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Introductory notes for the Special Issue related to the TC4 session at IMEKO's XXIV World Congress 2024

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Dear Readers,

In 2024, the city of Hamburg, in Germany, became the global hub for measurement science as it hosted the XXIV IMEKO World Congress from the 26th to the 29th of August. Held at the modern Congress Center Hamburg (CCH), the event was organized by the Physikalisch-Technische Bundesanstalt (PTB), Germany's National Metrology Institute.

Under the theme *Think Metrology*, the congress brought together hundreds of leading researchers, industry experts, and scientists from across the globe to shape the future of measurement and instrumentation. The program encompassed the full spectrum of measurement science, covering the whole set of 25 IMEKO Technical Committees, including the TC4-Measurement of Electrical Quantities.

TC4 addresses the measurement of electrical and magnetic quantities and the processing of measurement data through both hardware and software. Modern electronics and informatics serve as versatile tools for instrumentation, making it possible to process acquired data and extract additional information about the process under observation. Digital post-processing also enables various error-reduction methods, including autocalibration and self-tests. The accuracy of electronic instruments is dependent on the conversion between the analogue and digital domains and is susceptible to interference from various error sources. Consequently, another primary goal of TC4 is to ensure that measurement standards are continuously updated to keep pace with progress in electronic instrumentation.

The number of presentations in the TC4 track was 18. From all these papers, the Board of the TC4 sessions selected the papers for an extension potentially publishable in an Acta IMEKO special issue. The Authors of the selected papers were invited to extend their papers and submit them for refereeing. By the end of the review process, three papers were accepted; they are in this Special Issue for you to enjoy.

In the following, a brief introduction to each paper is provided.

The study presented in [1] explores the use of semi-autonomous drones for measuring the radiation patterns of VHF and UHF antenna systems, traditionally assessed using helicopters. Radiation pattern measurements are essential, particularly when replacing antennas. Drones offer greater flexibility and capabilities, prompting a re-evaluation of existing methods. The research focuses on amplitude errors caused by wavefront curvature in finite-distance measurements. Using Altair FEKO, horizontal and vertical radiation patterns for various antenna configurations are computed and compared to ideal infinite-distance results. These simulations are further validated against real-world measurements taken with a commercial quadcopter and a specialized device.

In [2], Authors examine the reliability of Phasor Measurement Units (PMUs) in digitalised electrical substations, focusing on fault conditions and their effect on system response in 5G network environments. Simulations assess how 5G infrastructure - especially the number and placement of gNBs (base stations) - affects IEC61850 data transmission in terms of latency and packet loss. Two case studies highlight how specific fault characteristics influence PMU system performance. The findings emphasize the need for detailed fault scenario simulations to develop strategies that enhance real-time fault detection, improve communication reliability, and ensure the stability of PMU/PDC systems in practical power grid applications.

In [3], it is presented the new magnetic measurements laboratory at CEM that would address the absence of a national reference standard in Spain, ensuring traceability for magnetic field measurements. The lab can measure magnetic field intensity and flux density for both DC and AC signals up to 50 kHz, using

primary Helmholtz coil standards to generate reference fields. A Nuclear Magnetic Resonance (NMR) sensor provides traceability by linking DC magnetic field measurements to a frequency standard. Environmental magnetic fields are a major source of uncertainty in low and medium flux density measurements, so an active compensation system is used to enhance accuracy and minimize measurement errors.

We hope you will enjoy your reading.

Luca Callegaro, Ján Šaliga, Jakub Svatoš

Section Editors

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