## Measuring Noise Figure with a Spectrum Analyzer Using the Y-Factor Method

This measurement method requires a spectrum analyzer, noise source and RF cables to calculate the noise figure of a device under test (DUT). First, the DUT is measured with the noise source turned off and then again with the source on [1]. The difference between these two values is the Y-Factor. The formula for Noise Figure is represented by Equation 1.

$$NF = 10\log\left(\frac{10^{ENR/_{10}}}{10^{Y/_{10}} - 1}\right) \tag{1}$$

Where *ENR* is the excess noise ratio which can be found in a table on the noise source itself or on its datasheet. *NF* is noise figure and *Y* is the Y-Factor. Figure 1 is a possible configuration for testing an amplifier.

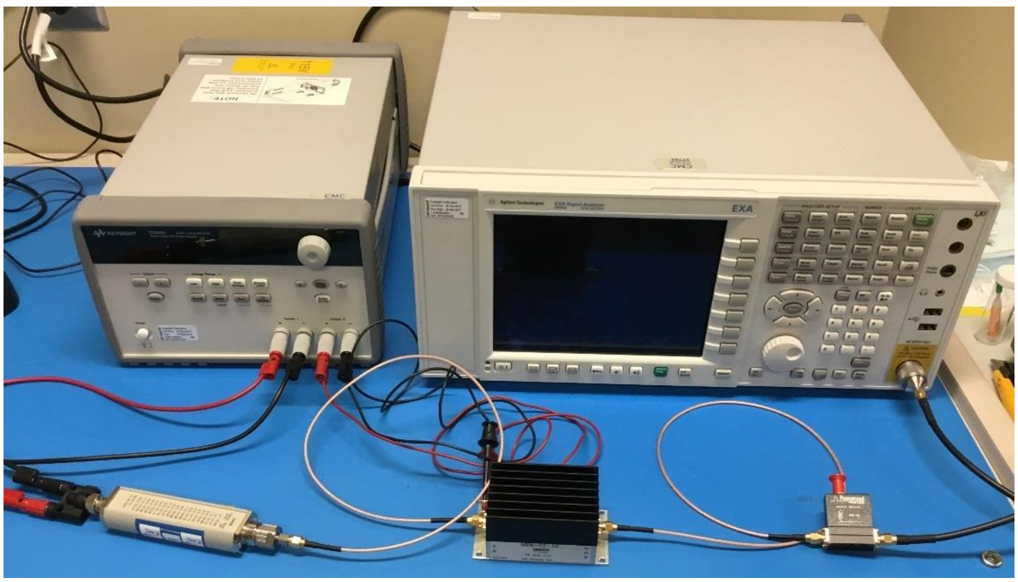


*Figure 1: Top, from left to right: Keysight E3649A Dual DC power supply, Agilent N9010A EXA spectrum analyzer. Bottom, from left to right: Agilent 346B Noise source, RF Bay amplifier, bias tee.*

In Figure 1, the DC power supply provides power to both the noise source and the amplifier through separate channels. The noise source, amplifier and bias tee[1] are connected in series with 3.5 mm cables.

Power on the DC supply and spectrum analyzer. On the power supply, set the voltage and current limits for the amplifier to what its datasheet specifies. Leave the noise source's voltage at zero since the first measurement is taken with the noise source off. On the spectrum analyzer, choose a central frequency to perform the measurements at. Set the central frequency to a value within both frequency ranges of the noise source and amplifier. The average button is essential for noise measurements with a spectrum analyzer. Without averaging, the power reading changes frequently and doesn't represent the data precisely. The more points used in the average, the greater the accuracy. However, more points also require more time. The user should find a balance between reasonable accuracy and time. Do not

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[1] A DC block is a suitable alternative to the bias tee. This spectrum analyzer has a maximum 0 Vdc input. Either a DC block, bias tee or other DC blocking instrument is necessary to ensure the machine only receives RF signals.

change the resolution bandwidth (RBW) or span between the first and second measurement. This will cause inaccurate results.

Supply the amplifier with power. The spectrum analyzer's reading should increase since energy is added to the system. Perform an average of the data and record the final value once all points have been collected. When taking averages, turn off the averaging function when a change is applied to the system. If the averaging function is kept on throughout the testing, points may be collected while the power reading is adjusting, producing error in results. Begin the average once the power reading has settled. Set the optimum input voltage and current for the noise source (expressed in the datasheet or on instrument) and turn on the DC supply for the source and the amplifier. The power reading will increase again since more energy is added to the system. Perform the second average and calculate the difference in dBm between the first and second measurement. This is the Y-Factor in Equation 1. Look up the ENR value for the central frequency that the measurements were taken at. Input the ENR and Y-Factor values into Equation 1 to solve for Noise Figure.

## References


[1] Keysight Technologies, "Noise figure Measurement Accuracy: The Y-Factor Method," *Application Note,* 29 June 2018.