Keysight Technologies
Noise and Noise Figure Measurements Made Simple

Application Brief

Noise is present in every electronic circuit, and it can disturb the signals sent from a transmitter to a receiver. Because these disturbances can limit the overall performance of any wireless system, noise is a fundamental parameter to be tested in all transmitter and receiver components. The signal and spectrum analyzers used to measure these devices must have better performance than the devices being characterized. As these measurements have become more and more complex, the signal analyzer has evolved to offer easy-to-use measurement applications and intuitive settings to help reduce complexity while instilling confidence that measurements are accurate. Today, the touch-enhanced UI technology widely used in smartphones, tablets and PCs can be readily adapted to large displays that are increasingly common in signal analyzers. Consequently, analyzers now provide new levels of interaction that enable intuitive connections between cause and effect during development, debugging and troubleshooting.

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Unlocking Measurement Insights

Improving Signal Analyzer Sensitivity

When testing devices with signal amplitudes near or below the observed noise floor of the signal analyzer, it is often desirable to compare differences between signals when optimizing between sensitivity and sweep speed. You can optimize a variety of parameters to improve the sensitivity of the signal analyzer and bring the noise floor to acceptable levels using any of the following techniques individually or in combination:

– Reduce signal analyzer attenuation
– Reduce resolution bandwidth
– Use a preamplifier
– Use the Noise Floor Extension feature

Specific multi-touch UI features such as the trace settings table and marker settings diagram help make noise (sensitivity) measurements faster and easier to implement. For technical information on the noise reduction techniques, please refer to the application briefs, Five Hints for Successful Measurements in Noise, literature number **5992-0932EN** and Four Hints for Successful Noise Figure Measurements, literature number **5992-1153EN**.

Accessing multiple traces simultaneously with the trace settings table

The trace settings table is a feature of the EXA's multi-touch UI, designed to allow for quick access to as many as six traces at one time. With the table, you can access parameters such as trace type, trace view, detector type and various math functions including power difference and sum and log offset and difference. The trace parameter settings — Trace Type = Trace Average, ViewBlank = Active and Detector = Average (Log/ RMS/V) — have been quickly enabled on traces 1 through 4, using the touchscreen interface, as shown in Figure 1.

Frequently Used Settings Available on Touchscreen

The Keysight Technologies, Inc. N9010B EXA signal analyzer, multi-touch provides a touchscreen UI that includes features such as drop down menus and customizable user menus. Rather than navigating through hardkeys, softkeys and long menus, most of the capabilities can be accessed with the tap of a finger. In addition, many frequently used display settings can be modified in the menu bar, measurement bar and annotation hotspot areas. It's as easy as tapping the settings tables and diagrams, or you can interact with the selected trace by stretching, pinching, dragging or tapping.

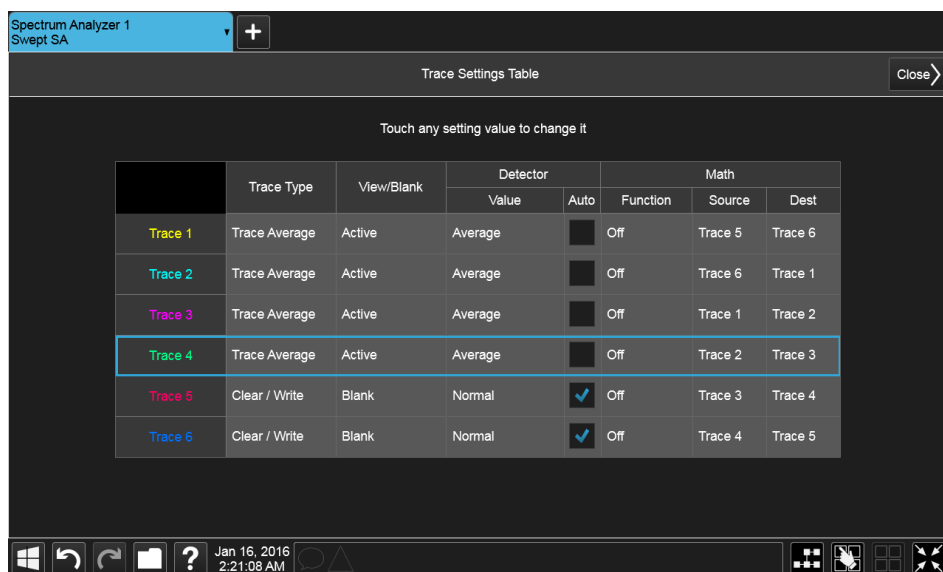|	Trace Type	View/Blank	Detector Value	Auto	Math Function	Math Source	Math Dest
Trace 1	Trace Average	Active	Average		Off	Trace 5	Trace 6
Trace 2	Trace Average	Active	Average		Off	Trace 6	Trace 1
Trace 3	Trace Average	Active	Average		Off	Trace 1	Trace 2
Trace 4	Trace Average	Active	Average		Off	Trace 2	Trace 3
Trace 5	Clear / Write	Blank	Normal	✓	Off	Trace 3	Trace 4
Trace 6	Clear / Write	Blank	Normal	✓	Off	Trace 4	Trace 5

Figure 1. Quickly and easily configure up to 6 traces using the trace settings table feature.

Configuring multiple markets with the marker settings diagram

The marker settings diagram is another feature that enables quick and easy configuration of up to 12 markers. The diagram provides a visual relationship between different markers and reference markers. Using the touchscreen, you can activate marker modes such as normal, delta and fixed (Figure 2a) and assign markers to selected traces (Figure 2b).
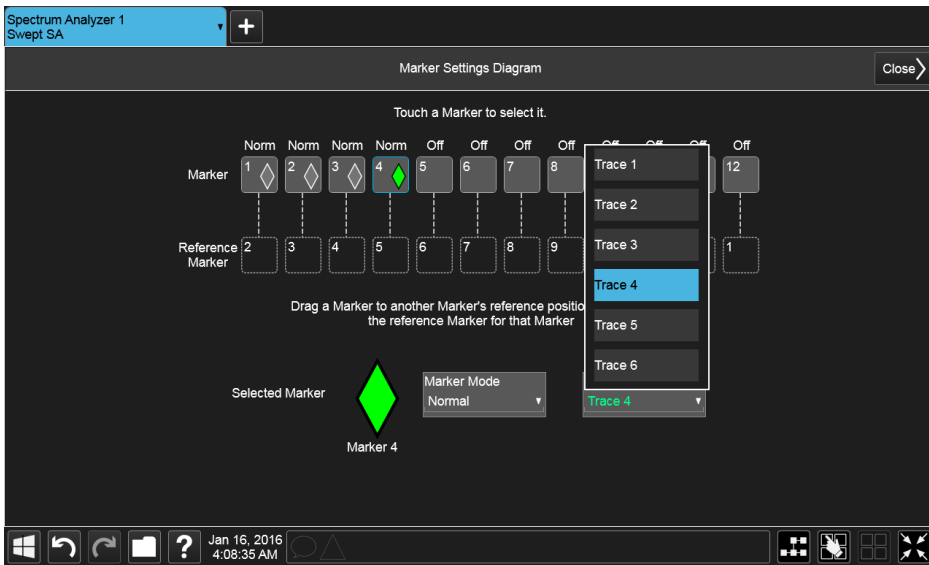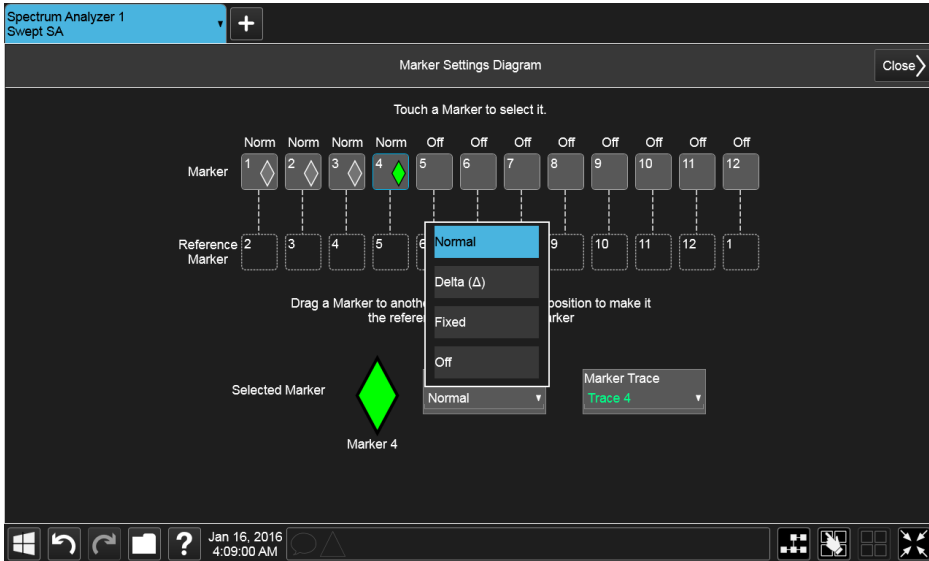
Figures 2a and 2b. Easily configure up to 12 markers using the marker settings diagram.

In Figures 2a and 2b, markers 1 through 4 were set to normal mode and assigned to traces 1-4, respectively. The marker table has been turned on for easy viewing of each marker value as we change parameters.

In Figure 3, traces 1 through 4 show how the signal analyzer's noise floor can be lowered by reducing attenuation and resolution bandwidth (traces 1 and 2) and by using the internal preamplifier and Noise Floor Extension (traces 3 and 4). Trace 4 shows a low-level signal appearing as the noise floor is reduced.
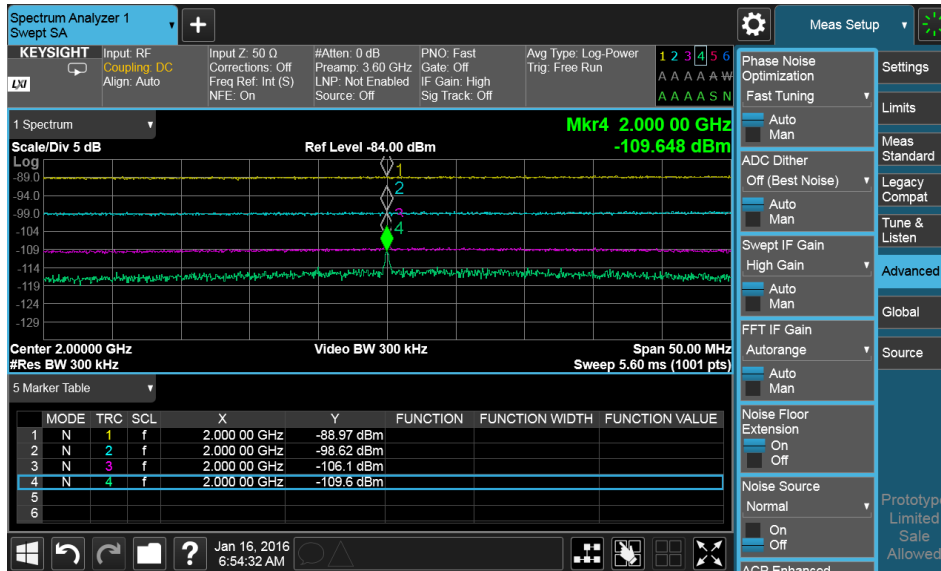

Figure 3. Easily view your measurement and data with spectrum and marker table windows.

Simplifying noise figure measurements

In the multi-touch EXA, the Mode / Measurement / View selector provides quick access to a suite of measurement application software ranging from parametric—phase noise, noise figure, analog demodulation—to the latest standards-compliant wireless measurements including LTE and WLAN (Figure 4).
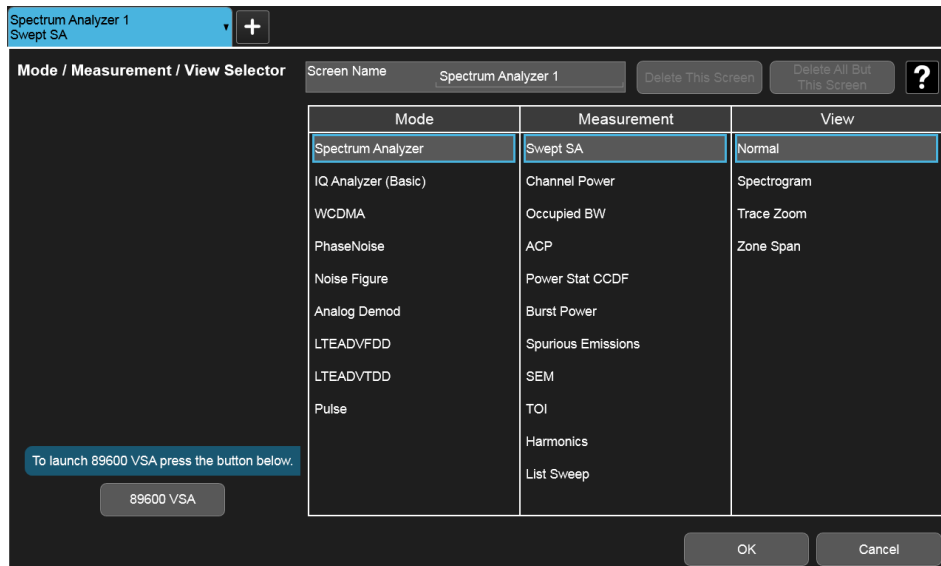

Figure 4. Mode / Measurement / View Selector makes it simple and fast to change from spectrum analyzer mode to noise figure mode.

Noise figure measurements are typically required in a development lab during new product design and optimization, as well as on the production floor to verify that device performance is meeting specification with adequate margin. The multi-touch X-Series measurement application for noise figure makes DUT set-up and calibration easier and more efficient.

The DUT measurement set-up diagram shows you how to properly connect the noise source, DUT, and analyzer (Figure 5). The measurement diagram shows how to set up noise figure measurements for amplifiers, downconverters and upconverters. With the touchscreen interface, the diagram gives you quick access to the parameter settings for your measurement.
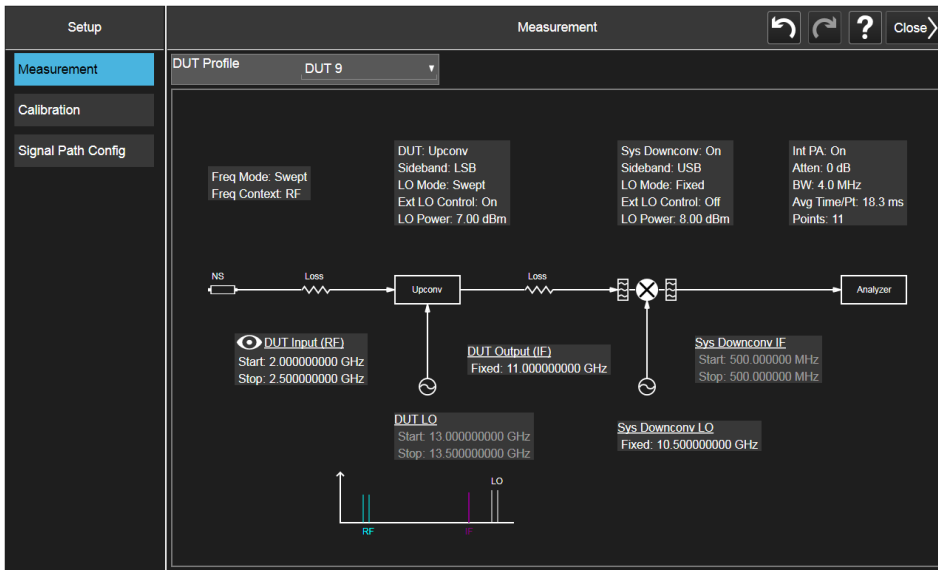

Figure 5. This built-in diagram shows how to set up an upconverter measurement.

Two connections are traditionally required for Y-factor noise figure measurements: a user calibration and the DUT noise figure measurement. The multi-touch noise figure measurement application speeds up this process by allowing you to calibrate up to 12 DUT profiles in a single step (Figure 6).
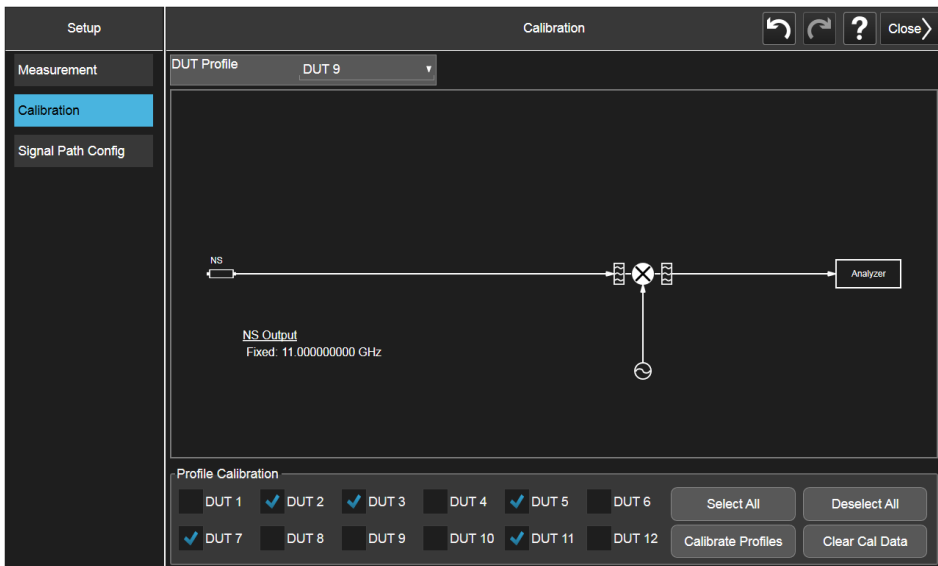

Figure 6. This noise source calibration set-up includes 12 DUT profiles.

Additionally, the internal calibration feature allows you to bypass the second-stage noise source user calibration and go directly to the DUT measurement. The internal calibration feature saves time without significantly affecting measurement uncertainty.

Getting dependable uncertainty readings - built-in

The multi-touch EXA comes with a built-in noise figure uncertainty calculator, which gives you a dependable uncertainty reading for a specified setup. The uncertainty calculator is pre-populated with data from the external USB preamplifier, the smart noise source, and the instrument itself. The calculator also gives some flexibility over the choice of distribution and specification style for the DUT characteristics. With the noise figure uncertainty calculator, you will know your measurement uncertainty and how to reduce it.
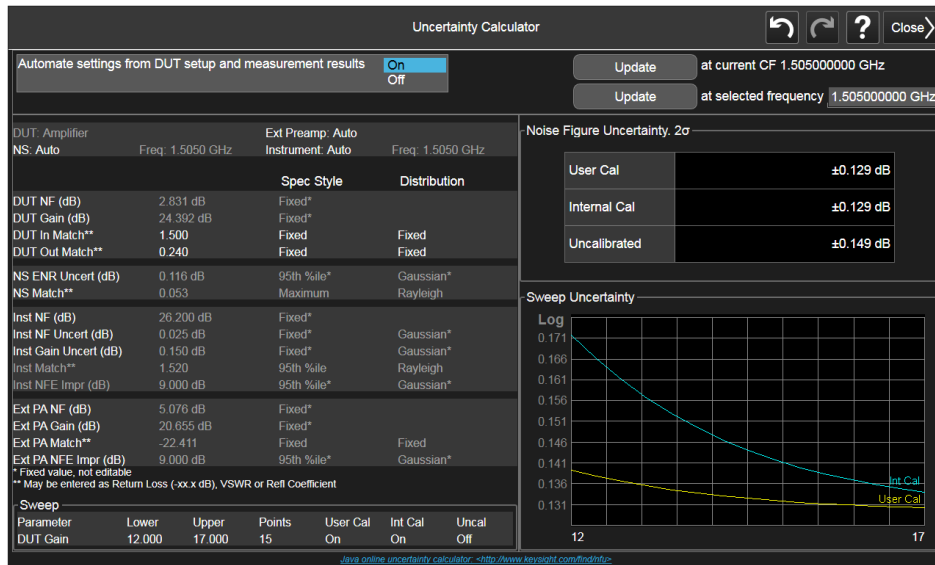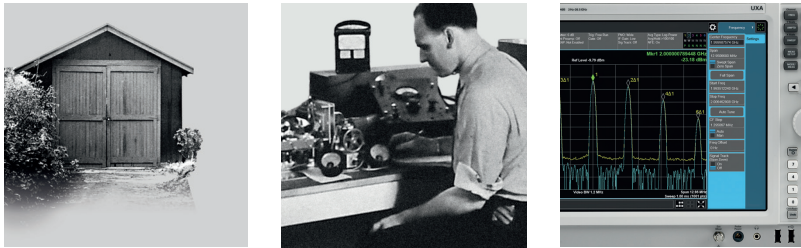

Figure 7. This built-in noise figure uncertainty calculator provides fast DUT measurement uncertainty readings.

Conclusion

This X-Series signal analyzers are the benchmark for accessible performance that puts you closer to the answer by easily linking cause and effect. Across the full spectrum - from CXA to UXA - you'll find the tools you need to design, test and deliver your next breakthrough.

A multi-touch EXA equipped with the noise figure measurement application is just one example. The EXA is your first, best choice when you need maximum value in signal analysis up to millimeter-wave frequencies. It helps you find the answer faster, whether you're seeking tighter design margins or shorter test times.

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