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## HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. In other documentation, to reduce potential confusion, the only change to product numbers and names has been in the company name prefix: where a product number/name was HP XXXX the current name/number is now Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

# **User's and Calibration Guide**

## **HP ESA-L1500A Spectrum Analyzer**



**HP Part No. E4411-90056    Supersedes E4411-90054**

**Printed in USA**

**April 1999**

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The following safety symbols are used throughout this manual. Familiarize yourself with the symbols and their meaning before operating this instrument.

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WARNING

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***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.**

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WARNING

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**This is a Safety Class 1 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 protected earth contact. Any interruption of the protective conductor inside or outside of the product is likely to make the product dangerous. Intentional interruption is prohibited.**

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WARNING

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**If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only.**

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**CAUTION**

*Caution* denotes a hazard. It calls attention to a procedure that, if not correctly performed or adhered to, could 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.

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The instruction documentation symbol. The product is marked with this symbol when it is necessary for the user to refer to the instructions in the documentation.



This symbol is used to mark the on position of the power line switch.



This symbol is used to mark the standby position of the power line switch.



This symbol indicates that the input power required is AC.

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# **1** **Preparing for Use and Printing**

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## Initial Inspection

Inspect the shipping container and verify that the contents are complete. Keep the container and cushioning material until you have inspected the spectrum analyzer.

**Table 1-1** contains the accessories shipped with the analyzer. If the contents are incomplete, or the spectrum analyzer does not pass the performance tests, notify the nearest Hewlett-Packard office. If the shipping container is damaged or the cushioning material shows signs of stress, also notify the carrier. Keep the shipping materials for the carrier's inspection. The HP office will arrange for repair or replacement without waiting for a claim settlement.

If the shipping materials are in good condition, retain them for possible future use. You may wish to ship the spectrum analyzer to another location or to return it to Hewlett-Packard for service. See [“How to Return Your Analyzer for Service”](#) on page 52 for more information about shipping materials.

If cleaning is necessary, use a damp cloth only.

---

**WARNING**

**To prevent electrical shock, disconnect the HP ESA-L1500A 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.**

---

**Table 1-1** Accessories Supplied with the Spectrum Analyzer

Description	HP Part Number	Comments
Adapter, Type N (m) to BNC (f)	1250-0780	Not shipped with Option 1DP. Two adapters are shipped with Option 1DN.
Power cable	See <a href="#">Table 1-4</a>	Shipped with analyzer.

## Power Requirements

The spectrum analyzer is a portable instrument and requires no physical installation other than connection to a power source. There is no need to select a line voltage.

**Table 1-2**

### AC Power Requirements

Voltage	90 to 250 Vrms
Frequency	47 to 440 Hz
Power Consumption, On	less than 200 W
Power Consumption, Standby	less than 5 W

**Table 1-3**

### DC Power Requirements

Voltage	12 to 22 Vdc <sup>a</sup>
Power Consumption	less than 175 W

a. 15 to 20 Vdc for serial prefix <US3745

## Checking the Fuse

Where IEC regulations apply, use a 5 by 20 mm, rated F5A, 250 V IEC approved fuse. This fuse may be used with input line voltages of 115 V or 230 V. Its HP part number is 2110-0709.

Where UL/CSA regulations apply, use a 5 by 20 mm rated fast blow, 5 A, 125 V UL/CSA approved fuse. *This fuse may only be used with an input line voltage of 115 V.* Its HP part number is 2110-0756.

The line fuse is housed in a small container in the upper left hand corner of the rear panel.

To remove the fuse, *first disconnect the power cord from the instrument.* Then insert the tip of a screwdriver into the slot at the middle of the container, and turn counterclockwise to extend the container.

---

WARNING

---

**For continued protection against fire hazard, replace the line fuse only with the same type and rating. The use of other fuses or material is prohibited.**

## **Power Cable**

The spectrum analyzer is equipped with a three-wire power cable, in accordance with international safety standards. When connected to an appropriate power line outlet, this cable grounds the instrument cabinet.

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WARNING

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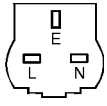
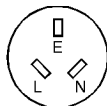
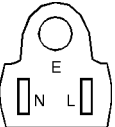
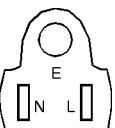
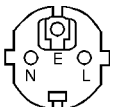
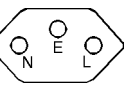
**Failure to ground the spectrum analyzer properly can result in personal injury. Before turning on the spectrum analyzer, you must connect its protective earth terminals to the protective conductor of the main power cable. Insert the main power cable plug only into a socket outlet that has a protective earth contact. DO NOT defeat the earth-grounding protection by using an extension cable, power cable, or autotransformer without a protective ground conductor.**

**If you are using an autotransformer, make sure its common terminal is connected to the protective earth contact of the power source outlet socket.**

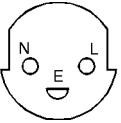
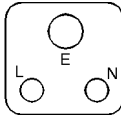
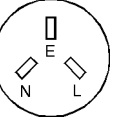
---

Various power cables are available to connect the spectrum analyzer to the types of ac power outlets unique to specific geographic areas. The cable appropriate for the area to which the spectrum analyzer is originally shipped is included with the unit. You can order additional ac power cables for use in different areas. The following table lists the available ac power cables, illustrates the plug configurations, and identifies the geographic area in which each cable is appropriate.

**Table 1-4 Power Cables**

Plug Type <sup>a</sup>	HP Cable Part Number	Plug <sup>b</sup> Description	Length cm (in.)	Cable Color	For Use in Country
250V 	8120-1351	Straight BS 1363A	229 (90)	Mint Gray	Option 900 United Kingdom, Hong Kong, Cyprus, Nigeria, Singapore, Zimbabwe
	8120-1703	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	



Plug Type <sup>a</sup>	HP Cable Part Number	Plug <sup>b</sup> Description	Length cm (in.)	Cable Color	For Use in Country
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.

---

## Preparation

- 
- WARNING** If this product is to be energized via an external autotransformer for voltage reduction, make sure that its common terminal is connected to a neutral (earthed pole) of the power supply.
- 
- CAUTION** This instrument has autoranging line voltage input. Be sure the supply voltage is within the specified range.
- 
- CAUTION** Ventilation Requirements: When installing the product in a cabinet, the convection into and out of the product must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the product 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.
- 
- NOTE** Install the instrument so that the detachable power cord is readily identifiable and is easily reached by the operator. The detachable power cord is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument. The front panel switch is only a standby switch and is not a LINE switch. Alternatively, an externally installed switch or circuit breaker (which is readily identifiable and is easily reached by the operator) may be used as a disconnecting device.
-

## Turning on the Analyzer for the First Time

When you turn on the spectrum analyzer, you will see the message “**Doing Initial Alignment**” on the display. This tells you that the instrument is performing a portion of its automatic alignment.

To make sure your spectrum analyzer meets specifications, allow a 5 minute warm-up before making calibrated measurements.

---

**NOTE**

It is normal to hear clicking when the Auto Alignment function is on. During the interval between sweeps portions of the spectrum analyzer’s circuitry are realigned. Some of the circuitry is controlled by relays. It is the rapid switching of these relays between sweeps which causes the clicking sound. Under normal operation, these relays will last over 50 years.

To eliminate the clicking sound, turn off the automatic alignment. (See the **Alignments** key description in Chapter 4.) The **Align Now All** function should, however, be performed periodically. For more information on how often to perform **Align Now All** when the Auto Alignment function is off, refer to Chapter 7, “Specifications.”

---

If you wish to use an external 10 MHz source as the reference frequency, connect an external reference source to the **10 MHz REF IN** connector on the rear panel. The signal level should be greater than  $-15$  dBm.

Perform the following steps:

1. Before using your spectrum analyzer, make sure it meets operating temperature conditions.
2. Plug the power cord into the spectrum analyzer.
3. Press I (the On key).

After a few seconds, the screen will display the firmware revision date in the YYYYMMDD format. For example, Rev 19970522 indicates revision May 22, 1997.

---

**NOTE**

Record the firmware date and keep it for reference. If you should ever need to call Hewlett- Packard for service or with any questions regarding your spectrum analyzer, it will be helpful to have the firmware date readily available.

If your spectrum analyzer is equipped with Option A4H (HP-IB and Parallel interface), the interface address (**HP-IB ADRS: XX**) also appears on the screen.

If your spectrum analyzer is equipped with Option 1AX (RS-232 and Parallel interface), the baud rate (**RS232: XXXX**) is displayed.

4. To meet spectrum analyzer specifications, allow a 5 minute warm-up before attempting to make any calibrated measurements.
5. Refer to Chapter 7, “Specifications,” for information on when you should perform automatic alignment functions.

## Printing with HP-IB

More than one instrument can communicate on the same HP-IB. Therefore, each device must have a unique HP-IB address.

The printer must be configured with an address which can be recognized by the spectrum analyzer. Be sure the spectrum analyzer's printer address is the same as that of the printer.

The spectrum analyzer will not print if it senses another controller on the HP-IB. Therefore, other controllers, such as computers, must be disabled. In most cases, it is sufficient to simply turn the other controllers **OFF**.

## Printing Using an HP-IB Interface

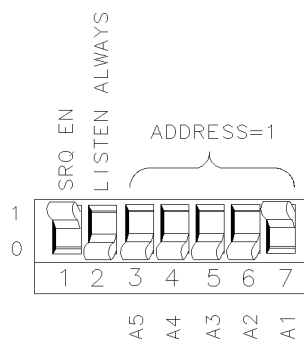
### Equipment

- HP ESA-L1500A Spectrum Analyzer equipped with Option A4H.
- HP 10833A (or equivalent) HP-IB cable.
- Printer with HP-IB Interface. Choose one of the following:
  - HP 2225A ThinkJet
  - HP 3630A PaintJet

## Interconnection and Printing Instructions

1. Turn off the printer and the spectrum analyzer.
2. Connect the printer to the spectrum analyzer using the HP-IB cable.
3. The printer usually resides at device address 1. See [Figure 1-1](#) for a typical HP-IB printer switch setup.

**Figure 1-1 ThinkJet Printer Switch Settings**



pu129e1

4. Turn on the spectrum analyzer and printer.
5. The printer usually resides at device address 1. To configure the spectrum analyzer to print to address 1, press the following keys:

**System**

**Printer**

**Port**

**HP-IB**

**Printer Addr** (appears in the menu only when **HP-IB** is selected)

**1**

**Enter**

6. Select the printer configuration for your spectrum analyzer by pressing the appropriate keys. (See “Selecting a Printer” in this chapter).

## Printing with RS-232

### Printing Using an RS-232 Interface

This section describes how to print using an RS-232 interface. The printer must be configured to be compatible with the spectrum analyzer. Pay particular attention to the following:

Character Size 8-Bits

Parity OFF

Baud Rate 9600 (typical)

Handshaking DTR=YES, DUPLEX=FULL

### Equipment

- HP ESA-L1500A Spectrum Analyzer equipped with Option 1AX.
- One of the following cables:
  - HP 24542G 9-25 pin RS-232 cable
  - HP C2932A 9-9 pin RS-232 cable (for use with LaserJet 4P and 4Plus)
- Printer with RS-232 interface. Choose one of the following:
  - HP 500 Series DeskJet
  - HP 2225D ThinkJet
  - HP 3630A PaintJet
  - Epson MX-80
  - Epson LQ-570
  - HP LaserJet
  - HP QuietJet or QuietJet Plus

Some models support color printing. Some models do not support the RS-232 interface.

### Interconnection and Printing Instructions

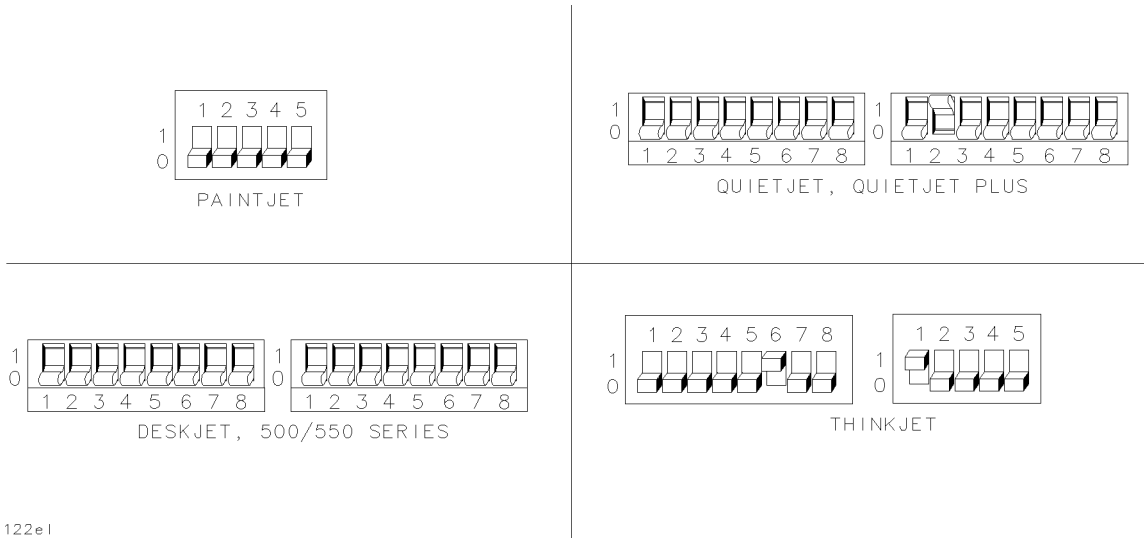
The RS-232 interface allows only one device to be connected to the spectrum analyzer. Refer to the programmer's guide for more information on RS-232 protocol.

1. Turn off the spectrum analyzer and the printer.

2. Connect the printer using an RS-232 cable.

The following Figure shows examples of some of the printer's switch configurations set up for 9600 baud. See your printer's documentation for more specific information.

**Figure 1-2 9600 Baud Settings for Serial Printers**



pu122e1

To set the spectrum analyzer baud rate to 9600, press:

- System**
- Printer**
- Port**
- Serial**
- Baud Rate (appears in the menu only when Serial is selected)**
- 9600**
- Enter**

3. Select the printer configuration for your spectrum analyzer by pressing the appropriate keys. (See "Selecting a Printer" in this chapter).



## Printing With a Parallel Interface

This section describes how to print using a parallel interface.

### Equipment

- HP ESA-L1500A Spectrum Analyzer equipped with Option A4H or 1AX.
- HP C2950A parallel printer cable.
- Printer with parallel interface. Choose one of the following:
  - HP 2225C ThinkJet
  - HP 310 Portable DeskJet
  - HP 3630A PaintJet
  - HP 500, 600, and 700 Series DeskJets
  - HP LaserJet
  - HP QuietJet or QuietJet Plus
  - LQ-570 Epson
  - MX-80 Epson

### Interconnection and Printing Instructions

1. Turn off the printer and the spectrum analyzer.
2. Connect the printer to the spectrum analyzer using the parallel printer cable.
3. If your printer has configuration switches, now is the time to set them. Refer to your printer's documentation for more specific information on your printer's configuration.
4. Turn on the spectrum analyzer and printer.
5. To print with a parallel interface press the following keys:

**System**

**Printer**

**Port**

**Parallel**

6. Select the printer configuration for your spectrum analyzer by pressing the appropriate keys. (See "Selecting a Printer" in this chapter).

---

## Selecting a Printer

This section describes how to select a printer listed in the **Select Printer** menus, as well as how to configure a printer unavailable as a menu selection, by using the **Define Printer** menu keys.

### How to Select a Printer

To access the printer selection menus, press the following keys:

- System**
- Printer**
- Select Printer**
- More** (if necessary)

If your printer is listed in the **Select Printer** menus, simply press the appropriate key. If the printer you wish to use is not listed, refer to “Defining a Printer” in this section.

### Defining a Printer

If you have searched the **Select Printer** menu keys, and your printer is not available as a selection, press the last menu key, which is labeled **User Defined**. When you press the **User Defined** key, the **Define Printer** key will appear in the menu.

The **Define Printer** key accesses the following menu of keys which may allow you to use your printer:

#### Resolution

Resolution allows you to select the optimal resolution number to be sent to the printer. Before a print, enter the resolution number using the numeric keypad. (The knob and step keys cannot be used.) Values to try include 75, 90, 100, 150, and 300.

#### Top Margin

Top Margin allows you to adjust the space above your print by entering a number using the numeric keypad. (The knob and step keys cannot be used.)

#### Bottom Margin

Bottom Margin allows you to adjust the space below your print by entering a number using the numeric keypad. (The knob and step keys cannot be used.)

**HP Color Mode DJ PJ Off**

HP Color Mode allows you to select between DeskJet, PaintJet, or Off. For most color printing, use DeskJet.

---

**NOTE**

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For color printing, the **Color Printing On Off** key must be set to **On**. Refer to the **Printer** key in Chapter 4, for all printer menu key descriptions.

**Expand On Off**

For printers that only support high resolutions, **Expand On Off** (with **On** selected) allows you to expand your prints by a factor of three.

---

## **2** **Getting Started**

## What You'll Find in this Chapter

This chapter introduces the basic functions of the spectrum analyzer. In this chapter you will:

- Get acquainted with the front-panel and rear-panel features.
- Get acquainted with the function keys.
- Learn about screen annotation.
- Make a basic measurement (using the internal alignment signal).
- Learn about the spectrum analyzer battery for retaining internal memory.

---

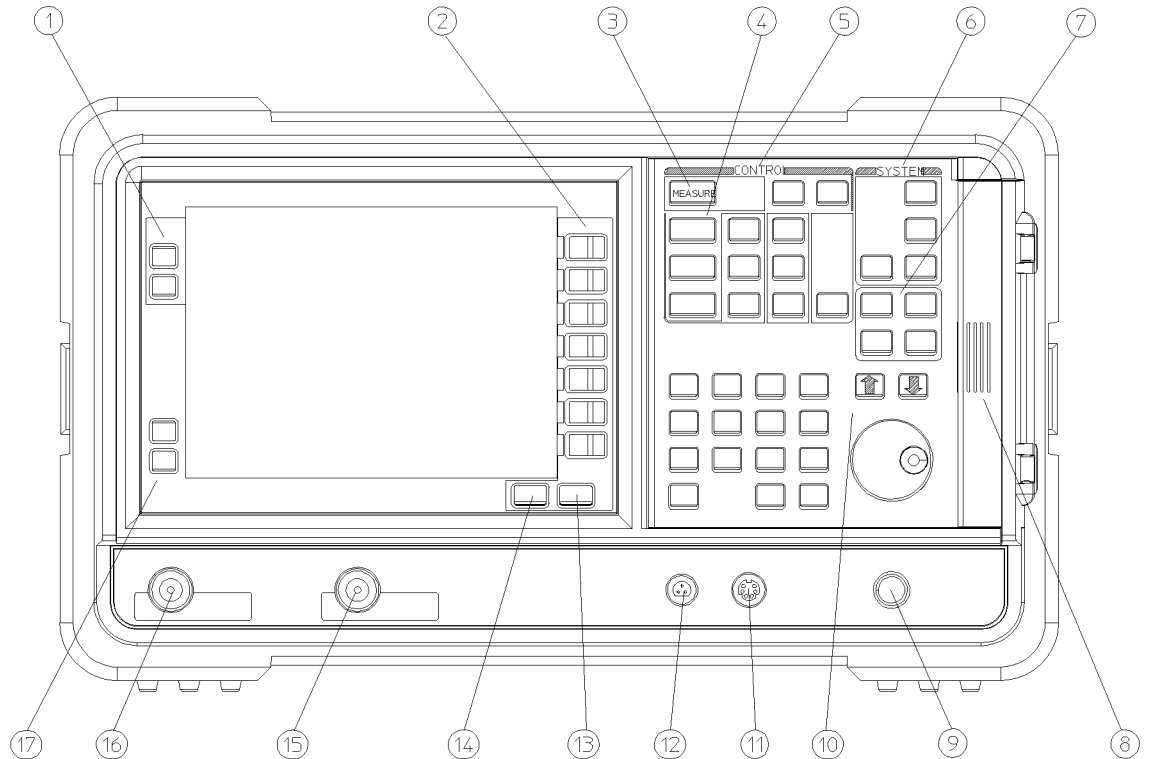
NOTE

Before using your spectrum analyzer, please read [Chapter 1, "Preparing for Use and Printing,"](#) which describes how to set up your spectrum analyzer and how to verify that it is operational. [Chapter 1](#) describes many safety considerations that should not be overlooked.

---

## Front Panel Features

**Figure 2-1** Front Panel Feature Overview



bn79a

- 1** **Brightness keys** allow you to change the brightness of the display.
- 2** **Menu keys** are the unlabeled keys next to the screen. The menu key labels are the annotation on the screen next to the unlabeled keys. Most of the labeled keys on the spectrum analyzer front panel (also called front panel keys) access menus of related function keys.
- 3** **Measure** accesses a menu of keys that make some common spectrum analyzer measurements.
- 4** **Frequency, Span, and Amplitude** are the three large keys that activate the primary spectrum analyzer functions and access menus of related functions.

- 5            **CONTROL** functions access menus that allow you to adjust the resolution bandwidth, adjust the sweep time, and control the instrument display. They also set other spectrum analyzer parameters needed for making measurements.
- 6            **SYSTEM** functions affect the state of the entire spectrum analyzer. Printer setup and alignment routines are accessed with the **System** key. The green **Preset** key resets the spectrum analyzer to a known state.
- The **File** key menu allows you to save and load traces, states, limit-line tables and amplitude correction factors to or from spectrum analyzer memory.
- Print** sends a copy of the screen data to a printer. Use the **Printer** menu keys under **System** before using the **Print** key. See Chapter 4 for more details.
- 7            **MARKER** functions control the markers, read out frequencies and amplitudes along the spectrum analyzer trace, automatically locate the signals of highest amplitude, and keep a signal in the center of the screen.
- 8            **EARPHONE.** The **EARPHONE** connector (located behind the door on the right side of the front panel) provides a connection for an earphone jack instead of using the internal speaker.
- 9            **VOLUME.** The **VOLUME** knob can adjust the volume of the internal speaker. The speaker is turned on and off with the **Speaker On Off** key in the **Det/Demod** menu.
- 10           **DATA** keys, which include the step keys, knob, and numeric keypad, allow you to change the numeric value of an active function.
- 11           **EXT KEYBOARD.** The **EXT KEYBOARD** connector is a 6-pin mini-DIN connector that is compatible with most PC keyboards. The external keyboard is not included with the spectrum analyzer. The external keyboard can be used to enter screen titles and remote commands.

---

**CAUTION**

---

Turn off the spectrum analyzer before connecting an external keyboard to the spectrum analyzer.

- 12           **PROBE POWER** provides power for high-impedance ac probes or other accessories.

- 13            **Esc.** The **Esc** (escape) key deactivates the active function and blanks the active function text from the display. **Esc** will abort a print (if one is in progress) and clear error messages from the analyzer display. It also clears input and tracking generator overload conditions.
- 14            **More.** The **More** key accesses other pages of a multi-page menu. A **1 of 2** type message is displayed just above the key if there is more than one page.
- 15            **INPUT 50Ω (INPUT 75Ω for Option 1DP)** is the signal input for the spectrum analyzer.
- 16            **RF OUT 50Ω (for Option 1DN) or RF OUT 75Ω (for Option 1DQ)** is the source output for the built-in tracking generator. *Option 1DN or 1DQ only.*

---

**CAUTION**

If the tracking generator output power is too high, it may damage the device under test. Do not exceed the maximum power that the device under test can tolerate.

---

- 17            The **I (On)** key turns the analyzer on, while the **O (Standby)** key turns most of the analyzer off. An instrument alignment is performed every time the analyzer is turned on. After turning on the analyzer, allow 5 minutes of warm-up time to ensure the analyzer will meet all specifications.

---

**NOTE**

The instrument continues to draw power when it is plugged into the ac power source even if the line power switch is in standby. The detachable power cord is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument. The front-panel switch is only a standby switch and is not a LINE switch (disconnecting device).

---

## Data Controls

Data controls are used to change values for functions such as center frequency, start frequency, resolution bandwidth, and marker position.

The data controls will change the active function in a manner prescribed by that function. For example, you can change center frequency in fine steps with the knob, in discrete steps with the step keys, or to an exact value with the numeric keypad. Resolution bandwidth, however, which can be set to discrete values in a 1, 3, 10 sequence only, is changed to the closest allowed value with any of the data controls.



## Knob

The knob allows continuous change of functions such as center frequency, reference level, and marker position. It also changes the values of many functions that change in increments only. Clockwise rotation of the knob increases values. For continuous changes, the extent of alteration is determined by the size of the measurement range; the speed at which the knob is turned affects the rate at which the values are changed.

Among other things, the knob enables you to change the center frequency, start or stop frequency, or reference level. In slow sweep times, the analyzer uses a smooth scrolling feature which is designed to move the trace display to the latest function value as the knob is turned. When either center frequency or reference level is adjusted, the signal will shift right or left or up or down with the rotation of the knob before a new sweep is actually taken. An asterisk is placed in the message block (the upper right-hand corner of the spectrum analyzer display) to indicate that the data on-screen does not reflect data at the current setting.

## Numeric Keypad

The numeric keypad allows entry of exact values for many of the spectrum analyzer functions. You may include a decimal point in the number portion. If not, the decimal point is placed at the end of the number.

Numeric entries must be terminated with a units key. When a numeric entry is begun, the menu keys show the units key labels. The units keys change depending on what the active function is. For example, the units keys for frequency span are **GHz**, **MHz**, **kHz**, and **Hz**, whereas the units for reference level are **+dBm**, **-dBm**, **mV**, and **μV**.

---

**NOTE**

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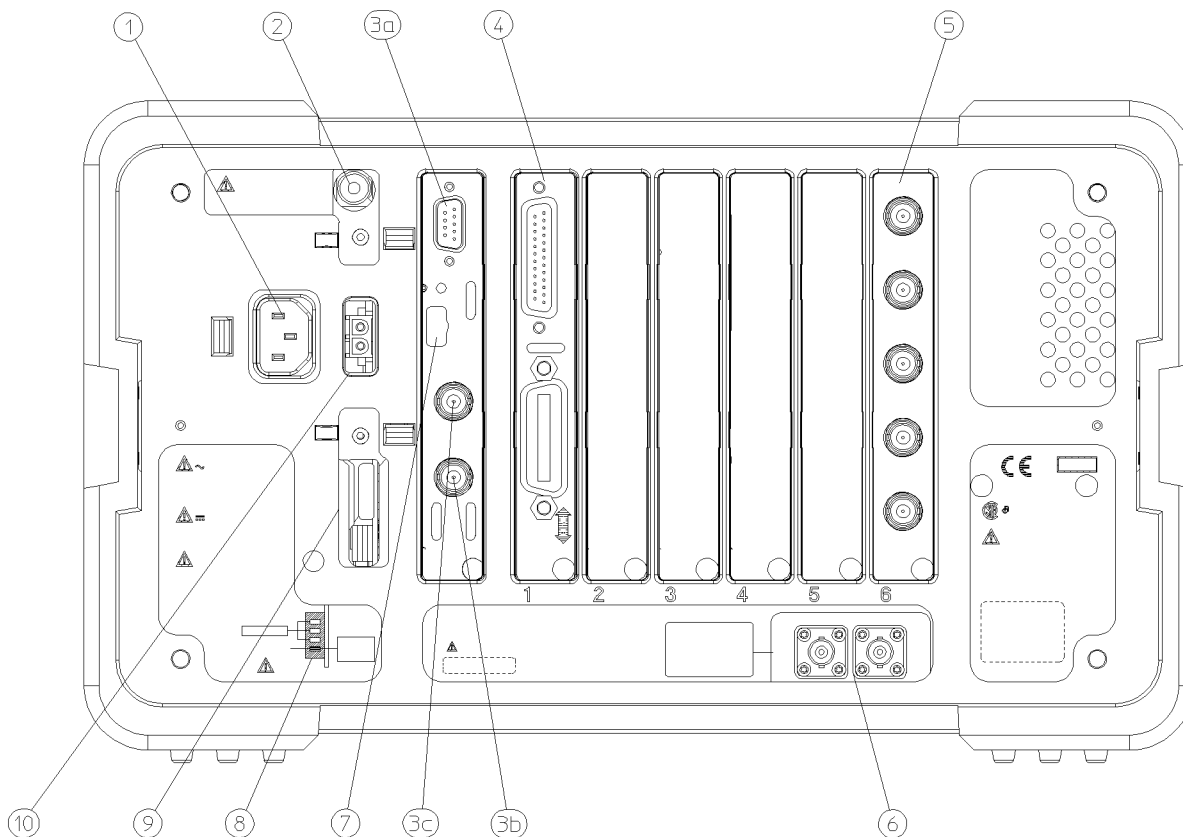
If an entry from the numeric keypad does not coincide with an allowed function value (for example, that of a 12 MHz bandwidth), the spectrum analyzer defaults to the nearest allowable value.

## Step Keys

The step keys allow discrete increases or decreases of the active function value. The step size depends upon the spectrum analyzer measurement range or on a preset amount. Each press results in a single step change. For those parameters with fixed values, the next value in a sequence is selected each time a step key is pressed. Changes are predictable and can be set for some functions. Out-of-range values or out-of-sequence values will not occur using these keys.

## Rear Panel Features

**Figure 2-2** Rear Panel Feature Overview



bn710a

**1** **Power input** is the input for the line power source. Make sure that the line-power source outlet has a protective ground contact.

**2** **Line Fuse.** The fuse is removed by twisting 1/4 turn. Replace only with a fuse of the same rating. See the label on the rear panel.

**3** **Standard Inputs/Outputs**

**3a** **VGA OUTPUT** drives an external VGA compatible monitor with a signal that has 31.5 kHz horizontal, 60 Hz vertical synchronizing rate, non-interlaced.

- 3b**                    **EXT TRIG IN (TTL)** accepts the positive edge of an external voltage input that triggers the spectrum analyzer internal sweep source.
- 3c**                    **HI SWP OUT (TTL)** indicates when the spectrum analyzer is sweeping.
- 4**                      **(Shown) HP-IB and parallel (Option A4H)** are optional interfaces. HP-IB supports remote instrument operation and direct printing of screen data. The parallel port is for printing only.
- (Not Shown) RS-232 and parallel (Option 1AX)** are optional interfaces. RS-232 supports remote instrument operation and direct printing of screen data. The parallel port is for printing only.

---

**NOTE**                    Only one optional interface can be installed at a time. Option 1AX or Option A4H must be installed in slot 1 on the rear panel. Option A4H is shown installed in slot 1 in Figure 6.

---

- 5**                      **Spectrum Analyzer Inputs/Outputs (Option A4J):**
- SWP OUT** provides a voltage ramp corresponding to the sweep of the spectrum analyzer (0 V to 10 V).
- HI SWP OUT (TTL)** indicates when the spectrum analyzer is sweeping.
- HI SWP IN (TTL)** can be grounded to stop sweeping.
- AUX VIDEO OUT** provides detected video output (before the analog-to-digital conversion) proportional to vertical deflection of the trace. Output is from 0 V to 1 V. Amplitude-correction factors are not applied to this signal. The output signal will be blanked occasionally during retrace by the automatic alignment routine. Select a very long sweep time to minimize this, or turn off the **Auto Align All** function (and use **Align Now All** manually to maintain calibration.) Refer to the **Alignments** key description in Chapter 4 for more information on alignment key functions.
- AUX IF OUT** is a 50  $\Omega$  21.4 MHz IF output that is the down-converted signal of the RF input of the spectrum analyzer. Amplitude-correction factors are not applied to this signal. This output is taken after the resolution bandwidth filters and step gains and before the log amplifier. The output signal will be blanked occasionally during retrace by the automatic alignment routine. Select a very long sweep time to minimize this, or turn off the **Auto Align All** function (and use **Align Now**

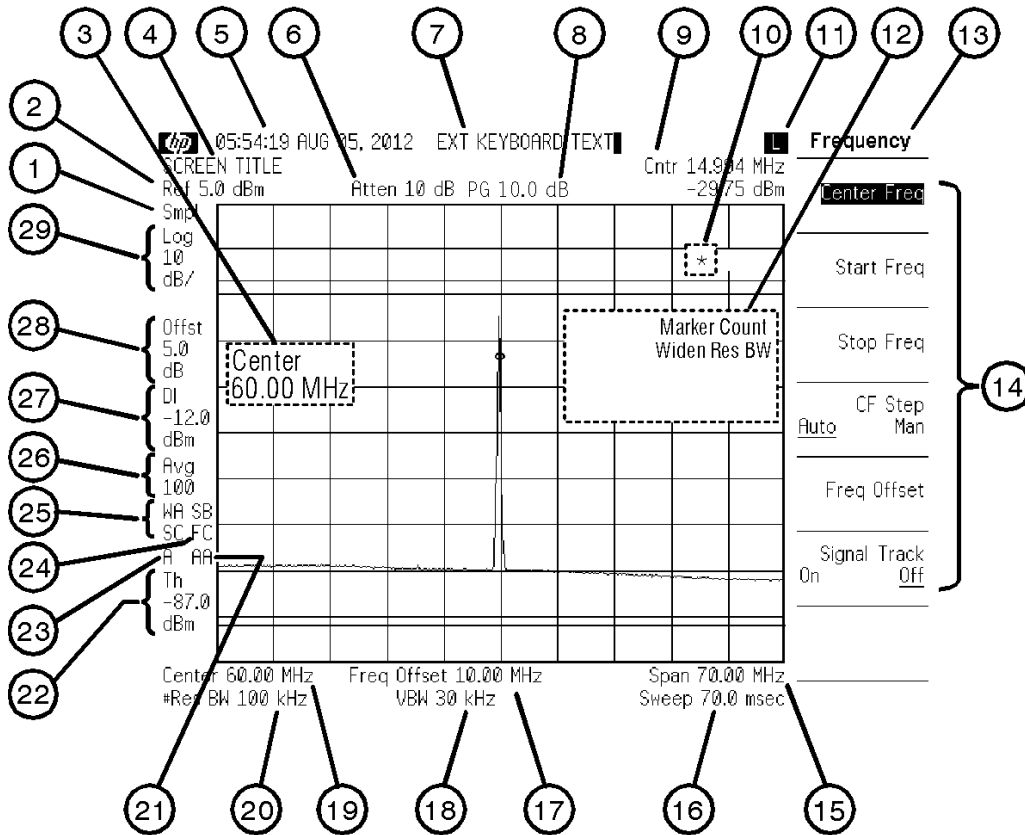
All manually to maintain calibration.) Refer to the **Alignments** key description in Chapter 4 for more information on alignment key functions.

- 6 **10 MHz REF IN** accepts an external frequency source to provide the 10 MHz, -15 to +10 dBm frequency reference used by the spectrum analyzer.  
**10 MHz REF OUT** provides a 10 MHz, 0 dBm minimum, timebase reference signal.
- 7 **Service Connector.** The service connector is for service use only.
- 8 **Power On Selection** selects a preference for when power is applied to the analyzer's rear panel power connector. The analyzer can be set to always be off when power is connected, or it can be set to go to the on/off condition that existed when power was disconnected. This is useful when the analyzer is used at an unattended location to ensure that the analyzer powers on after a power outage.
- 9 **DC Fuse.** Protects against too much power to the DC power connector on the rear panel of the spectrum analyzer.
- 10 **DC Power** is the input for the DC power source. Refer to "Power Requirements" in the Specifications Chapter.

## Screen Annotation

Here is an example of the annotation that may appear on a spectrum analyzer screen. The screen annotation is referenced by numbers which are listed in the following table. The Function Key column indicates which key activates the function related to the screen annotation. Refer to Chapter 4 for more information on a specific function key.

**Figure 2-3** Screen Annotation



ni744a

**Table 2-1**      **Screen Annotation**

<b>Item</b>	<b>Description</b>	<b>Function Key</b>
1	Detector mode	<b>Detector</b>
2	Reference level	<b>Ref Level</b>
3	Active function block	Refer to the description of the activated function.
4	Screen title	<b>Change Title</b>
5	Time and date display	<b>Time/Date On Off</b>
6	RF attenuation	<b>Attenuation Auto Man</b>
7	External keyboard entry	Refer to the external keyboard information in the Measurement Guide.
8	Preamplifier gain	<b>Ext Amp Gain</b>
9	Marker counter	<b>Marker Count On Off</b>
10	Measurement uncalibrated or function-in-progress messages	<b>Auto Couple</b>
11	Remote/local operation	See <b>Local</b> key in <a href="#">Chapter 4</a> .
12	Error messages	See <a href="#">Chapter 3</a> , “Troubleshooting.”
13	Key menu title	Dependent on key selection.
14	Key menu	See key label descriptions in <a href="#">Chapter 4</a> .
15	Frequency span or stop frequency	<b>Span, Stop Freq</b>
16	Sweep time	<b>Sweep Time Auto Man</b>
17	Frequency offset	<b>Freq Offset</b>
18	Video bandwidth	<b>Video BW Auto Man</b>
19	Center frequency or start frequency	<b>Center Freq, Start Freq</b>
20	Resolution bandwidth	<b>Resolution BW Auto Man</b>
21	Auto alignment routine is on	<b>Auto Align</b>
22	Threshold	<b>Threshold On Off</b>
23	Amplitude correction factors on	See “Using Amplitude Correction Factors” in the Measurement Guide.

<b>Item</b>	<b>Description</b>	<b>Function Key</b>
24	Trigger	<b>Trig</b>
25	Trace mode	<b>Trace</b>
26	Video average	<b>Video Average On Off</b>
27	Display line	<b>Display Line On Off</b>
28	Amplitude offset	<b>Ref Lvl Offst</b>
29	Amplitude scale	<b>Scale Type Log Lin</b>

Item 24 refers to the trigger and sweep modes of the spectrum analyzer. The first letter (“F”) indicates the spectrum analyzer is in free-run trigger mode. The second letter (“C”) indicates the spectrum analyzer is in continuous-sweep mode.

Item 25 refers to the trace modes of the spectrum analyzer. The first letter (“W”) indicates that the spectrum analyzer is in clear-write mode. The second letter is “A,” representing trace A. The trace B trace mode is “SB”, indicating trace B (“B”) is in the store-blank mode (“S”). The trace mode annotation for trace C is displayed under the trace mode annotation of trace A. The trace C trace mode is “SC”, indicating trace C (“C”) is in the store blank mode (“S”).

Refer to the following table for the screen annotation codes for trace, trigger, and sweep modes.

**Table 2-2**

**Screen Annotation for Trace, Trigger, and Sweep Modes**

<b>Trace Mode</b>	<b>Trigger Mode</b>	<b>Sweep Mode</b>
W clear write (traces A/B/C)	F free run	C continuous
M maximum hold (traces A/B)	L line	S single sweep
V view (traces A/B/C)	V video	
S store blank (traces A/B/C)	E external	
M minimum hold (trace C)		

---

## Key Overview

The keys labeled **Frequency**, **System**, and **Marker** are all examples of front panel keys. Pressing most front panel keys accesses menus of functions that are displayed along the right side of the display. These are called menu keys.

Menu keys list functions other than those accessed directly by the front panel keys. To activate a menu key function, press the key immediately to the right of the annotation on the screen. The menu keys that are displayed depend on which front panel key is pressed and which menu level is enabled.

If a menu key function's value can be changed, it is called an active function. The function label of the active function appears in inverse video after that key has been selected. For example, press **Amplitude**. This calls up the menu of related amplitude functions. Note the function labeled **Ref Level** (the default selected key in the Amplitude menu) appears in inverse video. **Ref Level** also appears in the active function block, indicating that it is the active amplitude function and can now be changed using any of the data entry controls.

A menu key with On and Off in its label can be used to turn the menu key's function on or off. To turn the function on, press the menu key so that On is underlined. To turn the function off, press the menu key so that Off is underlined. In the manual, when On should be underlined, it will be indicated as: **Video Average On Off (On)**.

A function with Auto and Man in the label can either be auto-coupled or have its value manually changed. The function's value can be changed manually by pressing the menu key until Man is underlined, and then changing its value with the numeric keypad, knob, or step keys. To auto-couple a function, press the menu key so that Auto is underlined. In the manual, when **Auto** should be underlined, it will be indicated as: **Attenuation Auto Man (Auto)**.

In some menus of keys, one key label will always be underlined to show which key has been selected. For example, when you press the **Mkr Readout** key (a Marker menu key) it will bring up its own menu of keys. The **Frequency** key, which is the default selected key, will be underlined. When you press another Mkr Readout menu key, the underline will move to that key to show it has been selected.

A summary of all front panel keys and their related menu keys can be found in [Chapter 4, "Front-Panel Key Reference."](#)



## Making a Measurement

Let's begin using the spectrum analyzer by measuring an input signal. Since the internal 50 MHz alignment signal is readily available, we will use it as our test signal.

You cannot hurt the spectrum analyzer by using the alignment signal and pressing any of the keys described in this section. Don't be afraid to play with the knob, step keys, or numeric keypad. (If you have experimented with other keys and wish to return to a known state, press the green **Preset** key.)

1. First, turn the instrument on by pressing **On**. Wait for the power-up process to complete.
2. Press the green **Preset** key.
3. Turn on the internal 50 MHz signal by pressing **System, 50 MHz osc On Off (On)**.
4. Set the frequency.

Press the **Frequency** key. **Center** appears on the left side of the screen, indicating that the center-frequency function is active. The **Center Freq** menu key label appears in inverse video to indicate that center frequency is the active function. The active function block is the space on the screen within the graticule where the active function messages appear. Active function values can be changed using the knob, step keys, or numeric keypad. Set the center frequency to 50 MHz with the **DATA** keys by pressing 50 MHz. The knob and step keys can also be used to set the center frequency.

5. Set the span.

Press **Span**. **span** is now displayed in the active function block, and the **Span** menu key label appears in inverse video to indicate it is the active function. Reduce the span to 20 MHz by using the knob, pressing the down key ( $\downarrow$ ), or pressing 20 MHz.

6. Set the amplitude.

When the peak of a signal does not appear on the screen, it may be necessary to adjust the amplitude level on the screen. Press **Amplitude. Ref Level 0.0 dBm** appears in the active function block. The **Ref Level** menu key label appears in inverse video to indicate that reference level is the active function. The reference level is the top graticule line on the display and is set to 0.0 dBm. Changing the value of the reference level changes the amplitude level of the top graticule line.

If desired, use the reference level function to place the signal peak at the top of the screen using the knob, step keys, or numeric keypad. (Marker functions measure the frequency and amplitude of a signal.)

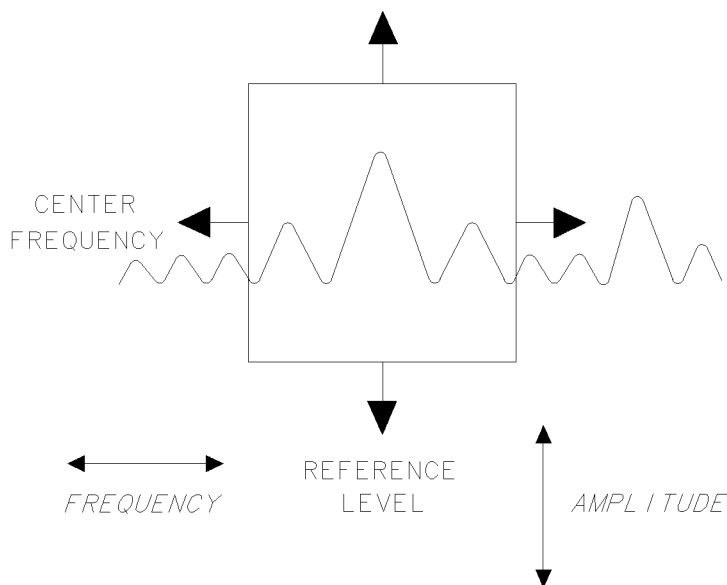
Figure 2-4 demonstrates the relationship between center frequency and reference level. The box in the figure represents the spectrum analyzer display. Changing the center frequency changes the horizontal placement of the signal on the display. Changing the reference level changes the vertical placement of the signal on the display. Increasing the span increases the frequency range that appears horizontally on the display.

---

**NOTE** Spectrum analyzers with Option 1DP default to display amplitude values in dBmV when in a log scale mode.

---

**Figure 2-4 Relationship between Frequency and Amplitude**



**7. Set the marker.**

You can place a diamond-shaped marker on the signal peak to find the signal's frequency and amplitude.

To activate a marker, press the **Marker** key (located in the **MARKER** section of the front panel). The **Marker Normal** label appears in inverse video to show that the marker is the active function. Turn the knob to place the marker at the signal peak.

You can also use the **Peak Search** key, which automatically places a marker at the highest point on the trace.

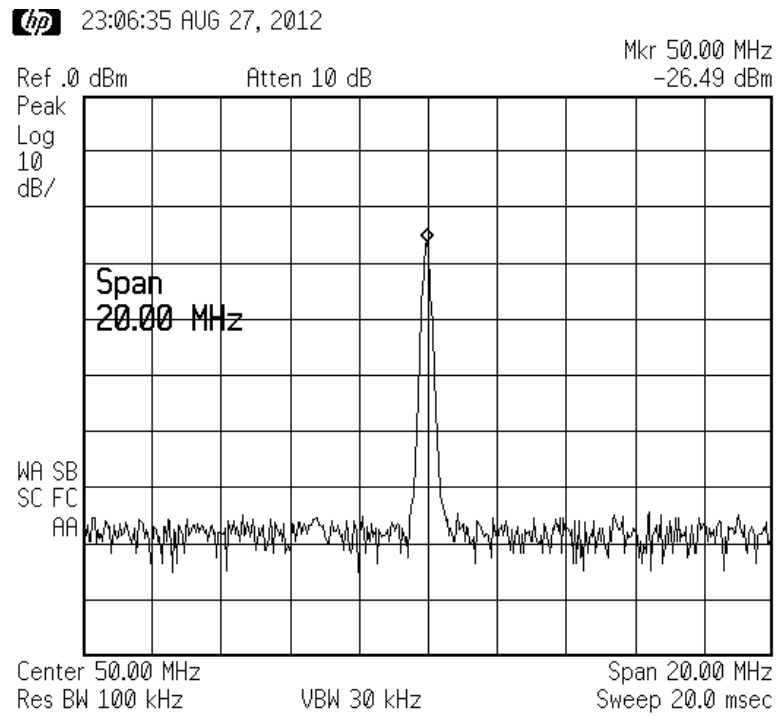
Readouts of marker amplitude and frequency appear in the active function block and in the upper right corner of the display. Look at the marker readout to determine the amplitude of the signal.

If another function is activated, the frequency and amplitude can still be identified by looking at the marker readout in the upper right corner of the display.

## Measurement Summary

1. Press the **Preset** key. Turn on the internal 50 MHz signal by pressing **System, 50 MHz osc On Off (On)**.
2. Set the center frequency by pressing the following keys: **Frequency, 50 MHz**.
3. Set the span by pressing the following keys: **Span, 20 MHz**.
4. The calibration signal is about  $-27$  dBm (25 dBmV for Option 1DP), below the top of the screen (almost three graticule divisions) using these spectrum analyzer settings. If desired, adjust the reference level: press **Amplitude** to activate the reference level, and use the knob or step keys to change the reference level and bring the signal to the top of the screen.
5. Determine the amplitude and frequency of the signal. You can either press **Peak Search** or press **Marker** and move the marker to the signal peak. Read the amplitude and frequency. The display should look like the one in [Figure 2-5](#). Frequency is displayed horizontally, and amplitude (power) is displayed vertically.

**Figure 2-5**      **Reading the Amplitude and Frequency**



## **Analyzer Accuracy and the Internal Alignment Process**

Data from the internal alignment routine is necessary for spectrum analyzer operation. The internal alignment routine runs continuously to ensure that the spectrum analyzer is using current alignment data that improves the spectrum analyzer frequency and amplitude accuracy. Press the **System, Alignments** keys to view the alignment menus. For more detailed information on the alignment keys, refer to [Chapter 4](#).

### **Warm-Up Time**

In order for the spectrum analyzer to meet its specifications, allow it to warm up for 5 minutes after being turned on before attempting to make any calibrated measurements. If **Auto Align Off** is selected, refer to the analyzer specifications for the conditions required to maintain calibration.

---

## Analyzer Battery Information

The spectrum analyzers use a 3.6 V lithium battery to enable the internal memory to retain data. The date when the battery was installed is on a label on the rear panel of the spectrum analyzer. See [Figure 2-6](#).

The minimum life expectancy of the battery is 8 years at 25 °C, or 1 year at 55 °C. If you experience problems with the battery or the recommended time period for battery replacement has elapsed, see “How to Return Your Analyzer for Service” in [Chapter 3](#).

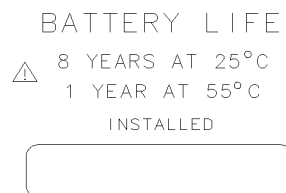
If you wish to replace the battery yourself, you can purchase the service documentation that provides all necessary test and maintenance information. The battery is soldered onto the spectrum analyzer processor board.

You can order the service documentation for an HP ESA-L1500A spectrum analyzer through your HP Sales and Service office. The documentation is described under “Service Documentation (Option 0BX)” in [Chapter 6](#) of this manual.

After replacing the spectrum analyzer battery, write the date of battery replacement on the rear-panel label.

**Figure 2-6**

### Rear-Panel Battery Information Label



pu132r



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## **3** **Troubleshooting**



## What You'll Find in This Chapter

This chapter includes information on how to check for a problem with your HP ESA-L1500A spectrum analyzer, and how to return it for service. It also includes descriptions of all of the spectrum analyzer built-in error messages.

Your spectrum analyzer is built to provide dependable service. However, if you experience a problem, or if you desire additional information or wish to order parts, options, or accessories, Hewlett-Packard's worldwide sales and service organization is ready to provide the support you need.

In general, a problem can be caused by a hardware failure, a software error, or a user error. Follow these general steps to determine the cause and to resolve the problem:

1. Perform the quick checks listed in "Check the Basics" in this chapter. It is possible that a quick check may eliminate your problem altogether.
2. If the problem is a hardware problem, you have several options:
  - Repair it yourself; see the "Service Options" section in this chapter.
  - Return the spectrum analyzer to Hewlett-Packard for repair; if the spectrum analyzer is still under warranty or is covered by an HP maintenance contract, it will be repaired under the terms of the warranty or plan (the warranty is at the front of this manual).

If the spectrum analyzer is no longer under warranty or is not covered by an HP maintenance plan, Hewlett-Packard will notify you of the cost of the repair after examining the unit. See "How to Call Hewlett-Packard" and "How to Return Your Analyzer for Service" for more information.

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**WARNING**

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**No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.**

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## Before You Call Hewlett-Packard

### Check the Basics

A problem can often be solved by repeating the procedure you were following when the problem occurred. Before calling Hewlett-Packard or returning the spectrum analyzer for service, please make the following checks:

1. Check the line fuse.
2. Is there power at the receptacle?
3. Is the analyzer turned on? Make sure the fan is running, which indicates that the power supply is on.
4. If the display is dark or dim, press the upper brightness key in the upper left corner of the front panel. This key will not automatically repeat if held down. It must be pressed repeatedly to continue to change the brightness.
5. If the display contrast is poor, press **Display** and **Contrast** (**Contrast** is the fifth key from the top). Then change the contrast using the knob, step keys, or numeric keypad.
6. If other equipment, cables, and connectors are being used with the HP ESA-L1500A spectrum analyzer, make sure they are connected properly and operating correctly.
7. Review the procedure for the measurement being performed when the problem appeared. Are all the settings correct?
8. If the analyzer is not functioning as expected, return the analyzer to a known state by pressing the **Preset** key.

Some analyzer settings are not affected by a Preset. If you wish to reset the spectrum analyzer configuration to the state it was in when it was originally sent from the factory, press **System, More, Default Config**.

9. Is the measurement being performed, and the results that are expected, within the specifications and capabilities of the spectrum analyzer? See the “Specifications” chapter in this manual for spectrum analyzer specifications.
10. In order to meet specifications, the spectrum analyzer must be aligned. Either **Auto Align All** must be selected (press **System, Auto Align, All**), or the analyzer must be manually aligned at least once per hour, or whenever the temperature changes more than 5° centigrade (press **System, Alignments, Align Now, All**). When **Auto Align All** is selected **AA** appears on the left edge of the display.

11. Is the spectrum analyzer displaying an error message? If so, refer to “Error Messages” in this chapter.
12. If the necessary test equipment is available, perform the performance verification tests in Chapter 9. Record all results on a Performance Verification Test Record form which follows the tests.

## Read the Warranty

The warranty for your spectrum analyzer is at the front of this manual. Please read it and become familiar with its terms.

If your spectrum analyzer is covered by a separate maintenance agreement, please be familiar with its terms.

## Service Options

Hewlett-Packard offers several optional maintenance plans to service your spectrum analyzer after the warranty has expired. Call your Hewlett-Packard sales and service office for full details.

If you want to service the spectrum analyzer yourself after the warranty expires, you can purchase the service documentation that provides all necessary test and maintenance information.

You can order the service documentation, Option 0BX, through your Hewlett-Packard sales and service office. Service documentation is described under “Service Documentation (Option 0BX)” in Chapter 6.

## How to Call Hewlett-Packard

Hewlett-Packard has sales and service offices around the world to provide you with complete support for your spectrum analyzer. To obtain servicing information or to order replacement parts, contact the nearest Hewlett-Packard Sales and Service Office listed in Table 6. In any correspondence or telephone conversations, refer to the instrument by its model number and full serial number. (Press the **System**, then **Show System** front-panel keys and the model, product, and serial number information will be displayed on your analyzer screen.)

**Table 3-1 Hewlett-Packard Sales and Service Offices**

<b>UNITED STATES</b>		
<p><b>Instrument Support Center</b> Hewlett-Packard Company (800) 403-0801</p>		
<b>EUROPEAN FIELD OPERATIONS</b>		
<p><b>Headquarters</b> Hewlett-Packard S.A. 150, Route du Nant-d'Avril 1217 Meyrin 2/ Geneva Switzerland (41 22) 780.8111</p>	<p><b>France</b> Hewlett-Packard France 1 Avenue Du Canada Zone D'Activite De Courtaboeuf F-91947 Les Ulis Cedex France (33 1) 69 82 60 60</p>	<p><b>Germany</b> Hewlett-Packard GmbH Hewlett-Packard Strasse 61352 Bad Homburg v.d.H Germany (49 6172) 16-0</p>
<p><b>Great Britain</b> Hewlett-Packard Ltd. Eskdale Road, Winnersh Triangle Wokingham, Berkshire RG41 5DZ England (44 734) 696622</p>		
<b>INTERCON FIELD OPERATIONS</b>		
<p><b>Headquarters</b> Hewlett-Packard Company 3495 Deer Creek Rd. Palo Alto, CA 94304-1316 USA (415) 857-5027</p>	<p><b>Australia</b> Hewlett-Packard Australia Ltd. 31-41 Joseph Street Blackburn, Victoria 3130 (61 3) 895-2895</p>	<p><b>Canada</b> Hewlett-Packard (Canada) Ltd. 17500 South Service Road Trans-Canada Highway Kirkland, Quebec H9J 2X8 Canada (514) 697-4232</p>
<p><b>Japan</b> Hewlett-Packard Japan, Ltd. 9-1 Takakura-Cho, Hachioji Tokyo 192, Japan (81 426) 60-2111</p>	<p><b>Singapore</b> Hewlett-Packard Singapore (Pte.) Ltd. 150 Beach Road #29-00 Gateway West Singapore 0718 (65) 291-9088</p>	<p><b>Taiwan</b> Hewlett-Packard Taiwan 8th Floor, H-P Building 337 Fu Hsing North Road Taipei, Taiwan (886 2) 712-0404</p>
<p><b>China</b> China Hewlett-Packard Co. 38 Bei San Huan X1 Road Shuang Yu Shu Hai Dian District Beijing, China (86 1) 256-6888</p>		

## How to Return Your Analyzer for Service

### Service Tag

If you are returning the spectrum analyzer to Hewlett-Packard for servicing, fill in and attach a blue service tag. Several service tags are supplied at the rear of this chapter. Please be as specific as possible about the nature of the problem. If you have recorded any error messages that appeared on the screen, or have completed a Performance Test Record, or have any other specific data on the performance of the spectrum analyzer, please send a copy of this information with the unit.

### Original Packaging

Before shipping, pack the unit in the original factory packaging materials if they are available. If the original materials were not retained, see “Other Packaging.”

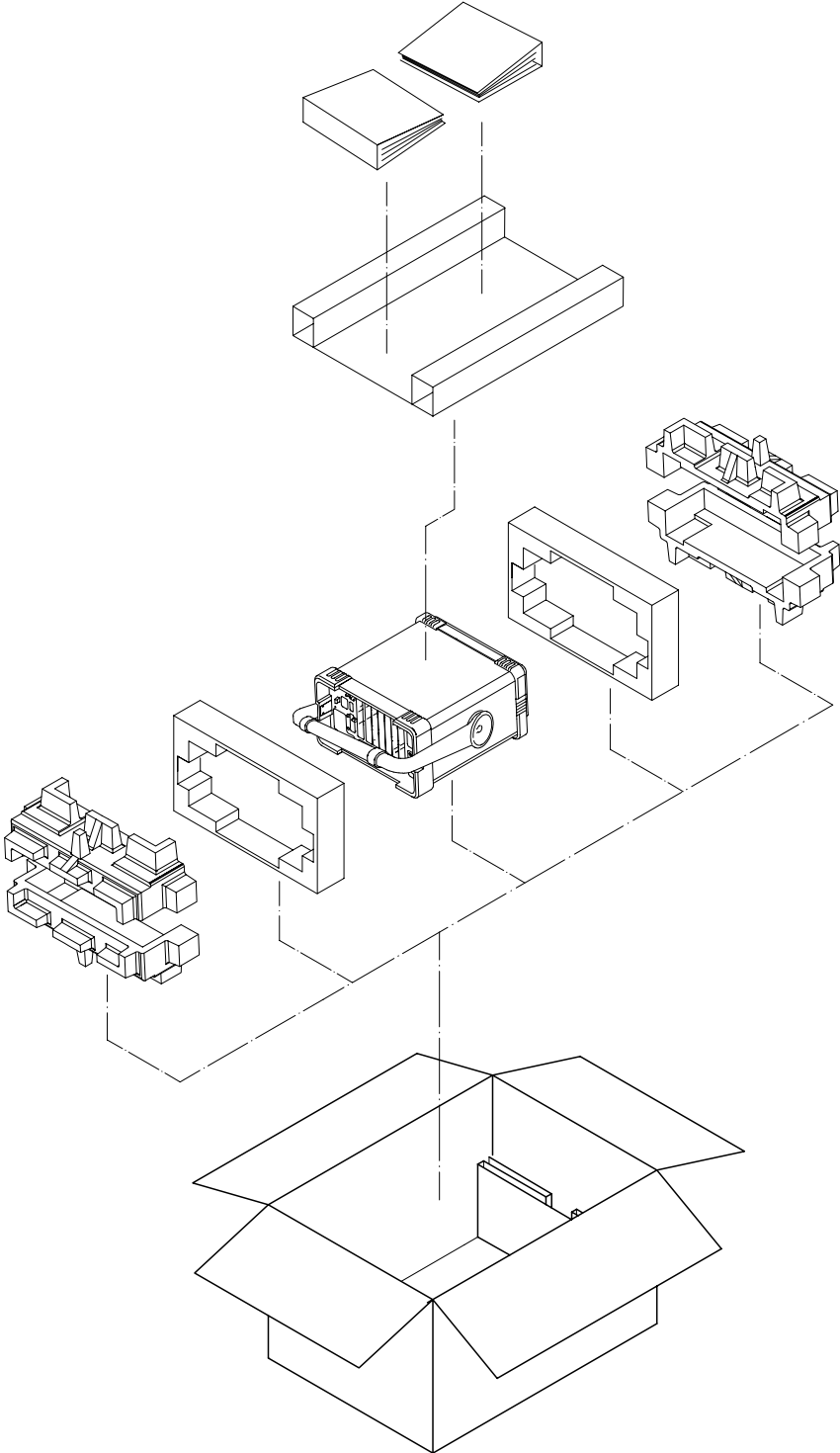
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**NOTE**

Ensure that the instrument handle is in the rear-facing position in order to reduce the possibility of damage during shipping. Refer to [Figure 3-1](#).

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**Figure 3-1**



form122

## Other Packaging

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**CAUTION**

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Spectrum analyzer damage can result from using packaging materials other than those specified. Never use styrene pellets in any shape as packaging materials. They do not adequately cushion the equipment or prevent it from shifting in the carton. They cause equipment damage by generating static electricity and by lodging in the spectrum analyzer louvers, blocking airflow.

You can repackage the instrument with commercially available materials, as follows:

1. Attach a completed service tag to the instrument.
2. If you have a front-panel cover, install it on the instrument; if not, protect the control panel with cardboard.
3. Wrap the instrument in antistatic plastic to reduce the possibility of damage caused by electrostatic discharge.
4. Use a strong shipping container. A double-walled, corrugated cardboard carton with 159 kg (350 lb) bursting strength is adequate. The carton must be both large enough and strong enough to accommodate the spectrum analyzer. Allow at least 3 to 4 inches on all sides of the analyzer for packing material.
5. Surround the equipment with three to four inches of packing material and prevent the equipment from moving in the carton. If packing foam is not available, the best alternative is S.D.-240 Air Cap™ from Sealed Air Corporation (Hayward, California, 94545). Air Cap looks like a plastic sheet filled with 1-1/4 inch air bubbles. Use the pink-colored Air Cap to reduce static electricity. Wrapping the equipment several times in this material should both protect the equipment and prevent it from moving in the carton.
6. Seal the shipping container securely with strong nylon adhesive tape.
7. Mark the shipping container “FRAGILE, HANDLE WITH CARE” to assure careful handling.
8. Retain copies of all shipping papers.

## Error Messages

The spectrum analyzer can generate various messages that appear on its screen during operation to indicate a problem.

There are three types of messages: hardware error messages (H), user-created error messages (U), and informational messages (M).

- Hardware error messages indicate the spectrum analyzer hardware is probably broken. Additional troubleshooting should be done to verify the failure.
- User-created error messages appear when the spectrum analyzer is used incorrectly. They are often generated during remote operation (entering programming commands using either a controller or the external keyboard).
- Informational messages provide information indicating the spectrum analyzer's progress within a specific procedure.

The messages are listed in alphabetical order on the following pages; each message is defined, and its type is indicated by an (H), (U), or (M).

**ADC-2V fail** Indicates a hardware failure. (H)

**ADC-Gnd fail** Indicates a hardware failure. (H)

**ADC-time fail** Indicates a hardware failure. (H)

**Align IF: gain limited, may recover next alignment** Indicates that an Align Now for the IF Assembly reached a hardware limit. Perform another Align Now IF. If the message persists there may be a hardware failure. Load the default values by pressing **System, Alignments, Load Defaults** and see if the alignment process fixes the problem. (M) or (H)

**Align IF: symmetry limited, may recover next alignment** Indicates that an Align Now for the IF Assembly reached a hardware limit. Perform another Align Now IF. If the message persists there may be a hardware failure. Load the default values by pressing **System, Alignments, Load Defaults** and see if the alignment process fixes the problem. (M) or (H)

**Align Now All needed** The instrument requires an Align Now, All. (M)

**Align RF skipped 50 MHz detected** Indicates that an Auto Align of the RF Assembly was not performed because of an input signal at 50 MHz that is  $>-25$  dBm. The alignment will not work when there is too much input power at 50 MHz. The analyzer will continue to measure properly, but automatic RF alignment will not function. To remove the message, remove the 50 MHz input signal and perform an Align Now RF. (U) or (M)



**Align RF skipped No align signal** Indicates that an Auto Align of the RF Assembly was not performed because the instrument's internal alignment signal was not detected or was invalid. This could be due to a problem with the accuracy or stability of the external 10 MHz reference, if one is present. (U) or (H)

**Alignment Needed** Occurs after a 'Load Defaults' of alignment data. A complete alignment must be performed. Press **Align Now, All**. (U) or (M)

**Atten auto set to 15 dB** Indicates that an input signal has been detected which is of sufficient level to force the input attenuator to be auto-coupled at 15 dB. No operator intervention is required. If the signal level is reduced the attenuator will stay at 15 dB.

This overload protection occurs at an input power level of 13 dBm  $\pm$ 7 dBm (nominal), or 68 dBmV  $\pm$ 7 dBmV for Option 1DP, when the input attenuation is auto-coupled and set to <15 dB. To return to the original measurement setup, reduce the input signal level and press **Amplitude**. Then press **Attenuation Auto Man** twice, to toggle back to Auto. (U) or (M)

When operating remotely, the status bit should be monitored for this condition to avoid incorrect measurement results.

**Cannot reach N dB points** Indicates that the number of dB specified for the N dB PTS function is greater than the distance of the signal peak from the spectrum analyzer noise floor or peak threshold. (U)

**CMD ERR: \_ \_ \_** The specified programming command is not recognized by the spectrum analyzer. (U)

**Configuration error: Front Panel/Display ID not recognized** At power on an error was encountered identifying the Front Panel/Display assembly. (H)

**Configuration error: Option ID not recognized** The hardware for an option was identified in an instrument that does not support it. (H)

**Configuration error: RF Assembly ID not recognized** At power on an error was encountered when identifying the RF Assembly. (H)

**Configuration error: RF-Source Impedance mismatch** A power up check determined that the RF Assembly and optional Tracking Generator Assembly do not have the same impedance. (H)

**Data Memory Full<data type>: \_ \_ \_** An attempt was made to save a file of <data type> to memory, however the memory space is full. (U)

**EXT REF** Indicates that the frequency reference is being supplied by an external 10 MHz source. (M)

**EXT Reference in use** An attempt to perform a Timebase alignment with an External Reference in use. (U)

**FILE NOT FOUND** Indicates that the specified file could not be loaded into spectrum analyzer memory or purged from memory because the file name cannot be found. (U)

**Freq corr off** Indicates that the Freq Correct selection is Off. (M)

**Input is internal** Indicates that the 50 MHz osc selection is On. With the 50 MHz oscillator On, the input is routed through an internal signal path. (M)

**INVALID AMPCOR: FREQ** For the AMPCOR command, the frequency data must be entered in increasing order. See the description for the AMPCOR programming command for more information. (U)

**INVALID CHECKSUM: USTATE** The user-defined state does not follow the expected format. (U)

**INVALID ENTER FORMAT** The enter format is not valid. See the appropriate programming command description to determine the correct format. (U)

**INVALID FILE NAME <file name>** Indicates the specified file name is invalid. A file name is invalid if there is no file name specified or the file name is too long. See the description for the SAVE programming command for more information. (U)

**Invalid flatness data: \_ \_ \_** A power up check determined an error in the instrument's flatness data. The 4-digit code may indicate the type of error. Error codes are described in the spectrum analyzer's service guide. (H)

**INVALID HP-IB ADRS/OPERATION** An HP-IB operation was aborted due to an incorrect address or invalid operation. Check that there is only one controller (the spectrum analyzer) connected to the printer. (U)

**INVALID HP-IB OPERATION REN TRUE** The HP-IB operation is not allowed. (This is usually caused by trying to print when a controller is on the interface bus with the spectrum analyzer.) To print to an HP-IB printer from the spectrum analyzer, you must disconnect any other controllers on the HP-IB. If you are using programming commands to print, you can use an HP BASIC command instead of disconnecting the controller. See the description for the PRINT command for more information. (U)

**INVALID ITEM:** Indicates an invalid parameter has been used in a programming command. (U)

**INVALID OUTPUT FORMAT** The output format is not valid. See the appropriate programming command description to determine the correct format. (U)

**INVALID RANGE: Stop < Start** Indicates that the first trace element specified for a range of trace elements is larger than the ending trace element. When specifying a trace range the starting element must be less than the ending element. For example, TRA[2,300] is legal but TRA[300,2] is not. (U)

**INVALID RS-232/OPERATION** An RS-232 operation was aborted due to an invalid operation. (U)

**INVALID START INDEX** Indicates that the first trace element specified for a range of trace elements is not within the trace range of the specified trace. (U)

**INVALID STOP INDEX** Indicates that the ending trace element specified for a range of trace elements is not within the trace range of the specified trace. (U)

**INVALID STORE DEST: \_ \_ \_** The specified destination field is invalid. (U)

**INVALID TRACE: \_ \_ \_** The specified trace is invalid. (U)

**INVALID VALUE PARAMETER: \_ \_ \_** The specified value parameter is invalid. (U)

**Marker Count Reduce SPAN** Indicates the resolution bandwidth to span ratio is too small to use the frequency count function. Check the span and resolution bandwidth settings. The acceptable Span/Res BW ratio is  $\leq 500$ . (U)

**Marker Count Widen Res BW** Indicates that the current resolution bandwidth setting is too narrow to use with the marker counter function. (U)

**Meas uncal** The measurement is uncalibrated. Check the sweep time, span, and bandwidth settings, or press **AUTO COUPLE**. (U)

**No points defined** Indicates the specified limit line or amplitude correction function cannot be performed because no limit line segments or amplitude correction factors have been defined. (U)

**Overload: Reduce Signal** A signal has been applied to the input connector that caused the overload protection circuitry to engage. The input signal must be reduced. After the signal is reduced, press Esc. The change in the instrument's amplitude state will disengage the overload protection function. Overload protection engages under the following conditions: (U) or (M)

Attenuator Setting	Attenuator Coupling	Input Power Level (50Ω)	Input Power Level (75Ω)
≥15 dB	Auto or Man	33 dBm ±3 dB (nominal)	76 dBmV ±3 dBmV
<15 dB	Man	13 dBm ±7 dB (nominal)	68 dBmV ±7 dBmV

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**CAUTION**

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Exposing the analyzer to high levels of input power over a prolonged time period can damage the circuitry.

When operating remotely, the status bit should be monitored for this condition to avoid incorrect measurement results.

**PARAMETER ERROR: \_ \_ \_** The specified parameter is not recognized by the spectrum analyzer. See the appropriate programming command description to determine the correct parameters. (U)

**Password required** Indicates that the service function cannot be accessed without the password. (U)

**Power-up selftest failed Boot ROM checksum:** Indicates a test of the bootrom produced a checksum error. (H)

**Power-up selftest failed RAM error:** Indicates a test of RAM produced an error. (H)

**Power-up selftest failed Checksum:** Indicates a test of the instrument ROM produced a checksum error. (H)

**Require 1 signal > PEAK EXCURSION above PEAK THRESHOLD** Indicates that the N dB PTS routine cannot locate a signal that is high enough to measure. The signal must be greater than the peak excursion above the threshold level to measure. (U)

**Require 3 signals > PEAK EXCURSION above PEAK THRESHOLD** Indicates that the % AM routine cannot locate three signals that are high enough to measure. The signals must be greater than the peak excursion above the threshold level to measure. (U)

**Require 4 signals > PEAK EXCURSION above PEAK THRESHOLD** Indicates that the TOI routine cannot locate four signals that are high enough to measure. The signals must be greater than the peak excursion above the threshold level to measure. (U)

**Required Option Not Installed** Indicates that the function selected requires optional hardware that is not currently available. (U)

**RF LO Unlocked** Indicates that the local oscillator within the instrument's RF assembly is unlocked. (H)

**S** in the status area of the display indicates that the service request is active. Service requests are a form of informational message. More information is available in the Programmer's Guide. (M)

**SAVE LOCK** The spectrum analyzer's internal memory has been locked. To unlock the memory, press **Internal Lock On Off** so that Off is underlined. For remote operation, use PSTATE OFF. (U)

**Signals do not fit expected % AM pattern** Indicates that the % AM routine cannot perform the percent AM measurement because the on-screen signals do not have the characteristics of a carrier with two sidebands. (U)

**Signals do not fit expected TOI pattern** Indicates that the TOI routine cannot perform the third-order intermodulation measurement because the on-screen signals do not have the characteristics of two signals and two distortion products. (U)

**Source Protected** A signal has been applied to the RF OUT connector which caused the source output protection circuitry to engage. The signal must be reduced. After the signal is reduced, press the ESC key to disengage the source output protection circuitry. (U) or (M)

**TABLE FULL** Indicates the upper or lower table of limit lines contains the maximum number of entries allowed. Additional entries to the table are ignored. (U)

**TG LO Unlocked** Indicates that the local oscillator within the instrument's tracking generator assembly is unlocked. (H)

**TG unlevelled** This message can indicate the following: that the source power is set higher or lower than the spectrum analyzer can provide, that the frequency span extends beyond the specified frequency range of the tracking generator, or that the calibration data for the tracking generator is incorrect. See "Stimulus-Response Measurements" in the User's Guide for more information. (U)

**Too many signal with valid N dB points** Indicates the N dB PTS function has located two or more signals that have amplitudes within the specified dB from the signal peak. If this happens, you should decrease the span of the spectrum analyzer so that only the signal that you want to measure is displayed. (U)

**Trace A is not available** Indicates that trace A is in the store-blank mode and cannot be used for limit-line testing. Use **CLEAR WRITE A** or **VIEW A** to change trace A from the store-blank mode to the clear write mode, and then turn on limit-line testing. (U)

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## **4** **Front-Panel Key Reference**

The key descriptions are organized like the spectrum analyzer menus. Use the following table to locate a specific key.

Key Label	Page Location
% AM On Off	page 91
50 MHz osc On Off	page 106
A ↔ B	page 113
A ↔ C	page 113
ADC	page 106
Align Now	page 106
Alignments	page 106
All	page 106
All but RF	page 106
All Ampcor	page 81
All Limits	page 81
All Memory	page 81
All States	page 81
All Traces	page 81
AM	page 74
Ampcor	page 67
Ampcor On Off	page 67
Amplitude	page 66
Amplitude On Off	page 100
Amptd Offset	page 101
Amptd Step Auto Man	page 100
Amptd Units	page 67
Annotation On Off	page 77
Attenuation Auto Man	page 66
Auto Align	page 106
Auto Couple	page 70
B → C	page 113
B ↔ C	page 113
B – DL → B	page 113

Key Label	Page Location
Baud Rate	page 108
Blank A, B, C	page 112
Bottom Margin	page 108
Brightness	page 71
BW/Avg	page 72
Center Freq	page 83
CF Step Auto Man	page 83
Change Title	page 76
Clear Title	page 77
Clear Write A	page 110
Clear Write B	page 111
Clear Write C	page 112
Coarse	page 107
Color Printing On Off	page 109
Contrast	page 77
Datemode MDY DMY	page 105
Define Printer	page 108
Default Config	page 107
Del Segment	page 88
Delete	page 81
Delete Limits	page 90
Delete Now	page 81
Delete Point	page 67
Demod	page 74
Det/Demod	page 74
Detector	page 74
Display	page 76
Display Line On Off	page 76
Dwell Time On Off	page 75
Edit Limits	page 88

Key Label	Page Location
Edit Line	page 88
Enter	page 78
Erase Internal	page 81
Esc	page 79
Execute Title	page 77
Expand On Off	page 108
Ext Amp Gain	page 68
External	page 115
File	page 80
Fine	page 107
Flat	page 88
Form Feed	page 109
Free Run	page 115
Freq Correct On Off	page 106
Freq Count	page 82
Freq Offset	page 83
Frequency	page 83
Full Span	page 102
Graticule On Off	page 77
HP Color Mode PJ DJ Off	page 108
HP-IB	page 108
IF	page 106
Input Z Corr 50 75	page 68
Internal Lock On Off	page 81
Inverse Time	page 86
Inverse Video On Off	page 77
Last Span	page 102
Limit Display Y N Auto	page 87
Limit Test On Off	page 87

Key Label	Page Location
Limits	page 87
Limits Fixed Rel	page 88
Line	page 115
LO	page 106
Load	page 80
Load Defaults	page 107
Load Now	page 80
(Local)	page 105
Marker	page 85
Marker # On Off	page 86
Marker $\Delta$	page 85
Marker All Off	page 86
Marker Count On Off	page 82
Marker Noise On Off	page 86
Marker Normal	page 85
Marker Trace Auto A B C	page 86
Max Hold A, B	page 112
Max Mixer Lvl	page 68
Max Pk $\rightarrow$ CF	page 97
Measure	page 87
Min Hold C	page 112
Min Search	page 98
Mkr $\Delta \rightarrow$ Span	page 98
Mkr $\rightarrow$ CF	page 97
Mkr $\rightarrow$ CF Step	page 98
Mkr $\rightarrow$ Ref Lvl	page 97
Mkr $\rightarrow$ Start	page 98
Mkr $\rightarrow$ Stop	page 98
Mkr Readout	page 86



<b>Key Label</b>	<b>Page Location</b>
Modify Ampcor	<a href="#">page 67</a>
More	<a href="#">page 92</a>
N dB Points On Off	<a href="#">page 91</a>
Negative Peak	<a href="#">page 74</a>
New Filename	<a href="#">page 80</a>
Next Peak	<a href="#">page 97</a>
Next Pk Left	<a href="#">page 97</a>
Next Pk Right	<a href="#">page 97</a>
Norm Ref Lvl	<a href="#">page 114</a>
Norm Ref Posn	<a href="#">page 114</a>
Normalize	<a href="#">page 113</a>
Normalize On Off	<a href="#">page 113</a>
Operations	<a href="#">page 113</a>
Parallel	<a href="#">page 108</a>
Peak	<a href="#">page 74</a>
Peak Excursn	<a href="#">page 97</a>
Peak Search	<a href="#">page 93</a>
Period	<a href="#">page 86</a>
Pk-Pk Search	<a href="#">page 98</a>
Pk Threshold	<a href="#">page 98</a>
Point	<a href="#">page 88</a>
Port	<a href="#">page 108</a>
Power On IP Last	<a href="#">page 106</a>
Power Sweep On Off	<a href="#">page 100</a>
Preferences	<a href="#">page 77</a>
Preset	<a href="#">page 94</a>
Print	<a href="#">page 96</a>
Print Softkeys On Off	<a href="#">page 109</a>
Printer	<a href="#">page 105</a>
Printer Addr	<a href="#">page 108</a>

<b>Key Label</b>	<b>Page Location</b>
Purge Ampcor	<a href="#">page 67</a>
Ref Lvl Offst	<a href="#">page 67</a>
Ref Level	<a href="#">page 66</a>
Remote Port HP-IB	<a href="#">page 105</a>
Remote Port Serial	<a href="#">page 106</a>
Resolution	<a href="#">page 108</a>
Resolution Auto Man	<a href="#">page 82</a>
Resolution BW Auto Man	<a href="#">page 72</a>
RF	<a href="#">page 106</a>
Sample	<a href="#">page 74</a>
Save	<a href="#">page 80</a>
Save Now	<a href="#">page 81</a>
Scale/Div	<a href="#">page 66</a>
Scale Type Log Lin	<a href="#">page 66</a>
Search	<a href="#">page 97</a>
Segment	<a href="#">page 88</a>
Select Amptd	<a href="#">page 67</a>
Select Freq	<a href="#">page 67</a>
Select Line Upper Lower	<a href="#">page 88</a>
Select Marker 1 2 3 4	<a href="#">page 85</a>
Select Point	<a href="#">page 67</a>
Select Printer	<a href="#">page 108</a>
Serial	<a href="#">page 108</a>
Service	<a href="#">page 108</a>
Set Date	<a href="#">page 105</a>
Set Time	<a href="#">page 105</a>
Show System	<a href="#">page 107</a>
Signal Track On Off	<a href="#">page 84</a>
Single Sweep	<a href="#">page 99</a>
Slope	<a href="#">page 88</a>

<b>Key Label</b>	<b>Page Location</b>
Source Amptd	page 100
Span	page 102
Span Zoom	page 102
Speaker On Off	page 74
Standby	page 103
Start Freq	page 83
State	page 80
Stop Freq	page 83
Sweep	page 104
Sweep Cont Single	page 104
Sweep Time Auto Man	page 104
Swp Coupling SR SA	page 104
System	page 105
Threshold On Off	page 76
Time	page 86
Time/Date	page 105
Time/Date On Off	page 105
Timebase	page 107
Title	page 76
Top Margin	page 108
Trace	page 110
Trace A B C	page 110
Trig	page 115
Type	page 88
User Defined	page 108
VBW/RBW Ratio	page 72
Video	page 115
Video Average On Off	page 72
Video BW Auto Man	page 72

<b>Key Label</b>	<b>Page Location</b>
View A, B, C	page 112
X Axis Units Freq Time	page 87
Zero Span	page 102

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## Amplitude

**Amplitude** activates the reference level function and accesses the amplitude menu keys. Amplitude menu key functions include the following: reference level, input attenuation, vertical scale, mixer level, amplitude units, amplitude correction, and amplitude offset.

<b>Ref Level</b>	allows the reference level to be changed. This function is activated when <b>Amplitude</b> is pressed. The reference level is the amplitude power or voltage represented by the top graticule line on the display. Changing the value of the reference level changes the absolute amplitude level (in the current amplitude units) of the top graticule line. Pressing any digit, 0 through 9, on the numeric keypad brings up the selected terminator menu. Key Access: <b>Amplitude</b>
<b>Attenuation Auto Man</b>	sets the input attenuation in 5 dB increments. The spectrum analyzer input attenuator, which is normally coupled to the reference level control, reduces the power level of the spectrum analyzer input signal at the input mixer. The attenuator is recoupled when Auto is underlined.
<b>CAUTION</b>	To prevent damage to the input mixer, the power level at the input mixer must not exceed +30 dBm. To prevent signal compression, power at the input to the first mixer must be kept below 0 dBm. With the attenuator set to Auto, a signal at or below the reference level will result in a mixer level at or below -10 dBm.  Key Access: <b>Amplitude</b>
<b>Scale/Div</b>	sets the logarithmic units per vertical graticule division on the display. <b>Scale/Div</b> only appears in the <b>Amplitude</b> menu when the <b>Scale Type Log Lin</b> key is set to <b>Log</b> . Using Scale/Div, values may range from 0.1 to 20 dB per division. Key Access: <b>Amplitude</b>
<b>Scale Type Log Lin</b>	scales the vertical graticule divisions in logarithmic units when <b>Log</b> is underlined, and the logarithmic units per division can be changed. Values may range from 0.1 to 20 dB per division. The default amplitude units are dBm when <b>Lin</b> is underlined. The vertical divisions are linearly scaled and the default amplitude units are volts. The reference-level value is set to the top of the display and the bottom graticule becomes zero volts. (Each division of the graticule is one-tenth of the reference level in volts.) Pressing <b>Scale Type Log Lin</b> always sets the units specified for the current amplitude scale. Pressing <b>Preset</b> or powering on the spectrum analyzer sets the default units. Key Access: <b>Amplitude</b>

**Amptd Units** accesses the softkeys that change the amplitude units. The amplitude units can be changed by pressing **dBm**, **dBmV**, **dBuV**, **Volts**, or **Watts**. When amplitude units is set to **Watts**, amplitude readings below 1 pW will be rounded to 0 pW. Key Access: **Amplitude**

**Ref Lvl Offst** adds an offset value to the displayed reference level. Offsets are entered by using the numeric keypad. Entering an offset does not affect the trace or the attenuation value. Reference-level offsets are used when gain or loss occurs between a device under test and the spectrum analyzer input. Thus, the signal level measured by the spectrum analyzer is the level at the input of an external amplitude-conversion device. When an amplitude offset is entered, its value appears on the left side of the display (as opposed to frequency offsets which appear at the bottom of the display). To eliminate an offset, press **Ref Lvl Offst**, **0**, **dB**. Pressing **Preset** also sets the offset to zero. Reference-level offsets are entered using the numeric keypad. See also the **Ext Amp Gain** softkey description. Key Access: **Amplitude**

**Ampcor** accesses the following **Ampcor** menu keys, which allow you to create or modify an amplitude-correction factors table. Key Access: **Amplitude**, **More**

**Ampcor On Off** turns the current amplitude-correction factors on or off. Key Access: **Amplitude**, **Ampcor**

**Modify Ampcor** accesses the following **Modify Ampcor** menu keys. Key Access: **Amplitude**, **Ampcor**

**Select Point**

allows you to create or edit an amplitude-correction factor data point. Enter the point number to be created or edited by using the numeric keypad, then press **Enter**. Press **Back Space** to correct errors.

Key Access: **Amplitude**, **Ampcor**, **Modify Ampcor**

**Select Freq**

allows you to enter the frequency value for an amplitude- correction point. Enter the frequency value by using the numeric keypad. Change the frequency value by using the step keys or the knob. Press **Back Space** to correct errors.

A frequency coordinate must always be specified for amplitude-correction factors.

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**NOTE** For amplitude-correction factors, a maximum of two entries with the same frequency are valid. Only the first and last points of a series with the same frequency values are used; any middle points are ignored.

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NOTE

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Amplitude-correction data is sorted in the table by frequency. The sorting occurs immediately after you have entered the frequency value via the front-panel.

Key Access: **Amplitude, Ampcor, Modify Ampcor**

**Select Amptd**

allows you to enter the amplitude value for the current amplitude-correction point. Change an amplitude value by using the step keys or the knob. Press **Back Space** to correct errors. Key Access: **Amplitude, Ampcor, Modify Ampcor**

**Delete Point**

deletes an amplitude-correction factor.  
Key Access: **Amplitude, Ampcor, Modify Ampcor**

**Purge Ampcor**

allows you to clear all data from the amplitude-correction tables. Key Access: **Amplitude, Ampcor, Modify Ampcor**

**Ext Amp Gain**

adds a positive or negative preamplifier gain value, which is subtracted from the displayed signal. The function is similar to the **Ref Lvl Offset** function, however with the **Ext Amp Gain** function, the attenuation may be changed depending on the preamplifier gain entered. A preamplifier gain offset is used for measurements that require an external preamplifier or long cables. The offset is subtracted from the amplitude readout so that the displayed signal level represents the signal level at the input of the preamplifier. The preamplifier gain offset is displayed at the top of the screen and is removed by entering zero. The preamplifier gain offset is entered using the numeric keypad. The preamplifier gain value is not affected by an instrument preset. Key Access: **Amplitude, More**

**Max Mixer Lvl**

lets you change the maximum input mixer level from  $-10$  dBm to  $-100$  dBm in 10 dB steps using the step keys, and 1 dB steps using the knob. The mixer level is equal to the reference level minus the attenuator setting. As the reference level changes, the input attenuator setting is changed to keep the power levels less than the selected level at the input mixer. Pressing **Preset** resets the maximum input mixer level to  $-10$  dBm. Key Access: **Amplitude, More**

**Input Z Corr 50 75**

sets the input impedance for voltage-to-power conversions. The impedance you select is for computational purposes only, since the actual impedance is set by internal hardware of  $50 \Omega$  (except for Option 1DP). The default is **50** (**75** with Option 1DP). Select the computational input impedance by pressing **Input Z Corr 50 75** so that **75** is underlined.

This is useful when measuring a 75  $\Omega$  device on an analyzer having a 50  $\Omega$  input impedance, and when using a 75  $\Omega$  to 50  $\Omega$  adapter on the analyzer input. Key Access: **Amplitude, More**

## **Auto Couple**

**Auto Couple** couples the following functions: resolution bandwidth, video bandwidth, attenuation, sweep time, center-frequency step, video bandwidth, and video-bandwidth to resolution-bandwidth ratio.

Coupled functions are functions that are linked. If one function is changed, the other function is changed. During normal operation, the sweep time, resolution bandwidth, and video bandwidth are coupled to span to yield optimum performance.

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## Brightness

The brightness of the display is controlled by two keys located next to each other at the upper left-hand corner of the spectrum analyzer, bordering the display. Twelve levels of brightness are provided; the top key makes the display brighter, and the lower key darkens the display. The lowest brightness level causes the display to be completely dark, as if the instrument were switched off. If the display is completely dark, press the top brightness button before troubleshooting the instrument.

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NOTE

The brightness keys do not automatically repeat when they are held down. To continue to increase or decrease the brightness, the appropriate key must be pressed repeatedly.

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## BW/Avg

The **BW/Avg** key activates the resolution bandwidth function and accesses the softkeys that control the bandwidth functions: **Resolution BW Auto Man**, **Video BW Auto Man**, and **VBW/RBW Ratio**. It also accesses **Video Average On Off**.

### Resolution BW Auto Man

changes the spectrum analyzers 3 dB resolution bandwidth from 1 kHz to 3 MHz in a 1, 3, 10 sequence using the step keys, and to 5 MHz using the numeric keypad. As the resolution bandwidth is decreased, the sweep time is increased to maintain amplitude calibration. Resolution bandwidth is also related to span. As span is decreased, the resolution bandwidth is decreased. A “#” mark appears next to **Res BW** on the display when it is not coupled. To recouple the resolution bandwidth, press **Resolution BW Auto Man** so that Auto is underlined (or press **Auto Couple**). The resolution bandwidth can be changed using the step keys, the knob, or the numeric keypad. Key Access: **BW/Avg**

### Video BW Auto Man

changes the spectrum analyzer post-detection filter from 1 Hz to 3 MHz in a 1, 3, 10 sequence using the step keys.

As the video bandwidth is decreased, the sweep time is increased to maintain amplitude calibration. A “#” mark appears next to **VBW** on the bottom of the spectrum analyzer display when it is not coupled. To couple the video bandwidth, press **Video BW Auto Man** so that Auto is underlined (or press **Auto Couple**).

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### NOTE

Auto-coupling the video bandwidth function also resets the **VBW/RBW** ratio to 0.300 X. If you want to auto-couple the video bandwidth to a nonstandard ratio, you must set the video bandwidth to auto-couple before setting the video-bandwidth/resolution-bandwidth ratio.

The video bandwidth can be changed by using the step keys, knob, or numeric keypad. Key Access: **BW/Avg**

### VBW/RBW Ratio

selects the ratio between the video and resolution bandwidths. If signal responses near the noise level are visually masked by the noise, the ratio can be set to less than 1 to lower the noise. The knob and step keys change the ratio in a 1, 3, 10 sequence. Pressing **Preset** and **Auto Couple** sets the ratio to 0.300 X. The ratio can be changed using the step keys or the knob. Front-Panel Key Access: **BW/Avg**

### Video Average On Off

initiates a digital averaging routine that averages displayed signals and noise by averaging a number of successive sweeps. The number of sweeps (N) to average is the number that is set by this function. This function does not affect the sweep time, bandwidth, or other analog characteristics of the spectrum analyzer. Annotation on the left side of the display indicates the current number of sweeps averaged. The

default number of sweeps is 100. Increasing the number of sweeps will smooth the trace. To turn off the video averaging function, press **Video Average On Off** so that **Off** is underlined. The number of sweeps can be entered using the numeric keypad. Key Access: **BW/Avg**

In single sweep mode (**Sweep, Sweep Cont Single (Single)**), N sweeps are taken. After each sweep, the new value of each display point is averaged in with the previously averaged data using the following formula:

$$A_{\text{avg}} = \left[ \frac{M-1}{M} \right] A_{\text{prior avg}} + \left[ \frac{1}{M} \right] A_m$$

Where:

$A_{\text{avg}}$  = new average value

$A_{\text{prior avg}}$  = average from prior sweep

$A_m$  = measured value on current sweep

M = number of current sweep

In continuous sweep mode (**Sweep, Sweep Cont Single (Cont)**), the same sequence is followed until M=N. At that point, the sweeps continue rather than stopping. For each new sweep, the current sweeps measured value divided by N is added to (N-1)/N times the prior average, creating a weighted rolling average.

If any measurement parameter, such as Center Freq, Span, Amplitude, or N, is changed while Video Average is On, the video average counter is reset to 0, i.e. M=0, and the trace average resets. If the analyzer is in single sweep mode, a new set of sweeps is taken only after **Sweep Cont Single (Single)** is pressed again.

## Det/Demod

**Det/Demod** accesses the softkeys controlling demodulation functions, detector functions, the speaker, and dwell time.

### Detector

accesses the **Detector** menu keys which allow you to select between **Peak**, **Sample**, and **Negative Peak** detection. When sample detection is selected, **Smp1** appears in the upper-left corner of the screen. Sample detection is used primarily to display noise or noise-like signals. This detection should not be used to make the most accurate amplitude measurement of non noise-like signals. In sample mode, the instantaneous signal value at the present display point is placed in memory. Sample detection is activated automatically for noise level markers or during video averaging.

When peak detection is selected, **Peak** appears in the upper-left corner of the screen. Peak detection is used primarily when measuring signals out of the noise floor. Peak detection obtains the maximum video signal between the last display point and the present display point and stores this value in memory. Peak detection is selected at power on and by pressing **Preset**.

Negative peak detection functions the same as peak detection, but selects the minimum video signal. When Negative Peak is selected, **Neg** appears in the upper-left corner of the screen. Negative peak detection is used to find signals that are close to, but below the noise floor. This detection should not be used to make the most accurate amplitude measurements of signals. Key Access: **Det/Demod**

### Demod

accesses the softkeys to select **AM** demodulation or turn demodulation **Off**. Key Access: **Det/Demod**

### Speaker On Off

turns the internal speaker on and off. The volume from the speaker is controlled by the front-panel volume control knob. Pressing **Preset** sets **Speaker On Off** to On.

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### NOTE

It is normal to hear clicking sounds when the Auto Alignment function is On and the analyzer is in Zero Span. During retrace, a small portion of the analyzer circuitry is realigned using relays. It is the rapid switching of these relays during retrace that causes the clicking sounds. To eliminate the clicking sounds, set Auto Alignment Off. When this is done, the Align Now All function should be performed periodically. Refer to “Specifications and Characteristics” for more information on how often to perform Align Now All when Auto Align is Off.

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Key Access: **Det/Demod**

**Dwell Time On Off** sets the dwell time for the marker pause, during which demodulation can take place. The dwell time can be set from 2 milliseconds to 100 seconds. Key Access: **Det/Demod**

## Display

**Display** accesses the **Title** menu keys which allow title entry, and the **Preferences** menu keys which allow you to turn the graticule, annotation, time/date, or inverse video, on or off. Display softkeys also include **Display Line On Off**, **Threshold On Off**, and **Contrast**.

- Display Line On Off** activates an adjustable horizontal line that is used as a visual reference line. The line, which can be used for trace arithmetic, has amplitude values that correspond to its vertical position when compared to the reference level. The value of the display line appears in the active function block and on the left side of the display. The display line can be adjusted using the step keys, knob, or numeric keypad. Pressing any digit, 0 through 9, on the numeric keypad brings up the selected terminator menu. To deactivate the display line, press **Display Line On Off** so that **Off** is underlined. (Also see the **Video** (trigger) key description in the **Trig** key menu.) Key Access: **Display**
- Threshold On Off** sets a lower boundary to the active trace. The threshold line “clips” signals that appear below the line when this function is on. The boundary is defined in amplitude units that correspond to its vertical position when compared to the reference level.
- The value of the threshold appears in the active-function block and on the lower- left side of the display. The threshold level does not influence the trace memory or marker position. The peaks found by the markers must be at least the peak- excursion value above the threshold level. The value of the threshold level can be changed using the step keys, the knob, or the numeric keypad. Pressing any digit, 0 through 9, on the numeric keypad brings up the selected terminator menu. If a threshold is active, press **Threshold On Off** until **Off** is underlined to turn the threshold display off. The threshold value affects peak searching even when the Threshold function is set to Off. The Threshold function is also activated by the Pk Threshold function in the **Search** menu. Key Access: **Display**
- Title** accesses the following **Title** menu keys which allows you to execute, change, or clear a title on your display. Key Access: **Display**
- Change Title** allows you to write a 53-character title across the top of the display. The marker readout may interfere with the last 26 characters. The markers can be turned off by pressing **Marker**, **Marker All Off**. Pressing **Change Title** accesses the softkey menus that contain the available characters and symbols.

A programming command can be entered in the display title area. It can then be executed from the front panel by pressing **Display, Title, Execute Title**.

The display title will remain until either **Change Title** is pressed again, or a trace is recalled that was previously saved with a title. A display title can also be cleared by using the clear function. Press **Display, Title, Clear Title**.  
Key Access: **Display, Title**

**Clear Title** allows you to clear a title from the front-panel display.  
Key Access: **Display, Title**

**Execute Title** executes a programming command which appears in the display title area of the spectrum analyzer. The **Change Title** function can be used to print programming commands in the title area of the display. The commands can then be executed from the front panel of the spectrum analyzer, without an external computer, by pressing the **Execute Title** softkey.  
Key Access: **Display, Title**

**Preferences** accesses a menu of the following display functions which allow you to turn the graticule, annotation, time/date, and inverse video on or off.  
Key Access: **Display**

**Graticule On Off** turns the display graticule on and off.  
Key Access: **Display, Preferences**

**Annotation On Off** turns the screen annotation on or off, however, softkey annotation will remain on the screen. The screen annotation may not be required for prints or during remote operation. Key Access: **Display, Preferences**

**Contrast** allows you to adjust the contrast of your spectrum analyzer display.  
Key Access: **Display**

**Inverse Video On Off** with **On** underlined, inverse video changes the display to have dark annotation against a light background. The spectrum analyzer is shipped from the factory with **Inverse Video Off**, which displays light annotation against a dark background. Key Access: **Display**

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## **Enter**

Pressing the **Enter** key terminates and enters into the spectrum analyzer a numerical value that has been entered from the front panel using the numeric keypad. (For most applications, it is better to use the units menu keys.)

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## **Esc**

The **Esc** (escape) key deactivates the active function and blanks the active function text from the display. No data can be accidentally entered using the knob, step keys, or numeric keypad.

Pressing **Esc** will also abort a print (if one is in progress), clear input or output overloads, and clear most error messages from the display.



## File

**File** accesses the softkey menus used to load, save, and delete data from spectrum analyzer memory.

### Load

accesses a softkey menu that allows you to load a saved spectrum analyzer state (**State**), select the trace in which trace data is to be loaded (**Trace A B C**) and load the trace data, load the current limit line tables (**Limits**), or load amplitude correction factors (**Ampcor**).

When loading limit line tables or amplitude-correction factors, press **Limits** or **Ampcor**, enter the trace register number, and press **Enter**. Valid trace register numbers are 0 through the maximum register number. The maximum register number is the number displayed during a save or load operation. If a display title is present, it is loaded with the trace data (but not with the limit line table or the amplitude-correction factors). If the display title does not exceed 34 characters, the time and date when the data was stored will also be displayed.

See “Using Instrument Features” in the *HP ESA-L1500A Measurement Guide* for more information. Key Access: **File**

**Load Now** loads a selected state, trace, limit line table, or amplitude- correction factor. Key Access: **File, Load**

### Save

accesses a softkey menu that allows you to store state data (**State**), select the trace in which trace data is to be saved (**Trace A B C**) and save the trace data, save limit line tables (**Limits**), and save amplitude-correction factors (**Ampcor**) in spectrum analyzer memory.

Saving state data saves the spectrum analyzer settings, but not the trace data. Saving trace data saves both the trace data and the state data.

States and traces are retained in spectrum analyzer memory even if the instrument is turned off or **Preset** is pressed.

See “Using Instrument Features” in the *HP ESA-L1500A Measurement Guide* for more information. Key Access: **File**

**New Filename** accesses a softkey menu for selecting display title characters for the naming of files. **New Filename** does not appear on the menu when **Internal Lock On Off** is On.

Filenames are not case-sensitive. They can be up to eight characters long. The extensions are assigned automatically and indicate whether the file is a trace, state, limit line or amplitude correction factor. The filename cannot be identical to the name of another file, and cannot contain spaces, commas, backslashes, or

periods. Valid characters include letters of the alphabet, numbers 0 through 9 and special characters '~!@#\$%^&()-\_{}' only. Key Access: **File, Save**

**Save Now** stores a selected state, trace, limit line table, or amplitude-correction factor in spectrum analyzer memory. **Save Now** is not available when **Internal Lock On Off is On** —it is replaced with (**Locked**). Key Access: **File, Save**

**Delete** accesses the delete softkey menu. Select **State** or **Trace** to clear an instrument state or trace. Select **Limits** to clear the current limit line table, or **Ampcor** to clear the current amplitude-correction factors table. Key Access: **File**

**Delete Now** allows you to delete a selected state, trace, limit line table, or amplitude-correction factor from spectrum analyzer memory. Key Access: **File, Delete**

**Erase Internal** accesses a softkey menu to clear data from spectrum analyzer memory. Selections include **All States**, **All Traces**, **All Limits**, **All Ampcor**, or **All Memory**. Key Access: **File**

**Internal Lock On Off** locks all the current internal state and trace registers against further data storage, when **On** is underlined. Pressing **Preset** sets **Internal Lock On Off** to **Off**.

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**NOTE** When **Internal Lock On Off** is set to **On**, none of the state registers can be overwritten.

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Key Access: **File**

## Freq Count

**Freq Count** activates the **Marker Normal** function if there are no markers, and then sets **Marker Count On Off** to On.

### Marker Count On Off

turns on the marker counter when **On** is underlined. If no marker is active before **Marker Count On Off** is pressed, a marker is activated at the center of the display. Press **Marker Count On Off** (so that **Off** is underlined), to turn the marker counter off. Press **Count ResIn Auto Man** to change the marker counter resolution to an uncoupled value.

An (\*) may appear in the upper right area of the display along with the message **Marker Count**. The ratio of the resolution bandwidth to span must be greater than 0.002 for the marker count function to work properly. **Marker Count Widen Res BW** appears on the display if the bandwidth to span ratio is less than 0.002. **widen RES BW** indicates that the resolution bandwidth must be increased.

Key Access: **Freq Count**

### Resolution Auto Man

allows the resolution of the marker counter to be selected manually or auto-coupled. The marker counter has a resolution range of 1 Hz to 100 kHz. The available resolution values are 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz, and 100 kHz. The resolution can be changed by using the step keys or by entering the resolution using the numeric keypad or knob. The marker counter resolution can be auto coupled to the span by pressing **Resolution Auto Man** so that **Auto** is underlined. The **Resolution Auto Man** softkey function is not affected by pressing **Auto Couple**.

Key Access: **Freq Count**

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## Frequency

**Frequency** activates the center frequency function, and accesses the menu of frequency functions. The center frequency, or start and stop frequency values appear below the graticule on the display.

Although the spectrum analyzer allows entry of frequencies greater than the specified frequency range, using frequencies greater than the frequency span of the spectrum analyzer is not recommended

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**NOTE** When changing both the center frequency and the span, change the frequency first since the span can be limited by the frequency value.

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**Center Freq** activates the center-frequency function which allows you to select a frequency to be centered on the display. Key Access: **Frequency**

**Start Freq** sets the frequency at the left side of the graticule. The left and right sides of the graticule correspond to the start and stop frequencies. When these frequencies are activated, their values are displayed below the graticule in place of center frequency and span. Key Access: **Frequency**

**Stop Freq** sets the frequency at the right side of the graticule. The left and right sides of the graticule correspond to the start and stop frequencies. When these frequencies are activated, their values are displayed below the graticule in place of center frequency and span. Key Access: **Frequency**

**CF Step Auto Man** changes the step size for the center-frequency function. Once a step size has been selected and the center frequency function is activated, the step keys change center frequency by the step-size value. The step size function is useful for finding harmonics and sidebands beyond the spectrum analyzers current frequency span. When auto-coupled, the center frequency step size is set to one graticule (10 percent of the span). Key Access: **Frequency**

**Freq Offset** allows the user to input a frequency offset value that is added to the frequency readout, to account for frequency conversions external to the spectrum analyzer. Offset entries are added to all frequency readouts including marker, start frequency, and stop frequency. Entering an offset does not affect the trace. Offsets are not added to the span. Frequency offsets are entered using the numeric keypad.

When a frequency offset is entered, its value appears on the bottom of the display (as opposed to reference level offsets, which appear on the left side of the display). To eliminate an offset, press **Freq Offset**, **0**, and **Enter**. Pressing **Preset** also sets the offset to zero. Key Access: **Frequency**

**Signal Track On  
Off**

moves the signal that is nearest to the active marker to the center of the display and keeps the signal there. **SIG-TRK** appears in the upper-right corner of the display. An (\*) may appear in the upper-right corner of the display while the spectrum analyzer is verifying that it has the correct signal.

Pressing **Signal Track On Off**, **Preset**, **Marker Normal**, or **Marker All Off** turns off the signal track function.

When signal track is on and the span is reduced, an automatic zoom is performed: the span is reduced in steps so that the signal remains at the center of the display. If the span is zero, signal track cannot be activated. Key Access: **Frequency**

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## Marker

**Marker** accesses the marker control keys which select the type and number of markers and turn them on and off. Markers are diamond-shaped characters that identify points of traces and allow the traces to be manipulated and controlled on the display. Up to four markers may appear on the display simultaneously; only one can be controlled at a time. The marker that is controlled is called the “active” marker. Pressing **Marker** activates the **Marker Normal** softkey.

**Marker Normal** activates a single frequency marker at the center frequency on the active trace if a marker is not already displayed. If a marker is displayed before the **Marker Normal** function is enabled, the marker is enabled at the position of the currently selected marker. Use the data controls to position the marker. Annotation in the active function block and in the upper-right corner indicates the frequency and amplitude of the marker. The marker stays on the trace at the horizontal screen position where it was left unless **Signal Track On Off**, or a “marker to” softkey function (such as **Mkr → CF**, **Mkr → RL**, **Mkr → CF STEP**, **Mkr Δ Span**, or **Min Search**) is selected. Pressing **Marker Normal** turns off the marker-delta function. Key Access: **Marker**

**Marker D** activates a second marker at the position of the first marker. (If no marker is present, two markers appear at the center of the display.) The amplitude and frequency of the first marker is fixed, and the second marker is under your control. Annotation in the active function block and in the upper-right corner of the display indicates the frequency and amplitude differences between the two markers. The delta marker readout will be incorrect if the scale type is changed between log and linear.

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**NOTE** If there are already four markers when **Marker Δ** is pressed, a nonactive marker disappears, the active marker becomes a reference marker, and the delta marker becomes the active marker. If marker noise is turned on while using **Marker Δ** and the noise marker is placed on the noise floor, the marker readout displays signal-to-noise.

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Key Access: **Marker**

**Select Marker**  
1 2 3 4 selects one of the four possible markers. A marker can be turned on once it is selected. A marker that has already been turned on will become active when it is selected. If a marker has already been turned on and assigned to a specific trace it will become active on that trace and the **Marker Trace Auto A B C** softkey will have the appropriate trace letter underlined. Key Access: **Marker**

<b>Marker # On Off</b>	turns the selected marker on or off. The marker which is currently selected by the <b>Select Marker 1 2 3 4</b> key, will be turned on or off. When a new marker is turned on by pressing <b>Marker # On Off</b> , the <b>Marker Trace Auto A B C</b> function always switches to <b>Auto</b> and the marker is put on the trace that is selected by the Auto mode. Key Access: <b>Marker</b>
<b>Marker Noise On Off</b>	reads out the average noise level, referenced to a 1 Hz noise power bandwidth. If no marker is present, a marker appears at the center of the display. The root-mean-square noise level (the mean value of the 32 display points about the marker) normalized to a 1 Hz noise power bandwidth, is read out. The sample detector is activated. If Marker Noise is turned On while a Marker $\Delta$ is selected, the signal-to-noise level is measured. Key Access: <b>Marker</b>
<b>Mkr Readout</b>	accesses a menu which allows you a selection of specific marker information. The selections include <b>Frequency</b> , <b>Period</b> , <b>Time</b> , and <b>Inverse Time</b> . Key Access: <b>Marker</b>
<b>Marker All Off</b>	turns off all of the markers, including markers used for marker track and demodulation. Marker annotation is also removed. Key Access: <b>Marker</b>
<b>Marker Trace Auto A B C</b>	<p>assigns a marker to a trace. Pressing <b>Marker Trace Auto A B C</b> will activate a marker on trace A if there are no markers turned on. If a marker is currently active, press <b>Marker Trace Auto A B C</b> until <b>A</b>, <b>B</b>, or <b>C</b> are underlined. The active marker will be moved to the selected trace.</p> <p>Selecting the <b>Auto</b> mode will move the marker to the trace that is automatically selected. The selection order is to first look for a trace in the clear-write mode, in the order of trace A, then trace B, then trace C. If no traces are currently being written, it will select a trace in the view-store mode, again in the order of trace A, B, then C.</p> <p>Key Access: <b>Marker</b>, <b>More</b></p>

## Measure

**Measure** accesses softkey menus that edit limit line functions (**Limits**), determine the N dB bandwidth of a signal (**N dB Points On Off**), determine % AM of a signal (**% AM On Off**), and determine third-order intercept (**TOI On Off**).

### Limits

accesses the following **Limits** menu keys. Limit lines can be created by the user to test trace data. A limit line is a test limit made up of a series of line segments, positioned according to frequency and amplitude within the measurement range of the spectrum analyzer. There can be one upper limit line and one lower limit line which set maximum and minimum test limits.

#### Limit Display Y N Auto

displays any portion of the limit lines that are currently within the spectrum analyzer display boundary. If **Y** (yes) is underlined, the limit lines are displayed. If **N** (no) is underlined, they are not displayed. If **Auto** is underlined, the display of the limit lines is dependent on **Limit Test On Off**. The limit lines will be displayed while the limit test function is turned on, otherwise they will be turned off. Key Access: **Measure, Limits**

**Limit Test On Off** turns the limit line testing and (if **Limit Display Auto** is selected) the display of the limit lines on and off. When limit line testing is enabled, every measurement sweep of trace A is compared to the limit lines. If trace A is at or within the bounds of the limit lines, **LIMIT PASS** is displayed. If trace A is out of the limit line boundaries, **LIMIT FAIL** is displayed. Key Access: **Measure, Limits**

#### X Axis Units Freq

##### Time

selects whether limit lines will be entered using frequency or sweep time to define the segments. They can be specified as a table of limit line segments of amplitude versus frequency, or of amplitude versus time. Time values are evaluated with respect to the spectrum analyzer sweep time. A time value of zero corresponds to the start of the sweep, which is at the left edge of the graticule.

Switching the limit line definition between frequency and time will erase the current limit line table. The message *If you are sure, press key again to purge data* will appear. Press **X Axis Units Freq Time** again to purge the limit line table and switch between frequency and time. Key Access: **Measure, Limits**



**Limits Fixed Rel** allows you to choose fixed or relative limit lines. The fixed (**Fixed**) type uses the current limit line as a reference with fixed frequency and amplitude values. The relative (**Rel**) setting causes the current limit line value to be relative to the displayed center frequency and reference-level amplitude values. When limit lines are specified with time, rather than frequency, the **Rel** setting only affects the amplitude values. The current amplitude values will be relative to the displayed reference-level amplitude, but the time values will always start at the left edge of the graticule.

As an example, assume you have a frequency limit line. If the limit line is specified as fixed, entering a limit line segment with a frequency coordinate of 300 MHz displays the limit line segment at 300 MHz. If the same limit line table is specified as relative, it is displayed relative to the spectrum analyzer center frequency and reference level. If the center frequency is at 1.0 GHz, a relative limit line segment with a frequency coordinate of 300 MHz will display the limit line segment at 1.3 GHz. If the amplitude component of the relative limit line segment is -10 dB, then -10 dB is added to the reference level value to obtain the amplitude of the given component (reference level offset included).

A limit line entered as fixed may be changed to relative, and one entered as relative may be changed to fixed. When changing between fixed and relative limit lines, the frequency and amplitude values in the limit line table change so that the limit line remains in the same position for the current frequency and amplitude settings of the spectrum analyzer. If a time and amplitude limit line is used, the amplitude values change but the time values remain the same.

Key Access: **Measure, Limits**

**Edit Limits** allows you to edit the current limit line tables by accessing the **Select Line Upper Lower**, and **Edit Line** keys. Use **Delete Limits** in the **Limits** menu to dispose of the current limit line table. Key Access: **Measure, Limits**

**Select Line Upper Lower** selects upper or lower limit line tables.

With **Lower** selected on the **Select Line Upper Lower** softkey, **Edit Line** allows you to view or edit the lower limit line table. Up to 30 entries are allowed for the lower limit line table. With the lower limit line table format, the coordinates for the lower limit line are specified, but none are specified for the upper limit line.

Even if upper limit line values exist, the lower limit line values are treated as a separate table from the upper limit line values. The lower limit line entries can have independent frequency (or time) and amplitude coordinates from upper limit line table entries.

With Upper selected on the **Select Line Upper Lower** softkey, **Edit Line** allows you to view or edit the upper limit line table. Up to 30 entries are allowed for the upper limit line table. With the upper limit line table format, the coordinates of the upper limit line are specified, but none are specified for the lower limit line. Even if lower limit line values exist, the upper limit line values are treated as a separate table from the lower limit line values. The upper limit line entries can have independent frequency (or time) and amplitude coordinates from lower limit line table entries. Key Access: **Measure, Limits**

**Edit Line** accesses the following **Edit Line** menu keys:

#### **Segment**

allows you to create or edit a limit line segment. Limit lines are created by entering frequency (time) and amplitude values into a limit line table. The frequency (time) and amplitude values specify a coordinate point from which a limit line segment is drawn. The coordinate point is the lowest frequency or time point of the line segment. Limit lines are constructed from left to right. To select a segment, press **Segment**, enter the segment number you wish to specify, then press a units key.

Up to 30 segments can be specified per limit line table. Key Access: **Measure, Limits, Edit Limits, Edit Line**

#### **Frequency**

(appears in menu when the **X Axis Units Freq Time** key has **Freq** underlined) allows you to enter a frequency value into a limit line table. Key Access: **Measure, Limits, Edit Limits, Edit Line**

#### **Time**

(appears in menu when the **X Axis Units Freq Time** key has **Time** underlined) allows you to enter a time value into a limit line table. Key Access: **Measure, Limits, Edit Limits, Edit Line**

### **Amplitude**

allows you to enter an amplitude value into a limit line table. Key Access: **Measure, Limits, Edit Limits, Edit Line**

### **Type**

accesses the following **Type** menu keys used to select a type of limit line:

**Slope** The slope key draws a straight line between the coordinate point of the current segment and the coordinate point of the next segment, producing limit line values for all frequencies between the two points. Key Access: **Measure, Limits, Edit Limits, Edit Line, Type**

**Flat** The flat key draws a zero-slope line between the coordinate point of the current segment and the coordinate point of the next segment, producing limit line values equal in amplitude for all frequencies between the two points. If the amplitude values of the two segments differ, the limit line “steps” to the frequency value of the second segment. Key Access: **Measure, Limits, Edit Limits, Edit Line, Type**

**Point** The point key specifies a limit value for the coordinate point. It specifies a limit at a single frequency or time, and for no other frequency/time points. For an upper limit line, a point segment is indicated by a line drawn from the coordinate point, vertically off the top of the screen. For a lower limit line, a point segment is indicated by a line drawn from the coordinate point vertically off the bottom of the screen. The line will continue to the right edge of the display, but testing stops at the defined point.

The point segment type should be used as the last segment in the limit line table. However, if the last segment in the table is not specified, an implicit point is automatically used. If a point segment at the right edge of the display is not desired, add a last-point segment to the limit line table that is higher in frequency than the displayed stop frequency. Key Access: **Measure, Limits, Edit Limits, Edit Line, Type**

### **Del Segment**

deletes the limit line entry for the selected segment number. Front-Panel Key Access: **Measure, Limits, Edit Limits, Edit Line**

**Delete Limits** allows you to purge data from the limit line tables. Key Access: **Measure, Limits**

**N dB Points On Off** automatically places two markers at points N dB from the highest point on the highest displayed signal, and determines the frequency difference between the two markers. N dB is the active function and the value of N is set by the user. The measurement defaults to -3 dB when it is first turned on. The measurement runs continuously, re-executing at the end of each sweep.

No other signal can appear on the display within N dB of the highest signal. The measured signal cannot have more than one peak that is greater than or equal to N dB. A signal must be greater than the peak excursion above the threshold to be identified. The setting for peak excursion may be increased from the 6 dB default value so that noise will not be identified as signals. Increasing the value too much may cause a smaller signal to be missed or misinterpreted as part of a larger signal. The amplitude scale may be either linear or logarithmic.

Key Access: **Measure**

**% AM On Off** determines the percent of amplitude modulation of the largest displayed signal and its two sidebands. The sidebands are assumed to be entirely from amplitude modulation. If there are differences in the sideband amplitude, the larger value is used. The measurement runs continuously, re-executing at the end of each sweep.

The three signals that make up the AM signal, must all be displayed. The frequency spacing of the sideband signals must be the same within the span accuracy of the measurement. All of the signals must be greater than the peak excursion above the threshold. The amplitude scale may be either linear or logarithmic. Key Access: **Measure**

**TOI On Off** finds the third-order intercept of the two highest amplitude signals and the two associated distortion products. The measurement compensates for unequal test signal amplitude. The measurement runs continuously, re-executing at the end of each sweep. The units for the displayed value can be selected by pressing the **Amptd Units** softkey. The two test signals and the two associated distortion products must all be displayed for the measurement to function. The relative amplitudes and frequencies of the displayed signals must fit the TOI pattern. All of the signals must be greater than the peak excursion above the threshold.

Key Access: **Measure**

## **More**

The **More** key is used to move between successive pages in multi-page menus. When the **More** key is active, a designation appears in the more field on the screen (such as 1 of 3), to show that there are more menu pages available.

## Peak Search

**Peak Search** immediately places the currently selected marker on the signal having the highest peak on the display. If no marker is active, a marker is created and placed on the highest peak.

**Peak Search** is an immediate execution key. Pressing **Peak Search** does not change the key menu activated on the display. A peak search may be performed while in any key menu.

## Preset

**Preset** provides a convenient starting point for making most measurements. Pressing **Preset** displays menu keys used for accessing the operating modes available for your spectrum analyzer. See the following Preset Conditions Table, for the conditions established by pressing **Preset**.

The instrument preset function performs a processor test, but does not affect alignment data. Pressing **Preset** clears both the input and output buffers, but does not clear trace B. The amplitude values of trace C are set to the reference level. Amplitude-correction factors are turned off. Limit line testing is turned off, but the limit line tables remain in spectrum analyzer memory. The status byte is set to 0.

**NOTE**

Turning the spectrum analyzer on performs an instrument preset. Turning on the spectrum analyzer also fetches alignment data; completes a processor test; clears trace B, trace C, and both the input and output buffers; turns off amplitude-correction factors; turns off limit line testing; and sets the status byte to 0. The last state of the spectrum analyzer (before it was switched off) is recalled when **Power On IP Last** is set so that **Last** is underlined.

**Table 4-1**

**Preset Conditions**

Amplitude correction factors	off
Amplitude units	default values
Annotation and graticule display	on
Attenuation	10 dB (auto-coupled)
Center frequency	750 MHz
CF step size	10% of span
Coupled functions	all set to AUTO
Detector	positive peak
Display line level	2.5 divisions below reference level, display off
Frequency offset	0 Hz
Limit line testing	off
Log scale	10 dB/division
Marker counter	off

Marker counter resolution	auto-coupled
Markers	off
Mixer level	-10 dBm
Reference level	0 dBm in power-on units
Reference level offset	0 dB
Reference level position	top (10th) graticule
Resolution bandwidth	3 MHz (auto-coupled)
Span	1.5 GHz
SRQ mask	octal 50
Start Frequency	0 Hz
Stop Frequency	1.5 GHz
State registers	unaffected
Sweep	continuous
Sweep Time	5 ms
Threshold level	one graticule above baseline, display off
Title	cleared
Trace A	clear-write
Trace B	store-blank
Trace C	store-blank, at reference level
Trace registers	unaffected
Trigger	free run
VBW/RBW ratio	0.3
Video averaging	off
Video bandwidth	1 MHz (auto-coupled)



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## Print

*Option A4H (HP-IB and Parallel) and 1AX (RS-232 and Parallel) only.* **Print** initiates an output of the display data, without an external controller, to a previously specified graphics printer. Refer to Chapter 1 of this manual or the *HP ESA-L1500A Spectrum Analyzer Programmer's Guide* for detailed information about printing.

Press the **Print** key to immediately print the screen to the currently-defined printer. The screen remains frozen (no further sweeps are taken) until the data transfer to the printer is complete. Press **System**, **Printer** to access menu keys to redefine the print device and port. Refer to the **System** key description in this chapter for more information about the structure and definitions of the printer and port keys.

If you need to abort a print in progress, use the **Esc** (escape) key.

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### NOTE

Printing requires an optional interface. Generally, spectrum analyzers printing to a printer with an HP-IB interface set the printer address to 1. Spectrum analyzers using the RS-232 interface to print, must have the baud rate set to match the baud rate of the printer being used. The *HP ESA-L1500A Spectrum Analyzer Programmer's Guide*, included with the optional interfaces, details the different interfaces. Refer to Chapter 1 for more information about printing.

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## Search

The **Search** key accesses the following marker and search function menu keys.

- Max Pk → CF** places a marker on the highest peak, and then changes the spectrum analyzer settings so that the peak is placed at the center frequency. Key Access: **Search**
- Mkr → CF** changes the spectrum analyzer settings so that the frequency of the marker becomes the center frequency. Key Access: **Search**
- Mkr → Ref Lvl** changes the spectrum analyzer settings so that the amplitude of the active marker becomes the reference level. Key Access: **Search**
- Next Peak** places the marker on the next highest peak. The signal peak must exceed the peak threshold value. If there is no peak, the marker will not move. (Also see the **Peak Excursn** and **Pk Threshold** key descriptions.) Key Access: **Search**
- Next Pk Right** moves the marker to the next peak to the right of the current marker. The signal peak must exceed the peak threshold value. If there is no peak to the right, the marker will not move. (Also see the **Peak Excursn** and **Pk Threshold** key descriptions.) Key Access: **Search**
- Next Pk Left** moves the marker to the next peak to the left of the current marker. The signal peak must exceed the peak threshold value. If there is no peak to the left, the marker will not move. (Also see the **Peak Excursn** and **Pk Threshold** key descriptions.) Key Access: **Search**
- Peak Excursn** sets the minimum amplitude variation of signals that the marker can identify as a peak. If a value of 10 dB is selected, the marker moves only to peaks that rise and fall more than 10 dB above the peak threshold value. Pressing **Preset** or turning on power resets the excursion to 6 dB, and the threshold to 90 dB below the reference level.

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### NOTE

Two signal peaks, which are so close together that the amplitude drop between them is less than the peak-excursion value, are not recognized as two peaks. A signal peak is recognized only if it has a peak excursion drop above the noise floor, on both sides of the signal.

When the peak excursion value is 6 dB or higher, the marker-peaking functions may not recognize signals less than 6 dB above the noise floor. To correct this, when measuring signals near the noise floor, the excursion value can be reduced even further. To prevent the marker

from identifying noise as signals, reduce the noise floor variance to a value less than the peak-excursion value by reducing the video bandwidth or by using video averaging. Key Access: **Search**

<b>Pk Threshold</b>	<p>sets a lower boundary to the active trace. The threshold line “clips” signals that appear below the line when this function is on. The boundary is defined in amplitude units that correspond to its vertical position when compared to the reference level. In other words, if the reference level is -10 dBm, and the threshold is set to -75 dBm, the threshold will remain 65 dB below the reference level as the reference level is changed.</p> <p>The value of the threshold appears in the active-function block and on the lower- left side of the display. The threshold level does not influence the trace memory or marker position. The peaks found by the markers must be at least the peak- excursion value above the threshold level. The value of the threshold level can be changed using the step keys, the knob, or the numeric keypad. Pressing any digit, 0 through 9, on the numeric keypad brings up the selected terminator menu. The threshold value affects peak searching functions (except for <b>Peak Search</b>) even when the <b>Pk Threshold</b> function is set to <b>On</b>. Key Access: <b>Search, More</b></p>
<b>Pk-Pk Search</b>	<p>finds and displays the frequency and amplitude differences between the highest and lowest trace points. Pressing <b>Pk-Pk Search</b> performs the routine similar to pressing the following keys: <b>Peak Search</b>, <b>Mkr Δ</b>, and <b>Mkr → Min</b>. Key Access: <b>Search, More</b></p>
<b>Min Search</b>	<p>moves the active marker to the minimum detected amplitude value. Key Access: <b>Search, More</b></p>
<b>Mkr → Start</b>	<p>changes the start frequency so that it is equal to the frequency of the active marker. This moves the active marker to the left edge of the display. Key Access: <b>Search, More</b></p>
<b>Mkr → Stop</b>	<p>changes the stop frequency so that it is equal to the frequency of the active marker. This moves the active marker to the right edge of the display. Key Access: <b>Search, More</b></p>
<b>Mkr → CF Step</b>	<p>changes the center-frequency step size to match the value of the active marker. Press <b>Frequency</b> then <b>CF Step Auto Man</b> to view the step size. If marker delta is active, the step size will be set to the frequency difference between the markers. Key Access: <b>Search, More</b></p>
<b>Mkr Δ → Span</b>	<p>sets the start and stop frequencies to the values of the delta markers. The start and stop frequencies will not be set if the delta marker is off. Key Access: <b>Search, More</b></p>

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## Single Sweep

**Single Sweep** changes the sweep control to single sweep if the spectrum analyzer is in the continuous sweep mode, and executes a sweep after the trigger condition is met. If the analyzer is already in single sweep, pressing **Single Sweep** re- executes a new sweep after the trigger condition is met.

## Source Amptd

**Source Amptd** accesses the tracking generator key functions. (*Options 1DN or 1DQ only*) Without Option 1DN or 1DQ, pressing **Source Amptd** will cause the error message “Required option not installed” to appear on the analyzer display.

**Amplitude On Off** activates (**On**) or deactivates (**Off**) the output power of the tracking generator. The power level can then be adjusted using the numeric keypad, step keys, or knob. Pressing any digit, 0 through 9, on the numeric keypad brings up the selected terminator menu. See specifications and characteristics in Chapter 9 for the available output power for your tracking generator. Key Access: **Source Amptd**

**Power Sweep On Off** activates (**On**) or deactivates (**Off**) the power-sweep function. The value of the power-sweep range is displayed in the active-function block when **Power Sweep On Off** is set to **On**. The analyzer continues to sweep the specified frequency range when power sweep is on. (To do a power sweep at a fixed frequency, set the analyzer to zero span at the desired frequency). The available power-sweep range is a function of the source attenuator setting. See “Specifications” for the available power sweep range.

The output power of the tracking generator is swept according to the sweep rate of the spectrum analyzer. The output power is always swept from the source power setting to a higher power setting (negative source power sweep values are not allowed).

Power-sweep measurements are particularly useful in making gain compression measurements or output power versus frequency measurements. Key Access: **Source Amptd**

**Attenuation Auto Man** allows you to select between automatic and manual adjustment of the tracking generator’s switching attenuator. The HP ESA-L1500A can be manually adjusted from 0 to 60 dB in 10 dB steps. When auto-coupled, the attenuation function automatically adjusts the attenuator to yield the source amplitude level specified by the **Amplitude On Off** softkey function. Set **Attenuation Auto Man** so that **Man** is underlined (decoupled) for power sweeps greater than 10 dB. Key Access: **Source Amptd**

**Amptd Step Auto Man** allows the user to set the step size of the power level, power offset, and power-sweep range functions of the tracking generator. The default setting is one vertical scale division. Key Access: **Source Amptd**

**Amptd Offset** offsets the displayed power of the tracking generator. Using the amplitude offset capability of the tracking generator allows you to take system losses or gains into account, thereby displaying the actual power delivered to the device under test. Key Access: **Source Amptd**

## Span

The **Span** key activates the Span function and accesses the menu of span functions. Pressing **Span** allows the user to change the frequency range symmetrically about the center frequency. The frequency-span readout describes the total displayed frequency range; to determine frequency span per horizontal graticule division, divide the frequency span by 10.

**Span Zoom** finds the highest signal peak on the display. If a marker is not already on the peak, it places a marker there, turns on the signal-track function, and activates the span function. Span Zoom then requires the user to enter a target span. Once entered, the analyzer reduces the span in steps, keeping the signal centered on the screen until the entered span is reached. Pressing **Span Zoom** performs the routine similar to pressing the following keys: **Peak Search**, **Frequency**, **Signal Track On Off (On)**, and **Span**. Key Access: **Span**

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**NOTE** Span Zoom leaves the spectrum analyzer in Signal Track mode.

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**Full Span** changes the spectrum analyzer span to full span showing the full frequency range of the spectrum analyzer. Full span turns **Signal Track On Off** to **Off**. Key Access: **Span**

**Zero Span** changes the frequency span to zero. Zero span turns **Signal Track On Off** to **Off**. Key Access: **Span**

**Last Span** changes the spectrum analyzer frequency span to the previous span setting. Key Access: **Span**

## **Standby**

The **Standby** key removes power from the spectrum analyzer, except for a small portion of circuitry inside the switching power supply. No internal timebase circuitry, or any other function outside of the power supply is powered when the spectrum analyzer is in “standby.”



## Sweep

The **Sweep** key activates the Sweep Time function, and accesses the sweep menu keys: **Sweep Time Auto Man**, **Sweep Cont Single**, and **Swp Coupling SR SA**.

- Sweep Time Auto Man** selects the length of time in which the spectrum analyzer sweeps the displayed frequency span. In all spans, the sweep time varies from 5 milliseconds to 2000 seconds. Reducing the sweep time increases the rate of sweeps. The sweep time can be changed using the step keys, the knob, or the numeric keypad. Key Access: **Sweep**
- Sweep Cont Single** switches the spectrum analyzer between the continuous-sweep mode and the single-sweep mode. If the spectrum analyzer is in single-sweep mode, **Single** is underlined. Press **Single** on the front panel, to enable a sweep when in single-sweep mode. When continuous-sweep mode is in use, one sweep follows another as soon as it is triggered. Pressing **Preset**, or turning the power on, selects continuous sweep. Key Access: **Sweep**
- Swp Coupling SR SA** selects stimulus-response (SR) or spectrum-analyzer (SA) auto-coupled sweep times. In stimulus-response mode, auto-coupled sweep times are usually much faster for swept-response measurements. Stimulus-response auto-coupled sweep times are typically valid in stimulus-response measurements when the system's frequency span is less than 20 times the bandwidth of the device under test. Key Access: **Sweep**

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## System (Local)

**System** accesses the System menu keys. Pressing **System (Local)** after the spectrum analyzer has been placed in the remote mode, places the spectrum analyzer in the local mode and enables front-panel control. During remote operation, “R” appears in the upper-right corner of the screen. A “T”, “L” or “S” may appear during remote operation, indicating talk, listen, or service request. Pressing the **System** key removes the “R” symbol in the upper-right corner.

**Printer** *Option A4H (HP-IB and Parallel) or 1AX (RS-232 and Parallel) only.* Accesses the **Printer** menu keys which allow you to configure your spectrum analyzer for printing, and select printer options. See **Printer** at the end of this section.

**Time/Date** accesses the following **Time/Date** menu keys used to set and display the real-time clock: Key Access: **System**

**Datemode MDY DMY** changes the display of the date from a month-day-year format to a day-month-year format. It is set to a month-day-year format when the instrument is Preset. Key Access: **System, Time/Date**

**Set Time** allows you to set the time of the real-time clock. Enter the time in 24 hour HHMMSS format, using the numeric keypad and pressing **Enter**. Valid hour (HH) values are from 00 to 23. Valid minute (MM) and second (SS) values are from 00 to 59. Key Access: **System, Time/Date**

**Set Date** allows you to set the date of the real-time clock. Enter the date in the YYMMDD format using the numeric keypad and press **Enter**. Valid year (YY) values are 00 through 99. Valid month (MM) values are from 01 to 12, and valid day values are from 01 to 31. Key Access: **System, Time/Date**

**Time/Date On Off** turns the display of the real-time clock on or off. Key Access: **System, Time/Date**

**Remote Port HP-IB** *Option A4H (HP-IB and Parallel) only.* Selects the remote port to allow programming from an external controller over HP-IB. It allows the HP-IB address to be entered using the numeric keypad only. The default address is 18. Key Access: **System**

- Remote Port Serial** *Option 1AX (RS-232 and Parallel) only.* Selects the remote port to allow programming from an external controller over a serial bus. It allows the baud rate to be set using the numeric keypad or step keys only. Baud rate values are as follows: 110, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200. Key Access: **System**
- Power On IP Last** determines the state of the spectrum analyzer when the spectrum analyzer is powered on. If the Power On function is set to **IP**, the state of the spectrum analyzer is the same as it is after **Preset** is pressed, when the spectrum analyzer is powered on. If the Power On function is set to **Last**, then the state that the spectrum analyzer was in when it was powered off is recalled.
- The setting (IP or Last) of the Power On function is not changed by pressing **Preset**. Use the **Power On IP Last** softkey function to change the setting of the spectrum analyzer state which is recalled at power on. Limit lines are not recalled when the spectrum analyzer is powered on. Key Access: **System**
- 50 MHz osc On Off** turns the internal alignment signal on or off. When the internal alignment signal is on, the RF input is disabled. Key Access: **System**
- Alignments** accesses the following **Alignments** menu keys which align the internal circuitry of the spectrum analyzer, load default values for the alignment system, turn on the frequency corrections, and adjust the 10 MHz reference. Key Access: **System**
- Auto Align** accesses the **Auto Align** menu keys. Selecting **All** turns on the automatic alignment of all measurement systems. **All but RF** turns on the automatic alignment of all measurement systems except the RF section. (Eliminating automatic alignment of the RF prevents changes in the input impedance between sweeps, which could cause input device instability.) **Off** turns off automatic alignment. When **Auto Align, All**, is selected, “**AA**” appears along the left edge of the display. When **Auto Align, All but RF**, is selected, “**AB**” appears. Key Access: **System, Alignments**
- Align Now** accesses the **Align Now** menu keys and immediately executes an alignment cycle of the selected system(s). Softkey selections include **All** (for the alignment of all systems), **ADC**, **LO**, **IF**, and **RF**. Key Access: **System, Alignments**
- Freq Correct On** **Off** controls use of some of the correction factors. When **On** is underlined, frequency correction factors are used. When **Off** is underlined, frequency correction factors are not used, and **Freq Corr Off** appears on the display. Turning the correction factors off degrades frequency accuracy.

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**NOTE** Correction factors must be on for the spectrum analyzer to meet its specified performance.

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Key Access: **System, Alignments**

**Timebase** accesses the **Fine** and **Coarse** Timebase menu keys, which allow control of the 10 MHz timebase frequency. This function is used to verify the settability of the 10 MHz reference and to adjust for changed operating conditions, such as temperature. Pressing **Load Defaults** or cycling power, resets the timebase to its original value. Key Access: **System, Alignments**

**Load Defaults** loads the default values for the alignment system, turns on the frequency corrections, and resets the timebase to the factory values. **Align Now, All**, must be selected after pressing **Load Defaults**. Key Access: **System, Alignments**

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**NOTE** For full alignment to be restored after loading defaults **Align Now, All**, must be run 5 times, or the instrument must be in **Auto Align** mode for 1 hour.

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**Show System** displays the number and description of the options installed in your spectrum analyzer. It also displays the instrument model number, product number, serial number, and firmware revision number. Key Access: **System**

**Default Config** resets the spectrum analyzer to the user configuration originally set at the factory. It also performs an instrument preset (see **Preset** in this chapter). The following table shows the default user-configuration settings which result from pressing **Default Config**. Key Access: **System, More**

Configuration	Default Value
Analyzer address (Option A4H)	18
Baud rate (Option 1AX)	9600
Date mode	Month-day-year format
External preamp	0 dB
Internal lock	Off
Power on	IP
Print softkeys	On

Configuration	Default Value
Printer address (Option A4H)	1
Printer port (Options A4H and 1AX)	Parallel
Time/Date display	On

**Service**

accesses the **Service** menu keys which require a password. For information, refer to the Troubleshooting chapter in the *HP ESA-L1500A Spectrum Analyzer Service Guide*. Key Access: **System, More**

**Printer**

**Printer**

*Option A4H (HP-IB and Parallel) or 1AX (RS-232 and Parallel) only.* Accesses the **Printer** menu keys which allow you to select from a list of common printers, define a printer, select a printing port, and select printer options. Key Access: **System**

**Select Printer**

accesses a list of printer types from which you can choose, and also accesses keys that allow you to define a printer, if yours is not listed. To define a printer, press **User Defined, Define Printer** to select five different definition attributes. **Resolution** is input using the keypad. The allowable range is from 75 to 2600 dots per inch. **Top Margin** and **Bottom Margin** allow you to adjust the white space above or below your print by entering a number using the numeric keypad. The allowable range is from 0 to four inches. Choose **HP Color Mode** to emulate the color drivers in an HP PaintJet printer (**PJ**), an HP DeskJet printer (**DJ**), or **Off** for single-color printers. Choose **Expand On** to expand the printed image by 3X, or choose **Expand Off** to print the image at 100%. Key Access: **System, Printer**

**Port**

*(Option A4H or 1AX only)* accesses a menu which allows you to select a printer port. The **Printer Addr** key appears in this menu only when **HP-IB** is selected. **Baud Rate** appears in this menu only when **Serial** is selected. Key Access: **System, Printer**

**HP-IB**

selects the HP-IB interface as the printer port. Key Access: **System, Printer, Port**

**Serial**

selects the serial interface as the printer port.

Key Access: **System, Printer, Port**

**Parallel**

selects the parallel interface as the printer port.

Key Access: **System, Printer, Port**

**Printer Addr**

*(Option A4H only)* allows you to change the HP-IB address of the printer. **Printer Addr** appears in the printer port menu only if **HP-IB** is selected.

Key Access: **System, Printer, Port**

**Baud Rate**

*(Option 1AX only)* sets the data transmission speed. **Baud Rate** appears in the printer **Port** menu only when **Serial** is selected. Key Access: **System, Printer, Port**

**Color Printing On Off** allows you to select between color or black and white printing. Key Access: **System, Printer**

**Print Softkeys On Off** allows you to print the menu key labels on the spectrum analyzer display printout when **On** is underlined. When **Off** is underlined, the analyzer display will print, as well as the lines between the menu keys, but the menu key labels will be blanked. Key Access: **System, Printer**

**Form Feed** allows you to send a form feed to the printer.

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NOTE

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If the **Form Feed** key is pressed without a printer connected to the spectrum analyzer, press **Esc** to regain control of the analyzer.

Key Access: **System, Printer**

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## Trace

**Trace** accesses the trace keys that allow you to store and manipulate trace information. Each trace is comprised of a series of data points that form a register where amplitude information is stored. The spectrum analyzer updates the information for any active trace with each sweep. If two traces are being written to, they are updated on alternating sweeps.

**Trace A B C** selects the softkey menu used for trace A, trace B, or trace C functions. Press **Trace A B C** until the letter of the desired trace is underlined.  
Key Access: **Trace**

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**CAUTION** When using normalization, the mode of traces B and C should not be changed.

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**Clear Write A** erases any data previously stored in trace A and continuously displays any signals during the sweep of the spectrum analyzer. This function is activated at power-on and by pressing **Preset**.

Changing the trace mode of trace C to clear write or minimum hold can change the trace mode of trace A. If trace A is in clear-write mode or maximum-hold mode when trace C is changed to clear write or minimum hold, the trace mode of trace A is changed to store blank.

The following table shows the trace mode of trace A before and after changing trace C to clear-write or minimum-hold trace mode.

<b>Trace Mode of Trace A Before</b>	<b>Trace Mode of Trace A After</b>
Clear write	Blank
Maximum hold	Blank
View	View

Changing the trace mode of trace A to clear write or maximum hold can change the trace mode of trace C. If trace C is in clear-write mode when trace A is changed to clear write or minimum hold, the trace mode of trace C is changed to minimum hold.

<b>Trace Mode of Trace C Before</b>	<b>Trace Mode of Trace C After</b>
Clear write	Minimum hold
Minimum hold	Minimum hold
View	View

Key Access: **Trace**

### Clear Write B

erases any data previously stored in trace B and continuously displays any signals detected during the sweep of the spectrum analyzer.

Changing the trace mode of trace C to clear write or minimum hold can change the trace mode of trace B. If trace B is in clear-write mode or maximum-hold mode when trace C is changed to clear write or minimum hold, the trace mode of trace B is changed to store blank.

The following table shows the trace mode of trace B before and after changing trace C to clear-write or minimum-hold trace mode.

<b>Trace Mode of Trace B Before</b>	<b>Trace Mode of Trace B After</b>
Clear write	Blank
Maximum hold	Blank
View	View

Changing the trace mode of trace B to clear write or maximum hold can change the trace mode of trace C. If trace C is in clear-write mode when trace B is changed to clear write or minimum hold, the trace mode of trace C is changed to minimum hold.

<b>Trace Mode of Trace C Before</b>	<b>Trace Mode of Trace C After</b>
Clear write	Minimum hold
Minimum hold	Minimum hold
View	View

Key Access: **Trace**



**Clear Write C** erases any data previously stored in trace C and continuously displays any signals detected during the sweep of the spectrum analyzer.

Changing the trace mode of trace C to clear write or minimum hold can change the trace mode of trace A and trace B. If trace A or trace B is in clear-write mode or maximum-hold mode when trace C is changed to clear write or minimum hold, the trace mode of trace A or trace B is changed to store blank. The following table shows the trace mode of trace A or trace B before and after changing trace C to clear-write or minimum-hold trace mode.

<b>Trace Mode of Trace A or B Before</b>	<b>Trace Mode of Trace A or B After</b>
Clear write	Blank
Maximum hold	Blank
View	View

If you want to use trace A or trace B in the clear-write or maximum-hold mode and do not want trace C to blank it, use minimum-hold or view-trace mode for trace C. Key Access: **Trace**

**Max Hold A or B** maintains the maximum level for each trace point of the selected trace (A or B), and updates each trace point if a new maximum level is detected in successive sweeps. Key Access: **Trace**

**Min Hold C** maintains the minimum level for each trace point of trace C, and updates each trace point if a new minimum level is detected in successive sweeps. Key Access: **Trace**

**View A, B, or C** holds and displays the amplitude data of the selected trace. The trace register is not updated as the spectrum analyzer sweeps. If trace A is deactivated by pressing **Blank A**, the stored data can be retrieved by pressing **View A**. Key Access: **Trace**

**Blank A, B, or C** stores the amplitude data for the selected trace, and removes it from the display. The selected trace register will not be updated as the spectrum analyzer sweeps. Key Access: **Trace**

**Operations**

accesses the following **Operations** menu keys:

- A ↔ B** exchanges the contents of the trace A register with the trace B register and puts trace A in view mode. Key Access: **Trace, Operations**
- B - DL → B** subtracts the display line from trace B and places the result in trace B. The B - DL → B function is a math operation. Key Access: **Trace, Operations**
- B ↔ C** exchanges the contents of trace B with trace C and puts trace B in view mode. Key Access: **Trace, Operations**
- A → C** copies trace A into trace C. Key Access: **Trace, Operations**
- B → C** copies trace B into trace C. Key Access: **Trace, Operations**

**Normalize**

accesses the following **Normalize** menu keys:

**Normalize On Off** copies trace A into trace B, subtracts trace B from trace A and adds the result to the normalized reference level. The result is displayed in trace A. The trace data is normalized with respect to the normalized reference level, even if the value of the normalized reference level is changed. This function remains in effect on all subsequent sweeps until it is turned off. A minus sign (-) appears between the trace A status and the trace B status in the display annotation while the function is active. To turn off the normalize function, press **Normalize On Off** so that Off is underlined.

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**CAUTION**

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When using normalization, the mode of traces B and C should not be changed.

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**CAUTION**

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Trace A should be in clear write mode prior to setting normalize to on.

The normalize function is most useful for applying correction data to a trace while making a stimulus response measurement with a tracking generator. For example, connect the cables and a thru line, in place of the device to be measured, between a tracking generator and the spectrum analyzer input. Notice that the frequency response is not perfectly flat, showing the response of the cables, as well as the flatness of both the tracking generator and the spectrum analyzer. Turn **Normalize On**. Notice that the displayed trace is now flat, or normalized. The position of the normalized trace can now be moved to a different position on the display by changing the normalized reference position. This may be useful if the device to be tested has

positive gain, such as an amplifier. Now replace the thru line with the device under test, and an accurate measurement of the gain or loss can be made.

Key Access: **Trace, Normalize**

**Norm Ref Lvl** sets the level (in dB) of the normalized reference.

Key Access: **Trace, Normalize**

**Norm Ref Posn** offsets the displayed trace without affecting the instrument gain or attenuation settings. This allows the displayed trace to be moved without decreasing measurement accuracy. The normalized reference position is indicated with a (>) character on the left side of the display and a (<) character on the right side of the display. Key Access: **Trace, Normalize**

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## Trig

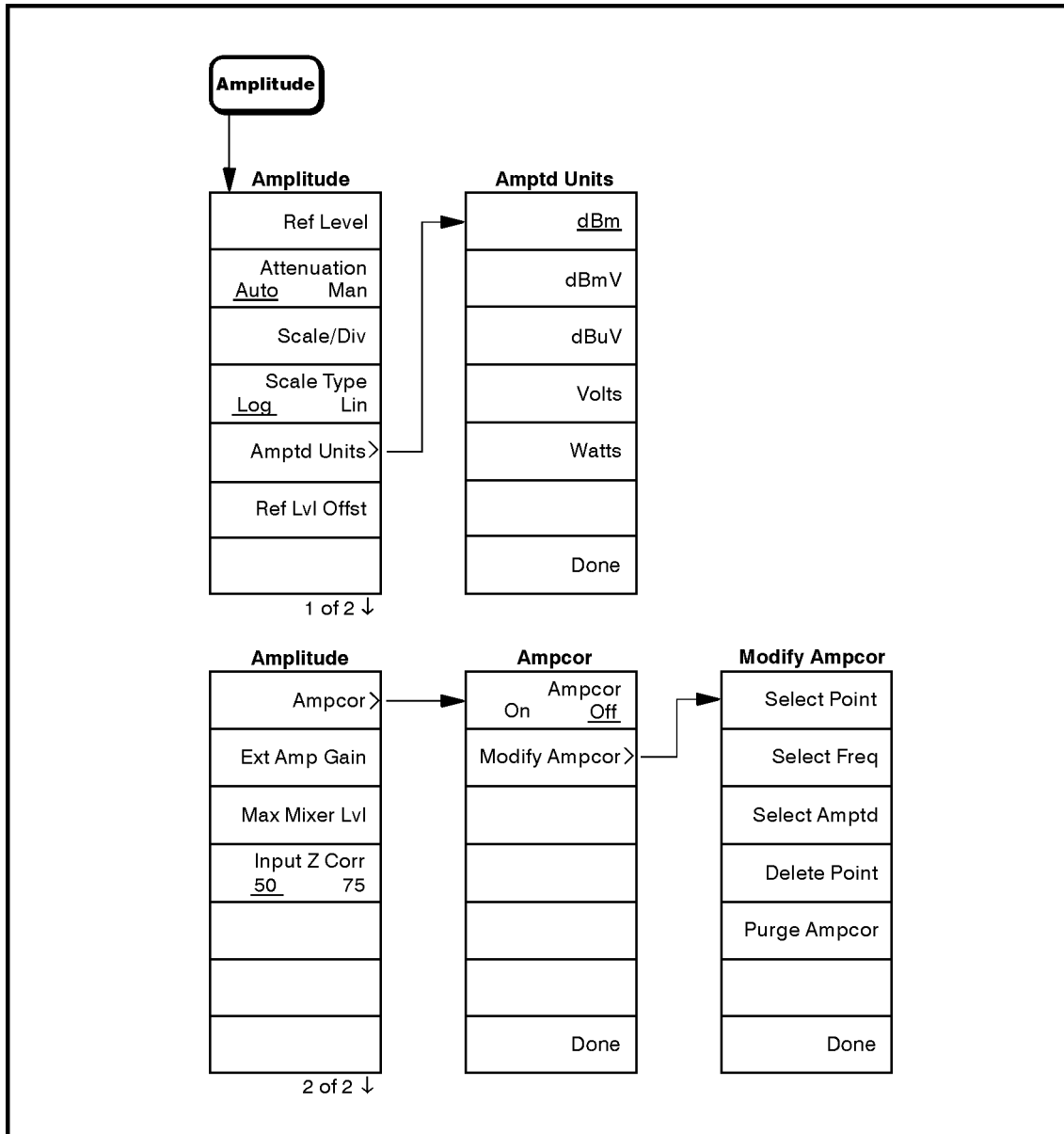
The **Trig** key accesses the menu of keys that allow you to select the sweep mode and trigger mode of the spectrum analyzer.

- Free Run** activates the trigger condition that allows the next sweep to start as soon as possible after the last sweep. Key Access: **Trig**
- Video** activates the trigger condition that allows the next sweep to start if the detected RF envelope voltage rises to a level set by the display line. When **Video** is pressed, the display line appears on the display. The spectrum analyzer triggers when the input signal exceeds the display line level at the left edge of the display. Key Access: **Trig**
- Line** activates the trigger condition that allows the next sweep to be synchronized with the next cycle of the line voltage. Key Access: **Trig**
- External** activates the trigger condition that allows the next sweep to start when positive- going external voltage (connected to **Ext Trig In** on the rear panel) passes through approximately 1.5 volts. The external trigger signal must be a 0 V to +5 V TTL signal. Key Access: **Trig**

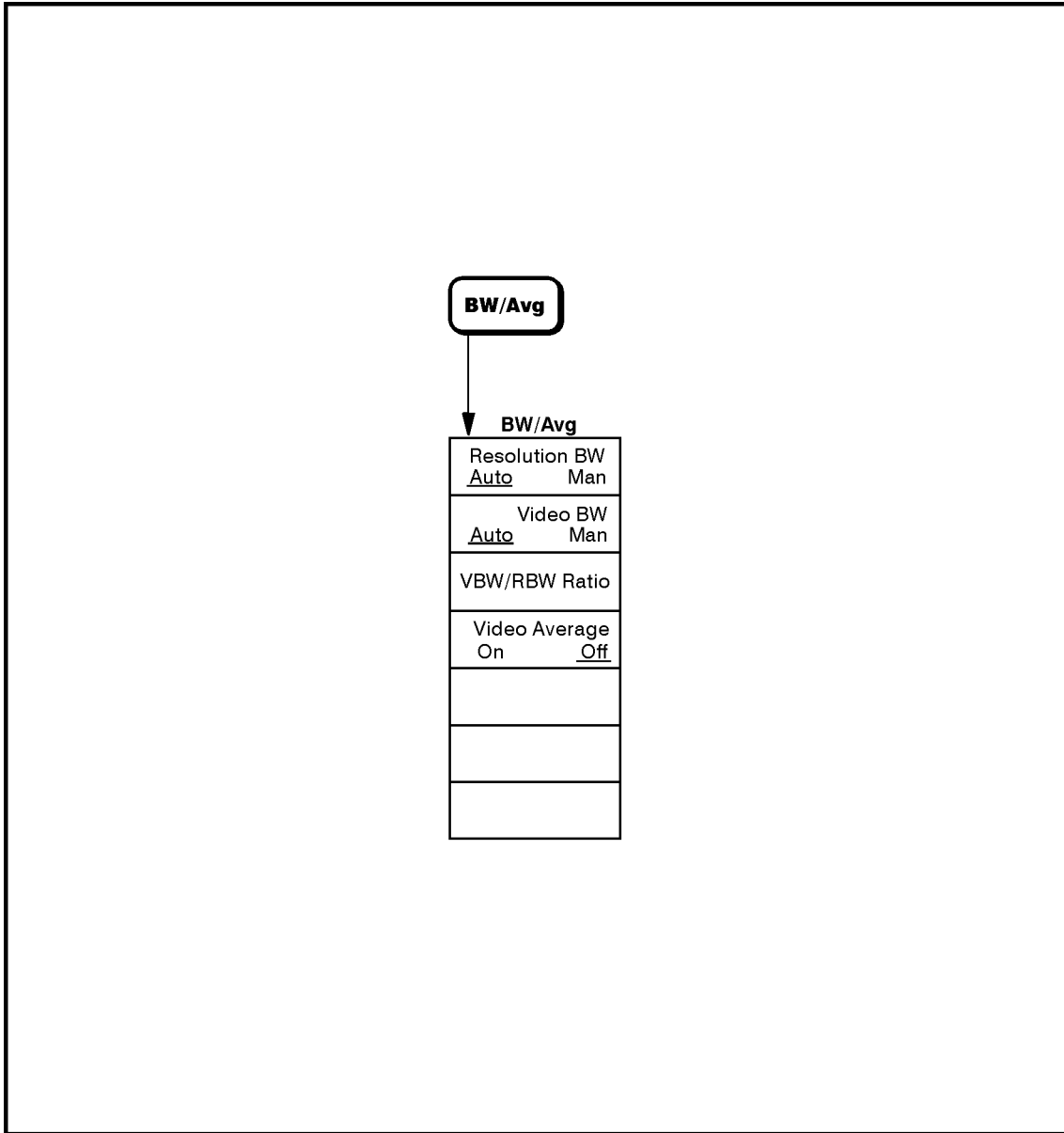


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## **5** **Menu Maps**

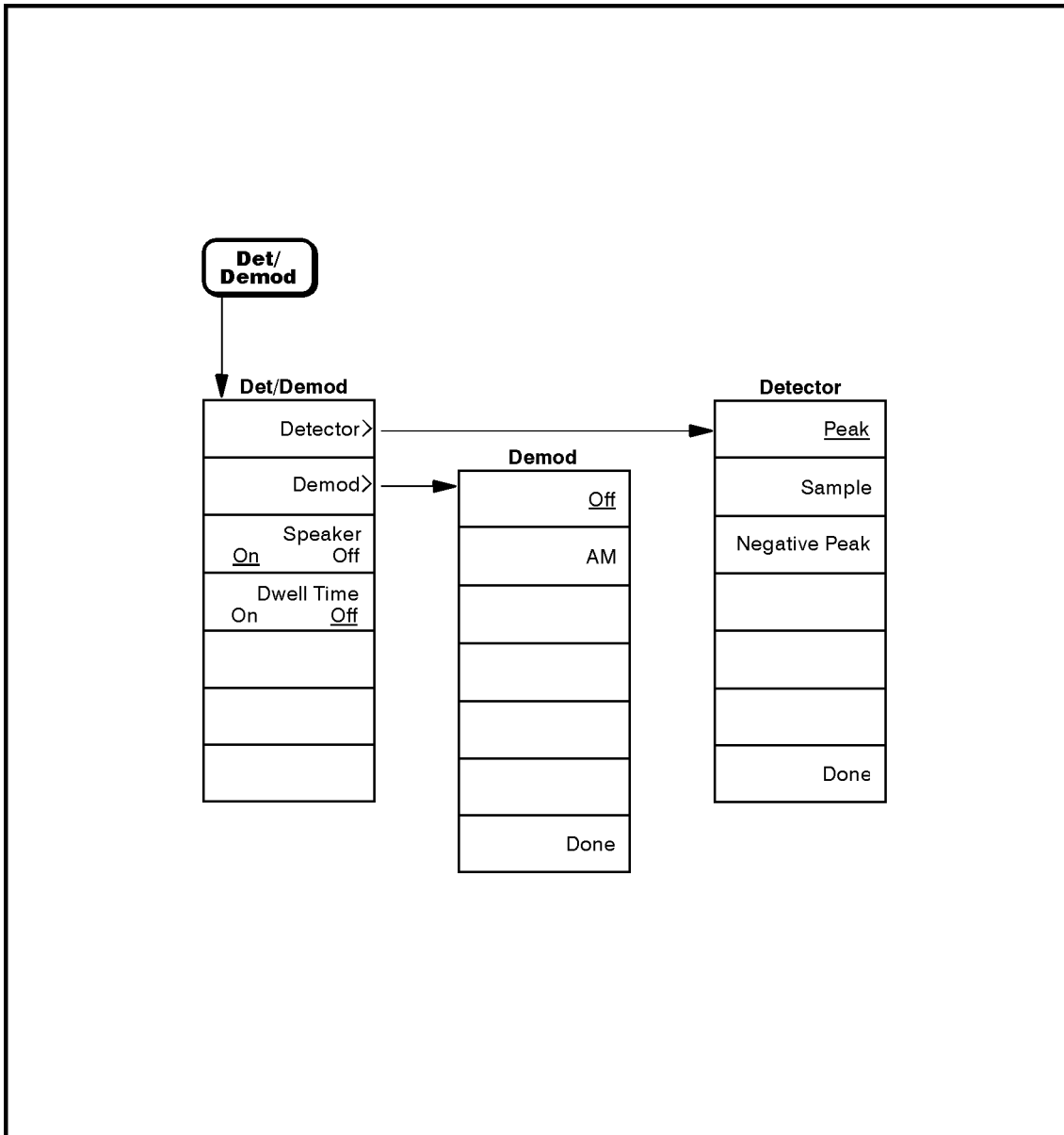


n1723a

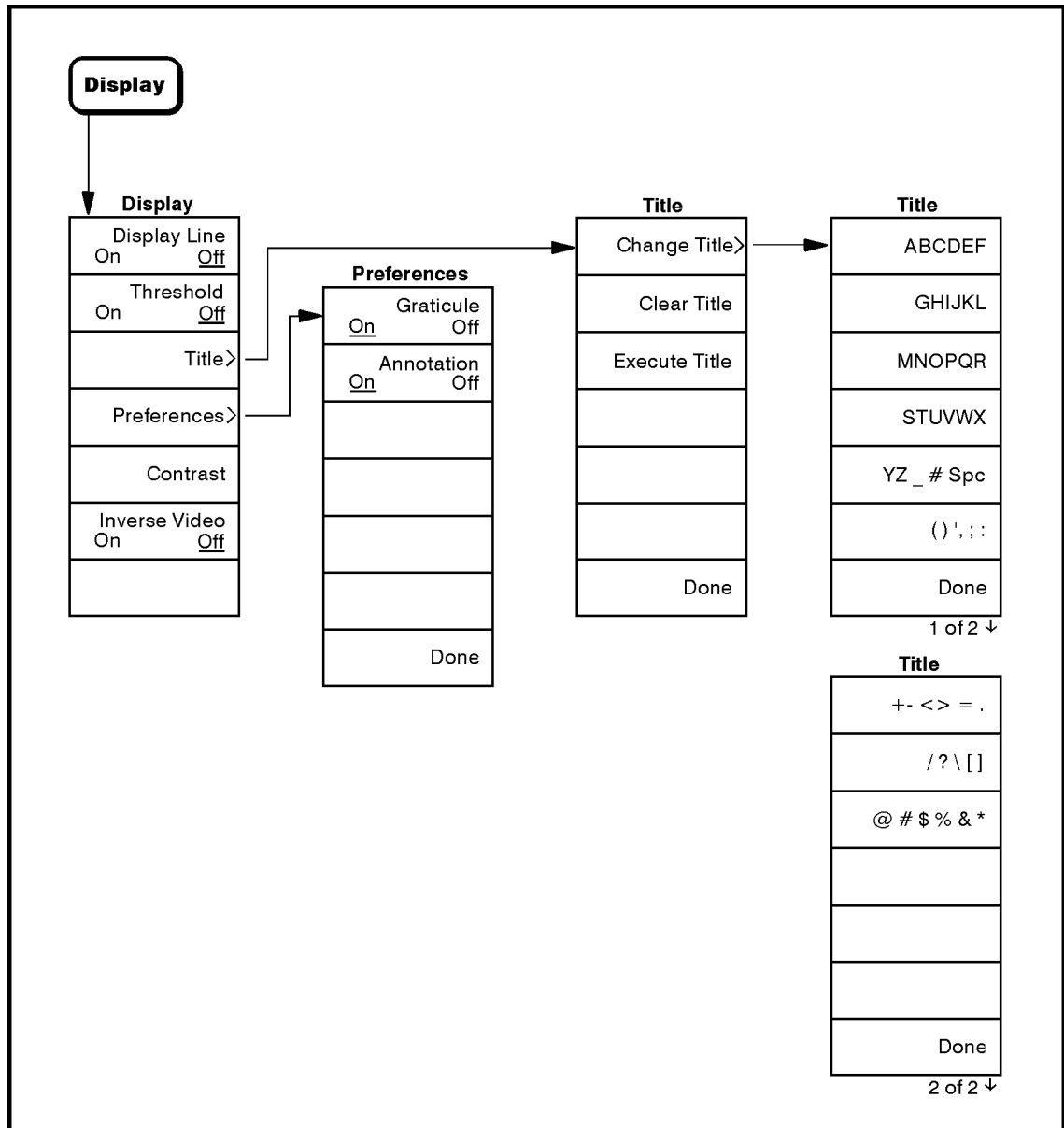


n1724a

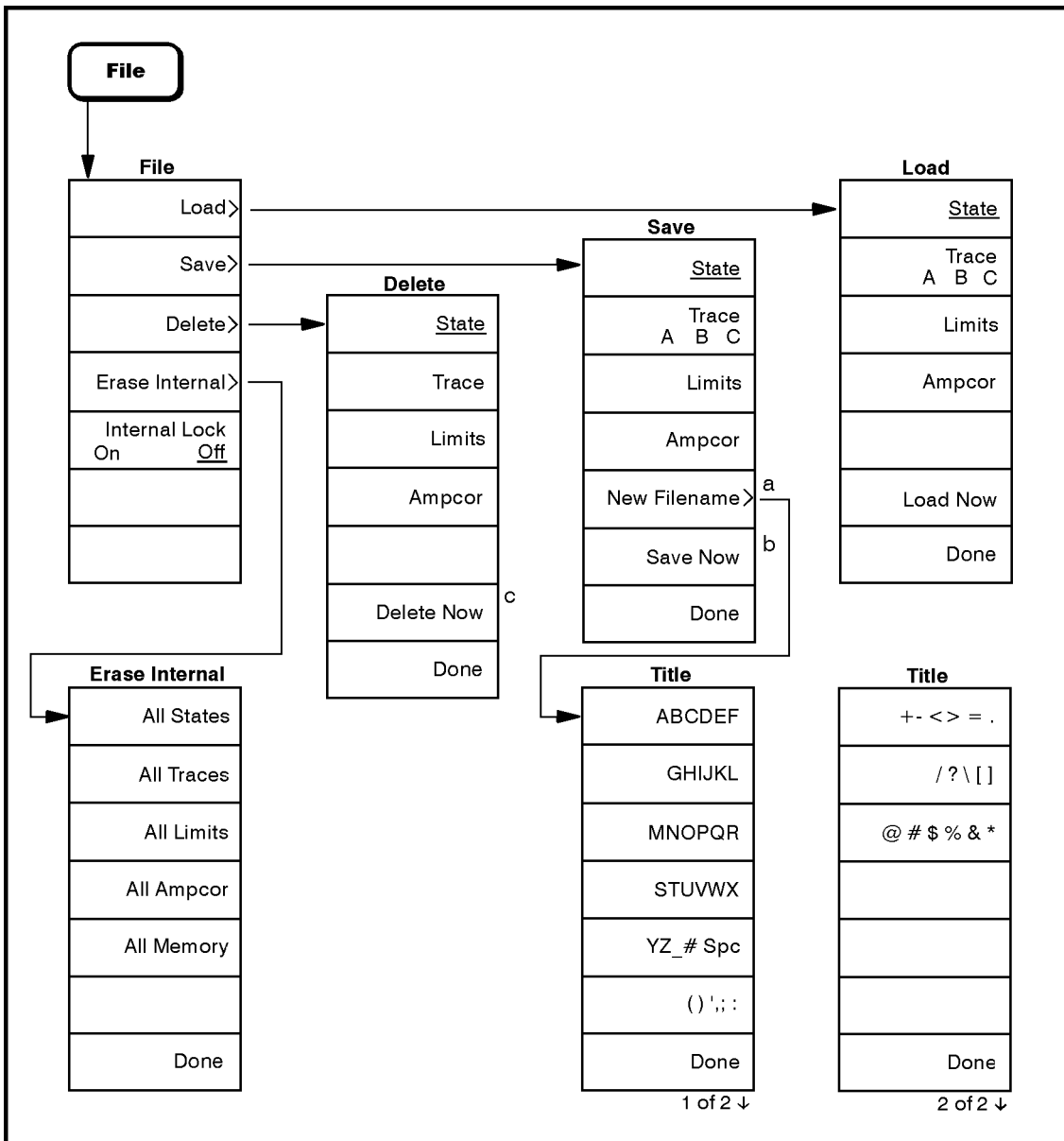




n1725a

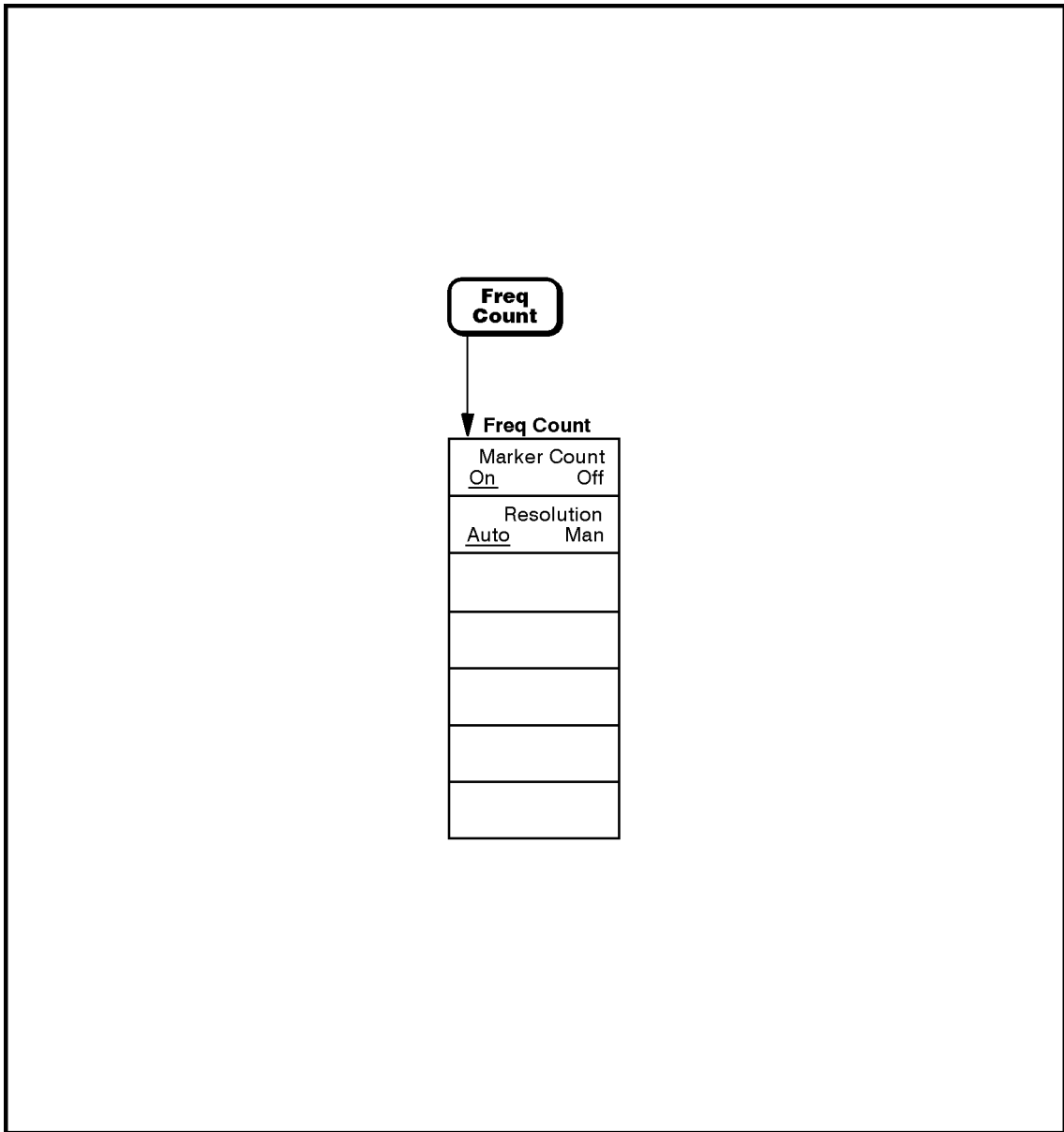


n1726a

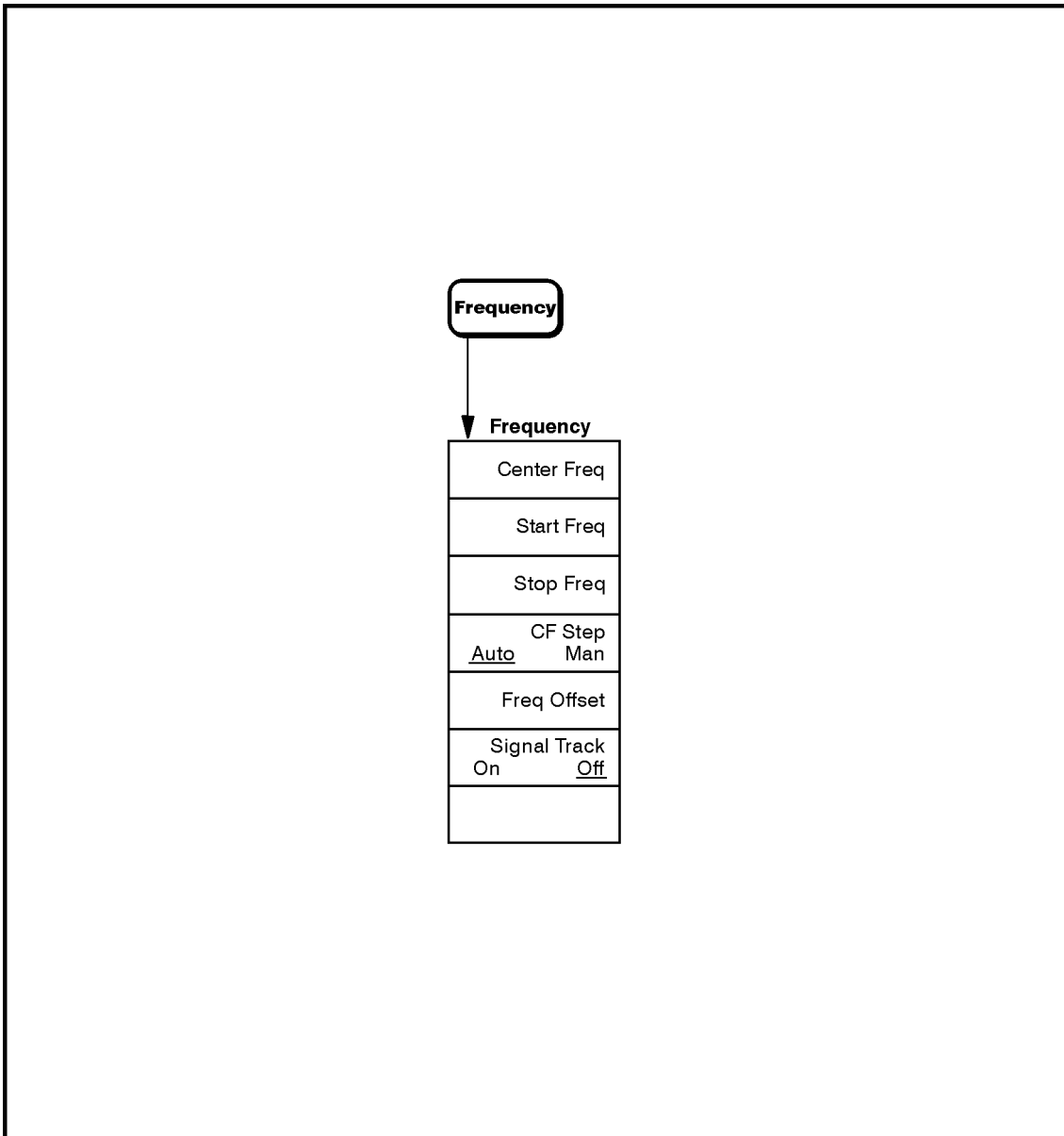


nl727a

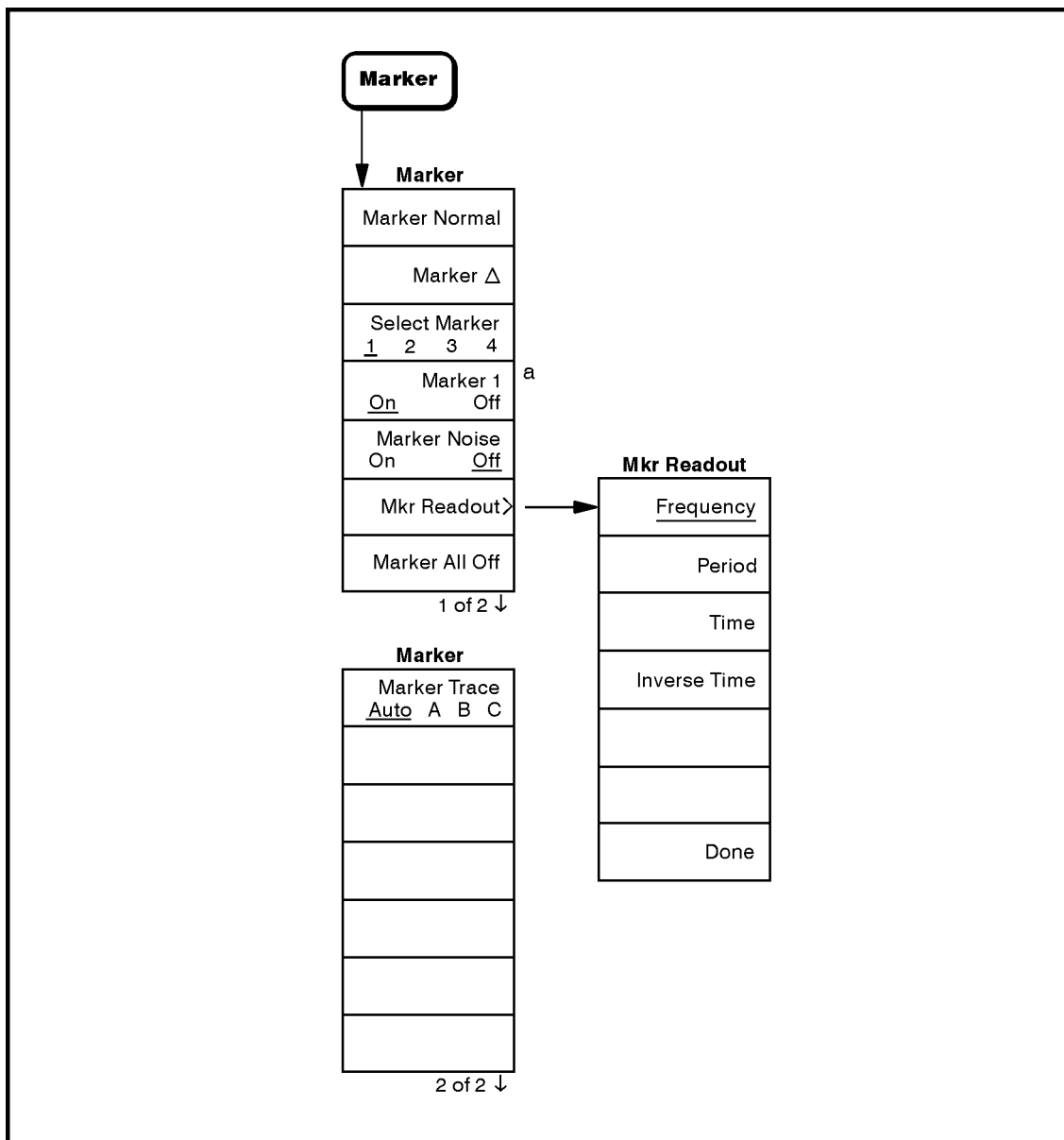
- a. **New Filename** appears in the menu only when **Internal Lock On Off** is **Off**.
- b. **Save Now** is replaced with **(Locked)** when **Internal Lock On Off** is **On**.
- c. **Delete Now** is replaced with **(Locked)** when **Internal Lock On Off** is **On**.



nl728a

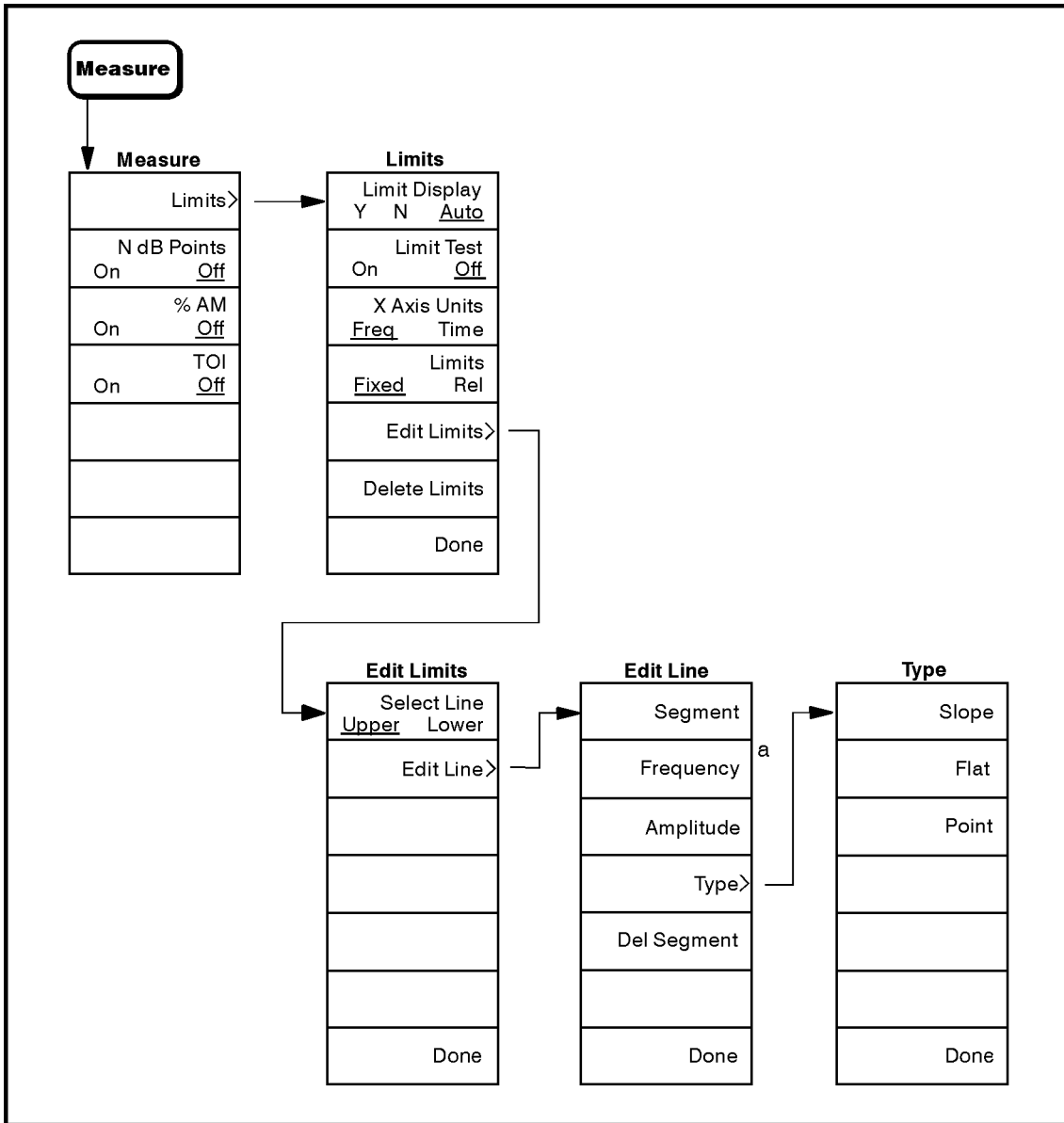


nl729a



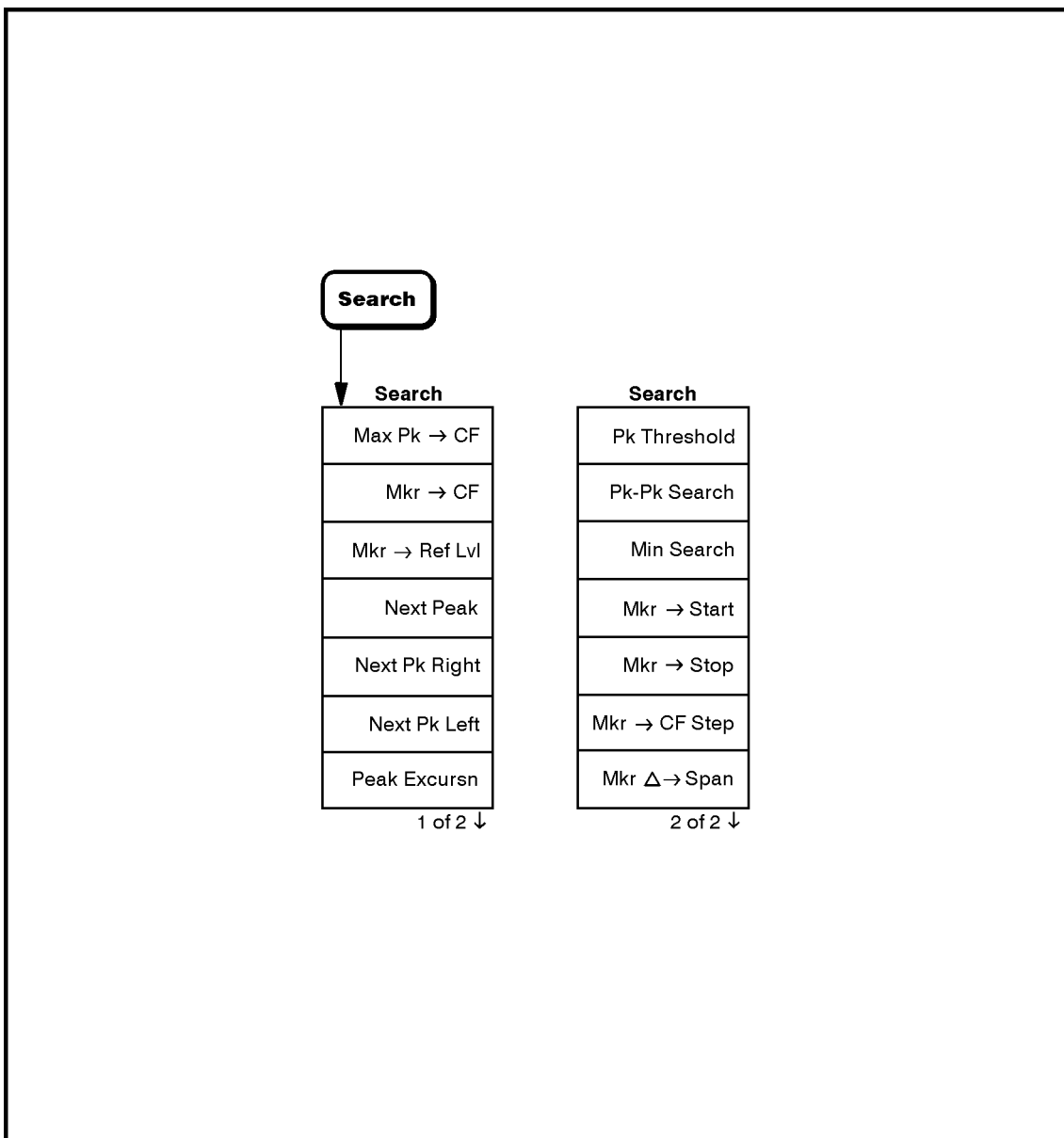
nl730a

- a. The marker number corresponds to the number of the marker selected with the **Select Marker 1 2 3 4** key.



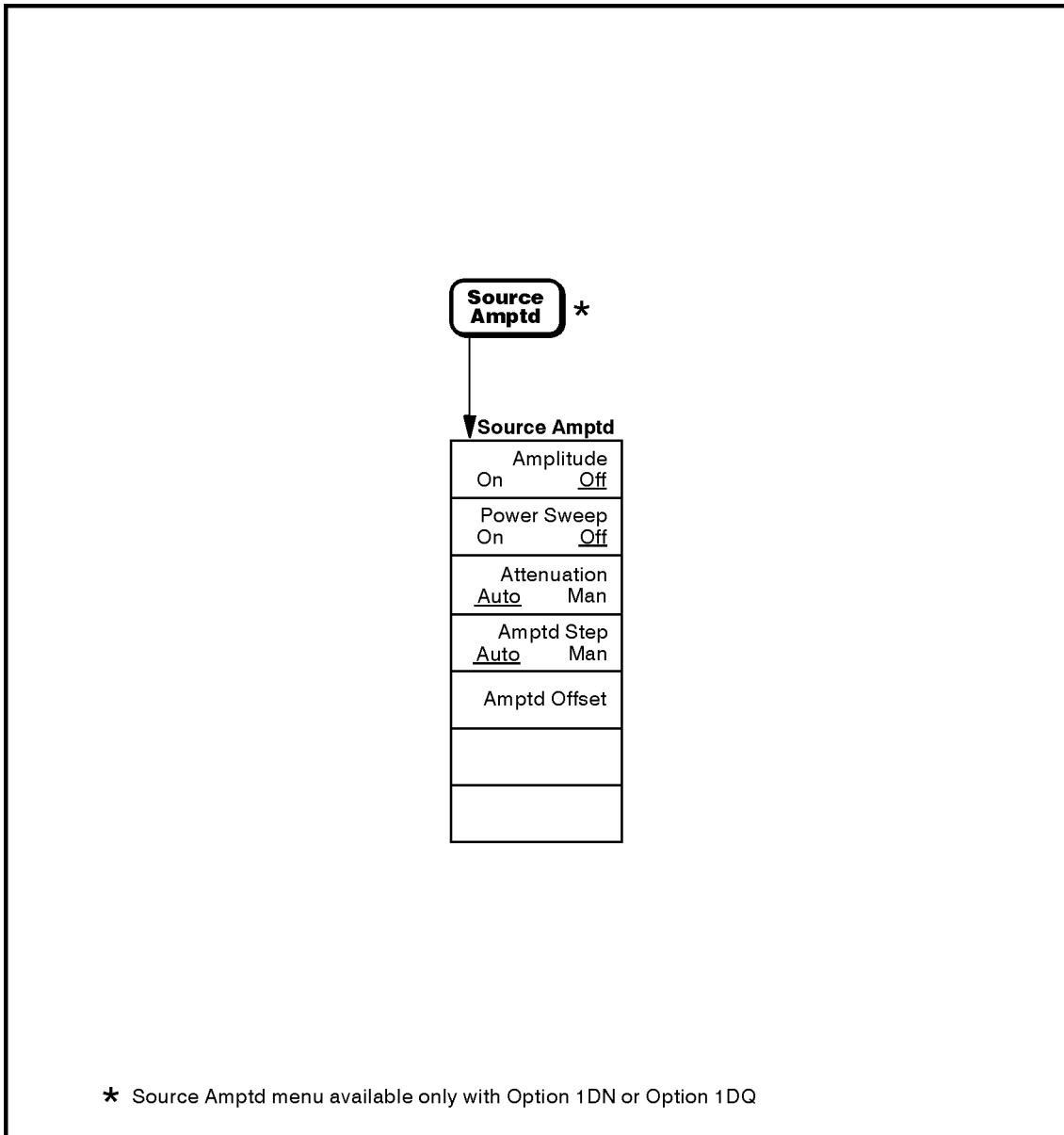
nl731a

- a. Frequency is replaced with Time when the X Axis Units Freq Time selection is Time.

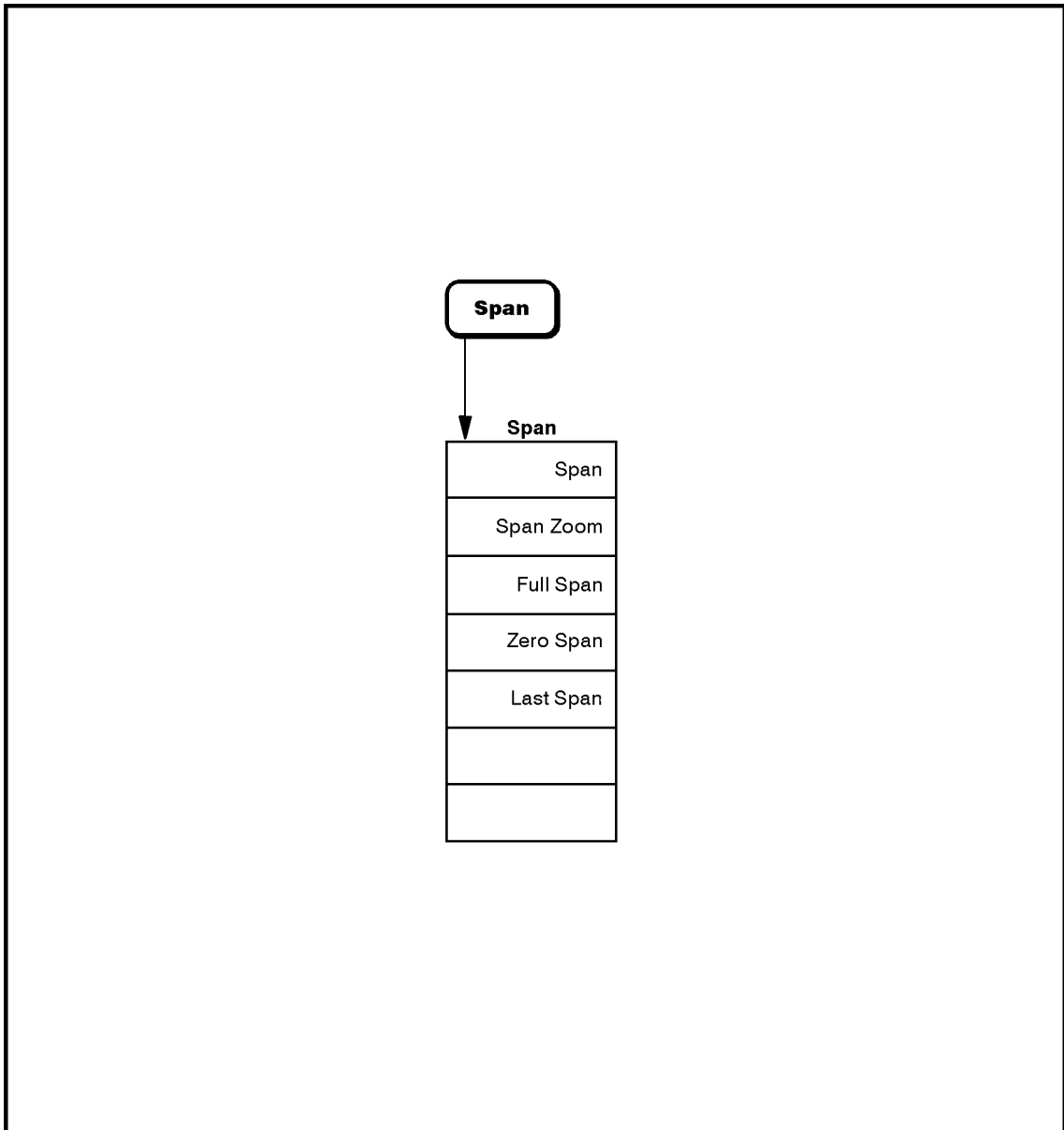


n1733a

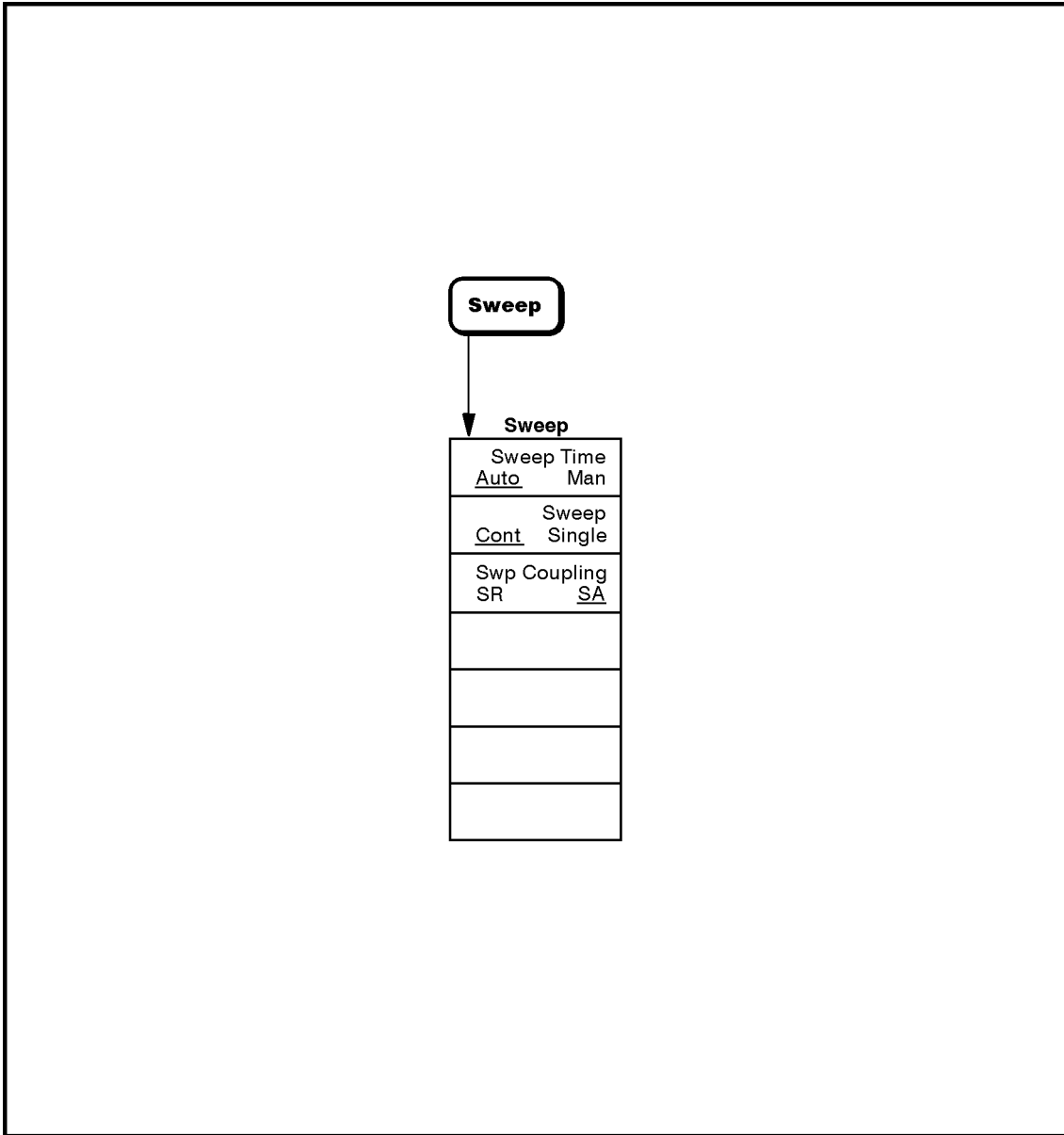




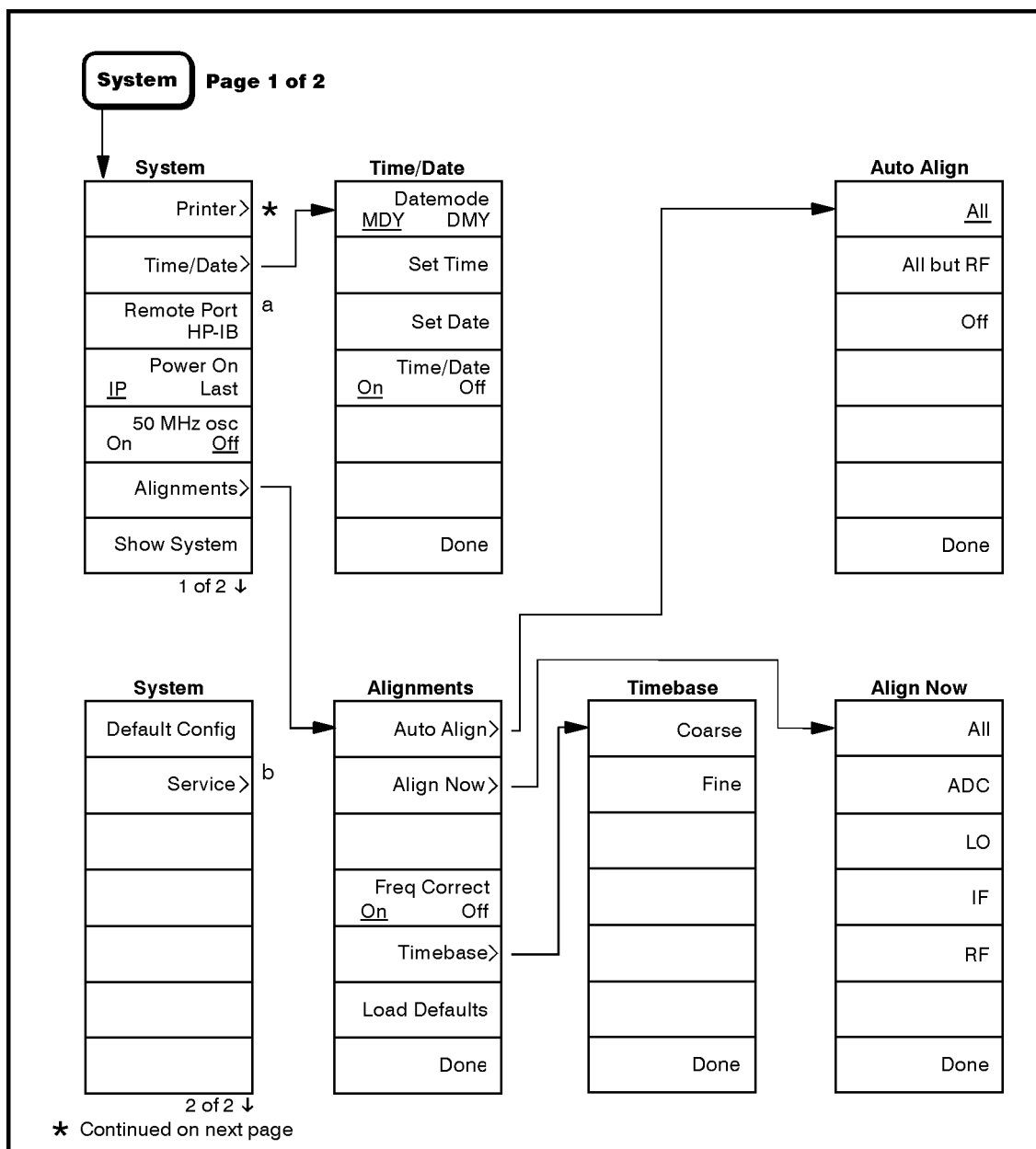
nl734a



n1735a

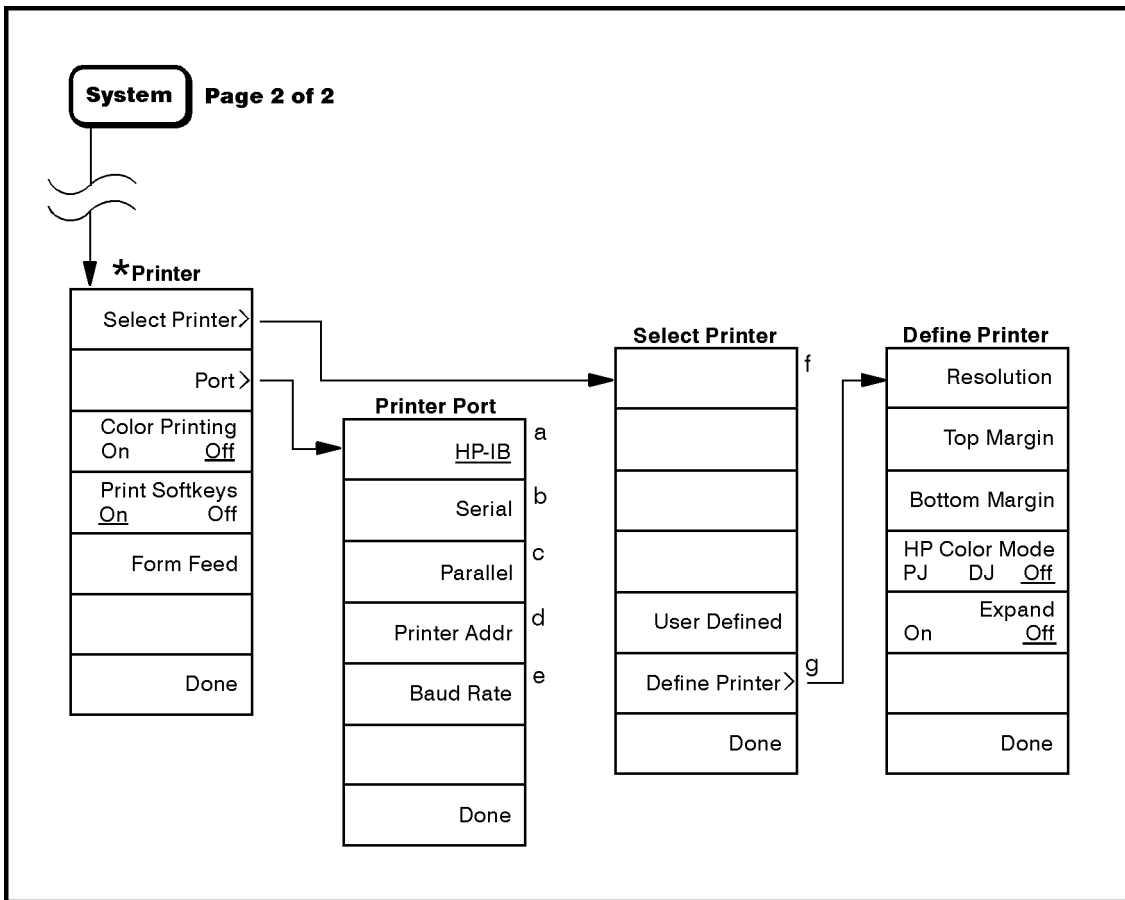


nl736a



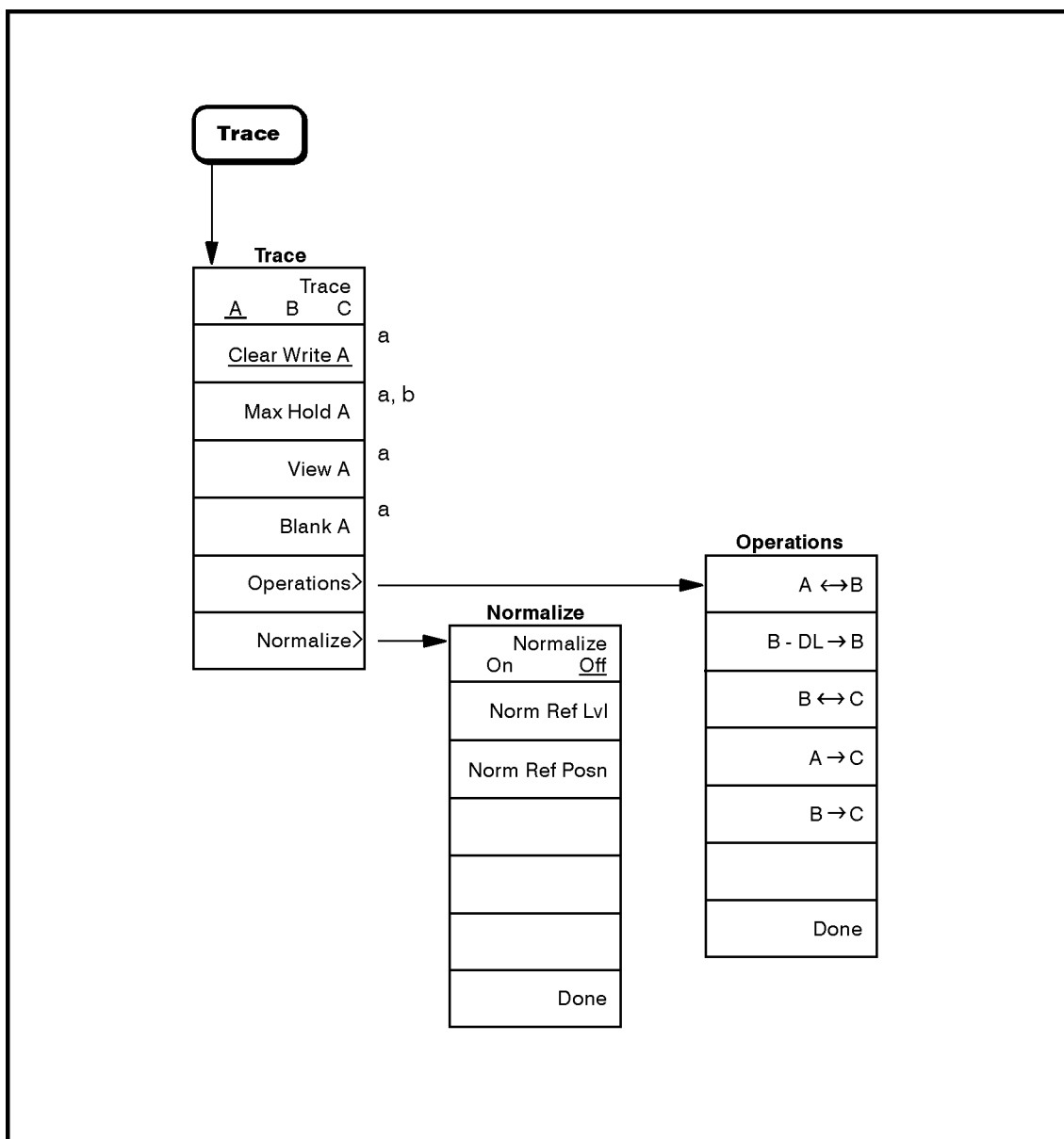
nl737a

- a. With Option A4H installed, **Remote Port HP-IB** appears. With Option 1AX installed, **Remote Port Serial** appears. When neither the A4H or 1AX options are installed, this key is blank.
- b. Access to the **Service** menu requires a password.



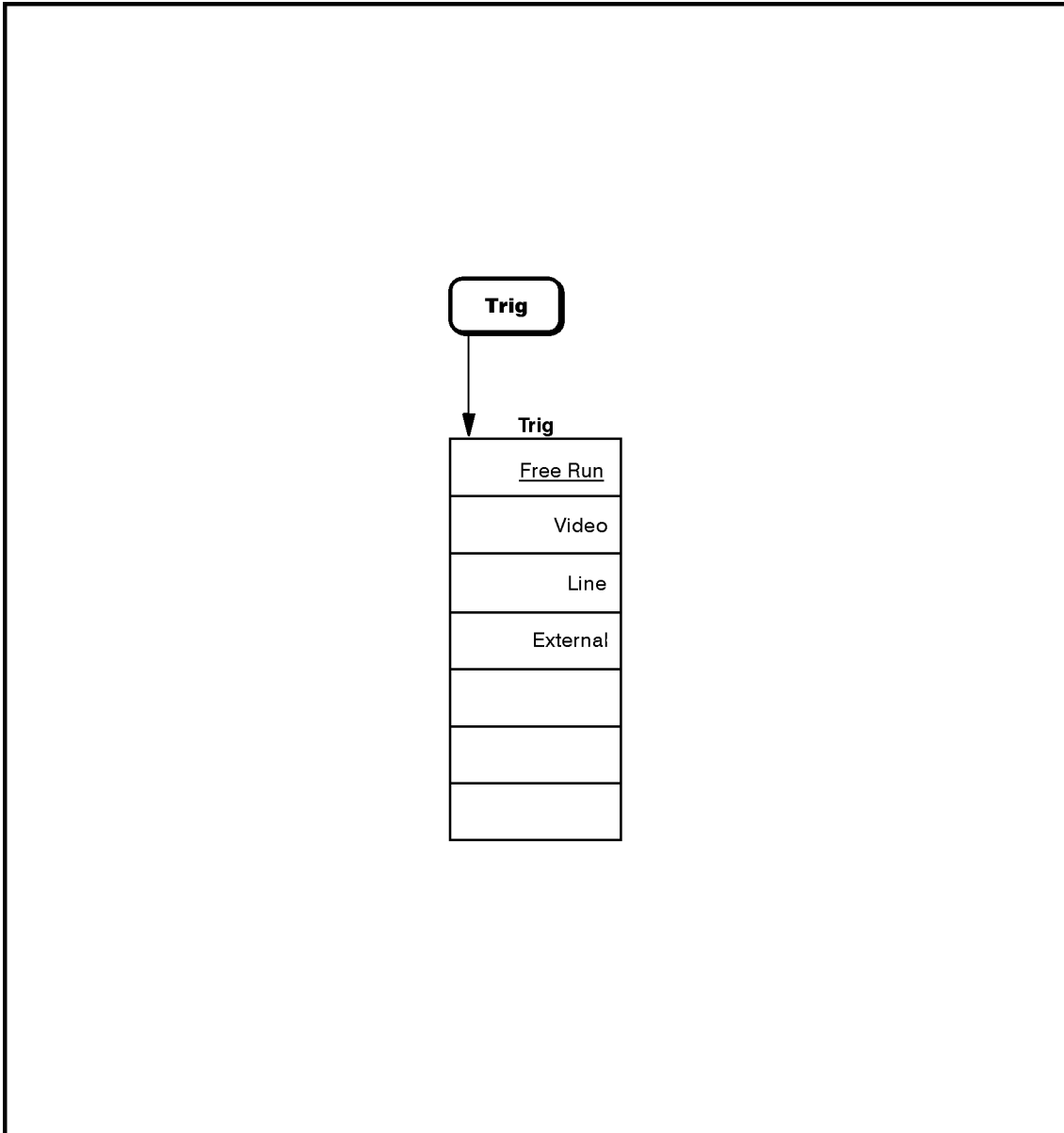
nl732a

- a. Option A4H (HP-IB and Parallel interface) only.
- b. Option 1AX (RS-232 and Parallel interface) only.
- c. Option A4H or 1AX only.
- d. Option A4H only. **Printer Addr** appears in the menu only when **HP-IB** is selected.
- e. Option 1AX only. **Baud Rate** appears in the menu only when **Serial** is selected.
- f. **Select Printer** accesses menus listing a selection of printers. It also accesses a **User Defined** key, which allows you to configure a printer which is not listed.
- g. **Define Printer** appears in the menu only when **User Defined** is selected.



nl738a

- The trace letter corresponds to the trace selected with the **Trace A B C** key.
- When Trace C is selected with the **Trace A B C** key, **Min Hold C** appears.



nl739a

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## **6 Options and Accessories**



## Options

Options can be ordered by option number when you order your spectrum analyzer. Some of the options are also available as kits that can be ordered and installed after you have received your spectrum analyzer.

### **Operating and Carrying Case (Option AYT and Option AYU)**

Option AYT (gray) and Option AYU (yellow) are protective soft operating and carrying cases. The case are made with rip-stop nylon. An outside pocket holds manuals or other accessories. A reinforced adjustable padded shoulder strap provides ergonomic distribution between the hand and shoulder. The front and rear panel soft covers adjust to be compatible with the front panel protective hard cover (Option UK9) and snap on battery pack (HP E1779A). Side ventilation allows for operation without removal, but the maximum operating temperature is reduced by 10 °C to 45 °C.

For Option AYT, order E4411A AYT. For Option AYU, order E4411A AYU.

Option AYT and AYU are also available after the purchase of your spectrum analyzer. Order E4411AU AYT or E4411AU AYU.

### **Transit Case (Option AXT)**

Option AXT adds a hard transit case. The hard transit case will survive commercial transportation. This rugged case has two wheels and an extendible handle for easy transport. The case can also accommodate two battery packs and ac adapters.

For Option AXT, order E4411A AXT.

Option AXT is also available after the purchase of your spectrum analyzer. Order E4411AU AXT.

### **12 Vdc Power Cable (Option A5D)**

Option A5D provides a 12 Vdc power cable that allows your spectrum analyzer to be powered from automotive or truck 12 V batteries. Option A5D requires spectrum analyzers with serial prefix of US3745 or greater. Analyzers with serial numbers prior to US3745 must order E4411AU Option R12 upgrade kit.

## **75 $\Omega$ Input Impedance (Option 1DP)**

This option provides a 75  $\Omega$  input impedance instead of the standard 50  $\Omega$  impedance. Spectrum analyzers with this option use cables, circuit boards, and front panels that are different from the standard units.

For Option 1DP, order E4411A 1DP.

Option 1DP is not retrofittable.

## **Tracking Generator (Option 1DN and Option 1DQ)**

Option 1DN (9 kHz to 1.5 GHz) and Option 1DQ (1 MHz to 1.5 GHz) provide a built-in tracking generator. This source-receiver combination makes insertion-loss, frequency response, and return-loss measurements. The tracking generator has a wide distortion-free dynamic range, plus good sensitivity and selectivity.

Option 1DN has the standard 50  $\Omega$  output impedance. Option 1DQ has a 75  $\Omega$  output impedance, and is available only with Option 1DP.

For Option 1DN, order E4411A 1DN. For Option 1DQ, order E4411A 1DQ.

Options 1DN and 1DQ are also available as retrofit kits after the purchase of your spectrum analyzer. Order E4411AU 1DN or E4411AU 1DQ.

## **IF, Sweep, and Video Inputs and Outputs (Option A4J)**

Option A4J provides the spectrum analyzer with inputs and outputs typically found on most spectrum analyzers. They are as follows: SWP OUT, HI SWP OUT (TTL), HI SWP IN (TTL), AUX VIDEO OUT, and AUX IF OUT.

See “Rear Panel Features” in Chapter 2 for more information.

For Option A4J, order E4411A A4J.

Option A4J is also available as a retrofit kit after the purchase of your spectrum analyzer. Order E4411AU A4J.

## **HP-IB and Parallel Interface (Option A4H)**

Option A4H allows you to control your spectrum analyzer from a computer that uses a Hewlett-Packard interface bus (HP-IB). Option A4H includes an HP-IB connector, a parallel interface connector for printers, and the *HP ESA-L1500A Spectrum Analyzer Programmer's Guide*.

Option A4H allows the spectrum analyzer to copy its display to a printer.

For Option A4H, order E4411A A4H.

Option A4H is also available as a retrofit kit after the purchase of your spectrum analyzer. Order E4411AU A4H.

## **RS-232 and Parallel Interface (Option 1AX)**

Option 1AX allows you to control your spectrum analyzer from a computer that uses an RS-232 interface. It includes an RS-232 9-pin connector, a parallel interface connector for printers, and the *HP ESA-L1500A Spectrum Analyzer Programmer's Guide*.

Option 1AX allows the spectrum analyzer to copy its display to a printer.

For Option 1AX, order E4411A 1AX.

Option 1AX is also available as a retrofit kit after the purchase of your spectrum analyzer. Order E4411AU 1AX.

## **Front Panel Protective Cover (Option UK9)**

The impact cover assembly snaps onto the front of your spectrum analyzer to protect the front panel during travel and when the unit is not in use.

For Option UK9, order E4411A UK9.

Option UK9 is also available as a retrofit kit after the purchase of your spectrum analyzer. Order E4411AU UK9.

## **50 $\Omega$ to 75 $\Omega$ Matching Pad (Option 1D7)**

This option provides a 50  $\Omega$  to 75  $\Omega$  matching pad with dc block to be used on the spectrum analyzer input. The pad has a frequency range of 9 MHz to 2 GHz. It adapts your standard 50  $\Omega$  spectrum analyzer to be compatible with a 75  $\Omega$  system under test. Connector types are 50  $\Omega$  N (m) to 75  $\Omega$  BNC (f).

For Option 1D7, order E4411A 1D7.

Option 1D7 can be ordered as E4411AU 1D7 after the purchase of your spectrum analyzer.

## **Rack Mount Kit With Handles (Option 1CP)**

Option 1CP provides the parts necessary to mount the spectrum analyzer in an HP System II cabinet or in a standard 19 inch (482.6 mm) equipment rack. It includes front handles and rack slides for added convenience.

For Option 1CP, order E4411A 1CP.

Option 1CP is also available as a retrofit kit after the purchase of your spectrum analyzer. Order E4411AU 1CP.

## **User's Guide and Calibration Guide (Option 0B1)**

Option 0B1 provides an additional copy of the *HP ESA-L1500A Spectrum Analyzer User's and Calibration Guide*, *HP ESA-L1500A Spectrum Analyzer Measurement Guide*, *HP ESA-L1500A Spectrum Analyzer Programmer's Guide*, and the *HP ESA-L1500A Self-Guided Demo*.

For Option 0B1, order E4411A 0B1.

To order Option 0B1 after the purchase of your spectrum analyzer, order E4411AU 0B1.

## **Service Documentation (Option 0BX)**

Option 0BX provides one copy of the assembly-level repair service guide and one copy of the component-level information packets. The assembly-level repair service guide describes assembly level troubleshooting procedures and adjustment procedures. The component-level information includes parts lists, component-location diagrams, and schematic diagrams for selected repairable assemblies. The manuals can be ordered separately.

For Option 0BX, order E4411A 0BX.

To order Option 0BX after the purchase of your spectrum analyzer, order E4411AU 0BX.

## **Commercial Calibration with Test Data (Option UK6)**

Option UK6 provides a commercial calibration certificate and the calibration test data with the spectrum analyzer, order E4411A UK6.

## **Benchlink Spectrum Analyzer Screen Capture Software (Option B70)**

Option B70 provides the ability to perform screen captures of the E4411A displays onto a PC. It also allows transfer of files between the analyzer and a PC.

For Option B70, order E4411A B70.

To order Option B70 after the purchase of your spectrum analyzer, order E4444A.

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## Accessories

A number of accessories are available from Hewlett-Packard to help you configure your spectrum analyzer for your specific applications. They can be ordered through your local HP sales and service office.

### RF and Transient Limiters

The HP 11867A and HP 11693A RF limiters protect the spectrum analyzer input circuits from damage due to high power levels. The HP 11867A operates over a frequency range of dc to 1800 MHz and begins reflecting signal levels over 1 mW up to 10 W average power and 100 watts peak power. The HP 11693A microwave limiter (0.1 to 12.4 GHz, usable to 18 GHz) guards against input signals over 1 milliwatt up to 1 watt average power and 10 watts peak power.

The 11947A transient limiter protects the spectrum analyzer input circuits from damage due to signal transients. It specifically is needed for use with a line impedance stabilization network (LISN). It operates over a frequency range of 9 kHz to 200 MHz, with 10 dB of insertion loss.

### 50 $\Omega$ /75 $\Omega$ Minimum Loss Pad

The HP 11852B is a low VSWR minimum loss pad that is required for measurements on 75  $\Omega$  devices using an spectrum analyzer with a 50  $\Omega$  input. It is effective over a frequency range of dc to 2 GHz.

### 75 $\Omega$ Matching Transformer

The HP 11694A allows you to make measurements in 75  $\Omega$  systems using a spectrum analyzer with a 50  $\Omega$  input. It is effective over a frequency range of 3 to 500 MHz.

### RF Bridges

The HP 86205A 50  $\Omega$  RF bridge and HP 86207A 75  $\Omega$  RF bridge can be used to make reflection measurements with the spectrum analyzer with tracking generator Options 1DN or 1DQ. These external directional bridges offer high directivity and excellent port match. The HP 86205A operates over a frequency range of 300 kHz to 6 GHz. The HP 86207A operates over a frequency range of 300 kHz to 3 GHz.

## AC Power Source

The HP 85901A provides 200 watts of continuous power for field and mobile application. The self-contained ac power source has outputs for either 115 V or 230 V and runs on its own internal battery, an external battery, or on another 12 Vdc source. Typical operating time exceeds 1 hour for 100 watt continuous use at room temperature.

## Snap on Rechargeable Battery

The HP E1779A is a rechargeable dc power sources that snaps on to the rear of your spectrum analyzer to provide freedom from ac power mains. Each battery will allow you cordless operation of your ESA-L1500A for up to 1.9 hours prior to recharging. The HP E1779A recharges in just 6 hours at 25 °C using the supplied ac adapter. Snap on design makes it quick and easy to convert the analyzer to dc operation or swap battery packs.

E1779A requires spectrum analyzers with serial prefix of US3745 or greater. Analyzers with serial numbers prior to US3745 must order E4411AU Option R12 upgrade kit.

## AC Probe

The HP 85024A high frequency probe performs in-circuit measurements without adversely loading the circuit under test. The probe has an input capacitance of 0.7 pF shunted by 1 M $\Omega$  of resistance and operates over a frequency range of 300 kHz to 3 GHz. High probe sensitivity and low distortion levels allow measurements to be made while taking advantage of the full dynamic range of the spectrum analyzer.

The HP 41800A low frequency probe has a low input capacitance and a frequency range of 5 Hz to 500 MHz.

## Broadband Preamplifiers and Power Amplifiers

Preamplifiers and power amplifiers can be used with your spectrum analyzer to enhance measurements of very low-level signals.

- The HP 10855A preamplifier provides a minimum of 22 dB gain from 2 MHz to 1300 MHz. (Power is supplied by the spectrum analyzer's probe power output.)
- The HP 8447D preamplifier provides a minimum of 25 dB gain from 100 kHz to 1.3 GHz.
- The HP 87405A preamplifier provides a minimum of 22 dB gain from 10 MHz to 3 GHz. (Power is supplied by the spectrum analyzer's probe power output.)

- The HP 85905A CATV 75 ohm preamplifier provides a minimum of 18 dB gain from 45 MHz to 1 GHz. (Power is supplied by the spectrum analyzer's probe power output.)

## **Carrying Strap (HP part number E4411-60028)**

The carrying strap is a reinforced, adjustable, padded shoulder strap providing ergonomic weight distribution between the hand and the shoulder.

## **External Keyboard**

The HP C1405B keyboard is an IBM AT compatible keyboard that can be connected to the external keyboard connector on the front panel of the spectrum analyzer. Any IBM AT compatible keyboard with a mini DIN connector will work. Screen titles and remote programming commands can be entered easily with the external keyboard.

## **HP-IB Cable**

*For use with Option A4H.* The HP 10833 HP-IB cables interconnect HP-IB devices and are available in four different lengths. HP-IB cables are used to connect printers and controllers to a spectrum analyzer.

## **Parallel Interface Cable**

*For use with Option A4H and 1AX* The HP 92284A parallel interface cable is a 36-pin to 25-pin male-to-male 2 meter cable used to connect supported printers to a spectrum analyzer.

## **Printer**

*For use with Option A4H or 1AX.* The DeskJet personal printers provide black and white or color printing for another form of permanent records of your test results. The HP LaserJet series printers are also compatible. The printers connect to the parallel interface installed on the spectrum analyzer with either Option A4H or 1AX.

## **RS-232 Cable**

*For use with Option 1AX.* The HP 24542G is a 3 meter 9-pin (f) to 25-pin (m) RS-232 cable. The HP 24542G cable can be used with HP DeskJet printers, HP LaserJet Series, and PCs with 25-pin (f) RS-232 connectors. The HP 24542U is a 3 meter 9-pin (f) to 9-pin (f) RS-232 cable for serial 9-pin PC connection to an analyzer. The LaserJet 4P and 4Plus require an HP C2932A 9-pin (m) to 9-pin (f) cable for RS-232 connection. The modem cable required is HP 24542M 9-pin (f) to 25-pin (m), and the PC cable is HP 24542U.





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## **7 Specifications**

## About This Chapter

This chapter contains specifications and characteristics for the HP ESA-L1500A spectrum analyzer. The distinction between specifications and characteristics is described as follows.

- Specifications describe the performance of parameters covered by the product warranty. (The temperature range is 0 °C to + 55 °C, unless otherwise noted.)
- Characteristics describe product performance that is useful in the application of the product, but is not covered by the product warranty.
- Typical performance describes additional product performance information that is not covered by the product warranty. It is performance beyond an indicated specification, that most units will exhibit.
- Nominal values indicate the expected, but not warranted, value of a parameter.

The following conditions must be met for the analyzer to meet its specifications.

- The analyzer is within the one year calibration cycle.
- If **Auto Align All** is selected, the analyzer will meet its specifications:
  - After 2 hours of storage within the operating temperature range,
  - 5 minutes after the analyzer is turned on.
- If **Auto Align Off** is selected, the analyzer will meet its specifications:
  - When the analyzer is at a constant temperature, within the operating temperature range, for a minimum of 2 hours,
  - After the analyzer is turned on for a minimum of 90 minutes, and **Align Now All** has been run,
  - When **Align Now All** is run every hour (or if the ambient temperature changes more than 5 °C).

## Frequency

	Specifications	Supplemental Information
<b>Frequency Range</b>		
50 $\Omega$	9 kHz to 1.5 GHz	
75 $\Omega$ ( <i>Option 1DP</i> )	1 MHz to 1.5 GHz	

	Specifications	Supplemental Information
<b>Frequency Reference</b>		
Aging	$\pm 2 \times 10^{-6}/\text{year}$	$\pm 1.0 \times 10^{-7}/\text{day}$ , characteristic
Settability	$\pm 0.5 \times 10^{-6}$	
Temperature Stability	$\pm 5 \times 10^{-6}$	

	Specifications	Supplemental Information
<b>Frequency Readout Accuracy</b>		
(Start, Stop, Center, Marker)	$\pm(\text{frequency readout} \times \text{frequency reference error}^{\text{a}} + \text{span accuracy} + 20\% \text{ of RBW})$	

- a. Frequency reference error = (aging rate  $\times$  period of time since adjustment + settability + temperature stability).

Specifications  
Frequency

	Specifications	Supplemental Information
<b>Marker Frequency Counter</b>		
Resolution	Selectable from 1 Hz to 100 kHz	
Accuracy <sup>a</sup>	$\pm(\text{marker frequency} \times \text{frequency reference error}^b + \text{counter resolution})$	

- a. Marker level to displayed noise level > 25 dB, Span  $\leq$  1.5 GHz, RBW/Span 0.002. "Marker Count Widen Res BW" annotation is displayed when RBW/Span < 0.002.
- b. Frequency reference error = (aging rate  $\times$  period of time since adjustment + settability + temperature stability).

	Specifications	Supplemental Information
<b>Frequency Span</b>		
Range	0 Hz (zero span), 100 Hz to 1.5 GHz	
Resolution	Four digits or 2 Hz, whichever is greater	
Accuracy	$\pm 1\%$ of span	

	Specifications	Supplemental Information
<b>Sweep Time</b>		
Range	5 ms to 2000 s	50 ms is the minimum sweep time with the built-in tracking generator.
Accuracy	$\pm 1\%$	
5 ms to 2000 s		
Sweep Trigger	Free Run, Single, Line, Video, External	

	<b>Specifications</b>	<b>Supplemental Information</b>
<b>Resolution Bandwidth</b>		
Range (-3 dB width)	1 kHz to 3 MHz, in 1-3-10 sequence	5 MHz, characteristic
Accuracy (1 kHz to 3 MHz RBW)	±20%	
Shape (1 kHz to 3 MHz RBW)		Synchronously tuned four poles, approximately Gaussian shape
Selectivity (60 dB/3 dB Bandwidth Ratio)		
1 kHz to 3 MHz RBW		<15:1

	<b>Specifications</b>	<b>Supplemental Information</b>
<b>Video Bandwidth (-3 dB)</b>		
Range	30 Hz to 1 MHz in 1-3-10 sequence	3 MHz, characteristic
Accuracy		±30%, characteristic
Shape		Post detection, single pole low-pass filter used to average displayed noise

	<b>Specifications</b>	<b>Supplemental Information</b>
<b>Stability</b>		
Noise Sidebands, offset from CW signal with 1 kHz RBW, 30 Hz VBW and sample detector		
≥10 kHz	≤ -90 dBc/Hz	
≥20 kHz	≤ -98 dBc/Hz	
≥30 kHz	≤ -102 dBc/Hz	
≥100 kHz	≤ -112 dBc/Hz	

Specifications  
Frequency

	<b>Specifications</b>	<b>Supplemental Information</b>
<b>Residual FM</b>  1 kHz RBW, 1 kHz VBW  System-Related Sidebands, offset from CW signal  ≥30 kHz	  ≤150 Hz pk-pk in 100 ms    ≤-65 dBc	

## Amplitude

Amplitude specifications do not apply for the negative peak detector mode.

	Specifications	Supplemental Information
<b>Measurement Range</b>		
50 $\Omega$	-120 dBm to +30 dBm	
75 $\Omega$ ( <i>Option 1DP</i> )	-65 dBmV to +72 dBmV	
Input Attenuator Range	0 to 60 dB, in 5 dB steps	

	Specifications	Supplemental Information
<b>Maximum Safe Input Level</b>		
Input attenuator setting $\geq 15$ dB		
Average Continuous Power		
50 $\Omega$	+30 dBm (1 W)	Signals > +33 dBm (2 W) nominal may trigger input protection, which disconnects the input path.
75 $\Omega$ ( <i>Option 1DP</i> )	+72 dBmV (0.2 W)	Signals > +79 dBmV (1 W) nominal may trigger input protection, which disconnects the input path.
Peak Pulse Power		
50 $\Omega$	+30 dBm (1 W)	
75 $\Omega$ ( <i>Option 1DP</i> )	+72 dBmV (0.2 W)	
dc	100 Vdc	dc transients may momentarily trigger input protection



Specifications  
Amplitude

	Specifications	Supplemental Information
<b>Input attenuator setting</b> <15 dB  <b>Average Continuous Power</b>  50 Ω  75 Ω ( <i>Option 1DP</i> )  <b>Peak Pulse Power</b>  50 Ω  75 Ω ( <i>Option 1DP</i> )  dc	+3 dBm (2 mW)    +58 dBmV (10 mW)   +3 dBm (2 mW)  +58 dBmV (10 mW)  100 Vdc	Signals > +6 dBm (4 mW) nominal may trigger input protection, which automatically increases input attenuation to 15 dB  Signals > +61 dBmV (15 mW) nominal may trigger input protection, which automatically increases input attenuation to 15 dB.   dc transients may trigger input protection

	Specifications	Supplemental Information
<b>1 dB Gain Compression</b>  <b>Total power at input mixer</b> <sup>a,b</sup>  50 Ω  75 Ω ( <i>Option 1DP</i> )	0 dBm  +46.75 dBmV	

- a. Mixer Power Level (dBm) = Input Power (dBm) – Input Attenuation (dB)  
 b. For resolution bandwidths ≤30 kHz, the maximum input signal amplitude must be ≤ reference level +10 dB. (*Option 1DP: For resolution bandwidths ≤30 kHz, the maximum input signal amplitude must be ≤ reference level +5 dB.*)

	Specifications	Supplemental Information
<p><b>Displayed Average Noise Level</b></p> <p>(Input terminated, 0 dB attenuation, <math>-70</math> dBm<sup>a</sup> reference level, 30 Hz VBW, sample detector, 1 kHz RBW)</p> <p>50 <math>\Omega</math></p> <p>400 kHz to 10 MHz <math>\leq -115</math> dBm</p> <p>10 MHz to 500 MHz <math>\leq -120</math> dBm</p> <p>500 MHz to 1.2 GHz <math>\leq -116</math> dBm</p> <p>1.2 GHz to 1.5 GHz <math>\leq -113</math> dBm</p> <p>75 <math>\Omega</math>, (Option 1DP)</p> <p>1 MHz to 10 MHz <math>\leq -63</math> dBmV</p> <p>10 MHz to 500 MHz <math>\leq -65</math> dBmV</p> <p>500 MHz to 1 GHz <math>\leq -60</math> dBmV</p> <p>1 GHz to 1.5 GHz <math>\leq -53</math> dBmV</p>		

a. 75  $\Omega$  Option 1DP: Use reference level  $-21.24$  dBmV.

	Specifications	Supplemental Information
<p><b>Display Range</b></p> <p>Log Scale</p> <p>Linear Scale</p> <p>Scale Units</p>	<p>0 to <math>-85</math> dB from reference level is calibrated; 0.1, 0.2, 0.5 dB/division and 1 to 20 dB/division in 1 dB steps; ten divisions displayed.</p> <p>Ten divisions</p> <p>dBm, dBmV, dB<math>\mu</math>V, V, and W</p>	

Specifications  
Amplitude

	Specifications	Supplemental Information
<b>Marker Readout Resolution</b>		
Log scale		
0 to -5 dB from ref level	0.1 dB	
-5 to -65 dB from ref level	0.05 dB	
Linear scale	0.05% of reference level	

	Specifications	Supplemental Information
<b>Frequency Response</b>		
50 $\Omega$ Relative to 50 MHz		
9 kHz to 1.5 GHz		
10 dB attenuation		
20 to 30 °C	$\pm 0.75$ dB	
0 to 55 °C	$\pm 1.0$ dB	
0, 5, 15 to 60 dB attenuation		$\pm 1.0$ dB, characteristic
75 $\Omega$ ( <i>Option 1DP</i> )		
Relative to 50 MHz		
1 MHz to 1.5 GHz		
10 dB attenuation		
20 to 30 °C	$\pm 0.75$ dB	
0 to 55 °C	$\pm 1.0$ dB	
0, 5, 15 to 50 dB attenuation		$\pm 1.0$ dB, characteristic
55 to 60 dB attenuation, 1 MHz to 1 GHz		$\pm 1.0$ dB, characteristic
1 GHz to 1.5 GHz		$\pm 1.2$ dB, characteristic

	Specifications	Supplemental Information
<b>Input Attenuation Switching Uncertainty at 50 MHz</b>  Attenuator Setting 0 dB to 5 dB 10 dB 15 dB 20 to 60 dB	  ±0.3 dB Reference ±0.3 dB ±(0.1 dB + 0.01 × Attenuator Setting)	

	Specifications	Supplemental Information
<b>Absolute Amplitude Accuracy</b>  At reference settings <sup>a</sup>	±0.3 dB	

a. Settings are: Reference Level -25 dBm (+26.76 dBmV for 75 Ω); Input Attenuation 10 dB; Center Frequency 50 MHz; Res BW 3 kHz; Video BW 10 kHz; Scale Linear; Span 2 kHz; sweep time coupled, sample detector, signal at reference level.

	Specifications	Supplemental Information
<b>RF Input VSWR</b>  Attenuator setting 50 Ω 0 to 5 dB 10 to 60 dB 75 Ω ( <i>Option 1DP</i> ) 1 MHz to 1 GHz 0 to 5 dB 10 to 60 dB 1 GHz to 1.5 GHz 0 to 60 dB		  1.55:1, characteristic 1.35:1, characteristic  1.55:1, characteristic 1.35:1, characteristic  2.0:1, characteristic

Specifications  
Amplitude

	Specifications	Supplemental Information
Input protection is tripped Internal 50 MHz osc is on Auto Align All is selected		Open input, characteristic Open input, characteristic Open input momentarily during retrace, characteristic

	Specifications	Supplemental Information
<b>Auto Alignment<sup>a</sup></b> Sweep-to-sweep variation		±0.1 dB

a. Set Auto Align to Off and use Align Now All to eliminate this variation.

	Specifications	Supplemental Information
<b>Resolution Bandwidth Switching Uncertainty</b> (at reference level) 3 kHz RBW 1 kHz, 10 kHz to 3 MHz RBW	Reference ±0.4 dB	

	Specifications	Supplemental Information
<b>Reference Level</b> Range Resolution Log Scale Linear Scale Accuracy, 50 Ω (at a fixed frequency, a fixed attenuation, and referenced to -35 dBm + atten setting) ≥-70 dBm + atten setting	Adjustable over Amplitude Measurement Range  ±0.01 dB ±0.12% of reference level  ±(0.3 dB + 0.01 × abs <sup>a</sup> (ref level – atten setting +35 dBm))	

	Specifications	Supplemental Information
<-70 dBm + atten setting	$\pm(0.6 \text{ dB} + 0.01 \times \text{abs}^a \text{ (ref level - atten setting +35 dBm)})$	
Accuracy, 75 $\Omega$ (at a fixed frequency, a fixed attenuation, and referenced to + 16.76 dBmV + atten setting)		
$\geq -21.24 \text{ dBmV}^b + \text{atten setting}$	$\pm(0.3 \text{ dB} + 0.01 \times \text{abs}^a \text{ (ref level - atten setting -16.76 dBmV)})$	
<-21.24 dBmV <sup>b</sup> + atten setting	$\pm(0.6 \text{ dB} + 0.01 \times \text{abs}^a \text{ (ref level - atten setting -16.76 dBmV)})$	

a. abs=Absolute value

b. -11.24 dBmV if frequency is > 1 GHz and resolution bandwidth is 30 kHz.

	Specifications	Supplemental Information
<b>Display Scale Switching Uncertainty</b>		
Linear to Log Switching	$\pm 0.25 \text{ dB}$ at reference level	
Log Scale Switching		No error

	Specifications	Supplemental Information
<b>Display Scale Fidelity</b>		
Log Maximum Cumulative		
0 to -85 dB from Reference Level	$\pm(0.3 \text{ dB} + 0.01 \times \text{dB from reference level})$	
Log Incremental Accuracy		
0 to -70 dB from Reference Level	$\pm 0.4 \text{ dB/4 dB}$	
Linear Accuracy	$\pm 3\%$ of reference level	

Specifications  
Amplitude

	Specifications	Supplemental Information
<b>Spurious Responses</b>		
50 Ω		
Second Harmonic Distortion		
2 MHz to 1.5 GHz	< -75 dBc for -40 dBm signal at input mixer. <sup>a</sup>	+35 dBm SHI (second harmonic intercept)
Third Order Intermodulation Distortion		
2 MHz to 5 MHz		+5 dBm, characteristic TOI (third order intercept)
5 MHz to 1.5 GHz	< -74 dBc for two -30 dBm signals at input mixer <sup>a</sup> and >50 kHz separation.	+7 dBm TOI
Other Input Related Spurious		
30 kHz ≤ offset ≤1200 MHz	< -65 dBc, for -20 dBm signal at input mixer <sup>a</sup> ≤1.5 GHz.	
Offset >1200 MHz	< -45 dBc, for -20 dBm signal at input mixer <sup>a</sup> ≤1.5 GHz.	
Noise Floor Degradation		
Input frequency = 1210.7 MHz ± RBW		< -62 dBc, for -45 dBm signal at input mixer <sup>a</sup>

a. Mixer Power Level (dBm) = Input Power (dBm) – Input Attenuation (dB)

	Specifications	Supplemental Information
<b>Spurious Responses</b>		
75 Ω		
Second Harmonic Distortion		
2 MHz to 1.5 GHz	< -75 dBc for +14 dBmV signal at input mixer. <sup>a</sup>	+89 dBmV SHI (second harmonic intercept)

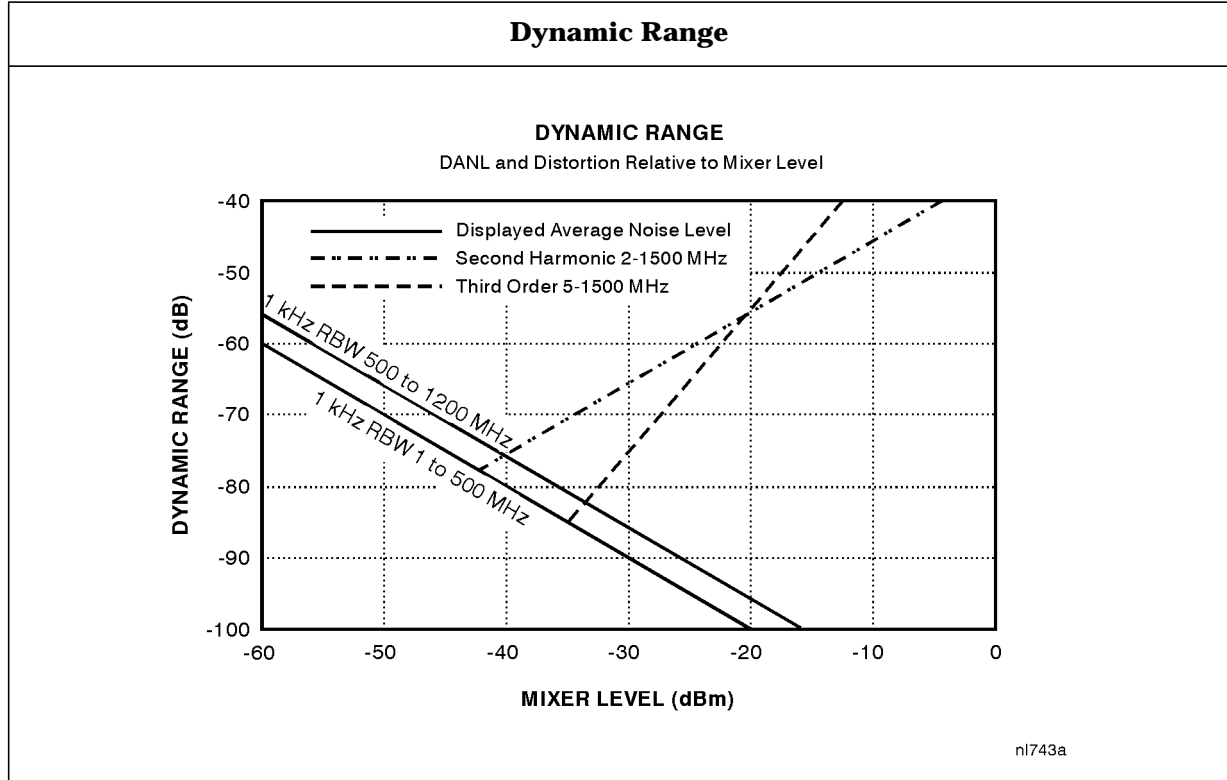
	Specifications	Supplemental Information
<b>Third Order Intermodulation Distortion</b>  2 MHz to 5 MHz  5 MHz to 900 MHz  900 MHz to 1.5 GHz  <b>Other Input Related Spurious</b>  30 kHz ≤ offset ≤1200 MHz  Offset >1200 MHz  <b>Noise Floor Degradation</b>  Input frequency = 1210.7 MHz ± RBW	  < -74 dBc for two +22.46 dBmV signals at input mixer <sup>a</sup> and >50 kHz separation.  < -74 dBc for two +20.76 dBmV signals at input mixer <sup>a</sup> and >50 kHz separation.  < -65 dBc, for +34 dBmV signal at input mixer <sup>a</sup> ≤1.5 GHz.  < -45 dBc, for +34 dBmV signal at input mixer <sup>a</sup> ≤1.5 GHz.	+57.76 dBmV, characteristic TOI (third order intercept)  +59.46 dBmV TOI  +57.76 dBmV, characteristic TOI (third order intercept)    < -62 dBc, for +9 dBmV signal at input mixer <sup>a</sup>

a. Mixer Power Level (dBm) = Input Power (dBm) – Input Attenuation (dB)

	Specifications	Supplemental Information
<b>Residual Responses</b> (Input terminated and 0 dB attenuation)  50 Ω  150 kHz to 1.5 GHz  75 Ω, (Option 1DP)  1 MHz to 1.5 GHz	  < -90 dBm  < -36 dBmV	



	Specifications	Supplemental Information
<b>AM Demod</b>		Tune and listen to AM signals



## Options

### Tracking Generator Specifications (Option 1DN or 1DQ)

(The temperature range for tracking generator specifications is 20°C to 30°C.)

	Specifications	Supplemental Information
<b>Output Frequency Range</b>		
50 $\Omega$ (Option 1DN)	9 kHz to 1.5 GHz	
75 $\Omega$ (Option 1DQ)	1 MHz to 1.5 GHz	

	Specifications	Supplemental Information
<b>Residual FM</b>		
< 10 MHz		$\leq 100$ Hz peak, 20 Hz to 10 kHz BW
$\geq 10$ MHz		$\leq 100$ Hz peak, 20 Hz to 200 kHz BW

	Specifications	Supplemental Information
<b>Output Power Level</b>		
<b>Range</b>		
50 $\Omega$ (Option 1DN)	0 to -70 dBm	
75 $\Omega$ (Option 1DQ)	+42.76 to -27.24 dBmV	
<b>Resolution</b>	0.1 dB	
<b>Absolute Accuracy (at 50 MHz with coupled source attenuator)</b>		
50 $\Omega$ (Option 1DN) Referenced to 0 dBm	$\pm 0.5$ dB	
75 $\Omega$ (Option 1DQ) Referenced to +42.76 dBmV	$\pm 0.5$ dB	

Specifications  
Options

	Specifications	Supplemental Information
<b>Vernier</b>		
Range	10 dB <sup>a</sup>	
Accuracy (with coupled source attenuator)		
50 Ω ( <i>Option 1DN</i> ) Referenced to 0 dBm	±0.75 dB, for 0 to -10 dBm	
75 Ω ( <i>Option 1DQ</i> ) Referenced to 42.76 dBmV	±0.75 dB, for +42.76 to +32.76 dBmV	
Output Attenuator Range	0 to 60 dB in 10 dB steps	

a. See the Output Accuracy table.

	Specifications	Supplemental Information
<b>Maximum Safe Reverse Level</b>		
50 Ω ( <i>Option 1DN</i> ) <sup>a</sup>		+20 dBm (0.1 W), 100 Vdc, characteristic
75 Ω ( <i>Option 1DQ</i> ) <sup>a</sup>		+69 dBmV (0.1 W), 100 Vdc, characteristic

a. dc transients may trigger reverse power protection.

	Specifications	Supplemental Information
<b>Output Power Sweep</b>		
Range		
50 Ω ( <i>Option 1DN</i> )	(-15 dBm to 0 dBm) – (Source Attenuator Setting)	
75 Ω ( <i>Option 1DQ</i> )	(+27.76 dBmV to +42.76 dBmV) – (Source Attenuator Setting)	
Resolution	0.1 dB	
Accuracy (zero span)	<1.5 dB peak-to-peak	

<b>Maximum Power Sweep Characteristics (Option 1DN)<sup>a</sup></b>		
<b>Manual Attenuator Setting</b>	<b>Allowed Source Amplitude (Start of Power Sweep Level)</b>	<b>Power Sweep Range</b>
0 dB	-15 dBm to 0 dBm	0 to 15 dB
10 dB	-25 dBm to -10 dBm	0 to 15 dB
20 dB	-35 dBm to -20 dBm	0 to 15 dB
30 dB	-45 dBm to -30 dBm	0 to 15 dB
40 dB	-55 dBm to -40 dBm	0 to 15 dB
50 dB	-65 dBm to -50 dBm	0 to 15 dB
60 dB	-75 dBm to -60 dBm	0 to 15 dB

- a. To get the maximum power sweep range, press Attenuation Auto Man (in the Source Amptd menu) so that Man is underlined. This turns off the auto coupling so that you can set the attenuation manually.

<b>Maximum Power Sweep Characteristics (Option 1DQ)<sup>a</sup></b>		
<b>Manual Attenuator Setting</b>	<b>Allowed Source Amplitude (Start of Power Sweep Level)</b>	<b>Power Sweep Range</b>
0 dB	+27.76 dBmV to +42.76 dBmV	0 to 15 dB
10 dB	+17.76 dBmV to +32.76 dBmV	0 to 15 dB
20 dB	+7.76 dBmV to +22.76 dBmV	0 to 15 dB
30 dB	-2.24 dBmV to +12.76 dBmV	0 to 15 dB
40 dB	-12.24 dBmV to +2.76 dBmV	0 to 15 dB
50 dB	-22.24 dBmV to -7.24 dBmV	0 to 15 dB
60 dB	-32.24 dBmV to -17.24 dBmV	0 to 15 dB

- a. To get the maximum power sweep range, press Attenuation Auto Man (in the Source Amptd menu) so that Man is underlined. This turns off the auto coupling so that you can set the attenuation manually.

Specifications  
Options

	Specifications	Supplemental Information
<b>Output Flatness</b> Referenced to 50 MHz, 0 dB attenuator 50 $\Omega$ (Option 1DN) 9 kHz to 1.5 GHz $\pm 2$ dB 10 MHz to 1.5 GHz $\pm 1.5$ dB 75 $\Omega$ (Option 1DQ) 1 MHz to 1.5 GHz $\pm 2$ dB 10 MHz to 1.5 GHz $\pm 1.5$ dB		

	Specifications	Supplemental Information
<b>Spurious Outputs</b> 50 $\Omega$ (Option 1DN) (0 dBm output) Harmonic Spurs 9 kHz to 20 MHz $< -20$ dBc 20 MHz to 1.5 GHz $< -25$ dBc Non-harmonic Spurs $< -35$ dBc		
75 $\Omega$ (Option 1DQ) (+42.76 dBmV output) Harmonic Spurs 1 MHz to 20 MHz $< -20$ dBc 20 MHz to 1.5 GHz $< -25$ dBc Non-harmonic Spurs $< -35$ dBc		

	Specifications	Supplemental Information
<b>Dynamic Range</b> <sup>a</sup> 50 $\Omega$ (Option 1DN) 400 kHz to 1 MHz $\geq 116$ dB 1 MHz to 500 MHz $\geq 120$ dB 500 MHz to 1.2 GHz $\geq 116$ dB 1.2 GHz to 1.5 GHz $\geq 113$ dB		

	Specifications	Supplemental Information
<i>75 Ω (Option 1DQ)</i>		
1 MHz to 500 MHz	≥107.76 dB	
500 MHz to 1 GHz	≥103.76 dB	
1 GHz to 1.5 GHz	≥97.76 dB	
Tracking Generator Feedthrough <sup>b</sup>		
<i>50 Ω (Option 1DN)</i>		
400 kHz to 1 MHz	≤ -116 dBm	
1 MHz to 500 MHz	≤ -120 dBm	
500 MHz to 1.2 GHz	≤ -116 dBm	
1.2 GHz to 1.5 GHz	≤ -113 dBm	
<i>75 Ω (Option 1DQ)</i>		
1 MHz to 500 MHz	≤ -65 dBmV	
500 MHz to 1 GHz	≤ -61 dBmV	
1 GHz to 1.5 GHz	≤ -55 dBmV	

- a. Dynamic range is the difference between the maximum power out and, either the tracking generator feedthrough or the receiver's displayed average noise level, whichever is higher.
- b. Leakage measured with maximum output power and input and output connectors terminated into their characteristic impedance.

	Specifications	Supplemental Information
<b>Output Tracking</b>		
Drift		No error
Swept Tracking Error		No error for coupled sweep times

	Specifications	Supplemental Information
<b>RF Power-Off Residuals</b>  50 $\Omega$ (Option 1DN) 100 kHz to 1.5 GHz  75 $\Omega$ (Option 1DQ) 1 MHz to 1.5 GHz		< -120 dBm, characteristic  < -65 dBmV, characteristic

	Specifications	Supplemental Information
<b>Output Attenuator</b>  Repeatability		$\pm 0.2$ dB, characteristic

	Specifications	Supplemental Information
<b>Output VSWR</b>		<2.5:1, characteristic

Tracking Generator Output Accuracy Characteristics, Option 1DN (in auto-coupled mode)					
TG Output Power Level	Attenuator Setting	Relative Accuracy (at 50 MHz, referred to 0 dBm)	Absolute Accuracy (at 50 MHz)	Relative Accuracy (referred to 0 dBm)	Absolute Accuracy
0 dBm	0 dB	0 dB (Ref)	$\pm 0.50$ dB	$\pm 1.50$ dB	$\pm 2.00$ dB
-0.1 to -10.99 dBm	0 dB	$\pm 0.75$ dB	$\pm 1.25$ dB	$\pm 2.25$ dB	$\pm 2.75$ dB
-11 to -20.99 dBm	10 dB	$\pm 1.35$ dB	$\pm 1.85$ dB	$\pm 3.00$ dB	$\pm 3.50$ dB
-21 to -30.99 dBm	20 dB	$\pm 1.65$ dB	$\pm 2.15$ dB	$\pm 3.30$ dB	$\pm 3.80$ dB
-31 to -40.99 dBm	30 dB	$\pm 1.95$ dB	$\pm 2.45$ dB	$\pm 3.60$ dB	$\pm 4.10$ dB
-41 to -50.99 dBm	40 dB	$\pm 2.25$ dB	$\pm 2.75$ dB	$\pm 3.90$ dB	$\pm 4.40$ dB
-51 to -60.99 dBm	50 dB	$\pm 2.55$ dB	$\pm 3.05$ dB	$\pm 4.20$ dB	$\pm 4.70$ dB
-61 to -70 dBm	60 dB	$\pm 2.85$ dB	$\pm 3.35$ dB	$\pm 4.50$ dB	$\pm 5.00$ dB

<b>Tracking Generator Output Accuracy Characteristics, Option 1DQ (in auto-coupled mode)</b>					
<b>TG Output Power Level</b>	<b>Attenuator Setting</b>	<b>Relative Accuracy (at 50 MHz, referred to +42.76 dBmV)</b>	<b>Absolute Accuracy (at 50 MHz)</b>	<b>Relative Accuracy (referred to +42.76 dBmV)</b>	<b>Absolute Accuracy</b>
+42.76 dBmV	0 dB	0 dB (Ref)	±0.50 dB	±1.50 dB	±2.00 dB
+42.66 to +31.77 dBmV	0 dB	±0.75 dB	±1.25 dB	±2.25 dB	±2.75 dB
+31.76 to +21.77 dBmV	10 dB	±1.35 dB	±1.85 dB	±3.00 dB	±3.50 dB
+21.76 to +11.77 dBmV	20 dB	±1.65 dB	±2.15 dB	±3.30 dB	±3.80 dB
+11.76 to +1.77 dBmV	30 dB	±1.95 dB	±2.45 dB	±3.60 dB	±4.10 dB
+1.76 to -8.23 dBmV	40 dB	±2.25 dB	±2.75 dB	±3.90 dB	±4.40 dB
-8.24 to -18.23 dBmV	50 dB	±2.55 dB	±3.05 dB	±4.20 dB	±4.70 dB
-18.24 to -27.23 dBmV	60 dB	±2.85 dB	±3.35 dB	±4.50 dB	±5.00 dB



## General

	Specifications	Supplemental Information
<b>Temperature Range</b>		
Operating <sup>a</sup>	0 °C to +55 °C	
Storage	-40 °C to +75 °C	

a. When using a soft carrying case, Option AYT or Option AYU, the operating temperature range is 0 °C to +45 °C.

	Specifications	Supplemental Information
<b>Audible Noise (ISO 7779)</b>		
Sound Pressure at 25 °C		<33 dB, (<4.8 Bels power)

	Specifications	Supplemental Information
<b>Military Specification</b>	Has been type tested to the environmental specifications of MIL-PRF-28800F class 3.	

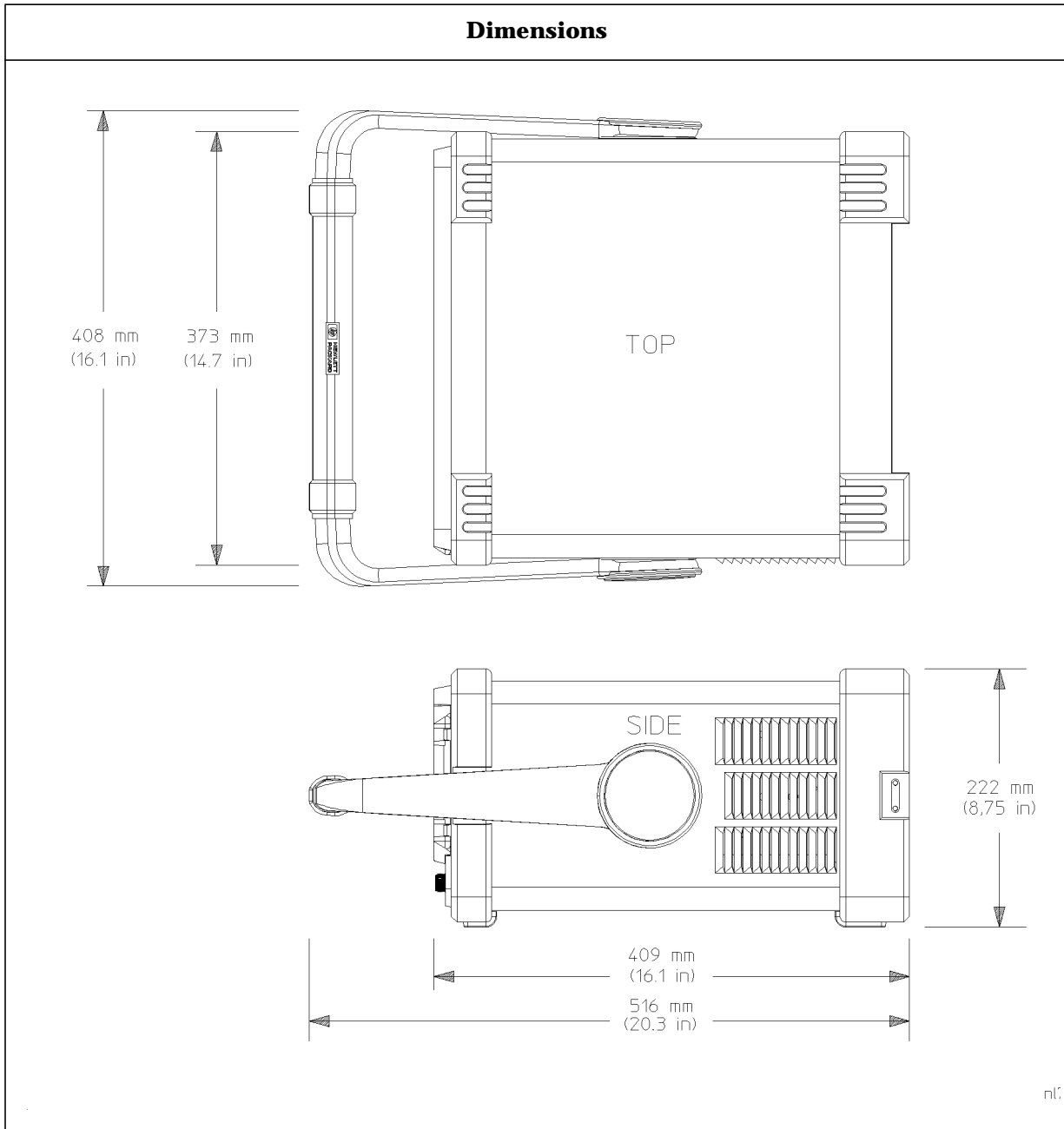
	Specifications	Supplemental Information
<b>EMI Compatibility</b>	Conducted and radiated emission is in compliance with CISPR Pub. 11/1990 Group 1 Class A.	

	Specifications	Supplemental Information
<b>Immunity Testing</b>		
Radiated Immunity		Testing was done at 3 V/m according to IEC 801-3/1984. When the analyzer tuned frequency is identical to the immunity test signal frequency there may be signals of up to -60 dBm displayed on the screen.
Electrostatic Discharge		Air discharges of up to 8 kV were applied according to IEC 801-2/1991. Discharges to center pins of any of the connectors may cause damage to the associated circuitry.

	Specifications	Supplemental Information
<b>Power Requirements</b>		
AC Operation		
Voltage	90 to 250 V rms	
Frequency	47 to 440 Hz	
Power Consumption, On	<200 W	
Power Consumption, Standby	<5 W	
DC Operation		
Serial prefix <US3745		
Voltage	15 to 20 Vdc	
Power Consumption	<175 W	
Serial prefix ≥US3745		
Voltage, turn-on	12 to 22 Vdc	For initial voltage ≥16 Vdc, turn-off voltage = 16 Vdc. For initial voltage <16 Vdc, turn-off voltage = 11.5 Vdc.
Power Consumption, On	<175 W	
Power Consumption, Standby	<1 W	

Specifications  
General

	Specifications	Supplemental Information
<b>Weight (without options)</b>		
Net		12.3 kg (27 lb), characteristic
Shipping		25 kg (55 lb), characteristic



## Inputs and Outputs

### Internal

	Specifications	Supplemental Information
<b>50 MHz osc</b> <sup>a</sup> Frequency Frequency Accuracy 50 Ω Amplitude <sup>c</sup> 75 Ω Amplitude (Option 1DP) <sup>c</sup>		50 MHz Frequency reference error <sup>b</sup> -27 dBm, nominal +24.8 dBmV, nominal

- a. Turn the 50 MHz osc signal on/off by pressing the keys: System, Alignments, and 50 MHz osc.
- b. Frequency reference error = (aging rate × period of time since adjustment + settability + temperature stability).
- c. The internal 50 MHz osc signal's actual power may differ from the nominal value.

### Front Panel

	Specifications	Supplemental Information
<b>INPUT 50 Ω</b> Connector Impedance	Type N female	50 Ω, nominal
<b>INPUT 75 Ω (Option 1DP)</b> Connector Impedance	BNC female	75 Ω, nominal

Specifications  
Inputs and Outputs

	Specifications	Supplemental Information
<b>RF OUT 50 <math>\Omega</math></b> ( <i>Option 1DN</i> )		
Connector	Type N female	
Impedance		50 $\Omega$ , nominal
<b>RF OUT 75 <math>\Omega</math></b> ( <i>Option 1DQ</i> )		
Connector	BNC female	
Impedance		75 $\Omega$ , nominal

	Specifications	Supplemental Information
<b>PROBE POWER</b>		
Voltage/Current		+15 Vdc, $\pm 7\%$ at 150 mA max., characteristic +12.6 Vdc $\pm 10\%$ at 150 mA max., characteristic

	Specifications	Supplemental Information
<b>EXT KEYBOARD</b>		
Connector	6-pin mini-DIN	Interface compatible with most PC keyboards

	Specifications	Supplemental Information
<b>Speaker</b>		
		Front panel knob controls volume

	Specifications	Supplemental Information
<b>Headphone</b>		
Connector	3.5 mm (1/8 inch) miniature audio jack	Front panel knob controls volume
Power Output		0.2 W into 4 $\Omega$ , characteristic

## Rear Panel

	Specifications	Supplemental Information
<b>10 MHz REF OUT</b>		
Connector	BNC female	
Impedance		50 $\Omega$ , nominal
Output Amplitude		>0 dBm, characteristic

	Specifications	Supplemental Information
<b>10 MHz REF IN</b>		
Connector	BNC female	Note: Analyzer noise sideband and spurious response performance may be affected by the quality of the external reference used.
Impedance		50 $\Omega$ , nominal
Input Amplitude Range		-15 to +10 dBm, characteristic
Frequency		10 MHz, nominal

	Specifications	Supplemental Information
<b>GATE TRIG/EXT TRIG IN</b>		
External Trigger Input		
Connector	BNC female	
Trigger Level		Positive edge initiates sweep in EXT TRIG mode (5 V TTL)

Specifications  
Inputs and Outputs

	Specifications	Supplemental Information
<b>GATE/HI SWP OUT</b> High Sweep Output Connector Level	BNC female	High = sweep; Low = retrace (5 V TTL)

	Specifications	Supplemental Information
<b>VGA OUTPUT</b> Connector Format Resolution	VGA compatible, 15-pin mini D-SUB  640 × 480	VGA (31.5 kHz horizontal, 60 Hz vertical sync rates, non-interlaced) Analog RGB

	Specifications	Supplemental Information
<b>AUX IF OUT</b> ( <i>Option A4J</i> ) Connector Frequency Amplitude Range Impedance	BNC female	21.4 MHz, nominal –10 to –70 dBm (uncorrected), characteristic. A signal at the reference level will produce a –10 dBm nominal output. 50 Ω, nominal

	Specifications	Supplemental Information
<b>AUX VIDEO OUT</b> ( <i>Option A4J</i> ) Connector Amplitude Range (into >10 kΩ)	BNC female	0 to 1 V (uncorrected), characteristic

	<b>Specifications</b>	<b>Supplemental Information</b>
<b>HI SWP IN</b> ( <i>Option A4J</i> )		
Connector	BNC female	
Input		Open collector, low stops sweep (5 V TTL)

	<b>Specifications</b>	<b>Supplemental Information</b>
<b>HI SWP OUT</b> ( <i>Option A4J</i> )		
Connector	BNC female	
Output		High = sweep, Low = retrace (5 V TTL)

	<b>Specifications</b>	<b>Supplemental Information</b>
<b>SWP OUT</b> ( <i>Option A4J</i> )		
Connector	BNC female	
Amplitude		0 to +10 V ramp, characteristic

	<b>Specifications</b>	<b>Supplemental Information</b>
<b>HP-IB Interface</b> ( <i>Option A4H</i> )		
Connector	IEEE-488 bus connector	
HP-IB Codes		SH1, AH1, T6, SR1, RL1, PP0, DC1, C1, C2, C3 and C28

	<b>Specifications</b>	<b>Supplemental Information</b>
<b>Serial Interface</b> ( <i>Option 1AX</i> )		
Connector	9-pin D-SUB	RS-232



Specifications  
Inputs and Outputs

	<b>Specifications</b>	<b>Supplemental Information</b>
<b>Parallel Interface</b> <i>(Option A4H or 1AX)</i> Connector	25-pin D-SUB	Printer port only

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## Regulatory Information

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### CAUTION

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This product is designed for use in Installation Category II and Pollution Degree 2 per IEC 1010 and 664 respectively.

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### NOTE

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This product 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 product in a safe condition.



The CE mark is a registered trademark of the 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.

**ISM 1-A**

This is a symbol of an Industrial Scientific and Medical Group 1 Class A product. (CISPER 11, Clause 4)

## DECLARATION OF CONFORMITY

according to ISO/IEC Guide 22 and EN 45014

**Manufacturer's Name:** Hewlett-Packard Co.

**Manufacturer's Address:** Microwave Instruments Division  
1400 Fountaingrove Parkway  
Santa Rosa, CA 95403-1799  
USA

declares that the product

**Product Name:** HP ESA-L1500A Spectrum Analyzer

**Model Number:** HP E4411A

**Product Options:** This declaration covers all options of the above product.

conforms to the following Product specifications:


**Safety:** IEC 1010-1:1990+A1 / 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:

This product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE-marking accordingly.

Santa Rosa, California, USA 6 Dec. 1996

  
John Hiatt/Quality Engineering Manager

European Contact: Your local Hewlett-Packard Sales and Service Office or Hewlett-Packard GmbH, Department HQ-TRE, Herrenberger Strasse 130, D-71034 Böblingen, Germany (FAX +49-7031-14-3143)

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## **8** **Required Equipment**

## Test Equipment

### Periodically verifying operation

The analyzer requires periodic verification of operation. Under most conditions of use, you should test the analyzer at least once a year with the complete set of performance verification tests.

**Table 8-1 Recommended Test Equipment**

Equipment	Critical Specifications for Equipment Substitution	Recommended Model	Use <sup>a</sup>
Digital Multimeter	Input Resistance: $\geq 10$ megohms Accuracy: $\pm 10$ mV on 100 V range	HP 3458A	P,A,T
DVM Test Leads	For use with HP 3458A Digital Multimeter	HP 34118B	T
Universal Counter	Time Interval Range: 25 ms to 100 ms Single Operation Range: +2.5 Vdc to -2.5 Vdc	HP 53132A or HP 5316B	P,A,T
Frequency Standard	Frequency: 10 MHz Timebase Accuracy (Aging): $< 1 \times 10^{-9}$ /day	HP 5071A	P,A
Measuring Receiver	Compatible with Power Sensors dB Relative Mode Resolution: 0.01 dB Reference Accuracy: $\pm 1.2\%$	HP 8902A	P,A,T
Microwave Frequency Counter	Frequency Range: 9 MHz to 7 GHz Timebase Accuracy (Aging): $< 5 \times 10^{-10}$ /day	HP 5352B	T
Oscilloscope	Bandwidth: dc to 100 MHz Vertical Scale Factor of 0.5 V to 5 V/Div	HP 54501A	T
Power Meter (Option 1DP)	Compatible with power sensors dB relative mode. Resolution: 0.01 dB Reference accuracy: $\pm 1.2\%$	HP 436A	P,A,T

Equipment	Critical Specifications for Equipment Substitution	Recommended Model	Use <sup>a</sup>
Power Sensor	Frequency Range: 100 kHz to 1500 MHz Maximum SWR: 1.60 (100 kHz to 300 kHz) 1.20 (300 kHz to 1 MHz) 1.1 (1 MHz to 2.0 GHz)	HP 8482A	P,A,T
Power Sensor, 75 $\Omega$ (Option 1DP)	Frequency Range: 1 MHz to 1500 MHz Maximum SWR: 1.18 (600 kHz to 1500 MHz) Impedance: 75 $\Omega$ Amplitude Range: -30 dBm to +20 dBm	HP 8483A	P,A,T
Power Sensor, Low Power	Frequency Range: 300 MHz Amplitude Range: -20 dBm to -70 dBm Maximum SWR: 1.1 (300 MHz)	HP8481D or HP 8484A	P,A,T
Synthesized Signal Generator	Frequency Range: 1 MHz to 1000 MHz Amplitude Range: -35 to +16 dBm SSB Noise: <-120 dBc/Hz at 20 kHz offset	HP 8663A or HP 8642A/B	P,A
Spectrum Analyzer, Microwave	Frequency Range: 100 kHz to 7 GHz Relative Amplitude Accuracy: 100 kHz to 1.5 GHz: < $\pm$ 1.8 dB Frequency Accuracy: < $\pm$ 10 kHz @ 7 GHz	HP 8566A/B	P,T
Synthesized Sweeper	Frequency Range: 10 MHz to 1.5 GHz Frequency Accuracy (CW): $\pm$ 0.02% Leveling Modes: Internal and External Modulation Modes: AM Power Level Range: -35 to +16 dBm	HP 8340A/B or HP 83630A	P,A,T
Synthesizer/ Function Generator	Frequency Range: 0.1 Hz to 20 MHz Frequency Accuracy: $\pm$ 0.02% Waveform: Triangle	HP 33120A or HP 3324A	P,A,T
Attenuator/Switch Driver	Compatible with HP 8494G and HP 8496G Programmable step attenuators	HP 11713A	P

Required Equipment  
Test Equipment

<b>Equipment</b>	<b>Critical Specifications for Equipment Substitution</b>	<b>Recommended Model</b>	<b>Use <sup>a</sup></b>
Attenuator, 1 dB Step	Attenuation Range: 0 to 11 dB Frequency Range: 4 GHz Connectors: Type-N female Calibrated at 50 MHz with accuracy of 0 to 11 dB attenuation: $\pm 0.010$ dB.	HP 8494A/G	P
Attenuator, 10 dB Step	Attenuation Range: 0 to 110 dB Frequency Range: 4 GHz Connectors: Type-N female Calibrated at 50 MHz with accuracy of: 0 to 40 dB attenuation: $\pm 0.020$ dB 50 to 100 dB attenuation: $\pm 0.065$ dB 110 dB attenuation: $\pm 0.075$ dB	HP 8496A/G	P
Attenuator, 10 dB Fixed	Nominal attenuation: 10 dB Frequency Range: dc to 12.4 GHz Connectors: Type-N(m) and Type-N(f)	HP 8491A Option 020	P
Attenuator Interconnect Kit	Mechanically and electrically connects HP 8494A/G and HP 8496A/G	HP 11716 Series	P

a. P = Performance Test, A = Adjustment, T = Troubleshooting

**Table 8-2 Recommended Accessories**

<b>Equipment</b>	<b>Critical Specifications for Accessory Substitution</b>	<b>Recommended Model</b>	<b>Use <sup>a</sup></b>
Active Probe	5 Hz to 500 MHz	HP 41800A	T
Active Probe	300 kHz to 3 GHz	HP 85024A	T
Attenuator, 3 dB	Type-N (m to f) Attenuation: 3 dB Frequency: dc to 12.4 GHz	HP 8491A Option 003	P
Attenuator, 10 dB	Type-N (m to f) Frequency: 300 MHz	HP 8491A Option 010	P,A,T
Attenuator, 20 dB	Type-N (m to f) Attenuation: 20 dB Frequency: dc to 12.4 GHz	HP 8491A Option 020	A

Equipment	Critical Specifications for Accessory Substitution	Recommended Model	Use <sup>a</sup>
Coupler, 9 dB	Coupling: Nominal 9 dB Insertion Loss: 2 dB	0955-0704	P,T
Directional Bridge	Frequency Range: 0.1 to 110 MHz Directivity: >40 dB Maximum VSWR: 1.1:1 Transmission Arm Loss: 6 dB nominal Coupling Arm Loss: 6 dB nominal	HP 8721A	P,T
6 GHz Directional Bridge	Frequency Range: 5 MHz to 1.5 GHz Directivity: >40 dB Coupling factor: 16 dB nominal Insertion Loss: 2 dB maximum	HP 86205A	P
Mechanical Adapter (Option 1DP)	Type-N (f), 75 $\Omega$ to Type-N (m), 50 $\Omega$	1259-0597	P,A,T
Minimum Loss Pad (Option 1DP)	Frequency Range: dc to 1.5 GHz Insertion loss: 5.7 dB, nominal	HP 11852B	P,A,T
Power Splitter	Frequency Range: 50 kHz to 1.5 GHz Insertion Loss: 6 dB nominal Output Tracking: <0.25 dB Equivalent Output SWR: <1.22:1	HP 11667A	P,A
Termination, 50 $\Omega$ (Option 1DN)	Impedance: 50 $\Omega$ nominal Connector: Type-N (m) (2 required)	HP 908A	P,T
Termination, 50 $\Omega$	Impedance: 50 $\Omega$ (nominal) Connector: BNC (m)	HP 11593A	P,A
Filter, 50 MHz Low Pass	Cutoff frequency: 50 MHz Rejection at 65 MHz: >40 dB Rejection at 75 MHz: >60 dB	0955-0306	P



Required Equipment  
Test Equipment

Equipment	Critical Specifications for Accessory Substitution	Recommended Model	Use <sup>a</sup>
Filter, 1 GHz Low Pass	Cutoff frequency: 1 GHz Rejection at 2 GHz: >60 dB	0955-0487	P
Termination, 75 $\Omega$ (Option 1DQ, 1DP)	Impedance: 75 $\Omega$ (nominal) (2 required for Option 1DQ) (1 required for Option 1DP)	HP 909E Option 201	P,T

a. P = Performance Test, A = Adjustment, T = Troubleshooting

**Table 8-3 Recommended Adapters**

Critical Specifications for Adapter Substitution	Recommended Model	Use <sup>a</sup>
BNC (f) to dual banana plug	1251-1277	P,A,T
BNC (m) to BNC (m)	1250-0216	P,T
BNC (m) to BNC (m), 75 $\Omega$ (Option 1DP)	1250-1288	P,T
BNC (f) to SMB (m)	1250-1237	T
BNC tee BNC (f,m,f)	1250-0781	A,T
SMB (m) to SMB (m)	1250-0813	T
Type-N (f) to APC 3.5 (f)	1250-1745	P,A,T
Type-N (f) to BNC (m)	1250-1477	P,T
Type-N (f) to BNC (m), 75 $\Omega$ (2 required for Option 1DP)	1250-1534	P,A,T
Type-N (m) to BNC (f) (4 required)	1250-1476	P,A,T
Type-N (f) to BNC (f), 75 $\Omega$ (Option 1DP)	1250-1536	P,T
Type-N (m) to BNC (m) (2 required)	1250-1473	P,T
Type-N (m) to BNC (m), 75 $\Omega$ (Option 1DP)	1250-1533	P,A,T
Type-N (f) to Type-N (f)	1250-1472	P,T
Type-N (m) to Type-N (m)	1250-1475	P,A,T
Type-N (f) to Type-N (f), 75 $\Omega$ (Option 1DP)	1250-1529	P,A,T
Type-N (f), 75 $\Omega$ , to Type-N (m), 50 $\Omega$ (Option 1DP)	1250-0597	P,A,T
Type-N (m) to SMA (f) (4 required)	1250-1250	P

<b>Critical Specifications for Adapter Substitution</b>	<b>Recommended Model</b>	<b>Use <sup>a</sup></b>
Type-N (m) to SMA (m)	1250-1636	P
SMB (f) to SMB (f)	1250-0692	T
50 to 75 $\Omega$ Minimum Loss Frequency Range: dc to 1.5 GHz Insertion Loss: 5.7 dB (Option 1DP)	HP 11852B	P,A,T

a. P = Performance Test, A = Adjustment, T = Troubleshooting

**Table 8-4 Recommended Cables**

<b>Critical Specifications for Cable Substitution</b>	<b>Recommended Model</b>	<b>Use <sup>a</sup></b>
Frequency Range: dc to 1 GHz Length: $\geq$ 122 cm (48 in) Connectors: BNC (m) both ends (4 required)	HP 10503A	P,A,T
Type-N, 62 cm (24 in)	HP 11500B/C	P,T
Type-N, 152 cm (60 in) (2 required)	HP 11500D	P,A,T
SMA, 62 cm (24 in) (2 required)	1820-1578	P
Frequency Range: dc to 310 MHz Length: 23 cm (9 in) Connectors: BNC (m) both ends	HP 10502A	P,T
BNC, 75 $\Omega$ , 30 cm (12 in) (option 1DP)	5062-6452	P,A,T
Cable, Test Length: $\geq$ 91 cm (36 in) Connectors: SMB (f) to BNC (m) (2 required)	85680-60093	T

a. P = Performance Test, A = Adjustment, T = Troubleshooting

Required Equipment  
Test Equipment



**Tests included in this section:**

1. 10 MHz Reference Accuracy
2. Resolution Bandwidth Switching Uncertainty
3. Noise Sidebands
4. System Related Sidebands
5. Residual FM
6. Frequency Span Readout Accuracy
7. Reference Level Accuracy
8. Scale Fidelity
9. Input Attenuation Switching Uncertainty
10. Resolution Bandwidth Accuracy
11. Frequency Readout and Marker Count Accuracy
12. Absolute Amplitude Accuracy
13. Frequency Response
14. Spurious Responses
15. Gain Compression
16. Other Input Related Spurious Responses
17. Sweep Time Accuracy
18. Displayed Average Noise Level
19. Residual Responses
20. Tracking Generator Feedthrough Options 1DN and 1DQ
21. Absolute Amplitude, Vernier, and Power Sweep Accuracy, Options 1DN and 1DQ
22. Tracking Generator Level Flatness, Options 1DN and 1DQ
23. Harmonic Spurious Outputs, Options 1DN and 1DQ
24. Non-Harmonic Spurious Outputs, Options 1DN and 1DQ

## Calibration

To perform calibration:

1. Run all performance verification tests listed in column 1 of [Table 9-1](#).
2. If any of the performance verification tests fail, perform the appropriate calibration adjustments listed in column 2 of [Table 9-1](#) which corresponds to the failure.
3. Repeat ALL of the performance verification tests listed in column 1 of [Table 9-1](#) if ANY calibration adjustments were made in [step 2](#). This will confirm that there is no interaction between adjustments which could negatively impact board performance.

[Table 9-1](#) lists the performance verification tests and adjustments needed for calibration. The performance tests are located in the following pages of this chapter. Adjustments are located in the service guide.

**Table 9-1 Calibration Requirements**

Test #	Column 1 Performance Verification Tests	Column 2 Calibration Adjustments
1	10 MHz Reference Accuracy	10 MHz Frequency Reference Adjustment
2	Resolution Bandwidth Switching Uncertainty	21.4 MHz IF Calibrator
3	Noise Sidebands	None
4	System Related Sidebands	None
5	Residual FM	None
6	Frequency Span Readout Accuracy	None
7	Reference Level Accuracy	21.4 MHz IF Calibrator
8	Scale Fidelity	21.4 MHz IF Calibrator
9	Input Attenuation Switching Uncertainty	Uncorrected Flatness Corrected Flatness
10	Resolution Bandwidth Accuracy	None
11	Frequency Readout and Marker Count Accuracy	None
12	Absolute Amplitude Accuracy	50 MHz Calibrator
13	Frequency Response	Uncorrected Flatness Corrected Flatness
14	Spurious Responses	None
15	Gain Compression	None

<b>Test #</b>	<b>Column 1 Performance Verification Tests</b>	<b>Column 2 Calibration Adjustments</b>
16	Other Input Related Spurious Responses	None
17	Sweep Time Accuracy	None
18	Displayed Average Noise Level	Frequency Response Adjustment
19	Residual Responses	None
20	Tracking Generator Feedthrough, Option 1DN and 1DQ	None
21	Absolute Amplitude, Vernier, and Power Sweep Accuracy, Option 1DN and 1DQ	Tracking Generator ALC Calibration Tracking Generator Frequency Slope
22	Tracking Generator Level Flatness, Option 1DN and 1DQ	Tracking Generator ALC Calibration Tracking Generator Frequency Slope
23	Harmonic Spurious Outputs, Option 1DN and 1DQ	None
24	Non-Harmonic Spurious Outputs, Option 1DN and 1DQ	None

**Table 9-2 HP 11713A Settings for HP 8494G and HP 8496G**

<b>1 dB Step Atten (dB)</b>	<b>Attenuator X</b>				<b>10 dB Step Atten (dB)</b>	<b>Attenuator Y</b>			
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>		<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>
0	0	0	0	0	0	0	0	0	0
1	1	0	0	0	10	1	0	0	0
2	0	1	0	0	20	0	1	0	0
3	1	1	0	0	30	1	1	0	0
4	0	0	1	0	40	0	0	1	0
5	1	0	1	0	50	1	0	1	0
6	0	1	1	0	60	0	1	1	0
7	1	1	1	0	70	1	1	1	0
8	0	0	1	1	80	0	0	1	1
9	1	0	1	1	90	1	0	1	1
10	0	1	1	1	100	0	1	1	1
11	1	1	1	1	110	1	1	1	1

When using the programmable versions of the 1 dB and 10 dB step attenuator (HP 8494G and HP 8496G), the HP 11713A Attenuator/Switch Driver must be used to control the attenuators. The HP 8494G 1 dB step attenuator should be connected as Attenuator X and the HP 8496G 10 dB step attenuator should be connected as Attenuator Y.

Use [Table 9-2](#) to determine the settings of Attenuator X and Attenuator Y to set the step attenuators to the desired value. In the columns labelled Attenuator X and Attenuator Y, a “1” indicates that section is on (the LED in the button will be lit), while a “0” indicates that section is off. For example, if the 1 dB step attenuator should be set to 2 dB and the 10 dB step attenuator should be set to 60 dB, sections 2, 6, and 7 should be on (lit) and all other sections should be off.



## 1. 10 MHz Reference Accuracy

The settability is measured by changing the setting of the digital-to-analog converter (DAC) which controls the frequency of the timebase. The frequency difference per DAC step is calculated and compared to the specification.

The related adjustment for this performance verification test is the “10 MHz Frequency Reference Adjustment.”

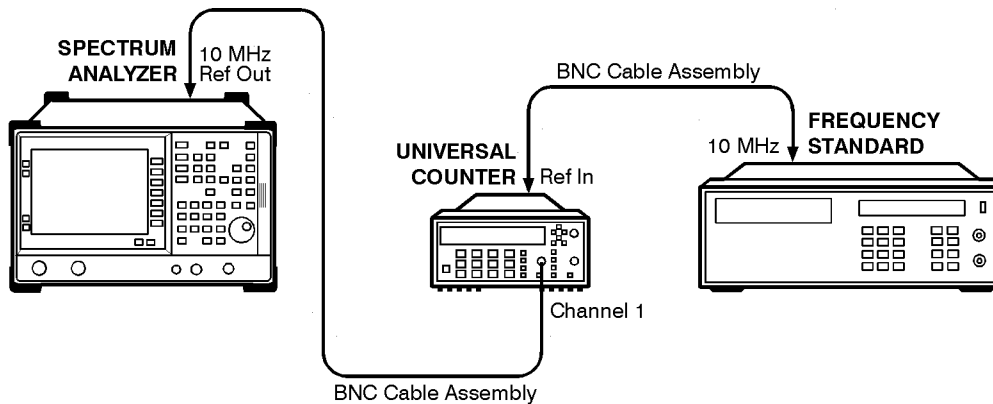
### Equipment Required

Universal counter (Instructions are for HP 53132A. For HP 5316B, refer to its user documentation.)

Frequency standard

Cable, BNC, 122-cm (48-in) (2 required)

**Figure 9-1** 10 MHz Reference Test Setup



nl71a

### Procedure

1. Connect the equipment as shown in [Figure 9-1](#). The frequency standard provides the reference for the universal counter.
2. Ensure that the analyzer has been on for at least five minutes before proceeding.
3. Set the frequency counter controls as follows:
  - a. Press **Gate & ExtArm**
  - b. Press any one of the arrow keys until DIGITS is displayed.
  - c. Press **Gate & ExtArm** again. Using the arrow keys, set the DIGITS number to 9.

- d. Press **Enter**
  - e. Press **Freq & Ratio**
  - f. On Channel 1, press **50 Ω/1 MΩ = 50 Ω**
4. Wait for the frequency counter reading to stabilize. Record the frequency counter reading in [Table 9-3](#) as Counter Reading 1.
  5. Set the analyzer by pressing the following keys:  
**System, Alignments, Timebase, Fine**
  6. Record the number in the active function block of the analyzer in [Table 9-3](#) as Timebase Fine.
  7. Press the ↑ (up arrow) key on the analyzer.
  8. Wait for the frequency counter reading to stabilize. Record the frequency counter reading in [Table 9-3](#) as Counter Reading 2.
  9. Press the ↓ (down arrow) key on the analyzer 2 times.
  10. Wait for the frequency counter reading to stabilize. Record the frequency counter reading in [Table 9-3](#) as Counter Reading 3.

**Table 9-3 10 MHz Reference Accuracy Worksheet**

<b>Description</b>	<b>Measurement</b>
Counter Reading 1	_____ Hz
Timebase Fine	_____
Counter Reading 2	_____ Hz
Counter Reading 3	_____ Hz

11. Calculate the frequency settability by performing the following steps:
  - Calculate the frequency difference between Counter Reading 2 and Counter Reading 1.
  - Calculate the frequency difference between Counter Reading 3 and Counter Reading 1.
  - Divide the difference with the greatest absolute value by two and record the value as TR Entry 1 of the performance verification test record.
  - Turn the analyzer power Off and On. The timebase DAC will be reset automatically to the value recorded in [step 6](#).

## 2. Resolution Bandwidth Switching Uncertainty

To measure the absolute amplitude calibration uncertainty the 50 MHz internal signal is measured after the auto alignment routine is finished.

To measure the resolution bandwidth switching uncertainty an amplitude reference is taken with the resolution bandwidth set to 3 kHz using the marker  $\Delta$  function. The resolution bandwidth is changed to settings between 3 MHz and 1 kHz and the amplitude variation is measured at each setting and compared to the specification. The span is changed as necessary to maintain approximately the same aspect ratio.

### Procedure

1. Press **Preset** on the analyzer, then wait for the preset routine to finish. Set the analyzer controls by pressing the following keys:
  - System, 50 MHz osc On Off (On)**
  - Frequency, 50 MHz**
  - Span, 10 MHz**
  - Peak Search**
  - Frequency, Signal Track On Off (On)**
  - Span, 50 kHz**
  - Amplitude, Amptd Units, dBm, Done**
  - Amplitude, -20 dBm**
  - Scale/Div, 1 dB**
  - BW/Avg, 3 kHz**
  - Video BW Auto Man, 1 kHz**
2. Press **Amplitude** and use the RPG to adjust the reference level until the signal appears five divisions below the reference level, then press the following keys:
  - Peak Search**
  - Marker, Marker  $\Delta$**
  - Frequency, Signal Track On Off (On)**
3. Set the analyzer resolution bandwidth and span according to [Table 9-4](#).

4. Press **Peak Search**, then record the Sig  $\Delta$ -Trk amplitude reading in the performance verification test record as indicated in [Table 9-4](#).
5. Repeat [step 3](#) and [step 4](#) for each of the remaining resolution bandwidth and span settings listed in [Table 9-4](#).

**Table 9-4 Resolution Bandwidth Switching Uncertainty**

Analyzer		Sig- $\Delta$ -Trk Amplitude Reading
RES BW Setting	SPAN Setting	TR Entry
3 kHz	50 kHz	0 (Ref)
1 kHz	50 kHz	1
10 kHz	50 kHz	2
30 kHz	500 kHz	3
100 kHz	500 kHz	4
300 kHz	5 MHz	5
1 MHz	10 MHz	6
3 MHz	10 MHz	7

### 3. Noise Sidebands

A 500 MHz CW signal is applied to the input of the analyzer. The marker functions are used to measure the amplitude of the carrier and the noise level 10 kHz, 20 kHz, 30 kHz, and 100 kHz above and below the carrier. The difference between these two measurements is compared to specification.

There are no related adjustment procedures for this performance test.

#### Equipment Required

Synthesized signal generator

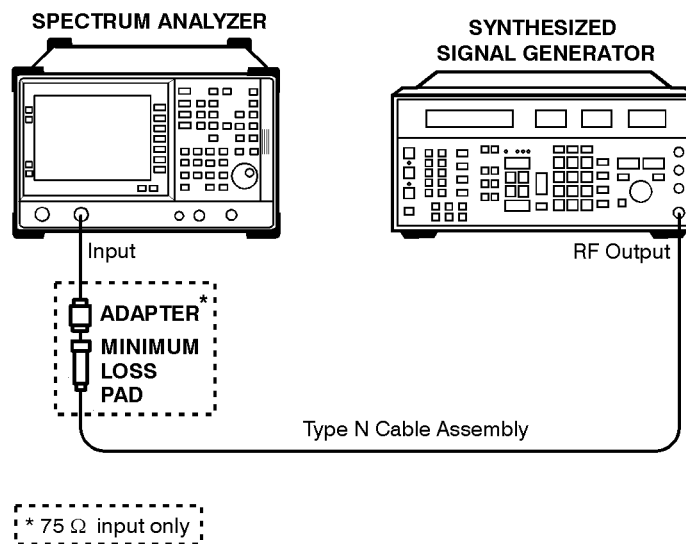
Cable, Type-N, 152-cm (60-in)

#### Additional Equipment for 75 $\Omega$ Input

Pad, minimum loss

Adapter, Type-N (f), to BNC (m), 75  $\Omega$

**Figure 9-2** Noise Sidebands Test Setup



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#### CAUTION

Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors, or damage to the connectors will occur.

## Procedure

This performance test consists of four parts:

Part 1: Noise Sideband Suppression at 10 kHz

Part 2: Noise Sideband Suppression at 20 kHz

Part 3: Noise Sideband Suppression at 30 kHz

Part 4: Noise Sideband Suppression at 100 kHz

Perform part 1 before performing part 2 or part 3 of this procedure.

A worksheet is provided at the end of this procedure for calculating the noise sideband suppression.

### Part 1: Noise Sideband Suppression at 10 kHz

1. Perform the following steps to set up the equipment:

a. Set the synthesized signal generator controls as follows:

**FREQUENCY, 500 MHz**

**AMPLITUDE, 0 dBm (50  $\Omega$  Input only)**

**AMPLITUDE, to +6 dBm (75  $\Omega$  Input only)**

**AM OFF**

**FM OFF**

b. Connect the equipment as shown in [Figure 9-2](#).

c. Press **Preset** on the analyzer, then wait for the preset routine to finish. Set the analyzer by pressing the following keys:

**Frequency, 500 MHz**

**Span, 10 MHz**

**Amplitude, Amptd Units, dBm**

**Done**

2. Press the following analyzer keys to measure the carrier amplitude.

**Peak Search**

**Frequency, Signal Track On Off (On)**

**Span, 50 kHz**

**BW/Avg, 1 kHz**

**Video BW Auto Man, 30 Hz**

**Frequency, Signal Track On Off (Off)**

**Sweep, Sweep Time, 5 sec**

### 3. Noise Sidebands

#### Single Sweep

Wait for the completion of a sweep, then press **Peak Search**.

3. Press the following analyzer keys to measure the noise sideband level at +10 kHz:

**Marker, Marker  $\Delta$**

**Marker Noise On Off(On)**

**Frequency, CF Step, 10 kHz**

**Center Freq  $\uparrow$**

**Span, Zero Span**

**Single Sweep**

Record the marker delta amplitude reading in [Table 9-5](#) as the Noise Sideband Level at +10 kHz.

4. Press the following analyzer keys to measure the noise sideband level at -10 kHz:

**Frequency  $\downarrow, \downarrow$**

**Single Sweep**

Record the marker amplitude reading in the Noise Sideband Worksheet as the Noise Sideband Level at -10 kHz.

5. Record the more positive value, either Noise Sideband Level at +10 kHz or Noise Sideband Level at -10 kHz from the Noise Sideband Worksheet as TR Entry 1 in the performance verification test record.

6. Press **Frequency,  $\uparrow$**

## Part 2: Noise Sideband Suppression at 20 kHz

1. Press the following analyzer keys to measure the noise sideband level at +20 kHz:

**Frequency, CF Step, 20 kHz**

**Center Freq,  $\uparrow$**

**Single Sweep**

Record the marker amplitude reading in the Noise Sideband Worksheet as the Noise Sideband Level at +20 kHz.

2. Press the following analyzer keys to measure the noise sideband level at -20 kHz:

**Frequency,  $\downarrow, \downarrow$**

**Single Sweep**

Record the marker amplitude reading in the Noise Sideband Worksheet as the Noise Sideband Level at  $-20$  kHz.

- Record the more positive value, either Noise Sideband Level at  $+20$  kHz or Noise Sideband Level at  $-20$  kHz from the Noise Sideband Worksheet as TR Entry 2 in the performance verification test record.
- Press Frequency,  $\uparrow$

### Part 3: Noise Sideband Suppression at 30 kHz

- Press the following analyzer keys to measure the noise sideband level at  $+30$  kHz:

Frequency, CF Step, 30 kHz

Center Freq,  $\uparrow$

Single Sweep

Record the marker amplitude reading in the Noise Sideband Worksheet as the Noise Sideband Level at  $+30$  kHz.

- Press the following analyzer keys to measure the noise sideband level at  $-30$  kHz:

Frequency,  $\downarrow, \downarrow$

Single Sweep

Record the marker amplitude reading in the Noise Sideband Worksheet as the Noise Sideband Level at  $-30$  kHz.

- Record the more positive value, either Noise Sideband Level at  $+30$  kHz or Noise Sideband Level at  $-30$  kHz from the Noise Sideband Worksheet as TR Entry 3 in the performance verification test record.
- Press Frequency,  $\uparrow$

### Part 4: Noise Sideband Suppression at 100 kHz

- Press the following analyzer keys to measure the noise sideband level at  $+100$  kHz:

Frequency, CF Step, 100 kHz

Center Freq,  $\uparrow$

Single Sweep

Record the marker amplitude reading in the Noise Sideband Worksheet as the Noise Sideband Level at  $+100$  kHz.



## 3. Noise Sidebands

2. Press the following analyzer keys to measure the noise sideband level at  $-100$  kHz:

Frequency, ↓, ↓

Single Sweep

Record the marker amplitude reading in the Noise Sideband Worksheet as the Noise Sideband Level at  $-100$  kHz.

3. Record the more positive value, either Noise Sideband Level at  $+100$  kHz or Noise Sideband Level at  $-100$  kHz from the Noise Sideband Worksheet as TR Entry 4 in the performance test verification record.

**Table 9-5**      **Noise Sideband Worksheet**

Description	Measurement
Noise Sideband Level at $+10$ kHz	_____ dBc/Hz
Noise Sideband Level at $-10$ kHz	_____ dBc/Hz
Noise Sideband Level at $+20$ kHz	_____ dBc/Hz
Noise Sideband Level at $-20$ kHz	_____ dBc/Hz
Noise Sideband Level at $+30$ kHz	_____ dBc/Hz
Noise Sideband Level at $-30$ kHz	_____ dBc/Hz
Noise Sideband Level at $+100$ kHz	_____ dBc/Hz
Noise Sideband Level at $-100$ kHz	_____ dBc/Hz

## 4. System Related Sidebands

A 500 MHz CW signal is applied to the input of the analyzer. The marker functions are used to measure the amplitude of the carrier and the amplitude of any system related sidebands 30 kHz above and below the carrier. System related sidebands are any internally generated line related, power supply related or local oscillator related sidebands.

There are no related adjustment procedures for this performance test.

### Equipment Required

Synthesized signal generator

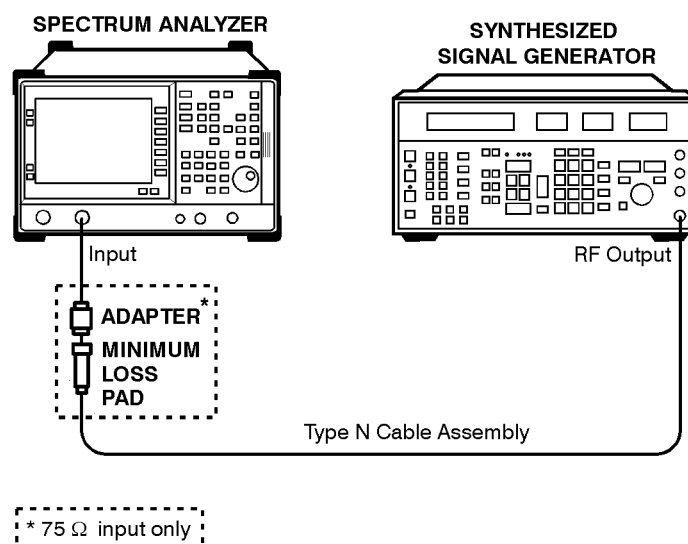
Cable, Type-N, 152-cm (60-in)

### Additional Equipment for 75 $\Omega$ Input

Pad, minimum loss

Adapter, Type-N (f), to BNC (m), 75  $\Omega$

**Figure 9-3** System Related Sidebands Test Setup



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**CAUTION**

Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors, or damage to the connectors will occur.

## Procedure

1. Perform the following steps to set up the equipment:
  - a. Set the synthesized signal generator controls as follows:
    - FREQUENCY, 500 MHz**
    - AMPLITUDE, 0 dBm (50  $\Omega$  Input only)**
    - AMPLITUDE, +6 dBm (75  $\Omega$  Input only)**
    - AM Off**
    - FM Off**
  - b. Connect the equipment as shown in [Figure 9-3](#).
  - c. Press **Preset** on the analyzer, then wait for the preset routine to finish. Set the analyzer by pressing the following keys:
    - Frequency, 500 MHz**
    - Span, 10 MHz**
2. Set the analyzer to measure the system related sideband above the signal by performing the following steps:
  - a. Press the following keys:
    - Peak Search**
    - Frequency, Signal Track On Off (On)**
    - Span, 200 kHz**
    - BW/Avg, 1 kHz**
    - Video BW Auto Man, 30 Hz**Allow the analyzer to take two complete sweeps. Then press the following keys:
    - Frequency, Signal Track On Off (Off)**
    - CF Step Auto Man, 130 kHz**
  - b. Press **Single Sweep** and wait for the completion of the sweep. Press **Peak Search**, then **Marker, Marker  $\Delta$** .
  - c. Press the following analyzer keys:
    - Frequency**
    - $\uparrow$  (step-up key)**
3. Measure the system related sideband above the signal by pressing **Single Sweep** on the analyzer. Wait for the completion of a new sweep, then press **Peak Search**.

4. Record the marker delta amplitude as TR Entry 1 of the performance verification test record.
5. Set the analyzer to measure the system related sideband below the signal by pressing the following analyzer keys:
  - ↓ (step-down key)
  - ↓ (step-down key)
6. Measure the system related sideband below the signal by pressing **Single Sweep**. Wait for the completion of a new sweep, then press **Peak Search**.

Record the marker delta amplitude as TR Entry 2 of the performance verification test record.

## 5. Residual FM

This test measures the inherent short-term instability of the analyzer LO system. With the analyzer in zero span, a stable signal is applied to the input and slope-detected on the linear portion of the IF bandwidth filter skirt. Any instability in the LO transfers to the IF signal in the mixing process. The test determines the slope of the IF filter in Hz/dB and then measures the signal amplitude variation caused by the residual FM. Multiplying these two values yields the residual FM in Hz.

There are no related adjustment procedures for this performance test.

### Equipment Required

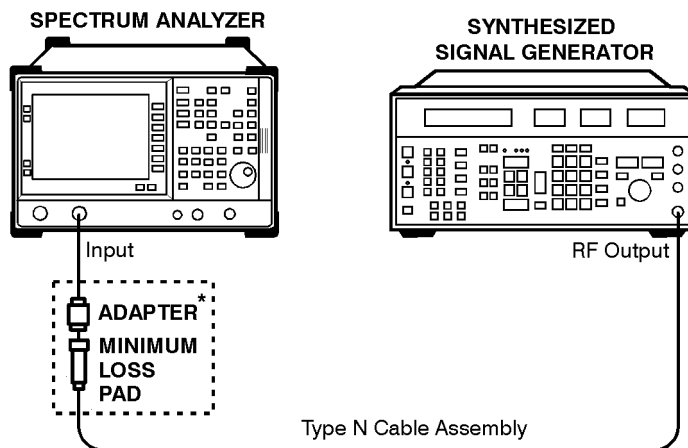
- Synthesized signal generator
- Cable, Type-N, 152-cm (60-in)

### Additional Equipment for 75 $\Omega$ Input

- Pad, minimum loss
- Adapter, Type-N (f), to BNC (m), 75  $\Omega$

**Figure 9-4**

### Residual FM Test Setup



\* 75  $\Omega$  input only

n1766a

#### CAUTION

Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors, or damage to the connectors will occur.

## Procedure

### Part 1: Residual FM

#### Determining the IF Filter Slope

1. Connect the equipment as shown in [Figure 9-4](#).
2. Set the synthesized signal generator controls as follows:
  - FREQUENCY, 500 MHz**
  - AMPLITUDE, -10 dBm (50  $\Omega$  Input only)**
  - AMPLITUDE, -4 dBm (75  $\Omega$  Input only)**
  - AM OFF**
  - FM OFF**
3. Press **Preset** on the analyzer, then wait for the preset routine to finish. Set the analyzer by pressing the following keys:
  - Frequency, 500 MHz**
  - Span, 1 MHz**
  - Amplitude, -9 dBm (50  $\Omega$  Input only)**
  - Amplitude, 39.8 dBmV (75  $\Omega$  Input only)**
  - Scale/Div, 2 dB**
  - BW/Avg, 1 kHz**
4. On the analyzer, press the following keys:
  - Peak Search**
  - Span, Span Zoom, 10 kHz**

Wait for the **Span 10kHz** message to appear. Press the following analyzer keys:

  - Search, Marker → Ref Lvl**
  - Marker, Marker 1 On Off (Off)**
5. On the analyzer, press the following keys:
  - Single Sweep**
  - Peak Search**
  - Marker, Marker  $\Delta$**

## 5. Residual FM

6. Rotate the analyzer RPG counterclockwise until the marker  $\Delta$  amplitude reads  $-8 \text{ dB} \pm 0.3 \text{ dB}$ . Press **Marker**  $\Delta$ . Rotate the knob counterclockwise until the marker  $\Delta$  amplitude reads  $-4 \text{ dB} \pm 0.3 \text{ dB}$ .

If you have difficulty achieving the  $\pm 0.3 \text{ dB}$  setting, then make the following analyzer settings:

**Sweep, Sweep Cont Single (Cont)**

**Span, 5 kHz**

**BW/Avg, Video BW Auto Man, 30 Hz**

Repeat [step 5](#)

7. Divide the marker delta frequency in hertz by the marker delta amplitude in dB to obtain the slope of the resolution bandwidth filter. For example, if the marker delta frequency is 1.08 kHz and the marker delta amplitude is 3.92 dB, the slope would be equal to 75.3 Hz/dB. Record the result below:

Slope \_\_\_\_\_ Hz/ dB

## Measuring the Residual FM

8. On the analyzer, press **Marker, Marker All Off, Peak Search**, then **Marker, Marker**  $\Delta$ . Rotate the knob counterclockwise until the marker  $\Delta$  amplitude reads  $-10 \text{ dB} \pm 0.3 \text{ dB}$ .
9. On the analyzer, press the following keys:

**Marker, Marker Normal**

**Search, Mkr**  $\rightarrow$  CF

**Single Sweep**

**BW/Avg, Video BW Auto Man, 1 kHz**

**Span, Zero Span**

**Sweep, 100 msec**

Press **Single Sweep**.

---

### NOTE

The displayed trace should be about five divisions below the reference level. If it is not, press **Sweep, Sweep Cont Single (Cont), Frequency**, and use the knob to place the displayed trace about five divisions below the reference level. Press **Single Sweep**.

10. On the analyzer, press **Search, More, Pk-Pk Search**. Read the marker delta amplitude, take its absolute value, and record the result as the Deviation.

Deviation \_\_\_\_\_ dB

11. Calculate the Residual FM by multiplying the Slope recorded in [step 7](#) by the Deviation recorded in [step 10](#).

Record this value as TR Entry 1 of the performance verification test record.



## 6. Frequency Span Readout Accuracy

For testing each frequency span, two synthesized sources are used to provide two precisely-spaced signals. The analyzer marker functions are used to measure this frequency difference and the marker reading is compared to the specification.

There are no related adjustment procedures for this performance test.

### Equipment Required

- Synthesized sweeper
- Synthesized signal generator
- Power splitter
- Adapter, Type-N (m) to Type-N (m)
- Adapter, Type-N (f) to APC 3.5 (f)
- Cable, Type-N, 152-cm (60-in) (*2 required*)
- Cable, BNC, 122-cm (48-in)

### Additional Equipment for 75 $\Omega$ Input

- Pad, minimum loss
- Adapter, Type-N (f), to BNC (m), 75  $\Omega$

### Procedure

#### Full Span Frequency Span Readout Accuracy

1. Connect the equipment as shown in [Figure 9-5](#). Note that the power splitter is used as a combiner. The synthesized signal generator provides the frequency reference for the synthesized sweeper.
2. Press **Preset** on the analyzer, then wait for the preset routine to finish.
3. Press **INSTRUMENT PRESET** on the synthesized sweeper and set the controls as follows:

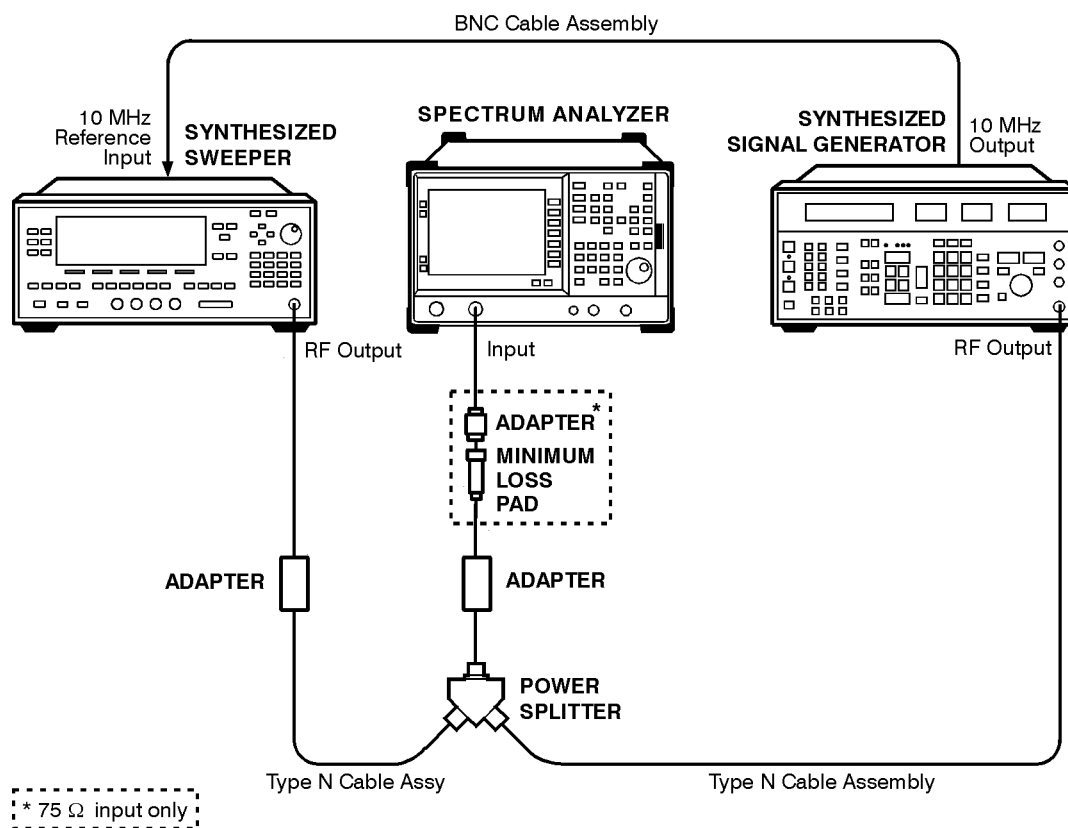
- CW, 1350 MHz**
- POWER LEVEL, -5 dBm**

4. On the synthesized signal generator, set the controls as follows:

**FREQUENCY, 150 MHz**

**AMPLITUDE, 0 dBm**

**Figure 9-5 Frequency Span Readout Accuracy Test Setup**



5. Adjust the analyzer center frequency, if necessary, to place the lower frequency on the second vertical graticule line (one division from the left-most graticule line).

6. On the analyzer, press **Single Sweep**. Wait for the completion of a new sweep, then press the following keys:

**Peak Search**

**Marker, Marker  $\Delta$**

**Search, Next Pk Right**

The two markers should be on the signals near the second and tenth vertical graticule lines (the first graticule line is the left-most).

## 6. Frequency Span Readout Accuracy

7. If necessary, continue pressing **Next Pk Right** until the active marker is on the right-most signal (1350 MHz).
8. Record the marker delta frequency reading as TR Entry 1 of the performance verification test record.

### 100 kHz and 100 MHz Frequency Span Readout Accuracy

9. Set the analyzer by pressing the following keys:

**Frequency, Start Freq, 10 MHz, Stop Freq, 110 MHz, Sweep, Sweep Cont Single (Cont)**

10. On the synthesized sweeper set the controls as follows:

**CW, 100 MHz**

**POWER LEVEL, -5 dBm**

11. Set the synthesized signal generator controls as follows:

**FREQUENCY, 20 MHz**

**AMPLITUDE, 0 dBm**

12. Adjust the analyzer center frequency to center the two signals on the display.

13. On the analyzer, press **Single Sweep**. Wait for the completion of a new sweep, then press the following keys:

**Peak Search**

**Marker, Marker  $\Delta$**

**Search, Next Pk Right**

The two markers should be on the signals near the second and tenth vertical graticule lines (the first graticule line is the left-most).

14. If necessary, continue pressing **Next Pk Right** until the active marker is on the right-most signal (100 MHz). Record the marker delta frequency reading in the performance test record as TR Entry 2.

15. Press **Marker, Marker All Off** on the analyzer.

16. Change to the next equipment settings listed in [Table 9-6](#).

17. On the analyzer, press **Single Sweep**. Wait for the completion of a new sweep, then press the following keys:

**Peak Search**

**Marker, Marker  $\Delta$**

**Search, Next Pk Right**

18. Continue pressing **Next Pk Right** until the marker delta on the right-most signal. Record the marker delta frequency reading in the performance test record.

19. Repeat [step 15](#) through [step 18](#) for the remaining analyzer span settings listed in [Table 9-6](#).

**Table 9-6 Frequency Span Readout Accuracy**

<b>Analyzer Start Frequency (MHz)</b>	<b>Analyzer Stop Frequency (MHz)</b>	<b>Synthesized Signal Generator Frequency (MHz)</b>	<b>Synthesized Sweeper Frequency (MHz)</b>	<b>TR Entry</b>	<b>Analyzer Span (MHz)</b>
0	1500	150	1350	1	1500
10	110	20	100	2	100
10	10.1	10.01	10.09	3	0.1
800	900	810	890	4	100
800	800.1	800.01	800.09	5	0.1
1400	1500	1410	1490	6	100
1499	1499.1	1499.01	1499.09	7	0.1

## 7. Reference Level Accuracy

A 50 MHz CW signal is applied to the Input 50  $\Omega$  of the analyzer through two step attenuators. The amplitude of the source is decreased in 10 dB steps and the analyzer marker functions are used to measure the amplitude difference between steps. The source's internal attenuator is used as the reference standard. The test is performed in both log and linear amplitude scales.

It is only necessary to test reference levels as low as  $-90$  dBm (with 10 dB attenuation) since lower reference levels are a function of the analyzer microprocessor manipulating the trace data. There is no error associated with the trace data manipulation.

### Equipment Required

Synthesized signal generator

1 dB step attenuator

10 dB step attenuator

Attenuator/ switch driver (if programmable step attenuators are used)

Cable, Type-N 152-cm (60-in)

Cable, BNC 122-cm (48-in) (*2 required*)

Attenuator interconnect kit

Adapter, Type-N (m) to BNC (f) (*2 required*)

### Additional Equipment for 75 $\Omega$ Input

Pad, minimum loss

Adapter, Type-N (f), to BNC (m), 75  $\Omega$

### Procedure

Calculate Actual Attenuation Errors

1. From the calibration data supplied with the 10 dB step attenuator, enter into column 2 of [Table 9-7](#) and [Table 9-8](#) the actual attenuation for the corresponding nominal attenuation settings. If using a programmable attenuator, enter the data for the section three 40 dB step.
2. Calculate the reference attenuation error by subtracting 40 dB from the actual attenuation for the 40 dB setting, and enter below.

Reference Atten Error = Actual Attenuation (40 dB) – 40 dB

Reference Atten Error \_\_\_\_\_ dB

3. To calculate the attenuation error at other nominal attenuator settings, subtract the attenuation error at the other settings from the reference atten error and enter the result in column 3 of [Table 9-7](#) and [Table 9-8](#).

Atten Error (X dB) = (Actual Attenuation (X dB) – Nominal Attenuation (X dB)) – Reference Atten Error

Example for 50 dB setting:

Actual Attenuation (40 dB) = 40.15 dB

Actual Attenuation (50 dB) = 50.08 dB

Reference Atten Error = 40.15 dB – 40 dB = 0.15 dB

Atten Error (50 dB) = (50.08 dB – 50 dB) – 0.15 dB  
= 0.08 dB – 0.15 dB  
= –0.07 dB

## Log Scale

1. Set the synthesized signal generator controls as follows:

**FREQUENCY, 50 MHz**

**AMPLITUDE, +10 dBm**

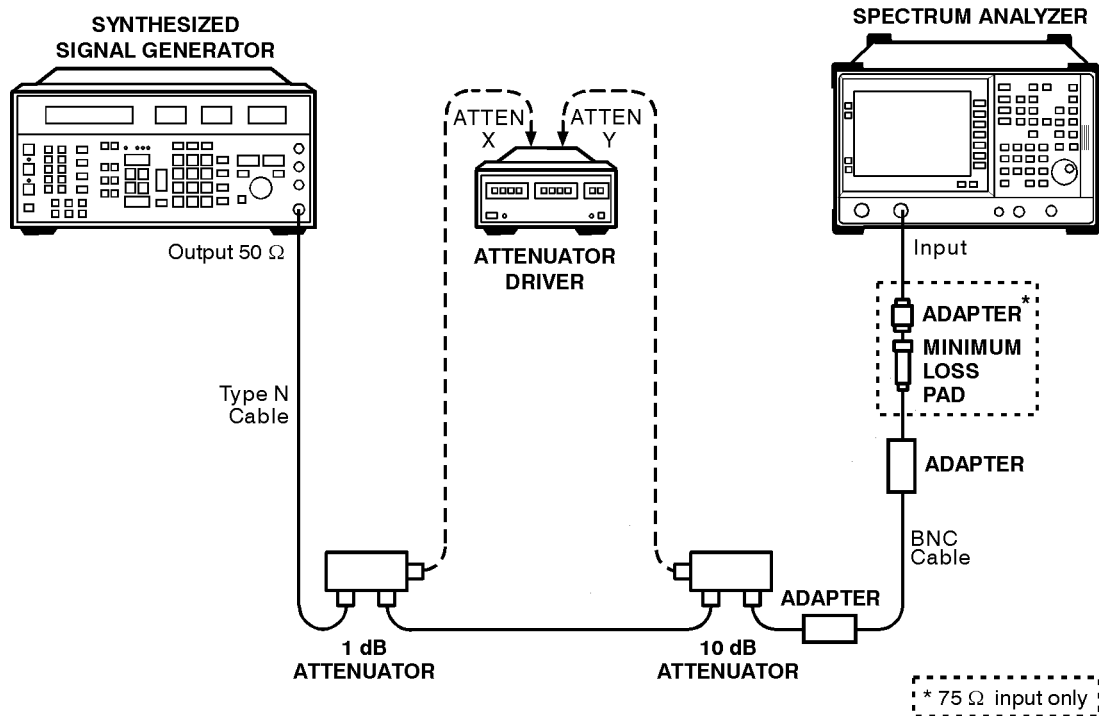
**AM OFF**

**FM OFF**

2. Connect the equipment as shown in [Figure 9-6](#). Set the 10 dB step attenuator to 30 dB attenuation and the 1 dB step attenuator to 10 dB attenuation.

*75 Ω Input only: Set the 1 dB step attenuator to 10 dB.*

**Figure 9-6 Reference Level Accuracy Test Setup**



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3. Press **Preset** on the analyzer, then wait for the preset routine to finish. Press **System, Alignments, Auto Align, Off**. Set the analyzer by pressing the following keys:

**Frequency, 50 MHz**

**Span, 10 MHz**

**Peak Search**

**Frequency, Signal Track On Off (On)**

**Span, 50 kHz**

**Amplitude, -30 dBm (50 Ω Input only)**

**Amplitude, +21.76 dBmV (75 Ω Input only)**

**Attenuation Auto Man, 5 dB**

**Scale/Div, 1 dB**

**BW/Avg, 3 kHz, Video BW Auto Man, 30 Hz**

4. Set the 1 dB step attenuator to place the signal peak 1 to 3 dB (one to three divisions) below the reference level. Refer to [Table 9-2](#) earlier in this chapter for information on manually controlling a programmable step attenuator with an HP 11713A attenuator/switch driver.

5. On the analyzer, press the following keys:

**Single Sweep**

**Peak Search**

**Marker, Marker  $\Delta$**

6. Set the 10 dB step attenuator and analyzer reference level according to [Table 9-7](#). At each setting, do the following:

- a. Press **Single Sweep** on the analyzer.
- b. Press **Peak Search**
- c. Record the marker delta amplitude reading in column 5 of [Table 9-7](#).
- d. Add the actual attenuation error to the analyzer marker  $\Delta$  amplitude and enter the result in the performance test record.

Example: for  $-40$  dBm reference level:

Analyzer marker  $\Delta$  amplitude =  $+0.17$  dB

Attenuation Error (50 dB) =  $-0.07$  dB

TR Entry 4 =  $0.17$  dB  $-0.07$  dB =  $0.10$  dB

---

NOTE

When entering reference levels on analyzers with  $75 \Omega$  inputs, enter the values in dBmV with 0.01 dB precision. That is,  $-8.24$  dBmV not  $-8.2$  dBmV. The reference level annotation rounds to the nearest 0.1 dB, but internal values are to the nearest 0.01 dB.

---



**Table 9-7 Reference Level Accuracy, Log Mode**

10 dB Attenuator Nominal Attenuation dB	10 dB Attenuator Actual Attenuation dB	Attenuation Error dB	Analyzer Reference Level <sup>a</sup>		Analyzer Marker $\Delta$ Amplitude dB	TR Entry
			dBm	dBmV		
30		0 (Ref)	-30	+21.76		0 (Ref)
20			-20	+31.76		1
10			-10	+41.76		2
40			-40	+11.76		3
50			-50	+1.76		4
60			-60	-8.24		5
70			-70	-18.24		6
80			-80	-28.24		7
90			-90	-38.24		8

a. Use the dBm column values for analyzers with a 50  $\Omega$  input and the dBmV column for analyzers with a 75  $\Omega$  input.

## Linear Scale

7. Set the 10 dB step attenuator to 30 dB attenuation.
8. Set the 1 dB step attenuator to 10 dB attenuation.  
*75  $\Omega$  Input only: Set the 1 dB step attenuator to 0 dB.*
9. Set the analyzer controls as follows:
  - Amplitude, -30 dBm (50  $\Omega$  Input)
  - Amplitude, +21.76 dBmV (75  $\Omega$  Input)
  - Scale Type Log Lin (Lin)
  - Amplitude, Amptd Units, dBm (50  $\Omega$  Input)
  - Amplitude, Amptd Units, dBmV (75  $\Omega$  Input)
  - Sweep, Sweep Cont Single (Cont)
  - Marker, Marker All Off
10. Set the 1 dB step attenuator to place the signal peak one to three divisions below the reference level.
11. On the analyzer, press the following keys:
  - Single Sweep

**Peak Search**

**Marker, Marker  $\Delta$**

12. Set the 10 dB step attenuator and analyzer reference level according to [Table 9-8](#). At each setting, do the following:
  - a. Press **Single Sweep** on the analyzer.
  - b. Press **Peak Search**
  - c. Record the marker delta amplitude reading in column 5 of [Table 9-8](#).
  - d. Add the actual attenuation error to the analyzer marker  $\Delta$  amplitude and enter the result in the performance test record.

---

**NOTE** When entering reference levels on analyzers with 75  $\Omega$  inputs, enter the values in dBmV with 0.01 dB precision. That is,  $-8.24$  dBmV not  $-8.2$  dBmV. The reference level annotation rounds to the nearest 0.1 dB, but internal values are to the nearest 0.01 dB.

---

**Table 9-8 Reference Level Accuracy, Linear Mode**

10 dB Attenuator Nominal Attenuation dB	10 dB Attenuator Actual Attenuation dB	Attenuation Error dB	Analyzer Reference Level <sup>a</sup>		Analyzer Marker $\Delta$ Amplitude dB	TR Entry
			dBm	dBmV		
30		0 (Ref)	-30	+21.76		0 (Ref)
20			-20	+31.76		9
10			-10	+41.76		10
40			-40	+11.76		11
50			-50	+1.76		12
60			-60	-8.24		13
70			-70	-18.24		14
80			-80	-28.24		15
90			-90	-38.24		16

- a. Use the dBm column values for analyzers with a 50  $\Omega$  input and the dBmV column for analyzers with a 75  $\Omega$  input.

13. Press **Preset, System, Alignments, Auto Align, All**.

---

## 8. Scale Fidelity

A 50 MHz CW signal is applied to the input of the analyzer through two calibrated step attenuators. The attenuators are the amplitude reference standard. The source is adjusted for a response at the reference level. The attenuators are then set to achieve a nominal amplitude below the reference level. The analyzer's amplitude marker is compared to the actual total attenuation to determine the scale fidelity error.

The test is performed in both log and linear amplitude scales.

### Equipment Required

Synthesized signal generator

1 dB step attenuator

10 dB step attenuator

Attenuator/ switch driver (if programmable step attenuators are used)

Cable, Type-N 152-cm (60-in)

Cable, BNC 122-cm (48-in) (*2 required*)

Attenuator interconnect kit

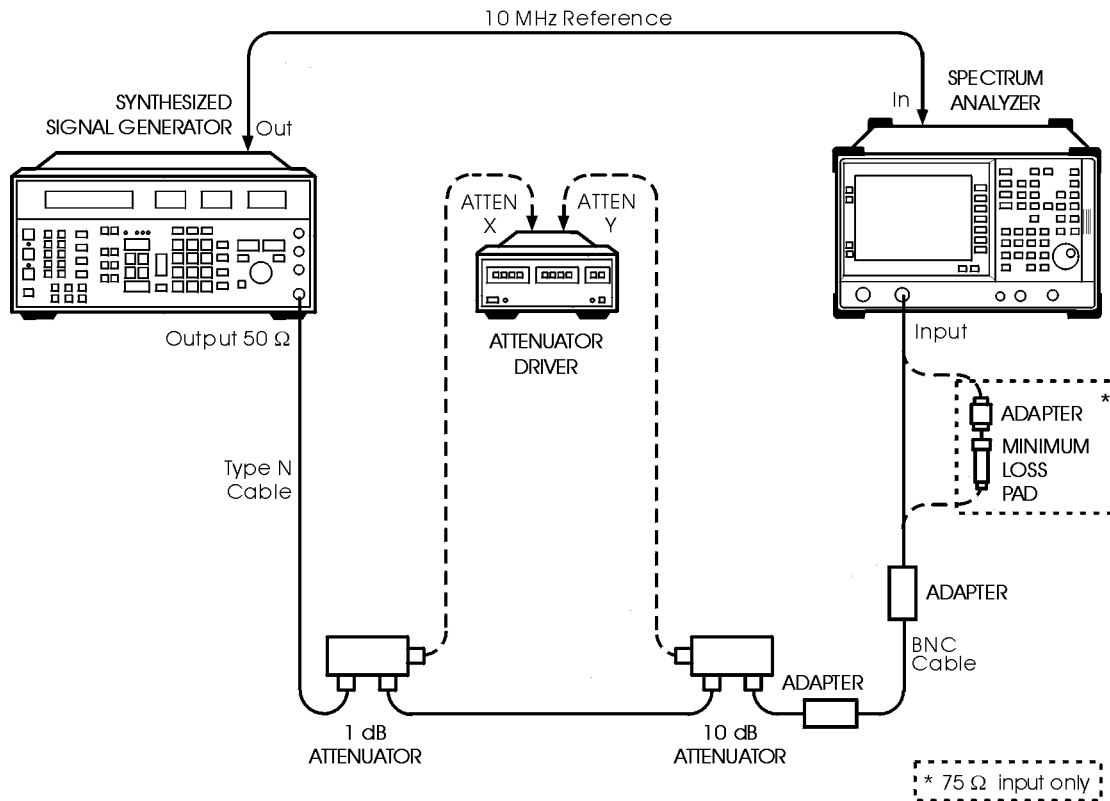
Adapter, Type-N (m) to BNC (f) (*2 required*)

### Additional Equipment for 75 $\Omega$ Input

Pad, minimum loss

Adapter, Type-N (f), to BNC (m), 75  $\Omega$

**Figure 9-7** Scale Fidelity Test Setup



n1769a2

**CAUTION** Use only 75 Ω cables, connectors, or adapters on instruments with 75 Ω connectors, or damage to the connectors will occur.

## Procedure

### Calculate Actual Attenuation Values

1. From the calibration data supplied with the 1 dB step attenuator, enter into column 3 of [Table 9-9](#) and [Table 9-10](#) the actual attenuation for the corresponding nominal attenuation settings. If the calibration data does not indicate an actual attenuation value for the 0 dB setting, enter 0 dB. If using a programmable attenuator, enter the data for the section three 4 dB step.
2. From the calibration data supplied with the 10 dB step attenuator, enter into column 5 of [Table 9-9](#) and [Table 9-10](#) the actual attenuation for the corresponding nominal attenuation settings. If

## 8. Scale Fidelity

the calibration data does not indicate an actual attenuation value for the 0 dB setting, enter 0 dB. If using a programmable attenuator, enter the data for the section three 40 dB step.

- For each dB from REF LVL (including 0 dB) setting indicated in [Table 9-9](#) and [Table 9-10](#), calculate the total actual attenuation from the actual attenuation columns for the 1 dB and the 10 dB step attenuators. For example, if the actual 1 dB step attenuator attenuation for the 6 dB setting is 5.998 dB and the actual 10 dB step attenuator attenuation for the 30 dB setting is 30.012 dB, the total actual attenuation for the -36 dB from REF LVL setting would be:

$$\text{Total Actual Attenuation} = 5.998 \text{ dB} + 30.012 \text{ dB} = 36.01 \text{ dB}$$

**Table 9-9 Cumulative and Incremental Log Fidelity**

dB from REF LVL	1 dB step atten. Nominal Attenuation	1 dB step atten. Actual Attenuation	10 dB step atten. Nominal Attenuation	10 dB step atten. Actual Attenuation	Total Actual Attenuation	Mkr $\Delta$ Reading	TR Entry Cumulative Log Fidelity Error	TR Entry Incremental Log Fidelity Error
(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)
0 (Ref)	0		0			0 (Ref)	0 (Ref)	0 (Ref)
-4	4		0				1	22
-8	8		0				2	23
-12	2		10				3	24
-16	6		10				4	25
-20	0		20				5	26
-24	4		20				6	27
-28	8		20				7	28
-32	2		30				8	29
-36	6		30				9	30
-40	0		40				10	31
-44	4		40				11	32
-48	8		40				12	33
-52	2		50				13	34
-56	6		50				14	35

<b>dB from REF LVL</b>	<b>1 dB step atten. Nominal Attenuation</b>	<b>1 dB step atten. Actual Attenuation</b>	<b>10 dB step atten. Nominal Attenuation</b>	<b>10 dB step atten. Actual Attenuation</b>	<b>Total Actual Attenuation</b>	<b>Mkr <math>\Delta</math> Reading</b>	<b>TR Entry Cumulative Log Fidelity Error</b>	<b>TR Entry Incremental Log Fidelity Error</b>
<b>(dB)</b>	<b>(dB)</b>	<b>(dB)</b>	<b>(dB)</b>	<b>(dB)</b>	<b>(dB)</b>	<b>(dB)</b>	<b>(dB)</b>	<b>(dB)</b>
-60	0		60				15	36
-64	4		60				16	37
-68	8		60				17	38
-72	2		70				18	N/A
-76	6		70				19	N/A
-80	0		80				20	N/A
-84	4		80				21	N/A

## Log Scale

### Setup for Log Scale Measurement

1. Connect the equipment as indicated in [Figure 9-7](#). The synthesized signal generator provides the frequency reference for the analyzer.
2. Press **Preset** on the analyzer. Press **System, Alignments, Auto Align, Off**. Set the controls as follows:

**Frequency, 50 MHz**

**Span, 45 kHz**

**Amplitude, Attenuation Auto Man, 10 dB**

**BW/Avg, Resolution BW Auto Man, 3 kHz**

**Video BW, 1 kHz**

3. Preset the synthesized signal generator and set the controls as follows:

**FREQUENCY, 50 MHz**

**AMPLITUDE, -3 dBm (50  $\Omega$  Input only)**

**AMPLITUDE, +4 dBm (75  $\Omega$  Input only)**

**AM OFF**

**FM OFF**

## 8. Scale Fidelity

4. Set the step attenuators to 0 dB attenuation. Refer to [Table 9-2](#) earlier in this chapter for information on manually controlling a programmable step attenuator with an HP 11713A attenuator / switch driver.
5. Press **Peak Search** on the analyzer.
6. Adjust the synthesized signal generator's amplitude until the analyzer's marker amplitude reads  $0 \text{ dBm} \pm 0.1 \text{ dB}$ .

*75  $\Omega$  Input only: Adjust the synthesized signal generator's amplitude until the analyzer's marker reads  $48.8 \text{ dBmV} \pm 0.1 \text{ dB}$ .*

7. On the analyzer, press **Marker**, **Marker  $\Delta$** .
8. Do not adjust the synthesized signal generator's amplitude after the reference is established.

### Measure Cumulative Log Fidelity

1. Set the 1 dB and 10 dB step attenuators as indicated in [Table 9-9](#) for the  $-4 \text{ dB}$  from REF LVL setting.
2. Press **Peak Search** on the analyzer and record the Mkr  $\Delta$  reading in column 7 of [Table 9-9](#).
3. Calculate the Cumulative Log Fidelity Error (CLFE) as follows and record the result in the performance verification test record as indicated in column 8 of [Table 9-9](#):

$$\text{CLFE} = \text{Total Actual Atten}(-4 \text{ dB from RL})$$

$$+ \text{Delta MKR Reading} - \text{Total Actual Atten} (0 \text{ dB from RL})$$

4. Repeat [step 1](#) through [step 3](#) for the remaining "dB from REF LVL" settings indicated in [Table 9-9](#). For each setting of  $-64 \text{ dB}$  and lower, press the following analyzer keys after [step 1](#):

**BW/Avg, Video Average On Off (On)**

**5, Enter**

### Calculate Incremental Log Fidelity

1. Calculate the Incremental Log Fidelity Error (ILFE) for "dB from REF LVL" settings of  $-4 \text{ dB}$  to  $-68 \text{ dB}$  using the current and previous Cumulative Log Fidelity Errors (CLFEs):

$$\text{ILFE} = \text{CLFE (current)} - \text{CLFE (previous)}$$

For example, if the CLFE for the  $-16 \text{ dB}$  from REF LVL setting is  $-0.07 \text{ dB}$  and the CLFE for the  $-20 \text{ dB}$  from REF LVL setting is  $+0.02 \text{ dB}$ , the ILFE for the  $-20 \text{ dB}$  from REF LVL settings is:

$$\text{ILFE}(-20 \text{ dB}) = 0.02 \text{ dB} - (-0.07 \text{ dB}) = 0.09 \text{ dB}$$

Record the result in the performance verification test record as indicated in column 9 of [Table 9-9](#).

## Linear Scale

### Setup for Linear Scale Measurement

1. Press **Preset** on the analyzer. Set the controls as follows:
  - Frequency, 50 MHz
  - Span, 10 kHz
  - BW/Avg, Resolution BW Auto Man, 3 kHz
  - Video BW, 100 Hz
  - Amplitude, Scale Type Log Lin (Lin)
  - More, Input Z Corr, 50
2. Preset the synthesized signal generator and set the controls as follows:
  - FREQUENCY, 50 MHz
  - AMPLITUDE,  $-3$  dBm (*50  $\Omega$  Input only*)
  - AMPLITUDE,  $+4$  dBm (*75  $\Omega$  Input only*)
  - AM OFF
  - FM OFF
3. Set the step attenuators to 0 dB attenuation. Refer to [Table 9-2](#) earlier in this chapter for information on manually controlling a programmable step attenuator with an HP 11713A Attenuator / Switch Driver.
4. Press **Peak Search** on the analyzer.
5. Adjust the synthesized signal generator's amplitude until the analyzer's marker amplitude read  $223.6$  mV  $\pm$  4 mV.
6. Do not adjust the synthesized signal generator's amplitude after the 223.6 mV reference is established



**Table 9-10 Linear Fidelity**

<b>dB from Ref Level</b>	<b>1 dB step atten Nominal Attenuation</b>	<b>1 dB step atten Actual Attenuation</b>	<b>10 dB step atten. Nominal Attenuation</b>	<b>10 dB step atten. Actual Attenuation</b>	<b>Total Actual Attenuation</b>	<b>Ideal Mkr Reading</b>	<b>Actual Mkr Reading</b>	<b>TR Entry Linear Fidelity Error</b>
<b>dB</b>	<b>dB</b>	<b>dB</b>	<b>dB</b>	<b>dB</b>	<b>dB</b>	<b>mV</b>	<b>mV</b>	<b>% of RL</b>
<b>0 (Ref)</b>	<b>0</b>		<b>0</b>			<b>0 (Ref)</b>	<b>0 (Ref)</b>	<b>0 (Ref)</b>
<b>-4</b>	<b>4</b>		<b>0</b>					39
<b>-8</b>	<b>8</b>		<b>0</b>					40
<b>-12</b>	<b>2</b>		<b>10</b>					41
<b>-16</b>	<b>6</b>		<b>10</b>					42
<b>-20</b>	<b>0</b>		<b>20</b>					43

### Calculate Ideal Marker Amplitude

Considering Total Actual Attenuation at the 0 dB from Ref Level setting to be  $AT_{ref}$ , and the Total Actual Attenuation at any other dB from Ref Level setting to be  $AT_{meas}$ , calculate the Ideal Mkr Reading, in millivolts, as follows and enter the result in column 7 of [Table 9-10](#):

$$\text{Ideal Mkr Reading (mv)} = 1000 \times \text{SQRT}[0.05 \times 10^{((-AT_{meas} + AT_{ref})/10)}]$$

For example, if  $AT_{ref} = 0.012$  dB and  $AT_{meas} = 7.982$ , the Ideal Mkr Reading for the -8 dB from Ref Level setting would be:

$$\begin{aligned} \text{Ideal Mkr Reading} &= 1000 \times \text{SQRT}[0.05 \times 10^{((-7.982 + 0.012)/10)}] \\ &= 1000 \times \text{SQRT}[0.05 \times 10^{(-7.97/10)}] \\ &= 1000 \times \text{SQRT}[0.05 \times 10^{(-0.797)}] \\ &= 1000 \times \text{SQRT}[0.05 \times 0.15959] \\ &= 1000 \times \text{SQRT}[0.007979] \\ &= 1000 \times 0.0893 \\ &= 89.3\text{mV} \end{aligned}$$

## Measure Linear Fidelity

1. Set the 1 dB and 10 dB step attenuators as indicated in [Table 9-10](#) for the -4 dB from REF LVL setting.
2. Press **Peak Search** on the analyzer and record the Mkr amplitude reading in column 8 of [Table 9-10](#).
3. Calculate the Linear Fidelity Error (LFE) as a percentage of reference level (RL), and record the result in the performance verification test record as indicated in column 9 of [Table 9-10](#).

$$\text{LFE}(\% \text{ of RL}) = 100 \times (\text{Actual Mkr Reading} - \text{Ideal Mkr Reading}) / 223.6 \text{ mV}$$

For example, if the Ideal Mkr Reading is 89.3 mV and the Actual Mkr Reading is 85 mV, the Linear Fidelity Error would be:

$$\begin{aligned} \text{LFE} &= 100 \times (85 - 89.3) / 223.6 \\ &= 100 \times (-4.3) / 223.6 \\ &= 100 \times 0.0192 \\ &= 1.92\% \text{ of RL} \end{aligned}$$

4. Repeat [step 1](#) through [step 3](#) above for the remaining dB from Ref Level settings indicated in [Table 9-10](#).
5. Press **Preset, System, Alignments, Auto Align, All** on the analyzer.
6. *75 Ω Input only:* Press **Amplitude, More, Input Z Corr 75**

## 9. Input Attenuation Switching Uncertainty

A 50 MHz CW signal is applied to the input of the analyzer through two calibrated step attenuators. The attenuators are the amplitude reference standard. The source is adjusted for a response at the reference level. The attenuators are then set to achieve a nominal amplitude below the reference level. The analyzer's amplitude marker is compared to the actual total attenuation to determine the scale fidelity error.

The spectrum analyzer marker functions are used to measure the amplitude differences. The step attenuator's actual attenuation values are used to correct the marker amplitude readings, yielding the input attenuation switching error.

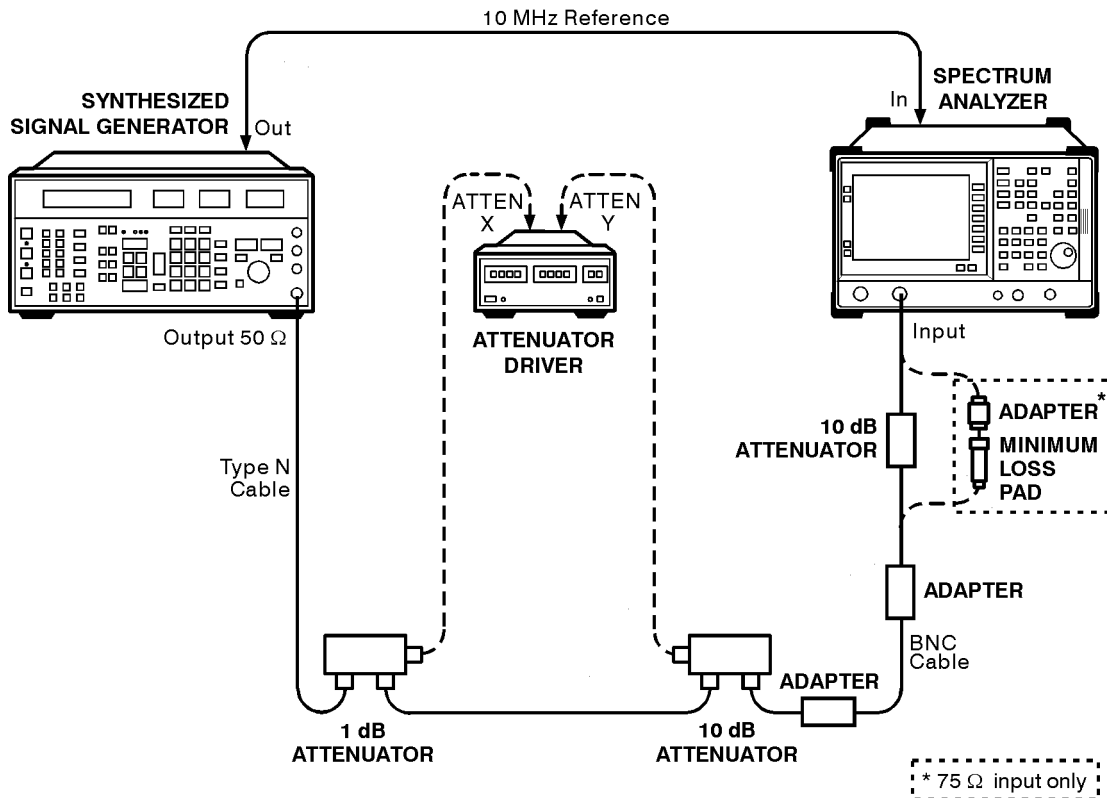
### Equipment Required

- Synthesized signal generator
- 1 dB step attenuator
- 10 dB step attenuator
- Attenuator/ switch driver (if programmable step attenuators are used)
- 10 dB fixed attenuator
- Cable, Type-N 152-cm (60-in)
- Cable, BNC 122-cm (48-in) (*2 required*)
- Attenuator interconnect kit
- Adapter, Type-N (m) to BNC (f) (*2 required*)

### Additional Equipment for 75 $\Omega$ Input

- Pad, minimum loss
- Adapter, Type-N (f), to BNC (m), 75  $\Omega$

**Figure 9-8** Input Attenuator Switching Uncertainty Test Setup



nl769a

**CAUTION** Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors, or damage to the connectors will occur.

## Procedure

### Calculate Actual Attenuation Values

1. From the calibration data supplied with the 1 dB step attenuator, enter into column 2 of [Table 9-11](#) the actual attenuation for the corresponding nominal attenuation settings. If the calibration data does not indicate an actual attenuation value for the 0 dB setting, enter 0 dB.
2. From the calibration data supplied with the 10 dB step attenuator, enter into column 4 of [Table 9-11](#) the actual attenuation for the corresponding nominal attenuation settings. If the calibration data does not indicate an actual attenuation value for the 0 dB setting, enter 0 dB.

## 9. Input Attenuation Switching Uncertainty

3. For each total nominal attenuation setting indicated in [Table 9-11](#), calculate the total actual attenuation from the actual attenuation columns for the 1 dB and the 10 dB step attenuators and enter the result in [Table 9-11](#). For example, if the actual 1 dB step attenuator attenuation for the 5 dB setting is 5.021 dB and the actual 10 dB step attenuator attenuation for the 30 dB setting is 29.981 dB, the total actual attenuation for the 35 dB total nominal attenuation settings would be:

$$\text{Total Actual Attenuation} = 5.021 \text{ dB} + 29.981 \text{ dB} = 35.002 \text{ dB}$$

4. Calculate the attenuation error by subtracting the difference between the actual and nominal attenuations for each total nominal attenuations from the difference between the actual and nominal attenuations for the 50 dB total nominal attenuation:

$$\text{AttenErr} = (\text{ActAtten}(50 \text{ dB}) - 50 \text{ dB}) - (\text{ActAtten}(\text{XdB}) - \text{NomAtten}(\text{XdB}))$$

Where:

AttenErr = Attenuator Error between the X dB and 50 dB settings

ActAtten(50 dB) = Actual Attenuation of the 50 dB setting

ActAtten(XdB) = Actual Attenuation of the X dB setting

NomAtten(XdB) = Nominal Attenuation of the X dB setting

**Example:**

$$\text{ActAtten}(50 \text{ dB}) = 50.15 \text{ dB}$$

$$\text{ActAtten}(35 \text{ dB}) = 35.002 \text{ dB}$$

$$\text{NomAtten}(35 \text{ dB}) = 35 \text{ dB}$$

$$\text{AttenErr} = (50.15 - 50) - (35.002 - 35)$$

$$= 0.15 - 0.002$$

$$= 0.148 \text{ dB}$$

Record the Attenuation Errors in [Table 9-12](#) for the appropriate Total Nominal Attenuation setting. Note that the Total Nominal Attenuations listed in [Table 9-12](#) are in a different order than those listed in [Table 9-11](#).

**Table 9-11 Actual Attenuation Worksheet**

<b>1 dB step Attenuator Nominal Attenuation</b>	<b>1 dB step Attenuator Actual Attenuation</b>	<b>10 dB step Attenuator Nominal Attenuation</b>	<b>10 dB step Attenuator Actual Attenuation</b>	<b>Total Nominal Attenuation</b>	<b>Total Actual Attenuation</b>
<b>(dB)</b>	<b>(dB)</b>	<b>(dB)</b>	<b>(dB)</b>	<b>(dB)</b>	<b>(dB)</b>
0		0		0	
5		0		5	
0		10		10	
5		10		15	
0		20		20	
5		20		25	
0		30		30	
5		30		35	
0		40		40	
5		40		45	
0		50		50	
5		50		55	
0		60		60	
5		60		65	

## Setup for Switching Uncertainty Measurement

1. Connect the equipment as indicated in [Figure 9-8](#). The synthesized signal generator provides the frequency reference for the analyzer. The 10 dB fixed attenuator (or minimum loss pad for 75  $\Omega$  input analyzers) should be connected directly to the analyzer's input connector.
2. Press **Preset** on the analyzer. Press **System, Alignments, Auto Align, Off**. Set the controls as follows:

**Frequency, 50 MHz**

**Span, 100 kHz**

**AMPLITUDE, -50 dBm (50  $\Omega$  Input only)**

**AMPLITUDE, -1.2 dBmV (75  $\Omega$  Input only)**

**Attenuation, 10 dB**

**Scale/Div, 2 dB/**

**BW/Avg, Resolution BW Auto Man, 30 kHz**

**Video BW, 100 Hz**

3. Preset the synthesized signal generator and set the controls as follows:

**FREQUENCY, 50 MHz**

**AMPLITUDE, +10 dBm (50  $\Omega$  Input only)**

**AMPLITUDE, +6 dBm (75  $\Omega$  Input only)**

**AM OFF**

**FM OFF**

4. Set the 1 dB step attenuator to 0 dB attenuation. Set the 10 dB step attenuator to 50 dB. Refer to [Table 9-2](#) earlier in this chapter for information on manually controlling a programmable step attenuator with an HP 11713A attenuator / switch driver.
5. Press **Peak Search** on the analyzer.
6. Adjust the synthesized signal generator's amplitude until the analyzer's marker amplitude reads  $-52 \text{ dBm} \pm 0.1 \text{ dB}$ .  
*75  $\Omega$  Input only: Adjust the synthesized signal generator's amplitude until the analyzer's marker reads  $-3.2 \text{ dBmV} \pm 0.1 \text{ dB}$ .*
7. On the analyzer, press **Peak Search, Marker, Marker  $\Delta$** .
8. Do not adjust the synthesized signal generator's amplitude after the reference is established.

**Table 9-12 Input Attenuation Switching Uncertainty Worksheet**

Spectrum Analyzer			Total Nominal Attenuation	Attenuation Error	Mkr $\Delta$ Reading	TR Entry (Switching Error)
Attenuation	Reference Level					
dB	dBm	dBmV	dB	dB	dB	dB
10	-50	-1.2	50	0	0	Ref
0	-60	-11.2	60			1
5	-55	-6.2	55			2
15	-45	+3.8	45			3
20	-40	+8.8	40			4
25	-35	+13.8	35			5
30	-30	+18.8	30			6
35	-25	+28.8	25			7
40	-20	+23.8	20			8
45	-15	+33.8	15			9
50	-10	+38.8	10			10
55	-5	+43.8	5			11
60	0	+48.8	0			12

### Measure Switching Uncertainty

1. Set the 1 dB and 10 dB step attenuators for the total nominal attenuation as indicated in [Table 9-12](#) for the 0 dB spectrum analyzer attenuation setting. [Table 9-11](#) may be used as a reference for setting the step attenuators to achieve the desired total nominal attenuation.
2. Set the spectrum analyzer reference level as indicated in [Table 9-12](#) for the 0 dB spectrum analyzer attenuation setting. For analyzers with 50  $\Omega$  inputs, use the column labeled “(dBm)”. For analyzers with 75  $\Omega$  inputs, use the column labeled “(dBmV)”.
3. Set the spectrum analyzer attenuation to 0 dB.
4. Press **Single Sweep** and wait for completion of a new sweep.
5. Press **Peak Search**. Record the marker amplitude in [Table 9-12](#) as the Mkr  $\Delta$  Reading.



**9. Input Attenuation Switching Uncertainty**

6. Repeat steps 1 through 5 above for the remaining spectrum analyzer attenuation settings listed in [Table 9-12](#).
7. Calculate the Switching Error by subtracting the Attenuation Error from the Mkr $\Delta$  Reading. Record the result in the performance verification test record as indicated in the TR Entry column of [Table 9-12](#).

$$\text{Switching Error} = \text{Mkr}\Delta \text{ Reading} - \text{Attenuation Error}$$

Example:

$$\text{Mkr}\Delta \text{ Reading} = -0.21 \text{ dB}$$

$$\text{Attenuation Error} = 0.148 \text{ dB}$$

$$\begin{aligned} \text{Switching Error} &= -0.21 \text{ dB} - 0.148 \text{ dB} \\ &= -0.358 \text{ dB} \end{aligned}$$

8. On the analyzer, press **System, Alignments, Auto Align, All**.

## 10. Resolution Bandwidth Accuracy

The output of a synthesized signal generator is connected to the input of the analyzer, characterized through a 1 dB step attenuator set to 3 dB.

The amplitude of the synthesized signal generator is set to a reference amplitude 5 dB below top of screen. A marker reference is set and the attenuator is set to 0 dB.

The analyzer's markers are then used to measure the 3 dB bandwidth. The first marker is set on the left filter skirt so that the marker delta amplitude is 0 dB plus the attenuator error for the 3 dB setting. The second marker is similarly set on the right filter skirt. The frequency difference between the two markers is the 3 dB bandwidth.

There are no related adjustments for this performance test.

### Equipment Required

Synthesized signal generator

Cable, BNC, 122-cm (48-in) (*2 required*)

Adapter, Type-N (m) to BNC (f) (*3 required*)

1 dB step attenuator

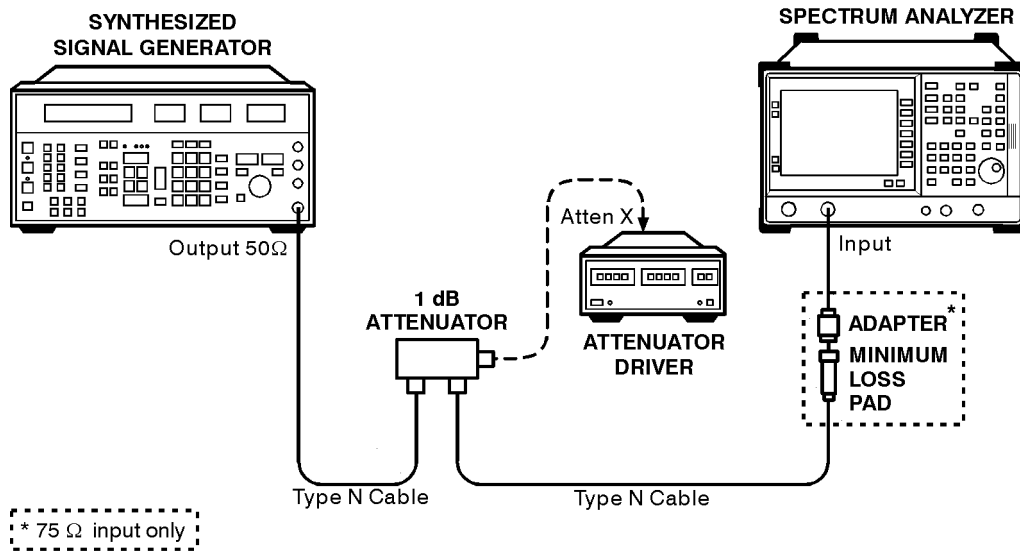
Attenuator/switch driver (if programmable step attenuators are used)

### Additional Equipment for 75 $\Omega$ Input

Pad, minimum loss

Adapter, Type-N (f), to BNC (m), 75  $\Omega$

**Figure 9-9 Resolution Bandwidth Accuracy Test Setup**



nl770a

**CAUTION**

Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors, or damage to the connectors will occur.

## Procedure

1. Connect the equipment as shown in [Figure 9-9](#).

## 3 dB Bandwidths

2. Set the synthesized signal generator controls as follows:

**AMPLITUDE, 0 dBm (50  $\Omega$  Input only)**

**AMPLITUDE, 6 dBm (75  $\Omega$  Input only)**

**FREQUENCY, 50 MHz**

3. Press **Preset** on the analyzer, then wait for the preset routine to finish. Press **System, Alignments, Auto Align, Off**. Set the analyzer by pressing the following keys:

**Frequency, 50 MHz**

**Span, 4.5 MHz**

**BW/Avg, 3 MHz**

**Video BW Auto Man, 30 Hz**

**Amplitude, Scale/Div 1 dB**

**Amptd Units, dBm, Done**

4. Set the step attenuator to 3 dB.
5. Press **Search, Max PK**→ **CF** on the analyzer.
6. Adjust the amplitude of the synthesized signal generator for a marker amplitude reading of  $-5 \text{ dBm} \pm 0.2 \text{ dB}$ .
7. Press **Peak Search, Marker, Marker**  $\Delta$  on the analyzer.
8. Set the attenuator to 0 dB. Note the attenuator error for the 3 dB setting.  
Attenuator Error (3 dB) \_\_\_\_\_ dB
9. On the analyzer, press **Marker**. Lower the marker frequency by adjusting the knob until the marker delta amplitude is 0 dB plus the attenuator error noted in [step 8](#)  $\pm 0.05 \text{ dB}$ .
10. Record the marker frequency readout in column 3 of [Table 9-13](#).
11. Using the analyzer knob, raise the marker frequency so that the marker delta amplitude is maximum. Continue increasing the marker frequency until the marker reads 0.0 dB plus the attenuator error noted in [step 8](#)  $\pm 0.05 \text{ dB}$ .
12. Record the marker frequency readout in column 4 of [Table 9-13](#).
13. Set the attenuator to 3 dB.
14. Press **Marker, Marker Normal** on the analyzer.
15. Repeat [step 5](#) through [step 14](#) for each of the Res BW and Span settings listed in [Table 9-13](#).
16. Subtract the lower marker frequency from the upper marker frequency. Record the difference as the 3 dB bandwidth, in the performance verification test record as indicated in [Table 9-13](#).  
 $3 \text{ dB Bandwidth} = \text{Upper Marker Frequency} - \text{Lower Marker Frequency}$
17. Press **Preset, System, Alignments, Auto Align, All**.

**Table 9-13                    3 dB Resolution Bandwidth Accuracy**

<b>Analyzer Span</b>	<b>Analyzer Res BW</b>	<b>Lower Marker Frequency</b>	<b>Upper Marker Frequency</b>	<b>TR Entry 3 dB Bandwidth</b>
4.5 MHz	3 MHz			1
1.5MHz	1 MHz			2
450 kHz	300 kHz			3
150 kHz	100 kHz			4
45 kHz	30 kHz			5
15 kHz	10 kHz			6
4.5 kHz	3 kHz			7
1.5 kHz	1 kHz			8

---

## 11. Frequency Readout and Marker Count Accuracy

The frequency readout accuracy of the analyzer is tested with an input signal of known frequency. By using the same frequency standard for the analyzer and the synthesized sweeper, the frequency reference error is eliminated.

There is no related adjustment for this performance test.

### Equipment Required

- Synthesized sweeper
- Adapter, Type-N (f) to APC 3.5 (f)
- Cable, Type-N, 152-cm (60-in)
- Cable, BNC, 122-cm (48-in)

### Additional Equipment for 75 $\Omega$ Input

- Pad, minimum loss
- Adapter, Type-N (f), to BNC (m), 75  $\Omega$

### Procedure

This performance test consists of two parts:

- [Part 1: Frequency Readout Accuracy](#)
- [Part 2: Marker Count Accuracy](#)

Perform Part 1 before Part 2.

### Part 1: Frequency Readout Accuracy

1. Connect the equipment as shown in [Figure 9-10](#). Remember to connect the 10 MHz REF OUT of the synthesized sweeper to the 10 MHz REF IN of the analyzer.
2. Perform the following steps to set up the equipment:
  - Press **INSTRUMENT PRESET** on the synthesized sweeper, then set the controls as follows:
    - CW, 1.490 GHz**
    - POWER LEVEL, -10 dBm**
  - Press **Preset** on the analyzer, then wait for the preset routine to finish. Set the analyzer by pressing the following keys:

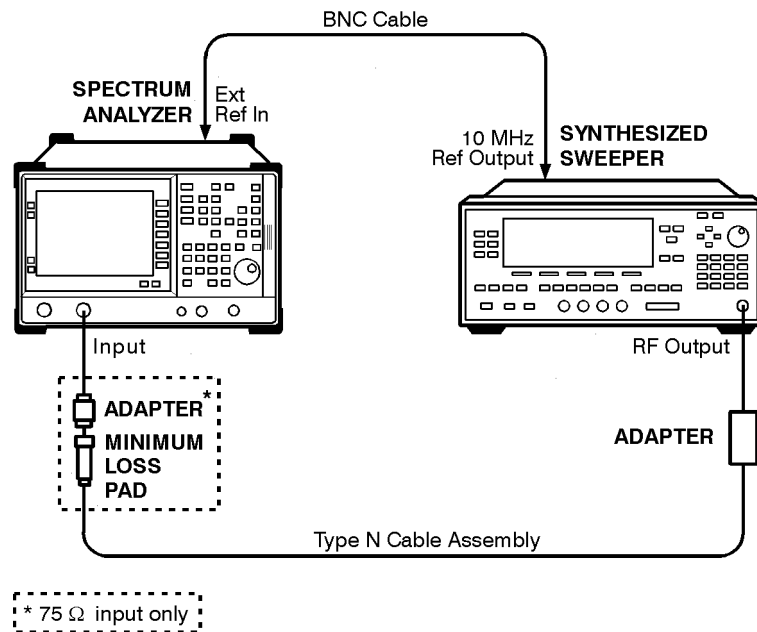
## 11. Frequency Readout and Marker Count Accuracy

Frequency, 1.490 GHz

Span, 10 MHz

BW/Avg, Resolution BW Auto Man, 100 kHz

Video BW Auto Man, 30 kHz

**Figure 9-10** Frequency Readout Accuracy Test Setup

nl771a

**CAUTION**

Use only 75 Ω cables, connectors, or adapters on instruments with 75 Ω connectors, or damage to the connectors will occur.

3. Press **Peak Search** on the analyzer to measure the frequency readout accuracy.
4. Record the marker frequency reading in the performance verification test record.
5. Change to the next analyzer span setting listed in [Table 9-14](#).
6. Repeat [step 3](#) through [step 5](#) for each analyzer span setting listed in [Table 9-14](#).

“[Part 1: Frequency Readout Accuracy](#)” is now complete. Continue with “[Part 2: Marker Count Accuracy](#).”

**Table 9-14**      **Frequency Readout Accuracy**

Spectrum Analyzer			TR Entry (Actual)
Res BW	VBW	Span	
100 kHz	30 kHz	10 MHz	1
1 kHz	1 kHz	100 kHz	2

**Part 2: Marker Count Accuracy**

Perform “[Part 1: Frequency Readout Accuracy](#)” before performing this procedure.

1. Press **Preset** on the analyzer, then wait for the preset routine to finish. Set the analyzer to measure the marker count accuracy by pressing the following keys:

**Frequency, 1.490 GHz**

**Span, 10 MHz**

**BW/Avg, Resolution BW Auto Man, 100 kHz**

**Marker Count, Marker Count On Off (On)**

**Resolution Auto Man, 1 Hz**

2. Press **Peak Search**, then wait for a count be taken (it may take several seconds).
3. Record the center frequency reading as TR Entry 3 of the performance verification test record.



## 12. Absolute Amplitude Accuracy

### Absolute Amplitude Accuracy

The level of a 50 MHz signal is measured with a power meter. A complete auto alignment is performed. The 50 MHz signal is then measured with the spectrum analyzer. The difference between the power meter and spectrum analyzer readings is calculated.

For analyzers with 75  $\Omega$  inputs, the minimum adapter's insertion loss is characterized using two power sensors and a power splitter. The measured insertion loss is then used to correct the difference between the power meter and spectrum analyzer readings.

### Equipment Required

- Synthesized signal generator
- Measuring receiver
- Power sensor, low power
- Cable, Type-N, 152-cm (60-in)
- Adapter, Type-N (f) to Type-N (f)

### Additional Equipment for 75 $\Omega$ Input

- Power sensor, 100 kHz to 1500 MHz, 75  $\Omega$
- Adapter, mechanical, Type-N (f), 75  $\Omega$  to Type-N (m) 50  $\Omega$
- Pad, minimum loss
- Adapter, Type-N (f), to BNC (m), 75  $\Omega$

### Procedure: Absolute Amplitude Accuracy Measurement

1. On the synthesized signal generator set the controls as follows:

- CW, 50 MHz**
- AMPLITUDE, -27 dBm (50  $\Omega$  Input only)**
- AMPLITUDE, -18 dBm (75  $\Omega$  Input only)**
- RF ON**
- AM OFF**
- FM OFF**

2. Calibrate the measuring receiver and low-power power sensor.

*75  $\Omega$  Input: Calibrate the measuring receiver and 75  $\Omega$  power sensor.*

3. Connect the signal generator output to the low-power power sensor through the Type-N cable, using an adapter.

*75  $\Omega$  Input: Connect the signal generator output to the 75  $\Omega$  power sensor through the Type-N cable using minimum loss pad and other adapters as necessary.*

4. Adjust the signal generator's power level for a power meter reading of  $-27$  dBm.

*75  $\Omega$  Input: Adjust the signal generator's power level for a power meter reading of  $-24$  dBm. Allow the power sensor adequate time to settle; the 75  $\Omega$  power sensor is being used on its lowest range.*

Record the power meter reading here.

Power Meter Reading \_\_\_\_\_ dBm

5. Press the following analyzer keys:

**Preset, System, Alignments, Align Now, All** (wait for alignment to finish), **Done, Auto Align, Off.**

**Frequency, 50 MHz**

**Span, 2 kHz**

**BW/Avg, Resolution BW Auto Man, 3 kHz**

**Video BW Auto Man 10 kHz**

6. Press **Amplitude  $-25$  dBm, Atten Auto Man 10 dB, Scale Type Log Lin (Lin).**

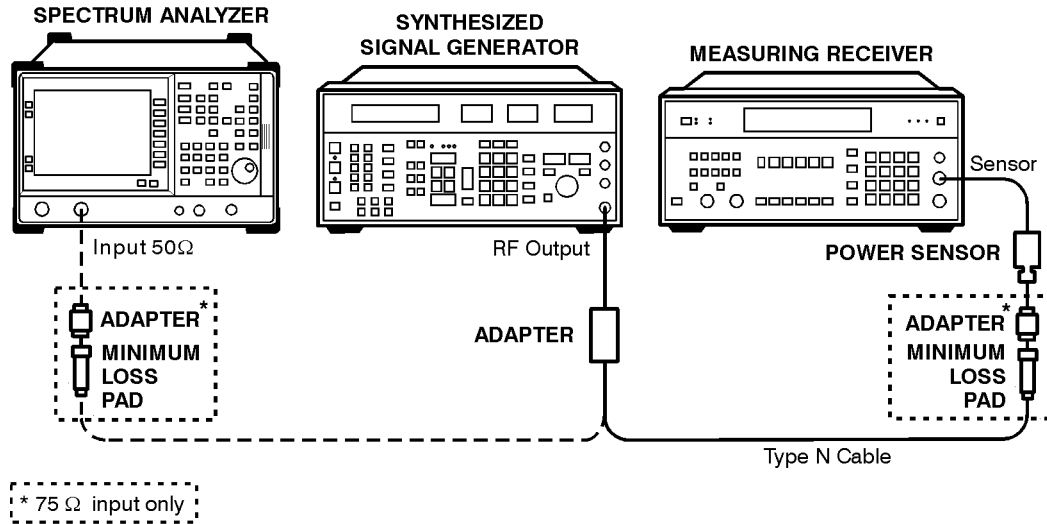
*75  $\Omega$  Input: Set the reference level to  $+26.76$  dBmV.*

7. Press **Det/Demod, Detector, Sample, Done.**

8. Disconnect the power sensor from the Type-N cable. Connect the Type-N cable to the analyzer 50  $\Omega$  input.

*75  $\Omega$  Input: Connect the Type-N cable to the analyzer 75  $\Omega$  input using a minimum loss adapter.*

**Figure 9-11 Absolute Amplitude Accuracy Test Setup**



nl772a

9. Press **Peak Search**.

10. Convert the marker amplitude reading from volts to dBm using the following equation:

$$50\Omega \text{ Input} \quad 10\log(\text{Mkr}(V^2/0.05))$$

$$75\Omega \text{ Input} \quad 10\log(\text{Mkr}(V^2/0.075))$$

$$\text{Mkr(dBm)} \quad \underline{\hspace{2cm}} \quad \text{dBm}$$

11. Subtract the power meter reading noted in [step 4](#) from the Mkr amplitude reading in dBm. Record the difference in the performance test record.

$$\text{TR entry} = \text{Mkr (dBm)} - \text{power meter reading.}$$

12. Press **Preset, System, Alignments, Auto Align, All**.

---

## 13. Frequency Response

The output of the synthesized signal generator is fed through a power splitter to a power sensor and the spectrum analyzer. The synthesized signal generator's power level is adjusted at 50 MHz to place the displayed signal at the spectrum analyzer center horizontal graticule line. The measuring receiver, used as a power meter, is placed in RATIO mode. At each new synthesized signal generator frequency and spectrum analyzer center frequency setting, the synthesized signal generator's power level is adjusted to place the signal at the center horizontal graticule line. The measuring receiver displays the inverse of the frequency response relative to 50 MHz.

For frequencies below 100 kHz, a synthesizer/function generator is used in place of the synthesized signal generator. A DVM and 50  $\Omega$  load are used in place of the power sensor and measuring receiver.

The related adjustments for this performance test are "Corrected Flatness" and "Uncorrected Flatness."

Analyzers with 75  $\Omega$  inputs are tested only down to 1 MHz. Also, a system flatness characterization is performed.

### Equipment Required

- Synthesized signal generator
- Measuring receiver (*used as a power meter*)
- Synthesizer/function generator
- Power sensor, 100 kHz to 1800 MHz
- Power splitter
- Adapter, Type-N (f) to APC 3.5 (f)
- Adapter, Type-N (m) to Type-N (m)
- Adapter, Type-N (m) to BNC (f) (*2 required*)
- Dual banana plug to BNC (f)
- BNC tee (BNC f,m,f)
- Cable, BNC, 122-cm (48-in) (*2 required*)
- Cable, Type-N, 152-cm (60-in)
- 50  $\Omega$  termination BNC (m)
- DVM HP3458, or HP34401A only

## Additional Equipment for 75 $\Omega$ Input

Power meter

Power sensor, 75  $\Omega$ , 1 MHz to 1500 MHz

Adapter, mechanical, Type-N (f) 75  $\Omega$  to Type-N (m) 50  $\Omega$

Adapter, Type-N (m), to BNC (m), 75  $\Omega$

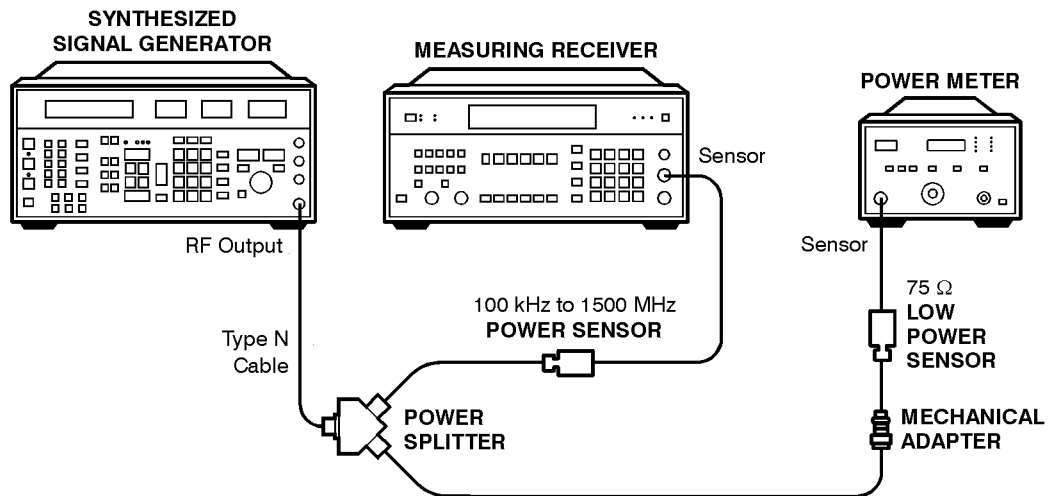
---

**CAUTION**


---

Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors, or damage to the connectors will occur.

**Figure 9-12 System Characterization Test Setup for 75  $\Omega$  Input.**



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## Procedure, Part 1, System Characterization for 75 $\Omega$ Input

---

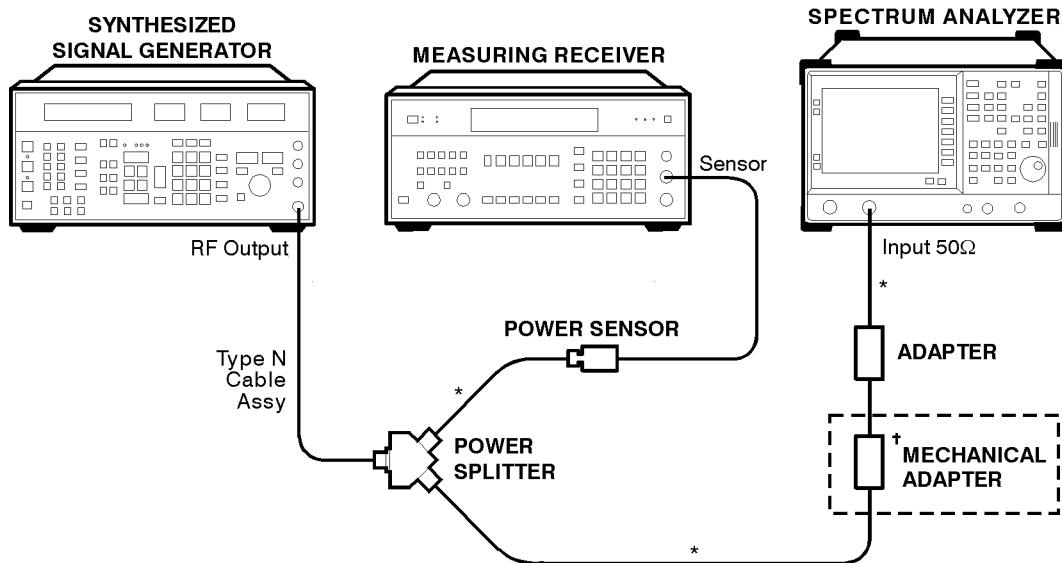
**NOTE**


---

The following procedure is only for spectrum analyzers equipped with 75  $\Omega$  input. If your spectrum analyzer is not equipped with 75  $\Omega$  input proceed with step 1 of "Frequency Response  $\geq 100$  kHz".

1. Zero and calibrate the measuring receiver and 100 kHz to 1500 MHz power sensor as described in the measuring receiver operation manual.
2. Zero and calibrate the power meter and 75  $\Omega$  power sensor as described in the power meter operation manual.

**Figure 9-13 Frequency Response Test Setup,  $\geq 100$  kHz**



Note: \* Indicates direct connection. Do not use a cable.  
† 75  $\Omega$  input only.

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**CAUTION**

Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors, or damage to the connectors will occur.

3. Connect the equipment as shown in [Figure 9-12](#). Be sure to use a mechanical adapter on analyzers with 75  $\Omega$  inputs.
4. Press **Blue Key, Special 00** on the synthesized signal generator. Set the synthesized signal generator controls as follows:
  - FREQUENCY, 1 MHz**
  - INCREMENT SET, 50 MHz**
  - AMPLITUDE, 5 dBm**
5. Adjust the synthesized signal generator amplitude for 0 dBm reading on the measuring receiver.
6. Record the power meter reading in column 4 of [Table 9-15](#), taking into account the calibration factors of both the 100 kHz to 1500 MHz power sensor and the 75  $\Omega$  power sensor.
7. On the synthesized signal generator, press **FREQUENCY, 50 MHz**.
8. Repeat [step 5](#) and [step 6](#), entering each power sensor's calibration factor into the respective power meter.
9. On the synthesized signal generator, press **FREQUENCY**, and  $\uparrow$  (up-arrow key), to step through the remaining frequencies listed in [Table 9-15](#). (No measurement is made at 100 kHz).

## 13. Frequency Response

At each new frequency repeat [step 5](#) and [step 6](#), entering each power sensor's calibration factor into the respective power meter.

System characterization is now complete for spectrum analyzers equipped with 75  $\Omega$  Input. Continue with "[Procedure, Part 2, Frequency Response, 100 kHz](#)" below.

### Procedure, Part 2, Frequency Response, $\geq 100$ kHz

---

**NOTE**


---

If your analyzer is equipped with a 75  $\Omega$  input, perform "Procedure for system characterization for 75  $\Omega$  input" before proceeding with this procedure.

1. Zero and calibrate the measuring receiver and 100 kHz to 1500 MHz power sensor in log mode as described in the measuring receiver operation manual.
2. Connect the equipment as shown in [Figure 9-12](#). Be sure to use a mechanical adapter on analyzers with 75  $\Omega$  inputs.
3. Press **Blue Key, Special 00** on the synthesized signal generator. Set the synthesized signal generator controls as follows:

**FREQUENCY, 50 MHz**

**INCREMENT SET, 50 MHz**

**AMPLITUDE, -8 dBm**

4. On the analyzer, press **Preset** and wait for the preset routine to finish. Set the analyzer by pressing the following keys:

**Frequency, 50 MHz**

**CF Step Auto Man, 50 MHz**

**Span, 20 kHz**

**Amplitude, Amptd Units, dBm, Done**

**Amplitude, -10 dBm, Attenuation Auto Man 10 dB**

**Scale/Div, 1 dB**

**BW/Avg, 10 kHz**

**Video BW Auto Man, 3 kHz**

**Peak Search**

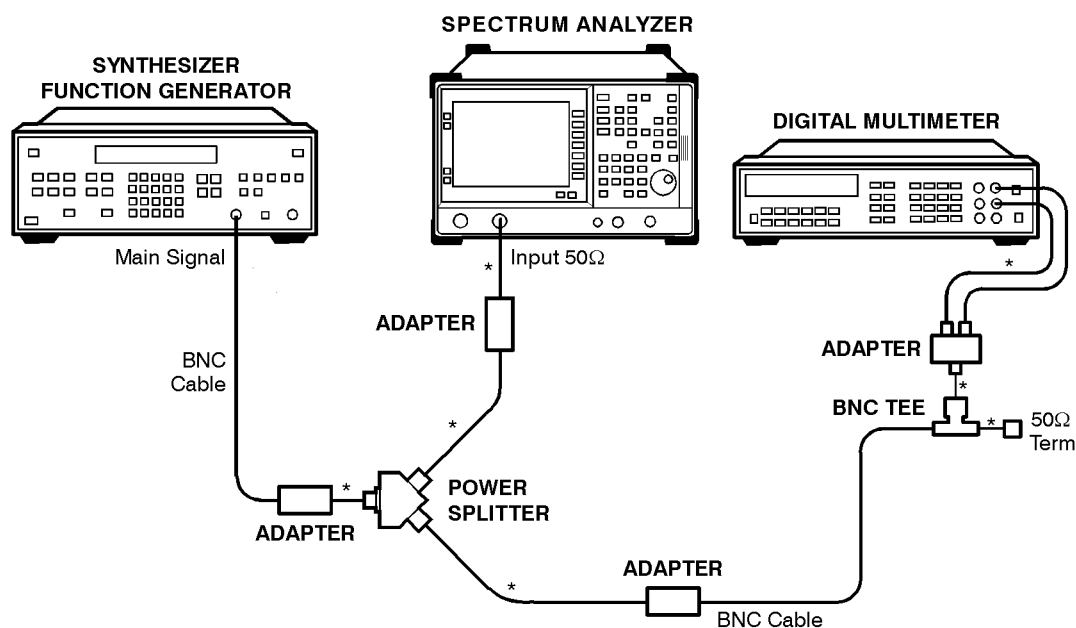
**Frequency, Signal Track On Off (On)**

5. Adjust the synthesized signal generator amplitude for a marker amplitude reading of  $-14$  dBm  $\pm 0.10$  dB.
6. Set the sensor Cal Factor on the measuring receiver, then press **RATIO**.

7. Set the synthesized signal generator frequency to 100 kHz.  
*75  $\Omega$  Input: Set frequency to 1 MHz.*
8. Adjust the synthesized sweeper power level for a spectrum analyzer marker amplitude reading of  $-14 \text{ dBm} \pm 0.10 \text{ dB}$ .
9. Press **Frequency**, **100 kHz** on the spectrum analyzer.  
*75  $\Omega$  Input: Press, **Frequency**, **1 MHz***
10. Set the sensor Cal Factor on the measuring receiver, then record the negative of the power ratio displayed on the measuring receiver in column 2 of [Table 9-15](#) as the Error Relative to 50 MHz at 100 kHz.  
*75  $\Omega$  Input: Error relative to 50 MHz at 1 MHz.*
11. Set the synthesized signal generator CW to 100 MHz.
12. Press **FREQUENCY**, **100 MHz** on the spectrum analyzer.
13. Adjust the synthesized sweeper power level for a spectrum analyzer marker amplitude reading of  $-14 \text{ dBm} \pm 0.05 \text{ dB}$ .
14. Set the sensor Cal Factor on the measuring receiver, then record the negative of the power ratio displayed on the measuring receiver in column 2 of [Table 9-15](#) as the Error Relative to 50 MHz at 100 MHz.
15. On the synthesized signal generator, press **FREQUENCY**, and  $\uparrow$  (step-up key), then on the spectrum analyzer, press **Frequency**, and  $\uparrow$  (step-up key).
16. Repeat [step 13](#) and [step 14](#) for each new frequency, entering the power sensor Cal Factor into the measuring receiver for each frequency setting as indicated in [Table 9-15](#).
17. *This step applies only to analyzers with 75  $\Omega$  inputs.*  
In [Table 9-15](#), starting with the error at 1 MHz, subtract column 4 (System Error) from column 2 (Error Relative to 50 MHz), and record the result in column 5 as the Corrected Error.



**Figure 9-14** Frequency Response Test Setup, <100 kHz



Note: \* Indicates direct connection. Do not use a cable.

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## Frequency Response, < 100 kHz

**NOTE**

*If your analyzer is equipped with 75  $\Omega$  Input, skip this section and go to Test Results.*

18. Connect the equipment as shown in [Figure 9-14](#).

Set the frequency synthesizer controls as follows:

**FREQUENCY, 100 kHz**

**AMPLITUDE, -8 dBm**

**AMPTD INCR, 0.05 dB**

19. Set the DVM as follows:

Function                      Sync AC Volts

Math                              dBm

RES Register                  50  $\Omega$

Front/Rear Terminals      Front

Resolution                      7.5 digits

20. On the analyzer, press the following keys:

**Frequency, 100 kHz**

21. Adjust the frequency synthesizer amplitude until the spectrum analyzer marker reads  $-14$  dBm. This corresponds to the amplitude at 100 kHz recorded in [step 10](#). Record the DVM amplitude in column 2 of [Table 9-16](#) for DVM Amplitude at 100 kHz.
22. On the spectrum analyzer, press **Peak Search**, **Marker**, **Marker**  $\Delta$ .
23. Set the spectrum analyzer and the frequency synthesizer to the next frequency settings listed in [Table 9-16](#).
24. At each frequency, adjust the frequency synthesizer amplitude for a Sig- $\Delta$ -Trk amplitude reading of  $0.00 \pm 0.05$  dB.
25. Record the DVM amplitude setting in column 2 of [Table 9-16](#) as the DVM amplitude.
26. Repeat [step 23](#) through [step 25](#) for each frequency setting listed in [Table 9-16](#).
27. For each of the frequencies in [Table 9-16](#), subtract the DVM Amplitude (column 2) from the DVM Amplitude at 100 kHz recorded in [step 21](#). Record the result as the Response Relative to 100 kHz (column 3) of [Table 9-16](#).
28. Add the entry from [Table 9-15](#) column 2 (100 kHz Error Relative to 50 MHz) that was recorded in [step 10](#), to each of the entries in [Table 9-16](#) column 3 (Response Relative to 100 kHz). Record the results as the Response Relative to 50 MHz (column 4) in [Table 9-16](#).

## Test Results

Perform the following steps to verify the frequency response of the spectrum analyzer.

1. Enter the most positive number from [Table 9-16](#), column 4:  
\_\_\_\_\_ dB  
*If your analyzer is equipped with 75  $\Omega$  Input, no entry is necessary.*
2. Enter the most positive number from [Table 9-15](#), column 2:  
\_\_\_\_\_ dB *For 75  $\Omega$  Input use column 5.*
3. Record the more positive of numbers from [step 1](#) and [step 2](#) in TR Entry 1 of the performance verification test record.
4. Enter the most negative number from [Table 9-16](#), column 4:  
\_\_\_\_\_ dB  
*If your analyzer is equipped with 75  $\Omega$  Input, no entry is necessary.*
5. Enter the most negative number from [Table 9-15](#), column 2:  
\_\_\_\_\_ dB *For 75  $\Omega$  Input use column 5.*

## 13. Frequency Response

6. Record the more negative of numbers from [step 4](#) and [step 5](#) in TR Entry 2 of the performance verification test record.

**Table 9-15**      **Frequency Response Errors Worksheet**

<b>Column 1 Analyzer Frequency (MHz)</b>	<b>Column 2 Error Relative to 50 MHz (dB)</b>	<b>Column 3 CAL FACTOR Frequency (GHz)</b>	<b>Column 4 System Error (75 Ω Input Only) (dB)</b>	<b>Column 5 Corrected Error (75 Ω Input Only) (dB)</b>
100 kHz		0.0001		
1 MHz		0.001		
50 (Ref)		0.05 or Ref CF		
100		0.1		
150		0.1		
200		0.3		
250		0.3		
300		0.3		
350		0.3		
400		0.3		
450		0.3		
500		0.3		
550		1.0		
600		1.0		
650		1.0		
700		1.0		
750		1.0		
800		1.0		
850		1.0		
900		1.0		
950		1.0		
1000		1.0		
1050		1.0		
1100		1.0		
1150		1.0		

<b>Column 1 Analyzer Frequency (MHz)</b>	<b>Column 2 Error Relative to 50 MHz (dB)</b>	<b>Column 3 CAL FACTOR Frequency (GHz)</b>	<b>Column 4 System Error (75 Ω Input Only) (dB)</b>	<b>Column 5 Corrected Error (75 Ω Input Only) (dB)</b>
1200		1.0		
1250		1.0		
1300		1.0		
1350		1.0		
1400		1.0		
1450		1.0		
1500		1.0		

**Table 9-16** Frequency Response, ≤100 kHz Worksheet

<b>Column 1 Analyzer Frequency</b>	<b>Column 2 DVM Amplitude (dBm)</b>	<b>Column 3 Response Relative to 100 kHz</b>	<b>Column 4 Response Relative to 50 MHz</b>
100 kHz		0 (Ref)	
75 kHz			
50 kHz			
20 kHz			
9 kHz			

## 14. Spurious Responses

This test is performed in two parts. Part 1 measures second harmonic distortion; Part 2 measures third order intermodulation distortion.

To test second harmonic distortion, a 50 MHz low pass filter is used to filter the source output, ensuring that harmonics read by the spectrum analyzer are internally generated and not coming from the source. To measure the distortion products, the power at the mixer is set 25 dB higher than specified. New test limits have been developed based on this higher power.

With  $-40$  dBm at the input mixer and the distortion products suppressed by 75 dBc, the equivalent Second Harmonic Intercept (SHI) is  $+35$  dBm ( $-40$  dBm + 75 dBc). Therefore, with  $-20$  dBm at the mixer, and the distortion products suppressed by 55 dBc, the equivalent SHI is also  $+35$  dBm ( $-20$  dBm + 55 dBc).

For third order intermodulation distortion, two signals are combined in a directional bridge (for isolation) and are applied to the spectrum analyzer input. The power level of the two signals is several dB higher than specified, so the distortion products will be suppressed less than the amount specified. In this manner, the equivalent third order intercept (TOI) is measured.

With two  $-30$  dBm signals at the input mixer and the distortion products suppressed by 74 dBc, the equivalent TOI is  $+7$  dBm ( $-30$  dBm + 74 dBc/2). However, if two  $-22$  dBm signals are present at the input mixer and the distortion products are suppressed by 58 dBc, the equivalent TOI is also  $+7$  dBm ( $-22$  dBm + 58 dBc/2).

Performing the test with a higher power level maintains the measurement integrity while reducing both test time and the dependency upon the source's noise sidebands (phase noise) performance. This test therefore measures the equivalent TOI.

There are no related adjustment procedures for this performance test.

### Equipment Required

- Synthesized signal generator
- Synthesized sweeper
- Measuring receiver (*used as a power meter*)
- Power sensor, 100 kHz to 1500 MHz
- 50 MHz low pass filter
- 1 GHz low pass filter
- 6 GHz Directional bridge

Cable, SMA, 61-cm (24-in) (*2 required*)

Cable, BNC, 120-cm (48-in)

Adapter, Type-N (m) to SMA (f) (*4 required*)

Adapter, Type-N (m) to Type-N (m)

Adapter, Type-N (m) to BNC (f)

Adapter, SMA (m) to Type-N (m)

## **Additional Equipment for 75 $\Omega$ Input**

Power sensor, 75  $\Omega$

Adapter, mechanical, 75  $\Omega$  to 50  $\Omega$

Pad, minimum loss

Adapter, Type-N (m), to BNC (m), 75  $\Omega$

## **Procedure**

This performance test consists of two parts:

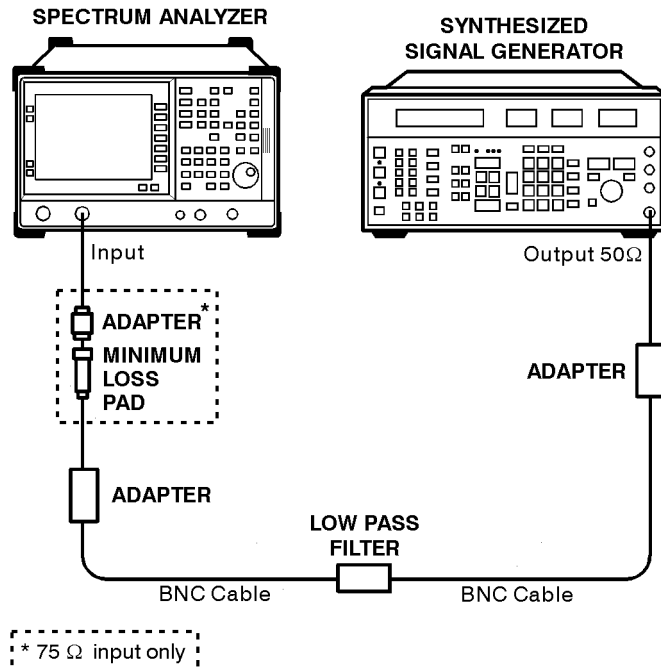
[Part 1: Second Harmonic Distortion, 40 MHz](#)

[Part 2: Third Order Intermodulation Distortion](#)

Perform Part 1 before Part 2.

## Part 1: Second Harmonic Distortion, 40 MHz

**Figure 9-15** Second Harmonic Distortion Test Setup, 40 MHz



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**CAUTION**

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Use only 75 Ω cables, connectors, or adapters on instruments with 75 Ω connectors, or damage to the connectors will occur.

1. Set the synthesized signal generator controls as follows:

**FREQUENCY, 40 MHz**

**AMPLITUDE, -10 dBm (50 Ω Input only)**

**AMPLITUDE, -4.3 dBm (75 Ω Input only)**

2. Connect the equipment as shown in [Figure 9-15](#).

*75 Ω Input only: Connect the minimum loss adapter between the LPF and Input 75 Ω.*

3. Press **Preset** on the spectrum analyzer, then wait for the preset routine to finish. Set the spectrum analyzer by pressing the following keys:

**Frequency, 40 MHz**

**Span, 1 MHz**

**Amplitude, -10 dBm (50 Ω Input only)**

**Amplitude, +44 dBmV (75  $\Omega$  Input only)**

**Attenuation Auto Man 10 dB**

**BW/Avg, 30 kHz**

4. Adjust the synthesized signal generator amplitude to place the peak of the signal at the reference level.

5. Set the spectrum analyzer control as follows:

**Span, 50 kHz**

**BW/Avg, 1 kHz**

**Video BW Auto Man, 100 Hz**

6. Wait for two sweeps to finish, then press the following spectrum analyzer keys:

**Search**

**More**

**Mkr  $\rightarrow$  CF Step**

**Marker, Marker  $\Delta$**

**Frequency.**

7. Press the  $\uparrow$  (step-up key) on the spectrum analyzer to step to the second harmonic (at 80 MHz). Press **Peak Search**. Record the marker delta amplitude reading in the performance verification test record as TR Entry 1.

## **Part 2: Third Order Intermodulation Distortion**

1. Zero and calibrate the measuring receiver and 100 kHz to 1500 MHz power sensor in log mode (power reads out in dBm), as described in the measuring receiver operation manual. Enter the power sensor's 50 MHz Cal Factor into the measuring receiver.

*75  $\Omega$  Input only: Use a 75  $\Omega$  power sensor.*

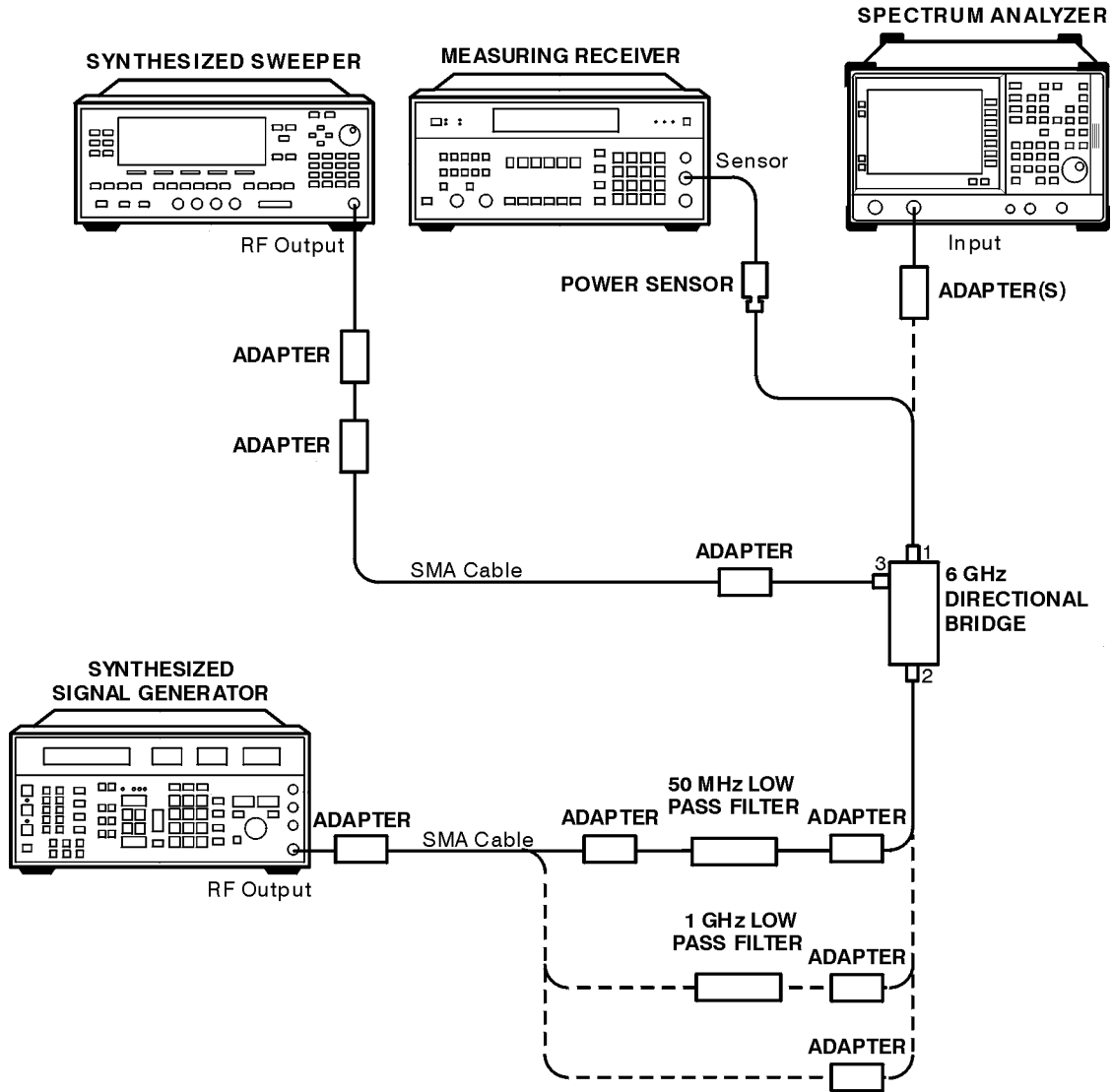
2. Connect the equipment as shown in [Figure 9-16](#) using the 50 MHz low pass filter and with the output of the directional bridge connected to the power sensor.

*75  $\Omega$  Input only: Use the power sensor with a 50  $\Omega$  to 75  $\Omega$  mechanical adapter in place of the 50  $\Omega$  adapter.*

*The power measured at the output of the 50  $\Omega$  directional bridge by the 75  $\Omega$  power sensor is the equivalent power "seen" by the 75  $\Omega$  analyzer.*



**Figure 9-16 Third Order Intermodulation Distortion Test Setup**



nl780a

**CAUTION**

Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors, or damage to the connectors will occur.

3. Proceed with steps 4 through 25 using the information and entries in [Table 9-17](#) for TOI Test 1. Then continue on with steps 26 through 30.
4. Set the synthesized signal generator's **FREQUENCY** to F1 as indicated in [Table 9-17](#). Set the **AMPLITUDE** to -10 dBm.

5. Press **PRESET** on the synthesized sweeper. Set the sweeper's **CW** frequency to F2 as indicated in [Table 9-17](#). Set the synthesized sweeper controls as follows:

**POWER LEVEL, +4 dBm**

**RF, Off**

6. On the spectrum analyzer, press **PRESET**, then wait until the preset routine is finished. Press **System, Alignments, Auto Align, Off**. Press **Frequency** and set the analyzer's **Center Freq** to F1 as indicated in [Table 9-17](#). Press the following keys on the spectrum analyzer:

**Frequency, CF Step Auto Man, 50 kHz**

**Span, 20 kHz**

**Amplitude, Amptd Units, dBm, Done**

**Ref Level, -15 dBm**

**Attenuation Auto Man 10 dB**

**BW/Avg, Video BW Auto Man, 300 Hz**

**Search, Peak Excursn, 3 dB**

7. On the synthesized signal generator, adjust the amplitude until the measuring receiver reads  $-12 \text{ dBm} \pm 0.1 \text{ dB}$ .
8. Disconnect the power sensor from the directional bridge. Connect the directional bridge directly to the spectrum analyzer RF Input using an adapter (do not use a cable).

*75  $\Omega$  Input only: Use a 50  $\Omega$  to 75  $\Omega$  mechanical adapter and a 75  $\Omega$  Type N (m) to BNC (m) adapter.*

---

**CAUTION**

---

Support the directional bridge and low pass filter to minimize stress on the spectrum analyzer's input connector.

9. In the following steps, the two input tones will be approximately 3 dB above the reference level and will appear "clipped". The marker readings are still accurate, however. On the spectrum analyzer, press the following keys:

**Peak Search**

**Search, Mkr  $\rightarrow$  CF**

**Marker, Marker $\Delta$**

**Frequency  $\uparrow$**

10. On the synthesized sweeper, set the **RF ON**.
11. Press **Peak Search** on the spectrum analyzer.

## 14. Spurious Responses

12. Adjust the power level until the Mkr $\Delta$  amplitude reads 0 dB  $\pm$ 0.05 dB.
13. On the spectrum analyzer, press **Frequency**,  $\downarrow$ ,  $\downarrow$ . This sets the center frequency to the frequency of the lower distortion product.
14. On the spectrum analyzer, Press **BW/Avg, Video Average, 20, Enter**. Wait for “AVG 20” to appear along the left side of the display.
15. On the spectrum analyzer, press **Peak Search** and record the marker amplitude reading in [Table 9-17](#) as the Lower Distortion Amplitude.
16. On the spectrum analyzer, press **Frequency**,  $\uparrow$ ,  $\uparrow$ ,  $\uparrow$ . This sets the center frequency to the frequency of the upper distortion product. Press **BW/Avg, Video Average Off**.
17. Set the signal generator’s **FREQUENCY** to F2 as indicated in [Table 9-17](#).
18. Set the synthesized sweeper’s **CW** frequency to F1 as indicated in [Table 9-17](#).
19. On the spectrum analyzer, Press **BW/Avg, Video Average, 20, Enter**. Wait for “AVG 20” to appear along the left side of the display.
20. On the spectrum analyzer, press **Peak Search** and record the marker amplitude reading in [Table 9-17](#) as the Upper Distortion Amplitude.
21. On the spectrum analyzer, press **BW/Avg, Video Average Off, Marker, Marker All Off**.
22. In [Table 9-17](#), record the most positive of the Upper Distortion Amplitude and Lower Distortion Amplitude as the Worst Distortion Amplitude. For example, if the Upper Distortion Amplitude is  $-72$  dBc, and the Lower Distortion Amplitude is  $-73$  dBc, record  $-72$  dBc as the Worst Distortion Amplitude.
23. If the analyzer has a  $50\ \Omega$  input, enter  $-22$  dBm as the Mixer Level in [Table 9-17](#). The mixer level is the input level minus the analyzer’s input attenuation. If the analyzer has a  $75\ \Omega$  input, enter  $+26.76$  dBmV as the Mixer Level in [Table 9-17](#).
24. Calculate the equivalent TOI by subtracting one-half of the Worst Distortion Amplitude (in dB) from the Mixer Level (in dBm or dBmV). For example, if the Worst Distortion Amplitude is  $-72$  dBc, and the Mixer Level is  $-22$  dBm, the TOI would be:

$$\text{TOI} = -22\ \text{dBm} - (-72\ \text{dB}/2) = -22\ \text{dBm} + 36\ \text{dB} = 14\ \text{dBm}$$

25. If the analyzer has a  $50\ \Omega$  input, record the calculated TOI in the performance verification test record as indicated in TR Entry  $50\ \Omega$  in [Table 9-17](#). If the analyzer has a  $75\ \Omega$  input, record the calculated TOI in the performance verification test record as indicated in TR Entry  $75\ \Omega$  in [Table 9-17](#).

**Table 9-17 Third Order Intercept (TOI) Worksheet**

<b>TOI Test</b>	<b>F1 (MHz)</b>	<b>F2 (MHz)</b>	<b>Lower Distortion Amplitude</b>	<b>Upper Distortion Amplitude</b>	<b>Worst Distortion Amplitude</b>	<b>Mixer Level</b>	<b>TR Entry 50 Ω</b>	<b>TR Entry 75 Ω</b>
1	50	50.05					2	5
2	900	900.05					3	6
3	1450	1450.05					4	7

26. Connect the equipment as shown in Figure 9-16 using the 1 GHz low pass filter and with the output of the directional bridge connected to the power sensor.

*75 Ω Input only: Use the power sensor with a 50 Ω to 75 Ω mechanical adapter in place of the 50 Ω adapter.*

27. Repeat steps 4 through 25 using the information and entries for TOI Test 2 in Table 9-17. It is not necessary to preset the synthesized sweeper and spectrum analyzer.

28. Connect the equipment as shown in Figure 9-16 without using a low pass filter and with the output of the directional bridge connected to the power sensor.

*75 Ω Input only: Use the power sensor with a 50 Ω to 75 Ω mechanical adapter in place of the 50 Ω adapter.*

29. Repeat steps 4 through 25 using the information and entries for TOI Test 3 in Table 9-17. It is not necessary to preset the synthesized sweeper and spectrum analyzer.

30. On the spectrum analyzer, press **Preset, System, Alignments, Auto Align, All.**

---

## 15. Gain Compression

Gain compression is measured by applying two signals, separated by 3 MHz. First, the test places a  $-26$  dBm signal at the input of the spectrum analyzer (the spectrum analyzer reference level is set to  $-10$  dBm). Then, a 0 dBm signal (46.75 dBmV for 75  $\Omega$ ) is applied to the spectrum analyzer, overdriving its input. The decrease in the first signal's amplitude (gain compression) caused by the second signal is the measured gain compression.

There are no related adjustment procedures for this performance test.

### Equipment Required

- Synthesized sweeper
- Synthesized signal generator
- Measuring receiver (*used as a power meter*)
- Power sensor, 100 kHz to 1500 MHz
- Directional bridge
- Cable, BNC, 120-cm (48-in) (*2 required*)
- Adapter, Type-N (f) to BNC (m)
- Adapter, Type-N (m) to BNC (m)
- Adapter, Type-N (f) to APC 3.5 (f)
- Adapter, Type-N (m) to BNC (f) (*2 required*)

### Additional Equipment for 75 $\Omega$ Input

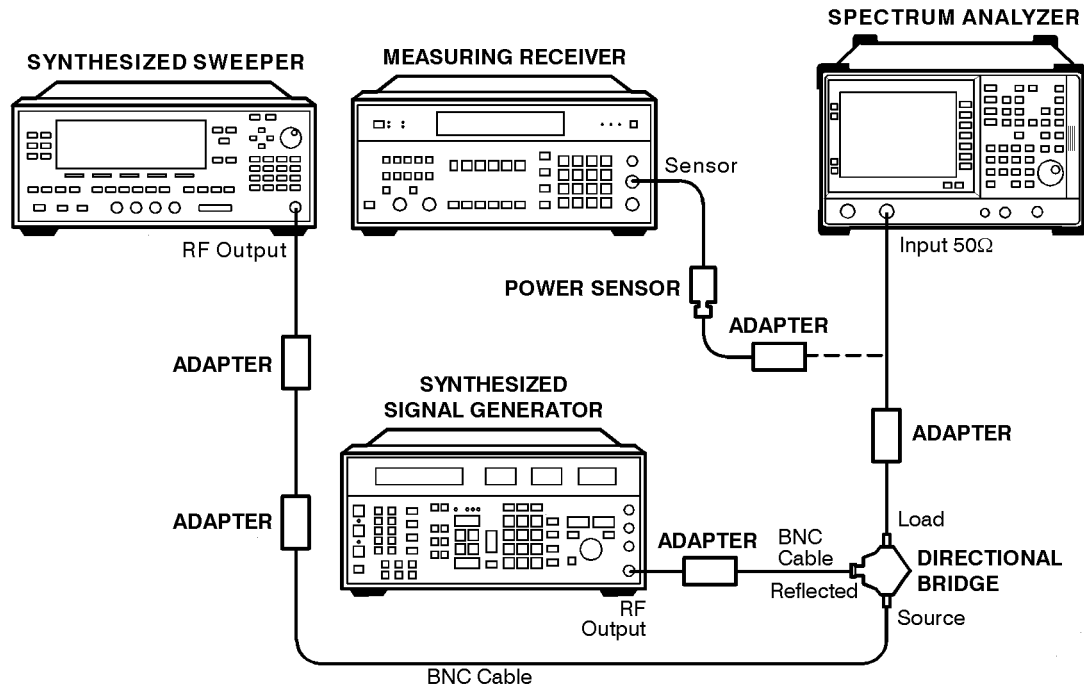
- Power sensor, 75  $\Omega$
- Adapter, Type-N (f), to BNC (m), 75  $\Omega$
- Adapter, BNC (m), to BNC (m), 75  $\Omega$

### Procedure

1. Zero and calibrate the measuring receiver and 100 kHz to 1500 MHz power sensor combination in log mode (power reads out in dBm) as described in the measuring receiver operation manual. Enter the power sensor's 50 MHz Cal Factor into the measuring receiver.  
*75  $\Omega$  Input only: Calibrate the 75  $\Omega$  power sensor.*
2. Connect the equipment as shown in [Figure 9-17](#), with the load port of the directional bridge connected to the power sensor.

*75  $\Omega$  Input only: Use the power sensor with a Type-N (f) to BNC (m) 75  $\Omega$  adapter and a BNC (m) to BNC (m) adapter. The power measured at the output of the 50  $\Omega$  directional bridge by the 75  $\Omega$  power sensor is the equivalent power “seen” by the 75  $\Omega$  analyzer.*

**Figure 9-17 Gain Compression Test Setup**



n176a

**CAUTION**

Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors, or damage to the connectors will occur.

3. Press **PRESET** on the synthesized sweeper, then set the controls as follows:
  - CW, 53 MHz**
  - POWER LEVEL, 6 dBm**
4. Set the synthesized signal generator controls as follows:
  - FREQUENCY, 50 MHz**
  - AMPLITUDE, -100 dBm**
5. On the spectrum analyzer, press **Preset**, then wait for the preset routine to finish. Press **System, Alignments, Auto Align, Off**. Press the spectrum analyzer keys as follows:
  - Frequency, 50 MHz**
  - Span, 2 MHz**

15. Gain Compression

**Amplitude, Amptd Units, dBm, Done**

**Amplitude, -10 dBm, Attenuation Auto Man 0 dB**

**Scale/Div, 2 dB**

**BW/Avg, 30 kHz**

6. On the synthesized sweeper, adjust the power level for a 0 dBm reading on the measuring receiver. Set RF to Off.

*75  $\Omega$  Input only: Adjust the power level for a -2.0 dBm reading.*

7. On the synthesized signal generator, set the amplitude to -14 dBm.

8. Disconnect the power sensor from the directional bridge and connect the directional bridge to the Input 50  $\Omega$  connector of the spectrum analyzer using an adapter. Do not use a cable.

*75  $\Omega$  Input only: Use a 75  $\Omega$  adapter, BNC (m) to BNC (m).*

9. On the spectrum analyzer, press the following keys:

**Peak Search**

**Frequency, Signal Track On Off (On)**

**Span, 150 kHz**

Wait for the Span 150 kHz message to appear.

10. On the synthesized signal generator, adjust the amplitude to place the signal 16 dB below the spectrum analyzer reference level.
11. On the spectrum analyzer, press **Peak Search**, then **Marker, Marker  $\Delta$** .
12. On the synthesized sweeper, set RF to On.
13. On the spectrum analyzer, press **Search**.
14. Read the marker delta amplitude and record its absolute value in the performance verification test record as TR Entry 1.
15. On the spectrum analyzer, press **System, Alignments, Auto Align, On**.

---

## 16. Other Input Related Spurious Responses

A synthesized source and the spectrum analyzer are set to the same frequency and the amplitude of the source is set to  $-10$  dBm. A marker-amplitude reference is set on the spectrum analyzer. The source is then tuned to several different frequencies where image responses could occur. At each source frequency, the source amplitude is set to  $-10$  dBm and the amplitude of the response, if any, is measured using the spectrum analyzer marker function. The marker-amplitude difference is then compared to the specification.

There are no related adjustment procedures for this performance test.

### Equipment Required

Synthesized sweeper  
Measuring receiver (*used as a power meter*)  
Power sensor, 100 kHz to 1500 MHz  
Adapter, Type-N (f) to APC 3.5 (f)  
Adapter, Type-N (f) to Type-N (f)  
Cable, Type-N, 152-cm (60-in)

### Additional Equipment for 75 $\Omega$ Input

Power sensor, 75  $\Omega$   
Adapter, Type-N (f), to BNC (m), 75  $\Omega$   
Adapter, BNC (m), to BNC (m), 75  $\Omega$   
Pad, minimum loss

### Procedure

1. Zero and calibrate the measuring receiver and 100 kHz to 1500 MHz power sensor in log mode (power reads out in dBm), as described in the measuring receiver operation manual. Enter the power sensor's 500 MHz Cal Factor into the measuring receiver.

*75  $\Omega$  Input only: Use a 75  $\Omega$  power sensor.*

2. Press **INSTRUMENT PRESET** on the synthesized sweeper and set the controls as follows:

**CW, 542.8 MHz**  
**POWER LEVEL,  $-10$  dBm**



## 16. Other Input Related Spurious Responses

3. Connect the equipment as shown in **Figure 9-18**. Connect the output of the synthesizer to the 100 kHz to 1500 MHz power sensor using adapters.

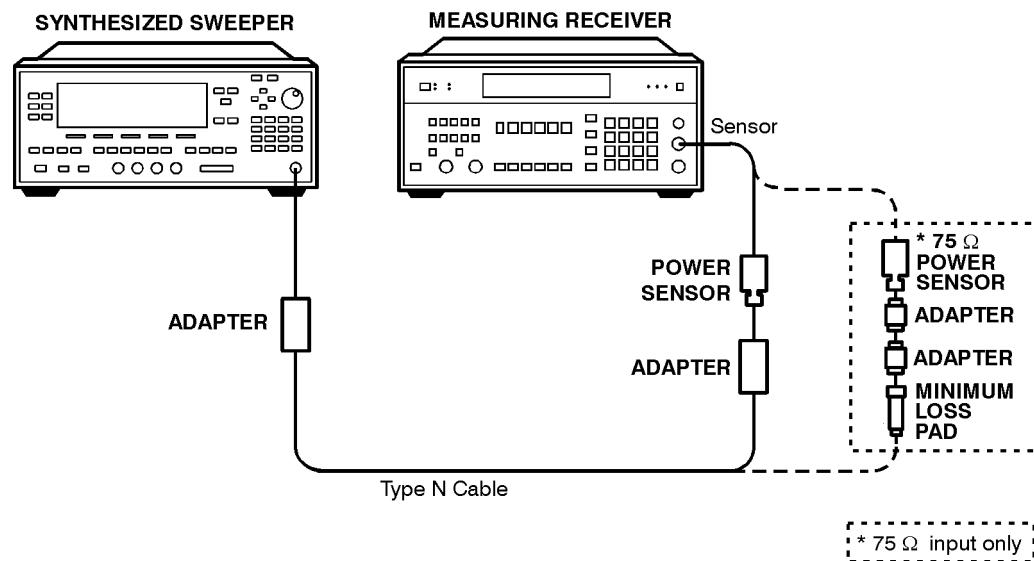
*75  $\Omega$  Input only: Use the minimum loss pad and 75  $\Omega$  adapters to connect to the 75  $\Omega$  power sensor.*

4. Adjust the synthesized sweeper power level for a  $-10 \text{ dBm} \pm 0.1 \text{ dB}$  reading on the measuring receiver.

*75  $\Omega$  Input only: Adjust the synthesized sweeper for a power level of  $-4.24 \text{ dBm}$  reading  $\pm 0.1 \text{ dB}$ .*

5. On the synthesized sweeper, press **SAVE, 1**.

**Figure 9-18 Other Input Related Spurious Responses Power Setting Setup**



ni779a

6. Set the CW frequency on the synthesized sweeper to 510.7 MHz.
7. Adjust the synthesized sweeper power level for a  $-10 \text{ dBm} \pm 0.1 \text{ dB}$  reading on the measuring receiver.
 

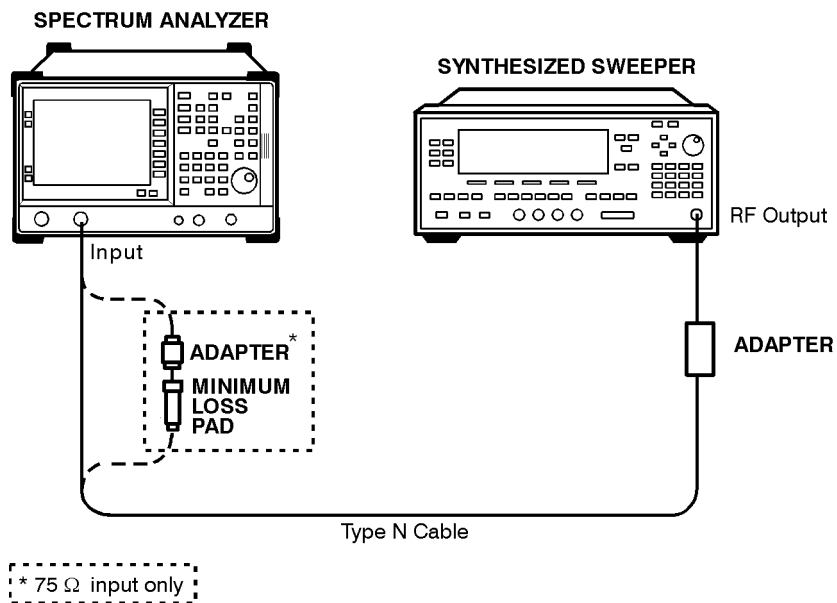
*75  $\Omega$  Input only: Adjust the synthesized sweeper for a power level of  $-4.24 \text{ dBm}$  reading  $\pm 0.1 \text{ dB}$ .*
8. On the synthesized sweeper, press **SAVE 2**.
9. Enter the power sensors Cal Factor for 1 GHz into the measuring receiver.
10. Set the CW frequency on the synthesized sweeper to 1310.7 MHz.
11. Adjust the synthesized sweeper power level for a  $-10 \text{ dBm} \pm 0.1 \text{ dB}$  reading on the measuring receiver.

*75  $\Omega$  Input only: Adjust the synthesized sweeper for a power level of  $-4.24$  dBm reading  $\pm 0.1$  dB.*

12. On the synthesized sweeper, press **SAVE 3**.
  13. Enter the power sensors Cal Factor for 100 MHz into the measuring receiver.
  14. Set the CW frequency on the synthesized sweeper to 100 MHz.
  15. Adjust the synthesized sweeper power level for a  $-10$  dBm  $\pm 0.1$  dB reading on the measuring receiver.
- 75  $\Omega$  Input only: Adjust the synthesized sweeper for a power level of  $-4.24$  dBm reading  $\pm 0.1$  dB.*
16. On the synthesized sweeper, press **SAVE 4**.
  17. Set the CW frequency on the synthesized sweeper to 500 MHz.
  18. Adjust the synthesized sweeper power level for a  $-10$  dBm  $\pm 0.1$  dB reading on the measuring receiver.
- 75  $\Omega$  Input only: Adjust the synthesized sweeper for a power level of  $-4.24$  dBm reading  $\pm 0.1$  dB.*
19. Connect the synthesized sweeper to the RF Input of the spectrum analyzer using the appropriate cable and adapters. See [Figure 9-19](#).

*75  $\Omega$  Input only: Use the minimum loss pad and a 75  $\Omega$  adapter as shown in [Figure 9-19](#).*

**Figure 9-19 Other Input Related Spurious Responses Measurement Setup**



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## 16. Other Input Related Spurious Responses

20. On the analyzer, press **Preset**, then wait for the preset routine to finish. Set the analyzer by pressing the following keys:

**Frequency, 500 MHz**

**Span, 10 MHz**

**Amplitude, Attenuation Auto Man, 10 dB**

**Peak Search**

**Frequency, Signal Track On Off (On)**

**Span, 200 kHz**

Wait for the **Span 200 kHz** message to disappear. Press the following analyzer keys:

**Search, Mkr → Ref Lvl**

**Frequency, Signal Track On Off (Off)**

**Peak Search, Marker, Marker Δ**

**Single Sweep**

21. For the first two frequencies listed in [Table 9-18](#), do the following:

- a. Set the synthesized sweeper to the listed CW frequency by pressing **RECALL, 1** for a CW frequency of 542.8 MHz or **RECALL, 2** for a CW frequency of 510.7 MHz.
- b. Press **Single Sweep** and wait for the completion of a new sweep.
- c. On the analyzer, press **Peak Search** and record the marker delta amplitude reading in the performance verification test record as indicated in [Table 9-18](#).

**Table 9-18**

**Spurious Responses**

<b>Synthesized Sweeper CW Frequency</b>	<b>TR Entry (Mkr Δ)</b>
542.8 MHz	1
510.7 MHz	2
1310.7 MHz	3

22. On the synthesized sweeper, press **RECALL 4**

23. On the analyzer press the following keys:

**Sweep, Sweep Cont Single (Cont)**

**Frequency, 100 MHz**

**Amplitude, -5 dBm (50 Ω Input only)**

**Amplitude, + 48.76 dBmV (75 Ω Input only)**

**Peak Search**

**Marker, Marker Normal**

**Search, Mkr → Ref Lvl**

**Peak Search**

**Marker, Marker Δ**

**Single Sweep**

24. On the synthesized sweeper, press **RECALL 3** for a CW frequency of 1310.7 MHz
25. Press **Single Sweep** on the analyzer and wait for a completion of a new sweep.
26. On the analyzer, press **Peak Search** and record the marker delta amplitude in the performance test record as TR Entry 3.

## 17. Sweep Time Accuracy

This test uses a synthesizer/function generator to amplitude modulate a 500 MHz CW signal from another signal generator. The analyzer demodulates this signal in zero span to display the response in the time domain. The marker delta frequency function on the analyzer is used to read out the sweep time accuracy.

There are no related adjustment procedures for this performance test.

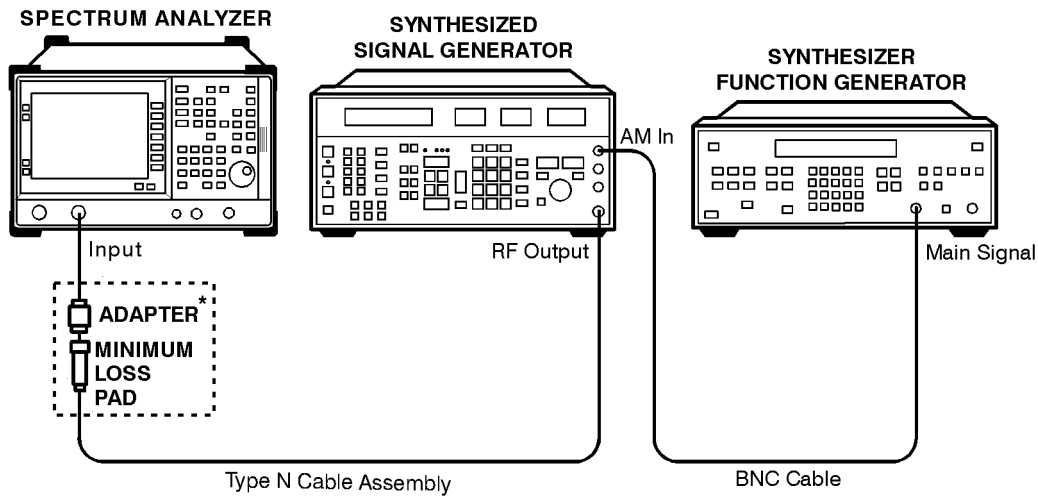
### Equipment Required

- Synthesizer/function generator
- Synthesized signal generator
- Cable, Type-N, 152-cm (60-in)
- Cable, BNC, 120-cm (48-in)

### Additional Equipment for 75 $\Omega$ Input

- Pad, minimum loss
- Adapter, Type-N (f), to BNC (m), 75  $\Omega$

**Figure 9-20** Sweep Time Accuracy Test Setup



\* 75  $\Omega$  input only

n1775a

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**CAUTION**

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Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors, or damage to the connectors will occur.

## Procedure

1. Set the synthesized signal generator to output a 500 MHz,  $-10$  dBm, CW signal. Set the AM and FM controls to off.

*75  $\Omega$  Input only: Set output level to  $-4$  dBm.*

2. Set the synthesizer/function generator to output a 500 Hz,  $+5$  dBm triangle waveform signal.
3. Connect the equipment as shown in [Figure 9-20](#).
4. Press **Preset** on the analyzer, then wait for the preset routine to finish. Set the analyzer by pressing the following keys:

**Frequency, 500 MHz**

**Span, Span Zoom, 50 kHz**

Wait for the `Span 50 kHz` message to appear. Press **Span**, then **Zero Span**.

Press the following analyzer keys:

**BW/Avg, 3 MHz**

**Sweep/Time, 20 ms**

**Amplitude, Scale Type Log Lin (Lin)**

**Search, Peak Excursion, 3 dB**

Adjust the signal generator amplitude for a mid-screen display.

5. Set the synthesized signal generator to EXT AM, 90% MODULATION.
6. On the analyzer, press **Trig** then **Video**. Adjust the video trigger so that the analyzer is sweeping.
7. Press **Single Sweep**. After the completion of the sweep, press **Peak Search, Search**. If necessary, press **Next Pk Left** until the marker is on the left-most signal. This is the “marked signal.”
8. Press **Marker, Marker  $\Delta$** , then **Search** and press **Next Pk Right** 8 times so the marker delta is on the eighth signal peak from the “marked signal.”

Record the marker delta reading in the performance verification test record.

9. Repeat [step 7](#) through [step 9](#) for the remaining sweep time settings listed in [Table 9-19](#).

**Table 9-19**                      **Sweep Time Accuracy**

<b>Spectrum Analyzer Sweep Time Setting</b>	<b>Synthesizer/Function Generator Frequency</b>	<b>TR Entry (MKR <math>\Delta</math>)</b>
20 ms	500.0 Hz	1
100 ms	100.0 Hz	2
1 s	10.0 Hz	3
10 s	1.0 Hz	4

## 18. Displayed Average Noise Level

This performance test measures the displayed average noise level within the frequency range specified. The analyzer input is terminated in 50  $\Omega$ .

The test tunes the analyzer frequency across the band, uses the marker to locate the frequency with the highest response, and then reads the average noise in zero span.

To reduce measurement uncertainty due to input attenuator switching and resolution bandwidth switching, a reference level offset is added. The 50 MHz alignment signal is used as the amplitude reference for determining the amount of offset required. The offset is removed at the end of the test by pressing instrument preset.

The related adjustment for this procedure is “Frequency Response Adjustment.”

### Equipment Required

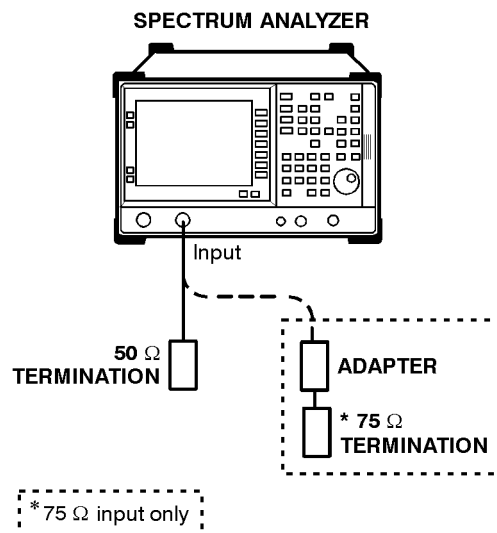
Termination, 50  $\Omega$  Type-N (m)

### Additional Equipment for 75 $\Omega$ Input

Termination, 75  $\Omega$  Type-N (m)

Adapter, Type-N (f), to BNC (m), 75  $\Omega$

**Figure 9-21** Displayed Average Noise Level Test Setup



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**CAUTION**

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Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors, or damage to the connectors will occur.

## Procedure

1. Press **Preset** on the analyzer, then wait for the preset routine to finish. Set the analyzer by pressing the following keys:

**System, 50 MHz osc On Off (On)**  
**Frequency, 50 MHz**  
**Span, 2 kHz**  
**Amplitude, -25 dBm**  
**Amplitude, +26.76 dBmV (75  $\Omega$  Input only)**  
**Attenuation Auto Man, 10 dB**  
**Scale Type Log Lin (Lin)**  
**Amptd Units, dBm, Done**  
**BW/Avg, 3 kHz**  
**Video BW Auto Man 10 kHz**  
**Det/Demod, Detector, Sample, Done**

2. Press **Single Sweep** and wait for a new sweep to complete.
3. Press **Peak Search** and record the marker amplitude reading.

Ref Amptd \_\_\_\_\_ dB

4. Press the following keys on the analyzer:

**Amplitude, Attenuation Auto Man 0 dB**  
**Scale Type Log Lin (Log)**  
**Amptd Units, dBm, Done**  
**BW/Avg, 1 kHz**  
**Video BW, 30 Hz**  
**Single Sweep**

5. Press **Peak Search** and record the marker amplitude reading.

Meas Amptd \_\_\_\_\_ dB

6. Calculate the necessary reference level offset by subtracting the Meas Amptd in step 5 from the Ref Amptd in step 3. If the calculated Ref Lvl Offst is greater than +0.05 dB or less than -0.05 dB, record the Ref Lvl Offst value below. Otherwise, enter 0.

Ref Lvl Offst = Ref Amptd – Meas Amptd

Ref Lvl Offst \_\_\_\_\_ dB

7. Press **System, 50 MHz osc On Off (Off)**, then **Amplitude, Ref Lvl Offst**, and enter the value recorded in step 6.

*75 Ω Input only:* Press **Amplitude, Amptd Units, dBm, Done**

8. Connect the 50 Ω termination to the analyzer input as shown in [Figure 9-21](#).

*75 Ω Input only:* Use the 75 Ω termination.

## 400 kHz

*If testing an analyzer with a 75 Ω input, skip [step 9](#) through [step 11](#) and proceed to [step 12](#) “1 MHz to 10 MHz”.*

9. Press **Frequency, 400 kHz**. Set the analyzer by pressing the following keys:

**Span, 50 kHz**

**Amplitude, –70 dBm**

**BW/Avg, 1 kHz**

**Video BW Auto Man, 30 Hz**

**Sweep, Sweep Time Auto Man, 5 sec**

**Det/Demod, Detector, Sample**

**Single Sweep**

Wait for the completion of a new sweep.

10. Press the following analyzer keys:

**Display, Display Line On Off (On)**

Adjust the display line so that it is centered on the average trace noise, ignoring any residual responses (refer to the Residual Responses verification test for any suspect residuals).

11. Record the display line amplitude setting as TR Entry 1 of the performance verification test record as the noise level at 400 kHz. The average noise level should be less than the specified limit.

## 1 MHz to 10 MHz

12. Press the following analyzer keys:

**Frequency, Start Freq, 1 MHz**

**Stop Freq, 10 MHz**

**Amplitude, -70 dBm (50  $\Omega$  Input only)**

**Amplitude, Amptd Units, dBmV, Done, Ref Level, -21.24 dBmV  
(75  $\Omega$  Input only)**

**BW/Avg, 100 kHz**

**Video BW Auto Man, 10 kHz**

**Sweep, Sweep Cont Single (Cont)**

**Sweep Time Auto Man (Auto)**

13. Press **Frequency** and adjust the start frequency setting, if necessary, to place the LO feedthrough just off-screen to the left.

14. Press the following analyzer keys:

**Single Sweep**

**Trace, Clear Write A**

**BW/Avg, Video Average On Off (On), 10, Enter**

**Single Sweep**

Wait until **AVG 10** is displayed to the left of the graticule (the analyzer will take ten sweeps, then stop).

15. Press **Peak Search** and record the marker frequency as the Measurement Frequency in [Table 9-20](#) for 1 MHz to 10 MHz.

16. Press the following analyzer keys:

**BW/Avg, Video Average On Off (Off)**

**BW/Avg, Resolution BW Auto Man (Auto)**

**Video BW Auto Man (Auto)**

**Span, 50 kHz**

**Frequency**

17. Set the center frequency to the Measurement Frequency recorded in [Table 9-20](#) for 1 MHz to 10 MHz.

18. Press the following analyzer keys:

**BW/Avg, 1 kHz**

**Video BW Auto Man, 30 Hz**

**Single Sweep**

Wait for the sweep to finish.

19. Press the following analyzer keys:

**Display, Display Line On Off (On)**

Adjust the display line so that it is centered on the average trace noise, ignoring any residual responses (refer to the Residual Responses verification test for any suspect residuals).

20. Record the display line amplitude setting as TR Entry 2 of the performance verification test record. The average noise level should be less than the specified limit. *75  $\Omega$  Input: TR Entry 6.*

## **10 MHz to 500 MHz**

21. Press the following analyzer keys:

**Frequency, Start Freq, 10 MHz**

**Stop Freq, 500 MHz**

**Amplitude, -70 dBm (50  $\Omega$  Input only)**

**Amplitude, Amptd Units, dBmV, Done, Ref Level, -21.24 dBmV  
(75  $\Omega$  Input only)**

**BW/Avg, 100 kHz**

**Video BW Auto Man, 10 kHz**

**Sweep, Sweep Cont Single (Cont)**

**Sweep Time Auto Man (Auto)**

22. Press **Frequency** and adjust the start frequency setting, if necessary, to place the LO feedthrough just off-screen to the left.

23. Press the following analyzer keys:

**Single Sweep**

**Trace, Clear Write A**

**BW/Avg, Video Average On Off (On), 10, Enter**

**Single Sweep**

Wait until **AVG 10** is displayed to the left of the graticule (the analyzer will take ten sweeps, then stop).

## 18. Displayed Average Noise Level

24. Press **Peak Search** and record the marker frequency as the Measurement Frequency in [Table 9-20](#) for 10 MHz to 500 MHz.

25. Press the following analyzer keys:

**BW/Avg, Video Average On Off (Off)**

**BW/Avg, Resolution BW Auto Man (Auto)**

**Video BW Auto Man (Auto)**

**Span, 50 kHz**

**Frequency**

26. Set the center frequency to the Measurement Frequency recorded in [Table 9-20](#) for 10 MHz to 500 MHz.

27. Press the following analyzer keys:

**BW/Avg, 1 kHz**

**Video BW Auto Man, 30 Hz**

**Single Sweep**

Wait for the sweep to finish.

28. Press the following analyzer keys:

**Display, Display Line On Off (On)**

Adjust the display line so that it is centered on the average trace noise, ignoring any residual responses (refer to the Residual Responses verification test for any suspect residuals).

29. Record the display line amplitude setting as TR Entry 3 of the performance verification test record. The average noise level should be less than the specified limit. *75  $\Omega$  Input: TR Entry 7.*

**Table 9-20 Displayed Average Noise Level Worksheet**

Frequency Range		Measurement Frequency	TR Entry (Displayed Average Noise Level)	
75 $\Omega$ Input	50 $\Omega$ Input		50 $\Omega$ Input	75 $\Omega$ Input
	400 kHz	400 kHz	1	
1 MHz to 10 MHz	1 MHz to 10 MHz		2	6
10 MHz to 500 MHz	10 MHz to 500 MHz		3	7
500 MHz to 1.0 GHz	500 MHz to 1.2 GHz		4	8
1.0 GHz to 1.5 GHz	1.2 GHz to 1.5 GHz		5	9

## **500 MHz to 1.2 GHz (75 $\Omega$ Inputs: 500 MHz to 1.0 GHz)**

30. Press the following analyzer keys:

**Frequency, Start Freq, 500 MHz**  
**Stop Freq, 1.2 GHz (50  $\Omega$  Input only)**  
**Stop Freq, 1.0 GHz (75  $\Omega$  Input only)**  
**BW/Avg, 1 MHz**  
**Video BW Auto Man, 10 kHz**  
**Sweep, Sweep Cont Single (Cont)**

31. Press the following analyzer keys:

**Single Sweep**  
**Trace, Clear Write A**  
**BW/Avg, Video Average On Off (On), 10, Enter**  
**Single Sweep**

Wait until **AVG 10** is displayed to the left of the graticule (the analyzer will take ten sweeps, then stop).

32. Press **Peak Search** and record the marker frequency as the Measurement Frequency in [Table 9-20](#) for 500 MHz to 1.2 GHz.

*75  $\Omega$  Input: 500 MHz to 1.0 GHz.*

33. Press the following analyzer keys:

**BW/Avg, Video Average On Off (Off)**  
**BW/Avg, Resolution BW Auto Man (Auto)**  
**Video BW Auto Man (Auto)**  
**Span, 50 kHz**  
**Frequency**

34. Set the center frequency to the Measurement Frequency recorded in [Table 9-20](#) for 500 MHz to 1.2 GHz.

*75  $\Omega$  Input: 500 MHz to 1.0 GHz.*

35. Press the following analyzer keys:

**BW/Avg, 1 kHz**  
**Video BW Auto Man, 30 Hz**  
**Single Sweep**

Wait for the sweep to finish.

36. Press the following analyzer keys:

**Display, Display Line On Off (On)**

Adjust the display line so that it is centered on the average trace noise, ignoring any residual responses (refer to the Residual Responses verification test for any suspect residuals).

37. Record the display line amplitude setting as TR Entry 4 of the performance verification test record. The average noise level should be less than the specified limit.

*75  $\Omega$  Input: TR Entry 8.*

### **1.2 GHz to 1.5 GHz (75 $\Omega$ Inputs: 1.0 GHz to 1.5 GHz)**

38. Press the following analyzer keys:

**Frequency, Start Freq, 1.2 GHz**

**Frequency, Start Freq, 1.0 GHz (75  $\Omega$  Input only)**

**Stop Freq, 1.5 GHz**

**BW/Avg, 1 MHz**

**Video BW Auto Man, 10 kHz**

**Sweep, Sweep Cont Single (Cont)**

39. Press the following analyzer keys:

**Single Sweep**

**Trace, Clear Write A**

**BW/Avg, Video Average On Off (On), 10, Enter**

**Single Sweep**

Wait until **AVG 10** is displayed to the left of the graticule (the analyzer will take ten sweeps, then stop).

40. Press **Peak Search** and record the marker frequency as the Measurement Frequency in [Table 9-20](#) for 1.2 GHz to 1.5 GHz.

*75  $\Omega$  Input: 1.0 GHz to 1.5 GHz.*

41. Press the following analyzer keys:

**BW/Avg, Video Average On Off (Off)**

**BW/Avg, Resolution BW Auto Man (Auto)**

**Video BW Auto Man (Auto)**

**Span, 50 kHz**

**Frequency**

42. Set the center frequency to the Measurement Frequency recorded in [Table 9-20](#) for 1.2 GHz to 1.5 GHz.

*75  $\Omega$  Input: 1.0 GHz to 1.5 GHz.*

43. Press the following analyzer keys:

**BW/Avg, 1 kHz**

**Video BW Auto Man, 30 Hz**

**Single Sweep**

Wait for the sweep to finish.

44. Press the following analyzer keys:

**Display, Display Line On Off (On)**

Adjust the display line so that it is centered on the average trace noise, ignoring any residual responses (refer to the Residual Responses verification test for any suspect residuals).

45. Record the display line amplitude setting as TR Entry 5 of the performance verification test record. The average noise level should be less than the specified limit.

*75  $\Omega$  Input: TR Entry 9.*



## 19. Residual Responses

The analyzer input is terminated and the analyzer is swept from 150 kHz to 1 MHz. Then the analyzer is swept in 10 MHz spans throughout the 1 MHz to 1.5 GHz range. Any responses above the specification are noted.

There are no related adjustment procedures for this performance test.

### Equipment Required

Termination, 50  $\Omega$ , Type-N (m)

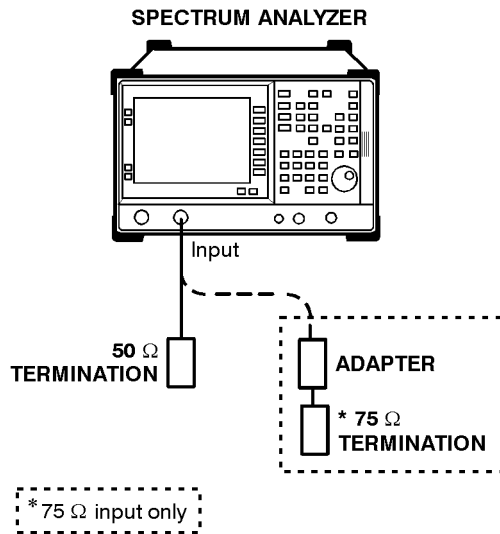
### Additional Equipment for 75 $\Omega$ Input

Termination, 75  $\Omega$  Type-N ( $\mu$ )

Adapter, Type-N (f), to BNC (m), 75  $\Omega$

Figure 9-22

### Residual Response Test Setup



n1762a

**CAUTION**

Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors, or damage to the connectors will occur.

## Procedure

### 150 kHz to 1 MHz

1. Connect the 50  $\Omega$  termination to the analyzer input as shown in [Figure 9-22](#).

*75  $\Omega$  Input only: Use the adapter and the 75  $\Omega$  termination and proceed with [step 4](#).*

2. Press **Preset**. Set the analyzer by pressing the following keys:

**Frequency, Start Freq, 150 kHz**

**Stop Freq, 1 MHz**

**Amplitude, -60 dBm**

**Attenuation Auto Man, 0 dB**

**BW/Avg, 3 kHz**

**Video BW Auto Man, 1 kHz**

**Display, Display Line On Off (On), -90 dBm**

3. Press **Single Sweep** and wait for a new sweep to finish. Look for any residual responses at or above the display line.

If a residual is suspected, press **Single Sweep** again. A residual response will persist on successive sweeps, but a noise peak will not. Note the frequency and amplitude of any residual responses above the display line in [Table 9-21](#).

### 1 MHz to 1.5 GHz

4. Press **Preset** on the analyzer, then wait for the preset routine to finish. Press the following keys:

**Frequency, 5 MHz**

**Span, 10 MHz**

**Amplitude, -60 dBm (50  $\Omega$  Input only)**

**Amplitude, -11.2 dBmV (75  $\Omega$  Input)**

**Attenuation Auto Man, 0 dB**

5. Press **Frequency**, then adjust the center frequency until the LO feedthrough (the “signal” near the left of the screen) is just off the left-most vertical graticule line. Press the following analyzer keys:

**Frequency, CF Step Auto Man, 9.8 MHz**

**BW/Avg, 10 kHz**

19. Residual Responses

Video BW Auto Man, 3 kHz

Display, Display Line On Off (On), -90 dBm

Display, Display Line On Off (On), -36 dBmV (75 Ω Input)

6. Press **Single Sweep** and wait for a new sweep to finish. Look for any residual responses at or above the display line. If a residual is suspected, press **Single Sweep** again. A residual response will persist on successive sweeps, but a noise peak will not. Note the frequency and amplitude of any residual responses above the display line in [Table 9-21](#).
7. Press **Frequency**, ↑ (step-up key), to step to the next frequency and repeat [step 6](#).
8. Repeat [step 7](#) until the range from 1 MHz to 1.5 GHz has been checked. (This requires 153 additional frequency steps.) The test for this band requires about 8 minutes to complete if no residuals are found. If the on screen annotation is obscuring possible residuals, just press the ESC key to clear it.

If there are any residuals at or near the frequency specification limits (1 MHz or 1.5 GHz), it is recommended that a known frequency source be used as a frequency marker. This will ensure that testing is done at or below the specification limits.

9. Record the highest residual from [Table 9-21](#) as TR Entry 1 in the performance verification test record. If no residuals are found, then record “N/A” in the performance verification test record.

**Table 9-21**

**Residual Responses above Display Line Worksheet**

Frequency (MHz)	Amplitude (dBm or dBmV)

## 20. Tracking Generator Feedthrough Options IDN and IDQ

The tracking generator output is terminated and set for 0 dBm output power (maximum output power). The analyzer input is also terminated. The noise level of the analyzer is then measured at several frequencies.

There are no related adjustments for this performance test.

### Equipment Required

Termination, 50  $\Omega$  Type-N (m) (2 required)

### Additional Equipment Required For 75 $\Omega$ RF Out

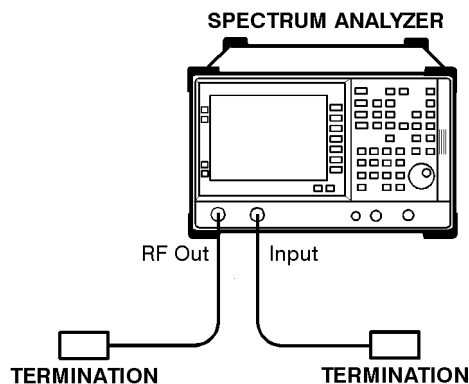
Termination, 75  $\Omega$  Type-N (m), (2 required)

Adapter, Type-N (m) to BNC (m), (2 required)

#### CAUTION

Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors or damage to the connectors will occur.

**Figure 9-23** Tracking Generator Feedthrough Test Setup



n1750a

### Procedure

1. Press **Preset** on the analyzer, then wait for the preset routine to finish. Set the analyzer by pressing the following keys:
  - System, 50 MHz osc On Off (On)
  - Frequency, 50 MHz
  - Span, 2 kHz

## 20. Tracking Generator Feedthrough Options IDN and IDQ

**Amplitude, -25 dBm (50  $\Omega$  RF Output only)**

**Amplitude, +26.76 dBmV (75  $\Omega$  RF Output only)**

**Attenuation Auto Man, 10 dB**

**Scale Type Log Lin (Lin)**

**Amptd Units, dBm, Done**

**BW/Avg, 3 kHz**

**Video BW Auto Man, 10 kHz**

**Det/Demod, Detector, Sample, Done**

2. Press **Single Sweep** and wait for a new sweep to complete.
3. Press **Peak Search** and record the marker amplitude reading.

Ref Amptd \_\_\_\_\_ dBm

4. Press the following keys on the analyzer:

**Amplitude, Attenuation Auto Man 0 dB**

**Scale Type Log Lin (Log)**

**Amptd Units, dBm, Done**

**BW/Avg, 1 kHz**

**Video BW, 30 Hz**

**Single Sweep**

5. Press **Peak Search** and record the marker amplitude reading.

Meas Amptd \_\_\_\_\_ dBm

6. Calculate the necessary reference level offset by subtracting the Meas Amptd in step 5 from the Ref Amptd in step 3. If the calculated Ref Lvl Offst is greater than +0.05 dB or less than -0.05 dB, record the Ref Lvl Offst value below. Otherwise, enter 0.

Ref Lvl Offst \_\_\_\_\_ dB

Ref Lvl Offst = Ref Amptd – Meas Amptd

7. Press **System, 50 MHz osc On Off (Off)**, then **Amplitude, Ref Lvl Offst**, and enter the value recorded in step 6.

8. Connect one 50  $\Omega$  termination to the analyzer Input 50  $\Omega$  and another to the tracking generator's RF Out 50  $\Omega$

*75  $\Omega$  RF Out only: Connect one 75  $\Omega$  termination to the analyzer Input 75  $\Omega$  using an adapter and another to the tracking generator's RF Out 75  $\Omega$  using an adapter.*

9. Set the analyzer by pressing the following keys:

**Frequency, 400 kHz** (*50  $\Omega$  RF Output only*)

**Frequency, 1 MHz** (*75  $\Omega$  RF Output only*)

**Span 0 Hz**

**Amplitude, -70 dBm** (*50  $\Omega$  RF Output only*)

**Amplitude, Amptd Units, dBmV, Done** (*75  $\Omega$  RF Output only*)

**Amplitude, -21.24 dBmV** (*75  $\Omega$  RF Output only*)

**Marker, Marker All Off**

**Sweep, Sweep Cont Single** (Cont)

10. Press the following analyzer keys:

**Source Amptd, Amplitude On Off 0 dBm** (*50  $\Omega$  RF Output only*)

**Source Amptd, Amplitude On Off +42.76 dBmV** (*75  $\Omega$  RF Output only*)

11. Press **Single Sweep**, then wait for completion of a new sweep. Press **Display, Display Line On Off (On)**

12. Adjust the display line so that it is centered on the average trace noise, ignoring any residual responses. Record the display line amplitude setting in [Table 9-22](#) as the noise level at 400 kHz.

*75  $\Omega$  RF Out only: Record the display line amplitude setting in [Table 9-22](#) as the noise level at 1 MHz.*

13. Press **Frequency, Center Freq**, and enter the next frequency in [Table 9-22](#). The center frequency of the analyzer equals the output frequency of the tracking generator.

*75  $\Omega$  RF Out only: Do not set the tracking generator RF Out to frequencies below 1 MHz.*

14. Repeat [step 11](#) through [step 13](#) for the remaining Tracking Generator Output Frequencies (spectrum analyzer center frequencies) listed in [Table 9-22](#).

*75  $\Omega$  RF Out only: Do not set the tracking generator RF Out to frequencies below 1 MHz.*

*75  $\Omega$  RF Out only: Skip to [step 19](#).*

15. In [Table 9-22](#), locate the most positive Noise Level Amplitude for output frequencies less than or equal to 1 MHz. Record this amplitude as TR Entry 1 of the performance verification test record.

**Table 9-22 TG Feedthrough Worksheet**

Tracking Generator Output Frequency	Noise Level Amplitude (dBm or dBmV)
400 kHz <sup>a</sup>	
1 MHz	
20 MHz	
50 MHz	
100 MHz	
250 MHz	
400 MHz	
500 MHz	
700 MHz	
850 MHz	
1000 MHz	
1200 MHz	
1300 MHz	
1450 MHz	
1500 MHz	

a. This frequency does not apply to analyzers with 75  $\Omega$  tracking generators

16. In [Table 9-22](#), locate the most positive Noise Level Amplitude for frequencies greater than 1 MHz and less than or equal to 500 MHz. Record this amplitude as TR Entry 2 of the performance verification test record.
17. In [Table 9-22](#), locate the most positive Noise Level Amplitude for frequencies greater than 500 MHz and less than or equal to 1200 MHz. Record this amplitude as TR Entry 3 of the performance verification test record.
18. In [Table 9-22](#), locate the most positive Noise Level Amplitude for frequencies greater than 1200 MHz. Record this amplitude as TR Entry 4 of the performance verification test record.

---

**NOTE**

---

The following steps apply only to analyzers with 75  $\Omega$  RF Out.

19. In [Table 9-22](#), locate the most positive Noise Level Amplitude for frequencies between 1 MHz and 500 MHz. Record this amplitude as TR Entry 5 of the performance verification test record.
20. In [Table 9-22](#), locate the most positive Noise Level Amplitude for frequencies greater than 500 MHz and less than or equal to 1000 MHz. Record this amplitude as TR Entry 6 of the performance verification test record.
21. In [Table 9-22](#), locate the most positive Noise Level Amplitude for frequencies greater than 1000 MHz. Record this amplitude as TR Entry 7 of the performance verification test record.



## 21. Absolute Amplitude, Vernier, and Power Sweep Accuracy, Options 1DN and 1DQ

A calibrated power sensor is connected to the tracking generator output to measure the power level at 50 MHz.

The measuring receiver is set for RATIO mode so that future power level readings are in dB relative to the power level at 0 dBm. The output power level setting is decreased in 1 dB steps and the power level is measured at each step. The difference between the ideal and actual power levels is calculated at each step.

Since a power sweep is accomplished by stepping through the vernier settings, the peak-to-peak variation of the vernier accuracy is equal to the power sweep accuracy.

### Equipment Required

Measuring receiver

Power sensor, 100 kHz to 1500 MHz

### Additional Equipment Required for 75 $\Omega$ RF Out

Power sensor, 75  $\Omega$

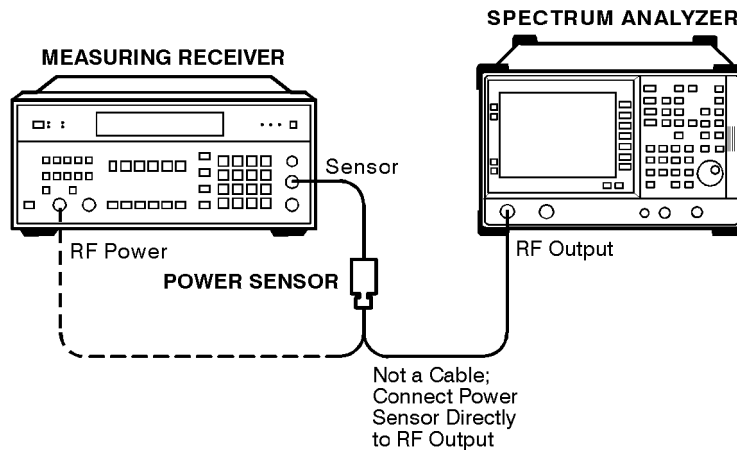
Adapter, Type-N (f) to BNC (m), 75  $\Omega$

### Procedure

1. Press **Preset** on the spectrum analyzer, then wait for the preset routine to finish. Set the spectrum analyzer by pressing the following keys:

**Frequency, 50 MHz**

**Span, Zero Span**

**Figure 9-24 Absolute Amplitude, Vernier, and Power Sweep Accuracy Test Setup**

nl719a

**CAUTION**

Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors, or damage to the connectors will occur.

2. Zero and calibrate the measuring receiver and 100 kHz to 1500 MHz power sensor in log mode (power reads out in dBm), as described in the measuring receiver operation manual. Enter the power sensor's 50 MHz Cal Factor into the measuring receiver.
3. Connect the 100 kHz to 1500 MHz power sensor to the RF Out 50  $\Omega$  as shown in [Figure 9-24](#).

*75  $\Omega$  RF Out only: Connect the power sensor to the RF Out 75  $\Omega$  as shown in [Figure 9-24](#).*

4. On the spectrum analyzer, press:

**Source Amptd, Amplitude, On Off (On), 0 dBm**  
(50  $\Omega$  RF Output only)

**Source Amptd, Amplitude, On Off (On), +42.76 dBmV** (75  $\Omega$   
RF Output only)

**Single Sweep**

**Source Amptd, Attenuation Auto Man, 0 dB**

5. Read the power level displayed on the measuring receiver and record the result as TR Entry 1 of the performance verification test record as the Absolute Amplitude Accuracy.

*75  $\Omega$  RF Out only: Add 6 dB to the power level displayed on the measuring receiver and record the result as TR Entry 1 of the performance verification test record as the absolute accuracy.*

21. Absolute Amplitude, Vernier, and Power Sweep Accuracy, Options 1DN and 1DQ

6. Press **Ratio** on the measuring receiver. Power levels now readout in dB relative to the power level just measured at the 0 dBm output power level setting.
7. Set the Source Amplitude to the settings indicated in [Table 9-23](#). At each setting, record the power level displayed on the measuring receiver in [Table 9-23](#).
8. Calculate the absolute vernier accuracy by subtracting the Source Amplitude setting from the Measured Power Level for each Source Amplitude setting in [Table 9-23](#).

*75 Ω RF Out only: Use the source amplitude settings for Option 1DN analyzers.*

$$\text{Vernier Accuracy} = \text{Measured Power Level (dB)} - \text{Source Amplitude (dBm)}$$

9. Locate the most positive and most negative absolute vernier accuracy values for Source Amplitude levels of -1 dBm to -10 dBm recorded in [Table 9-23](#). Record in the performance verification test record the Positive Vernier Accuracy as TR Entry 2 and the Negative Vernier Accuracy as TR Entry 3.

*75 Ω RF Out only: For source amplitudes of +41.76 dBmV to +32.76 dBmV.*

Positive Vernier Accuracy \_\_\_\_\_ dB

Negative Vernier Accuracy \_\_\_\_\_ dB

10. Locate the most positive and most negative Absolute Vernier Accuracy values for all Source Amplitude levels in [Table 9-23](#) and record below.

Positive Power Sweep Accuracy \_\_\_\_\_ dB

Negative Power Sweep Accuracy \_\_\_\_\_ dB

11. Calculate the power sweep accuracy by subtracting the Negative Power Sweep Accuracy recorded in the previous step from the Positive Power Sweep Accuracy recorded in the previous step. Record this value as TR Entry 4 of the performance verification test record as the Power Sweep Accuracy.

$$\text{Power Sweep Accuracy} = \text{Positive Power Sweep Accuracy} - \text{Negative Power Sweep Accuracy}$$

**Table 9-23 Vernier Accuracy Worksheet**

<b>Source Amplitude Setting</b>		<b>Measured Power Level</b>	<b>Vernier Accuracy</b>
Option 1DN dBm	Option 1DQ dBmV	(dB)	(dB)
-1	+41.76		
-2	+40.76		
-3	+39.76		
-4	+38.76		
-5	+37.76		
-6	+36.76		
-7	+35.76		
-8	+34.76		
-9	+33.76		
-10	+32.76		
-11	+31.76		
-12	+30.76		
-13	+29.76		
-14	+28.76		
-15	+27.76		

---

## 22. Tracking Generator Level Flatness, Options 1DN and 1DQ

A calibrated power sensor is connected to the tracking generator output to measure the power level at 50 MHz. The measuring receiver is set for RATIO mode so that future power level readings are in dB relative to the power level at 50 MHz.

The tracking generator is then stepped to several frequencies throughout its range. The output power difference relative to the power level at 50 MHz is measured at each frequency and recorded.

For frequencies below 100 kHz, a digital voltmeter and precision 50  $\Omega$  termination are used to measure the power of the tracking generator output. The DVM is set to readout in dBm using the MATH function with R value set to 50  $\Omega$ . The dBm equation used is:

$$\text{dBm} = 10\log\left(\frac{E^2}{R}\right)$$

The DVM readout is corrected by making the readings relative to the 100 kHz reading from the power sensor.

*Analyzers with 75  $\Omega$  tracking generators are only tested from 1 MHz to 1500 MHz.*

### Equipment Required

- Measuring receiver
- Power sensor, 100 kHz to 1.5 GHz
- Digital voltmeter
- 50  $\Omega$  termination
- BNC (f) to dual banana plug
- Cable, BNC 91-cm (36-in)
- Adapter, Type-N tee, (m)(f)(f)
- Adapter, Type-N (m) to BNC (f)

### Additional Equipment Required for 75 $\Omega$ RF Out

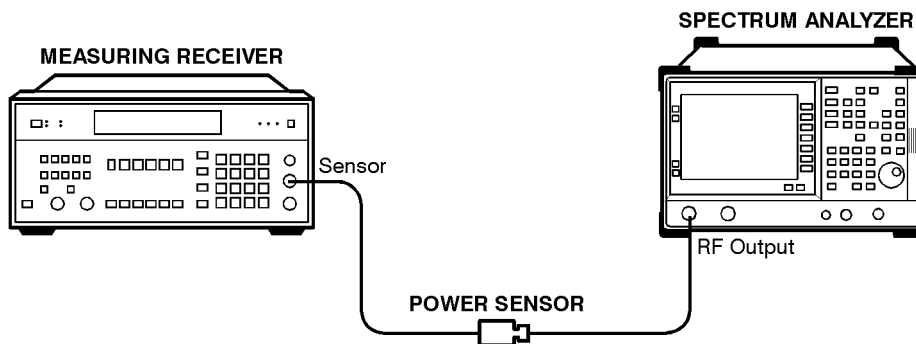
- Power sensor, 75  $\Omega$
- Adapter, Type-N (f) to BNC (m), 75  $\Omega$

---

**CAUTION** Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors or damage to the connectors will occur.

---

**Figure 9-25 Tracking Generator Level Flatness Test Setup**



nl721 a

## Procedure

1. Press **Preset** on the spectrum analyzer, then wait for the preset routine to finish. Set the spectrum analyzer by pressing the following keys:
  - Frequency, 50 MHz**
  - CF Step Auto Man, 100 MHz**
  - Span, Zero Span**
  - Source Amptd, Amplitude On Off (On), 0 dBm (50  $\Omega$  RF Output only)**
  - Source Amptd, Amplitude On Off (On), +42.76 dBmV (75  $\Omega$  RF Output only)**
  - Single Sweep**
2. Zero and calibrate the measuring receiver and 100 kHz to 1.5 GHz power sensor in log mode (power reads out in dBm), as described in the measuring receiver operation manual. Enter the power sensor 50 MHz Cal Factor into the measuring receiver.
  - 75  $\Omega$  RF Out only: Zero and calibrate the 75  $\Omega$  power sensor.*
3. Connect the 100 kHz to 1.5 GHz power sensor to the RF Out 50  $\Omega$ . Refer to [Figure 9-25](#).
  - 75  $\Omega$  RF Out only: Connect the 75  $\Omega$  power sensor through an adapter to the RF Out 75 $\Omega$ .*

## 22. Tracking Generator Level Flatness, Options 1DN and 1DQ

4. Press **RATIO** on the measuring receiver. The measuring receiver readout is now in power levels relative to the power level at 50 MHz.
5. Set the spectrum analyzer center frequency to 100 kHz. Press **Single Sweep**.

*75  $\Omega$  RF Out only: Set the spectrum analyzer center frequency to 1 MHz.*

6. Enter the appropriate power sensor Cal Factor into the measuring receiver as indicated in [Table 9-24](#).
7. Record the power level displayed on the measuring receiver as the Level Flatness in [Table 9-24](#).
8. Repeat [step 5](#) through [step 7](#) to measure the flatness at each center frequency setting listed in [Table 9-24](#). The  $\uparrow$  (step-up key) may be used to tune to center frequencies above 100 MHz.

*75  $\Omega$  RF Out only: Repeat [step 5](#) through [step 7](#) to measure the flatness at the frequencies above 1 MHz listed in [Table 9-24](#).*

**Table 9-24 Tracking Generator Level Flatness Worksheet**

Center Frequency	Level Flatness (dB)	Cal Factor (MHz)
100 kHz <sup>a</sup>		0.1
300 kHz <sup>a</sup>		0.3
500 kHz <sup>a</sup>		0.3
1 MHz		1
2 MHz		3
5 MHz		3
10 MHz		10
20 MHz		30
40 MHz		50
50 MHz	0 (Ref)	50
80 MHz		100
100 MHz		100
200 MHz		300
300 MHz		300
400 MHz		300
500 MHz		300

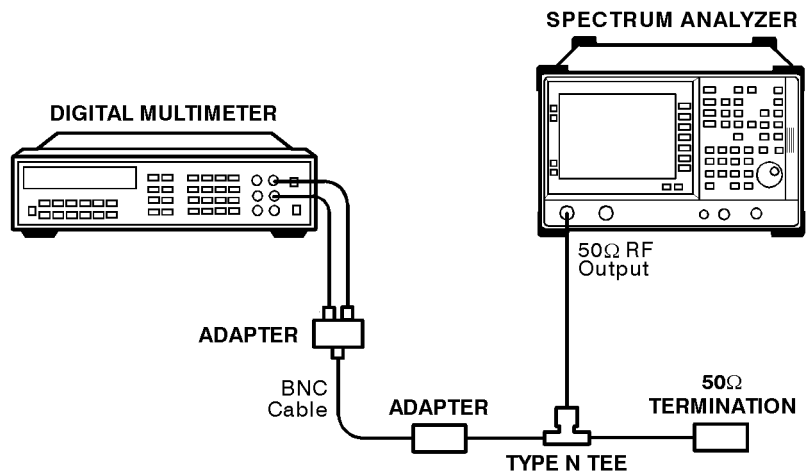
Center Frequency	Level Flatness (dB)	Cal Factor (MHz)
600 MHz		300
700 MHz		1000
800 MHz		1000
900 MHz		1000
1000 MHz		1000
1100 MHz		1000
1200 MHz		1000
1300 MHz		1000
1400 MHz		1000
1500 MHz		2000

a. These frequencies do not apply to analyzers with 75 Ω tracking generators.

*75 RF Out only. Skip step 9 through step 14.*

9. Disconnect the Power Sensor from the RF Out 50 Ω and connect the equipment as shown in [Figure 9-26](#).

**Figure 9-26 Tracking Generator Level Flatness, Center Frequency ≤100 kHz**



n1722a



## 22. Tracking Generator Level Flatness, Options 1DN and 1DQ

10. Set the DVM to measure AC Volts. Press the following DVM keys so that it reads out in dBm:

**50 STORE 4** (sets resistance to 50  $\Omega$  for dBm calculation)

**MATH 4** (sets DVM to read out in dBm)

11. Set the spectrum analyzer center frequency to 9 kHz and press **Single Sweep**. Record the DVM readout in column 2 of [Table 9-25](#).

12. Repeat [step 11](#) for all center frequencies listed in [Table 9-25](#).

**Table 9-25**

**Tracking Generator Level Flatness Worksheet, 100 kHz**

Center Frequency	DVM Readout dBm	Corrected Level Flatness dB
9 kHz		
20 kHz		
40 kHz		
60 kHz		
80 kHz		
100 kHz		

13. Subtract the 100 kHz Level Flatness readout in [Table 9-24](#) from the 100 kHz DVM Readout in [Table 9-25](#) and record as the DVM Offset at 100 kHz.

DVM Offset \_\_\_\_\_ dB

For example, if the Level Flatness reading from [Table 9-24](#) is +0.7 dB and the DVM Readout from [Table 9-25](#) is -0.53 dBm, the DVM offset would be -1.23 dB.

DVM - Level Flatness = DVM Offset

14. Add the DVM Offset from [step 13](#) to each of the DVM Readouts in [Table 9-25](#) and record as the Corrected Level Flatness in column 3.

For example, if the DVM Readout from [Table 9-25](#) is +0.22 dBm, and the DVM Offset is -1.23 dB, the corrected readout would be -1.01 dB.

DVM + DVM Offset = Corrected Readout

15. Locate the most positive Level Flatness reading in [Table 9-24](#) and [Table 9-25](#) for frequencies of 10 MHz and less and record this value as TR Entry 1 of the performance verification test record.

*75  $\Omega$  RF Out only: Do not use the data in [Table 9-25](#).*

16. Locate the most negative Level Flatness reading in [Table 9-24](#) and [Table 9-25](#) for frequencies of 10 MHz and less and record this value as TR Entry 2 of the performance verification test record.

*75  $\Omega$  RF Out only: Do not use the data in [Table 9-25](#).*

17. Locate the most positive Level Flatness reading in [Table 9-24](#) for frequencies greater than 10 MHz and record this value as TR Entry 3 of the performance verification test record.

18. Locate the most negative Level Flatness reading in [Table 9-24](#) for frequencies greater than 10 MHz and record this value as TR Entry 4 of the performance verification test record.

## 23. Harmonic Spurious Outputs, Options 1DN and 1DQ

The tracking generator output is connected to the input of a microwave spectrum analyzer. The tracking generator is tuned to several different frequencies and the amplitude of the second and third harmonics relative to the fundamental are measured at each frequency.

There are no related adjustment procedures for this performance test.

### Equipment Required

Spectrum analyzer, microwave

Cable, Type-N, 62-cm (24-in)

Cable, BNC, 23-cm (9-in)

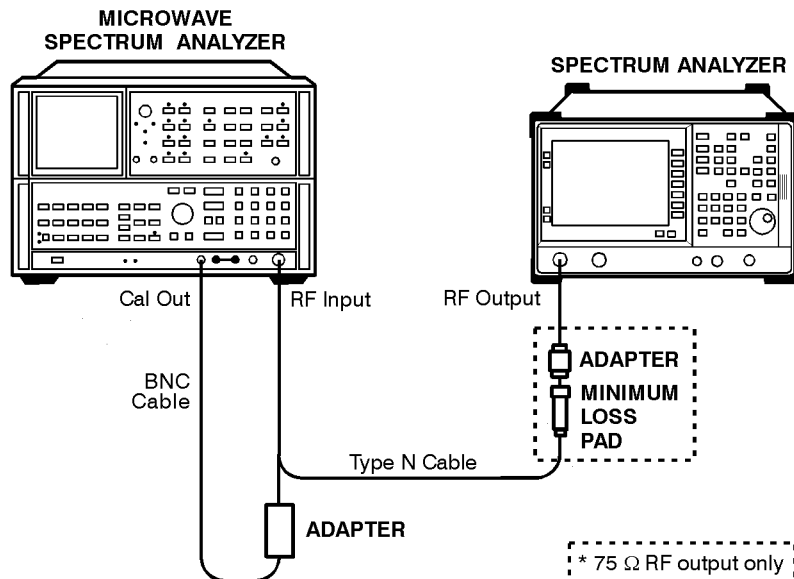
Adapter, Type-N (m) to BNC (f)

### Additional Equipment Required for 75 $\Omega$ RF Out

Pad, minimum loss

Adapter, Type-N (f) to BNC (m), 75  $\Omega$

**Figure 9-27** Harmonic Spurious Outputs Test Setup



n1776a

#### CAUTION

Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors or damage to the connectors will occur.

## Procedure

1. Press **Preset** on the spectrum analyzer, then wait for the preset routine to finish. Set the spectrum analyzer by pressing the following keys:

**Frequency, 10 MHz**

**Span, Zero Span**

**Amplitude, Amptd Units, dBm, Done**

**Source Amptd, Amplitude On Off (On), 0 dBm (50  $\Omega$  RF Output only)**

**Source Amptd, Amplitude On Off (On), +42.76 dBmV  
(75  $\Omega$  RF Output only)**

**Single Sweep**

2. *It is only necessary to perform the next step if more than two hours have elapsed since a front-panel calibration of the microwave spectrum analyzer was performed.*

*The microwave spectrum analyzer should be allowed to warm up for at least 30 minutes before proceeding.*

Perform a front-panel calibration of the microwave spectrum analyzer by performing the following steps:

Note that the following steps are for an HP 8566A/B microwave spectrum analyzer; the steps may be different if you are using another microwave spectrum analyzer.

- Connect a BNC cable between CAL Output and RF Input.
  - Press **2 – 22 GHz (INSTR PRESET), RECALL, 8**. Adjust AMPTD CAL for a marker amplitude reading of  $-10$  dBm.
  - Press **RECALL, 9**. Adjust FREQ ZERO for a maximum amplitude response.
  - Press **SHIFT, Frequency SPAN** to start the 30 second internal error correction routine.
  - Press **SHIFT, START FREQ** to use the error correction factors just calculated.
3. Connect the Type-N cable from the tracking generator output to the microwave spectrum analyzer RF Input as shown in [Figure 9-27](#).
  4. Set the microwave spectrum analyzer controls as follows:
    - CENTER FREQUENCY, 10 MHz**
    - SPAN, 100 kHz**
    - REFERENCE LEVEL, +5 dBm (50  $\Omega$  RF Output only)**
    - REFERENCE LEVEL, 0 dBm (75  $\Omega$  RF Output only)**

23. Harmonic Spurious Outputs, Options 1DN and 1DQ

**RES BW, 30 kHz**

**LOG dB/DIV, 10 dB**

**CF STEP SIZE, 10 MHz**

5. Set up the microwave spectrum analyzer by performing the following steps:

Note that the following steps are for an HP 8566A/B microwave spectrum analyzer, the steps may be different if you are using another microwave spectrum analyzer.

- Press **SIGNAL TRACK** (On). Wait for the signal to be displayed at center screen.
  - Press **Mkr** → **Ref Lvl**.
  - Press **Peak Search**, **SIGNAL TRACK** (Off), **MARKER** Δ
  - Press **CENTER FREQUENCY** and the step-up key to tune to the second harmonic. Press **Peak Search**. Record the marker amplitude reading in [Table 9-26](#) as the 2nd Harmonic Level for the 10 MHz Tracking Generator Output Frequency.
  - Perform this step only if the Tracking Generator Output Frequency is less than 500 MHz. Press **CENTER FREQUENCY** and the step-up key to tune to the third harmonic. Press **Peak Search**. Record the marker amplitude reading in [Table 9-26](#) as the 3rd Harmonic Level for the 10 MHz Tracking Generator Output Frequency.
  - Press **MARKER** (Off).
6. Change the spectrum analyzer center frequency to the next frequency listed in [Table 9-26](#).
  7. Change the microwave spectrum analyzer center frequency and center frequency step size to the next frequency listed in [Table 9-26](#), then repeat [step 5](#). Note that the microwave spectrum analyzer frequency is the same as the Tracking Generator Output Frequency.

**Table 9-26 Harmonic Spurious Responses Worksheet**

<b>Tracking Generator Frequency</b>	<b>2nd Harmonic Level (dBc)</b>	<b>3rd Harmonic Level (dBc)</b>
10 MHz		
100 MHz		
300 MHz		
750 MHz		N/A

8. Record the 10 MHz 2nd Harmonic Level in [Table 9-26](#) as TR Entry 1 of the performance verification test record.
9. Locate the most positive 2nd Harmonic Level in [Table 9-26](#) for frequencies between 100 MHz and 750 MHz and record as TR Entry 2 of the performance verification test record.
10. Record the 10 MHz 3rd Harmonic Level in [Table 9-26](#) as TR Entry 3 of the performance verification test record.
11. Locate the most positive 3rd Harmonic Level in [Table 9-26](#) for frequencies between 100 MHz and 300 MHz and record as TR Entry 4 of the performance verification test record.

---

## 24. Non-Harmonic Spurious Outputs, Options 1DN and 1DQ

The tracking generator output is connected to the input of a microwave spectrum analyzer. The tracking generator is set to several different output frequencies.

For each output frequency, several sweeps are taken on the microwave spectrum analyzer over different frequency spans and the highest displayed spurious response is measured in each span. Responses at the fundamental frequency of the tracking generator output or their harmonics are ignored. The amplitude of the highest spurious response is recorded.

There are no related adjustments for this performance test.

### Equipment Required

Spectrum analyzer, microwave

Cable, Type-N, 62-cm (24-in)

Cable, BNC, 23-cm (9-in)

Adapter, Type-N (m) to BNC (f)

### Additional Equipment Required for 75 $\Omega$ RF Out

Pad, minimum loss

Adapter, Type-N (f) to BNC (m), 75  $\Omega$

### Procedure

1. Press **Preset** on the spectrum analyzer, then wait for the preset routine to finish. Set the spectrum analyzer by pressing the following keys:

**Frequency, 50 MHz**

**Span, Zero Span**

**Source Amptd, Amplitude On Off (On), 0 dBm (50  $\Omega$  RF Output only)**

**Source Amptd, Amplitude On Off (On), +42.76 dBmV (75  $\Omega$ ) RF Output only.**

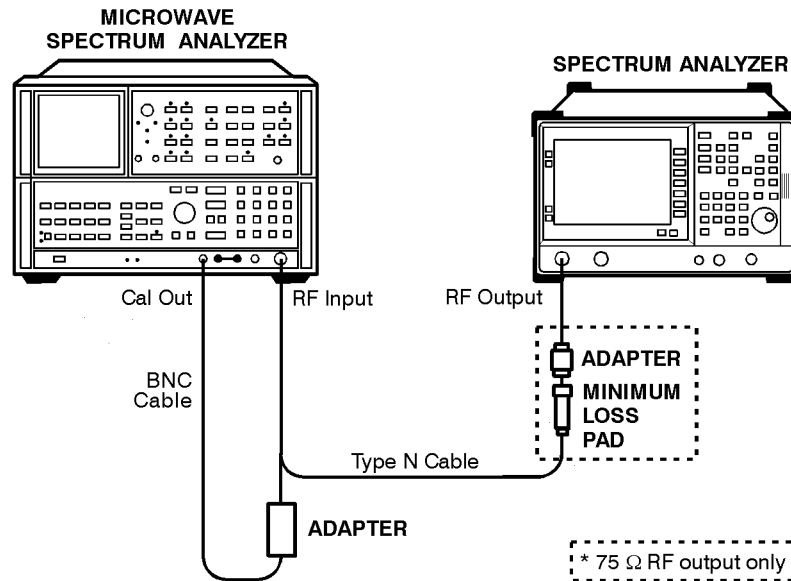
---

**CAUTION**

---

Use only 75  $\Omega$  cables, connectors, or adapters on instruments with 75  $\Omega$  connectors or damage to the connectors will occur.

**Figure 9-28 Non-Harmonic Spurious Outputs Test Setup**



nl776a

2. On the spectrum analyzer, press **Single Sweep**.

*It is only necessary to perform the next step if more than 2 hours have elapsed since a front-panel calibration of the microwave spectrum analyzer has been performed.*

*The microwave spectrum analyzer should be allowed to warm up for at least 30 minutes before proceeding.*

3. Perform a front-panel calibration of the microwave spectrum analyzer by performing the following steps:

Note that the following steps are for an HP 8566A/B microwave spectrum analyzer, the steps may be different if you are using another microwave spectrum analyzer.

- Connect a BNC cable between CAL Output and RF Input.
- Press **2 – 22 GHz (INSTR PRESET), RECALL, 8**. Adjust AMPTD CAL for a marker amplitude reading of  $-10$  dBm.
- Press **RECALL, 9**. Adjust **FREQ ZERO** for a maximum amplitude response.
- Press **SHIFT, FREQUENCY SPAN** to start the 30 second internal error correction routine.
- Press **SHIFT, START FREQ** to use the error correction factors just calculated.



## Measuring Fundamental Amplitudes

4. Connect the Type-N cable from the tracking generator output to the microwave spectrum analyzer RF Input as shown in [Figure 9-28](#).
5. Set the spectrum analyzer center frequency to the Fundamental Frequency listed in [Table 9-27](#).
6. Set the microwave spectrum analyzer controls as follows:
  - SPAN, 100 kHz**
  - REFERENCE LEVEL, +5 dBm (50  $\Omega$  RF Out only)**
  - REFERENCE LEVEL, 0 dBm (75  $\Omega$  RF Out only)**
  - ATTEN, 20 dB**
  - LOG dB/DIV, 10 dB**
7. Set the microwave spectrum analyzer CENTER FREQUENCY to the Fundamental Frequency listed in [Table 9-27](#).
8. On the microwave spectrum analyzer, press **Peak Search**. Press **MARKER** → **REF LVL**. Wait for another sweep to finish.
9. Record the microwave spectrum analyzer marker amplitude reading [Table 9-27](#) as the Fundamental Amplitude.
10. Repeat [step 5](#) through [step 9](#) for all Fundamental Frequency settings [Table 9-27](#).

**Table 9-27**

### Fundamental Response Amplitudes Worksheet

Fundamental Frequency	Fundamental Amplitude (dBm)
10 MHz	
750 MHz	
1.5 GHz	

## Measuring Non-Harmonic Responses

11. On the spectrum analyzer, set the center frequency to 10 MHz.
12. Set the microwave spectrum analyzer Start Freq, Stop Freq, and Res BW as indicated in the first row of [Table 9-28](#).
 

*75  $\Omega$  outputs only: Measure only at start frequencies of 1 MHz and greater.*
13. Press **SINGLE** on the microwave spectrum analyzer and wait for the sweep to finish. Press **Peak Search**.

14. Verify that the marked signal is not the fundamental or a harmonic of the fundamental by performing the following steps:

Note that the following steps are for an HP 8566A/B microwave spectrum analyzer, the steps may be different if you are using another microwave spectrum analyzer.

- a. Divide the marker frequency by the fundamental frequency (the spectrum analyzer center frequency setting). For example, if the marker frequency is 30.3 MHz and the fundamental frequency is 10 MHz, dividing 30.3 MHz by 10 MHz yields 3.03.
- b. Round the number calculated in [step a](#) to the nearest whole number. In the example above, 3.03 should be rounded to 3.
- c. Multiply the fundamental frequency by the number calculated in [step b](#). Following the example, multiplying 10 MHz by 3 yields 30 MHz.
- d. Calculate the difference between the marker frequency and the frequency calculated in [step c](#) above. Continuing the example, the difference would be 300 kHz.
- e. Due to span accuracy uncertainties in the microwave spectrum analyzer, the marker frequency might not equal the actual frequency. Given the marker frequency, check if the difference calculated in [step d](#) is within the appropriate tolerance:

For marker frequencies <5 MHz, tolerance =  $\pm 200$  kHz

For marker frequencies <55 MHz, tolerance =  $\pm 750$  kHz

For marker frequencies >55 MHz, tolerance =  $\pm 10$  MHz

- f. If the difference in [step d](#) is within the indicated tolerance, the signal in question is the fundamental signal (if the number in [step b](#) = 1) or a harmonic of the fundamental (if the number in [step b](#) >1). This response should be ignored.

15. Verify that the marked signal is a true response and not a random noise peak by pressing **SINGLE** to trigger a new sweep and press **Peak Search**. A true response will remain at the same frequency and amplitude on successive sweeps but a noise peak will not.

If the marked signal is *not* the fundamental or a harmonic of the fundamental (see [step 14](#)) and is a true response (see [step 15](#)), proceed with [step 17](#).

16. If the marked signal is either the fundamental or a harmonic of the fundamental (see [step 14](#)) or a noise peak (see [step 15](#)), move the marker to the next highest signal by pressing **SHIFT**, **Peak Search**. Repeat [step 14](#).

*The following step is only performed if the marker signal is not the fundamental or harmonic of the fundamental and is a true response.*

## 24. Non-Harmonic Spurious Outputs, Options 1DN and 1DQ

17. Calculate the difference between the amplitude of marked signal and the fundamental amplitude as listed in [Table 9-27](#).

For example, if the fundamental amplitude for a fundamental frequency of 10 MHz is +1.2 dBm and the marker amplitude is -40.8 dBm, the difference is -42 dBc.

Record this difference as the non-harmonic response amplitude for the appropriate spectrum analyzer center frequency and microwave spectrum analyzer start and stop frequency settings in [Table 9-28](#).

Non-Harmonic Amplitude = Marker Amplitude – Fundamental Amplitude

18. If a true non-harmonic spurious response is not found, record “NOISE” as the non-harmonic response amplitude in [Table 9-28](#) for the appropriate spectrum analyzer center frequency and microwave spectrum analyzer start and stop frequency settings.

19. Repeat [step 13](#) through [step 18](#) for the remaining microwave spectrum analyzer settings for start frequency, stop frequency, and resolution bandwidth; and for the spectrum analyzer center frequency setting of 10 MHz.

20. Repeat [step 12](#) through [step 19](#) with the spectrum analyzer center frequency set to 750 MHz.

21. Repeat [step 12](#) through [step 19](#) with the spectrum analyzer center frequency set to 1.5 GHz.

22. Locate in [Table 9-28](#) the most-positive non-harmonic response amplitude. Record this amplitude as the highest non-harmonic response amplitude in TR Entry 1 of the performance verification test record.

**Table 9-28 Non-Harmonic Responses Worksheet**

Microwave Spectrum Analyzer Settings			Non-Harmonic Response Amplitude (dBc)		
Start Freq (MHz)	Stop Freq (MHz)	Resolution Bandwidth	at 10 MHz Center Freq	at 750 MHz Center Freq	at 1.5 GHz Center Freq
9 kHz <sup>a</sup>	0.1 <sup>a</sup>	300 Hz <sup>a</sup>			
0.1 <sup>b</sup>	5.0	10 kHz			
5.0	55	100 kHz			
55	1240	1 MHz			
1240	1500	1 MHz			

a. 75 Ω RF outputs: Omit this frequency range.

b. 75 Ω RF outputs: Set the start frequency to 1 MHz.



## HP ESA-L1500A Performance Verification Test Record

**Table 10-1 HP ESA-L1500A Performance Verification Test Record**

Hewlett-Packard Company			
Address: _____		Report No. _____	
_____		Date _____	
_____			
Model HP ESA-L1500A			
Serial No. _____		Ambient temperature _____ °C	
Options _____		Power mains line frequency _____ Hz (nominal)	
Firmware Revision _____		Relative humidity _____ %	
Customer _____		Tested by _____	
<b>Test Equipment Used:</b>			
Description	Model No.	Trace No.	Cal Due Date
Synthesized sweeper	_____	_____	_____
Synthesizer/function generator	_____	_____	_____
Synthesized signal generator	_____	_____	_____
Measuring receiver	_____	_____	_____
75 Ω termination	_____	_____	_____
RF power sensor	_____	_____	_____
Low-power power sensor	_____	_____	_____
75 Ω power sensor	_____	_____	_____
1 dB step attenuator	_____	_____	_____
10 dB step attenuator	_____	_____	_____
Universal frequency counter	_____	_____	_____
Frequency standard	_____	_____	_____
Power splitter	_____	_____	_____
50 MHz low pass filter	_____	_____	_____
50 Ω termination	_____	_____	_____



<b>Hewlett-Packard Company</b>				
<b>Model HP ESA-L1500A</b>		<b>Report No. _____</b>		
<b>Serial No. _____</b>		<b>Date _____</b>		
<b>Test Description</b>	<b>Minimum</b>	<b>Results Measured</b>	<b>Maximum</b>	<b>Measurement Uncertainty</b>
<b>4. System Related Sidebands</b>				
Sideband Below Signal		(1) _____	-65 dBc	±1.31 dB
Sideband Above Signal		(2) _____	-65 dBc	±1.31 dB
<b>5. Residual FM</b>		(1) _____	150 Hz	±11.67 Hz
<b>6. Frequency Span Readout Accuracy</b>	MkrΔ Reading			
Span				
1500 MHz	1185.00 MHz	(1) _____	1215.00 MHz	±6.12MHz
100 MHz	79 MHz	(2) _____	81 MHz	±408 kHz
100 kHz	79 kHz	(3) _____	81 kHz	±408 Hz
100 MHz	79 MHz	(4) _____	81 MHz	±408 kHz
100 kHz	79 kHz	(5) _____	81 kHz	±408 Hz
100 MHz	79 MHz	(6) _____	81 MHz	±408 kHz
100 kHz	79 kHz	(7) _____	81 kHz	±408 Hz
<b>7. Reference Level Accuracy</b>				
Log Mode				
Reference Level				
dBm    dBmV				
-30    +21.76	0 (Ref)	0 (Ref)	0 (Ref)	
-20    +31.76	-0.40 dB	(1) _____	+0.40 dB	±0.194 dB
-10    +41.76	-0.50 dB	(2) _____	+0.50 dB	±0.194 dB
-40    +11.76	-0.40 dB	(3) _____	+0.40 dB	±0.206 dB
-50    +1.76	-0.50 dB	(4) _____	+0.50 dB	±0.206 dB

<b>Hewlett-Packard Company</b>  <b>Model HP ESA-L1500A</b> <span style="float: right;"><b>Report No.</b> _____</span> <b>Serial No.</b> _____ <span style="float: right;"><b>Date</b> _____</span>				
Test Description	Minimum	Results Measured	Maximum	Measurement Uncertainty
-60    -8.24 -70    -18.24 -80    -28.24 -90    -38.24	-0.60 dB -1.00 dB -1.10 dB -1.20 dB	<b>(5)</b> _____ <b>(6)</b> _____ <b>(7)</b> _____ <b>(8)</b> _____	+0.60 dB +1.00 dB +1.10 dB +1.20 dB	±0.206 dB ±0.206 dB ±0.206 dB ±0.206 dB
<b>Linear Mode</b>  <b>Reference Level</b> dBm    dBmV -30    +21.76 -20    +31.76 -10    +41.76 -40    +11.76 -50    +1.76 -60    -8.24 -70    -18.24 -80    -28.24 -90    -38.24	0 (Ref) -0.40 dB -0.50 dB -0.40 dB -0.50 dB -0.60 dB -1.00 dB -1.10 dB -1.20 dB	0 (Ref) <b>(9)</b> _____ <b>(10)</b> _____ <b>(11)</b> _____ <b>(12)</b> _____ <b>(13)</b> _____ <b>(14)</b> _____ <b>(15)</b> _____ <b>(16)</b> _____	0 (Ref) +0.40 dB +0.50 dB +0.40 dB +0.50 dB +0.60 dB +1.00 dB +1.10 dB +1.20 dB	±0.194 dB ±0.194 dB ±0.206 dB ±0.206 dB ±0.206 dB ±0.206 dB ±0.206 dB ±0.206 dB
<b>8. Scale Fidelity</b>  <b>Log Mode</b> dB from Ref Level 0 -4 -8 -12 -16 -20	<b>Cumulative Error</b>			
	0 (Ref) -4.34 dB -8.38 dB -12.42 dB -16.46 dB -20.50 dB	0 (Ref) <b>(1)</b> _____ <b>(2)</b> _____ <b>(3)</b> _____ <b>(4)</b> _____ <b>(5)</b> _____	0 (Ref) -3.66 dB -7.62 dB -11.58 dB -15.54 dB -19.50 dB	±0.165 dB ±0.133 dB ±0.133 dB ±0.133 dB ±0.132 dB



Performance Verification Test Record  
 HP ESA-L1500A Performance Verification Test Record

<b>Hewlett-Packard Company</b> <b>Model HP ESA-L1500A</b> <span style="float: right;"><b>Report No.</b> _____</span> <b>Serial No.</b> _____ <span style="float: right;"><b>Date</b> _____</span>				
Test Description	Minimum	Results Measured	Maximum	Measurement Uncertainty
-24	-24.54 dB	<b>(6)</b> _____	-23.46 dB	±0.133 dB
-28	-28.58 dB	<b>(7)</b> _____	-27.42 dB	±0.133 dB
-32	-32.62 dB	<b>(8)</b> _____	-31.38 dB	±0.133 dB
-36	-36.66 dB	<b>(9)</b> _____	-35.34 dB	±0.133 dB
-40	-40.70 dB	<b>(10)</b> _____	-39.30 dB	±0.132 dB
-44	-44.74 dB	<b>(11)</b> _____	-43.26 dB	±0.133 dB
-48	-48.78 dB	<b>(12)</b> _____	-47.22 dB	±0.133 dB
-52	-52.82 dB	<b>(13)</b> _____	-51.18 dB	±0.133 dB
-56	-56.86 dB	<b>(14)</b> _____	-55.14 dB	±0.149 dB
-60	-60.90 dB	<b>(15)</b> _____	-59.10 dB	±0.149 dB
-64	-64.94 dB	<b>(16)</b> _____	-63.06 dB	±0.150 dB
-68	-68.98 dB	<b>(17)</b> _____	-67.02 dB	±0.150 dB
-72	-73.02 dB	<b>(18)</b> _____	-70.98 dB	±0.150 dB
-76	-77.06 dB	<b>(19)</b> _____	-74.94 dB	±0.150 dB
-80	-81.10 dB	<b>(20)</b> _____	-78.90 dB	±0.149 dB
-84	-85.14 dB	<b>(21)</b> _____	-82.86 dB	±0.150 dB
Log Mode dB from Ref Level	Incremental Error			
0	0 (Ref)	0 (Ref)	0 (Ref)	
-4	-0.4 dB	<b>(22)</b> _____	+0.4 dB	±0.165 dB
-8	-0.4 dB	<b>(23)</b> _____	+0.4 dB	±0.133 dB
-12	-0.4 dB	<b>(24)</b> _____	+0.4 dB	±0.133 dB
-16	-0.4 dB	<b>(25)</b> _____	+0.4 dB	±0.133 dB
-20	-0.4 dB	<b>(26)</b> _____	+0.4 dB	±0.132 dB
-24	-0.4 dB	<b>(27)</b> _____	+0.4 dB	±0.133 dB

<b>Hewlett-Packard Company</b> <b>Model HP ESA-L1500A</b> <span style="float: right;"><b>Report No.</b> _____</span> <b>Serial No.</b> _____ <span style="float: right;"><b>Date</b> _____</span>				
Test Description	Minimum	Results Measured	Maximum	Measurement Uncertainty
-28	-0.4 dB	(28) _____	+0.4 dB	±0.133 dB
-32	-0.4 dB	(29) _____	+0.4 dB	±0.133 dB
-36	-0.4 dB	(30) _____	+0.4 dB	±0.133 dB
-40	-0.4 dB	(31) _____	+0.4 dB	±0.132 dB
-44	-0.4 dB	(32) _____	+0.4 dB	±0.133 dB
-48	-0.4 dB	(33) _____	+0.4 dB	±0.133 dB
-52	-0.4 dB	(34) _____	+0.4 dB	±0.133 dB
-56	-0.4 dB	(35) _____	+0.4 dB	±0.149 dB
-60	-0.4 dB	(36) _____	+0.4 dB	±0.149 dB
-64	-0.4 dB	(37) _____	+0.4 dB	±0.150 dB
-68	-0.4 dB	(38) _____	+0.4 dB	±0.150 dB
Linear Mode dB from Ref Level  0 -4 -8 -12 -16 -20	0 (Ref) -3.0% -3.0% -3.0% -3.0% -3.0%	0 (Ref) (39) _____ (40) _____ (41) _____ (42) _____ (43) _____	0 (Ref) +3.0% +3.0% +3.0% +3.0% +3.0%	±1.21% ±0.63% ±0.40% ±0.22% ±0.16%
<b>9. Input Attenuation Switching Uncertainty</b> Attenuation  0 5 15	-0.30 dB -0.30 dB -0.30 dB	(1) _____ (2) _____ (3) _____	+0.30 dB +0.30 dB +0.30 dB	±0.192 dB ±0.192 dB ±0.179 dB

<b>Hewlett-Packard Company</b>				
<b>Model HP ESA-L1500A</b>		<b>Report No. _____</b>		
<b>Serial No. _____</b>		<b>Date _____</b>		
<b>Test Description</b>	<b>Minimum</b>	<b>Results Measured</b>	<b>Maximum</b>	<b>Measurement Uncertainty</b>
20	-0.30 dB	<b>(4)</b> _____	+0.3 dB	±0.179 dB
25	-0.35 dB	<b>(5)</b> _____	+0.35 dB	±0.179 dB
30	-0.40 dB	<b>(6)</b> _____	+0.40 dB	±0.179 dB
35	-0.45 dB	<b>(7)</b> _____	+0.45 dB	±0.179 dB
40	-0.50 dB	<b>(8)</b> _____	+0.50 dB	±0.179 dB
45	-0.55 dB	<b>(9)</b> _____	+0.55 dB	±0.179 dB
50	-0.60 dB	<b>(10)</b> _____	+0.60 dB	±0.179 dB
55	-0.65 dB	<b>(11)</b> _____	+0.65 dB	±0.179 dB
60	-0.70 dB	<b>(12)</b> _____	+0.70 dB	±0.179 dB
<b>10. Resolution Bandwidth Accuracy</b>				
3 dB Resolution Bandwidth				
3 MHz	2.4 MHz	<b>(1)</b> _____	3.6 MHz	±33 kHz
1 MHz	0.8 MHz	<b>(2)</b> _____	1.2 MHz	±11 kHz
300 kHz	240 kHz	<b>(3)</b> _____	360 kHz	±3.3 kHz
100 kHz	80 kHz	<b>(4)</b> _____	120 kHz	±1.1 kHz
30 kHz	24 kHz	<b>(5)</b> _____	36 kHz	±330 Hz
10 kHz	8 kHz	<b>(6)</b> _____	12 kHz	±110 Hz
3 kHz	2.4 kHz	<b>(7)</b> _____	3.6 kHz	±33 Hz
1 kHz	0.8 kHz	<b>(8)</b> _____	1.2 kHz	±11 Hz

<b>Hewlett-Packard Company</b>				
<b>Model HP ESA-L1500A</b>		<b>Report No. _____</b>		
<b>Serial No. _____</b>		<b>Date _____</b>		
<b>Test Description</b>	<b>Minimum</b>	<b>Results Measured</b>	<b>Maximum</b>	<b>Measurement Uncertainty</b>
<b>11. Frequency Readout Accuracy and Marker Count Accuracy</b>  Frequency Readout Accuracy  Span 10 MHz 100 kHz Marker Count Accuracy Counter Resolution 1 Hz	Frequency (MHz)			
	1.48988	(1) _____	1.49012	0 Hz
	1.4899988	(2) _____	1.4900012	0 Hz
	1.489999999	(3) _____	1.490000001	0 Hz
<b>12. Absolute Amplitude Accuracy</b>	-0.30 dB	(1) _____	+0.30 dB	±0.131 dB
<b>13. Frequency Response</b>  Max Positive Response (20 to 30 °C)  Max Negative Response (20 to 30 °C)  Max Positive Response (0 to 55 °C)  Max Negative Response (0 to 55 °C)		(1) _____	+0.75 dB	±0.284 dB
	-0.75 dB	(2) _____		±0.284 dB
		(1) _____	+1.0 dB	±0.284 dB
	-1.0 dB	(2) _____		±0.284 dB

<b>Hewlett-Packard Company</b>				
<b>Model HP ESA-L1500A</b>		<b>Report No.</b> _____		
<b>Serial No.</b> _____		<b>Date</b> _____		
<b>Test Description</b>	<b>Minimum</b>	<b>Results Measured</b>	<b>Maximum</b>	<b>Measurement Uncertainty</b>
<b>14. Spurious Responses</b>				
Second Harmonic Distortion		(1) _____	-55 dBc	±1.41 dB
Third Order Intermodulation Distortion, 50 Ω Input				
50 MHz		(2) _____	+7 dBm	±1.02 dB
900 MHz		(3) _____	+7 dBm	±1.02 dB
1450 MHz		(4) _____	+7 dBm	±1.02 dB
Third Order Intermodulation Distortion, 75 Ω Input				
50 MHz		(5) _____	+59.46 dBmV	±1.02 dB
900 MHz		(6) _____	+59.46 dBmV	±1.02 dB
1450 MHz		(7) _____	+57.76 dBmV	±1.02 dB
<b>15. Gain Compression</b>				
		(1) _____	1.0 dB	±0.22 dB
<b>16. Other Input Related Spurious Responses</b>				
542.8 MHz		(1) _____	-65 dBc	±1.22 dB
510.7 MHz		(2) _____	-65 dBc	±1.22 dB
1310.7 MHz		(3) _____	-45 dBc	±1.22 dB
<b>17. Sweep Time Accuracy</b>				
Sweep Time	MkrΔ Reading			
20 ms	15.8 ms	(1) _____	16.2 ms	±104.5 μs
100 ms	79.0 ms	(2) _____	81.0 ms	±523 μs
1 s	790.0 ms	(3) _____	810.0 ms	±5.23 ms
10 s	7.90 s	(4) _____	8.10 s	±52.3 ms

Hewlett-Packard Company				
Model HP ESA-L1500A		Report No. _____		
Serial No. _____		Date _____		
Test Description	Minimum	Results Measured	Maximum	Measurement Uncertainty
<b>18. Displayed Average Noise Level</b>  Frequency (50 Ω Input) 400 kHz 1 MHz to 10 MHz 10 MHz to 500 MHz 500 MHz to 1.2 GHz 1.2 GHz to 1.5 GHz		(1) _____	-115 dBm	±1.51 dB
		(2) _____	-115 dBm	±1.51 dB
		(3) _____	-120 dBm	±1.51 dB
		(4) _____	-116 dBm	±1.51 dB
		(5) _____	-113 dBm	±1.51 dB
Frequency (75 Ω Input) 1 MHz to 10 MHz 10 MHz to 500 MHz 500 MHz to 1.0 GHz 1.0 GHz to 1.5 GHz		(6) _____	-63 dBmV	±1.51 dB
		(7) _____	-65 dBmV	±1.51 dB
		(8) _____	-60 dBmV	±1.51 dB
		(9) _____	-53 dBmV	±1.51 dB
<b>19. Residual Responses</b>  150 kHz to 1.5 GHz (50 Ω Input)  1 MHz to 1.5 GHz (75 Ω Input)		(1) _____	-90 dBm	±1.12 dB
		(1) _____	-36 dBmV	±1.12 dB
<b>20. Tracking Generator Feedthrough</b>  <i>Option 1DN only:</i> ≤ 1 MHz > 1 MHz to ≤500 MHz > 500 MHz to ≤1.2 GHz > 1.2 GHz to ≤1.5 GHz		(1) _____	-116 dBm	±1.51 dB
		(2) _____	-120 dBm	±1.51 dB
		(3) _____	-116 dBm	±1.51 dB
		(4) _____	-113 dBm	±1.51 dB







Performance Verification Test Record  
HP ESA-L1500A Performance Verification Test Record

## Symbols

% AM On Off, 91  
(Local) key, 105

## Numerics

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