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POWER TRANSMISSION MEASUREMENT USING AN AMPLIFIED NOISE SOURCE

APPLICATION NOTE

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Power Transmission Measurement Using an Amplified Noise Source

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INTRODUCTION

As 5G chipsets develop into increasingly highly integrated devices incorporating on-board power amplifiers, antennas and frequencies increase to millimeter wave range, conducted RF power measurements are now becoming physically impractical or impossible to perform. As an effort to overcome the lack of physical connections, OTA testing techniques have been developed to quantify and analyze devices inside RF test enclosures. Test enclosures provide a controlled and isolated environment for testing today's devices. Devices placed in the test enclosure can be remotely activated and subjected to a variety of tests with transmit and receive antennas located inside the enclosure. The antennas are connected to a variety of signal sources to stimulate the device and instruments such as spectrum analyzers, vector network analyzers or power meters in order to capture and measure the response.

Compared to signal generators, which can only excite a limited set of frequencies, noise sources are attractive as a signal source due to their wideband spectrum, which more closely mimics real-life cellular signals encoded through orthogonal frequency division multiplexing (OFDM). These signals have very high peak power compared to their average power, which tends to saturate amplifiers. For highly-integrated MIMO or array antennas with a large number of built-in amplifiers, being able to test for saturation with a realistic test signal is invaluable.

This application note explores the further use of a noise source as a wideband signal source. As an example system, the noise source is used to test transmission and path loss between two Vivaldi antennas in an isolated enclosure.

TEST SETUP

Image 1 Antenna test setup within an RF test enclosure - schematic representation

The antenna system used in the aforementioned setup consisted of two DVTEST Vivaldi broadband antennas directly transmitting towards each other in a dbSAFE RF test enclosure. These antennas were connected to external devices through SMA connectors on the enclosure's I/O panel. This setup is demonstrated on Image 1. The noise source used for this measurement was the NC1128B amplified noise module, manufactured by Noisecom (Wireless Telecom Group). To reduce random fluctuation on the measurement, the averaging function of the spectrum analyzer was used, such that only the average noise power was visible. To verify the results, a VNA was also used to measure transmitted power through the antenna system.

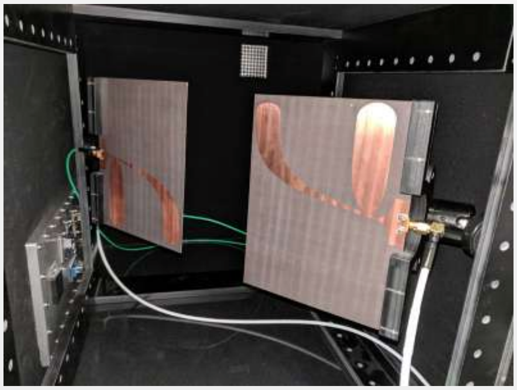


Image 2 Antenna test setup within an RF test enclosure

MEASUREMENT AND ANALYSIS

To achieve the best results, the measurement needs to be corrected for ripple from the noise source, as well as corrected for additional noise introduced by the spectrum analyzer. These measurements are labeled as follows:

P_1 = Noise power due to spectrum analyzer (no noise source)

P_2 = Power measured directly from noise source, without antenna system

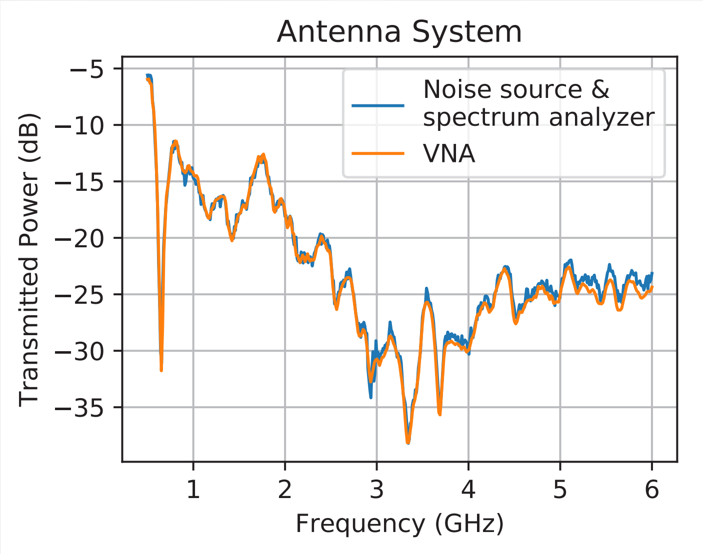
P_3 = Power measured from noise source through the antenna system

To calculate the transmitted power T, taking these corrections into account, the following equation was used:

$$T = \frac{P_3 - P_1}{P_2 - P_1}$$

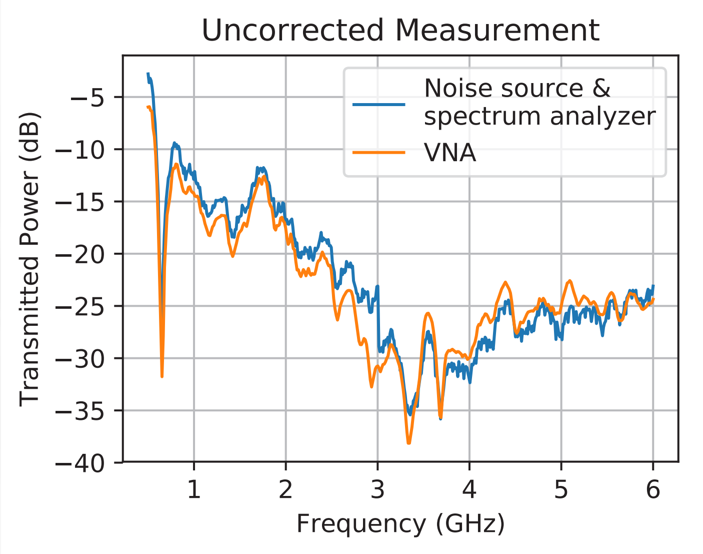
The main aim is to subtract the extra power produced by the spectrum analyzer (P_1), and subsequently, determine the ratio of output power to input power. This produced results in very good agreement with the VNA up to 6 GHz, shown below. This measurement was conducted over the range of 0.5 – 6 GHz, but this range could theoretically be extended to higher frequencies.

Figure 1



Even without these additional corrections, the measurement with the noise source aligns reasonably to the VNA measurement and can be used as a check against device failure, such as in a production environment. The measurement results without these additional corrections are shown on Figure 2.

Figure 2



CONCLUSION

Noise sources are seeing increased use as a signal source due to their ability to mimic OFDM cellular signals, and test for amplifier saturation in highly-integrated MIMO or array antennas. This application note has demonstrated the ability to conduct accurate transmitted power measurements with a noise source as a broadband signal source. This could for example, be used in a production test environment to verify interconnects, or as a cheaper alternative to signal generators for highly parallel testing. Amplified noise sources also show promise for high-frequency testing, where signal generators grow increasingly expensive in comparison to noise sources.

About the Author:

David Sawyer, RF Specialist Engineer at DVTEST Inc., has extensive test and measurement experience in RF and microwave technology. Graduated in Electronics Engineering from the University of Alberta, Canada, he has been actively involved in RF and microwave design and device measurement, research, wireless device characterization and instrumentation. David has authored or co-authored numerous papers in the areas of RF and electromagnetics. He is one of DVTEST's most talented engineers dedicated to solving the diverse challenges the rapid advancement of RF testing is bringing today and tomorrow.

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