument damage.

CAUTION

This instrument has autoranging line voltage input; be sure the supply voltage is within the specified range.

CAUTION

This product is designed for use in Installation Category II and Pollution Degree 2 per IEC 1010 and 664 respectively.

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.

Statement of Compliance

This instrument has been designed and tested in accordance with IEC Publication 1010, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The instruction documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the instrument in a safe condition.

Cleaning Instructions








WARNING

To prevent electrical shock, disconnect the test set from mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.

Shipping Instructions

Always ship the instrument using the original packaging. Shipping the instrument in anything other than the original packaging may result in non-warranted damage.

Instrument Markings


	The instruction manual symbol. The product is marked with this symbol when it is necessary for the user to refer to the instructions in the manual.
	The CE mark shows compliance with European Community. (If accompanied by a year, it is the year when the design was proven.)
	The CSA mark is the Canadian Standards Association safety mark.
	This symbol is used to mark the ON position of the power line switch.
	This symbol is used to mark the OFF position of the power line switch.
	This symbol indicates that the input power required is ac.
ISM 1-A	This is a symbol of an Industrial Scientific and Medical Group 1 Class A product.
 N279	The C-Tick mark signifies compliance with an EMC requirement. It is a registered trademark of the Australian Spectrum Management Agency.

Regulatory Information

Notice for Germany: Noise Declaration

This is to declare that this instrument is in conformance with the German Regulation on Noise Declaration for Machines (Laermangabe nach der Maschinenlaermrerordnung –3.GSGV Deutschland).	
Acoustic Noise Emission/Geraeuschemission	
LpA < 70 dB	LpA < 70 dB
Operator position	am Arbeitsplatz
Normal position	normaler Betrieb
per ISO 7779	nach DIN 45635 t. 19

Declaration of Conformity

DECLARATION OF CONFORMITY	
According to ISO/IEC Guide 22 and EN 45014	
Manufacturer's Name:	Hewlett-Packard Co.
Manufacturer's Address:	1400 Fountaingrove Parkway Santa Rosa, CA 95403-1799 USA
Declares that the products:	
Product Name:	Multiport Test Set
Model Number:	HP 87050E, HP 87075C
Product Options:	This declaration covers all options of the above products.
Conform to the following product specifications:	
Safety: IEC 61010-1:1990 / EN 61010-1:1993 CAN/CSA-C22.2 No. 1010.1-92	
EMC: CISPR 11:1990/EN 55011:1991 Group 1, Class A IEC 801-2:1984/EN 50082-1:1992 4 kV CD, 8 kV AD IEC 801-3:1984/EN 50082-1:1992 3 V/m, 27-500 MHz IEC 801-4:1988/EN 50082-1:1992 0.5 kV sig. lines, 1 kV power lines	
Supplementary Information:	
The products herewith comply with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carry the CE-marking accordingly.	
	
Santa Rosa, CA, USA 13 Apr. 1999	Greg Pfeiffer/Quality Engineering Manager
European Contact: Your local Hewlett-Packard Sales and Service Office or Hewlett-Packard GmbH Department HQ-TRE, Herrenerberger Strasse 130, D71034 Boblingen, Germany (FAX +49-7031-14-3143)	

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