A STATISTICAL APPROACH TO RF VECTOR NETWORK ANALYZER CORRECTIONS

Donald C. DeGroot
NIST, Electromagnetics Division, Boulder, Colorado

We describe a statistical framework for correcting measurements of RF and microwave scattering parameters, focusing on the application of a new 16-term method to a wideband vector network analzyer (VNA). Before examining the details of this method, we will examine why statistical treatments of vector network analyzers are only now gaining some attention, and why the VNA user community has managed to perform calibrations at all when just taking a single measurement of a deterministic number of standards. A new class of wideband network analyzer is a major driver for the adoption of statistical analysis because of their increased noise level. These instruments are used to characterize nonlinear circuits and devices by measuring harmonically rich signals. The wideband VNA either downconverts a broadband harmonic series or modulated signals into a wide intermediate frequency (IF) channel. The IF bandwidth can be larger than 4 MHz, increasing the noise in the measured data by many orders of magnitude over traditional, one-tone-at-a-time VNAs. To work with the noisy data in nonlinear network analysis, a joint effort between NIST and the Vrije Universiteit Brussel produced a new method for estimating the 16-term VNA model. It applies a convenient nonlinear least-squares optimization process to multiple measurements (electrical and connector repeats) of transmission line and reflection standards, and gives estimates for both the VNA model parameters and the propagation constant for the transmission line standards. By comparing the distribution equation residuals at the end of the process to what one would expect for Gaussian noise in the measurements, the method estimates the modeling errors in comparison to the maximum likely-hood result. The talk gives quantitative statements regarding the quality of the parameters, showing parameter values and estimates of their Type A uncertainty. It also shows that the modeling errors are typically less that a factor of 6 smaller than the Type A uncertainty induced by the measurement noise. Finally we present extensive simulation results showing that the parameters are statistically unbiased.

Abstract Submission Form

2004 National Radio Science Meeting

Abstract: degroot25134

Date Received: September 23, 2004

1. (a)
Donald DeGroot
NIST
Mail Code 818.01
325 Broadway
Boulder, CO
80305 USA
degroot@boulder.nist.gov

   (b) 303-497-7212

   (c) 303-497-3970

2. A - Electromagnetic Metrology
3. (a)
4. I - Invited Paper, Program chair: Jeffrey Jargon¡br¿¡br¿
5. Special Session - Microwave Measurements at NIST.