# Guest Editorial AMPS 2021 Special Section

THE IEEE International Workshop on Applied Measurements for Power Systems (AMPS) is the main event promoted by TC-39 of the Instrumentation and Measurement Society.

The 2021 edition is the 11th in a series that began in 2010 and marks the return of the workshop after a gap year in 2020 due to the restrictions of the Covid-19 pandemic.

Unfortunately, the restrictions in 2021 too only allowed for a virtual workshop, which took place from September 29 to October 1, 2021. Despite the virtual format, the workshop was successful, with the usual and fruitful discussions involving all members of the measurements in power systems community.

Topics included conventional and nonconventional current and voltage sensors, phasor measurement units (PMUs), measurements systems and devices in smart grids, distributed measurement systems, measurements on electric power plants and machines, Information and Communications Technology (ICT) issues in power system measurements, new generation of revenue metering, measurement systems for diagnostic in power networks, and definition and measurement of power quality indices. The contributions were presented and discussed in ten oral sessions.

Technically extended versions of ten of the papers presented at AMPS 2021 have now been accepted for publication in the Special Section of the IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT (TIM), selected after a thorough peer-review process.

The works related to power quality measurements address a range of issues, from harmonic instability and resonance, to suprarmonic estimation. In particular, in [A1], Kaufhold *et al.* provide a measurement-based blackbox method to analyze the harmonic stability of single-phase power electronic devices for low power applications in low-voltage (LV) networks without the need to derive detailed models of the devices. Next to air coils emulating impedances, a simple voltage source that generates a sinusoidal voltage at power frequency is sufficient for the proposed method.

In [A2], Frigo and Braun present a new method for the identification and estimation of supraharmonic components. The method is based on Compressive Sensing theory, and a Taylor-Fourier Multifrequency model estimates the dynamic phasor of each suprarmonic component. Its performance is validated in plausible operating conditions, inspired by real-world acquisitions.

In [A3], Kannan *et al.* propose a noninvasive harmonic resonance detection technique for public LV networks, which relies only on the measurement of voltage and current at the LV busbar. The proposed technique is formulated in three stages, identifying the presence of harmonic resonance, the resonant harmonic order and bandwidth, and the resonant intensity.

A second set of AMPS papers in this Special Section address the digitalization of the power grid, in particular, ICT solutions for power quality analysis and PMUs as substation IEDs. Specifically, in [A4], Olivan *et al.* introduce a system capable of characterizing onsite digital instrument transformers from the analysis of the IEC 61850/IEC 61869-9 frames injected by the Stand-Alone Merging Unit (SAMU) in digital substations. Besides, the second objective of this work is to implement a suitable computation architecture to monitor distributed Power Quality nodes.

In [A5], Agustoni *et al.* present the design and development of a stand-alone PMU based on digital inputs. The prototype has been characterized in terms of estimation accuracy and enriched with a novel functionality that allows for monitoring the time quality of the sampled value (SV) data stream. In this way, the device truly becomes an Intelligent Electronic Device (IED) that guarantees higher interoperability as well as a more robust management of sporadic synchronization issues. This work takes us seamlessly to the group of papers on phasor measurement units (PMUs) and application of synchrophasor measurements.

In [A6], Bashian *et al.* propose a multistep technique to maximize accuracy in P-class PMUs based on the combination of Multiple Signal Classification (MUSIC), narrowband disturbance whitening and Taylor–Kalman Filtering.

Still on PMU algorithms, in [A7], Frigo *et al.* present an enhanced version of Taylor–Fourier Multifrequency approach for PMU-based measurements. The method is based on the joint application of window functions and iterative support refinement by means of the phasor first-order derivative. The performance is characterized through extensive numerical simulation of non-standard test conditions that reproduce the challenges of real-world scenarios, with fundamental dynamics superimposed to interfering tones.

In [A8], Pegoraro *et al.* introduce an improved method to carry out the simultaneous estimation of line parameters, tap changer ratios, and systematic measurement errors for a three-phase power system equipped with PMUs. The proposed method is based on the suitable modeling of the measurement chain and on three-phase constraint equations (voltage drop and current balance) of all the components involved. Its effectiveness is confirmed by tests performed on a IEEE 14 bus test system reproduced as a three-phase system under different operative conditions.

With reference to device testing, in [A9], Mariscotti *et al.* discuss the issue of measuring conducted emissions of Switched Mode Power Supplies (SMPSs) for the 2–1000 kHz frequency range, by analyzing variability caused by setup elements and test conditions.

Digital Object Identifier 10.1109/TIM.2022.3200276

Eventually, in [A10], Xiang *et al.* focus on contactless dc current measurement with a method suitable for on-site measurement of high voltage direct current (HVDC) overhead lines. In this method, a vertical magnetic field sensor array is designed to measure the spatial magnetic field on the ground. On the basis of these measurements and the overhead-line specifications obtained from utilities, an algorithm can accurately calculate the current values.

The high number and quality of the published articles show that, despite all the challenges in performing experimental activities from February 2020, the IEEE community working on measurements in power systems is vital and always ready to tackle the measurement issues that continuously arise from the daily interactions with industries, utilities, and research institutions. We are sure that the Special Section of the IEEE TIM dedicated to AMPS will help disseminating the research results and stimulating this process.

## Acknowledgment

We sincerely thank all the colleagues involved in the review process, whose qualified support has been of fundamental importance to guarantee the high quality of the published articles. We also thank Prof. Ruqiang Yan, Editor-in-Chief of the IEEE Transactions on Instrumentation and Measurement, and R. Wehmeier, whose tireless work made possible the publication of this Special Section.

Ferdinanda Ponci, *Guest Editor*
Institute for Automation of Complex Power Systems
RWTH Aachen University
52062 Aachen, Germany
e-mail: fponci@eonerc.rwth-aachen.de

Roberto Tinarelli, *Guest Editor*
Department of Electrical, Electronic and Information Engineering "G. Marconi"
University of Bologna
40126 Bologna, Italy

## Appendix: Related Articles

[A1] E. Kaufhold, C. A. Duque, J. Meyer, and P. Schegner, "Measurement-based black-box harmonic stability assessment of single-phase power electronic devices based on air coils," *IEEE Trans. Instrum. Meas.*, vol. 71, 2022, Art no. 9002509.
[A2] G. Frigo and J. Braun, "Supraharmonic dynamic phasors: Estimation of time-varying emissions," *IEEE Trans. Instrum. Meas.*, vol. 71, 2022, Art no. 1501611.
[A3] S. Kannan, J. Meyer, J. Rens, and P. Schegner, "A novel extended noninvasive harmonic resonance detection technique for public low-voltage networks," *IEEE Trans. Instrum. Meas.*, vol. 71, 2022, Art no. 9002711.
[A4] M. A. Oliván, J. Bruna, R. Matute, A. Mareca, and D. Cervero, "A computer-based IEC 61850 sampled values analyzer for parallel power quality analysis," *IEEE Trans. Instrum. Meas.*, vol. 71, 2022, Art no. 9003908.
[A5] M. Agustoni, P. Castello, and G. Frigo, "Phasor measurement unit with digital inputs: Synchronization and interoperability issues," *IEEE Trans. Instrum. Meas.*, vol. 71, 2022, Art no. 5501910.
[A6] A. Bashian, D. Macii, D. Fontanelli, and D. Petri, "A tuned whitening-based Taylor–Kalman filter for P Class phasor measurement units," *IEEE Trans. Instrum. Meas.*, vol. 71, 2022, Art. no. 9002913.
[A7] G. Frigo, P. A. Pegoraro, and S. Toscani, "Enhanced support recovery for PMU measurements based on Taylor–Fourier compressive sensing approach," *IEEE Trans. Instrum. Meas.*, vol. 71, 2022, Art. no. 9004211.
[A8] P. A. Pegoraro, C. Sitzia, A. V. Solinas, and S. Sulis, "PMU-based estimation of systematic measurement errors, line parameters, and tap changer ratios in three-phase power systems," *IEEE Trans. Instrum. Meas.*, vol. 71, 2022, Art. no. 9003012.
[A9] A. Mariscotti, L. Sandrolini, and G. Pasini, "Variability caused by setup and operating conditions for conducted EMI of switched mode power supplies over the 2–1000 kHz interval," *IEEE Trans. Instrum. Meas.*, vol. 71, 2022, Art. no. 1501009.
[A10] Y. Xiang, R. X. Chen, and K. L. Chen, "Contactless HVDC overhead-line current monitoring by a magnetic sensor array with sensing parameter correction function," *IEEE Trans. Instrum. Meas.*, vol. 71, 2022, Art. no. 9004613.

**Ferdinanda Ponci** (Senior Member, IEEE) received the Ph.D. degree in electrical engineering from the Politecnico di Milano, Milan, Italy, in 2002.

She was with the Department of Electrical Engineering, University of South Carolina, Columbia, SC, USA, from 2003 to 2009, when she joined the Institute for Automation of Complex Power Systems, E.ON Research Center, RWTH Aachen University, Aachen, Germany, where she is currently a Professor for monitoring and distributed control for power systems. Her research interests include advanced measurement, monitoring, and automation of active distribution systems.

Prof. Ponci is a member of the Administration Committee of the IEEE Instrumentation and Measurement Society and the Liaison with IEEE Women in Engineering.

**Roberto Tinarelli** (Senior Member, IEEE) received the M.S. degree in electrical engineering from the University of Bologna, Bologna, Italy, in 2000, and the Ph.D. degree in electrical engineering from the Polytechnic of Milan, Milan, Italy, in 2004.

He is currently an Associate Professor of electrical measurements with the Guglielmo Marconi Department of Electrical, Electronic and Information Engineering, University of Bologna. He has authored or coauthored about 200 scientific papers. He is a co-inventor of some World Intellectual Property Organization patents in the field of sensors and instrument transformers. His current research interests include design and metrological characterization of instruments for measurement under nonsinusoidal conditions, design and characterization of new electromagnetic-fields sensors and instrumentation, and reliability study of electronic devices.