

# Noise Parameter vs Noise Figure Measurements

## Agilent Technologies and Maury Microwave



- *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 Agilent PNA-X with Maury tuner and software*
- *Optimize the performance of your products*

### 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.



**Agilent Technologies**

# Noise Parameter vs Noise Figure Measurements

*"Noise figure measurements may not be sufficient to fully characterize your product to the limits demanded by your customers"*

## 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.

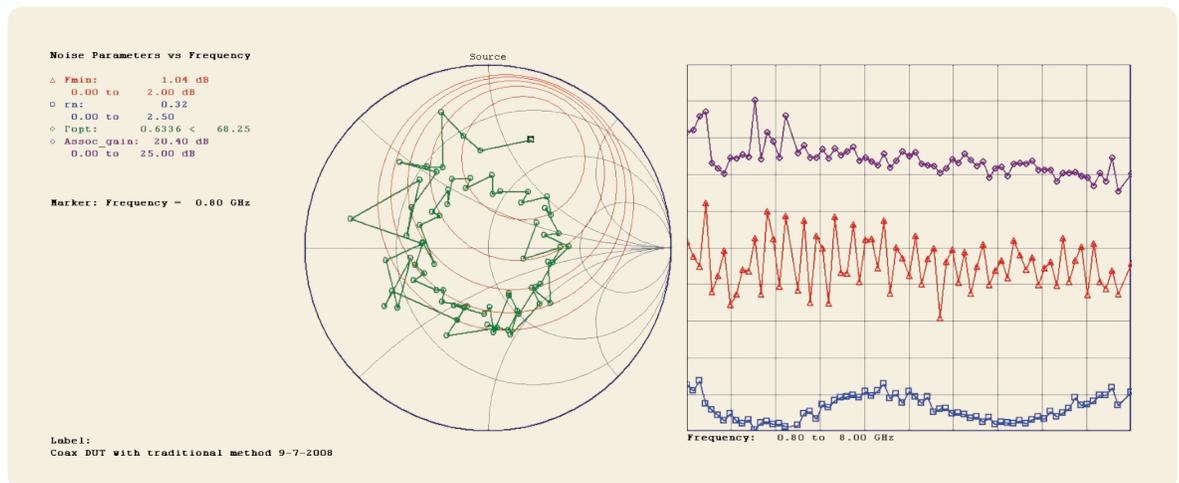
When measuring S-parameters, it is common practice to sweep 400 or more points to examine the details of an amplifier's performance. Attempting to measure noise parameters across this number of frequency points can result in test and calibration times taking many days. Not only is this time consuming,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

## 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 scatter produced by the traditional approach results in measurement uncertainty.*

# Noise Parameter vs Noise Figure 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 using an Agilent Technologies PNA-X network analyzer with an integrated noise receiver, a noise source and a tuner and software supplied by Maury Microwave Corporation.

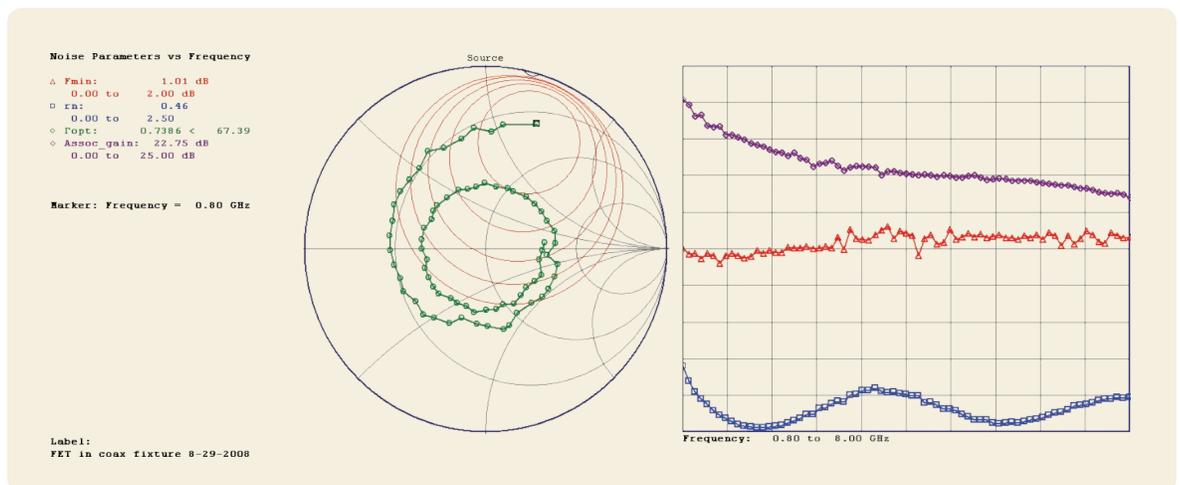
The results speak for themselves. A microwave FET was tested using both the traditional and the new approach. It was tested from 0.8 GHz to 8 GHz with a step frequency of 0.1 GHz, giving 73 test frequencies. This is much larger than is typically used with the traditional method.

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.



*Smoother results with less scatter gives more accurate and less ambiguous results.*

# Noise Parameter vs Noise Figure Measurements

## System Components

### Agilent Technologies

<b>N5242A</b>	PNA-X network analyzer
<b>N5242A-200</b>	2 ports, single source
<b>N5242A-219</b>	Add extended power range and bias-tees to 2-port analyzer
<b>N5242A-029</b>	Fully-corrected noise-figure measurements to 26.5 GHz
<b>436C</b>	10 MHz to 26.5 GHz noise source, nominal 15 dB ENR

*Other options are available; contact your local Agilent sales engineer for more details*

### Maury Microwave

#### *Tuner – select from:*

<b>MT981BU10</b>	High-power automated tuner 0.25 to 8.0 GHz
<b>MT982EU30</b>	7 mm automated tuner 0.8 to 18 GHz
<b>MT983A01</b>	3.5 mm automated tuner 4.0 to 26.5 GHz
<i>plus</i>	
<b>MT993B</b>	Noise parameter measurement software
<b>MT993B01</b>	Ultra-fast noise characterization using PNA-X
<b>MT992F</b>	System control option

*Other options are available; contact Maury Sales for more details*

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**Maury Microwave** has been in business for 50+ years and has become the world's leading manufacturer of laboratory devices and system components, with an emphasis on device characterization and automated tuning systems.

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