Guest Editorial

THE WORLD must solve important challenges to control and transform energy in an efficient way. Examples of this are in transportation, renewable energies, and industrial applications. These problems can be solved using power converters based on modern power semiconductor devices. An ideal converter has the following characteristics:

1) sinusoidal input and output currents;
2) operation with unity power factor;
3) regeneration capability;
4) compact design with a good power-to-weight ratio.

All these characteristics can be fulfilled by matrix converters, and this is the reason for the tremendous interest in this topology. In the last decade, many advances in the development of this topology have been presented, including industrial applications up to the megawatt level. The use of matrix converters in real applications and the challenges that these applications present are very timely and important. This special issue presents to the power electronics community the most recent advances with topics such as the following:

1) use of matrix converters for aerospace, transportation, renewable energy, and industrial applications;
2) new control/modulation methods for matrix converter applications, including space vector modulation (SVM), direct torque control, and predictive control;
3) implementation of intelligent current commutation strategies;
4) matrix-converter-derived topologies (indirect, sparse, very sparse, ultrasparse, cascade, multilevel, etc.).

It is our pleasure to present this "Special Section on Matrix Converters—Part I" of the IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, which reports the latest contributions in this field. Due to the high number of good papers submitted, this Special Section will be divided into two parts. The papers of this first part are grouped as follows.

I. New topologies.
II. Modulation and control methods.
III. Applications.

I. New Topologies

1) *Review of three-phase PWM ac–ac converter topologies*; J. W. Kolar, T. Friedli, J. Rodriguez, and P. W. Wheeler.
2) *Medium-voltage matrix converter design using cascaded single-phase power cell modules*; J. Kang, E. Yamamoto, M. Ikeda, and E. Watanabe.

II. Modulation and Control Methods

1) *Simple carrier-based PWM technique for a three-to-nine-phase direct ac–ac converter*; S. M. Ahmed, A. Iqbal, H. Abu-Rub, J. Rodriguez, C. A. Rojas, and M. Saleh.
2) *An efficient DSP-FPGA-based real-time implementation method of SVM algorithms for an indirect matrix converter*; M. Hamouda, H. F. Blanchette, K. Al-Haddad, and F. Fnaiech.

III. Applications

1) *Design and practical implementation of a novel variable-speed generation system*; M. Shi, B. Zhou, J. Wei, Z. Zhang, Y. Mao, and C. Han.
2) *New configuration of traction converter with medium-frequency transformer using matrix converters*; P. Drabek, Z. Peroutka, M. Pittermann, and M. Cedl.
3) *Common mode EMI model for a direct matrix converter*; J. Espina, J. Balcells, A. Arias, and C. Ortega.

We hope that this Special Section will increase the interest of the scientific community in this very dynamic area and will motivate the generation of new ideas for future research applications. The Guest Editors express their gratitude to the authors for sending their contributions and to the reviewers for their expertise and dedication to the review process. Finally, our special acknowledgment is dedicated to the Editor-in-Chief of the IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, Mo-Yuen Chow, and to the Journal Administrator, Sandra McLain, for their enthusiastic support.

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Johann W. Kolar (M'89–SM'04–F'10) received the M.Sc. and Ph.D. degrees (*summa cum laude/promotio sub auspiciis praesidentis rei publicae*) from Vienna University of Technology, Vienna, Austria.

He was appointed Professor and Head of the Power Electronic Systems Laboratory, Swiss Federal Institute of Technology (ETH) Zurich, Zurich, Switzerland, on February 1, 2001. He has proposed numerous novel pulsewidth-modulation converter topologies and modulation and control concepts, e.g., the Vienna rectifier, the Swiss rectifier, and the three-phase ac–ac sparse matrix converter. He has published over 400 scientific papers in international journals and conference proceedings and has filed more than 80 patents.

Patrick W. Wheeler (M'00) received the Ph.D. degree in electrical engineering from the University of Bristol, Bristol, U.K., in 1993, for his work on matrix converters.

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