Justervesenet

Report on Electromagnetic Metrology Activities at JV, Norway Prepared for the 30th Meeting of the CCEM, 22-24 March 2017

Staff

Dr. Helge Malmbekk – ACI/ACV – Group leader – hma@justervesenet.no
Mr. Kåre Lind, working a few days a week after formal retirement - ACI/ACV - kli@justervesenet.no
Mr. Frank Sengebusch – DCV, DC-Josephson – fse@justervesenet.no
Mr. Tore Sørsdal – Resistance, QHR, CCC – tsr@justervesenet.no
Mr. Kristian Ellingsberg – Power and Energy – kbe@justervesenet.no
Mr. Bjørnar Karlsen – Started Phd-program in December 2014. bka@justervesenet.no

ACI/ACV

- The last years, we have extensively tested our self-designed high precision AC/DC current shunts, with excellent results. A production line has been established with a Norwegian company, which assemble the shunts for us. The AC-DC difference has been shown to be within ± 10 ppm up to 100 kHz for 30 mA - 20 A. Some of the shunts (30 mA – 3 A) have been calibrated up to 1 MHz, where the AC-DC difference has a maximum value of -60 ppm. Calibrating the current shunts at an extended frequency range, means that they can be used for calibrating the mV-range of e.g. a Fluke 5790A.

- We are currently part of the EMPIR QuADC project for further development of AC Josephson setups with voltages up to MHz frequencies. We have together with a university college in Horten, Norway, demonstrated flip chip bonding of photo diodes to a carrier developed in collaboration with NPL and PTB. A custom optical fibre connection has been proved to work mechanically in liquid He, for optically generating electrical current which can be delivered to the JAWS arrays. Work remains for optimizing the AC generated current pulses.

- Mr. Bjørnar Karlsen spent 5 months of his PhD-study during 2016/2017 at NPL, where he was working on measurements of the photo diodes related to the QuADC project. He has also been working on developing voltage dividers and buffer amplifiers.

- In April/May 2016, Dr. Helge Malmbekk conducted a 2 month research stay at NPL, as part of the EMPIR project ACQ-PRO, which is a research potential project on AC Josephson standards. The projects aim, is to spread the knowledge of, and research on, AC Josephson systems across the EURAMET-region. The work was concentrated on using a step-wise approximated sine wave, generated by the PJVS to calibrate a voltmeter, by using a DAC generated sine wave as a real time calibrated transfer standard.

- During the last year, we have been testing various designs for range resistors for the ACV scale in the 1 -1000 V range. The most successful prototypes have been made by soldering surface mount resistors on a Cu coated Aluminum Nitride substrate. A step up of the ACV scale with a recalculation of the uncertainties are under way.

DCI/DCV and resistance

- A Zener comparison with BIPM, was conducted in the first months of 2015 (BIPM.EM-K11) (There is currently a typo in the online abstract, so the results are only correct in the full report). An on-site DC-Josephson comparison with BIPM (BIPM.EM-K10) was conducted during the summer of 2016. During the measurements, there was significant difficulties related to the JV array being one of the first original arrays issued by PTB for which the Shapiro constant voltage steps do not cross the zero current axis at 10 V. The comparison was withdrawn from the database, as stable results were not obtained from the comparison. We are planning to upgrade the system with either a new DC chip, or by a programmable system.

- Our last run of our QHR setup was in 2012/2013, and after some years of problems with the setup and replacing parts of the electronics of the CCC, we are planning to run new measurements in the spring of 2017. Problems with an aging CCC has led to some difficulties, but substantial efforts have resulted in an in-house repair of the system.

- Installation of a new room temperature bridge has been tested and verified against our old bridge.

Power & Energy

- We have developed a continuous Sampling Watt Meter, which has been tested and verified for operation in some calibration services. Development of the system is still on-going and various operation modes are explored.

- We are currently involved in the TracePQM EMPIR project, where we are working on algorithms to be used in a sampling system of power and power quality measurements. The project is a joint effort in by developing and validating a modular metrology grade system for the measurement of power and PQ parameters using digital sampling techniques.

- As part of the upcoming ADVENT EMPIR project, we will develop an active current shunt for measuring on low power devices without disrupting the current flow in the system.

Publications

- Eivind Bardalen, Thai Anh Tuan Nguyen, Helge Malmbekk, Oliver Kieler, Muhammad Nadeem Akram and Per Øhlckers. (2016, September). Packaging of fiber-coupled optoelectronic module for cryogenic voltage standards. In Electronic System-Integration Technology Conference (ESTC), 2016 6th (pp. 1-4). IEEE.
- Eivind Bardalen, Thai Anh Tuan Nguyen, Helge Malmbekk, Oliver Kieler and Per Øhlckers. (2016, July). Packaging of fiber-coupled module for Josephson junction array voltage standards. In Precision Electromagnetic Measurements (CPEM 2016), 2016 Conference on (pp. 1-2). IEEE.
- Eivind Bardalen, Muhammad Nadeem Akram, Helge Malmbekk and Per Øhlckers. (2015). Review of Devices, Packaging, and Materials for Cryogenic Optoelectronics. Journal of Microelectronics and Electronic Packaging, 12(4), 189-204.
- Bjørnar Karlsen, Kåre Lind, Helge Malmbekk and Per Øhlckers. (2016, June). Simulation and development of high precision Voltage dividers and buffer for AC voltage metrology up to 1 MHz. In Ph. D. Research in Microelectronics and Electronics (PRIME), 2016 12th Conference on (pp. 1-4). IEEE.
- Bjørnar Karlsen, Kåre Lind, Helge Malmbekk and Per Øhlckers. (2016, July). Development of high precision voltage dividers and buffer for AC voltage metrology up to 1 MHz. In Precision Electromagnetic Measurements (CPEM 2016), 2016 Conference on (pp. 1-2). IEEE.