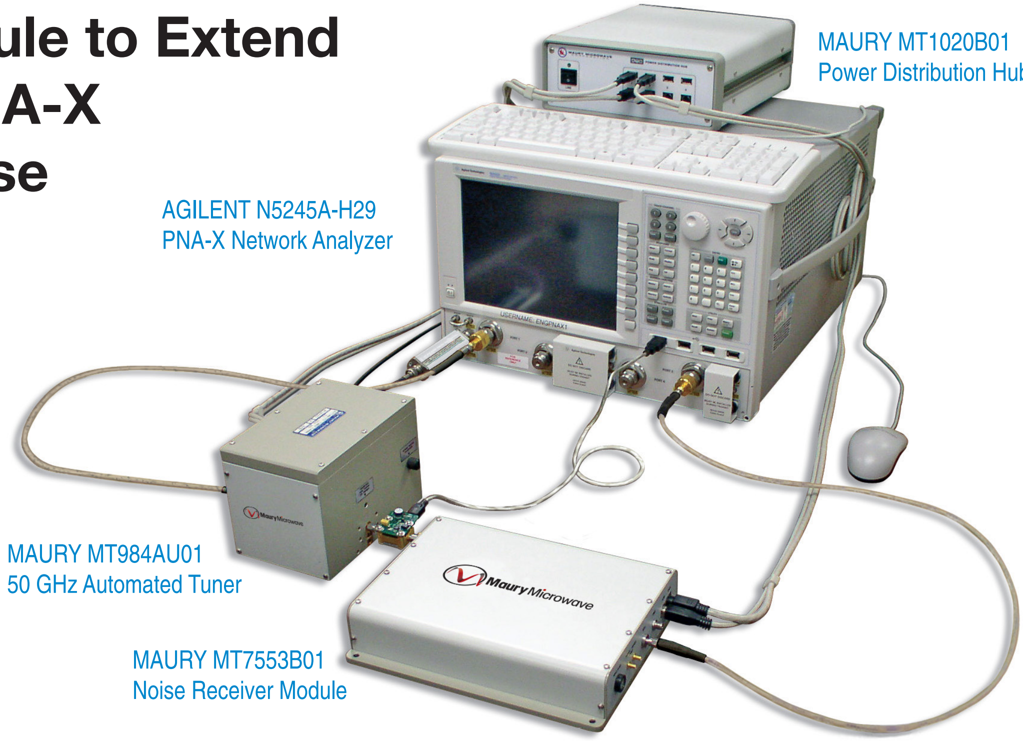
May 2010

Using an Impedance Tuner and Noise Receiver Module to Extend the Agilent PNA-X to 50 GHz Noise Parameters



Typical setup for 8 – 50 GHz noise parameter measurements using a Maury MT7553B01 Noise Receiver Module and a Maury MT984AU01 Automated Tuner with the Agilent's PNA-X.

Introduction

The most common measure of noise is the figure-of merit referred to as Noise Figure. Noise figure is usually measured in a 50Ω environment and seeks to quantify the signal-to-noise degradation caused by an amplifier. There are many common instruments that can be used to calculate noise figure, including dedicated NFAs, spectrum analyzers and most recently Agilent Technologies' PNA-X. However, while the PNA-X can measure S-Parameters to 26 GHz, 50 GHz or above, it can only measure 50Ω noise figure to 26 GHz using an internal noise receiver (options 029 or H29).

Noise figure, however, varies with the source impedance presented to the amplifier so it 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. Additionally, designers often require Noise Parameters beyond 26 GHz, often to 50 GHz or above.

Maury Microwave offers tailored solutions for 50 GHz Noise Parameter measurements using a PNA-X, including noise parameter measurement software, impedance tuners to 50 GHz, and a Noise Receiver Module.

MT7553B01 50 GHz Noise Receiver Module

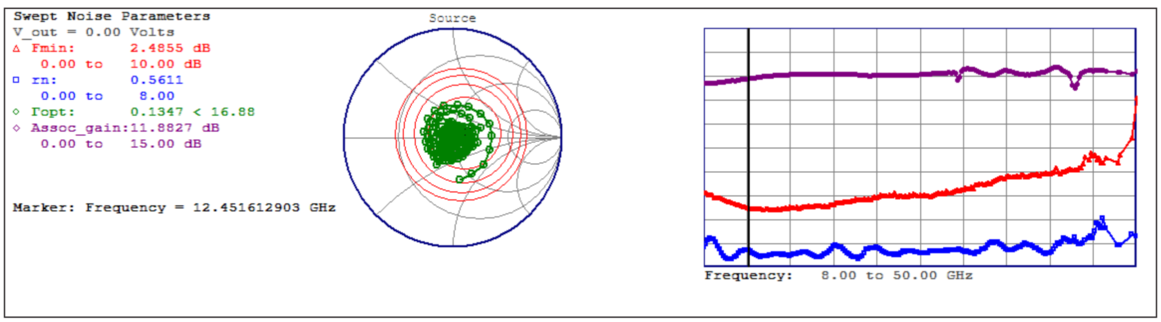
The MT7553B01 is much more than a simple downconverter, it is the backbone of a 50 GHz noise parameter measurement system. A downconverter accepts an input signal (commonly referred to as RF signal) at F1 and mixes it with local oscillator signal F2, resulting in an intermediate frequency (IF) of F1-F2, a frequency able to be directly measured by a NFA. The Noise Receiver Module consists of a downconverter including integrated mixer and local oscillator, as well as integrated bias networks to power device under test, integrated RF switches to switch between internal VNA and NFA paths, and integrated low-noise amplifier (LNA) to improve receiver noise figure. In essence, the MT7553 replaces the entire output block, or receiver module, of our noise parameter measurement system and is designed for easy on-wafer integration. Because the Noise Parameter and S-Parameter ports on the PNA-X are one and the same, the MT7553B01 uses a transfer switch to internally combine both pathways into one external port, easily connected to the PNA-X.

Speed and Accuracy Improvements

Maury Microwave has developed a new ultra-fast noise parameter measurement method (patent pending) that improves overall calibration and measurement time by a factor of 100X-400X, bringing measurements that once took tens or hundreds of hours down to tens of minutes. Two key features contribute to this breakthrough speed improvement: 1)The tuner is characterized with one set of states (physical tuner positions) that are selected to give reasonable impedance spread over the frequency band of interest; and 2) the noise power measurement is swept over the frequency range at each state, so the tuner only moves to each position once. This takes advantage of the fast sweep capability of modern instruments, and saves time by minimizing tuner movement. The new method improves noise parameter measurement speed by two orders of magnitude, and produces data that is smoother, with less scatter than the traditional method. Measurement at ultrahigh speed eliminates temperature drift, and use of a VNA with an internal noise receiver simplifies the setup and makes it much more stable and consistent. The ultra-high speed makes it practical to always do a full in-situ calibration to minimize errors, measure more frequencies for a better view of scatter and cyclical errors, and use smoothing with more confidence. The higher frequency density also enhances accuracy by reducing shifts due to aliasing.

Conclusion

For the first time ever, designers can measure more accurate noise parameters in 1/100th the time to 50 GHz by combining Maury's revolutionary noise parameter measurement techniques with its MT7553B01 Noise Receiver Module, impedance tuners and the Agilent PNA-X.



Typical 8-50 GHz single-sweep measurement using a Maury MT7553B01 Noise Receiver Module and a Maury MT984AU01 Automated Tuner with the Agilent's PNA-X.

Reference documents:

5C-042 — *Theory of Noise Measurement*; Maury Microwave Corporation - Engineering Department. First published in July 1999.

5A-042 — *A New Noise Parameter Measurement Method Results in More than 100x Speed Improvement and Enhanced Measurement Accuracy*; Gary Simpson and Amar Ganwani - Maury Microwave Corporation with David Ballo and Joel Dunsmore - Agilent Technologies, Santa Rosa. First published in December 2008 as a Technical Paper presented to the 72nd IEEE ARFTG Microwave Measurement Conference; Republished in this format by Maury Microwave Corporation in March 2009, with permission.

4T-085 — *MT7553 Noise Receiver Modules;* Maury Microwave Product Data Sheet.

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