

Instrument Messages and Functional Tests

Agilent Technologies PSA Spectrum Analyzers

This manual provides documentation for the following instrument:

Agilent Technologies PSA Series

E4440A (3 Hz – 26.5 GHz)



Agilent Technologies

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Documentation is updated periodically. For the latest information about Agilent PSA spectrum analyzers, including firmware upgrades and application information, see: <http://www.agilent.com/find/psa>.

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1 Instrument Messages

This chapter describes the following types of messages displayed on the analyzer:

- **Error Messages**, beginning on [page 2](#), appear at the bottom of the screen in the status line.

These messages normally indicate that a user-error has occurred as a result of either front-panel or remote interface activity.

- **Informational Messages**, beginning on [page 16](#), appear at the bottom of the screen in the status line

These messages simply provide information; you are not required to do anything.

- **Status Messages**, beginning on [page 17](#), appear in the upper-right portion of the screen grid

These messages indicate conditions that can cause the display of incorrect data.

Error Messages

Error messages appear at the bottom of the screen in the status line (in yellow on color displays). This section provides information to help you understand and resolve errors:

- An overview of error queues, below.
- An overview of the information provided in an error message, on [page 3](#).
- A description of the types of error messages, on [page 4](#).
- A description of error messages, grouped by type, beginning on [page 5](#).

Error Queues

There are two types of errors in the instrument, and two corresponding error queues:

- Front panel
- Remote interface (SCPI)

If an error condition occurs, it may be reported to both error queues.

These two queues are viewed and managed separately, as described in the following table.

Characteristic	Front-Panel Display Error Queue	SCPI Remote Interface Error Queue
Capacity (number of errors)	11	30
Overflow Handling	Circular (rotating). Drops oldest error as new error comes in.	Linear, first-in/first-out. Replaces newest error with: <code>-350,Queue overflow</code>
Viewing Entries	Press: System, Show Errors ^a	Use SCPI query <code>SYSTEM:ERRor?</code>
Clearing the Queue	Press: System, Show Errors, Clear Error Queue	Power up. Send a <code>*CLS</code> command. Read last item in the queue.

a. Error history includes the date and time an error last occurred, the error number, the error message, and the number of times the error occurred.

Error Message Information

The system-defined error numbers are chosen on an enumerated (“1 of N”) basis. The *<error description>* portion of the error query response (*not* the number) appears at the bottom of the screen in the status line (in yellow on color displays).

NOTE To see an error *number*, view the error queue as described on [page 2](#).

In this chapter, an explanation is included with each error to further clarify its meaning. The last error described in each class (for example, -400, -300, -200, -100) is a “generic” error. In selecting the proper error number to report, more specific error codes are preferred.

There are also references in this chapter to the IEEE Standard 488.2-1992, *IEEE Standard Codes, Formats, Protocols and Common Commands for Use with ANSI/IEEE Std 488.1-1987*. New York, NY, 1992.

Error Message Types

Events do not generate more than one type of error. For example, an event that generates a query error will not generate a device-specific, execution, or command error.

Query Errors (-499 to -400) indicate that the instrument output queue control has detected a problem with the message exchange protocol described in IEEE 488.2, Chapter 6. Errors in this class set the query error bit (bit 2) in the event status register (IEEE 488.2, section 11.5.1). These errors correspond to message exchange protocol errors described in IEEE 488.2, 6.5. In this case:

- Either an attempt is being made to read data from the output queue when no output is either present or pending, or
- data in the output queue has been lost.

Device-Specific Errors (-399 to -300 and 102 to 799) indicate that a device operation did not properly complete, possibly due to an abnormal hardware or firmware condition. These codes are also used for self-test response errors. Errors in this class set the device-specific error bit (bit 3) in the event status register (IEEE 488.2, section 11.5.1).

The <error_message> string for a *positive* error is not defined by SCPI. A positive error indicates that the instrument detected an error within the GPIB system, within the instrument's firmware or hardware, during the transfer of block data, or during calibration.

Execution Errors (-299 to -200) indicate that an error has been detected during instrument execution.

Command Errors (-199 to -100) indicate that the instrument parser detected an IEEE 488.2 syntax error. Errors in this class set the command error bit (bit 5) in the event status register (IEEE 488.2, section 11.5.1). In this case:

- Either an IEEE 488.2 syntax error has been detected by the parser (a control-to-device message was received that is in violation of the IEEE 488.2 standard. Possible violations include a data element which violates device listening formats or whose type is unacceptable to the device.), or
- an unrecognized header was received. These include incorrect device-specific headers and incorrect or unimplemented IEEE 488.2 common commands.

0: No Error

NOTE Error numbers are displayed in the error queue, *not* on the display.
To see an error *number*, view the error queue as described on [page 2](#).

0 No error

The queue is empty. Either every error in the queue has been read, or the queue was cleared by power-on or *CLS.

–499 to –400: Query Errors

The instrument output queue control has detected a problem with the message exchange protocol described in IEEE 488.2, Chapter 6. Errors in this class set the query error bit (bit 2) in the event status register (IEEE 488.2, section 11.5.1). These errors correspond to message exchange protocol errors described in IEEE 488.2, 6.5.

In this case, either an attempt is being made to read data from the output queue when no output is either present or pending, or data in the output queue has been lost.

NOTE Error numbers are displayed in the error queue, *not* on the display.

To see an error *number*, view the error queue as described on [page 2](#).

–400 Query Error

This is a generic query error for devices that cannot detect more specific errors. The code indicates only that a query error as defined in IEE 488.2, 11.5.1.1.7 and 6.3 has occurred.

–399 to –300: Device-Specific Errors

Some device operations did not properly complete, possibly due to an abnormal hardware or firmware condition. These codes are also used for self-test response errors. Errors in this class set the device-specific error bit (bit 3) in the event status register (IEEE 488.2, section 11.5.1).

NOTE Error numbers are displayed in the error queue, *not* on the display.
To see an error *number*, view the error queue as described on [page 2](#).

- 330 Self-test failed; EEPROM checksum for <card>
- The card identification header for a hardware card is incorrect. If the card is not properly identified, the instrument is likely to be non-functional. Report this error to the nearest Agilent Technologies sales or service office.
- 321 Out of memory
- An internal operation needed more memory than was available. Report this error to the nearest Agilent Technologies sales or service office.
- 310 System error
- An internal system problem was detected. Report this error to the nearest Agilent Technologies sales or service office.
- 300 Device-specific error
- This is a generic device-dependent error for devices that cannot detect more specific errors. The code indicates only that a device-dependent error as defined in IEEE 488.2, 11.5.1.1.6 has occurred. Report this error to the nearest Agilent Technologies sales or service office.

-299 to -200: Execution Errors

An error has been detected by the instrument's execution control block. Errors in this class set the execution error bit (bit 4) in the event status register (IEEE 488.2, section 11.5.1).

NOTE Error numbers are displayed in the error queue, *not* on the display.
To see an error *number*, view the error queue as described on [page 2](#).

- 253 Corrupt media
A removable media was found to be bad or incorrectly formatted. Any existing data on the media may have been lost.
- 250 Mass storage error; EEPROM write timeout on EEPROM
Failure to initialize EEPROM. Report this error to the nearest Agilent Technologies sales or service office.
- 241 Hardware missing
Missing device hardware. For example, an option is not installed.

Hardware missing; no such SIO address
The expected board is not installed. Report this error to the nearest Agilent Technologies sales or service office.
- 230 Data corrupt or stale
Possibly invalid data. A new measurement was started but not completed.
- 224 Illegal parameter value
You have sent a parameter for this command that is not allowed. See the Function Reference.
- 222 Data out of range
A legal program data element was parsed but could not be executed because the interpreted value was outside the legal range defined by the device (see IEEE 488.2 11.5.1.1.5).
- 221 Settings conflict; Command incompatible with span pair marker
Using remote commands, you have tried to adjust the start or stop frequency of a span pair marker. You can adjust only the center and span.

Settings conflict; Command incompatible with band pair marker

Using remote commands, you have tried to adjust the center frequency or span of a delta pair marker. You can adjust only the reference marker frequency or the delta marker frequency.

-200 Execution Error

For devices that cannot detect more specific errors, this code indicates only that an execution error as defined in IEEE 488.2, 11.5.1.1.5 has occurred.

–199 to –100: Command Errors

The instrument parser detected an IEEE 488.2 syntax error. Errors in this class set the command error bit (bit 5) in the event status register (IEEE 488.2, section 11.5.1). In this case:

- Either an IEEE 488.2 syntax error has been detected by the parser (a control-to-device message was received that is in violation of the IEEE 488.2 standard. Possible violations include a data element which violates device listening formats or whose type is unacceptable to the device.), or
- an unrecognized header was received. These include incorrect device-specific headers and incorrect or unimplemented IEEE 488.2 common commands.

NOTE Error numbers are displayed in the error queue, *not* on the display.
To see an error *number*, view the error queue as described on [page 2](#).

–120 Numeric data error

This error (and errors –121 through –129) is generated when parsing a data element that appears to be numeric, including non-decimal numeric types. This message is used if the device cannot detect a more specific error.

–100 Command error

This is a generic syntax error for devices that cannot detect more specific errors. The code indicates only that a command error as defined in IEEE 488.2, 11.5.1.1.4 has occurred.

102 to 799: Device-Specific Errors

Some device operations did not properly complete, possibly due to an abnormal hardware or firmware condition. These codes are also used for self-test response errors. Errors in this class set the device-specific error bit (bit 3) in the event status register (IEEE 488.2, section 11.5.1).

The *<error message>* string for a *positive* error is not defined by SCPI. A positive error indicates that the instrument detected an error within the GPIB system, within the instrument firmware or hardware, during the transfer of block data, or during calibration.

NOTE Error numbers are displayed in the error queue, *not* on the display.
To see an error *number*, view the error queue as described on [page 2](#).

102	High 50MHz Power Level	There is too much 50 MHz energy at the RF port for alignments to run. Reduce input power and run alignments again.
103	Sampling Oscillator Unlock	Report this error to the nearest Agilent Technologies sales or service office.
104	1st LO Unlock	The first LO on has lost phase lock. Report this error to the nearest Agilent Technologies sales or service office.
105	2nd LO Unlock	The second LO has lost phase lock. Report this error to the nearest Agilent Technologies sales or service office.
106	4th LO Unlock	The fourth LO has lost phase lock. Report this error to the nearest Agilent Technologies sales or service office.
107	Sample Clock Unlock	Report this error to the nearest Agilent Technologies sales or service office.
108	Cal Oscillator Unlock	Report this error to the nearest Agilent Technologies sales or service office.

- 202 No peak found
No peak found that meets the criteria under **Peak Search, Search Param.**
- 208 Unable to execute preselector centering, not tuned to YTF band
You tried to center the preselector with the analyzer frequency too low. Preselector centering can be performed only for frequencies above 3.025 GHz.
- 209 Preselector centering failed, Narrow the span and try again
You tried to center the preselector with the analyzer span too wide. Preselector centering can be performed only for spans below 1.123 GHz.
- 601 File not found
The analyzer could not find the specified file.
- 602 Media is protected
A save was attempted to a write-protected device.
- 604 File name error
An invalid file name was specified. Use filenames with a maximum of 8 characters (letters and digits only), and use a 3-character extension. File names are not case-sensitive. This error also occurs if you try to delete a nonexistent file.

The following messages represent additional conditions that can generate this error:
- File name error; Directory does not have a default file type
 - File name error; Directory does not support extenders
 - File name error; Empty filename
 - File name error; Illegal extender
 - File name error; Illegal filename character
 - File name error; Only one : is allowed
 - File name error; Only one extender character allowed
- 605 Data corrupt or stale; EEPROM copy of <file>
The EEPROM copy of an internal file is either corrupt or otherwise unusable. The system automatically updates the non-volatile RAM copy of the EEPROM copy using a default initialization. The actual EEPROM file is left as it is. Report this error to the nearest Agilent Technologies sales or service office.

Data corrupt or stale; RAM copy of <file>
The non-volatile RAM copy of an internal file is either corrupt or is out of date with the EEPROM master copy (if one exists). The system automatically re-initializes the file from EEPROM (if appropriate) or from a default algorithm. A potential cause is a failing backup battery. Report this error to the nearest Agilent Technologies sales or service office.

- 606 Data questionable; EEPROM copy of <file>
EEPROM error occurred. The EEPROM copy of an internal file is either corrupt or otherwise unusable. The system automatically updates the non-volatile RAM copy of the EEPROM copy using a default initialization. The actual EEPROM file is left as it is. Report this error to the nearest Agilent Technologies sales or service office.
- 610 File access is denied
The file is protected and cannot be accessed.
- 615 File exists
You attempted to save to a file that already exists. Either delete the existing file or select a new name, then try again.
- 619 Can't Auto-Couple RBW in Zero Span
You sent a remote command to set the RBW into auto while in zero span.
- 620 Can't Auto-Couple Sweep Time in Zero Span
You sent a remote command to set the sweep time to auto while in zero span.
- 622 External reference missing or out of range
The external frequency reference signal is missing, has too low an amplitude, or does not match the frequency value that you previously entered into instrument memory.
- 623 Printer not responding
Check the printer. It may not be connected properly or turned on.
- 627 Media not writable
A save was attempted to a device that could not be written to. Try a known-good disk.
- 751 Instrument state may be corrupt, state has been reset to initial values
While trying to load a trace or state, the state information was found to be in error. This may be because the state had been stored on a later revision of analyzer firmware. A default set of state variables was loaded instead. There is nothing wrong with the analyzer.
- 752 Unable to load state from file

Attempt to load a state from a file failed.

753 Unable to save state to file

Attempt to save a state to a file failed. See the associated error messages for the cause (press **System, Show Errors**).

755 Unable to load state from register

Attempt to load a state from an internal state register failed.

756 Unable to save state to register

Attempt to save a state to an internal state register failed. See the associated error messages for the cause (press **System, Show Errors**).

757 Unable to load user state, factory preset was done

A user preset failed, so the factory preset values were used. Save a valid state into user preset and try again.

758 Unable to save user state

Attempt to save a user preset state failed. See the associated error messages for the cause (press **System, Show Errors**).

763 Bad, missing, or unformatted disk

The floppy disk is not inserted properly, is not formatted, or the directory cannot be read. Insert a known good disk and try again.

764 Unable to save file

Attempt to save a file failed; the file was not saved. See the associated error messages for the cause (press **System, Show Errors**).

765 Unable to load file

Attempt to load a file failed; the file was not loaded.

- 767 Failed to Initialize ISTATE regions. Fatal LDS error
Attempt to initialize the instrument state has failed. Cycle instrument power. If this fails to correct the problem, contact your nearest Agilent Technologies service center.
- 768 Unable to load user state, required instrument mode is not installed
Attempt to load a state failed, because the state was saved with a measurement personality that is not currently loaded. Load the appropriate personality and try again.
- 770 Incorrect filename, allowable extensions are .gif or .wmf
You sent a remote command to save a screen file but did not specify a valid extension.
- Incorrect filename, allowable extension is .sta
You sent a remote command to save a state file but did not specify a valid extension.
- Incorrect filename, allowable extensions are .trc or .csv
You sent a remote command to save a trace file but did not specify a valid extension.
- 781 Video Trigger cannot be active with Average Detector
You sent a remote command to do one of the following:
- Turn on video trigger while the Average Detector or a Marker Function is active.
 - Turn on the Average Detector or a Marker Function while Video Trigger is active.

Informational Messages

These messages simply provide information; you are not required to do anything. Information in brackets (such as <directoryname>), is a previously-provided input.

Informational messages appear at the bottom of the screen in the status line.

<directoryname> directory deleted

The directory indicated has been successfully deleted.

<directoryname1> directory renamed to <directoryname2>

Directory name1 has been successfully renamed to directory name2.

<filename> file loaded

The filename indicated has been successfully loaded.

<filename> file saved

The filename indicated has been successfully saved.

<filename> file copied

The filename indicated has been successfully copied.

<filename> file deleted

The filename indicated has been successfully deleted.

<filename1> file renamed to <filename2>

Filename1 has been successfully renamed to filename2.

Directory already exists

Each directory and file must have a unique name. The directory name you have entered is currently being used on the selected drive. You may either enter a new name or rename the directory currently existent.

Status Messages

These messages indicate conditions that can cause the display of incorrect data. The name of the corresponding status bit appears in parenthesis. Some messages display *only* the status bit (as noted).

Status messages appear in the upper right portion of the screen grid.

* (Invalid Data)

Data on the screen may not match the screen annotation. For example, while analyzer settings are changing or when any trace is in view mode.

1st IF Overload (IF/ADC Over Range)

The IF section has been overloaded. Measurement results may be invalid.

50 MHz Osc Unlevel (50 MHz Osc Unleveled)

The internal 50 MHz amplitude reference source has become unlevelled. This condition must be corrected before a valid alignment can be performed.

(ADC Align Failure) *status bit only, no message*

The alignment routine was unable to align the analog-to-digital converter (ADC).

System, Alignments, Align All Now Needed (Align Needed)

The instrument requires an **Align All Now**. Restore the alignment by pressing **System, Alignments, Align All Now**.

Ext Ref (*no corresponding status bit*)

The frequency reference is being supplied by an external 10 MHz source.

Final IF Overload (IF/ADC Overrange)

The final IF section has been overloaded. Measurement results may be invalid.

First IF Overload (IF/ADC Overrange)

The first IF section has been overloaded. Measurement results may be invalid. Either increase the input attenuation or decrease the input level.

Instrument Messages

Status Messages

Freq Count: Reduce Span/RBW ratio

The span is too wide for the current resolution bandwidth. Either reduce the span or increase the RBW.

Frequency Reference Error (Freq Ref Unlocked)

The frequency reference has been tuned too far off of 10 MHz. This condition may be corrected by cycling power on the analyzer.

(IF Align Failure) *status bit only, no message*

A failure has occurred during the IF alignment. Measurement results may be invalid.

LO Out Unlevel (LO Out Unleveled)

Indicates the output of the local oscillator (LO) has become unlevelled. This condition must be corrected to make valid measurements.

LO Unlevel (LO Unleveled)

Indicates the internal circuitry of the local oscillator (LO) has become unlevelled. This condition must be corrected to make valid measurements.

LO Unlock (Synth Unlocked)

Indicates the phase locked circuitry of the local oscillator (LO) has become unlocked. This condition must be corrected to make valid measurements.

Meas Uncal (Oversweep)

The measurement is uncalibrated. Check the sweep time, span and bandwidth settings, or press **Auto Couple**.

(RF Align Failure) *status bit only, no message*

A failure has occurred during the alignment of the RF section. Measurement results may be invalid.

2 Functional Tests

These tests, which check various instrument parameters, offer a high degree of confidence that the instrument is operating correctly. These tests are recommended as a check of instrument operation (incoming inspection or after a repair). These tests are also designed to test an instrument (operating within the temperature range defined by the instrument specifications) using a minimum set of test equipment.

NOTE The instrument is checked against limits that are wider than the published specifications. Measurement uncertainty analysis is *not* available for functional tests.

This chapter includes the following:

- **Getting Started** (pre-test conditions and specifications)
- **Required Test Equipment** (summarized list)
- **Functional Tests** include the following (beginning on [page 23](#)):
 - Test Limits (pass/fail criteria)
 - Test Descriptions
 - Required Test Equipment (specific to each test)
 - Graphical Interpretations of Test Setups (figures)
 - Test Procedures
 - Tables for Recording Measurement Data

List of Functional Tests

- Amplitude Accuracy at 50 MHz on [page 23](#)
- Displayed Average Noise Level on [page 27](#)
- Frequency Readout Accuracy on [page 30](#)
- Frequency Response (Flatness) on [page 32](#)
- Amplitude Linearity on [page 36](#)
- Second Harmonic Spurious Responses on [page 39](#)

Functional Tests vs. Performance Verification Tests

The functional tests check a much smaller range of parameters and a limited number of data points for each parameter. They require only limited test equipment.

NOTE If a functional test does not pass, performance verification tests must be run to confirm that a problem exists.

Performance verification tests span a wide range of instrument parameters and provide the highest level of confidence that the instrument conforms to published specifications. These tests are time consuming and require extensive test equipment.

Getting Started

Performing Functional Tests

1. Ensure that you have the proper test equipment.
2. Switch on the unit under test (UUT) and let it warm up (in accordance with warm-up requirements in the instrument specifications).
3. Allow sufficient warm-up time for the required test equipment (refer to individual instrument documentation for warm-up specifications).
4. Ensure that the frequency reference is set to *Internal*. To test that the instrument is set up properly, press the **Input/Output** key. The **Freq Ref** softkey should have *Int* underlined. If not, press the **Freq Ref** softkey until *Int* is underlined.
5. Following instrument warm-up, perform the auto align routine by pressing the **System, Alignment,** and **Align All Now** keys.

NOTE Functional test accuracy depends on the precision of the test equipment used. Ensure that all of the test equipment is calibrated before running a functional test.

Required Test Equipment

The table below outlines the required test equipment needed to perform the functional tests. Alternate equipment model numbers are given in case the recommended equipment is not available.

If neither the recommended nor the alternative test equipment are available, you may use substitute equipment that meets or exceeds the critical specifications required to perform the functional tests.

Table 2-1 Required Equipment List

Item	Critical Specifications	Recommended Agilent Model Number	Alternate Agilent Model Number
Adapters			
3.5 mm(f) to 3.5mm(f) (connector saver for 83630B)		5061-5311	
3.5 mm(f) to N(f)		1250-1745	
BNC(f) to SMA(m)		1250-1200	
BNC(m) to SMA(f)		1250-1700	
Type N(f) to BNC(m)		1250-1534	
Type N(f) to N(f)		1250-1472	1250-0777
Type N(m) to 3.5 mm(f)		1250-1744	
Type N(m) to 3.5 mm(m)		1250-1743	
Type N(m) to BNC(f)		1250-1476	
Attenuators			
10 dB Step Attenuator	<i>Range: 0 to 60 dB</i>	355D	
20 dB Fixed Attenuator	<i>Accuracy: < 0.5 dB</i>	8491A	8491B
Cables			
APC 3.5 mm (1 meter)		8120-4921	
Cable, BNC (2 required)	120 cm (48 in.) BNC cable	10503A	
Signal Source			
Synthesized Sweeper	<i>Frequency: 10 MHz to 26.5 GHz Harmonic level: < -40 dBc Amplitude range: 10 to -20 dBm Frequency Accuracy: 0.02%</i>	83630B	83640B, 83650B

Table 2-1 Required Equipment List (Continued)

Item	Critical Specifications	Recommended Agilent Model Number	Alternate Agilent Model Number
Miscellaneous Equipment			
Filter, 50 MHz Low Pass	<i>Cutoff Frequency: 50 MHz Rejection at 65 MHz: > 40 dB Rejection at 75 MHz: > 60 dB</i>	0955-0306	
Power Meter	<i>Power Reference Accuracy: ±1.2% Compatible with power sensor</i>	E4418B	E4419B
Power Sensor	<i>Frequency Range: 50 MHz to 26.5 GHz Amplitude Range: -25 to 10 dBm</i>	8485A	E4413A
Power Splitter, 3.5 mm	<i>Nominal Insertion Loss: 6 dB Tracking Between Ports: < 0.25 dB</i>	11667B	11667A
Termination, 50Ω	<i>Type N(m) Connector Frequency: 1 MHz to 4 GHz</i>	909A Option 012	

Amplitude Accuracy at 50 MHz

Test Limits

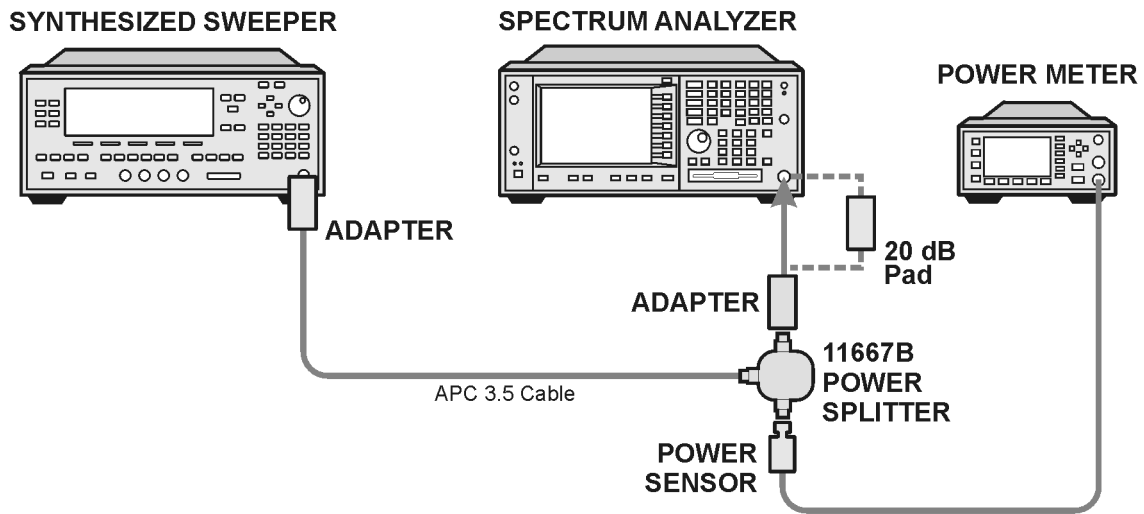
Amplitude Accuracy should remain within ± 0.5 dB of the measured source value across the range of source levels and changes in resolution bandwidth. Option 1DS (preamp option) should remain within ± 1.2 dB of measured values.

Test Description

A synthesized sweeper is used as the signal source for the test. The source amplitude is varied using the signal source amplitude control. The resolution bandwidth is also varied on the spectrum analyzer. The source amplitude is measured by the power meter and spectrum analyzer at each setting, and the values compared. The difference between each pair of measurements indicates the amplitude accuracy.

Item	Critical Specifications	Recommended Agilent Model Numbers
Adapter	Type-N(m), to 3.5 mm(m)	1250-1743
Adapter	3.5 mm(f) to 3.5 mm(f)	5061-5311
Attenuator, 20 dB	<i>Accuracy: < 0.5 dB</i>	8491A
Cable	APC 3.5 mm, 1 meter	8120-4921
Power Meter	Compatible with power sensor	E4418B
Power Sensor	<i>Amplitude Range: -25 dBm to 10 dBm</i>	8485A
Power Splitter	3.5 mm 6 dB loss	11667B
Synthesized Sweeper	<i>Typical Temperature Stability: 0.01 dBc/°C</i>	83630B

Figure 2-1 Amplitude Accuracy Test Setup



Procedure

1. Zero and calibrate the power meter.
2. Configure equipment as shown in [Figure 2-1](#), with the power splitter connected to the spectrum analyzer input.

CAUTION To minimize stress on the test equipment connections, support the power sensor.

3. If the auto alignment for the analyzer has not been performed within the past 24 hours, press **System, Alignment, Align All Now** to perform the auto alignment routine.
4. Press **Preset** on the analyzer.
5. Set up the spectrum analyzer by pressing:
 - Frequency, 50 MHz
 - Input/Output, RF Coupling (DC)
 - Mode Setup, RBW VBW ST
 - Auto Swp Time, Accy
 - Sweep, Sweep Type (SWP)
 - Span, 75 MHz
 - BW/AVG, 1 MHz
6. Set up the synthesized sweeper by pressing:
 - CW, 50 MHz
 - Power Level, 0 dBm
 - RF (On)

7. On the spectrum analyzer, press:

BW/Avg, Average (On)
10, Enter

8. Perform the following steps for each row listed in [Table 2-2](#):

- a. Set the synthesized sweeper amplitude to the value listed in the Nominal Source Amplitude column in [Table 2-2](#).
- b. Set the Res BW and Span as listed in each row of the table.
- c. Record the source amplitude, as measured by the power meter, in the Power Meter Amplitude column of [Table 2-2](#).
- d. On the spectrum analyzer, press **Restart, Peak Search**.
- e. Wait for the spectrum analyzer to finish averaging.
- f. Record the signal amplitude, as measured by the analyzer in the Measured Amplitude column of [Table 2-2](#).
- g. Calculate the signal amplitude accuracy error using the following equation, and record the results under the Amplitude Accuracy Error column:

$$\text{Amplitude Accuracy Error} = \text{Meas_amp} - \text{Power_meter}$$

Table 2-2 Amplitude Accuracy Results

Nominal Source Amplitude (dBm)	Preamp (Option 1DS)	Res BW (kHz)	Span (kHz)	Measured Amplitude Meas_amp (dBm)	Power Meter Amplitude Power_meter (dBm)	Amplitude Accuracy Error (dB)	Test Limit (dB)
-4	Off	1000	75000				0.8
-4	Off	300	31800				0.8
-4	Off	100	10600				0.8
-4	Off	30	3180				0.8
-4	Off	10	1060				0.8
-4	Off	1	106				0.8
-13	Off	1	106				0.8

Testing Option 1DS (Preamp)

Instruments containing Option 1DS must have the preamp function turned on and tested. In order to enable this function, press **Amplitude, More 1 of 3, Int Preamp (On)**.

Procedure

1. Connect the 20 dB pad between the input of the spectrum analyzer and the power splitter, as shown in [Figure 2-1](#)
2. Set the synthesized sweeper amplitude to the value listed in the Nominal Source Amplitude column in [Table 2-3](#).
3. Set the Res BW and Span as listed in [Table 2-3](#).
4. Record the source amplitude, as measured by the power meter, in the Power Meter Amplitude column of [Table 2-3](#).
5. On the spectrum analyzer, press **Restart, Peak Search**.
6. Wait for the analyzer to finish averaging.
7. Record the signal amplitude as measured by the analyzer in the measured amplitude column of [Table 2-3](#).
8. Calculate the signal amplitude accuracy using the following equation:

$$\text{Amplitude Accuracy Error} = \text{Meas_amp} + 20 \text{ dB} - \text{Corrected Power Value}$$

9. Record the results under the Amplitude Accuracy Error column of [Table 2-3](#).

Table 2-3 Amplitude Accuracy Results (Option 1DS)

Nominal Source Amplitude (dBm)	Preamp (Option 1DS)	Res BW (kHz)	Span (kHz)	Measured Amplitude Meas_amp (dBm)	Power Meter Amplitude Power_meter (dBm)	Amplitude Accuracy Error (dB)	Test Limit (dB)
-13	On	1	106				1.2

Displayed Average Noise Level (DANL)

Test Limits (with 0 dB input attenuation)

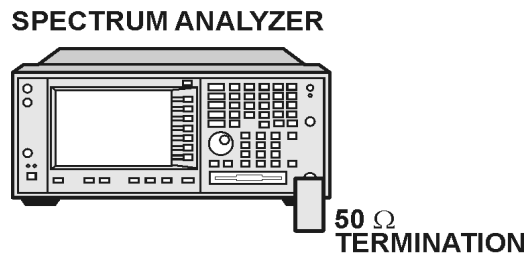
Frequency Range	Maximum
1 MHz to 10 MHz	-140 dBm
10 MHz to 3.0 GHz	-148 dBm
3.0 GHz to 6.6 GHz	-147 dBm
6.6 GHz to 13.2 GHz	-145 dBm
13.2 GHz to 22.0 GHz	-142 dBm
22.0 GHz to 26.5 GHz	-139 dBm

Test Description

The Displayed Average Noise Level (DANL) of the spectrum analyzer is measured across a 10 kHz frequency span at several center frequencies. The analyzer input is terminated into a 50Ω load. A test is performed to assure the measurement is not performed in the presence of a residual response. The measurement is then averaged, and the result is normalized to a 1 Hz bandwidth.

Item	Critical Specifications (for this test)	Recommended Agilent Model
Termination	50Ω Type-N(m)	909A Option 012

Figure 2-2 DANL/Noise Figure Test Setup



ee82a

Procedure

1. Configure the equipment as shown in [Figure 2-2](#).
2. Press **Preset** on the analyzer.
3. Set up the spectrum analyzer by pressing:
 - FREQUENCY, Center Freq, 5 MHz**
 - Input/Output, RF Coupling, DC**
 - Span, 10 kHz**
 - AMPLITUDE, -70 dBm**
 - Amplitude, Attenuation, 0 dB**
 - BW/Avg, 1 kHz**
 - Video BW, 100 Hz**
 - Average (On), 20, Enter**
4. Press **Display**, then press the **Display Line** key.
5. Rotate the RPG knob and set the display line at the average amplitude of the displayed noise floor by visual inspection.
6. Confirm that the measurement will be performed on the spectrum analysis noise floor and not on a residual response within the displayed 10 kHz span.

NOTE Ignore the residual response if one appears when taking the measurement.

7. Enter the value of the display line as the Measured Average Noise Level at 5 MHz column in [Table 2-4](#).
8. Normalize the measured value to a 1 Hz BW by adding -30 dB to the measured value.

NOTE The -30 dB value is added because the formula used to calculate the value of the noise power in a 1 Hz BW when measured with a 1 kHz BW is:

$\text{Noise} = 10 \text{ Log } (\text{bw } 2 / \text{bw } 1)$ where bw 2 is the 1 kHz BW we measure and bw 1 is 1 Hz BW we want to normalize to.

Therefore, $10 \text{ Log } (1000) = 30 \text{ dB}$, so the noise floor will be 30 dB lower in a 1 Hz BW.

9. Enter the normalized value of the displayed average noise level in [Table 2-4](#).
10. The value of the normalized displayed average noise should be less than the specification value.
11. Change the analyzer center frequency to the next value listed in [Table 2-4](#).
12. Repeat steps 4 through 10 to fill in the remainder of [Table 2-4](#).

Table 2-4 Displayed Average Noise Level (DANL) Results

Center Frequency	Measured Average Noise Level (dBm)	Normalized Average Noise Level (1 Hz BW) (dBm)	Test Limits (dBm)
5 MHz			-140
2 GHz			-148
6 GHz			-147
13 GHz			-145
20 GHz			-142
26.5 GHz			-139

Frequency Readout Accuracy

Test Limits

Frequency Readout Accuracy is equivalent to the following equation:

$$\pm (0.25\% \times \text{span} + 5\% \times \text{RBW} + 2 \text{ Hz} + 0.5 \times \text{horizontal resolution})$$

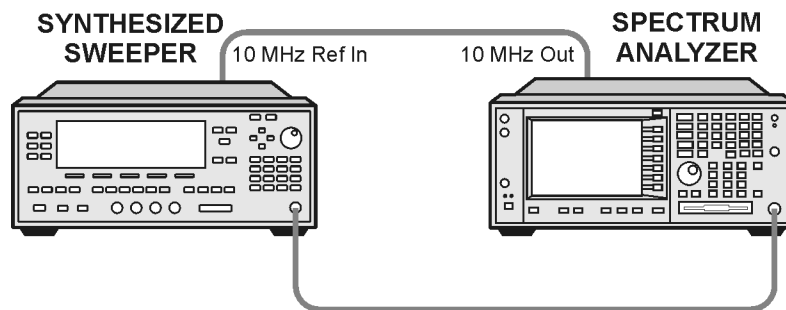
NOTE See results table for actual values.

Test Description

The frequency readout accuracy is measured in several spans and center frequencies that allow both internal analyzer synthesizer modes and prefilter bandwidths to be tested. Frequency reference error is eliminated by using the same frequency standard for the analyzer and signal source.

Item	Critical Specification (for this test)	Recommended Agilent Model
Adapter	Type-N(m), to 3.5 mm(f)	1250-1744
Adapter	3.5 mm(f) to 3.5 mm(f)	5061-5311
Cable	APC 3.5 mm, 1 meter	8120-4921
Synthesized Sweeper	<i>Frequency</i> . Capable of 2 GHz (must have external reference input)	83630B

Figure 2-3 Frequency Readout Accuracy Test Setup



ee86a

Procedure

1. Configure the equipment as shown in [Figure 2-3](#). Confirm the analyzer’s built-in auto alignment has been performed within the past 24 hours.

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

a. On the synthesized sweeper, press **PRESET**, then set the controls as follows:

POWER LEVEL, -10dBm
CW, 1505 MHz, RF (On)

b. On the spectrum analyzer, press **Preset**.

3. Set up the spectrum analyzer by pressing:

System, Reference, 10 MHz, Ext (0n)
Frequency, 1505 MHz
Det/Demod, Detector, Sample
Span, 2990 MHz

NOTE Ensure Ref Level is set to 0 dBm. In addition, ensure Resolution BW and Video BW are both set to Auto.

4. Press **Peak Search** on the analyzer to measure the frequency readout accuracy. If the instrument is functioning correctly, the marker reading in the active function block will be between the values listed in [Table 2-5](#). Record the marker value in the Marker Frequency Readout column in [Table 2-5](#).

5. On the spectrum analyzer, change the span and center frequency as listed in [Table 2-5](#).

6. Change the synthesized sweeper frequency to match the center frequency of the analyzer.

7. Repeat step 4 until the Marker Frequency Readout column of [Table 2-5](#) is complete.

Table 2-5 Frequency Readout Accuracy Results

Span (MHz)	Center Frequency (MHz)	Minimum	Marker Frequency Readout	Maximum
2990	1505	1.495 GHz		1.515 GHz
127.2	1505	1.5045 GHz		1.5055 GHz
54.1	1505	1.50480 GHz		1.50520 GHz
7.95	1505	1.504968 GHz		1.505032 GHz
0.106	1505	1.5049996 GHz		1.5050004 GHz
1.98	517.59	517.5829 MHz		517.5971 MHz
1.98	832.50	832.4928 MHz		832.5071 MHz

Frequency Response (Flatness)

Test Limits

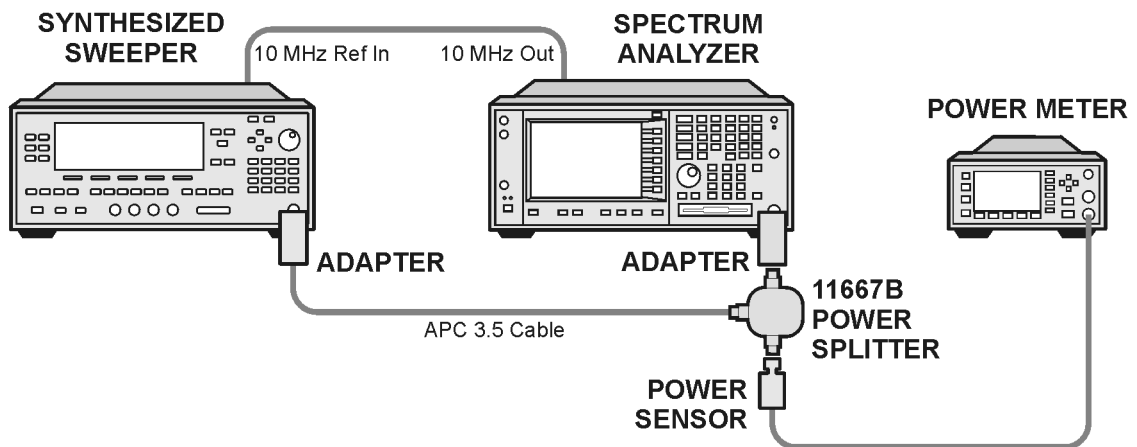
Frequency Range	Maximum (50Ω Inputs)
3 Hz to 3 GHz	≤1.5 dB
3 GHz to 6.6 GHz	≤2.5 dB
6.6 GHz to 13.2 GHz	≤3.0 dB
13.2 GHz to 22 GHz	≤3.5 dB
22 GHz to 26 GHz	≤3.5 dB

Test Description

The frequency response test measures the spectrum analyzer's amplitude error as a function of the tuned frequency. Measurements are made ranging from 50 MHz to 26 GHz. The signal source amplitude is measured with a power meter to eliminate error due to source flatness.

Item	Critical Specifications (for this test)	Recommended Agilent Model
Adapter	Type N(m) to 3.5 mm(m)	1250-1743
Adapter	Type N(m) to 3.5 mm(f)	1250-1744
Adapter	3.5 mm(f) to 3.5 mm(f)	5061-5311
Cable	APC 3.5 mm, 1 meter	8120-4921
Cables (2 required)	BNC, 120 cm (48 in.)	10503A
Power Meter	Compatible with power sensor	E4418B
Power Sensor	<i>Frequency Range: 50 MHz to 26.5 GHz</i>	8485A
Power Splitter	<i>Frequency Range: 50 MHz to 26.5 GHz Tracking between ports: < 0.25 dB</i>	11667B
Synthesized Sweeper	<i>Frequency Range: 50 MHz to 26 GHz</i>	83630B

Figure 2-4 Frequency Response Test Setup



Procedure

1. Zero and calibrate the power meter and power sensor as described in the power meter operation manual.
2. Configure the equipment as shown in [Figure 2-4](#).

NOTE Connect the power splitter to the spectrum analyzer input using the appropriate adapter. Do not use a cable.

3. Assure the spectrum analyzer's built-in auto alignment has been performed within the last 24 hours.
4. Preset both the spectrum analyzer and the synthesized sweeper.
5. Set up the synthesized sweeper by pressing:
 - CW, 50 MHz**
 - Power level, -8 dBm**
6. Set up the spectrum analyzer by pressing:
 - Frequency, 50 MHz**
 - Span, 20 kHz**
 - Amplitude (ref level), -10 dBm**
 - Attenuation, 10 dB**
 - Scale/Div, 2 dB**
 - BW/AVG, 10 kHz**
 - Video BW, 3 kHz**
7. Adjust the synthesized sweeper output power for a power meter display of -14 dBm ± 0.1 dB.

NOTE The power level of the synthesized sweeper remains unchanged for the duration of the test.

8. Press the **Peak Search** key on the signal analyzer to position the marker on the peak of the signal.
9. Refer to Table 2-6, “Frequency Response (Flatness) Results.” Enter the amplitude of the signal displayed on the spectrum analyzer into the $Meas_{Amp}$ column of [Table 2-6](#).
10. Enter the power meter reading into the $Power_{Meter}$ column of [Table 2-6](#).
11. Tune the synthesized sweeper and spectrum analyzer to the next frequency listed in [Table 2-6](#).
12. Enter the power sensor calibration factor into the power meter.
13. Repeat steps 8-14 and complete the remainder of [Table 2-6](#).
14. Compute the flatness error ($Flat_{Error} = Meas_{Amp} - Power_{Meter}$). The flatness error should be less than the value listed in the Flatness Error Test Limit column.
15. Enter the computed flatness error value into the $Flat_{Error}$ column of [Table 2-6](#).

Table 2-6 Frequency Response (Flatness) Results

Center Frequency	Analyzer Amplitude Meas _{amp}	Power Meter Measurement Power _{meter}	Flatness Error Flat _{error}	Flatness Error Test Limits (dB)
50 MHz				±1.5
1 GHz				±1.5
2 GHz				±1.5
3 GHz				±1.5
3.5 GHz				±2.5
5 GHz				±2.5
6 GHz				±2.5
7 GHz				±3.0
10 GHz				±3.0
13 GHz				±3.0
14 GHz				±3.5
16 GHz				±3.5
22 GHz				±3.5
23 GHz				±3.5
25 GHz				±3.5
26.5 GHz				±3.5

Amplitude Linearity

Test Limits

The linearity error will be $\leq \pm 1.0$ dB with ≤ -10 dBm at the mixer.

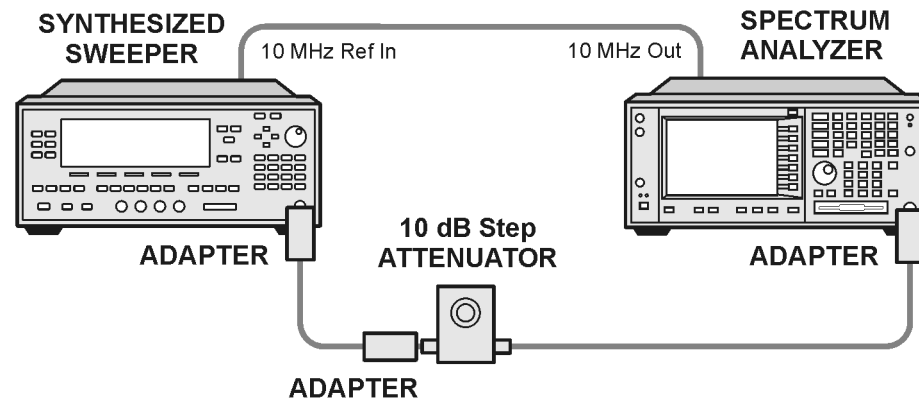
Test Description

This test checks the amplitude linearity of the instrument by maintaining a constant reference level and measuring signals of different amplitudes over most of the display range. This test sets the input attenuator to 10 dB and the Reference Level to 0 dBm. The external attenuator is set to 0 dB, and the amplitude of the source is adjusted to set the displayed signal at the reference level.

The instrument's internal marker is used to measure the reference amplitude. The Marker Delta function is activated and the RF input is reduced using the external precision step attenuator. Signal input levels from 0 dBm to -50 dBm are measured.

Item	Critical Specifications (for this test)	Recommended Agilent Model
Adapter	Type-N(m), to BNC(f)	1250-1476
Adapter	3.5 mm(f) to 3.5mm(f)	5061-5311
Adapter	BNC(m) to SMA(f)	1250-1700
APC 3.5 mm (1 meter)	APC 3.5 mm, 1 meter	8120-4921
Attenuator, 10 dB Step	<i>Range: 0-50 dB</i> <i>Frequency: 50 MHz</i> <i>Accuracy: ± 0.25 dB</i>	355D
Cables (2 required)	BNC, 120 cm (48 in.)	10503A
Synthesized Sweeper	<i>Output Level Accuracy: 0 to -15 dBm: ± 1.0 dB</i>	83630B

Figure 2-5 Amplitude Linearity Setup



ee84a

NOTE Averaging is used for all measurements to improve repeatability and reduce measurement uncertainty.

Procedure

1. Configure the equipment as shown in [Figure 2-5](#).
2. Set up the synthesized sweeper by pressing:
 - Frequency, 50 MHz
 - Amplitude, -2 dBm
 - RF On/Off, On
3. Set up the spectrum analyzer by pressing:
 - Frequency, 50 MHz
 - Span, Zero Span

NOTE On the analyzer, ensure the reference level is 0 dBm and the attenuator is set to 10 dB.

- BW/AVG, 30 kHz
 - Average, 10, Enter
 - Marker (to turn on Marker function)
4. Set the external 10 dB attenuator to 0 dB.
 5. Adjust the amplitude on the signal source until the marker amplitude on the analyzer reads 0 dBm \pm 0.2 dB.
 6. On the analyzer, press the Single key to trigger a 10 sweep average.

7. On the analyzer, activate the Marker Delta function by pressing **Marker, Delta**.
8. Perform the following steps for each attenuator setting listed in the table below:
 - a. Select the next External attenuator setting.
 - b. Press the **Single** key to trigger a 10 sweep average.
 - c. Enter the delta marker value into [Table 2-7](#).
 - d. Check delta marker reading against the test limits.

Table 2-7 Amplitude Linearity Results

External Attenuator Setting	Minimum (dB)	Marker Delta Value (dB)	Maximum (dB)
0	N/A	Reference	N/A
10	-11.0		-9.0
20	-21.0		-19.0
30	-31.0		-29.0
40	-41.0		-39.0
50	-51.0		-49.0

Second Harmonic Distortion (SHD)

Test Limits

Applied Frequency	Mixer Level	Distortion
40 MHz	-20 dBm	< -55 dBc

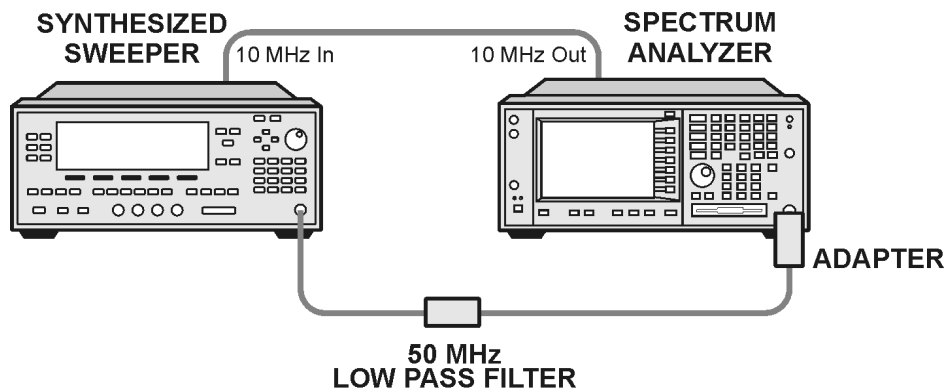
Test Description

This test checks the second harmonic distortion of the spectrum analyzer by tuning to twice the input frequency and examining the level of the distortion product. A low pass filter is inserted between the source and the spectrum analyzer to prevent the second harmonic from artificially raising the second harmonic product displayed on the analyzer.

The power level at the input mixer is 20 dB higher than specified to allow the distortion product to be seen. For example, the instrument specification may state that with a -40 dBm signal at the input mixer, the distortion product should be suppressed by >-75 dBc.

The equivalent Second Harmonic Intercept (SHI) is 35 dBm (-40 dBm + 75 dBc). This test is performed with -20 dBm at the mixer and verifies the distortion product is suppressed by -55 dBc. This ensures the SHI is also 35 dBm (-20 dBm + 55 dBc).

Item	Critical Specifications (for this test)	Recommended Agilent Model
Adapter	Type-N(m) to BNC(f)	1250-1476
Adapter	BNC(m) to SMA(f)	1250-1700
Cable	APC 3.5 mm, 1 meter	8120-4921
Filter, 50 MHz Low Pass	<i>Cutoff Frequency: 50 MHz Rejection at 65 MHz: > 40 dB Rejection at 75 MHz: > 60 dB</i>	0955-0306
Synthesized Sweeper	<i>Frequency: 50 MHz Spectral Purity: Better than -30 dBc</i>	83630B

Figure 2-6 Second Harmonic Distortion Test Setup

ee85a

Procedure

1. Configure the equipment as shown in [Figure 2-6](#).
2. Press **Preset** on the spectrum analyzer and the synthesized sweeper.
3. Set up the spectrum analyzer by pressing:
 - Frequency, 40 MHz
 - Amplitude, -10 dBm
 - Span, 1 MHz
 - Sweep, Sweep Type, SWP (Swept)
4. Set up the synthesized sweeper by pressing:
 - CW Frequency, 40 MHz
 - Level, -10 dBm
 - RF (On)
5. On the analyzer, press **Peak Search**.
6. Adjust the synthesized sweeper amplitude for a spectrum analyzer display of -10 dBm \pm 0.1 dBm.
7. On the analyzer, activate the marker delta function by pressing the **Marker** and **Delta** keys.
8. Set the analyzer Center Frequency to 80 MHz.
9. Press **BW/Avg, Average** and enter the number **20** using the numeric keypad. Then, press **Enter** to begin the twenty sweep averaging routine and read the Marker Delta value. Enter the displayed value under the Measured Second Harmonic Distortion (dBc) heading in [Table 2-8](#).

Table 2-8 Second Harmonic Distortion Results

Applied Frequency (MHz)	Measured Second Harmonic Distortion (dBc)	Specification (dBc)
40		<-55

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