33rd Meeting of the CCEM, 8th – 9th March 2023

News from NPL (UK)

DC and Low Frequency

NPL has been using an epitaxial graphene QHR sample operating in a dry cryostat at 5 T, 4 K for several years now for routine resistance traceability. We have tested the ability to measure customer 100 Ω standards directly against the QHR in batches through automated 4-terminal switches. The same compact dry cryostat also houses a CCC, which has been in development. This now demonstrates comparable noise, stability and accuracy to the existing liquid helium CCC used for calibrations. We are preparing to put this into service for accredited measurements covering 1 Ω to 10 kΩ. This is part of a general move away from reliance on liquid helium for maintenance and dissemination of electrical standards.

NPL's programmable Josephson system (based on a 10 V NIST chip driven with custom NPL-designed electronics) has demonstrated DC operation in a continuous-cycle pumped helium-4 cryostat. Ongoing work aims to demonstrate AC voltage operation in this same cryostat. The conventional Josephson array used for routine DC Zener calibrations is still maintained in a liquid helium dewar, but it is anticipated that it will be replaced by a cryo-cooled system in the next few years.

During 2023, NPL will stop producing paper certificates for calibrations in DC/LF, and will only provide these on request from customers. The e-cert replacements are at present electronically signed pdf documents, but we hope to explore options for fully machine readable DCCs once standards for this are established.

NPL maintains an active research programme in single-electron current standards. In 2023, the focus of this programme is the development of multiplexed arrays of up to 64 electron pumps.

RF and Microwave

NPL has established D-band power measurement (110 GHz to 170 GHz) and E-band (10 kHz to 90 GHz) S-parameter measurement systems through participating in the EMPIR 18SIB09 TEMMT project. Different international comparisons have been performed with the established measurement systems and good agreement has been obtained. These measurement systems will help to characterise standards which are used by the automotive and telecommunications industries.

The use of paper calibration certificates is being phased out, as for the DC and low frequency area, and replaced with electronically signed PDFs. Options for machine readable DCCs will be explored in the future.

Magnetics

Recent work has produced significant advancements in our capability to characterise soft magnetic materials, such as electrical steels. Parameters such as AC loss are now performed at much higher frequencies, from 400 Hz to 2 kHz (ISO 17025), and up to 10 kHz (R&D) on Epstein samples of interest to electric motor designers. Systems have also been developed to characterise these materials, specifically CoFe used in the aerospace industry, over the temperature range -60 °C to 200 °C. In addition, the resistivity of such materials with thicknesses down to 0.1 mm can now be measured over the same temperature range.

Three axis magnetic sensors can now be characterised to determine their orthogonality, a key parameter for space applications. Within our ambient (Earth's) field cancellation system, a 3D rotation stage has been designed that allows 360° rotation in all orientations. The locus constraint methodology allows the determination of parameters such as gain, offset and orthogonality to be determined when only the applied magnetic field is known.