Noise Parameter vs Noise Figure Measurements

Keysight Technologies and Maury Microwave

Noise Parameter Measurements in Minutes Rather than Days

The characterization of noise within a device or circuit is critical for many RF design engineers. Customers demand an accurate specification of the noise within the products they purchase and designers have to understand noise effects in order to maximise the performance of their products. The most commonly used measurement is noise figure, but this parameter is not always sufficient. Noise figure is widely used in manufacturing test, but it is not sufficient for circuit and system designers who need to know how to improve and optimize their design for best performance.

To meet these challenges you must turn to noise parameters. In the past it was not practical for circuit and systems engineers to measure noise parameters; the equipment was too specialized and the measurements took too long, often days, to complete. Now using an off-the-shelf instrument and only a noise tuner as an accessory, complete noise parameter characterization is practical, fast and just as easy as measuring S-parameters. This gives you the opportunity to optimize the performance of your products and specify them with the tighter limits demanded by your customers.

- Improves on noise figure measurements
- Makes noise parameter measurements practical
- Noise parameters measured in minutes, not days
- Characterize circuits and devices more accurately
- More accurate specification of noise in your products
- Uses Keysight PNA-X with Maury tuner and software
- Optimize the performance of your products

KEYSIGHT TECHNOLOGIES

Noise Parameter vs Noise Figure Measurements

Noise Parameter Measurements

The traditional approach to measuring noise parameters involves a vector network analyzer (VNA), a separate noise source and noise figure analyzer and an external tuner to vary the source impedances presented to the device under test (DUT). Measurements are made at a number of points across a frequency band, with a spread of source impedances at each frequency.

Before the measurements can be made, the entire system has to be calibrated for accurate S-parameter measurement. Once this has been achieved the user then calibrates the noise receiver and measures the DUT noise parameters at every frequency point across the frequency range. Using the traditional approach, calibrating the noise receiver and measuring the noise parameters at every frequency point leads to very long test times.

When measuring S-parameters, it is common practice to sweep 400 or more points to examine the details of an amplifier's performance. Attempting to measure noise parameters across this number of frequency points can result in test and calibration times taking many days. Not only is this time consuming, it can also introduce errors due to temperature drift.

In many cases designers are forced to compromise on the number of frequency points over which they make their measurements, resulting in inaccuracy and ambiguity in their measurements.

A New Approach

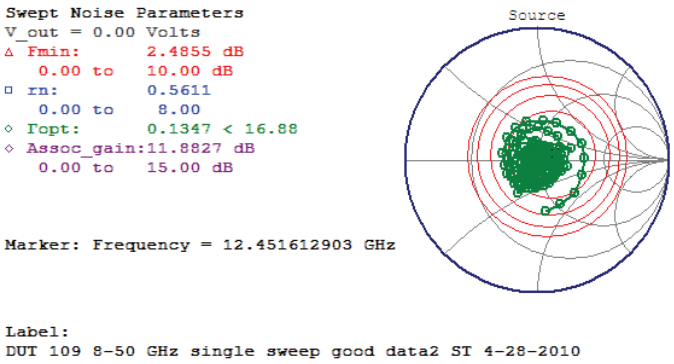
A new approach to noise parameter measurements solves the problem by reducing the test and calibration times by two orders of magnitude. Measurements over 400 frequency points that would take over 160 hours using the traditional approach can now be implemented in less than 30 minutes, over 300 times faster.

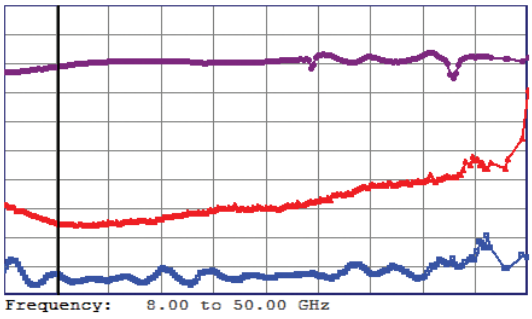
This gives immediate advantages to the designer characterizing the noise parameters of a device. There is no need to compromise on the number of frequency points, the accuracy is improved dramatically, and the ambiguity in the measurements is minimized. The new measurement approach is implemented with a Keysight Technologies PNA-X network analyzer with an integrated noise receiver, a noise source and a tuner and software supplied by Maury Microwave Corporation.

Noise Figure Measurements

The most common measure of noise is the figure-of-merit called noise figure. Noise figure is usually measured in a 50-ohm environment and seeks to quantify the signal-to-noise degradation caused by an amplifier. Noise figure, however, varies with the source impedance presented to the amplifier so is not sufficient to fully characterize your devices.

The variations due to source impedance can be characterized and represented in terms of noise parameters. It is essential to understand the noise parameters of your devices, especially when designing low-noise amplifiers using mismatched devices.





The results speak for themselves. A microwave FET was tested using both the traditional and the new approach. It was tested from 0.8 GHz to 8 GHz with a step frequency of 0.1 GHz, giving 73 test frequencies. This is much larger than is typically used with the traditional method. The measurements made using the new method exhibit much smoother results with lower scatter. This allows more accurate characterization of the parameters. In addition, the test times are slashed from over 30 hours to just over 8 minutes.

With this new approach the measurement of noise parameters now becomes a practical option for all RF designers. You don't have to compromise your noise parameter measurements or rely solely on noise figure measurements. You can now use noise parameters to optimize the performance of your products and characterize them in terms of the tight specifications required by your customers

System Components

Keysight Technologies

N524xB	PNA-X network analyzer
N524xB-029[1]	Add low-noise receiver
S93029A	Noise figure measurements with vector correction
346x	Noise source
Other options are available; contact your local Keysight sales engineer for more details	

1. N5241/42/49B, requires one of options 21x, 22x, 41x, or 42x. N5244/45/47B, requires one of options 22x or 42x. N5245B, Option 029 cannot be ordered with Option 425. N5247B, noise receiver works up to 50 GHz only.

Maury Microwave

MT98x	Automated Impedance Tuner (0.227 MHz to 65 GHz coaxial)
MT7553x	Optional NSM and NRM
MT993x	ATS Noise parameter measurement software
Other options are available; contact Maury Sales for more details	

To learn how this solution can address your specific needs please contact Keysight's solutions partner, Maury Microwave
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