Editorial: Special Issue on Wide Bandgap Power Devices and Their Applications, 2014

WIDE bandgap power devices have reached a level of maturity where the discussion no longer focuses on whether these are realistic future components or not. Instead, the focus of the discussion is on actual solutions to device problems and on how these devices should be implemented in various applications. In some cases, the new devices simply replace existing silicon-based power devices, but more often a redesign of the system is necessary in order to fully exploit the benefits of the new devices. In very special cases, entirely new applications are enabled by the characteristics of the new devices, for instance regarding high-temperature operation. In the case of silicon carbide (SiC), a wide spectrum of applications are under consideration with ratings from a few kilowatts up to high-voltage/high-power systems. As a matter of fact, low-power SiC converters are close to market introduction, while a less significant progress is observed as the power levels are increased. In the case of gallium nitride (GaN), highly compact power supply solutions, combined with revolutionary assembly ideas to achieve a next level of power density, are under discussion and in development as well.

This Special Issue aims to address a variety of issues ranging from device-related topics to problems associated with introduction of SiC and GaN power devices in specific applications. Modeling issues are always important when new technologies should be introduced, because modeling (with different degrees of detail) is necessary for efficient development of new concepts. Another important issue common to all wide bandgap power devices is the ability to handle high switching speeds. This includes circuit and module design, driver design, and problems with self-sustained oscillations and electromagnetic interference. In many applications high-temperature operation is the key to introduction of SiC power devices. Usually, packaging issues dominate the discussions in this context, but sometimes enabling components like capacitors or fans are the most challenging issues to deal with. Finally, the aim of this special issue is to provide an overview of the development status regarding different converter designs using wide bandgap power devices, and without going into details, it pleases us that this special issue proves that a tremendously rich development has taken place in this field during the last few years.

This Special Issue received 155 original submissions of which 48 were accepted for publication at the time of writing this editorial. Four of these papers were already published in the April issue.

The papers have been organized with respect to their topics and the final layout is as follows.

Survey and device related topics (four papers), reliability (two papers), modeling (five papers), packaging and modules (five papers), high-temperature aspects (four papers), gate and base drivers and aspects on switching speed (five papers), cascode circuits (four papers), dc–dc converters (six papers), resonant and soft-switching converters (three papers), matrix converters (three papers), grid-side and motor-drive applications (three papers).

The single most important group of persons contributing to this special issue is of course the authors. However, the many reviewers who dedicated so many hours of their valuable time to the scrutiny of all accepted and rejected papers deserve an appreciation with the same degree of dignity.

We would also like to express our deepest gratitude to the Associate Editors, for handling the reviews and seriously considering all the comments by the reviewers before giving recommendations regarding the acceptance or rejection of the manuscripts. Taking the right decisions is one of the most important issues in order to create a top-quality scientific journal like IEEE TRANSACTIONS ON POWER ELECTRONICS. The following Associate Editors have contributed to the establishment of this special issue:

1) M. Bakowski, Acreo, Sweden;
2) J. Biela, ETH Zurich, Switzerland;
3) T. P. Chow, Rensselaer Polytechnic Institute, USA;
4) J. A. Ferreira, Delft Univ. of Technology, Netherlands;
5) N. Kaminski, University of Bremen, Germany;
6) Lindemann, Otto von Guericke Universität, Germany;
7) J. Lutz, Chemnitz University of Technology, Germany;
8) Mantooth, University of Arkansas, USA;
9) P. Mattavelli, Università degli Studi di Padova, Italy;
10) P. Mawby, University of Warwick, U.K.;
11) S. Norrga, KTH Royal Institute of Tech., Sweden;
12) Omura, Kyushu Institute of Technology, Japan;
13) P. Ranstad, Alstom Power, Sweden;
14) K. Shenai, Argonne National Lab., USA;
15) L. Tolbert, University of Tennessee, USA;
16) F. Udrea, University of Cambridge, U.K.;
17) C-M Zetterling, KTH Royal Institute of Tech., Sweden.

Finally, we would like to thank the past Editor-in-Chief F. Blaabjerg for initiating this project, and B. Lehman, the current Editor-in-chief for handling all kinds of matters regarding the administration of the reviews and manuscripts. L. Sorensen deserves equal appreciation for her rapid and meticulous handling of all administrative matters.

HANS-PETER NEE, *Guest Editor*
JOHANN W. KOLAR, *Guest Editor*
PETER FRIEDRICHS, *Guest Editor*
JACEK RABKOWSKI, *Guest Editor*

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In 1999, he was appointed a Professor of power electronics at KTH, where he currently serves as the Head of the Electrical Energy Conversion Department. His current research interests include power electronic converters, semiconductor components, and control aspects of utility applications, such as flexible ac transmission systems, high-voltage dc transmission, and variable-speed drives.

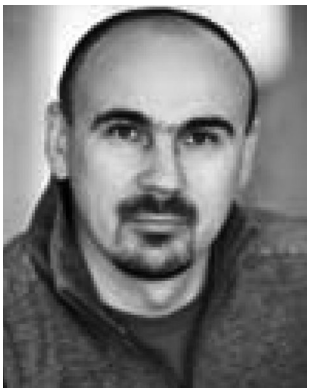
Dr. Nee received the Energy Prize by the Swedish State Power Board in 1991, the ICEM'94 (Paris) Verbal Prize in 1994, the Torsten Lindström Electric Power Scholarship in 1996, and the Elforsk Scholarship in 1997. He is a member of the European Power Electronics and Drives Association, involved with the Executive Council and the International Scientific Committee. He is also an Associate Editor of the IEEE TRANSACTIONS ON POWER ELECTRONICS and was on the Board of the IEEE Sweden Section for several years, serving as its Chairman during 2002–2003.

Johann W. Kolar (S'89–M'91–SM'04–F'10) is a Full Professor in Power Electronics at the Swiss Federal Institute of Technology (ETH) Zurich, Zurich, Switzerland and Chair of the ETH Power Electronic Systems Laboratory, Zurich. He has proposed numerous novel converter topologies and modulation/control concepts, e.g., the VIENNA Rectifier, the Swiss Rectifier, and the three-phase ac–ac sparse matrix converter. In this context, he has published more than 400 scientific papers and has filed more than 110 patents. The focus of his current research is on ac–ac and ac–dc converter topologies with low effects on the mains, solid-state transformers for smart microgrids, ultracompact and ultraefficient converter modules employing latest power semiconductor technology (SiC and GaN), power supply on chip systems, multiobjective optimization, and ultrahigh speed and bearingless motors. In the course of his research, he has supervised more than 60 Ph.D. students and Postdocs.

Dr. Kolar received 17 IEEE Transactions or Conference Prize Paper Awards. He initiated and/or is the Founder/Cofounder of four ETH spin-off companies. He is a Member of the Steering Committees of several leading international conferences in the field and has been serving as an Associate Editor of the IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS AND POWER ELECTRONICS.

Peter Friedrichs was born in 1968 in Aschersleben, Germany. He received the Dipl.-Ing. degree in microelectronics from the Technical University of Bratislava, Bratislava, Slovakia, in 1993. He started a Ph.D. work at the Fraunhofer Institut FhG-IIS-B, Erlangen, Germany.

In 1996, he joined the Corporate Research of the Siemens AG and was involved in the development of power switching devices on SiC, mainly power MOSFETs and vertical junction FETs. He joined SiCED GmbH & Co. KG, a company being a joint venture of Siemens and Infineon and originated from the former Siemens Research Group, on March 1, 2000. From 2004 to 2011, he was the Managing Director of SiCED, responsible for all technical issues. After the integration of SiCED's activities into Infineon, he joined Infineon as a Senior Director Silicon Carbide on April 1, 2011. He holds more than ten patents in the field of SiC power devices and technology and is an Author or Coauthor of more than 50 scientific publications and conference contributions in this field.



Jacek Rabkowski (M'10) received the M.Sc. and Ph.D. degrees in electrical engineering from Warsaw University of Technology, Warsaw, Poland, in 2000 and 2005, respectively.

In 2005, he joined the Institute of Control and Industrial Electronics, Warsaw University of Technology, as an Assistant Professor. During 2010–2013, he was also with the Electrical Energy Conversion (E2C) Laboratory, KTH Royal Institute of Technology, Stockholm, Sweden. His research interests include novel topologies of power converters and pulse width modulation techniques, particularly drive units and converters with SiC devices.

Dr. Rabkowski serves as a Chairman of the Joint Industrial Electronics Society/Power Electronics Society Chapter in the frame of the IEEE Poland Section.