Agilent
ESA-E Series Spectrum Analyzers
Noise Figure Measurements Personality

Technical Overview with Self-Guided Demonstration
Option 219

The noise figure measurement personality for the ESA-E Series transforms the industry's most flexible spectrum analyzer into an application-focused tool for noise figure analysis.

The ESA-E Series provides all the flexibility you have come to expect from the successor to the 8590-E Series spectrum analyzer -- then takes a giant leap forward in performance and ease of use.

Agilent Technologies

Add Noise Figure and Gain Measurements to Your Set of Test and Development Tools

A key measurement in the development of devices and systems is its noise figure. The overall noise figure of a system is one of the limiting factors in its performance. Making noise figure measurements can be a tedious manual process. With Agilent's noise figure measurement systems, these measurements can be fast and easy to make with accurate results. Meet many of your measurement needs with a one-analyzer solution from Agilent.

- Perform system calibration easily and quickly.
- Analyze the device noise figure in several different formats.
- Characterize the noise figure of frequency conversion devices.
- Calculate measurement uncertainty easily.

The Agilent ESA-E Series offers mid-performance spectrum analysis up to 26.5 GHz[1], combining powerful one-button measurements and the industry's most versatile feature set in a rugged, portable, affordable package. Expand the ESA to include noise figure measurements with the noise figure measurement personality and hardware (Option 219).

The noise figure measurements personality provides noise figure and gain measurements up to the 26.5 GHz frequency range of the ESA, with specified measurements over the 10 MHz to 3 GHz range.

1. 325 GHz with external mixing.

The technical overview includes:
- Measurement details
- Demonstrations
- ESA-E Series key specifications for the noise figure personality
- Related literature
- Ordering information

All demonstrations use the Agilent N4002A SNS Series noise source, mixer, amplifier and 70 MHz band pass filter. The keystrokes surrounded by [ ] indicate hard keys, while key names surrounded by { } indicate soft keys located on the right edge of the display.

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Figure 1. Noise Figure Features

Demonstration preparation

To configure the measurement system, the ESA-E Series with Option 219 provides two interfaces.

- The SNS Series noise source connector for use with Agilent N400XA SNS Series noise sources
- The +28V (pulsed) noise source drive output for compatibility with existing 346 Series noise sources

In this case, simply connect the N4002A SNS Series noise source to the ESA using a 11730A cable to automatically transfer the ENR data to the NFA.

To perform the following demonstrations, you will need:

Product type	Model number	Required options
ESA-E Series spectrum analyzer	E4401B/02B/04B/05B/07B	• Option 1DS Built in preamplifier • Option 219 Noise figure measurement personality and hardware

Figure 2. Smart noise source N4002A

Noise figure measurement process summary

Measuring the noise figure of a device requires knowledge of the measurement system. Once the noise figure of the measurement instrument is known and the gain of the DUT is known, then the noise figure of the DUT can be calculated, after which the overall noise figure is measured. To make noise figure measurements follow these three easy steps:

1. Enter the excess noise ratio (ENR) values of the noise source in dB.
2. Calibrate the measurement personality.
3. Make noise figure measurements.

Switch to the noise figure measurement personality

Spectrum analyzers can make many different types of measurements. The noise figure personality, one of many modes that the ESA-E Series can be operated in, makes a cost-effective way to expand the capability of this essential engineering tool.

Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
Switch to the noise figure measurement personality	[Preset] [Mode] ({More 1 of 2} if necessary) {Noise Figure}

Entering the ENR table for a noise source manually or automatically

The noise source used for this demonstration is the N4002A SNS Series noise source, which has a calibrated range of 10 MHz to 26.5 GHz. The SNS Series noise sources work with the ESA-E Series to simplify measurement set-up and improve accuracy. Only available for use with Agilent instruments, the SNS Series provides the following advantages:

- Automatic download of ENR data to the ESA, speeding overall setup time
- Electronic storage of ENR calibration data, which all but eliminates the opportunity for user error
- Automatic sensing of the ambient temperature of the measurement environment, allowing the ESA to compensate for changes during the measurement cycle thus increasing the accuracy and reliability of noise figure measurements

Agilent also provides an interface for use with existing 346 series noise sources to help you preserve your capital investment. These noise sources do not operate automatically as do the SNS Series, however they are available with disks containing the noise source ENR data to facilitate the measurement process.

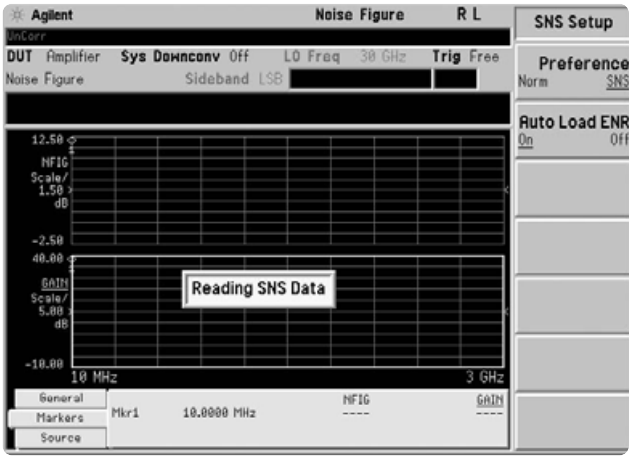
The ESA allows you to set the preference for which noise source drive output you want to use. Once calibration data is entered into the measurement personality, system calibration and DUT measurements can be made. A common ENR table can be used for calibration and measurements in most cases; however, in the case of mixers, for example, the frequency range of the source for measurements may be outside the range for calibration, and therefore two sources are required. In this instance, the calibration ENR table is different from the measurement ENR table so the common table function is turned off.

This exercise illustrates the different methods of entering excess noise ratio numbers.

Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
Automatic upload of ENR data from SNS Series noise source	[Meas Setup] {ENR} {SNS Setup} {Preferences Norm SNS} *Toggles to SNS if on Norm* {Auto Load ENR On Off} *Toggles to On if Off*
Connect the SNS to the ESA using the 11730A cable	**No key presses are required for this step**
Verify that the data has correctly transferred over	[Return] {Meas & Cal Table...}

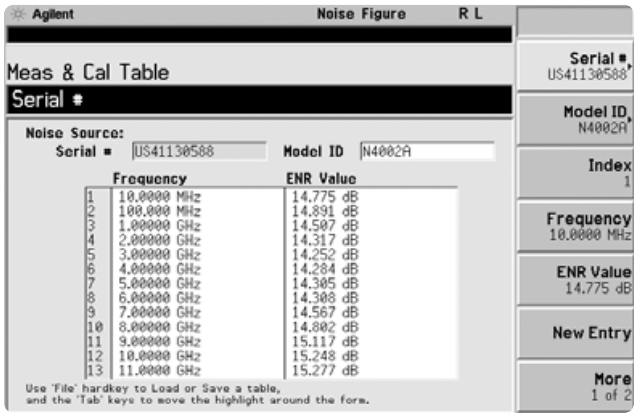
Step 1: Preferred step with Smart noise source.

Figure 3. Automatic upload of ENR data from SNS EEPROM



If the noise source preference was a normal 346 Series noise source, then this is the same interface that you would use to enter the ENR data. The 346 Series comes with a disk containing the noise source ENR data. Load it as follows.

Figure 4. Common ENR table with ENR data for N4002A SNS Series noise source



Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
Load the ENR numbers from disk	[File] {Load} {Type} {More 1 of 3} {ENR Meas/Common Table}
Change directory to A:\ if not already selected	{Dir Select}, use [⇑] or [⇓] arrows to select drive A for the floppy then press {Dir Select}. Highlight the ENR file name using [⇑] or [⇓] and then press {Load Now}
If you misplace the disks, you can enter the ENR values by manually adding the serial and model numbers from annotation on the noise source	{Meas Setup} {ENR} {Meas & Cal Table} [Return] {Serial #} Use the numeric pad and alpha editor to enter the serial number, then press {model ID} and enter the model number using the alpha editor and numeric key pad
Add ENR values versus frequency	Press {Index} 1, {Frequency} 10 {MHz}, {ENR Value}, [13.14] {dB}. Repeat the process for index 2 and so on
The table auto sorts by frequency	

Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
Saving the calibration data to a floppy or the internal memory of the ESA	Press [File], {Save}, {Dir Select}, use [⇑] or [⇓] to select drive A for the floppy, then press {Dir Select}. Press {Name} and use the Alpha Editor to name the file. When finished entering the name, press [Return] and {Save Now}

Calibration of the noise figure measurement personality

For accurate noise figure measurements, the measurement system must first be calibrated to identify and correct the system's inherent noise figure before a DUT can be measured. The ESA's noise figure personality measures the noise figure of the entire measurement system and then removes it from the total noise figure measurement so that only the DUT's noise figure and gain are displayed.

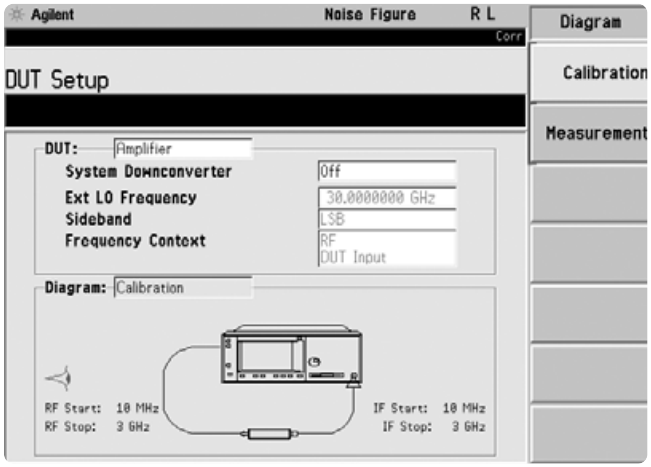
Use the following calibration process:

1. Select the frequency range appropriate for the DUT
2. Set the number of points and set the number of averages. *Any jitter in the calibration step will add to the measurement uncertainty of all subsequent measurements. Therefore a long averaging time should be used for calibration in order to reduce this source of uncertainty to a negligible level.*
3. If the DUT does not have gain or if the gain is low then turn on the built-in preamplifier before beginning calibration.

Now perform a system calibration.

Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
Connect the SNS to the ESA input connector	No key presses are required for this step
Access the DUT setup diagram to obtain guidelines on setup connections for calibration of an amplifier as a DUT.	[Mode Setup] {DUT Setup...}
Press the tab keys to navigate your way around the form. When the form highlights the diagram field "blue", you should use the softkey to change the parameter.	

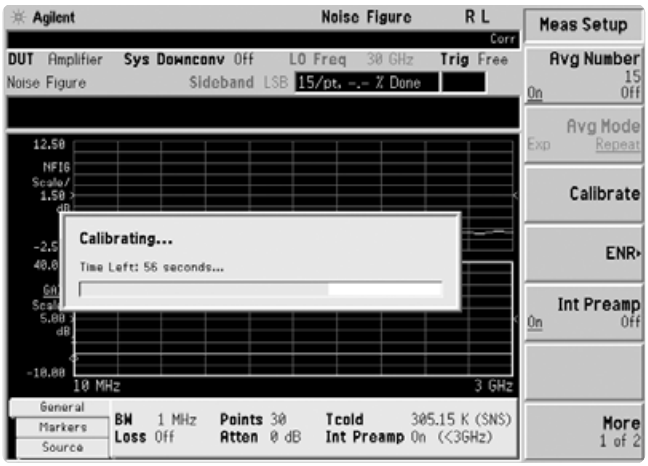
Figure 5. The DUT setup form allows the user to prepare the measurement personality for measuring specific devices and setups, and provides information on how to setup the instrumentation for either calibration as show or measurement



Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
Set the start frequency	[Frequency] {Start Freq}, 10 MHz
Set the stop frequency	[Frequency] {Stop Freq}, 3 GHz
Set the number of points at which to measure	[Frequency] {Points}, 30 {enter}
Set the averaging function to 15 averages	[Meas Setup] {Avg Number On} 15 {Enter}
Calibrate the measurement personality	[Meas Setup] {Calibrate} {Calibrate}

Step 2: Calibration of the ESA

Figure 6. The ESA is set to sweep a number of times (defined by averaging) across the user defined frequency range, cycling through all the defined attenuator settings to ensure that a corrected noise figure measurement is made



Noise figure and gain measurements

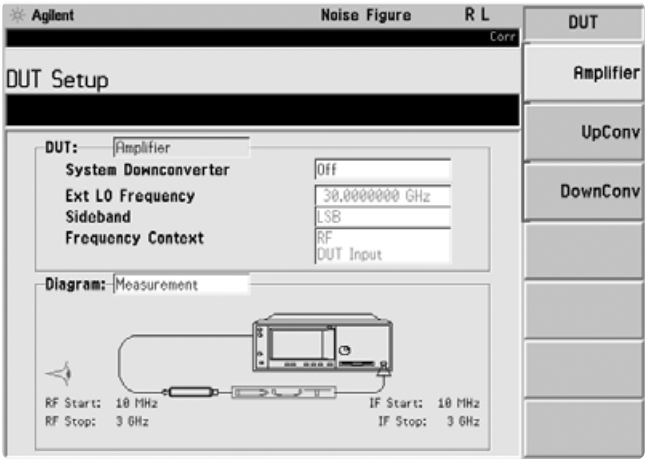
Now that the measurement personality is calibrated with the noise source connected directly to the input, it is a simple matter to make noise figure and gain measurements on a device.

Disconnect the noise source from the input and connect the DUT to the input and connect the noise source to the DUT as shown in Figure 7.

As soon as the DUT is connected to the ESA the system will begin sweeping, measuring the noise figure and gain of the amplifier. The user has the flexibility to select single or continuous sweep based on what the intention is. Additionally, the user can specify a lower number of averages to permit a faster measurement.

Step 3: Noise figure measurement

Figure 7. DUT setup form



Using the display features

The noise figure personality has many features to help you interpret and analyze noise figure measurements.

Scale and reference level values

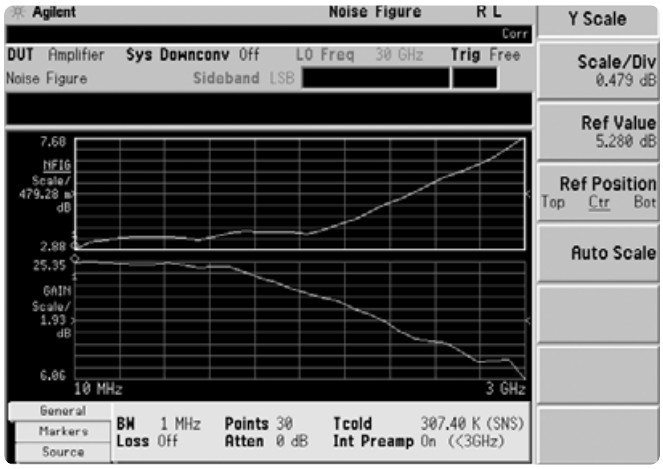
The scale in dB per division and the reference values can be adjusted to give an optimized view of the measured results. The scale per division can be adjusted from 0 to 20 dB. The reference level can be placed at the top, in the center or at the bottom of the graph. The reference level is also adjustable from –100 dB to +100 dB.

Use the Auto Scale feature to give the broadest view of the measured trace. The lowest point will be placed at the bottom of the graph and the highest value at the top of the graph.

Perform display scaling.

Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
Expand the trace to fit the graph for a better view of the measurement using the Auto Scale function as shown in Figure 8	Press [Amplitude] use [Next Window] to high light the graph to be expanded then press {Auto Scale}

Figure 8. Display of noise figure and gain after auto scaling



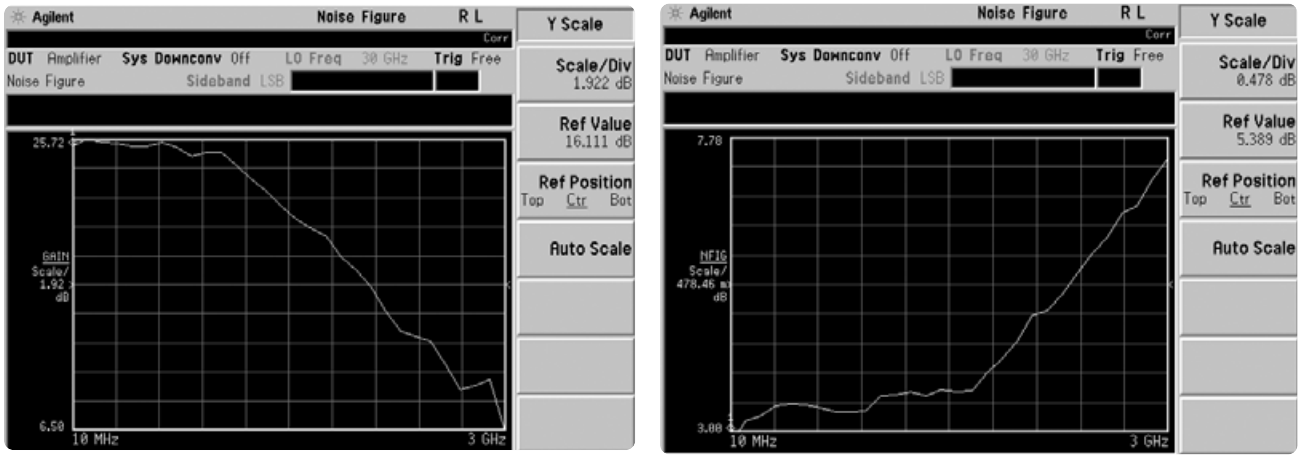
Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
Set the scale of the graphical view	Press [Next Window] to highlight the graph to be changed. In this case the Gain window. Press {Scale/Div} and enter the new value 2 {dB}
Set the reference value	Press [Amplitude] {Ref Value} and enter the value 20 and press dB
Set the position of the reference	Move the position of the Reference Value by toggling through {Ref Position Top Ctr Bot}

More display features

Select and zoom active window
This feature allows you to highlight a window and then enlarge it for closer analysis.

Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
Highlight the window of interest	Press [Next Window] until the window you want is highlighted
Enlarge the window for closer analysis	Press [Zoom]
Switch to another window (Figures 9a and 9b)	Press [Next Window]

Figures 9a and 9b. Full screen display of noises figure and device gain



General, markers and source tabs

The three tabs at the bottom of the screen are accessed using the [|←] and [→|] tab arrow keys on the front panel of the ESA. The general tab shows information about BW, number of points, Tcold value, loss, attenuator and internal preamplifier settings.

The marker tab gives the frequency, noise figure and gain of each of the markers. The source tab has information about the noise source, including serial number and model identification.

Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
View the general tab at the bottom of display	Use the right and left tab keys at the bottom of the front panel to scroll through the tabs
View the source tab at the bottom of the display	Use the right and left tab keys

Figure 10. General information display

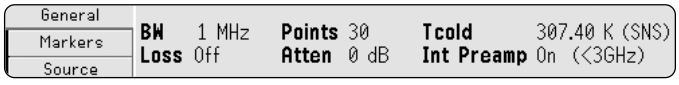
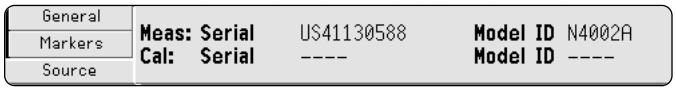


Figure 11. Noise source information



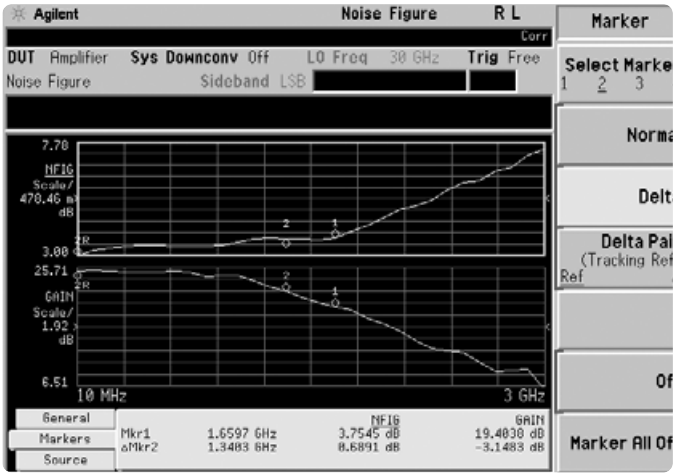
Markers

A total of four normal markers can be placed on the graphical display. The placement of the markers is limited to the number of equally spaced calibration points. For example, if there are 11 calibration points then the markers can be placed on each of the vertical graticule lines. A delta marker can be created for each normal marker, which in turn becomes the reference marker For example, marker 2 will change to marker 2 and 2R where 2R is the reference and 2 would be the delta.

Note: that it is not necessary to toggle to the marker tab when selecting marker functions. This is automatically displayed. Additionally, the analyzer toggles to the general tab once markers are turned off.

Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
The marker function operates the same as the standard ESA-E Series	To turn marker on, press [Marker]
Turn on marker 2	Press {Select Marker 2} and press {Normal}
Active delta marker 2. The marker table under the graphical display reflects the delta marker information	First place the marker to a reference point using knob or up/down arrows. Press {Delta}. Move the marker relative to the reference marker
Switch between displaying the absolute frequency of the delta marker and the reference marker frequency	Press {Delta Pair}. Note the change in frequency above the graphical display

Figure 12. Display of markers and delta markers on the ESA allow noise figure and gain to be read along the entire sweep



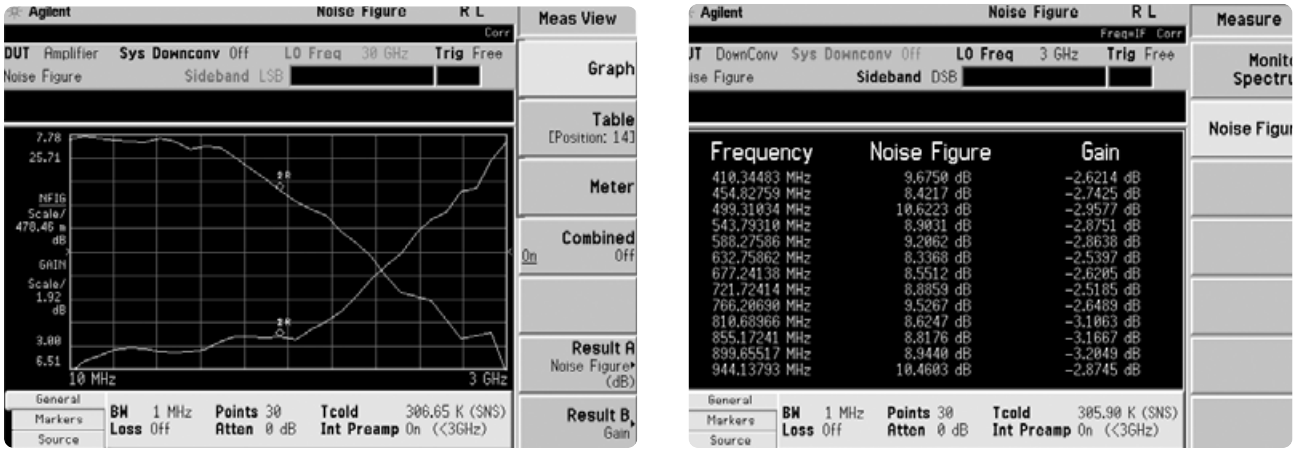
Change format of the active window

The default view of the window is the graphical mode with noise figure in the top and gain in the bottom. The two graphs can be combined to display both traces on one graph. There are two other views available:

- Table mode, which provides a stream of numerical readouts and allows for more in depth analysis
- Meter mode, which provides quick and easy to read measurement information and facilitates testing.

Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
To combine both traces on one graph, see Figure 13	Press [View/Trace] {Combined on}
Activate the table mode	Press [View/Trace] {Table}
Activate the meter mode	Press [View/Trace] {Meter}

Figures 13a and 13b.
Combined and table display mode on the ESA

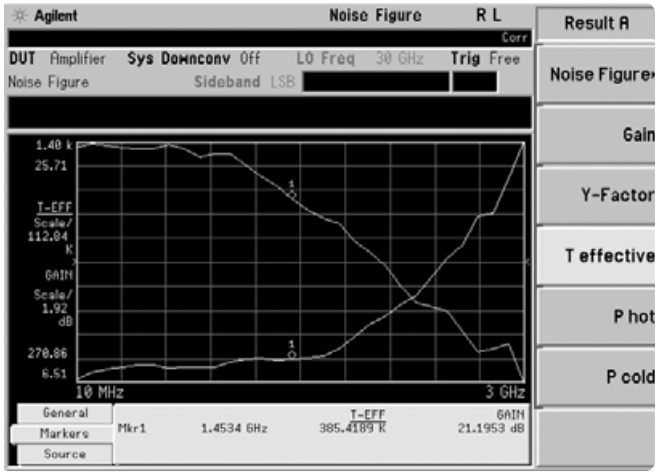


Change the displayed measurement result

The default display of the ESA is noise figure and gain; however there is a separate facility for displaying six different types of measurement results. This can be done independently for the two windows.

Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
Activate the table mode, see Figure 14	Press [View/ Trace]{Result A}{T effective}
Scale the view appropriately	Press [Amplitude]{Auto Scale}

Figure 14. Different measurement result type on ESA

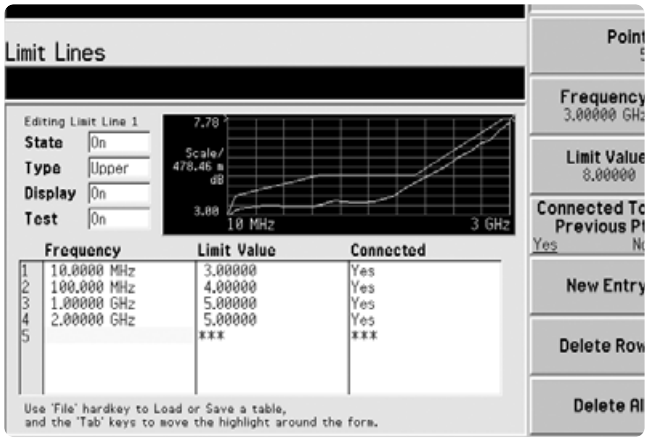


Creating and testing to limit lines

In the manufacturing environment, you can increase manufacturing throughput by inserting pass/fail limit lines for your measurements. The operator can quickly and efficiently quantify noise figure and gain by using this function, and dramatically reduce the time spent testing each DUT. Up to four limit lines can be set up, two for the upper and two for the lower graphs. The upper graph limit lines are designated using up arrows and the lower graph limit lines using down arrows. The limit lines can be designated as upper limit or lower limit and each can have a test pass/fail indicator.

Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
Open the limit line editor, select upper limit keys for the upper graph and turn on the limit test	[Display] {limits} {limit line 1} {Edit}, use [|←] [→|] tab under display to highlight "State". Press {On}, move to Type, press {Upper}, move to Display {On}, move to Test {On}
Insert limit values for 10 MHz, 100MHz, 1, 2, and 3 GHz Limit line values are not context sensitive and take on the value of the set of results to which they are being applied	Use [|←] [→|] tab keys to highlight point 1. Press {Frequency 10 MHz}, {limit Value} [3] {x 1}, {Connected Yes}, {Point 2} {Frequency 100 MHz}, {Limit Value} [4] {x 1}, {Connected Yes}, {Point 3}, {Frequency 1 GHz}, {Limit Value} [5] {x 1}, {Connected Yes}, {Point 4}, {Frequency 2 GHz}, {Limit Value} [5] {x 1}, {Connected Yes}, {Point 5}, {Frequency 3 GHz}, {Limit Value} [8] {x 1}, {Connected Yes}

Figure 15. Limit line editor on the ESA



Noise figure uncertainty calculator

The noise figure personality (Option 219) has a built-in uncertainty calculator. To calculate the overall measurement uncertainty, simply choose the default noise source (N4002A for example), enter the input and output match of the DUT and the gain/noise figure of the DUT from the measurement display. Some default values for the ESA have already been entered.

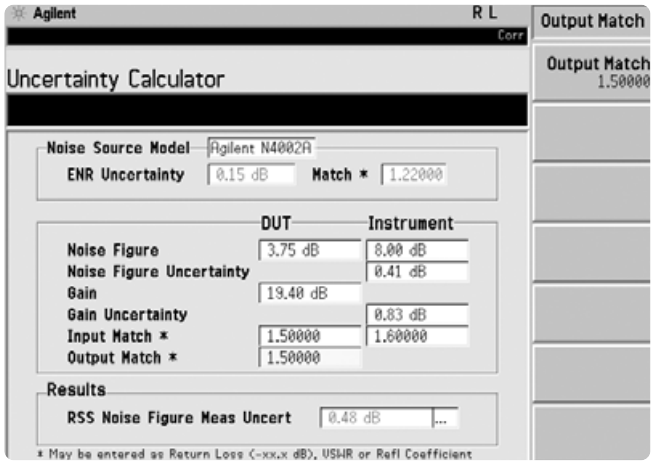
Using the built-in uncertainty calculator to measure the uncertainty of the measurement for:

Example

D.U.T. with 19.4 dB gain
D.U.T. NF: 3.75 dB
N4002A ENR (12 to 16 dB) F < 3 GHz
ESA instrument noise figure uncertainty: ±0.41 dB for this range

Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
Select uncertainty calculator	Press [Mode Setup], {Uncertainty Calculator}
Choose N4002A as the noise source	Use [|←] [→|] tab keys to highlight Noise Source Model box. Press {N4002A}
Setup the instrument NF and Gain uncertainty for ENR and frequency range of measurement. *Instrument noise figure ~ what you saw in lab 3 during uncorrected measurement after calibration*	Use [|←] [→|] tab keys to highlight "Instrument Noise Figure" and enter 8 dB. Highlight "Noise figure uncertainty" and enter 0.41 dB. Highlight "Gain uncertainty" and enter 0.83 dB
Enter the Noise Figure and Gain values from the measurements graph or marker table	Using tab keys to highlight "DUT Noise Figure" and enter 3.7545 dB. (To view the marker table, press [Return] and to return to the calculator press {Uncertainty Calculator}. Then highlight "DUT Gain" and enter 19.4 dB
The input and output match of the DUT is determined from the specifications sheet or measured using a network analyzer	Highlight DUT Input Match and enter 1.5, Highlight DUT Output Match and enter 1.5
The measurement uncertainty is then calculated and the results is display at the bottom of the form	

Figure 16. Uncertainty calculator display showing result for the example to the left



Noise figure measurements using a mixer as the DUT

There are some additional setups to consider when a down conversion is included in the noise figure measurement, for example measuring the noise figure of a mixer. For this example, we use a mixer as a down-converter with an IF at 70MHz, LO at 3GHZ and both RF sidebands are used, 2930 and 3070 MHz double-side band (DSB).

- The measurement as well as the calibration is made at the IF frequency.
- When an IF frequency is chosen, it is a good idea to keep the frequency as low as possible in order to avoid large differences in ENR values between the upper and lower sidebands when using DSB mode. This is because it is the ENR value at the LO that is used in the measurement (this is a compromise since it is centered between the two sidebands).
- Since this device has some loss, it is recommended that the internal preamp be used.
- Compensate for two sidebands by selecting DSB.
- Any broadband noise in the LO will directly affect results. This can be solved by using either a high pass or low pass filter at the LO port to remove the noise at the IF frequency. Place an IF filter at the input of the spectrum analyzer to remove LO feed through. Usually mixers have around 20 dB isolation between the LO-IF port, so the high powered LO will seriously affect results.

Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
Setup the ESA for down conversion measurements as shown in the diagrams below. It is recommended that the internal preamp be used when measuring devices that have low gain	Press {Meas Setup} {More 1 of 2} {Restore Meas Defaults} Press {Meas Setup} {Int Preamp On Off} Press [Mode Setup] {DUT Setup...}{Down Conv}
Setup the LO frequency (Figure 17) on the ESA	Move to "Ext LO frequency" using tab keys the enter 3 GHz. Tab to Sideband and choose DSB
Setup the fixed IF frequency	[Frequency] {Freq mode}{Fixed} {Fixed frequency}{70 MHz}
Calibration: connect the noise source to the input of the ESA	Press [Meas setup]{Calibrate}{Calibrate}

Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
Measure the DUT: Connect the mixer IF (I) port to the ESA, the LO (L) port to the signal source and the RF (R) to the noise source	To add more averaging, press [Meas Setup] then {Avg Number On)

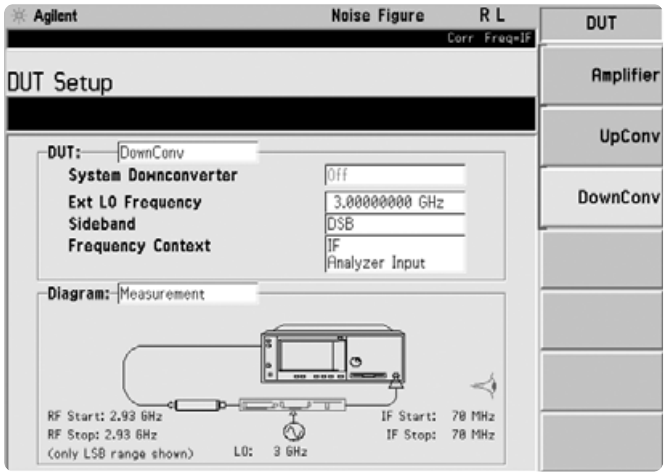


Figure 17. Setup for measuring a mixer at a fixed LO and fixed IF

Instructions: E4438C ESG vector spectrum analyzer	Keystrokes: E4438C ESG vector signal generator
Setup the source for + 7 dBm at 3 GHz	On E4438C press [Frequency][3] GHz [Amplitude] [7]{dBm}[RF On]

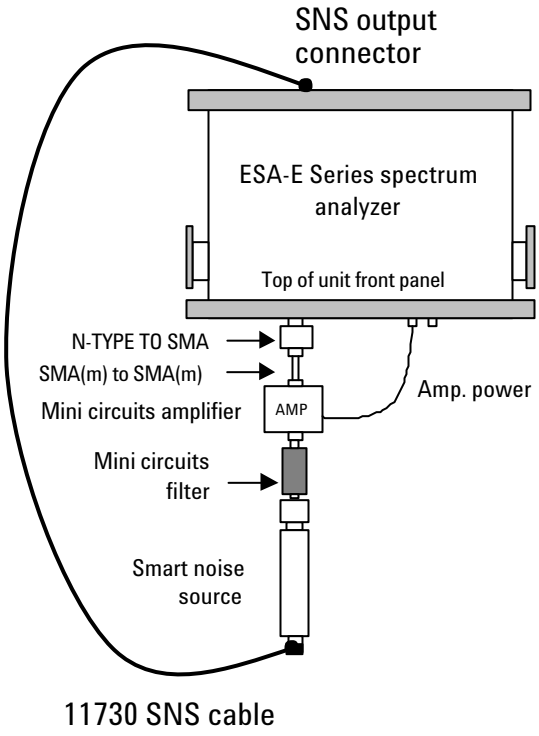
Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
Change the ESA display to meter mode, more appropriate for a single frequency measurement	[View/Trace]{Meter}

Figure 18.
The meter view showing noise figure and Gain (conversion loss) of a mixer

Narrowband noise figure measurements

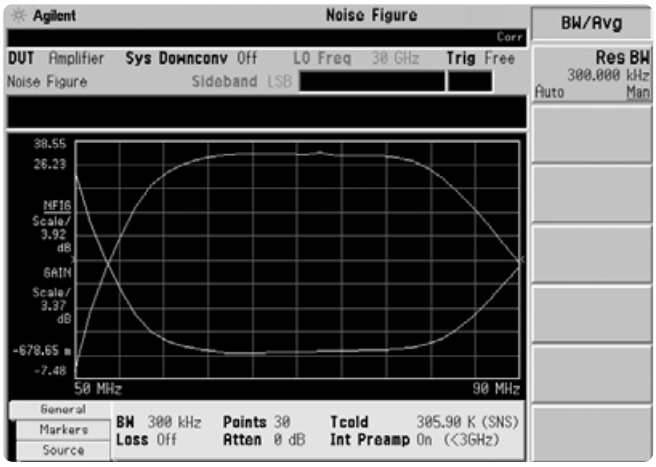
The noise figure measurement personality has the capability to reduce the resolution bandwidth allowing narrow bandwidth measurements. As the bandwidth narrows, the measurement jitter increases. To reduce the jitter, increase the number of averages. In this measurement example, the DUT will be a band pass filter with the center frequency of 70 MHz. The start and stop frequencies are set and the number of points to be measured are set at 30. Figure 19 is an example of a narrowband measurement setup.

Figure 19.
Connection diagram for narrow band measurements



Instructions: ESA-E Series spectrum analyzer	Keystrokes: ESA-E Series spectrum analyzer
Setup the ESA for narrow band measurements	Press [Mode Setup] {DUT Setup...}{Amplifier}
Connect the noise source directly to the spectrum analyzer	
Set start and stop frequency	[Frequency]{Freq Mode Swept}{Start Freq, 50 MHz}{Stop Freq, 90 MHz}
Set the number of measurement points	[Frequency]{Points} 30 enter
Set the resolution bandwidth	[BW/Avg], 300 kHz
To reduce measurement jitter add averaging, then calibrate	[Meas Setup]{Avg Number On} 10{Enter}, {Calibrate}{Calibrate}
To measure the DUT connect the filter to the noise source and the other end to the input of the amplifier and the output of the amplifier to SA input	
To achieve the display shown below	[Trace/View], {Combined On} [Amplitude]{Auto Scale}

Figure 20. Narrow band measurements display of filter in cascade with amplifier



Spectrum Analyzers that Meet More than Just Your Noise Figure Needs

Easy to use – noise figure measurements made simple

- Simultaneous measurement of noise figure and gain
- Automatic download of ENR data with SNS Series noise sources
- Automatic ambient temperature sensing with SNS Series noise sources
- User friendly interface with helpful setup diagrams
- Loss compensation
- Pass/fail functionality with limit line testing
- Internal uncertainty calculator
- User-selectable measurement result and display format
- Built-in help key for quick reference without manuals
- Noise figure/spectrum analyzer switching mode

With spectrum analysis – maximize measurement capability and confidence

- 99 dB third-order dynamic range to view low level distortion and intermodulation
- 1 Hz digital resolution bandwidth that is up to 220 times faster than analog
- Continuous automatic background alignment that guarantees repeatability over varying temperatures

Upgradeable – ready for other applications

- Versatile card cage architecture for hardware expansion
- Instrument firmware and software upgrades available on the web
- Wide bandwidth digital demodulation platform
- Modulation analysis, GSM/GPRS, cdmaOne and Bluetooth™, are four of many options available
- Choose the performance you need, when you need it, and upgrade in the future

PC connected – speed measurement data analysis and enable remote instrument control

- Store measurement results in spreadsheet format using the built-in floppy disk drive or transfer data directly to your PC with IntuiLink software[1]
- BenchLink Web Remote software enables remote control of an ESA-E over the Internet.
- Industry standard SCPI programmable instrument language for remote control
- GPIB (Option A4H), RS-232 (Option 1AX) interface available

1. For more information about IntuiLink software, visit our Web site at http://www.agilent.com/find/IntuiLink

Fast – finish your job quicker

- Five minute warm-up time for full accuracy
- Forty-five measurement updates per second for higher probability of intercept and real-time response

Portable – sophisticated measurement performance anywhere

- Rugged case, water resistant front panel
- Snap on battery (E1779A) or 12 Vdc adapter (Option A5D)
- Carrying/operating/transit case (Option AYT/AYU/AXT)

Great for R&D plus more

R&D

- Affordable spectrum and vector modulation analysis on every engineers bench
- Unparalleled flexibility with ten measurement personalities to address any measurement need

Manufacturing

- Spurious testing to 26.5 GHz and external mixing capability to 325 GHz
- Flexible troubleshooting tool for production rework
- Excellent accuracy for narrower test margins and improved yield
- Engineering analysis of root cause

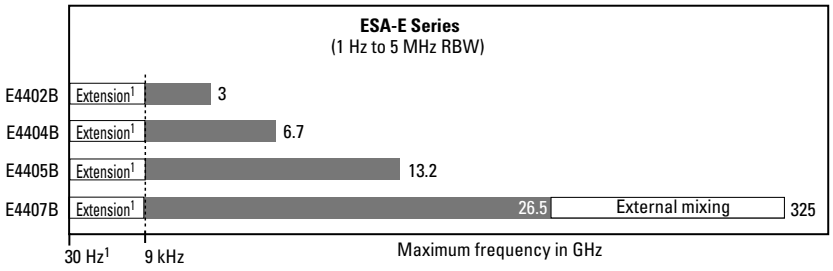
Maintenance

- Portable troubleshooting tool for field repair engineers
- All-weather use

Ordering Information

Here is how you order your ESA-E spectrum analyzer with the noise figure measurement capability.

First, choose your frequency range.



Now, choose your option configuration.

ESA-E series spectrum analyzer plus options

Task	Recommended option configuration
General RF and microwave spectrum analysis	**ESA standard analyzer (Option STD[2])**
Noise figure measurement	219 – Noise figure measurement personality and hardware
Improved sensitivity	1DS – Built-in 3 GHz preamplifier
Improved resolution	1DR – Narrow resolution BW (10 Hz or 1 Hz with Opt 1D5)
Accurate frequency readout	1D5 – High-stability time base
RF and microwave spectrum analyzer with digital demodulation capability	**ESA communication test analyzer (Option COM[2])**
Noise figure measurement	219 – Noise figure measurement personality and hardware
Improved sensitivity	1DS – Built-in 3 GHz preamplifier
Improved resolution	1DR – Narrow resolution BW (10 Hz or 1 Hz with Opt 1D5)
Accurate frequency readout	1D5 – High stability time base

Additional recommended options and accessories

Option 060	Improved EMI performance
Option 120	Improved wide offset phase noise
Option A5D	12 Vdc power cable
Option AXT	Hard transit case
Option AYT	Soft carrying / operating case
Option UK9	Front panel cover
E1779A	Battery pack
11909A	Low noise preamplifier (9 kHz to 1 GHz)
8449B	Microwave preamplifier (1 GHz to 26.5 GHz)
83006A	Amplifier (10 MHz to 26.5 GHz)

Select a noise source

Recommended
Agilent smart noise source N4000A (10 MHz to 18 GHz nominal ENR 6dB)
Agilent smart noise source N4001A (10 MHz to 18 GHz, nominal ENR 15 dB)
Agilent smart noise source N4002A (10 MHz to 26.5 GHz nominal ENR 15dB)

Additional noise sources
Agilent 346A (noise source, 10 MHz to 18 GHz, nominal ENR 6 dB)
Agilent 346B (noise source, 10 MHz to 18 GHz, nominal ENR 15 dB)
Agilent 346C (noise source, 10 MHz to 26.5 GHz, nominal ENR 15 dB)
Noise Com NC3201Y (noise source, 100 kHz to 1 GHz)

1. Nominal
2. Ordering the ESA express Option STD or COM will result in the best available delivery and favorable price.

Specifications Summary

Noise figure

Frequency range: 10 MHz to 3 GHz
Noise source ENR

With internal preamp 1DS & 1 MHz RBW

Meas. range (Specified)	**Instr. uncertainty** (Specified)
0 to 20 dB	±0.24 dB
0 to 30 dB	±0.41 dB
0 to 35 dB	±0.46 dB

4.5 to 6.5 dB
12 to 17 dB
20 to 22 dB

Frequency range: 3 GHz to 26.5 GHz

Nominally same as above.
Total noise figure uncertainty will often be dominated by instrument gain uncertainty.

Gain

Frequency range: 10 MHz to 3 GHz
Noise source ENR

With internal preamp 1DS & 1 MHz RBW

Meas. range (Specified)	**Instr. uncertainty** (Specified)
-20 to 40 dB	±0.83 dB
-20 to 40 dB	±0.83 dB
-20 to 40 dB	±0.83 dB

4.5 to 6.5dB
12 to 17 dB
20 to 22 dB

Frequency range: 3 GHz to 26.5 GHz

Instrument uncertainty (nominal)
±2.7 dB

Literature

ESA Series literature

ESA-E Series Spectrum Analyzers, brochure,
literature number 5968-3278E

Select the Right Agilent Analyzer for Your Needs, Selection Guide
literature number 5968-3413E

E4401B, E4402B, E4404B, E4405B and E4407B ESA-E Series Spectrum Analyzers, Data Sheet
literature number 5968-3386E

ESA/EMC Spectrum Analyzer Configuration Guide
literature number 5968-3412E

PSA Series literature

PSA Series, Brochure,
literature number 5980-1283E

NFA Series literature

NFA Series, Brochure,
literature number 5980-0166E

Application literature

10 Hints for Making Successful Noise Figure Measurements, App Note 57-3
literature number 5980-0288EN

Fundamentals of RF and Microwave Noise Figure Measurements, App Note 57-1
literature number 5952-8255E

Noise Figure Measurement Accuracy-The Y Factor Method App Note 57-2
literature number 5952-3706A

Additional Information

For the latest information on the Agilent ESA-E Series, see our Web page at:

www.agilent.com/find/esa

Agilent Technologies' Test and Measurement Support, Services, and Assistance
Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is available for at least five years beyond the production life of the product. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

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Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify that it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost upon request. Many self-help tools are available.

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Your Advantage means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and onsite education and training, as well as design, system integration, project management, and other professional engineering services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

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Online Assistance:
www.agilent.com/find/assist

Product specifications and descriptions in this document subject to change without notice.

Printed in U.S.A., April 29, 2004
5989-0215EN

Agilent Technologies