

Special Issue on Robust Design and Reliability of Power Electronics, IEEE Transactions on Power Electronics, May 2015

POWER electronics is entering more and more applications as the world is becoming more electrified. We see power electronics being a key technology for renewable energy generation and long-distance power transmission, as well for hundreds of other applications across a variety of industries. Aircraft, cars, ships, and other autonomous energy systems are also being equipped with more power electronics. To master these technologies, it has for many years been clear that a combination of the control, power, and electronics disciplines is essential, such as that proposed by William E. Newell in 1974 and illustrated in Fig. 1(a).

As many power electronics-based products become mass-produced and incorporated into critical locations, much more attention is being paid to the reliability and robustness of power electronics products. This drive is paralleled by a push for power electronics technology to become cheaper in combination with decreasing size, increasing efficiency, achieving higher power density, and being robust for very high loads. It is known that electronic equipment is stressed by many factors, including mission profile, temperature, humidity, vibration, cosmic rays, etc., which degrade components. Therefore, in order to meet the expected lifetime of a product (and keep the failure rate at an expected value), the next paradigm in power electronics should have a better design for reliability, wherein many new disciplines are taken into account. Fig. 1(b) illustrates this and includes analytical physics for physics of failure analysis and lifetime modeling; design and verification for taking a better simulation approach for design using lifetime models and data about the mission profile; and control and monitoring, which puts more intelligence into a product when it is operating.

Power electronics is a field that will continue to be challenging as new components enter the market (such as wide-bandgap devices), new materials are used for packaging, and better models and simulation tools are needed, in addition to cost-efficient test methods. Also, putting more intelligence into the product will require new communication as well as data-handling methods in order to keep costs low.

For this Special Issue on Robust Design and Reliability in Power Electronics, 127 manuscripts were received and 45 papers were finally selected for publication. This issue is organized into three sections: analytical physics (15 papers), design and verification (11 papers), and control and monitoring (19 papers). The topics addressed include the basic wear-out phenomenon in new power devices, robust design methods, and fault detection and fault handling of power converters, among others. It is the editors' hope that these papers will be a source of inspiration for new research, as this topic is only in an emerging state—especially in academia.

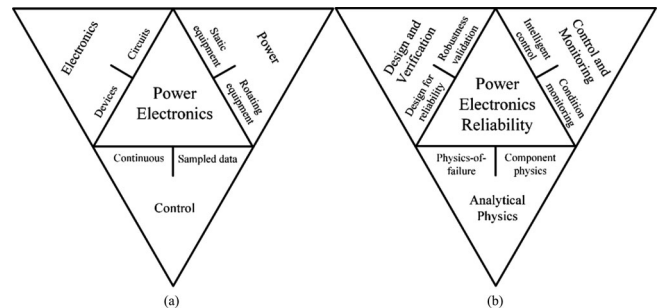


Fig. 1. Concepts in power electronics design: (a) disciplines proposed in 1974 by William E. Newell. (b) Disciplines for reliable and robust design of power electronics.

We want to thank the following Associate Editors for their support of the publication of this special issue:

Robert Balog, Texas A&M, USA

Maryam Saedifard, Georgia Tech, USA

Huai Wang, Aalborg University, Denmark

Stan Atcitty, Sandia National Laboratories, USA

Barry Mather, National Renewable Energy Laboratory, USA

Faisal Khan, University of Utah, USA

Alejandro Dominguez-Garcia, University of Illinois at Urbana-Champaign, USA

Peter P. D. Rimmen, Danfoss Power Electronics, Denmark

Suresh Perinpanayagam, Boeing Prognostic Center, Cranfield University, U.K.

Henry S. H. Chung, City University of Hong Kong, HK

Sarah Kurtz, NREL, USA

Thierry Lebey, Lycée d'enseignement général et technologique, France

Alfred Rufer, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland

Josef Lutz, Chemnitz University of Technology, Germany

Finally, we would like to thank the Editor-in-Chief, B. Lehman, for his support during the entire review process for this special issue (and for supporting the proposal), and L. Sorensen for her handling of all administrative matters. All papers submitted from Guest Editor-in-Chief universities were handled by an impartial Editor-in-Chief to avoid conflict of interest.

FREDE BLAABJERG, *Guest Editor in Chief*

Center of Reliable Power Electronics (CORPE),

Aalborg University, Denmark

MICHAEL M. PECHT, *Guest Editor in Chief*

Center for Advanced Life Cycle Engineering (CALCE),

University of Maryland, College Park, USA



Frede Blaabjerg (S'86–M'88–SM'97–F'03) received the Ph.D. degree from Aalborg University, Aalborg, Denmark.

From 1987 to 1988, he was with ABB-Scandia, Randers, Denmark. He became an Assistant Professor in 1992, an Associate Professor in 1996, and a Full Professor of power electronics and drives in 1998. His current research interests include power electronics and its applications such as in wind turbines, PV systems, reliability, harmonics, and adjustable speed drives.

Dr. Blaabjerg received the 15 IEEE Prize Paper Awards, the IEEE PELS Distinguished Service Award in 2009, the EPE-PEMC Council Award in 2010, the IEEE William E. Newell Power Electronics Award in 2014, and the Villum Kann Rasmussen Research Award in 2014. He was an Editor-in-Chief of the IEEE TRANSACTIONS ON POWER ELECTRONICS from 2006 to 2012. He has been a Distinguished Lecturer for the IEEE Power Electronics Society from 2005 to 2007 and for the IEEE Industry Applications Society from 2010 to 2011. He is nominated as being between the most 250 Highly Cited Researchers in Engineering by Thomson/Reuters.



Michael Pecht received the M.S. degree in electrical engineering, and the M.S. and Ph.D. degrees in engineering mechanics from the University of Wisconsin at Madison, Madison, WI, USA.

He is a world-renowned expert in strategic planning, supply chain management, design, test, IP, and risk assessment of electronic products and systems. He is the Founder and the Director of CALCE (Center for Advanced Life Cycle Engineering) at the University of Maryland, which is funded by more than 150 of the world's leading electronics companies at more than US\$6M/year. He has written more than 700 technical articles and has seven patents.

Dr. Pecht received the IEEE Exceptional Technical Achievement Award for his innovations in the area of prognostics and systems health management in 2010. He received the highest reliability honor, the IEEE Reliability Society's Lifetime Achievement Award in 2008. He is a Professional Engineer, an ASME Fellow, an SAE Fellow, and an IMAPS Fellow. He is the Editor-in-Chief of IEEE ACCESS, and served as the Chief-Editor of the IEEE TRANSACTIONS ON RELIABILITY for nine years, and the Chief Editor for *Microelectronics Reliability* for 16 years.