Agilent Technologies E444xA Option H26

User's and Service Guide

Agilent Technologies
E444xA Option H26

User's and Service Guide

This guide applies to firmware revision A.06.01 or greater

Use this manual with the following documents:

Agilent Technologies PSA Series Spectrum Analyzer User's and Programmer's Reference Guide

Agilent Technologies

Manufacturing Part Number: E4440-90560

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Warranty Statement

Safety Notes

The following safety notes are used throughout this manual. Familiarize yourself with each of the notes and its meaning before operating this instrument. All pertinent safety notes for using this product can be found in the standard manual.

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

CAUTION Caution denotes a hazard. It calls attention to a procedure that, if not correctly performed or adhered to, 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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Agilent Technologies, Inc. certifies that this product met its published specifications at the time of shipment from the factory. Agilent Technologies, Inc. further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

Definitions

- *Specifications* describe the performance of parameters covered by the product warranty (temperature - 0 to 55 °C, unless otherwise noted.)
- *Typical* describes additional product performance information that is not covered by the product warranty. It is performance beyond specification that 80% of the units exhibit with a 95% confidence level over the temperature range 20 to 30 °C. Typical performance does not include measurement uncertainty.
- *Nominal* values indicate expected performance, or describe product performance that is useful in the application of the product, but is not covered by the product warranty.

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Documentation is updated periodically. For the latest information about Agilent Technologies PSA Analyzers, including firmware upgrades and application information, please visit the following Internet URL:

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Contents

1 Overview

Description

The Agilent Technologies E444xA Option H26 consists of a high band preamp with a nominal gain of 27 dB at the front end of the spectrum analyzer. The performance and ease of use come from the high gain of the preamplifier, the ability to switch the preamp in and out and the use of the instruments flatness correction tables to reduce the amplitude errors.

The preamp has a frequency range from 3 GHz to the upper frequency limit of the analyzer. Refer to Table 1-1. The preamp can be enabled or disabled via remote SCPI commands or from the front panel interface. The lowband preamp (Option 1DS) operates below 3 GHz and the highband preamp (Option H26) operates above 3 GHz.

Table 1-1 Preamp frequency range

Model	Preamp Frequency range
E4440A	3 GHz to 26.5 GHz
E4443A	3 GHz to 6.7 GHz
E4445A	3 GHz to 13.2 GHz
E4446A	3 GHz to 44 GHz
E4448A	3 GHz to 50 GHz

NOTE All instrument specifications are considered to be **NOMINAL** values of performance when the highband preamp is engaged. For example, specifications for absolute amplitude accuracy are now **NOMINAL** in performance and may still be useful but are not specified.

CAUTION **Excessive Relay Switch wear can occur if the instrument is sweeping from below 2.85 GHz and the Stop Frequency is above 3.05 GHz.**

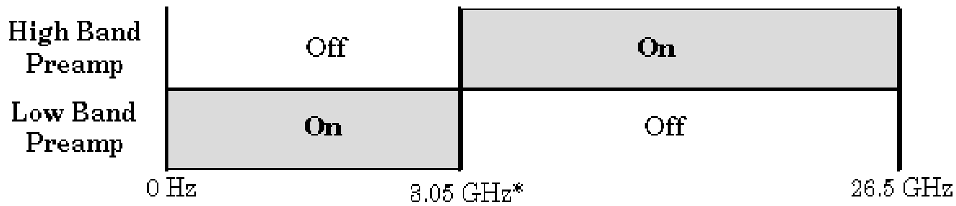
CAUTION **The Damage Level is reduced to +20 dBm when the Option H26 is enabled.**

Flatness characteristics of the preamp will be stored in the User memory file titled "Other." This can be used to compensate for the variations in amplitude of the High Band PreAmp. Refer to "Accessing the Flatness Compensation Table" on page 3-5.

When not using the highband preamp, displayed average noise level may still be degraded due to the extra length of cable in the option. Refer to "Displayed Average Noise Level (Preamp Off)" on page 1-7.

If the instrument preamp is “ON” and sweeping from below 3 GHz to above 3 GHz, the instrument will automatically switch the highband preamp to the “ON” state above 3 GHz. Refer to Figure 1-1.

Figure 1-1 Lowband vs. Highband Frequency Diagram for E4440A[1]



* The “3.05 GHz” switch point occurs when sweeping from below 3 GHz to above 3 GHz. The highband preamp low frequency point is extended down to 3.0 GHz if the start frequency is set to 3.0 GHz.

NOTE Please note that in Full Band Sweep, Retrace time has been increased to reduce relay wear at band-cross. To reduce the retrace time, sweep completely in either side of the band-cross frequency.

CAUTION **Excessive Relay Switch wear can occur if the instrument is sweeping from below 2.85 GHz and the Stop Frequency is above 3.05 GHz**.

To find descriptions of specific analyzer functions refer to the *Agilent Technologies PSA Spectrum Analyzers User’s and Programming Reference Guide.*

1. See Table 1-1, “Preamp frequency range” for other model numbers.

Characteristics

Table 1-2 Option H26 Nominal Performance when the Preamp is On

Description	Nominal Performance		Supplemental Information
	E4440A, E4443A, E4445A	**E4446A, E4448A**	
Preamp Gain			
3 GHz to 30 GHz	27 dB	27 dB	
Above 30 GHz	n/a	24 dB	
Amplitude			
Measurement Range	DANL to +16 dBm	DANL to +20 dBm	
Max Safe Input Level			page 1-5
Avg Total Power	+20 dBm	+20 dBm	See Caution below
Gain compression			
1 dB Gain Comp Point[a]	–6 dBm	–6 dBm	Table 1-3 on page 1-5
VSWR			page 1-6
DANL degradation[b]			page 1-7
3 GHz	0.4 dB	0.4 dB	
12 GHz	0.7 dB	0.8 dB	
26 GHz	1.1 dB	1.4 dB	
50 GHz	n/a	2.2 dB	
Noise Figure			page 1-8

a. at the Preamp RF input
b. with Option H26 preamp off.

CAUTION **The Damage Level is reduced to +20 dBm when the Option H26 is enabled.**

Maximum Input Level

The maximum allowable input level without damage is +20 dBm when the preamp is on. The input level calculation varies for different PSA models. See below.

E4440A, E4443A and E4445A:

As mentioned, the maximum allowable input level without damage is +20 dBm when the preamp is on. This is not the power at the input connector minus the on-screen input attenuator setting. The maximum allowable input level is the power at the input connector minus the actual input attenuation. This is because the preamp is located after the 0-4 dB attenuator stages but before the 6, 10, 20, 30 dB attenuator stages. Therefore, the attenuation value entered on the instrument is in most cases, not the input attenuation to the preamp. Refer to Table 1-3 for the actual input attenuation.

E4446A and E4448A:

Here too, the maximum allowable input level without damage is +20 dBm when the preamp is on. For the E4446A and E4448A, the on-screen attenuation is the actual input attenuation to the preamp, therefore the maximum allowable input level without damage is the power at the input connector minus the on-screen attenuation. Refer to Table 1-3 for the actual input attenuation.

Table 1-3 Input Attenuator vs. Actual Input Attenuation

Input Attenuator Setting > 3 GHz	Actual Input Attenuation at Preamp Input for E4440A, 43A, and 45A	Actual Input Attenuation at Preamp Input for E4446A, and E4448A
0 dB	0 dB	0 dB
2 dB	2 dB	2 dB
4 dB	4 dB	4 dB
6 dB	0 dB	6 dB
8 dB	2 dB	8 dB
10 dB	0 dB	10 dB
12 dB	2 dB	12 dB

VSWR

The VSWR graphs show the nominal instrument VSWR from 3 GHz to 26.5 GHz for the E4440A (see Figure 1-2), and from 3 GHz to 50 GHz for the E4448A (see Figure 1-3) with the Option H26 Preamp On, and 0 dB attenuation. The graphs show the behavior of two instruments, an E4440A and an E4448A. The E4443A and E4445A will have similar behavior to the E4440A and likewise the E4446A will have similar behavior to the E4448A.

Figure 1-2 Nominal E4440A Instrument VSWR 3 GHz to 26.5 GHz; High Band Preamp On, Attenuation = 0 dB

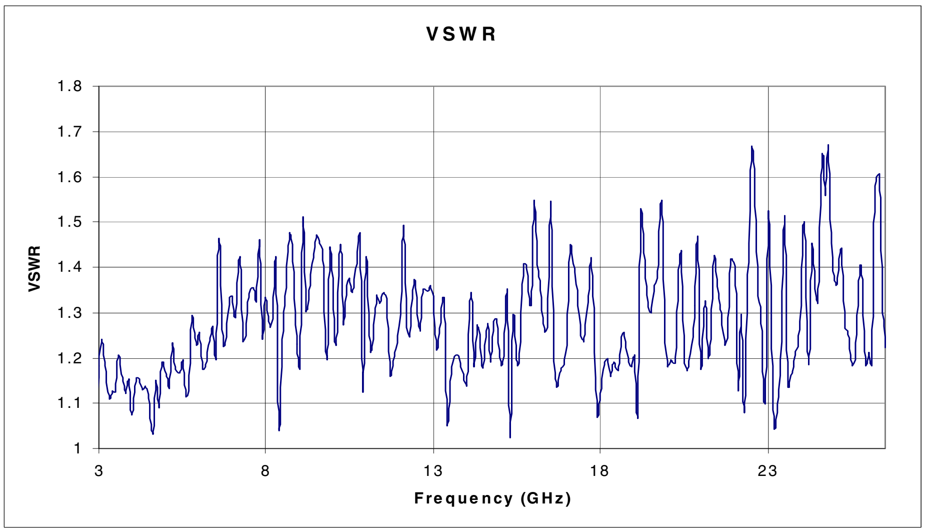
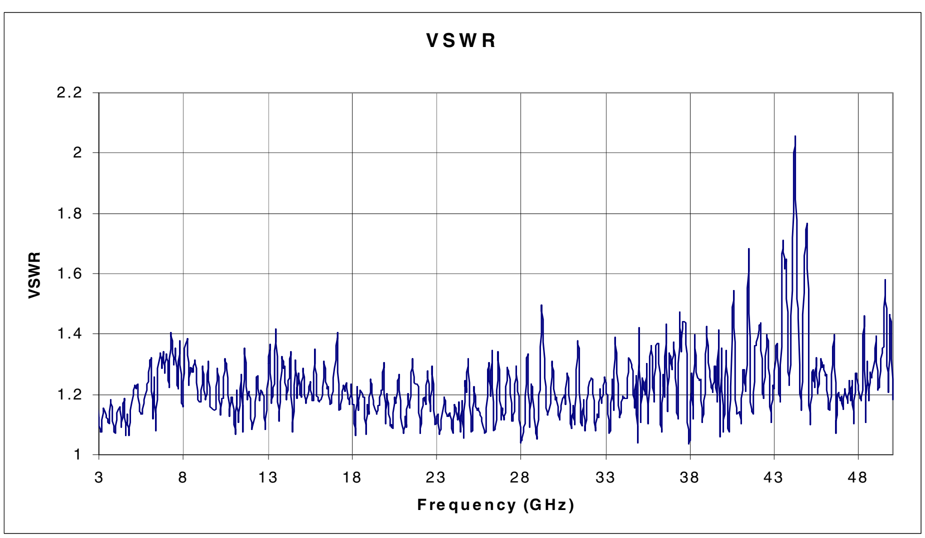


Figure 1-3 Nominal E4448A Instrument VSWR 3 GHz to 50 GHz; High Band Preamp On, Attenuation = 0 dB



Displayed Average Noise Level (Preamp Off)

Due to the additional length of RF cable, and insertion loss of the RF switch by the inclusion of option H26, the standard instrument displayed average noise level (DANL) (H26 Off) may be nominally degraded. Equation 1-1, "DANL degradation for E4440A, E4443A, and E4445A H26" and Equation 1-2, "DANL degradation for E4446A and E4448A H26" are provided in calculating the degradation for specific frequencies other than those given in Table 1-2 on page 1-4.

"Appendix" on page 4-1 is provided to manually verify DANL performance.

Equation 1-1 DANL degradation for E4440A, E4443A, and E4445A H26

$$DH26 = D + 0.2 + ((0.45/26.5) \times F) + 7.5 \times \left(\frac{5.758 + 4.89 \times F - 0.146 \times F^2 + 2.433 \times 10^{-3} \times F^3}{1200}\right)$$

Equation 1-2 DANL degradation for E4446A and E4448A H26

$$DH26 = D + 0.15 + (0.02 \times F) + 7 \times \left(\frac{8.473 + 6.86 \times F - 0.159 \times F^2 + 1.831 \times 10^{-3} \times F^3}{1200}\right)$$

For all equations, *F* is the Frequency in GHz.

D is the term used for representing the instrument's DANL specification found in the PSA Series Specification Guide.

DH26 is the term used to represent the resultant instrument DANL from the inclusion of Option H26.

Noise Figure Measurement Personality and Option H26

This section provides nominal performance information for the PSA series, Option 219, Noise Figure Measurement as it relates to the Option H26, High Band Preamp.

CAUTION **Excessive Relay Switch wear can occur if the instrument is sweeping from a start frequency of 3.05 GHz and below to above 3.05 GHz. This is different than when operating in the SA Mode.**

You need the following equipment to use this personality/hardware combination.

Table 1-4 Hardware, Firmware and Software Requirements

Firmware	Software	Hardware	
Revision Number	Noise Figure Measurement Personality	Front End Driver Board	Option 1DS Internal Pre-Amp
≥ A.06.01	Option 219	Rev b or later	Required

NOTE The Noise Figure Measurement personality (Option 219) requires Revision “b” or later of the Front End Driver assembly. This supplies the +28 V output (labelled “NOISE SOURCE DRIVE OUT +28 V (PULSED)” on the rear panel), which is needed to drive the noise source. To see which version is installed on your PSA, press **System**, **Show Hdwr**. If you have an earlier revision than Revision “b,” contact your Agilent Technologies representative.
Refer to http://www.agilent.com/find/psa for further information.

Table 1-5 Instrument Uncertainty for Noise Figure with Option H26

Description	Specifications	Supplemental Information
Instrument Uncertainty		Nominally the same as for the 10 MHz to 3 GHz range
	There are no warranted specifications for Option H26. Refer to Table 1-2 on page 1-4 for Nominal Performance	H26 Preamp caution[a]
		Band Crossing caution[b]
3 to 10 GHz		Well-controlled preselector[c]
10 to 20 GHz		Good preselector stability[d]
20 to 26.5 GHz		Preselector Drift Effects[e]

a. The Special Option H26 preamp can reduce the total NF measurement uncertainty substantially above 3 GHz because it will reduce the effective noise figure of the measurement system, and thus it will reduce the sensitivity of the total NF uncertainty to the Instrument Gain Uncertainty. But if the signal levels into the preamp are large enough, the preamp may experience some compression. The compression differences between the noise-source-on and noise-source-off states causes an error that must be added to Instrument Noise Figure Uncertainty for use in the Noise Figure Uncertainty Calculator. Such signal levels are quite likely for the case where the DUT has some combination of high gain, high noise figure and wide bandwidth.   Here's an example: The measurement will be made at 18 GHz. The typical preamp gain is 25 dB and the noise figure is 7 dB. We will assume the DUT has 20 dB gain, a 10 dB NF, and a passband from 5 to 30 GHz. We will use a noise source with 17 dB ENR. When the noise source is on, the DUT output can be computed by starting with kTB (–174 dBm/Hz) and adding 10×log(30 GHz – 5 GHz) or 104 dB, giving –70 dBm for the thermal noise. Add to this the ENR of the noise source (17 dB) combined with the NF of the DUT (10 dB) to give an equivalent input ENR of 18 dB, thus –52 dBm input noise power. Add the gain of the DUT (20 dB) to find the DUT output power to be –32 dBm. The noise figure of the H26 preamp may be neglected. The H26 preamplifier gain of 25 dB adds, giving a preamplifier output power of –7 dBm. The typical 1 dB compression point of this amplifier at its output is +19 dBm.
Therefore, the output noise is 26 dB below the 1 dB compression point. This amplifier will have negligible compression. As a rule of thumb, the compression of a noise signal is under 0.1 dB if the average noise power is kept 7 dB below the 1 dB CW compression point. The compression in decibels will usually double for every 3 dB increase in noise power. Use cases with higher gain DUTs could be compressed, leading to additional errors.
b. The band 0 to band 1 crossing should be avoided. In addition to the wear-out mechanisms (see Caution on page 1-8) involved in measurements that overlap the 3 GHz band crossing, there will also be performance degradations. There will be thermal instabilities in such measurements that will add nominally 0.2 dB Instrument Uncertainty. The uncertainty of some NF or Gain measurements are greatly multiplied from the Instrument Uncertainty. See the Uncertainty Calculator included with the Noise Figure Measurement for details.
c. In this frequency range, the preselector is well-controlled and there should be no need for special measurement techniques.
d. In this frequency range, the preselector usually requires no special measurement techniques in a lab environment. But if the temperature changes by a few degrees, or the analyzer frequency is swept or changed across many gigahertz, there is a small risk that the preselector will not be centered well enough for good measurements.
e. In this frequency range, the preselector behavior is not warranted. There is a modest risk that the preselector will not be centered well enough for good measurements. This risk may be reduced but not eliminated by using the analyzer at room temperature, limiting the span swept to a few gigahertz, and not changing the operating frequency range for many minutes.

Nominal values of Noise Figure are given in Figure 1-4 and Figure 1-5.

Figure 1-4 Nominal E4440A Instrument Noise Figure; 3 GHz to 26.5 GHz with H26 Preamp On

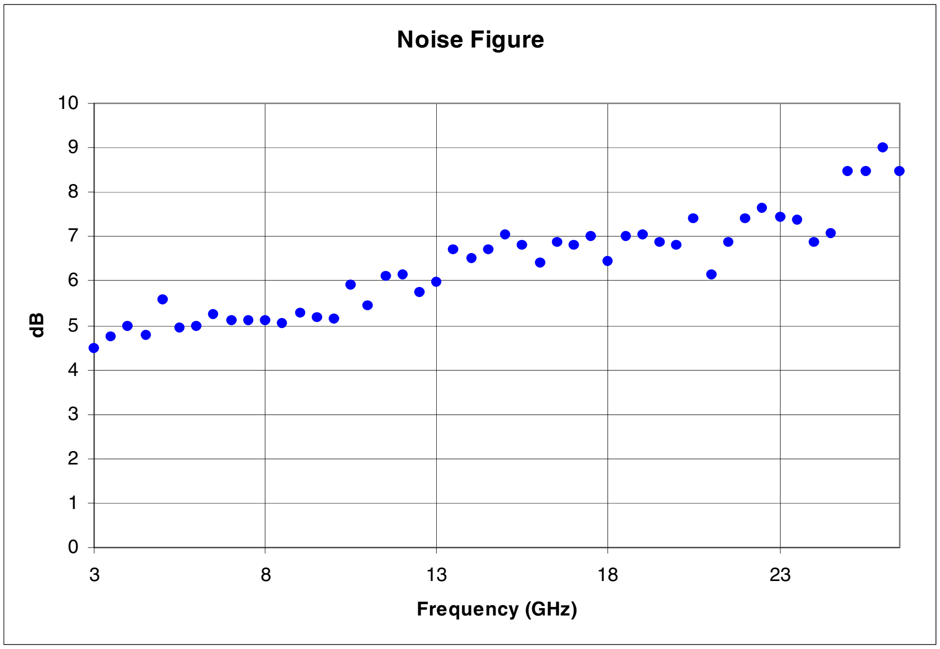
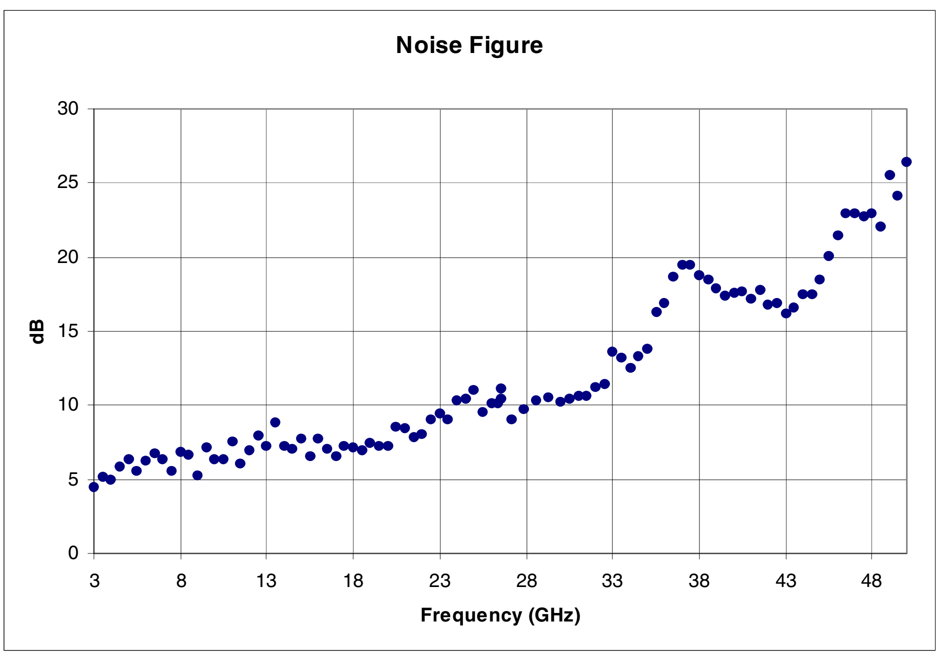


Figure 1-5 Nominal E4448A Instrument Noise Figure; 3 GHz to 50 GHz with H26 Preamp On

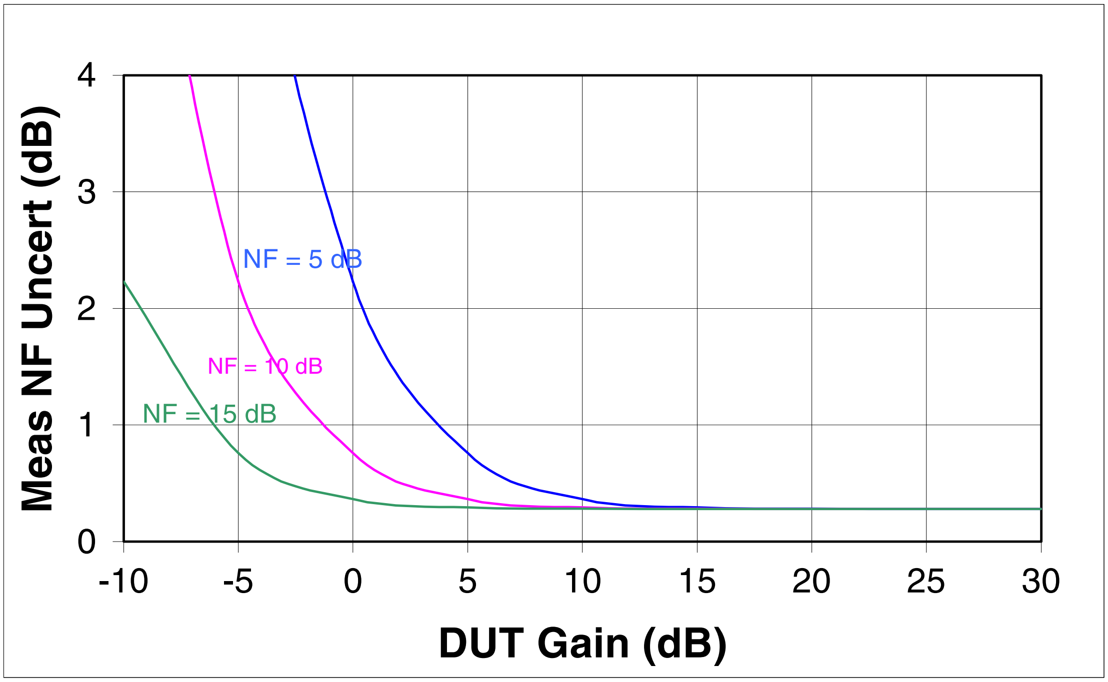


Preamp ON:

Computed Measurement NF Uncertainty vs. DUT Gain, > 3 GHz (Non-warranted Frequency Range)

Assumptions: Measurement Frequency 12 GHz, Instrument NF = 6.4 dB[1], Instrument VSWR = 1.5[2], Instrument Gain Uncertainty = 2.2 dB, Instrument NF Uncertainty = 0.05 dB, Agilent 346B Noise Source with Uncertainty = 0.2 dB, Source VSWR = 1.25, DUT input/output VSWR = 1.5.

Figure 1-6 NF Uncertainty vs. DUT Gains > 3 GHz, Preamp On



1. The preamp/analyzer combination NF is 6.4 dB; the internal preamp alone has a gain of 27 dB and a NF of 5 dB.
2. Instrument VSWR is now that of the internal preamp; VSWR = 1.5

Performance Verification

To verify the performance of the E444xA Option H26, refer to Figure 1-7. In this example, an 83650B Synthesized Sweeper was used, but a similar RF source could also be used.

CAUTION **The Damage Level is reduced to +20 dBm when the Option H26 is enabled.**

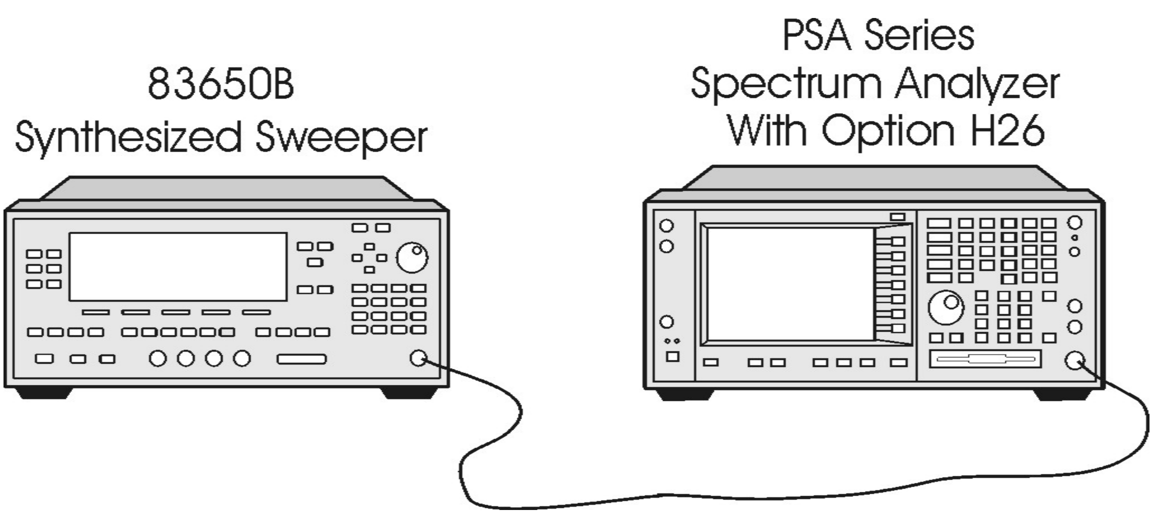
1. Set the Signal Source to 5 GHz at –30 dBm. Verify the RF Power using a power meter. Connect the source to the PSA RF Input.
2. Measure the amplitude on E444xA H26 with preamp off.
3. Turn on the preamp, insuring that the Amp Corr is also on. Refer “Front Panel Key Select” on page 3-3 and “Flatness Compensation Table” on page 3-5 for more information.
4. Measure the amplitude on the PSA screen.

The measured amplitude should be ± 5dB of the measured input signal from step 2.

5. Repeat at 15 GHz, 20 GHz, 35 GHz, and 40 GHz.

NOTE Even with option H26 disabled, the instrument may fail the DANL test when performing the *PSA Series Performance Verification Tests*. This is due to the insertion loss in the switches and cables used with H26. If a failure occurs, refer to “Appendix” on page 4-1 to manually check DANL. This check can be used to determine if the instrument needs to be troubleshot for a higher than normal H26 DANL level.

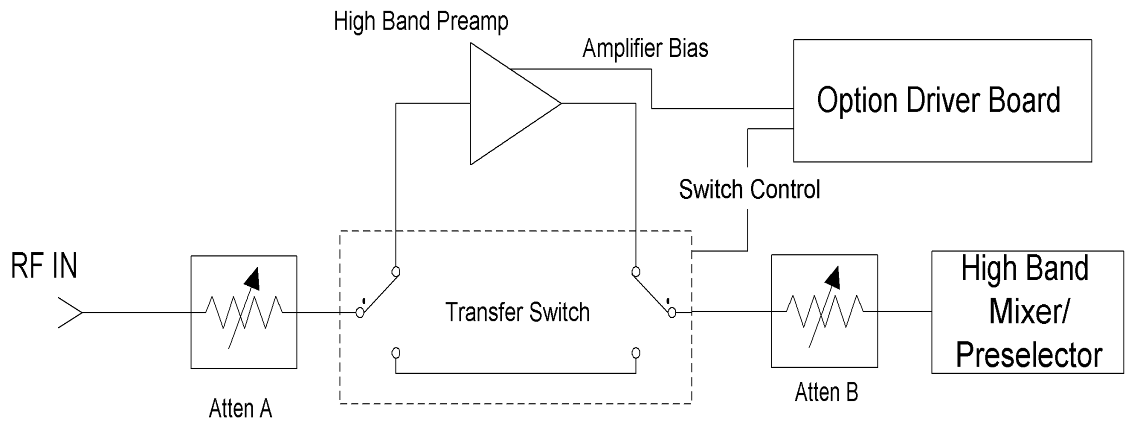
Figure 1-7 Performance Verification Set-up



Block Diagram

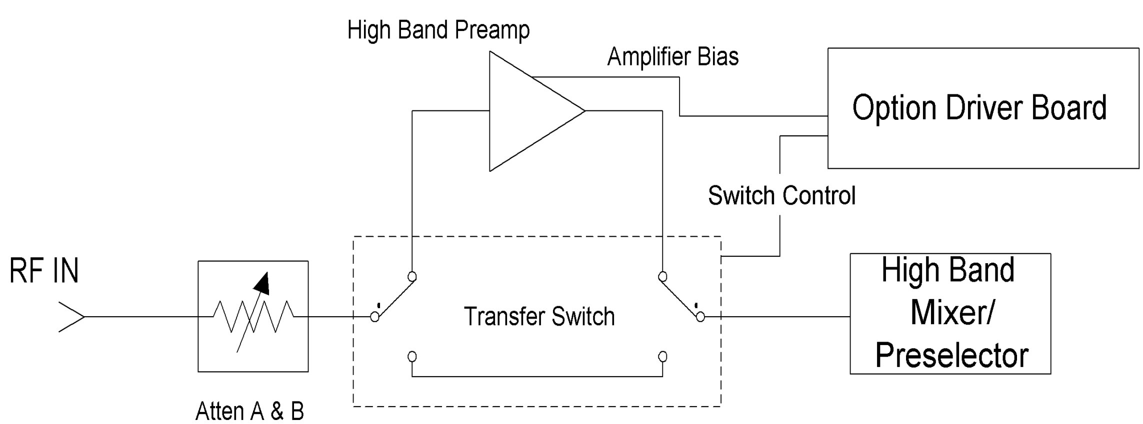
Refer to Figure 1-8. The preamp and high frequency transfer switch are located between the first attenuator and the second attenuator.

Figure 1-8 E4440A, E4443A, and E4445A H26 Block Diagram



Refer to Figure 1-9. The preamp and high frequency transfer switch are located between the attenuator and the highband mixer/preselector.

Figure 1-9 E4446A and E4448A H26 Block Diagram



Replaceable Parts

Table 1-6 E4440A, E4443A, and E4445A Option H26 Replaceable Parts

Description	Agilent Part Number	Quantity
Microwave amplifier	0955-1663	1
Bracket, Option H26	E4440-00051	1
Semi-rigid cable assembly (Switch In)	E4440-20302	1
Semi-rigid cable assembly (Amp In)	E4440-20303	1
Semi-rigid cable assembly (Amp Out)	E4440-20304	1
Semi-rigid cable assembly (Switch Out)	E4440-20305	1
Cable assembly, switch control	E4440-60427	1
Board Assembly, PSA H26	E4440-60358	1
Cable assembly, amp bias	E4446-60067	1
Transfer switch 26 GHz	N1811TL-CFG002[a]	1

a. N1811TL-CFG002 has standard options 124-026-201-302-403.

Table 1-7 E4446A, and E4448A Option H26 Replaceable Parts

Description	Agilent Part Number	Quantity
Microwave amplifier	0955-1617	1
Transfer switch 50 GHz	87222-60011	1
Attenuator bracket	E4440-00020	1
Cable Assembly, ribbon, 10 conductor	E4440-60071	1
Board Assembly, PSA H26	E4440-60358	1
Bracket, Option H26	E4446-00008	1
Semi-rigid cable assembly (Switch In)	E4446-20060	1
Semi-rigid cable assembly (Amp In)	E4446-20061	1
Semi-rigid cable assembly (Amp Out)	E4446-20062	1
Semi-rigid cable assembly (Switch Out)	E4446-20063	1
Wire harness cable assembly (bias)	E4446-60067	1

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2 Example Measurements

What is in This Chapter

This chapter demonstrates analog and digital analyzer measurements with the Agilent E444xA Option H26 and how it relates to a signal with the preamp “ON” or “OFF.”

- “Equipment for Test Set-ups” on page 2-3.
- “Analog Test Set-up” on page 2-4.
- “Digital Test Set-up” on page 2-6.

To find descriptions of specific analyzer functions, refer to the *Agilent Technologies PSA Series Spectrum Analyzers User’s and Programmer’s Reference Guide*.

Equipment for Test Set-ups

Use the following equipment to set-up the Option H26 for an analog or digital measurement.

Table 2-1 Required Test Equipment

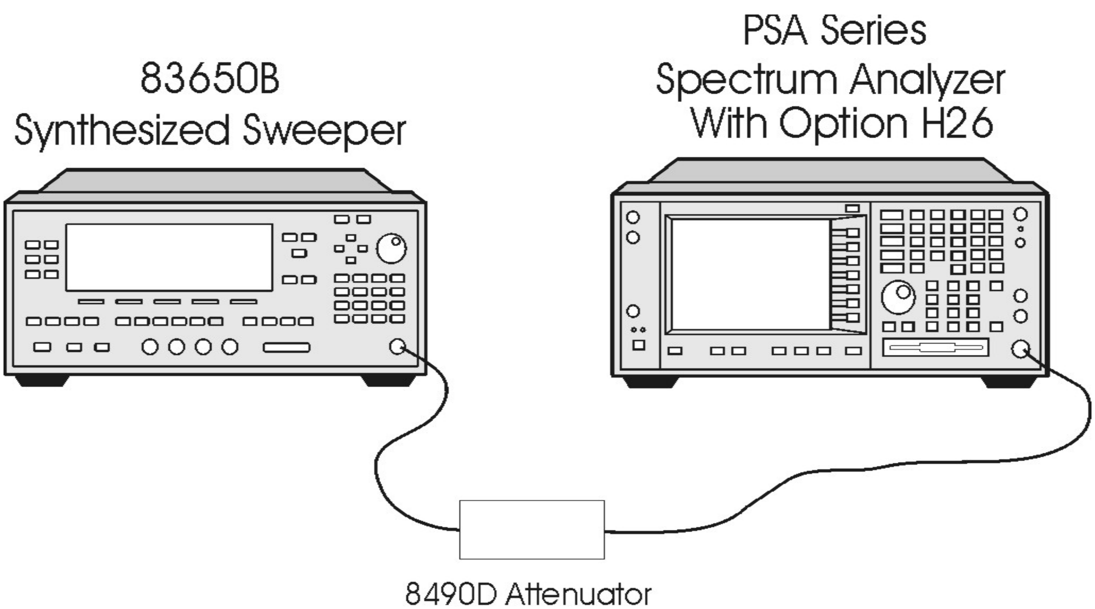
Test Equipment	Quantity	Recommended Model
Various Adapters	n/a	n/a
Various cables	n/a	n/a
Synthesizer Sweeper 10 MHz to 50 GHz	1	83650B[1]
Attenuator 20 dB or greater	1	8490D

1. An 83630B can be used with the E4440A, E4443A, or E4445A.

Analog Test Set-up

Using the Agilent Technologies E444xA Option H26 will allow the user to view low amplitude analog signals. Use the following instrument set-ups for viewing an analog signal. Use the “Front Panel Key Select” on page 3-3 and “GPIB Control of Preamp Gain” on page 3-4 to control the instrument while making measurements.

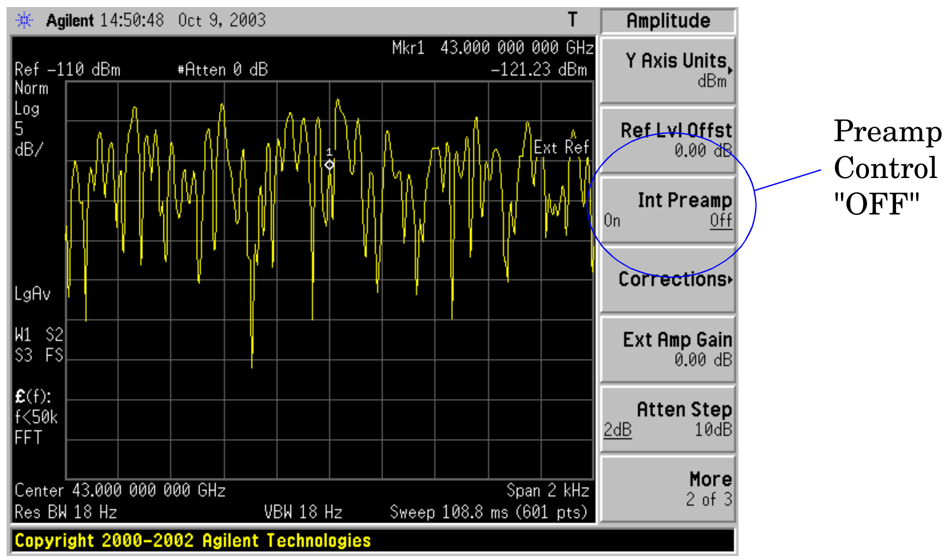
Figure 2-1 Analog Test Set-up



The setup shown in Figure 2-1, “Analog Test Set-up” can be used to look for low amplitude signals that would normally be within the noise floor of the spectrum analyzer.

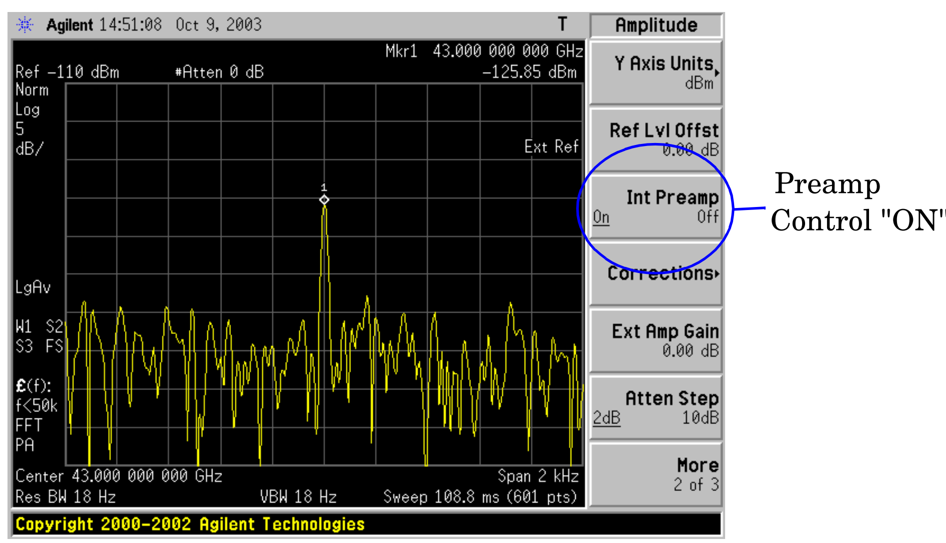
In the example, a low amplitude, 26 GHz signal is generated with the Agilent 83650B. The amplitude was further reduced by using an 8490D coaxial attenuator, which produced a signal that was hidden in the noise floor of the spectrum analyzer in normal operation. Refer to Figure 2-2, "Analog Input Signal with Preamp OFF."

Figure 2-2 Analog Input Signal with Preamp OFF



When the internal preamp is turned on, the noise floor of the spectrum analyzer is reduced, revealing the signal of interest. Refer to Figure 2-3, "Analog Input Signal with Preamp ON."

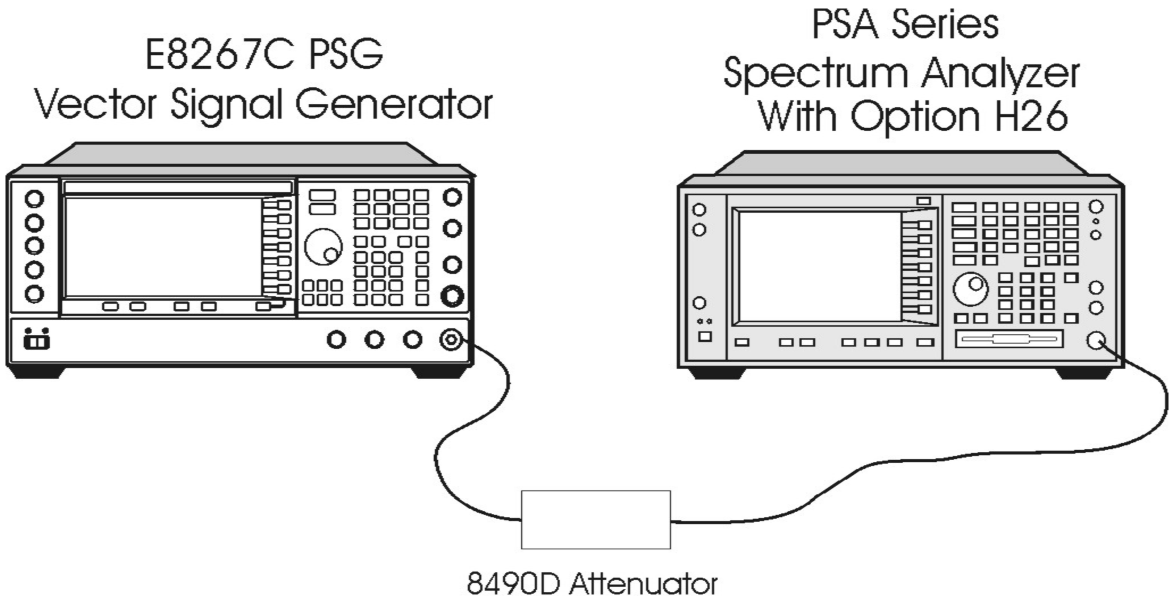
Figure 2-3 Analog Input Signal with Preamp ON



Digital Test Set-up

Using the Agilent Technologies E444xA Option H26 will allow the user to view low amplitude digital signals. Use the following instrument set-up to view an example of a digital signal. Use the "Front Panel Key Select" on page 3-3 and "GPIB Control of Preamp Gain" on page 3-4 to control the instrument while making measurements.

Figure 2-4 Digital Test Set-up



The test set-up shown in Figure 2-4, "Digital Test Set-up" can also be used to look for a low amplitude modulated signals. In the example, we try to see the carrier suppression of a multitone digital signal.
The 20 GHz signal was generated by an Agilent E8267C Vector Signal Generator.

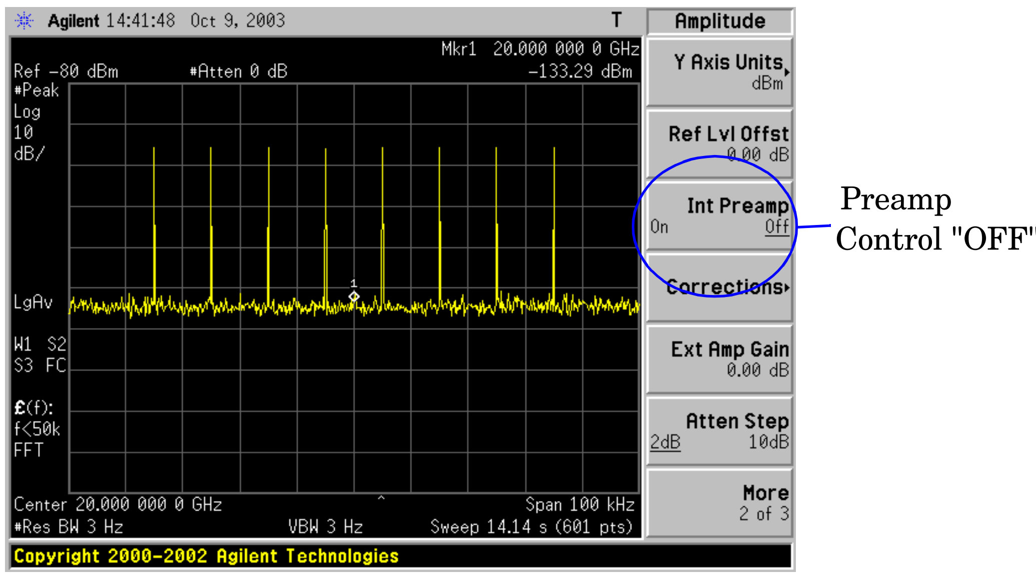
The E8267C was configured using the following keystrokes:

[AMPLITUDE] > -60 > dBm [MODE] > Multitone > On

The default settings of the source were used to produce the signal as shown. The amplitude was reduced even further by using a coaxial attenuator, model number 8490D.

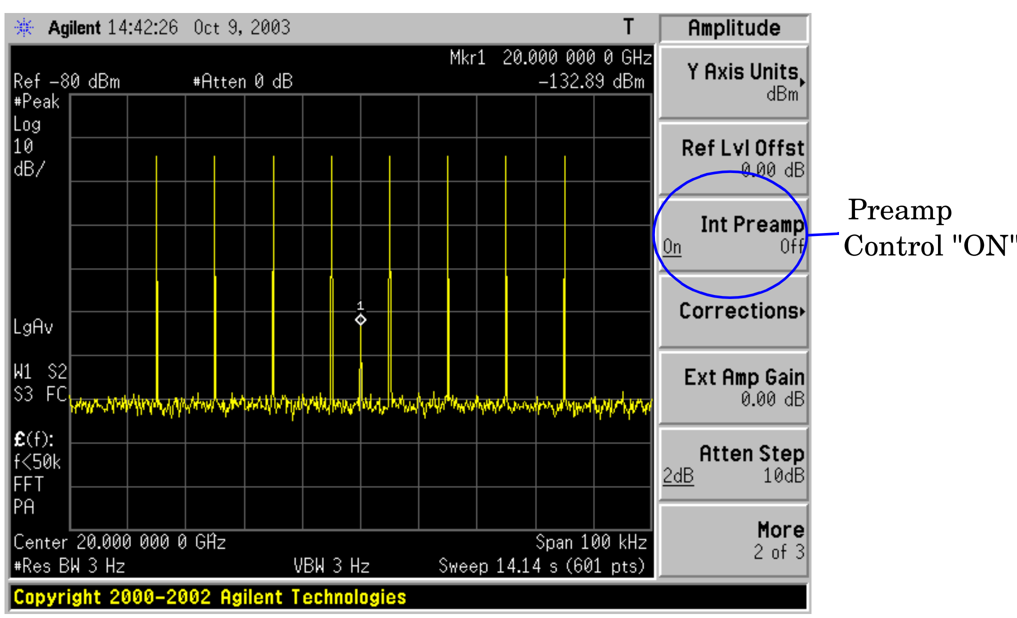
This produced the multitone signal as shown in Figure 2-5, "Digital Input Signal with Preamp OFF." Notice that we cannot detect the carrier signal at 20 GHz.

Figure 2-5 Digital Input Signal with Preamp OFF



When the Option H26 highband preamplifier is turned on, the noise floor of the spectrum analyzer is reduced thus revealing the carrier signal at 20 GHz. Refer to Figure 2-6, "Digital Input Signal with Preamp ON."

Figure 2-6 Digital Input Signal with Preamp ON



3 User Interface

What is in This Chapter

This chapter provides instructions on using the preamp via the front panel, through GPIB commands, accessing the flatness compensation table reloading and recreating the flatness correction table for your instrument.

- "Front Panel Key Select" on page 3-3.
- "GPIB Control of Preamp Gain" on page 3-4
- "Flatness Compensation Table" on page 3-5.

To find descriptions of specific analyzer functions, refer to the *Agilent Technologies PSA Series Spectrum Analyzers User's and Programmer's Reference Guide*.

Front Panel Key Select

AMPLITUDE Y Scale

Activates the reference level function and accesses the amplitude menu keys only while the instrument is in Spectrum Analysis mode. Amplitude menu keys allow you to set functions that affect the way data on the vertical axis is displayed or corrected.

Int Preamp
On Off

Agilent E444xA with Option 1DS and H26 turns the internal preamps on and off. Pressing **Int Preamp (On)** results in a correction being applied to compensate for the gain of the 1DS preamp so that amplitude readings show the value at the input connector. To apply corrections to the H26 Highband Preamp amplitude readings, corrections are manually applied and are explained in the section titled "Accessing the Flatness Compensation Table" on page 3-5. When the preamps are on, a `PA` indication appears on the left side of the display.

The lowband preamp is specified to operate over a 1 MHz to 3 GHz frequency range and the highband preamp is specified to operate from 3 GHz to the upper frequency limit of the instrument[1] depending on the model. Refer to Figure 1-1, "Lowband vs. Highband Frequency Diagram for E4440A" on page 1-3.

Key Access: **AMPLITUDE Y Scale > More 1 of 3**

1. Refer to Table 1-1 on page 1-2 for other model numbers and frequency ranges.

GPIB Control of Preamp Gain

The following SCPI commands apply to the Agilent E444xA Option 1DS and H26.

Refer to *Agilent Technologies PSA Spectrum Analyzer User's and Programmer's Reference Guide,* to locate SCPI command subsystems and subsections that apply to the standard functions of the Agilent Technologies E444xA PSA-Series Spectrum Analyzer.

Preamp Gain Command Interface

`[:SENSe]:POWer[:RF]:GAIN[:STATe] OFF|ON|0|1`

`[:SENSe]:POWer[:RF]:GAIN[:STATe]?`

The above two commands turns the internal lowband and highband preamp on or off.

Factory Preset and *RST: Off

Remarks: This command is available only with Option 1DS installed.

Front Panel Access: **AMPLITUDE/Y Scale > More 1 of 3 > Int Preamp On Off**

Refer to Figure 2-3, "Analog Input Signal with Preamp ON" on page 2-5 for an example of an analog "ON" state of the highband preamp.

Refer to Figure 2-6, "Digital Input Signal with Preamp ON" on page 2-7 for an example of a digital "ON" state of the highband preamp.

Flatness Compensation Table

The following sections will cover the following:

- "Accessing the Flatness Compensation Table" on page 3-5.
- "GPIB Control of the Flatness Compensation Table" on page 3-5
- "Reloading the Flatness Correction Table" on page 3-6.
- "Recreating the Flatness Correction Table" on page 3-7.

Accessing the Flatness Compensation Table

During the Swept Flatness test routine at the factory, correction data points are collected with the highband preamp in the OFF state. The test is then run again with the highband preamp ON. The corrections are then applied to get the best flatness response.

The flatness compensation table is available for the user to apply corrections for an improved flatness response while the highband preamp is on. The following keystrokes will aid the user in accessing the flatness compensation table.

[AMPLITUDE] > More 1 of 3 > Corrections > Other > Correction > On | Off

NOTE When sweeping from below 2.85 GHz to above 3.05 GHz, the corrections table will cause amplitude errors in the 2.85 GHz – 3 GHz band. To avoid these errors, set the start frequency above 2.85 GHz.

NOTE The instrument does not automatically enable the Amplitude Corrections, they must be enabled by the user where appropriate. Unlike the option 1DS lowband preamp where the lowband preamp flatness is corrected automatcally, the Amplitude Correction "**OTHER**" must be turned "ON" when the Preamp is turned "ON" and turned "OFF" when the Preamp is turned "OFF." Measurement errors will result if this is not done.

GPIB Control of the Flatness Compensation Table

The following SCPI commands related to the Agilent E444xA Option 1DS and H26.

Refer to *Agilent Technologies PSA Spectrum Analyzer User's and Programmer's Reference Guide,* to locate SCPI command subsystems and subsections that apply to the standard functions of the Agilent Technologies E444xA PSA-Series Spectrum Analyzer.

Preamp Compensation Table Command Interface

The following command turns on or off the correction system.

`[:SENSe]:CORRection:CSET:ALL[:STATe] OFF|ON|0|1`

The following command turns on or off the correction file to be used[1].

`[:SENSe]:CORRection:CSET3:[:STATe] OFF|ON|0|1`

Reloading the Flatness Correction Table

As a cautionary measure, the flatness corrections stored in the "Other" users file have been provided on a matching serialized disk to be reloaded into the specific spectrum analyzer in the event the flatness corrections are deleted from the instrument.

Insert the serialized disk into the instrument. Use the following keystrokes to reload the serialized flatness corrections data from the disk to the specific instrument.

[FILE] > Load > Type > More 1 of 2 > Corrections > Dir Select > [↑ | ↓] > Drive A > [↑ | ↓] > "H26CORR" > Load Now

Verification of the Flatness Correction Data

To verify the download, use the following keystrokes then verify that the data is visible in the table.

[AMPLITUDE] > More 1 of 3 > Corrections > Other > Edit

Press **[RETURN]** so as not to disturb the data.

1. where CSET3 is the correction set value for "Other".

Recreating the Flatness Correction Table

This section is provided in the event that both the disk and the internal correction tables become corrupt or lost. This procedure can be used to re-create the flatness correction table.

Table 3-1 Required Test Equipment (recreating)

Test Equipment	Quantity	Recommended Model
Various Adapters	n/a	n/a
Various cables	n/a	n/a
Synthesizer Sweeper 10 MHz to 50 GHz	1	83650B[1]

1. An 83630B can be used for the E4440A, E4443A or E4445A.

Connections

1. Connect the 10 MHz Reference Output from the PSA to the Reference In of the source.
2. Turn on the Reference Output on the PSA.

[System] > Reference > 10 MHz Out > On

3. Use Table 3-2 for the PSA settings.

Table 3-2 PSA Instrument Settings

Setting	Value
Span	2 MHz
Attenuation	10 dB[1]
Ref Level	–30 dBm
Scale/Div	5 dB

1. MUST be in Manual Mode:
[AMPLITUDE] > Atten > Manual > 10 dB

4. Turn off the corrections on the PSA.

   [AMPLITUDE] > More 1 of 3 > Corrections > Apply Corrections > Off

5. Use Table 3-3 for the Source settings.

Table 3-3 Source Instrument Settings

Setting	Value
Frequency	follows PSA frequency
Power Level	–35 dBm

Procedure

1. Select 199 frequency points for use in the correction table. The first point should be 2.85 GHz and the final point should be the upper frequency limit of the PSA under test.

The PSA and the source will be set to each frequency chosen.

Repeat the following sequence of steps for each frequency on the PSA and Source in generating the replacement correction table. The PSA and the source will be set to each frequency chosen.

- **[AMPLITUDE] > More 1 of 3 > Int Preamp Off**

Adjust the source to display the input signal on the PSA screen. This should be at least 20 dB above the noise floor.

- **[Peak Search]**
- **[Marker] > Delta**
- **[AMPLITUDE] > More 1 of 3 > Int Preamp On**

Record the amplitude delta. Refer to Table 3-4 on page 3-9 for a sample table. The use of a spreadsheet is helpful in recording the points.

NOTE Any adjustment points ≤ 3 GHz will need to be measured with the PSA start frequency of 2.85 GHz and a stop frequency of 3.06 GHz in order to insure that the instrument is in band 1.

Table 3-4 A Sample Frequency Amplitude Sheet

Point	Frequency (GHz)	Delta Amplitude (dB)	Correction (dBm[1])
1	2.849[2]	0 dB	0 dB
2	2.85	___ dB	– (___ dB)
…	___ GHz	___ dB	– (___ dB)
200	___ GHz[3]	___ dB	– (___ dB)

1. The correction field will contain the negative, or opposite of the Amplitude field. The correction value is what the instrument uses rather than the Amplitude (or error) value.
2. This point is needed so that the corrections are not applied to Band 0.
3. This should be the upper limit of the PSA.

Entering the Flatness Correction Data

To manually enter these recorded values into the PSA instrument, perform the following sequence for each point.

- **[AMPLITUDE] > More 1 of 3 > Corrections > Other > Edit**
- Select [**FREQUENCY**] 2.849 **GHz**
- Select **[AMPLITUDE]** 0 **dB**

After each entry, the Point counter automatically increments for entry of the next point.

- Select [**FREQUENCY**] 2.85 **GHz**
- Select **[AMPLITUDE]** ___ **dB** (Refer to Table 3-4)
- Continue entering data for each point in the table.

Press **[RETURN]**, when finished.

To use the new correction table, insure that the corrections are turned on.

CAUTION It is recommended that the correction set entered be saved on the internal drive or a floppy disk for future references. See the *PSA User's and Programming Reference Guide* for information on saving correction values.

4 Appendix

DANL Manual Performance Verification

The Displayed Average Noise Level manual performance verification measures the preamp “off” DANL of Option H26. The test measures the noise in zero span with a 1 kHz resolution bandwidth, and then normalizes the amplitude to a 1 Hz bandwidth.

DANL is defined as the average of the displayed trace. There is no practical method for manually reading the average of the trace. This procedure averages the trace 100 times and then the operator scrolls the display line to the middle of the trace. The display line reading is considered the trace average. The reading is normalized to a 1 Hz RBW by subtracting 30 dB ($10 \times \text{Log}(1000)$) from the display line value.

Table 4-7 on page 4-7 directs the user to a specific Test Record for that instrument. Table 4-8 on page 4-8 is provided for traceability of the instruments used in the testing.

Procedure

1. Connect the appropriate termination to the PSA RF input connector.
   Press **[System] > Alignments > Align All Now.**
2. Press **Preset**. Set the analyzer controls by pressing the following keys:

   SPAN, Span, 0 Hz

   Sweep, Sweep Time, 20 ms

   Amplitude, Ref Level, -100 dBm

   Amplitude, Attenuation, Man, 0 dB

   BW/AVG, Res BW, 1 kHz

   BW/AVG, Average, On

   Single

3. Press **[AMPLITUDE] > More 1 of 3 > In Preamp > On.** (This is the lowband preamp.)
4. Press **[FREQUENCY]** and enter the first frequency listed in Table 4-1 on page 4-3.

Table 4-1 DANL (PSA with Option 1DS)

Frequency	Normalized DANL
100 kHz	**1)**
199 kHz	**2)**
201 kHz	**3)**
499 kHz	**4)**
501 kHz	**5)**
9.9 MHz	**6)**
10.1 MHz	**7)**
1.0 GHz	**8)**
1.2 GHz	**9)**
2.4 GHz	**10)**
2.6 GHz	**11)**
3.0 GHz	**12)**

5. Press **Single** and wait for 100 averages.
6. Press **Display, Display Line, On**.
7. Scroll the display line so that it bisects the trace. Read the display line amplitude and subtract 30 from the value. Record the result under “Normalized DANL” in the table.
8. Repeat step 5 through step 8 for all frequencies listed in Table 4-1.
9. Record the results of Table 4-1 in the test record table for your model instrument later in this chapter. Refer to Table 4-7 on page 4-7.
10. Press **[AMPLITUDE], More 1 of 3, Int Preamp, Off**.
11. Press **[FREQUENCY**] and enter the first frequency listed in Table 4-2.

Table 4-2 DANL (All PSA Instruments)

Frequency	Normalized DANL
10 kHz	**13)**
99 kHz	**14)**
101 kHz	**15)**
990 kHz	**16)**
1.01 MHz	**17)**
500 MHz	**18)**

Table 4-2 DANL (All PSA Instruments)

Frequency	Normalized DANL
1.1 GHz	**19)**
1.3 GHz	**20)**
2.0 GHz	**21)**
2.4 GHz	**22)**
2.6 GHz	**23)**
3.0 GHz	**24)**
3.1 GHz	**25)**
4.0 GHz	**26)**
5.0 GHz	**27)**
6.5 GHz	**28)**
6.7 GHz	**29)**

12. Press **Single** and wait for 100 averages.
13. Press **Display, Display Line, On**.
14. Scroll the display line so that it bisects the trace. Read the display line amplitude and subtract 30 from the value. Record the result under "Normalized DANL" in the table.
15. Repeat step 12 through step 15 for all frequencies listed in Table 4-2.
16. Record the results of Table 4-2 in the test record table for your model instrument later in this chapter. Refer to Table 4-7 on page 4-7. If the analyzer is an E4443A stop here.
17. Repeat step 12 through step 15 for all frequencies listed in Table 4-3.

Table 4-3 DANL (PSA E4445A, E4440A, E4446A, E4448A)

Frequency	Normalized DANL
8.0 GHz	**30)**
9.0 GHz	**31)**
10.0 GHz	**32)**
11.0 GHz	**33)**
12.0 GHz	**34)**
13.1 GHz	**35)**

18. Record the results of Table 4-3 in the test record table for your model instrument later in this chapter. Refer to Table 4-7 on page 4-7. If the analyzer is an E4445A stop here.

19.Repeat step 12 through step 15 for all frequencies listed in Table 4-4.

Table 4-4 DANL (PSA E4440A, E4446A, E4448A)

Frequency	Normalized DANL
13.3 GHz	**36)**
14.0 GHz	**37)**
15.0 GHz	**38)**
16.0 GHz	**39)**
17.0 GHz	**40)**
18.0 GHz	**41)**
19.9 GHz	**42)**
20.1 GHz	**43)**
21.0 GHz	**44)**
22.4 GHz	**45)**
22.6 GHz	**46)**
24.0 GHz	**47)**
25.0 GHz	**48)**
26.4 GHz	**49)**

20.Record the results of Table 4-4 in the test record table for your model instrument later in this chapter. Refer to Table 4-7 on page 4-7. If the analyzer is an E4440A stop here.

21.Repeat step 12 through step 15 for all frequencies listed in Table 4-5.

Table 4-5 DANL (PSA E4446A, E4448A)

Frequency	Normalized DANL
27.0 GHz	**50)**
28.0 GHz	**51)**
29.0 GHz	**52)**
30.0 GHz	**53)**
31.0 GHz	**54)**
32.0 GHz	**55)**
33.0 GHz	**56)**
34.0 GHz	**57)**
35.5 GHz	**58)**

Table 4-5 **DANL (PSA E4446A, E4448A)**

Frequency	Normalized DANL
36.5 GHz	**59)**
37.5 GHz	**60)**
38.5 GHz	**61)**
39.0 GHz	**62)**
40.0 GHz	**63)**
41.0 GHz	**64)**
42.0 GHz	**65)**
43.0 GHz	**66)**
43.9 GHz	**67)**

22.Record the results of Table 4-5 in the test record table for your model instrument later in this chapter. Refer to Table 4-7 on page 4-7. If the analyzer is an E4446A stop here.

23.Repeat step 12 through step 15 for all frequencies listed in Table 4-6.

Table 4-6 **DANL (PSA E4448A)**

Frequency	Normalized DANL
44.1 GHz	**68)**
45.0 GHz	**69)**
46.0 GHz	**70)**
47.0 GHz	**71)**
48.0 GHz	**72)**
49.0 GHz	**73)**
50.0 GHz	**74)**

24.Record the results of Table 4-6 in the test record table for your model instrument later in this chapter. Refer to Table 4-7 on page 4-7.

Table 4-7 Model Number Verification Test Record

Model Number	Table Number
E4440A	Table 4-9 on page 4-10
E4443A	Table 4-10 on page 4-13
E4445A	Table 4-11 on page 4-15
E4446A	Table 4-12 on page 4-17
E4448A	Table 4-13 on page 4-20

Table 4-8 Agilent E444xA Performance Verification Test Record

Agilent Technologies

Address: ______________________________ Report No. ____________________

______________________________ Date ____________________

____

Model E4440A

Serial No. ________________ Ambient temperature _______° C

Options ________________ Relative humidity_______%

Firmware Revision __________ Power mains line frequency ______ Hz (nominal)

Customer ______________________________ Tested by ____________________

Test Equipment Used:

Description	Model No.	Trace No.	Cal Due Date
Synthesized Signal Generator	________	________	________
Synthesized Signal Source	________	________	________
Synthesized Sweeper #1	________	________	________
Synthesized Sweeper #2	________	________	________
Function Generator	________	________	________
Power Meter, Dual-Channel	________	________	________
RF Power Sensor #1	________	________	________
RF Power Sensor #2	________	________	________
Microwave Power Sensor	________	________	________
Digital Multimeter	________	________	________
Universal Counter	________	________	________
Frequency Standard	________	________	________
RF Power Splitter	________	________	________
Microwave Power Splitter	________	________	________
50 Ω Termination	________	________	________
1 dB Step Attenuator	________	________	________
10 dB Step Attenuator	________	________	________
6 dB Fixed Attenuator	________	________	________
10 dB Fixed Attenuator	________	________	________

Table 4-8 Agilent E444xA Performance Verification Test Record

20 dB Fixed Attenuator	________	________	________
Directional Bridge	________	________	________
Directional Coupler	________	________	________
Notes/comments:	________________________________		
	________________________________		

Table 4-9 Agilent E4440A Performance Verification Test Record

Agilent Technologies					
Model E4440A		**Report No. ___________**			
Serial No. ___________		**Date ___________**			
Test Description	**Minimum**	**Results Measured**		**Maximum**	**Measurement Uncertainty**
Displayed Average Noise Level	Note: Enter results with preamp on in the appropriate section based upon the ambient temperature when the test was performed.				
Preamp On					
100 kHz		(1)________		–159 dBm	±0.07 dB
199 kHz		(2)________		–159 dBm	±0.07 dB
201 kHz		(3)________		–159 dBm	±0.07 dB
499 kHz		(4)________		–159 dBm	±0.07 dB
501 kHz		(5)________		–163 dBm	±0.07 dB
9.9 MHz		(6)________		–166 dBm	±0.07 dB
10.1 MHz		(7)________		–169 dBm	±0.07 dB
1.0 GHz		(8)________		–168 dBm	±0.07 dB
1.2 GHz		(9)________		–167 dBm	±0.07 dB
2.4 GHz		(10)________		–165 dBm	±0.07 dB
2.6 GHz		(11)________		–165 dBm	±0.07 dB
3.0 GHz		(12)________		–165 dBm	±0.07 dB
Preamp Off					
10 kHz		(13)________		–134 dBm	±0.07 dB
99 kHz		(14)________		–134 dBm	±0.07 dB
101 kHz		(15)________		–144 dBm	±0.07 dB
990 kHz		(16)________		–144 dBm	±0.07 dB
1.01 MHz		(17)________		–149 dBm	±0.07 dB
500 MHz		(18)________		–154 dBm	±0.07 dB
1.1 GHz		(19)________		–154 dBm	±0.07 dB
1.3 GHz		(20)________		–153 dBm	±0.07 dB
2.0 GHz		(21)________		–153 dBm	±0.07 dB
2.4 GHz		(22)________		–153 dBm	±0.07 dB

Table 4-9 Agilent E4440A Performance Verification Test Record

Agilent Technologies					
Model E4440A			Report No. ___________		
Serial No. ___________			Date ___________		
Test Description		Minimum	Results Measured	Maximum	Measurement Uncertainty
	2.6 GHz		(23)________	–152 dBm	±0.07 dB
	3.0 GHz		(24)________	–152 dBm	±0.07 dB
	3.1 GHz		(25)________	–151 dBm	±0.07 dB
	4.0 GHz		(26)________	–151 dBm	±0.07 dB
	5.0 GHz		(27)________	–151 dBm	±0.07 dB
	6.5 GHz		(28)________	–151 dBm	±0.07 dB
	6.7 GHz		(29)________	–149 dBm	±0.07 dB
	8.0 GHz		(30)________	–149 dBm	±0.07 dB
	9.0 GHz		(31)________	–149 dBm	±0.07 dB
	10.0 GHz		(32)________	–149 dBm	±0.07 dB
	11.0 GHz		(33)________	–149 dBm	±0.07 dB
	12.0 GHz		(34)________	–149 dBm	±0.07 dB
	13.1 GHz		(35)________	–149 dBm	±0.07 dB
	13.3 GHz		(36)________	–146 dBm	±0.07 dB
	14.0 GHz		(37)________	–146 dBm	±0.07 dB
	15.0 GHz		(38)________	–146 dBm	±0.07 dB
	16.0 GHz		(39)________	–146 dBm	±0.07 dB
	17.0 GHz		(40)________	–146 dBm	±0.07 dB
	18.0 GHz		(41)________	–146 dBm	±0.07 dB
	19.9 GHz		(42)________	–146 dBm	±0.07 dB
	20.1 GHz		(43)________	–146 dBm	±0.07 dB
	21.0 GHz		(44)________	–142 dBm	±0.07 dB
	22.4 GHz		(45)________	–142 dBm	±0.07 dB
	22.6 GHz		(46)________	–141 dBm	±0.07 dB
	24.0 GHz		(47)________	–141 dBm	±0.07 dB

Table 4-9 Agilent E4440A Performance Verification Test Record

Agilent Technologies					
Model E4440A			**Report No. ___________**		
Serial No. ___________			**Date ___________**		
Test Description		**Minimum**	**Results Measured**	**Maximum**	**Measurement Uncertainty**
	25.0 GHz		(48)________	–141 dBm	±0.07 dB
	26.4 GHz		(49)________	–141 dBm	±0.07 dB

Table 4-10 Agilent E4443A Performance Verification Test Record

Agilent Technologies				
Model E4443A		**Report No. __________**		
Serial No. __________		**Date __________**		
Test Description	**Minimum**	**Results Measured**	**Maximum**	**Measurement Uncertainty**
Displayed Average Noise Level	Note: Enter results with preamp on in the appropriate section based upon the ambient temperature when the test was performed.			
Preamp On				
100 kHz		(1)________	–159 dBm	±0.07 dB
199 kHz		(2)________	–159 dBm	±0.07 dB
201 kHz		(3)________	–159 dBm	±0.07 dB
499 kHz		(4)________	–159 dBm	±0.07 dB
501 kHz		(5)________	–163 dBm	±0.07 dB
9.9 MHz		(6)________	–166 dBm	±0.07 dB
10.1 MHz		(7)________	–169 dBm	±0.07 dB
1.0 GHz		(8)________	–168 dBm	±0.07 dB
1.2 GHz		(9)________	–167 dBm	±0.07 dB
2.4 GHz		(10)________	–165 dBm	±0.07 dB
2.6 GHz		(11)________	–165 dBm	±0.07 dB
3.0 GHz		(12)________	–165 dBm	±0.07 dB
Preamp Off				
10 kHz		(13)________	–134 dBm	±0.07 dB
99 kHz		(14)________	–134 dBm	±0.07 dB
101 kHz		(15)________	–144 dBm	±0.07 dB
990 kHz		(16)________	–144 dBm	±0.07 dB
1.01 MHz		(17)________	–149 dBm	±0.07 dB
500 MHz		(18)________	–154 dBm	±0.07 dB
1.1 GHz		(19)________	–154 dBm	±0.07 dB
1.3 GHz		(20)________	–153 dBm	±0.07 dB
2.0 GHz		(21)________	–153 dBm	±0.07 dB
2.4 GHz		(22)________	–153 dBm	±0.07 dB

Table 4-10 Agilent E4443A Performance Verification Test Record

Agilent Technologies				
Model E4443A		Report No. __________		
Serial No. __________		Date __________		
Test Description	**Minimum**	**Results Measured**	**Maximum**	**Measurement Uncertainty**
2.6 GHz		(23)_______	–152 dBm	±0.07 dB
3.0 GHz		(24)_______	–152 dBm	±0.07 dB
3.1 GHz		(25)_______	–151 dBm	±0.07 dB
4.0 GHz		(26)_______	–151 dBm	±0.07 dB
5.0 GHz		(27)_______	–151 dBm	±0.07 dB
6.5 GHz		(28)_______	–151 dBm	±0.07 dB
6.7 GHz		(29)_______	–149 dBm	±0.07 dB

Table 4-11 Agilent E4445A Performance Verification Test Record

Agilent Technologies					
Model E4445A			**Report No. __________**		
Serial No. __________			**Date __________**		
Test Description		**Minimum**	**Results Measured**	**Maximum**	**Measurement Uncertainty**
	Displayed Average Noise Level	Note: Enter results with preamp on in the appropriate section based upon the ambient temperature when the test was performed.			
	Preamp On				
	100 kHz		(1)________	–159 dBm	±0.07 dB
	199 kHz		(2)________	–159 dBm	±0.07 dB
	201 kHz		(3)________	–159 dBm	±0.07 dB
	499 kHz		(4)________	–159 dBm	±0.07 dB
	501 kHz		(5)________	–163 dBm	±0.07 dB
	9.9 MHz		(6)________	–166 dBm	±0.07 dB
	10.1 MHz		(7)________	–169 dBm	±0.07 dB
	1.0 GHz		(8)________	–168 dBm	±0.07 dB
	1.2 GHz		(9)________	–167 dBm	±0.07 dB
	2.4 GHz		(10)________	–165 dBm	±0.07 dB
	2.6 GHz		(11)________	–165 dBm	±0.07 dB
	3.0 GHz		(12)________	–165 dBm	±0.07 dB
	Preamp Off				
	10 kHz		(13)________	–134 dBm	±0.07 dB
	99 kHz		(14)________	–134 dBm	±0.07 dB
	101 kHz		(15)________	–144 dBm	±0.07 dB
	990 kHz		(16)________	–144 dBm	±0.07 dB
	1.01 MHz		(17)________	–149 dBm	±0.07 dB
	500 MHz		(18)________	–154 dBm	±0.07 dB
	1.1 GHz		(19)________	–154 dBm	±0.07 dB
	1.3 GHz		(20)________	–153 dBm	±0.07 dB
	2.0 GHz		(21)________	–153 dBm	±0.07 dB
	2.4 GHz		(22)________	–153 dBm	±0.07 dB

Table 4-11 Agilent E4445A Performance Verification Test Record

Agilent Technologies					
Model E4445A			**Report No. __________**		
Serial No. __________			**Date __________**		
Test Description		**Minimum**	**Results Measured**	**Maximum**	**Measurement Uncertainty**
	2.6 GHz		(23)________	–152 dBm	±0.07 dB
	3.0 GHz		(24)________	–152 dBm	±0.07 dB
	3.1 GHz		(25)________	–151 dBm	±0.07 dB
	4.0 GHz		(26)________	–151 dBm	±0.07 dB
	5.0 GHz		(27)________	–151 dBm	±0.07 dB
	6.5 GHz		(28)________	–151 dBm	±0.07 dB
	6.7 GHz		(29)________	–149 dBm	±0.07 dB
	8.0 GHz		(30)________	–149 dBm	±0.07 dB
	9.0 GHz		(31)________	–149 dBm	±0.07 dB
	10.0 GHz		(32)________	–149 dBm	±0.07 dB
	11.0 GHz		(33)________	–149 dBm	±0.07 dB
	12.0 GHz		(34)________	–149 dBm	±0.07 dB
	13.1 GHz		(35)________	–149 dBm	±0.07 dB

Table 4-12 Agilent E4446A Performance Verification Test Record

Agilent Technologies					
Model E4446A			**Report No. __________**		
Serial No. __________			**Date __________**		
Test Description		**Minimum**	**Results Measured**	**Maximum**	**Measurement Uncertainty**
	Displayed Average Noise Level	Note: Enter results with preamp on in the appropriate section based upon the ambient temperature when the test was performed.			
	Preamp On				
	100 kHz		(1)_______	−158 dBm	±0.07 dB
	199 kHz		(2)_______	−158 dBm	±0.07 dB
	201 kHz		(3)_______	−158 dBm	±0.07 dB
	499 kHz		(4)_______	−159 dBm	±0.07 dB
	501 kHz		(5)_______	−161 dBm	±0.07 dB
	9.9 MHz		(6)_______	−167 dBm	±0.07 dB
	10.1 MHz		(7)_______	−167 dBm	±0.07 dB
	1.0 GHz		(8)_______	−166 dBm	±0.07 dB
	1.2 GHz		(9)_______	−166 dBm	±0.07 dB
	2.4 GHz		(10)_______	−163 dBm	±0.07 dB
	2.6 GHz		(11)_______	−163 dBm	±0.07 dB
	3.0 GHz		(12)_______	−163 dBm	±0.07 dB
	Preamp Off				
	10 kHz		(13)_______	−136 dBm	±0.07 dB
	99 kHz		(14)_______	−136 dBm	±0.07 dB
	101 kHz		(15)_______	−144 dBm	±0.07 dB
	990 kHz		(16)_______	−144 dBm	±0.07 dB
	1.01 MHz		(17)_______	−149 dBm	±0.07 dB
	500 MHz		(18)_______	−153 dBm	±0.07 dB
	1.1 GHz		(19)_______	−153 dBm	±0.07 dB
	1.3 GHz		(20)_______	−152 dBm	±0.07 dB
	2.0 GHz		(21)_______	−152 dBm	±0.07 dB
	2.4 GHz		(22)_______	−151 dBm	±0.07 dB
	2.6 GHz		(23)_______	−151 dBm	±0.07 dB

Table 4-12 Agilent E4446A Performance Verification Test Record

Agilent Technologies					
Model E4446A			Report No. ___________		
Serial No. ___________			Date ___________		
Test Description		Minimum	Results Measured	Maximum	Measurement Uncertainty
	3.0 GHz		(24)________	–151 dBm	±0.07 dB
	3.1 GHz		(25)________	–150 dBm	±0.07 dB
	4.0 GHz		(26)________	–150 dBm	±0.07 dB
	5.0 GHz		(27)________	–150 dBm	±0.07 dB
	6.5 GHz		(28)________	–150 dBm	±0.07 dB
	6.7 GHz		(29)________	–145 dBm	±0.07 dB
	8.0 GHz		(30)________	–145 dBm	±0.07 dB
	9.0 GHz		(31)________	–145 dBm	±0.07 dB
	10.0 GHz		(32)________	–145 dBm	±0.07 dB
	11.0 GHz		(33)________	–145 dBm	±0.07 dB
	12.0 GHz		(34)________	–145 dBm	±0.07 dB
	13.1 GHz		(35)________	–145 dBm	±0.07 dB
	13.3 GHz		(36)________	–144 dBm	±0.07 dB
	14.0 GHz		(37)________	–144 dBm	±0.07 dB
	15.0 GHz		(38)________	–144 dBm	±0.07 dB
	16.0 GHz		(39)________	–144 dBm	±0.07 dB
	17.0 GHz		(40)________	–143 dBm	±0.07 dB
	18.0 GHz		(41)________	–143 dBm	±0.07 dB
	19.9 GHz		(42)________	–143 dBm	±0.07 dB
	20.1 GHz		(43)________	–141 dBm	±0.07 dB
	21.0 GHz		(44)________	–141 dBm	±0.07 dB
	22.4 GHz		(45)________	–141 dBm	±0.07 dB
	22.6 GHz		(46)________	–138 dBm	±0.07 dB
	24.0 GHz		(47)________	–138 dBm	±0.07 dB
	25.0 GHz		(48)________	–138 dBm	±0.07 dB
	26.4 GHz		(49)________	–138 dBm	±0.07 dB
	27.0 GHz		(50)________	–140 dBm	±0.07 dB

Table 4-12 Agilent E4446A Performance Verification Test Record

Agilent Technologies					
Model E4446A		Report No. ___________			
Serial No. ___________		Date ___________			
Test Description		**Minimum**	**Results Measured**	**Maximum**	**Measurement Uncertainty**
	28.0 GHz		(51)________	–140 dBm	±0.07 dB
	29.0 GHz		(52)________	–140 dBm	±0.07 dB
	30.0 GHz		(53)________	–140 dBm	±0.07 dB
	31.0 GHz		(54)________	–140 dBm	±0.07 dB
	32.0 GHz		(55)________	–132 dBm	±0.07 dB
	33.0 GHz		(56)________	–132 dBm	±0.07 dB
	34.0 GHz		(57)________	–132 dBm	±0.07 dB
	35.5 GHz		(58)________	–132 dBm	±0.07 dB
	36.5 GHz		(59)________	–127 dBm	±0.07 dB
	37.5 GHz		(60)________	–127 dBm	±0.07 dB
	38.5 GHz		(61)________	–129 dBm	±0.07 dB
	39.0 GHz		(62)________	–129 dBm	±0.07 dB
	40.0 GHz		(63)________	–129 dBm	±0.07 dB
	41.0 GHz		(64)________	–129 dBm	±0.07 dB
	42.0 GHz		(65)________	–129 dBm	±0.07 dB
	43.0 GHz		(66)________	–129 dBm	±0.07 dB
	43.9 GHz		(67)________	–129 dBm	±0.07 dB

Table 4-13 Agilent E4448A Performance Verification Test Record

Agilent Technologies					
Model E4448A		Report No. ________			
Serial No. ________		Date ________			
Test Description		**Minimum**	**Results Measured**	**Maximum**	**Measurement Uncertainty**
	Displayed Average Noise Level	Note: Enter results with preamp on in the appropriate section based upon the ambient temperature when the test was performed.			
	Preamp On				
	100 kHz		(1)________	–158 dBm	±0.07 dB
	199 kHz		(2)________	–158 dBm	±0.07 dB
	201 kHz		(3)________	–158 dBm	±0.07 dB
	499 kHz		(4)________	–159 dBm	±0.07 dB
	501 kHz		(5)________	–161 dBm	±0.07 dB
	9.9 MHz		(6)________	–167 dBm	±0.07 dB
	10.1 MHz		(7)________	–167 dBm	±0.07 dB
	1.0 GHz		(8)________	–166 dBm	±0.07 dB
	1.2 GHz		(9)________	–166 dBm	±0.07 dB
	2.4 GHz		(10)________	–163 dBm	±0.07 dB
	2.6 GHz		(11)________	–163 dBm	±0.07 dB
	3.0 GHz		(12)________	–163 dBm	±0.07 dB
	Preamp Off				
	10 kHz		(13)________	–136 dBm	±0.07 dB
	99 kHz		(14)________	–136 dBm	±0.07 dB
	101 kHz		(15)________	–144 dBm	±0.07 dB
	990 kHz		(16)________	–144 dBm	±0.07 dB
	1.01 MHz		(17)________	–149 dBm	±0.07 dB
	500 MHz		(18)________	–153 dBm	±0.07 dB
	1.1 GHz		(19)________	–153 dBm	±0.07 dB
	1.3 GHz		(20)________	–152 dBm	±0.07 dB
	2.0 GHz		(21)________	–152 dBm	±0.07 dB
	2.4 GHz		(22)________	–151 dBm	±0.07 dB
	2.6 GHz		(23)________	–151 dBm	±0.07 dB

Table 4-13 Agilent E4448A Performance Verification Test Record

Agilent Technologies				
Model E4448A		Report No. ___________		
Serial No. ___________		Date ___________		
Test Description	**Minimum**	**Results Measured**	**Maximum**	**Measurement Uncertainty**
3.0 GHz		(24)________	–151 dBm	±0.07 dB
3.1 GHz		(25)________	–150 dBm	±0.07 dB
4.0 GHz		(26)________	–150 dBm	±0.07 dB
5.0 GHz		(27)________	–150 dBm	±0.07 dB
6.5 GHz		(28)________	–150 dBm	±0.07 dB
6.7 GHz		(29)________	–145 dBm	±0.07 dB
8.0 GHz		(30)________	–145 dBm	±0.07 dB
9.0 GHz		(31)________	–145 dBm	±0.07 dB
10.0 GHz		(32)________	–145 dBm	±0.07 dB
11.0 GHz		(33)________	–145 dBm	±0.07 dB
12.0 GHz		(34)________	–145 dBm	±0.07 dB
13.1 GHz		(35)________	–145 dBm	±0.07 dB
13.3 GHz		(36)________	–144 dBm	±0.07 dB
14.0 GHz		(37)________	–144 dBm	±0.07 dB
15.0 GHz		(38)________	–144 dBm	±0.07 dB
16.0 GHz		(39)________	–144 dBm	±0.07 dB
17.0 GHz		(40)________	–143 dBm	±0.07 dB
18.0 GHz		(41)________	–143 dBm	±0.07 dB
19.9 GHz		(42)________	–143 dBm	±0.07 dB
20.1 GHz		(43)________	–141 dBm	±0.07 dB
21.0 GHz		(44)________	–141 dBm	±0.07 dB
22.4 GHz		(45)________	–141 dBm	±0.07 dB
22.6 GHz		(46)________	–138 dBm	±0.07 dB
24.0 GHz		(47)________	–138 dBm	±0.07 dB
25.0 GHz		(48)________	–138 dBm	±0.07 dB
26.4 GHz		(49)________	–138 dBm	±0.07 dB
27.0 GHz		(50)________	–140 dBm	±0.07 dB

Table 4-13 Agilent E4448A Performance Verification Test Record

Agilent Technologies				
Model E4448A		Report No. __________		
Serial No. __________		Date __________		
Test Description	Minimum	Results Measured	Maximum	Measurement Uncertainty
28.0 GHz		(51)________	–140 dBm	±0.07 dB
29.0 GHz		(52)________	–140 dBm	±0.07 dB
30.0 GHz		(53)________	–140 dBm	±0.07 dB
31.0 GHz		(54)________	–140 dBm	±0.07 dB
32.0 GHz		(55)________	–132 dBm	±0.07 dB
33.0 GHz		(56)________	–132 dBm	±0.07 dB
34.0 GHz		(57)________	–132 dBm	±0.07 dB
35.5 GHz		(58)________	–132 dBm	±0.07 dB
36.5 GHz		(59)________	–127 dBm	±0.07 dB
37.5 GHz		(60)________	–127 dBm	±0.07 dB
38.5 GHz		(61)________	–129 dBm	±0.07 dB
39.0 GHz		(62)________	–129 dBm	±0.07 dB
40.0 GHz		(63)________	–129 dBm	±0.07 dB
41.0 GHz		(64)________	–129 dBm	±0.07 dB
42.0 GHz		(65)________	–129 dBm	±0.07 dB
43.0 GHz		(66)________	–129 dBm	±0.07 dB
43.9 GHz		(67)________	–129 dBm	±0.07 dB
44.1 GHz		(68)________	–126 dBm	±0.07 dB
45.0 GHz		(69)________	–125 dBm	±0.07 dB
46.0 GHz		(70)________	–125 dBm	±0.07 dB
47.0 GHz		(71)________	–125 dBm	±0.07 dB
48.0 GHz		(72)________	–125 dBm	±0.07 dB
49.0 GHz		(73)________	–125 dBm	±0.07 dB
50.0 GHz		(74)________	–124 dBm	±0.07 dB