ARFTG-97th Microwave Measurement Conference

CONDUCTED AND OTA MEASUREMENT CHALLENGES FOR URBAN, RURAL & SATCOMM CONNECTIVITY

June 25th, 2021

Virtual Event

Conference Program

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Welcome to ARFTG-97th Symposium

The 97th ARFTG general co-chairs Marco Spirito and Jon Martens would like to welcome you to this year symposium, part of the IMS 2021 week.

The technical program co-chairs Basim Noori and Jeffery Jargon have put together an outstanding program for this conference. The main conference includes four virtual sessions of ARFTG paper presentations which contain outstanding invited and contributed papers. The first session is on "Modeling and Simulations" and includes a live streamed invited paper on "Measurement-Based Modeling of Backhaul Communication Systems of Complex Terrain" by Dr. Julius Kusuma from Facebook Connectivity. The second session is on "Metrology" which starts off with an invited live streamed presentation on "Multiphysics Phase-Field Method to Study Electroformation of Memristive Dielectric Thin Films" given by Dr. John Sevic of Embry–Riddle Aeronautical University. The third and fourth sessions on "Measurements" and "Over-the-Air" provides several interesting contributions of classical topics of interest for the ARFTG community, so tune in and follow the recorded presentations. The ARFTG will also host two User's Forums during the week (NVNA and On-Wafer), scheduled for Thursday 24th June as live events.

Details on content and scheduling can be found at the 97th ARFTG Symposium web page.

With the 97th ARFTG symposium being held virtually, it will allow for registered attendees to view the presentations at their own convenience with all accepted submissions recorded and presented in oral format. Additionally, you will have an opportunity to interact with paper authors during live Q&A sessions scheduled during Friday the 25th of June. Most events will take place during the morning hours in the US to allow best coverage worldwide. Conference invited talks will be live-streamed.

We would like to recognize and thank all the participants of the 97th ARFTG Steering Committee for their time and their effort to make this a successful ARFTG Symposium.

Marco Spirito
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TU Delft

Jon Martens
General co-Chair
Anritsu

Basim Noori
TPC Chair
Wolfspeed

Jeffrey Jargon
TPC co-Chair
NIST

Program at a Glance

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
21 JUNE 2021	22 JUNE 2021	23 JUNE 2021	24 JUNE 2021	25 JUNE 2021
			9:00 – 10:30 EDT **NVNA User's Forum**	9:00 – 10:30 EDT **Session 1** **Invited Talk: Measurement-Based Modeling of Backhaul Communication Systems of Complex Terrain** Julius Kusuma (Facebook Connectivity Lab)
			11:00 – 12:30 EDT **On-Wafer User's Forum**	11:00 – 12:30 EDT **Session 2** **Invited Talk: Multiphysics Phase-Field Method to Study Electroformation of Memristive Dielectric Thin Films** Dr. John Sevic, Embry (Riddle Aeronautical University)
				13:30 – 14:15 EDT **Session 3**
				14:30 – 15:15 EDT **Session 4**

Thursday 9:00 – 12:30 EDT

	NVNA Users Forum (live)
9:00 — 10:30 EDT	Session with Q&A NVNA User's Forum Organizers: Patrick Roblin (OSU), Apolinar Reynoso Hernandez (CICESE), Jean-Pierre Teyssier (Keysight Technologies), Dominique Schreurs (KU Leuven), Tibault Reveyrand (XLIM), Karun Rawat (I.I.T)
10:30 — 11:00 EDT	Break
	On-Wafer Users Forum (live)
11:00 — 12:30 EDT	Session with Q&A On-Wafer User's Forum Organizers: Andrej Rumiantsev (MPI Corporation), Marco Spirito (Delft University of Technology), and Jon Martens (Anritsu)
12:30 EDT	End of Thursday's Conference events

Friday 9:00 – 15:15 EDT

Session 1: Modeling and Simulation

9:00 — 9:40 EDT

Invited talk: Measurement-Based Modeling of Backhaul Communication Systems of Complex Terrain (live)

Julius Kusuma (Facebook Connectivity Lab)

Many people around the world still lack mobile broadband coverage, especially in rural areas. For example, in 2018 over 100 million people in rural parts of Latin America did not have broadband coverage. Microwave wireless backhaul is an important enabler of broadband coverage in rural areas, providing low capex, low data cost, and fast time to market. The conventional design-to-deployment workflow of carrier-grade microwave backhaul relies on Clear Line of Sight (CLOS) links. When CLOS is not available, network designers use active or passive repeaters. Often, the added cost makes the business case unfeasible.

Recently, we introduced a new design-to-deployment workflow based on Diffractive Non Line of Sight (NLOS) links. Our first Diffractive NLOS workflow, called NLOSv1, is focused on standard carrier-grade tools, including standard hardware and empirical link prediction tools. Systematic measurements and experiments showed that Diffractive NLOS is feasible for single diffraction, small angles, and modest foliage. Further, our partners Internet para Todos and Mayutel have deployed dozens of links in their production networks in Peru. Design studies and real-world deployments show that NLOSv1 gives significant coverage-cost gains, and provides reliable carrier-grade backhaul links.

9:40 — 10:30 EDT

Q&A for Session 1 papers

On the Formalism of Heterodyne Mixer Phase Synchronization in Microwave Receivers

Loren Betts (Keysight)

Heterodyne receivers are commonly used to down-convert Radio Frequency (RF) signals to an intermediate frequency (IF) for digitization and analysis. The receiver can consist of one or more mixers with one or more Local Oscillator (LO) generators. In the most simplistic form, the mixer multiplies the RF signal with the LO signal to generate an IF signal for analysis. Applications of a heterodyne receiver are far reaching and commonly used in aerospace/defense, commercial communications, and signal/network analysis. If the RF signal has spectral content that exceeds the frequency bandwidth of the IF, the LO frequency is often adjusted to down-convert the spectral components in multiple frequency segments after which the resulting sets of IF data are then combined to represent the original RF signal at the IF. To correctly represent the RF signal, the amplitude and phase of the down-converted signal must be preserved. In other words, the absolute amplitude of the spectral components must be maintained and the phase relationship between the spectral components (cross-frequency phase) must be maintained. In certain LO generator modalities a change in the generator

frequency results in a non-deterministic LO phase resulting in a non-deterministic phase between the down-converted spectral components. This paper provides the mathematical underpinnings of utilization of an impulse generator to eliminate non-deterministic LO phase.

Basics Investigation of Electromagnetic Sensing for Wood Moisture contents

Masahiro Horibe (AIST)

This paper demonstrates to measure the moisture contents in wood peace by microstrip transmission line (MSTL) sensor in the wide range of moisture contents from 9 % to 190 %. Vector network analyzer measured that transmission characteristics strongly depend on moisture contents in wood peace. In the analysis, real and imaginary of transmission characteristics were changed by sample setting condition, but its variations of real and imaginary were strongly correlated with linear expression. In addition, parameters of the expression related to moisture contents. Thus, calibration curves were carried out and the curves were also able to calculate moisture contents from electromagnetic measurement results. Furthermore, adopting multiple frequency measurement improves accuracy in wide range moisture measurements.

Simple Trapping Model for GaN HEMTs

John Wood, Zul Mokhti, and Yueying Liu (Wolfspeed)

A simple model to describe the influence of trapping on the RF electrical behavior of GaN HEMTs is presented. The trapping models are incorporated into a simplified FET model. The FET model is compared with pulse transient measurements made on a variety of test samples, and used for predictions of RF and modulated-signal performance, to illustrate how trapping can affect the behavior of real FETs. This model is used for comparison of different technology approaches and for trend analysis.

Investigation on practical problems in on-wafer measurement for actual devices

Ryo Sakamaki and Masahiro Horibe (AIST)

The study investigates on some practical problems in on-wafer measurement for actual-used devices in the millimeter-wave (mmW) frequencies. In terms of thickness of metallization, it is noted that range of the tilt angles, which probe is correctly contacted on surface of metallization, is decreased with thickness of the metallization being thinner. Range of the tilt angle was only 0.25 degrees in worst case when thickness of metallization was 0.8 µm. Tilt of sample chuck and surface of sample cause difference in probe positions in vertical directions of several microns, and results in difference in measured transmission coefficients of a CMOS device which were ranged from -3.2 dB to -4.4 dB. Finally, RF signal detection (RSD) technique was applied for evaluation of four of CMOS chips. The RSD technique well-works even in the CMOS devices.

A Comparison of Terahertz Permittivity Measurements of Several Dielectric Materials Using Frequency and Time Domain Methods

Christopher Green and Jeffrey Seligman

Frequency and time domain methods for extracting the complex permittivity of laminates at THz frequencies are compared. Materials are characterized with free space systems that incorporate the Vector Network Analyzer with frequency extenders, or a Time Domain

Spectrometer system. Data resolution, polarization anomalies, amplitude oscillations, frequency range, accuracy, and parameter extraction methodology (including reflections) are presented and compared. Both methods are advantageous with good agreement existing between the data.

10:30 — 11:00 EDT

Break

Session 2: Metrology

11:00 — 11:40 EDT

Invited Talk: Multiphysics Phase-Field Method to Study Electroformation of Memristive Dielectric Thin Films

Dr. John Sevic (Embry–Riddle Aeronautical University)

Nanoscale dielectric thin films display a rich variety of physical behaviors suitable for next-generation solid-state memory technology. These thin films, particularly those fabricated from transition metals, such as niobium, form oxides exhibiting memristive behavior, responsible for the memory function. Memristive behavior obtains from various electronic and ionic transport phenomena, including Poole-Frenkel and Mott hopping, respectively. These atomically thin nanoscale memristive thin films layers, on the order of 10 nm, present several challenges for a traditional multi-physics drift-diffusion formulation due to interface effects, anisotropy, and scattering, so alternative frameworks are needed for further computational analysis. One such method is the phase field method, which treats the interface formed by an ensemble of charge carriers as an unknown; this principle is simialr to melting ice, whose interface is both unknown and dynamic. By casting memristive interface equilibrium as a variational problem, coupled to charge conservation, the dynamical evolution of this interface, which forms a conducting channel, can be studied in a self-consistent computationally efficient framework.

11:40 — 12:30 EDT

Q&A for Session 2 papers

Updates to the traceability of mm-wave power measurements at NIST

Aaron Morgan Hagerstrom, Angela Stelson, Jeff Jargon, and Christian Long (NIST)

Metrological traceability helps ensure the reliability of measurements by allowing them to be compared with established international standards with well-understood uncertainties. A thorough uncertainty analysis is therefore necessary to provide traceable measurements. In this paper, we summarize recent updates to the measurement procedures and uncertainty analysis for NIST's calibrations of power sensors with WR-15 connectors. The improvements include a more detailed uncertainty analysis with a more complete treatment of type A uncertainty, and the establishment of traceability of DC voltage measurements and scattering parameter measurements to primary standards.

Robust mTRL implementation for probing standards manufactured on PCBs

Michael E Gadringer (Graz University of Technology)

The Through-Reflect-Line (TRL) and multiline-TRL (mTRL) calibration are well known for accurate parameterization of the systematic errors of a vector network analyzer (VNA). When applying this approach to calibration/deembedding in connection with PCBs tested on a probe station, the imperfections of the RF probe to PCB transitions add to the overall measurement uncertainty. These measurement imperfections may result in an incorrect output of the mTRL algorithm due to faulty measurements. To mitigate this situation, an implementation of the mTRL calibration is presented which, on the one hand, focuses on a robust implementation able to cope with mentioned measurement conditions and, on the other hand, tags possible improper measurements.

On the Influence of Thru- and Line-Length-Related Effects in CPW-Based Multiline TRL Calibrations;

Gia Ngoc Phung and Uwe Arz (PTB)

The quality of calibration standards in on-wafer measurements has a strong impact on the accuracy of the multiline Thru-Reflect Line (TRL) calibration. Especially the thru standard is one of the most critical calibration standards. For instance, it has been demonstrated recently that the probe effects are more pronounced, if the length of the Thru is selected too small. In this case, the mTRL calibration is more sensitive towards probe coupling effects. Therefore, this paper reports on a systematic study on the impact of the thru length on the mTRL calibration accuracy. Additionally, the influence of the length of the calibration standards will be discussed together with the influence of probe and neighborhood effects for coplanar waveguides (CPW).

Pre-Silicon direct Calibration/De-embedding Evaluation and Device Parameters Uncertainty Estimation

Ciro Esposito (TU Dresden)

In this contribution we present a simulation testbench capable to separate and quantify all the major sources of uncertainties in user-designed direct calibration/de-embedding test-fixtures. The calibrated data systematic errors arising from the different response of the standard definitions when compared to their in-fixture ones as well as the random contributions arising from the instrument noise and probe (variable) misplacement are described and propagated through the calibration equations versus frequency. Finally, the s-parameter uncertainties are further propagated to the device level parameters, i.e., gate capacitance and transducer gain to provide the required link between calibration accuracy and modelling quality. Preliminary measurement data in the 140GHz-220GHz are compared versus the uncertainty model prediction.

Precision Offset Short Calibration Standards for 1.35 mm Coaxial Line Sizes

Masahiro Horibe (AIST)

This paper summarizes to establish the calibration standards of offset short devices in 1.35 mm coaxial line size. Reference values of standards were characterized by electromagnetic simulation and following cascading analysis of connector and line. The, VNA has been calibrated by database calibration using four offset short devices. Measurement capability was demonstrated by measuring four different types of device under test by two sets of calibration

kit. Furthermore, Calibration standards for scattering parameters has established in the frequency range up to 90 GHz in 1.35 mm coaxial line system.

Broadband Characterization of Co-planar GSG Wirebonds for RF Heterogeneous 2.5D Integration

Ziad Hatab, Erich Leitgeb, and Michael E Gadringer (Graz University of Technology)

With the advancement in silicon interposer technology and Through Silicon Vias (TSVs) heterogeneous 2.5D integration at mm-wave frequencies is becoming more approachable than ever. In this work, we investigated co-planer Ground-Signal-Ground (GSG) wirebonds as cost-effective interconnect for RF 2.5D applications. On-silicon GSG wirebonds of 25 µm diameter and 100 µm pitch were realized and measured at different lengths and at frequencies up to 40 GHz. Circuit modeling of the measurements showed excellent agreement. Additionally, GSG wirebonds with lengths below 500 µm achieved insertion loss below 2 dB up to 40 GHz, while still leaving space for improvements, e.g., by reducing bond pitch or deploying ribbon bonds.

12:30 — 13:30 EDT Break

Session 3: Measurements

13:30 — 14:15 EDT Q&A for Session 3 papers

Linearity Characterization of the Self-Enhanced Class J PA Operating Mode through Modulated-Signal Load-Pull Measurements

Frederik Vanaverbeke (NXP Semiconductors), Michael B Satinu (NXP Semiconductors), Michele Squillante (Anteverta-mw B.V.), and Kevin Kim (NXP Semiconductors)

Recently, single-tone harmonic load-pull measurements provided evidence for the self-enhanced Class J operating mode in RF power transistors. In Class J, the non-linear drain-source capacitance causes the drain-voltage to peak without the phase-shift as in the case with a linear drain-source capacitance, resulting in increased output-power and drain-efficiency. Due to the nature of RF power transistors, improvements in efficiency tend to compromise linearity and vice versa. In this work, we present a methodical way to characterize the linearity-efficiency trade-off of the self-enhanced Class J operating mode through on-wafer modulated-signal harmonic load-pull measurements. Rather than only characterizing the single-ended device in the maximum power and maximum efficiency impedances, extra consideration went into choosing loading impedances that bring the device in a state that is most resemblant of the state of a carrier-device in a Doherty arrangement.

Automated Noise-Parameter Measurements of Cryogenic LNA

Alexander Sheldon (University of Calgary), Leo Belostotski, Hamdi Mani (Arizona State University), Christopher Groppi (Arizona State University), and Karl Warnick (Brigham Young University)

This paper addresses the need for measured cryogenic noise parameters. The measurement process is discussed and an analysis of the measurement uncertainty is performed. To verify proper operation of the measurement system, measurements of a 1-to-2-GHz radio-astronomy low-noise amplifier (LNA) at 20, 75, and 296 K are presented. In these measurements, the typical 1σ measurement uncertainty in noise temperatures and minimum noise temperatures is < 10%.

Combined Wideband Active Load-Pull and Modulation Distortion Characterization with a Vector Network Analyzer

Alberto Maria Angelotti (University of Bologna), Gian Gibiino (University of Bologna), Alberto Santarelli (University of Bologna), Troels Nielsen (Keysight Technologies), and Jan Verspecht (Keysight Technologies)

We present a demonstrator set-up for amplifier error-vector magnitude (EVM) characterization in the presence of wideband load termination arbitrarily set by the user through active modulated signal injection. In the proposed implementation, both the EVM characterization and the wideband active load-pull (WALP) technique are solely based on iso-frequency ratioed measurements obtainable with legacy vector network analyzer (VNA) technology. By avoiding broadband signal demodulation, this approach allows to remove any receiver bandwidth limitation, thus enhancing measurement accuracy and enabling realistic modulation distortion assessment across arbitrarily-wide test bandwidths. The method is tested on a packaged power amplifier circuit for 5 and 30 MHz modulation bandwidths around 1.2 GHz.

Issues of Multi-Notch NPR Characterization Procedures

Ricardo Figueiredo (University of Aveiro) and Nuno Borges Carvalho (Instituto de Telecomunicacoes)

This work exposes limitations of multi-notch NPR, which have been neglected, that make experimental results hard to compare with classic NPR measurements. In fact, it demonstrates, theoretically and experimentally, how swept-notch NPR is a better linearity metric than multi-notch NPR, particularly in the presence of nonlinear dynamic effects. This calls for the replacement of multi-notch NPR by swept-notch NPR.

Characterization of the frequency dependent match for optimal performance of wideband power amplifiers

Sanket Chaudhary (University of Aveiro), Marina Jordao (Instituto de Telecomunicacoes, University of Aveiro), Nuno Borges Carvalho (Instituto de Telecomunicacoes), Marc Vanden Bossche (NI), and Adam Cooman (Ampleon)

This paper investigates optimum load synthesis methods for wideband multi-carrier compatible Power Amplifiers (PAs) using active modulated load-pull analysis. The analysis demonstrates that frequency-dependent optimum impedance enhances the Power Added Efficiency (PAE) up to 3-5% and the gain up to 1-2dB near and beyond the 1-dB compression. The proposed optimum impedance synthesis approach offers more comprehensive information about the Device Under Test (DUT) performance for real-time wideband applications. Moreover, it provides an analysis platform to determine the optimal frequency-dependent matching network across the modulation band for wideband PAs.

14:15 — 14:30 EDT Break

Session 4: OTA

14:30 — 15:15 EDT Q&A for Session 4 papers

On Over-the-Air Far-Field Measurements Below Fraunhofer Distance

Jan Fromme, Jiaju Cai, Vincent Kotzsch, Gerardo Orozco, and Marc Vanden Bossche (NI)

Over-the-Air measurements are critical for the validation and test of active antenna arrays required to operate at mmWave frequencies. In this paper we verify through measurements a recent research result stating that one can measure significantly below the commonly used Fraunhofer far-field distance with still acceptable results. For the validation we use a horn antenna as well as an exemplary phased array antenna measured for varying distances using the NI mmWave OTA validation system. While the results for the horn antenna match quite well with the theoretical expectation, for the phased array antenna we observe slightly higher deviation. But overall the results confirm that when measuring below the Fraunhofer distance results are still reasonable and usable for selected use cases.

The Antenna Dome Real-Time Distributed Antenna Pattern Characterization System

Ferry A Musters, Marco Spirito, and Richard Coesoij (TU Delft)

In this contribution we present the hardware components the system architecture and the software modules constituting the base of the TU Delft high speed Antenna Dome. The modular architecture together with the custom designed detecting unit cell allows for real-time 2D antenna characterization, providing user defined performance, optimized for the 5G FR2 mm-wave band. The various high frequency (i.e., antenna, square-law detector) and logical sub-system composing the dual-polarization signal acquisition unit are described and evaluated for their performance. The routines and algorithm allowing for accurate 2D spatial interpolation and the system calibration/normalization are reviewed. Finally, preliminary measurement data of antennas operating in the FR2 band are presented.

Novel EM-Field Measurement Method by Using a Lambda/2 Dipole LED Antenna as a Signal Strength Indicator

Daiki Ikeno, Yuji Koita, Masashi Nakatsugawa, Tamami Maruyama (National Institute of Technology, Hakodate College), and Yasuhiro Tamayama (Nagaoka University of Technology)

A novel EM-field measurement method by using a lambda/2 dipole LED antenna was proposed. The lambda/2 dipole LED antenna can be lit by the received DC power fed by rectifying RF signals. The LED's brightness depends on the DC power provided, suggesting use as an EM field strength indicator where the lambda/2 dipole LED antenna is located. First, the EM field and wireless power transfer efficiency were simulated to investigate the lambda/2 dipole LED antenna's potential. We constructed a prototyped measurement system for experiments. The system was composed of CdS cell photodetectors, a voltage measuring circuit with indicators,

and the lambda/2 dipole LED antenna. The received power with antenna directed x-direction was measured the largest among x-, y-, and z-directions. The corrected received power for x- and z-directions was compared using the simulated Poynting vector components. The points showed good agreement ensuring the effectiveness of using an lambda/2 dipole LED antenna as a signal strength indicator to measure the EM field.

Extended Range mmWave for Fixed Wireless Applications

Randall S Fassbinder (US Cellular), Laetitia Falconetti (Ericsson), Sam Guirguis (Qualcomm), Elisiario Cunha Neto (Ericsson), Arturo Ortega (Qualcomm), Narothum Saxena (US Cellular), Michael Chard (Qualcomm), Kausik Ray Chaudhuri (Qualcomm), Atanu Halder (US Cellular), Rahul D Patel (Ericsson), and Michael Irizarry (US Cellular)

The large bandwidth of mmWave spectrum for 5G NR correlate to greatly increased throughputs and expanded capacity for RAN networks. It is not without its challenges though as mmWave does not penetrate indoors and has propagation limitations compared to sub-6 GHz spectrum. However, mmWave enables fixed wireless access (FWA) applications to provide residential homes with high-speed broadband connection. In this article, we present findings from our field trial which involved use of FWA high power customer premise equipment (CPE) with some optimizations on the gNodeB to achieve distance of 5Kms with speeds in excess of 100Mbps. This study shows the feasibility of fixed wireless for extended coverage especially suitable for rural areas.

Design and Realization of a Compact Size Active Antenna for UHF Satellite Communication

Abdellatif BOUYEDDA (XLIM), Bruno BARELAUD (XLIM), and Laurent GINESTE (EXOTIC-SYSTEMS)

This paper presents the design and fabrication of a low noise amplifier and a Folded Inverted F Antenna loaded with an Split Ring Resonator cell for UHF satellite communication. The antenna is designed and simulated using a 3D EM simulator. It has a total size of 32mm*32mm*1.5mm, an omnidirectional radiation pattern in the xy-plane and a gain of -16.4 dB. The designed LNA has a low current consumption of 3.2 mA at 3.3 V, a maximum noise figure of 1.16 dB and a minimum gain of 16.5 dB in the band from 400 to 466 MHz. EM circuit co-simulations are performed with ADS for the LNA design. The LNA and antenna are prototyped and simulation results are validated by performing measurements of S-parameters using the PNA-X and noise figure measurements using the cold source and Y-factor method. The active antenna will be the result of integrating the LNA and the antenna. A satellite detection test is performed using the evaluation board of Kineis, the designed LNA and antenna.

Calibration Method for an RF I-V Based HF RFID Impedance Measurement System

Benjamin J. B. Deutschmann (Graz University of Technology), Michael E Gadringer (Graz University of Technology), Richard Fischbacher (Graz University of Technology), Lukas Görtschacher (NXP Semiconductors), Franz Amtmann (NXP Semiconductors),Erich Merlin (NXP Semiconductors), Ulrich Muehlmann (NXP Semiconductors), and Jasmin Grosinger (TU Graz)

This paper presents a novel measurement system based on the radio frequency (RF) current-voltage (I-V) method of impedance measurements, capable of providing high sensitivity over a wide range of impedance. We use this system to characterize high frequency (HF) radio frequency identification (RFID) chips. A newly developed calibration method enables us to calibrate the system using three well-known calibration standards. Besides, we estimated the accuracy of our measurement system using another set of well-known reference standards.

We achieved a high accuracy (1.5%) compared with related measurement systems, which are, in general, based on vector network analyzer (VNA) measurements (3.2%). In comparison with VNA-based systems, our proposed measurement system provides a low-cost, yet accurate method of measuring HF RFID chip impedances.

Dynamic Range Definitions and Measurement Applied To Radar Digital Receiver Exciter (DREX)

John O Mortensen (UCCS), Rick Sturdivant (MPT), and Mark Wickert (UCCS)

Dynamic range is a performance parameter used to measure the performance of receivers. Though it has been used since the early days of radio and radar systems, there are many ways to describe and test it. The purpose of this paper is to describe five possible definitions and some of the test methods used in dynamic range characterization. The intended application is receivers used in digital receiver exciters (DREX) often found in phased array radar. The methods are described, compared, and a test example is provided. Finally, conclusions are provided with recommendations.

15:15 EDT End of Conference

See you again at ARFTG-98th Conference!

98th ARFTG Microwave Measurement Conference

Non-Linear Methods and Measurements for RF and mm-wave

Las Vegas, NV USA, January 16-17, 2022

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Call for Papers

The theme for the 98th ARFTG Conference (which will be co-located with Radio and Wireless Week) is "Non-Linear Methods and Measurements for RF and mm-wave". We encourage the submission of original papers demonstrating innovative approaches to non-linear methods in state-of-the-art high-frequency test and measurement. Contributions exploring all areas of RF, microwave, and mm-wave measurements are welcome. Suggested topics include but are not limited to:

- *5G, internet of things (IoT), and over the air (OTA) measurement & calibration*
- *RF-to-Digital, Mixed Signal, Dig-RF, Linearization Techniques*
- *Non-Linear, Large-Signal, Waveforms Measurement and Modelling*
- *RF, Microwave, mm-wave Measurement for Circuits, Devices and Systems*
- *Advances in On-Wafer or In-Fixture measurements, Calibration and De-embedding*
- *Metrology, Calibration and Material Measurements*

https://www.arftg.org/index.php/upcoming-conference/upcoming-conference-2

Deadlines

September 17, 2021	Electronic abstract/summary is due in PDF format.
October 15, 2021	Paper acceptance and classification will be communicated.
November 05, 2021	Publication-ready paper is due in PDF format.

Instructions for Authors

Instructions for authors are outlined briefly below. More details can be found on the ARFTG web-site: http://www.arftg.org/index.php/upcoming-conference/author-instructions. Authors are strongly encouraged to use the template on that webpage to prepare both initial summary and final paper submissions.

We request that authors submit a 4-page summary with supporting figures of both experimental setups and measurement results to enable evaluation with respect to the interests of the participants and the novelty of the work.

Contributed papers will be presented as 20-minute talks or in an interactive poster session. Final papers will be published as part of the ARFTG proceedings in IEEE Xplore, provided it has been presented at the conference.

Financial Support for Students

ARFTG provides financial support to graduate students to attend the fall/winter ARFTG conference with our ARFTG Student Sponsorship Initiative. Please see the program webpage (http://www.arftg.org/index.php/membership/student-sponsorship) or contact our sponsorship chair (Joe Gering, sponsorship@arftg.org) for more details.

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The 98th ARFTG Conference also offers an outstanding exhibition and sponsorship opportunity. Please contact our Exhibits Chair (Joel Dunsmore, exhibits@arftg.org) or our Sponsors Chair (Joe Gering, sponsorship@arftg.org) directly for further information.

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