



Introductory notes for the Acta IMEKO Special Issue on the 24th IMEKO Technical Committee 4 International Symposium and the 22nd International Workshop on Analogue-to-Digital Conversion and Digital-to-Analogue Conversion Modelling and Testing

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Dear Readers,

Measurement has always been a tool by which we can observe the world around us. This concept was once again confirmed during the 24th IMEKO Technical Committee 4 (TC4) International Symposium, which showed how topics related to the world of measurement range across many fields of knowledge.

The IMEKO TC4 International Symposium is one of the most important events in the fields concerned with the theoretical and practical aspects of the measurement of electrical quantities and related instrumentation. It involves institutions and academia in a discussion of the state of the art and issues that require a joint approach by engineers, academics and other experts of measurement, instrumentation, testing and metrology.

The 24th edition of the Symposium was originally planned to be held in Palermo, Italy; however, due to the COVID-19 emergency, the committee was forced to organise the event as a virtual conference. We do hope that, soon, there will be another chance to host you all in Palermo. The virtual Symposium was organised to make an online conference not so different from a live event. It was challenging to set up a web platform to enable live presentations, and we thank the organising team, who addressed this issue professionally. It was also challenging to pursue IMEKO TC4's standard mission of creating an international platform where experts from academia and industry can consider the measurement of electrical quantities,

emphasising both theoretical and practical aspects of research in the field.

As in the last editions, the 2020 Symposium covered a large number of engineering fields, from digitalisation to renewable energy and from acoustic and mechanical measurements to biomedical and chemical fields.

The large space devoted to quantum metrology was a novelty this year. Thanks to the help of many physicist colleagues, it was, in fact, possible to propose both a special session and a plenary talk on the subject. In this issue, quantum metrology is represented by Martina Marzano et al., who, in the paper 'Design and development of a coaxial cryogenic probe for precision measurements of the quantum Hall effect in the AC regime', describe and characterise a cryogenic probe able to perform very accurate measurements in the alternating current (AC) regime with impedance bridges. The characterisation results show that the probe can be usefully employed to reach the quantisation condition in Hall devices, performing sensitive direct current (DC) measurements.

Three papers in the issue concern metrological characterisation.

A first contribution, 'Metrological characterisation of current transformers calibration unit for accurate measurement' by Valentyn Isaiev et al., proposes an approach to simulate the errors generated by current transformers with the aim of characterising the performances of the AC comparators commonly used to calibrate the transformers. The results show

that the proposed approach can achieve several tenths of $\mu\text{A}/\text{A}$ when calibrating a commercial transformer calibration unit under ordinary laboratory conditions.

The paper by Stefano Sorti et al., 'Metrological characterisation of rotating-coil magnetometer systems' characterises a rotating-coil magnetometer for the measurement of integral magnetic-field harmonics in accelerator magnets. The authors focus their attention on modelling the mechanical components of the device to predict the transducer response in both static and dynamic conditions.

Sioma Baltianski, in the paper 'Bias-induced impedance effect of the current-carrying conductors', presents previously unstudied properties of current-carrying conductors utilising impedance spectroscopy. The methodology is based on the superposition of test signals and bias affecting the objects under study. The work shows that the studied objects have an additional low-frequency impedance that can be either capacitive, inductive or both, depending on the current density and the properties of the material.

As in the last editions, a high number of papers in the Symposium concerned sensors and actuators. A special session was dedicated to the topic, which, in this special issue, is represented by five papers.

A first contribution, by Giovanni Gugliandolo et al., 'On the design and characterisation of a microwave microstrip resonator for gas sensing applications', deals with relative humidity monitoring. The proposed solution is based on a one-port microwave gas transducer developed by coupling a microstrip resonator for electromagnetic wave propagation. The developed transducer can be applied to detect different target gases by selecting an appropriate sensing material tailored to the specific sensing application.

The paper by Federica Vurchio et al., 'Comparative evaluation of three image analysis methods for angular displacement measurement in a MEMS microgripper prototype: a preliminary study', compares measurements performed using different methods for the angular displacement of a comb drive in a microelectromechanical system (MEMS) gripper prototype for biomedical applications. The angular displacement was measured by means of two novel automatic procedures based on an image analysis method. The performances of the proposed procedures were compared with those of a semi-automatic method.

The contribution by Antonino Quattrocchi et al., 'PMMA-coated fiber Bragg grating sensor for measurement of Ethanol in liquid solution: manufacturing and metrological evaluation', explores the possibility of measuring the concentration of ethanol in aqueous solutions by using polymethyl methacrylate (PMMA) as a coating material for a single-mode fibre Bragg grating sensor. A prototype of this sensor was developed and compared to traditional sensors.

The paper by Lorenzo Ciani et al., 'Design optimisation of a wireless sensor node using a temperature-based test plan', deals with the design optimisation of a sensor node in a wireless mesh network under temperature stress. Since there is not a specific standard for this kind of system, a customised test plan was developed in this work.

Tommaso Addabbo et al., in the paper 'Solar energy harvesting for LoRaWAN-based pervasive environmental monitoring', propose the architecture of a self-powered low-power wide-area network sensor node for the pervasive measurement of particulate matter concentrations in urban areas. To validate the effectiveness of the proposed solution, various

field tests were carried out with the integrated environmental monitoring device.

Three contributions in the issue deal with biomedical measurement.

Imran Ahmed et al., in the paper 'IoMT-based biomedical measurement systems for healthcare monitoring: a review', present an extended overview of recent activities towards the development of Internet of Medical Things (IoMT)-based biomedical measurement systems for various healthcare applications. Several approaches that are used in the development of these systems are presented and discussed, and metrological aspects related to accuracy, reliability and calibration requirements are considered.

A second contribution, by Giorgia Fiori et al., 'A preliminary study on an image analysis based method for lowest detectable signal measurements in Pulsed Wave Doppler ultrasounds', proposes and validates a novel image-analysis-based method for the estimation of the lowest detectable signal in the spectrogram of blood flow velocity.

The paper by Marius-Vasile Ursachianu et al., 'Experimental study on SAR reduction from cell phones', deals with the measurement of the specific absorption rate (SAR) relative to the emissions generated by three different generations of mobile phone. The test results quantify the dependence of the measured values on the positioning of the antenna, the size of the device, the relative position to the human head and the presence of protective cases.

In the Palermo Symposium, the topic of renewable energy was highlighted, and it is represented here by three papers.

The first contribution, by Marco Balato et al., 'Buck-based DMPPT emulator: a helpful experimental demonstration unit', deals with the troublesome question of the efficiency reduction in mismatched photovoltaic systems. In particular, the paper describes the realisation and use of a buck-based distributed maximum power point tracking (DMPPT) emulator able to fully understand the advantages offered by the DMPPT approach in various operative conditions.

Alessio Carullo et al., in the paper 'An innovative correction method of wind speed for efficiency evaluation of wind turbines', propose an innovative statistical method to evaluate the average efficiency of wind turbines by correcting the wind speed at the entrance of the rotor assessed by a nacelle anemometer. The measured values, in fact, were systematically lower than the actual ones. The proposed statistical approach, unlike those already presented in the literature, does not need data measured from a meteorological station but is based only on the power curve declared by the turbine manufacturer.

The aim of the paper by Davide Aloisio et al., 'Comparison of machine learning techniques for SoC and SoH evaluation from impedance data of an aged lithium ion battery', is the determination of the state of charge (SoC) and the state of health (SoH) of batteries. The proposed approach, which was applied on an aged lithium-ion battery, was based on different machine learning techniques, and the performances of these were compared.

The topic of electromagnetic compatibility is treated by Andrea Mariscotti et al. Their contribution, 'Review of models and measurement methods for compliance of electromagnetic emissions of electric machines and drives', discusses the problem of electromagnetic compliance for electric machinery and power drives by introducing and reviewing the normative references for electromagnetic emissions, the available modelling approaches and their accuracy and the measurement methods. The influence

of the setup, environment and behaviour of various types of machines is also considered.

Energy monitoring is the subject of the paper by Barbara Cannas et al., 'NILM techniques applied to a real-time monitoring system of the electricity consumption'. The work presents a low-frequency non-intrusive load monitoring (NILM) system suitable for a typical domestic user. The system is able to disaggregate and keep track of a device's consumption by analysing low frequency aggregate data.

Andrea Mariscotti, in the paper 'Power quality metrics for DC grids with pulsed power loads', analyses the interaction between pulsed power loads and a DC grid and then focuses on metrics to quantitatively describe such interactions and on the impact on DC grid operation and power quality.

The contribution by Jakub Svatos et al., 'System for an acoustic detection, localisation and classification', presents a system able to detect, localise and classify gunshots. The system consists of sensor units that continuously monitor acoustic events and an advanced digital signal processing technique that analyses the acoustic data.

Lastly, among the papers of the 22nd IMEKO International Workshop on Analogue-to-Digital Conversion (ADC) and Digital-to-Analogue Conversion (DAC) Modelling and Testing, the paper by Tomasz Kowalski et al., 'Design, characterisation, and digital linearisation of an ADC analogue front-end for

gamma spectroscopy measurements', deals with the design, characterisation and performance assessment of an analogue front end for use in the Polish National Centre for Nuclear Research's gamma spectrometry system. In-field experiments involving actual spectrometry measurements validated the designed front end.

We would like to conclude these brief introductory notes by thanking, first, the authors for their interesting and high-quality papers and the reviewers for their indispensable and professional contribution.

Moreover, we would like to thank our past editor in chief, Dušan Agrež, who started the production of this special issue with us, our current editor in chief, Francesco Lamonaca, who has undertaken his new assignment with the same professionalism and competence as his predecessors, and the IMEKO TC4 chairperson, Alexandru Sălceanu, for his invaluable support and advice.

It was a great honour for us to act as guest editors, and we hope that the readers will find this issue of Acta IMEKO useful and inspiring.

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Guest Editors