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Report from SP Technical Research Institute of Sweden within the field of Electrical Metrology

Organisation

The SP Group consists of eight companies including the parent company SP Technical Research Institute of Sweden AB, www.sp.se . The Swedish state is via RISE Research Institutes of Sweden Holding AB the sole owner of the SP Group. SP operates from about 30 sites all over Sweden plus one in Norway and one in Denmark. Its headquarters and main facilities are in Borås. The SP Group has a staff of about 1400 and a turnover of 165 MEUR.

The board of directors of the SP group is: CEO Maria Khorsand, CTO Margaret Simonson McNamee, CBDO Johan Rune Nielsen and CFO Per-Gunnar Asbjörnsen. SP´s activities as a NMI is coordinated by the Department for Measurement Technology which also holds most of the staff working in the field of metrology or quality assured measurements, about 110 employees. In 2014 Jan Johansson replaced Håkan Nilsson as NMI program manager.

Technical news since last CCEM meeting in 2013

Subfield DC and Quantum metrology

In this field SP is participating in three EMRP project: AIM QuTE, Q-WAVE and GraphOhm.

In AIM QuTE a two terminal impedance bridge based on AC voltage synthesis using two SINIS Josephson arrays has been investigated. Preliminary results were presented at the CPEM 2014 [D1].

In Q-WAVE generation of waveforms using a programmable Josephson array and Delta-Sigma modulation is done. An improved totem pole filter with high input and low output impedance has been developed and characterised. The filter was presented at the CPEM 2014 [D2].

In GraphOhm we have manufactured QHR samples of graphene in cooperation with Chalmers University of Technology and distributed to partners [D3]. We have recently made our first realisation of resistance based on graphene. The result is in good agreement with our realisation using GaAs samples.

A method for scaling of dc-voltage developed by MSL, NZ has been implemented and further improved in cooperation with MSL, the working range has been extended down to 1 mV. The method is now used in an automatic calibration system for dc-voltage in the range 1 mV to 1 kV starting from our maintained 10 V level. The results of the calibration system in the mV-range are in good agreement with our realization based on a binary Josephson array [D4].

References:

[D1] G. Eklund, T. Bergsten, V. Tarasso and K.-E. Rydler, ” Progress towards an Impedance Bridge using two Programmable Josephson Voltage Standards”. Dig. Conf. Prec. Electrom. Meas., CPEM 2014, Rio de Janeiro, Brasilien, pp. 224-225, Aug 2014.

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Subfield Power and Energy

Power and energy

Based on the developments of an high frequency power standard we now have CMC for power measurement at frequencies up to 1 MHz adequate for calibration of common Power analysers.

Work is going on to further improve the accuracy of power measurement at high frequency. An improved mathematical model of a coaxial short circuit has been made which can be used for modelling of thermal converters [P1].

References:

[P1] M. Högås, K.-E. Rydler, J. Stenarsson, and K. Yhland, “An Analytic Solution of the Magnetic Field and Inductance in the Main Region of a Coaxial Short Circuit.” Dig. Conf. Prec. Electrom. Meas., CPEM 2014, Rio de Janeiro, Brasilien, pp. 276-277, Aug 2014.

High voltage and current

A new high voltage laboratory was taken into full commission in the fall of 2013 and was inaugurated in September 2014 . It is designed for measurements up to 800 kV ac-voltage and 1 MV dc-voltage.

SP coordinated the ENG07 HVDC project to its fulfilment in Oct 2013. SP applied for funding in two JRPs in the EMRP, Energy 2013 call, where ENG61-Future Grid was accepted and commenced in June 2014. The Future Grid project regards development of advanced current sensors, among others an optical current sensing system using the Faraday effect.

In the ENG07 HVDC project two 1000 kV dividers where designed and built [H1][H2]. One 1000 kV wideband HVDC reference divider and one 1000 kV reference divider for the lab of SP where calibrated and intercompared in a final test at Aalto University in Espoo [H3][H4]. Both dividers reached an unprecedented accuracy, which surpassed the project measurement uncertainty target by a factor of 2 – 5, giving a conservative CMC-entry of 50 µV/V expanded measurement uncertainty.

The modular divider has been used for several traceable calibrations of HVDC measuring systems up to 1 MV in customers' laboratories and shown a very high stability and robustness. Recent on-site measurements confirms that the wide bandwidth also give a capability of measuring switching impulse to a full 1000 kV.

A successful development of traceable measurement of dielectric dissipation factor at Very Low Frequency, is now considered for a CMC-entry.

References:

[H1] J. Hällström, A. Bergman, S. Dedeoğlu, A P. Elg, E. Houtzager4, J.V. Klüss, T. Lehtonen1, W. Lucas, A. Merev, J. Meisner, E. P. Suomalainen and C. Weber "Design and performance of a wideband 1000 kV HVDC modular reference divider." ISH2013.

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[H5] A. Bergman, S. Bergman, C. Hoffmann, E. Paulus and A-P. Elg, "Traceable measurement of dielectric dissipation factor at Very Low Frequency", ISH2013

Subfield RF and MW

Guided waves

SP participates in one JRP in the EMRP program, SiB62 HF circuits. In the EMPIR program we participate in the project 14IND10 MET5G Metrology for 5G Communications which is now under negotiation [6],[7].

Since several years we are partners in the GHz Centre, which is a microwave research centre of excellence financed by VINNOVA and operated by Chalmers in collaboration with industry and SP. Within the GHz Centre at Chalmers we are working on S-parameter measurements on membrane circuits suitable for THz frequencies and measurements of broadband S-parameters. [1-5],[8]

Our measurements and report for the key comparison on Scattering Coefficients by Broad-Band Methods 100 MHz - 33 GHz - 3.5 mm connector (CCEM.RF-K5c.CL) were completed.

References:

[G1] T. Aik Yean, V. Drakinskiy, K. Yhland, J. Stenarson, T. Bryllert, and J. Stake, "Analytical Extraction of a Schottky Diode Model From Broadband S-Parameters," Microwave Theory and Techniques, IEEE Transactions on, vol. 61, no. 5, pp. 1870-1878, 2013

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EM fields

Since 2007 we are active in the Chase centre, which is an antenna centre of excellence financed by Vinnova and operated by Chalmers in collaboration with industry and research institutes. SP participates in two Chase centre projects: the chase V2X project which focuses on correlating measured or simulated antenna module properties with results from field measurements, and the User OTA project which focuses on data collection from basis stations on mobile terminal user statistics. Collected data can be used for evaluation of terminals, user statistics, wireless coverage, etc. The work at SP has resulted in a number of journal and conference papers.

Methods to correlate on-site emission measurements with either semi-anechoic or reverberation chamber emission measurements are investigated in the EMRP project JRP IND60 EMC. The level of the Q-value in the on-site test determines how the temporary test site should be treated.

SP has been developed a three unique versions of Multipath Propagation Simulators (MPS). The latest one is updated with multiband Doppler shift generators developed by SP. This work origins from the ETTE project and now continuing in Wireless Communication in Automotive Environment (WCAE) funded by FFI/Vinnova

A open area test site for antenna calibrations below 1 GHz is completed and verified as calibration test site according to EN55016-1-5(2004) with amendment A1(2012).

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