Joint Research Project

Metrology for optical and RF communication systems

Newsletter April 2015

Introduction

We are pleased to welcome you to the second newsletter for IND51 “MORSE”. This project aims to provide metrological support tailored to the needs of RF and optical communication R&D supporting the EU “2020 Digital Agenda for Europe” and future Horizon 2020 projects. It also builds on earlier work IND16 “Ultrafast,” which improved the capability in Europe for traceable waveform measurement. The Physical Layer is only part of the communications system but research in this area supports the introduction of new equipment which affects the capacity and operating costs of the system.

Quiet Zone Probing of the Compact Antenna Test Range

A Compact Antenna Test Range (CATR) has been installed in the institut d'électronique et de télécommunications de Rennes (IETR) millimeter wave antenna test facility in order to be able to measure high gain antennas from 18 GHz to 110 GHz. The quiet zone of the CATR is a cylinder (of diameter 60 cm and depth 60 cm) whose axis is merged with the optical axis of the chamber.

The electromagnetic field has been measured inside the quiet zone so as to check the capabilities of the CATR. A quiet zone field probing, specifically the measurement of the complex (magnitude and phase) electric field, has been performed at 60 GHz thanks to the 2D scanner developed in the MORSE project. The results are reported in the following figure (abscissa: horizontal plane, ordinate: vertical plane).

The quality of the synthesized plane wave is good and meets our expectations. Moreover, these first results will be exploited in the MORSE project.

A second quiet zone probing will be performed following the requirement of the MORSE project. For this second measurement campaign, the scanner will be improved by further minimizing the planarity errors and the errors generated by the RF cables movements.

References

L. Le Coq, B. Fuchs, T. Kozan, T. Andersson, S. Burgos, “Compact Antenna Test Range implementation in IETR millimetre wave antenna test facility,” in *IEEE International Conference on Antenna Measurements and Applications*, Nov. 2014.

L. Le Coq and B. Fuchs, “Design and manufacturing of a high accuracy planar scanner for millimeter wave applications,” in *IEEE International Conference on Antenna Measurements and Applications*, Nov. 2014.

L. Le Coq, B. Fuchs, T. Kozan, T. Andersson, S. Burgos, "IETR Compact Antenna Test Range : implementation and validation," submitted to *European Conference on Antennas and Propagation (EUCAP)*, April 2015.

Contact & further information

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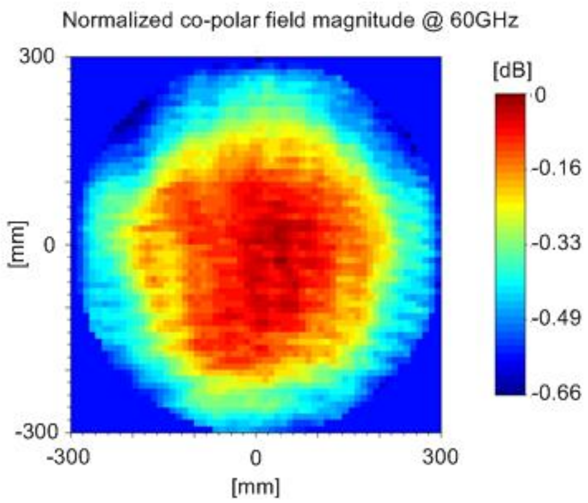
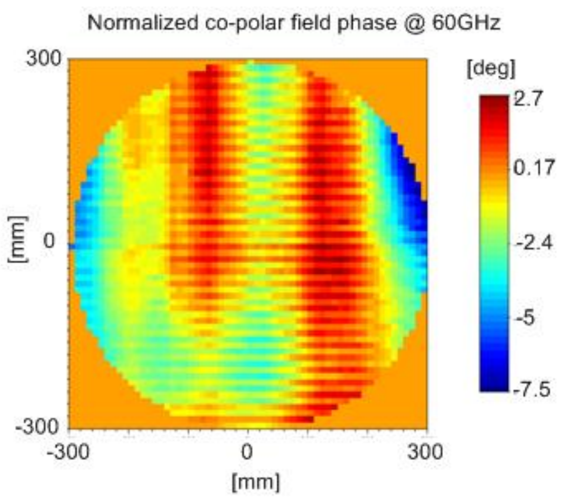


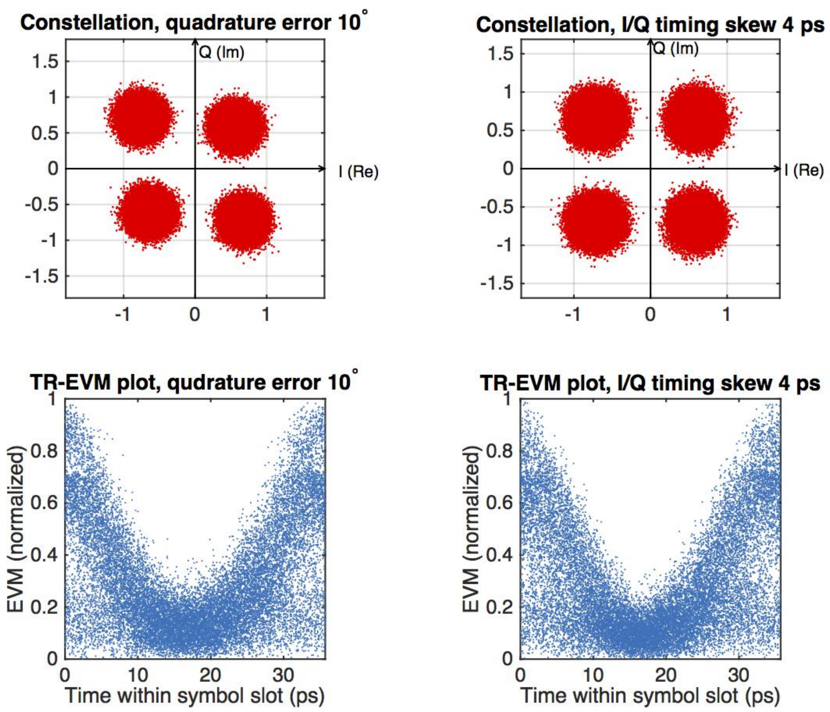


High-speed optical communication measurements at Chalmers

Metrology support for the next generations of optical communication systems (400 -1000 Gbits/sec) is a key element of the MORSE project and NPL, CMI and Chalmers University bring together the waveform, communication metrology and Optical test-bed facilities for this work. Martin Hudlicka (CMI), Irshaad Fatadin and David Humphreys (NPL) have been working with Carl Lundström at Chalmers in the Photonics Laboratory using equipment loaned by Keysight and EXFO to quantify the optical communication system behaviour. The objective is to characterize optical transmitters and receivers in an economic manner, without resorting to full bit-error counting at several levels of optical signal-to-noise ratios (OSNR) at the receiver.

The state-of-the-art optical communications systems are based on coherent detection and multi-level modulation formats such as QPSK and 16-QAM which are commonly used for radio-communications. These systems operate at high baud rates, e.g. 28 GBaud and are also normally polarization-multiplexed to double the throughput. For example a single optical channel can carry 224 Gbits/sec as 16-QAM using two polarization states. The high-speed test-bed system at Chalmers comprises a transmitter based on a Keysight arbitrary waveform generator with an optical I/Q modulator (to generate a signal with controllable impairments) and a receiver which consists of an optical hybrid, high-speed photodetectors, and a Tektronix 100 Gsamples/s real-time oscilloscope. In addition Keysight and EXFO optical modulation analysers (OMA) were available for evaluation.

Error-vector-magnitude (EVM) is an important quality parameter that is extensively used in radio-communications and this parameter has now been applied in the optical environment [1]. Within the test-bed environment, EVM, error counting (Bit Error Ratio) and OSNR can be calculated to give the BER vs. OSNR relationship using real-time data. In addition, EVM was also measured using the OMA together with sampled data to generate a time resolved (TR)-EVM plot [2]. The figure shows constellation diagrams, measured with the real-time oscilloscopes and TR-EVM plots measured with the OMA. Analysis of the data is currently underway and aims to indicate how EVM and TR-EVM can be used to quantify transmitter impairments, and how these quantities should be measured in a traceable manner.



References

[1] Schmogorow, et al., “Error vector magnitude as a performance measure for advanced modulation formats”, IEEE Photon. Technol. Lett. 24, pp 61-63 (2012).

[2] Sunnerud, et al., “Characterization of optical modulation formats at 100 Gb/s and beyond by coherent optical sampling”, J Lightwave Technol. 30, pp. 3747-3759 (2012).

Contact & further information

More detail of this work and the results will shortly be available on the stakeholder area of the MORSE website.

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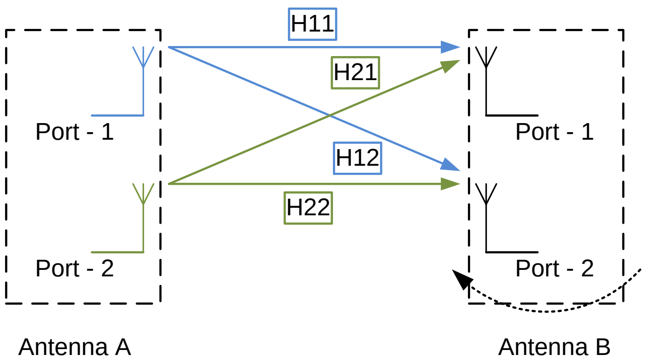
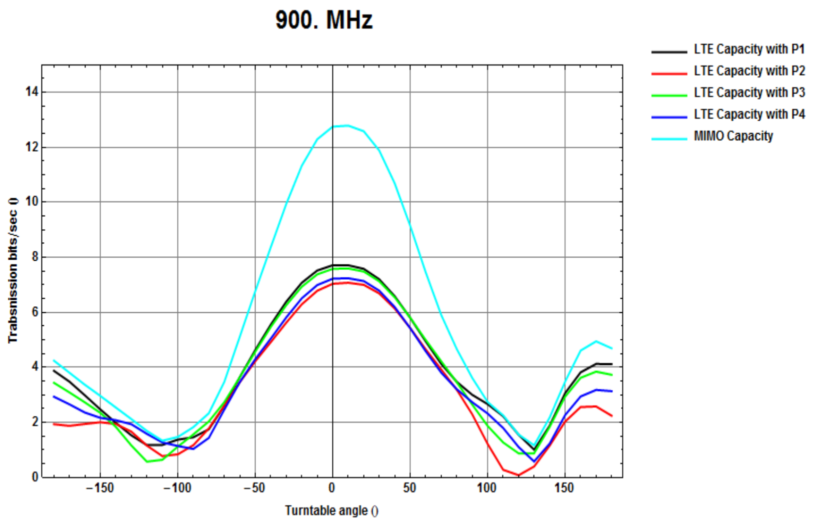
Characterization of MIMO antenna

A concept derived from the two stage method [1] according to the standard has been applied to characterize MIMO (Multiple Input Multiple Output) antennas. The first step of the two stage method consists of measuring the propagation channels between two MIMO antennas, taking into account the complex transmission properties of each channel (amplitude and phase). This first step is achieved in an anechoic chamber using a vector analyzer as well as an automatic rotating arm to determine the full antenna diagram for the MIMO antennas (schematic representation of the setup in the first picture).

In a second step, based on the complex transmission properties of each channel, simulations are performed in order to determine the maximum channel capacity according to Shannon theorem. However, the Shannon formula provides a theoretical channel capacity that is rarely encountered in real situations. Therefore, in addition the channel capacity has been determined taking into account the available transmission protocols like LTE. These simulations are represented in the second picture below for a pair of two Laird antennas at the frequency of 900 MHz. They show that the LTE transmission protocol behaves well, as compared to the theoretical Shannon limit outside of the main antenna beam. However, directly in the beam, it seems that the LTE transmission protocol provides less transmission capacity than the Shannon limit.

This two stage method will be tested experimentally using a real LTE transmission system in an anechoic chamber. In case of good agreement between simulations and experiments we would perform MIMO characterization of antennas by a fast measurement of the complex antenna diagram with simulations taking into account the transmission protocol.





References

[1] 3GPP. Measurements of radiated performance for MIMO and multi-antenna reception for HSPA and LTE terminals. 3GPP TR 37.976 version 11.0.0 Release 11. March 2012.

Contact & further information

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Important dates and events

Do's and Don'ts for mm-wave Antenna Characterization, 21 April 2015, Delft, The Netherlands

[Event details]

Keysight Insight Seminar Series in co-operation with TU Delft, NPL, LNE, University of Rennes 1, TU Eindhoven and NSI

With the continuous increase in the speed of low-cost technologies like RF CMOS and BiCMOS, complex mm-wave systems are becoming a reality.

Automotive radar, multi-gigabit connectivity are just some of the emerging application in the mm-wave bands, employing state-of-the-art planar and smart antenna systems.

To address the needs of such applications mm-wave characterization should cover all the aspects from material characterization, to antenna element measurements up to the verification of smart antenna systems.

In this seminar we will review the pitfall and solutions adopted in various mm-wave characterization laboratories throughout Europe, ranging from near-field, compact-range and far-field setups, addressing both the connectorized and the on-wafer world, with their unique features and problems.

This seminar presents several works carried out in the MORSE project. The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union.

Reports available in the Stakeholder area:

- IM-14-9519 IND51 Stakeholder
- IND51 MORSE D1.1.1 MIMO OTA review
- IND51 MORSE D1.2.1 Preliminary paper study to define concept for metrology in LTE systems
- IND51 MORSE D2.1.1 Antenna pattern measurement - Antenna Software Modelling Packages
- IND51 MORSE D2.1.2 Antenna pattern measurement - under sampling strategies
- IND51 MORSE D2.1.3 Antenna pattern measurement - NF to FF Strategies

New collaborators join MORSE:

- ETH Zurich, Switzerland is working with METAS on smart antenna measurements
- Quintel Technology Ltd, UK is working with NPL, testing out faster undersampling algorithms

www.metas.ch

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