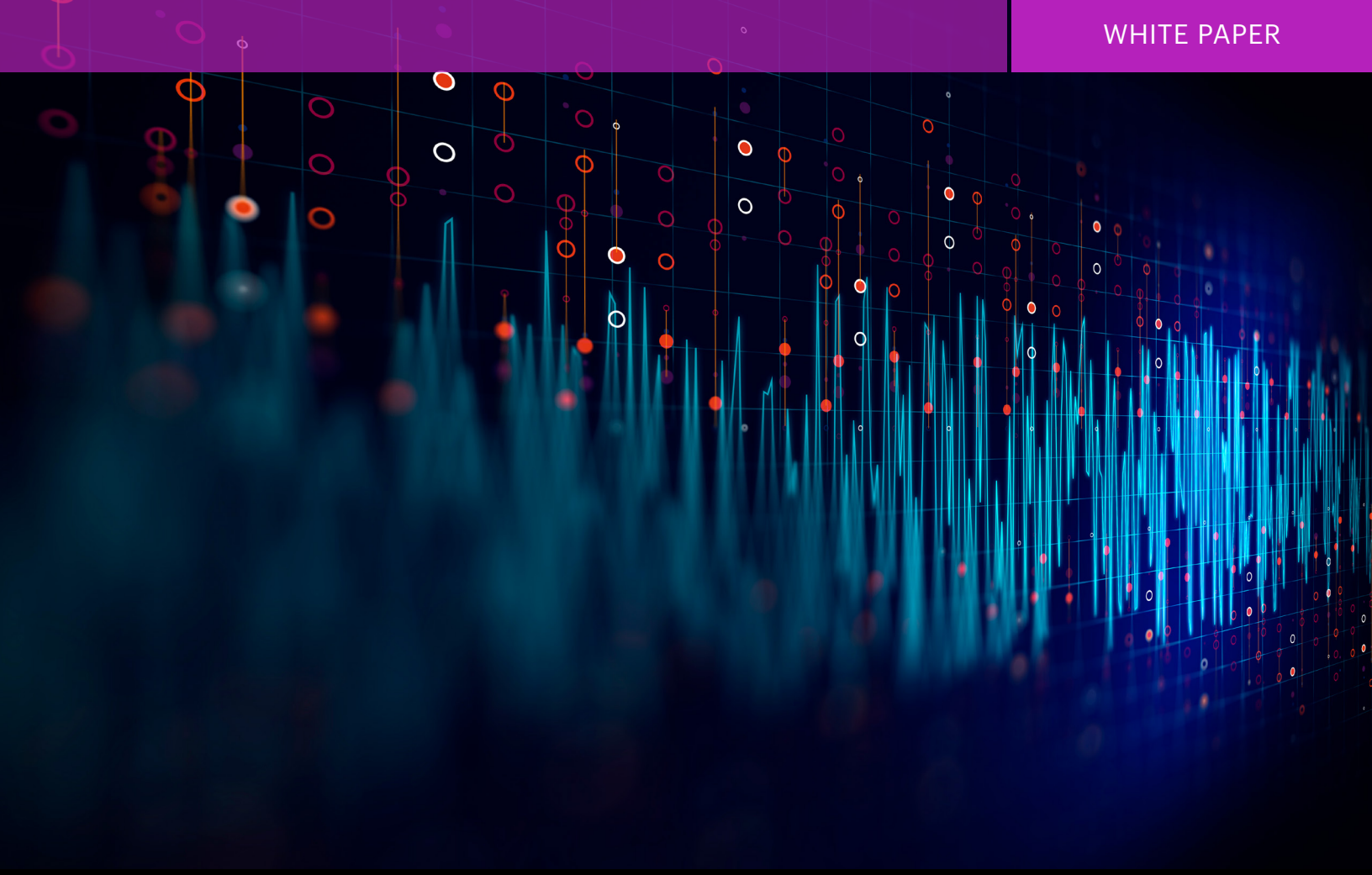
WHITE PAPER



Three Ways USB Noise Sources Help You

Removing uncertainty in Y-factor measurements

KEYSIGHT

Noise figure is a key performance parameter in many RF systems. Noise figure represents the degradation in signal-to-noise ratio as the signal passes through a device. Since all devices add a finite amount of noise to the signal, the noise figure is always greater than 1. A low noise figure provides improved signal-to-noise ratio for analog receivers, and reduces bit error rate in digital receivers. As a parameter in a communications link budget, a lower receiver noise figure allows smaller antennas or lower transmitter power for the same system performance.

In a development laboratory, noise figure measurements are essential to verify new designs. Having the right tools for the job can significantly speed up this development step to get products to market faster.

The Y-factor technique is a common method of measuring the noise figure of a device. Y-factor is a ratio of two noise power levels, one measured with the noise source on and the other with the noise source off.

$$Y = \frac{N^{ON}}{N^{OFF}}$$

Noise figure analyzers or other similar measurement instruments can use the Y-factor to calculate the noise figure of the device under test (DUT). Y-factor measurements involve a calibration step and a measurement step. USB noise sources can help with calibration and measurement in three main ways:

1. Automatic upload of calibration data
2. Real time temperature monitoring and automatic correction
3. Versatile connectivity to benchtop and modular instruments

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1. Faster Calibration

The Y-factor technique of noise figure measurements involves the use of a noise source that has a pre-calibrated Excess Noise Ratio (ENR). The ENR is a measure of the output of the noise source. ENR is the output noise level ratio between ON and OFF, expressed in dB. It can be measured as a difference between noise source temperatures T_{hot} and T_{cold}, divided by T0, which is assumed to be 290 K (measured in kelvin, K). Any uncertainty in the ENR transfers into uncertainty of the measured noise figure, dB for dB.

Before making a measurement, the known ENR noise source is used to calibrate the instrument (Figure 1). This allows the instrument to normalize to the noise source's ENR and establish a baseline. However, the noise source's ENR can vary with frequency. The USB noise source comes preloaded with ENR versus frequency data which is automatically transferred to the instrument during calibration. This saves significant setup time over manually uploading calibration data and removes uncertainty by preventing potential human error from manually entering data.

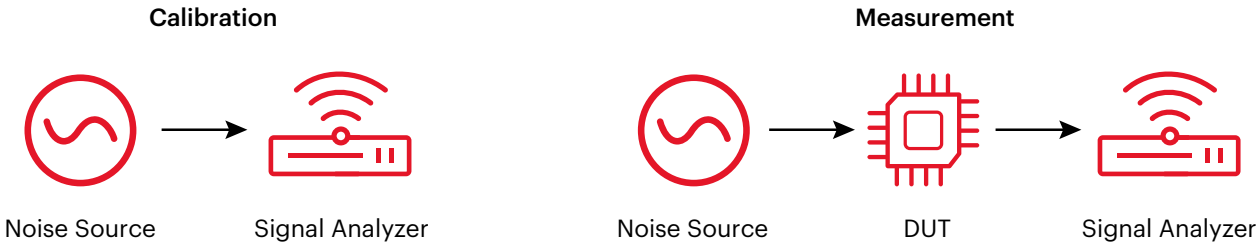

Figure 1. Noise factor calibration and measurement.

2. Real Time Temperature

Another source of uncertainty in noise figure measurements is the temperature of the noise source. The thermal noise power generated in a conductor is proportional to its physical temperature on the absolute scale (measured in kelvin, K).

When the noise source's ENR is calculated at calibration, its "off" temperature is assumed to be 290 K. However, when the off temperature is not 290 K, the physical temperature of the noise source should be measured and compensation must be applied to the measurements. The USB noise source comes with a temperature sensor that gives instruments an accurate off temperature.

3. Versatility

Traditionally, noise sources are powered by specialized connectors to the instrument. This limits usage of the noise sources to instruments with a supporting connection. A USB-powered noise source can be used with a wide variety of instruments, both benchtop and modular. While they still work with noise figure analyzers, you can also use the USB noise source with an existing signal analyzer to reduce the number of instruments and the complexity of test.

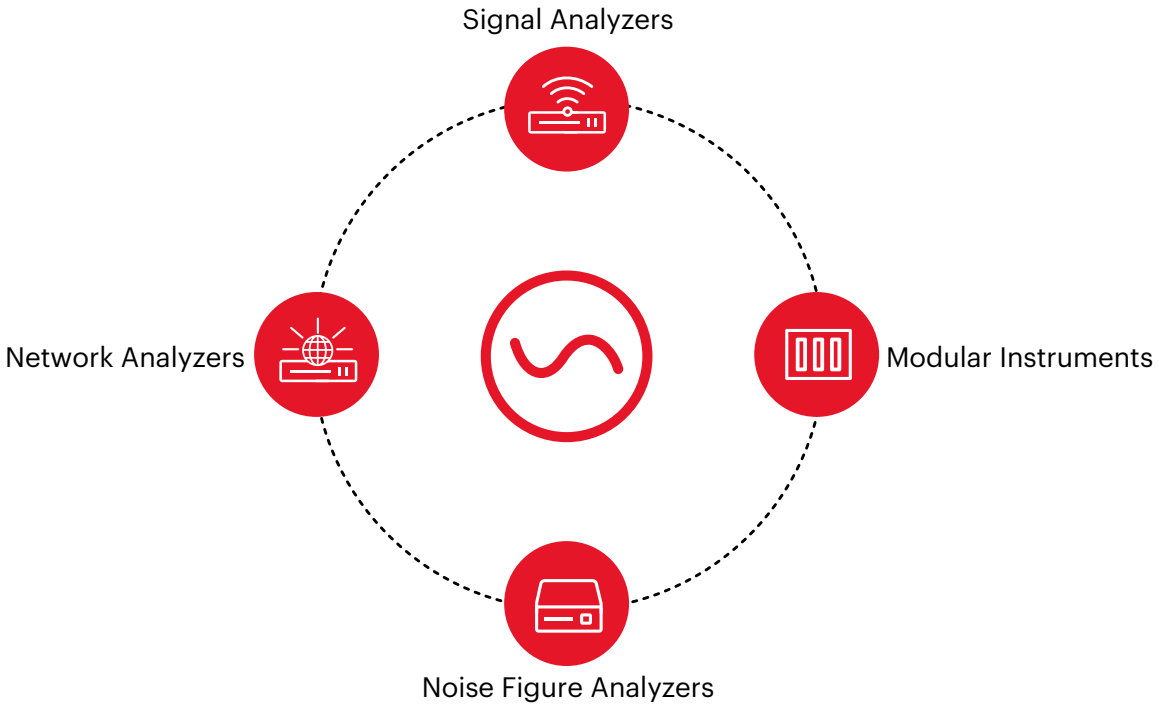

Figure 2. Compatible instruments.

Conclusion

USB noise sources are a fantastic alternative for noise figure measurements because of their ease, reliability, and versatility.

- Automatic upload of calibration data reduces the chance of human error and speeds up calibration.
- Real-time temperature monitoring reduces uncertainty in noise figure measurements by applying error correction.
- The USB connection offers flexibility in connection to compatible instruments with no need for a specialized interface.

Further Reading

To learn more about USB noise source solutions, visit the U1831C product page.

For an in-depth look into noise figure measurement, download the application note: Noise Figure Measurement Accuracy: The Y-factor Method.