Joint Research Project

Metrology for optical and RF communication systems

Newsletter May 2014

Introduction

We are pleased to welcome you to the first 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.

Communications is a technology of minimisation; you need only sufficient energy to transport data with an acceptable level of loss. On the other hand, for metrology you require more than "just sufficient" to determine the quality of the information. So – are these incompatible aims? Not really as the scenarios are different: Metrology supports design, manufacture and deployment but in operation, metrology would only discipline the monitoring systems.

The project started with a Kick-off meeting in July 2013 (see photo) and during the last nine months we have made good progress in each of the three main technical areas and these are represented here together with a profile of the key scientists involved. We now have an advisory board, currently comprising five members, in place to help shape the work (more details on the webpage [1]).

We have joined COST IC1004 which has active research on over the air testing and presented an overview at the 9th MC and Scientific Meeting in Ferrara.

The website [1] and our Group on Linked-In [2] are points of access to published material and registering as a stakeholder gives access to additional material. We welcome collaborators from industry and academia to work alongside us and gain a mutual benefit. WiCO (Shanghai) joined the consortium as a collaborator last December. We treat confidentiality seriously and collaborator data can only be accessed by the team members working in that area – with an appropriate non-disclosure agreement in place.

References

[1] http://www.emrp-ind51-morse.org

[2] http://www.linkedin.com/groups/IND51-MORSE-7424784/about

Contact & further information

David Humphreys, NPL, david.humphreys@npl.co.uk

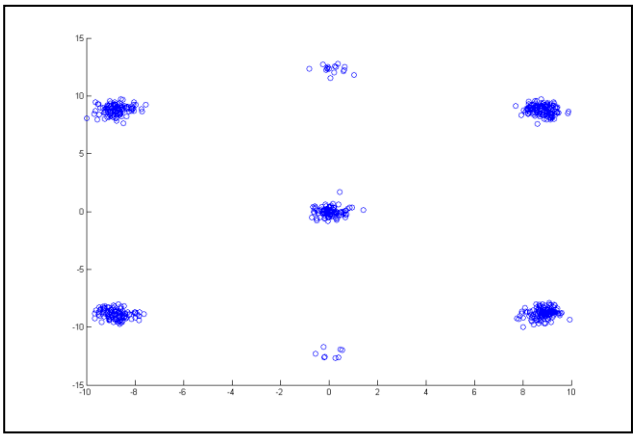
Dr David Humphreys is the project coordinator and participated in the Euramet IND16 "Ultrafast" project. He is a Science Leader in the "Electromagnetic Technologies" Group at NPL and has published over 100 papers. He was awarded the 1987 IEE Ambrose Fleming Premium.

LTE power measurements

Traceability of LTE power measurements is important for measuring the exposure in terms of electromagnetic radiation. It is a key issue in the protection against non-ionizing radiation. It is also important for measuring Signal to Noise Ratio (SNR), commonly used to measure the quality of a transmission channel. Moreover, LTE is a good example of MIMO technologies. It uses OFDM modulation.

In order to achieve proper power measurements of LTE signals, it is important to quantify the LTE reference signals, and therefore to fully demodulate the LTE signal in order to quantify each resource element. First demodulations tests have been performed. For this purpose, LTE signal has been produced by a commercial LTE signal generator. The signal has been isolated into its I and Q components. The synchronization has to be found e.g. using the Zadoff-Chu sequence of synchronization symbols, and fine corrections are further applied in order to correct phase-error. The first results are shown in the picture where all resource elements vectors of a symbol have been represented on the picture.

The constellation is clearly available. Further work is needed in order first to evaluate the uncertainty propagation of our algorithm, and to test the robustness of this algorithm against effects like noise, fading and Doppler effects.



Finally, commercial equipment available on the market should be calibrated with this method and tests of real tests exposure measurements of LTE base stations will be performed with this method. This will provide insight to the knowledge of RF exposure as most probes are calibrated using CW signals and the comparison of calculated peak power against RMS power measurement for various modulation schemes will help define the maximum level of exposure for a given level of RMS power measurement.

References

[1] Pythoud, F., Mühlemann, B. "Technical Report: Measurement Method for LTE Base Stations", METAS-Report Nr. 2012-218-808, 3rd May 2012.

[2] Frédéric Pythoud, « CCEM.RF-K20: Comparison of electrical field strength measurements", Metrologia, 43, Tech. Suppl. 01006, 2006.

Contact & further information

Frédéric Pythoud, METAS, frederic.pythoud@metas.ch

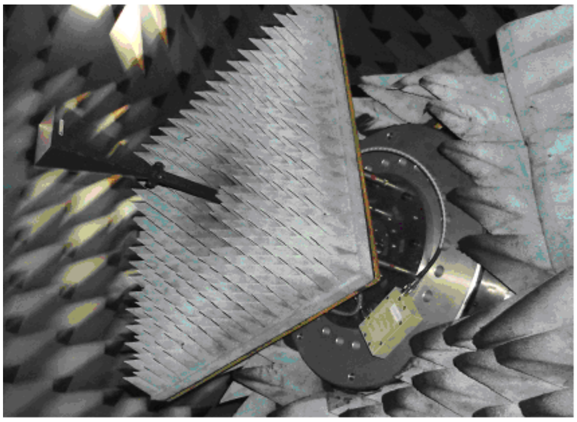
Dr Frederic Pythoud is leader of the "Terrestrial wireless communications" workpackage. He is head of the emc laboratory of METAS. He has a large and broad experience in the areas of physics, telecommunication, electromagnetic compatibility, and metrology.

Characterization of antennas

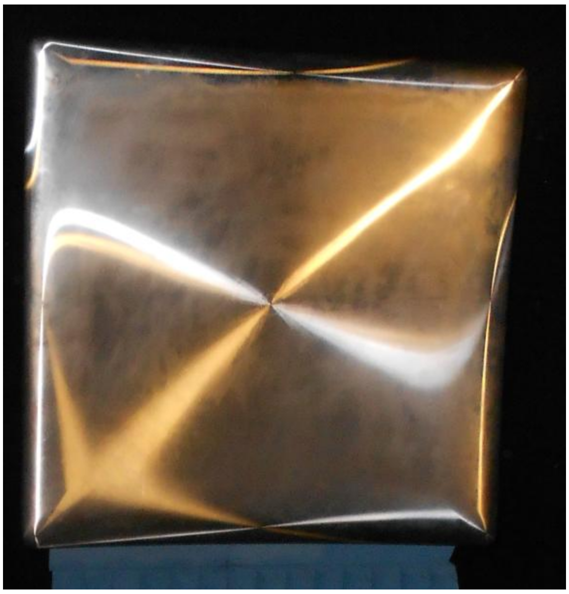
High frequency antennas operating in the millimeter wavelength range are becoming more and more complex and require accurate characterization to validate the design that typically results from a costly R&D process. One of the most used test ranges are the compact antenna test range, planar near-field facility and spherical near-field facility [1]. One of the drawbacks of these facilities is the time needed to setup the measurement, either because of the number of sampling needed in near-field facility or because of the need to perform multiple measurements to compensate the effect of field tapper in compact antenna test range.

By developing a set of post-processing algorithms for antenna measurement the measurement time will be reduced with a limited impact on accuracy. The development strategy for the spherical near-field facility is base on the mixing of simulated data set with experimental results. The measured data set will be reduced using a krieging technique. And example of test antenna can be seen on the first picture.

For the improvement of compact antenna test range techniques a method based on the modeling of antenna to reflector coupling based on plane wave spectrum decomposition is under development. The analysis of the reflector quiet zone field will be based on the measurement of the field using a high accuracy planar scanner and a field probe. The planar scanner has been manufactured and integrated, it will be tested on the compact range visible on the second picture.



The project also includes the development of a prototype Electro-optic field sensor operating in the millimeter wavelength domain to validate the feasibility of the use of such technology in near-field scanning, which could bring improvement by minimizing the scattering of the probe over the measured field. The crystal type has been selected and tests on an existing sensor show the feasibility of the measurement at frequencies up to 100 GHz [2].



References

[1] Nguyen N. T., Ettorre M., Delhote N., Baillargeat D., Le Coq L., Sauleau R., “Design and characterization of 60-GHz integrated lens antennas fabricated through ceramic stereolithography”, IEEE Transactions on Antennas and Propagation 58, 8 (2010) 2757-2762

[2] H. Füser and M. Bieler, "Terahertz Frequency Combs," J Infrared Milli Terahz Waves DOI: 10.1007/s10762-013-0038-8.

Contact & further information

Jean-Marie Lerat, LNE, jean-marie.lerat@lne.fr

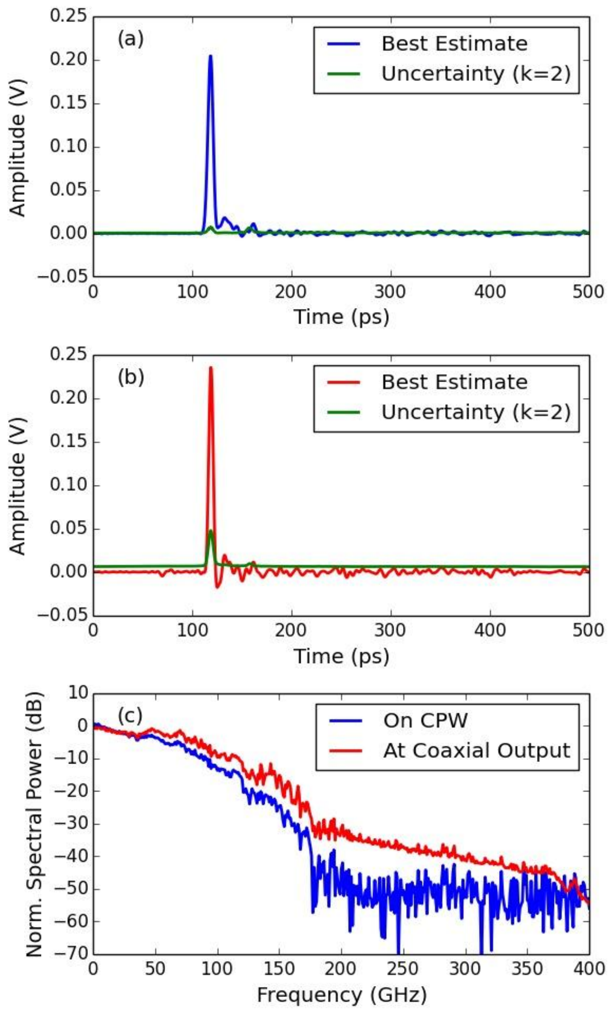
Dr Jean-Marie Lerat is leader of the “Characterization of antennas” workpackage. He is also involved in the IND16 “Ultrafast” project. He is the head of the RF metrology division at LNE and has a fair experience in the field of RF systems and microwave propagation

Characterization of ultrafast photodiodes

Ultrafast photodiodes are important and integral devices for optical communication systems. For proper functionality and the realization of high data rates in such systems it is essential to exactly characterize the photodiodes’ time and frequency responses. Within the MORSE research project corresponding techniques based on femtosecond lasers are currently being developed. So far, preliminary results on an ultrafast photodiode with a 1.85 mm coaxial connector (u2t, XPDV3320R) have been obtained.

In these measurements optical femtosecond pulses with a center wavelength of 1.6 µm have been used to excite the photodiode and the generated voltage pulses have been transferred with a microwave probe from the 1.85 mm coaxial connector to a coplanar waveguide that was fabricated on a GaAs substrate. A second laser pulse with the same center wavelength has been used to detect the ultra-short voltage pulses employing the electro-optic effect of the GaAs substrate [1].

Figure (a) shows the shape of the voltage pulses measured on the CPW. The traces have already been corrected for the transfer function of the electro-optic detection and the mismatch of the transmission lines [2]. After characterization of the microwave probe, the shape of the voltage pulses at the coaxial end of the photodiode has been obtained, see Figure (b). Figure (c) shows a comparison of the normalized spectral power of the voltage pulses plotted in (b) and (c).



References

[1] H. Füser, S. Eichstädt, K. Baaske, C. Elster, K. Kuhlmann, R. Judaschke, K. Pierz, and M. Bieler, "Optoelectronic time-domain characterization of a 100 GHz sampling oscilloscope," Measurement Science and Technology 23, 025201 (2012).

[2] M. Bieler and H. Füser, "Realization of an ultra-broadband voltage pulse standard utilizing time-domain optoelectronic techniques," Proc. SPIE 8624, 862417 (2013).

Contact & further information

Mark Bieler, PTB, mark.bieler@ptb.de

Dr Mark Bieler is leader of the "impact" workpackage and is active in several of the technical workpackages. He is Coordinator for the Euramet IND16 "Ultrafast" project, heads the "Femtosecond Measurement Techniques" Working Group at PTB, and has published over 100 journal and conference papers. He was awarded the 2005 German AHMT Messtechnikpreis.

Important dates and events

Workshop on Metrology for Digital Signals, 10 June 2014, Delft, The Netherlands

A workshop on the precise measurement of digital signals will take place at the Dutch Metrology Institute VSL. Please contact Faisal Mubarak (fmubarak@vsl.nl) for more details.

EMRP IND16 final meeting, 18-19 June 2014, Prague, Czech Republic

The final meeting of Euramet IND16 "Ultrafast" project will take place in Prague with open sessions about achievements in all technical workpackages. Please contact Mark Bieler (mark.bieler@ptb.de) or Martin Hudlicka (mhudlicka@cmi.cz) for more details.

CPEM, 24-29 August 2014, Rio de Janeiro, Brazil

The CPEM is devoted to topics related to electromagnetic measurements at the highest accuracy levels. These cover the frequency spectrum from dc through the optical region. IND51 JRP-Partners will be presenting work of the JRP at the conference including one Plenary Talk on using "The femtosecond laser as a microwave instrument".

ECOC Conference, 21-25 September 2014, Cannes, France

The ECOC is the largest conference on optical communication in Europe, and one of the most prestigious and long-standing events in this field worldwide. IND51 JRP-Partners will be presenting work of the JRP at the conference.

Imprint This work has been supported by the European Metrology Research Programme (EMRP) project "IND51 MORSE". The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union.

Editor Mark Bieler (mark.bieler@ptb.de)