Nonlinear measurements to investigate memory effects of RF transistors and active devices

76th ARFTG, FALL 2010, Friday Dec. 3 1:15 PM – 5:00 PM, Clearwater, FL

Topic: This workshop will take a tour of usual nonlinear measurements of RF active devices, with a particular focus on the characterization of long-term memory effects. Such effects are usually consequences of thermal time constants, trapping effects, or other phenomena. Identifying these effects is critical in understanding the component behaviour. This workshop will present several extensions of classical nonlinear measurement techniques in order to exhibit data on particular memory effects: CW and pulsed I(V), CW and pulsed multi-bias S-parameters, low frequency S-parameters, CW and pulsed Load-Pull, and multi-sine and pulsed NVNA waveforms. The implementation of long term memory effects in device models will also be discussed.

Scheduled Speakers:

1:15pm – 1:20pm	Introduction, Loren Betts
1:20pm – 2:05pm	Gustavo Avolio
2:05pm – 2:50pm	Jean-Pierre Teyssier
2:50pm – 3:20pm	Coffee break,
3:20pm – 4:05pm	Youngseo Ko
4:05pm – 4:50pm	Jan Verspecht
4:50pm – 5:00pm	Conclusion, Loren Betts

Organizer: Loren Betts, Agilent Technologies, Santa Rosa, CA

Loren Betts received his BSc degree in computer engineering from the University of Alberta, Canada, in 1997, and his MSc degree in electrical engineering from Stanford University in 2003. In 2010 he completed his PhD degree in electrical engineering from The University of Leeds, UK. His PhD research was focused on the Nonlinear Vector Network Analyzer (NVNA) based on the Agilent PNA-X. He led a team that won the “Barnholt Innovation Award” for the NVNA as the invention of the year at Agilent Technologies in 2008. He also was awarded the “Bill Hewlett Award” in 2010 for his work on pulse detection techniques used in the PNA and PNA-X network analyzers. He is currently a research scientist and senior engineer at Agilent Technologies focusing on complex stimulus/response measurements and modeling of nonlinear components utilizing vector network analyzers.

Paper details

Nonlinear measurement techniques for low-and high-frequency characterization of active devices

Authors: Gustavo Avolio, Dominique Schreurs

Abstract: The exponential evolution of wireless systems during the last decades has forced the investigation of new semiconductor technologies in the context of microwave applications. In particular, gallium nitride (GaN) based active components represent the most promising candidates due to their excellent features which make them suitable for high power operation in the high-frequency range. However, this technology still manifests limitations, such as defects in the materials, which strongly impair the high-frequency performance. For this reason the characterization step is fundamental and unavoidable. The present talk is oriented to report the experimental investigations on several GaN technologies by exploiting different characterization methods, including low- and high-frequency nonlinear characterization techniques, based on the use of continuous wave and modulated excitations with a particular focus on dispersion and its impact on the nonlinear behaviour.

Gustavo Avolio obtained the M.Sc degree in electronic engineering at the University of Calabria (UniCAL), Italy. In 2008 he joined TELEMIC Division of the Katolieke Universiteit of Leuven, Belgium, as PhD student. His research work focuses on large-signal measurements and non-linear characterization techniques on microwave active devices.

Dominique Schreurs obtained the M.Sc. and PhD degrees in electronic engineering at the Katholieke Universiteit (K.U.)Leuven, Belgium. She now is associate professor at K.U. Leuven. Her main research is on the use of small-signal and large-signal vector measurements in the characterization and modelling of non-linear microwave and millimeter wave devices and circuits. She is serving on the ARFTG Executive Committee as Education Chair. She is also an elected member on MTT-S AdCom.

Pulsed measurements from I(V) to Time Domain Load-Pull to control memory effects

Author: Jean-Pierre Teyssier

Abstract: A classical way to keep under control the long-term memory effects (thermal effects, trapping effects) is to perform nonlinear measurements during short pulses, and to ensure these pulses are shorter than the long term memory effect time constants. This approach has been applied for a long time to pulsed I(V) and to pulsed multibias S-parameters for equivalent scheme model extraction. More recently, pulsed measurements have been applied to load-pull and time domain waveform measurements. This presentation will explain all these pulsed setups and show the interest of new enhanced pulsed mode with bursts. Several interesting measurement results will be commented.

Jean-Pierre Teyssier was born in 1963 in Brive, France. Since 1990, he works as researcher at the IRCOM / XLIM lab, University of Limoges, France, in the group of RF nonlinear devices and circuits. He has presented his PhD Thesis in 1994, the subject was about pulsed I(V) and pulsed S-Parameters for nonlinear characterization of microwave active devices. He is involved in the design of measurement

systems and instrumentation for microwave nonlinear investigations, with an emphasis on time domain pulsed large signal characterization of transistors. Since 2008, Pr Teyssier is involved in the start-up company VTD, witch provides NVNA solutions for load-pull setups.

Broadband multisine NVNA measurements for identification of memory effects

Authors: Youngseo Ko, Patrick Roblin

Abstract: The methodology for wideband width calibrated measurements with an LSNA will be reviewed. The measurements of deterministic multisine signals and their application to the identification of memory effects will then be explored. The modelling of memory effects, including group delay extraction, memory polynomial and B-spline function will be presented.

Youngseo Ko was born in Seoul, South Korea, in 1981. He received the B.S. degree from Hanyang University, in 2007, and the M.S. in Electrical and Computer Engineering from The Ohio State University, Columbus, OH, in 2009. His research interests include large-signal analysis and modelling of non-linear RF devices and power amplifiers.

Patrick Roblin was born in Paris, France, in 1958. He received the Master of Physics degree from the Louis Pasteur University, Strasbourg, France, in 1980, and a D.Sc. degree in electrical engineering from Washington University, St. Louis, MO, in 1984. Since 1984 he has been with the Department of Electrical and Computer Engineering, at The Ohio State University (OSU), Columbus, OH, where he is now a Professor. His present research interests include the measurement, modelling, design and linearization of non-linear RF devices and circuits.

Extension of X-parameters to include Long-Term Memory Effects

Author: Jan Verspecht

Abstract: A unified theory and methodology is presented to characterize and model long-term memory effects of microwave components by extending the X-parameter model to include dynamics that are identified from pulsed envelope X-parameter measurements on an NVNA. The model correctly predicts the response to time-varying RF excitations that excite long-term memory effects in power amplifiers. The model is implemented in the ADS circuit envelope simulator and accurately predicts dynamic effects like asymmetric spectral regrowth, sweet spots and large signal step response transients.

Jan Verspecht received the electrical engineering and Ph.D. degrees from the Vrije Universiteit Brussel (VUB), Brussels, Belgium, in 1990 and 1995, respectively. From 1990 until 1999 he was a Research Engineer with the Hewlett-Packard Company. From 1999 until 2002 he was a Technical Leader with Agilent Technologies. In 2003 he founded the company Jan Verspecht b.v.b.a., where he presently holds the position of Director and Chief Consultant. In 2007 Dr. Verspecht was elevated to the grade of IEEE Fellow by the IEEE Board of Directors. He is the inventor of X-parameters.