



President's Column

The Need for Power Electronics Engineers

At recent IEEE Board of Directors meetings in Canada, Andrew Grove of Intel was lauded as this year's IEEE Medal of Honor recipient (see IEEE Spectrum, June 2000). In his keynote speech, he reminisced about Intel's history, but then began to discuss the future. One key technology featured prominently in his future view: power (referring to power electronics). The needs for



efficient, precise energy conversion are growing so rapidly that Grove foresees a "renaissance for power engineers." I hope some of our Intel members will let him know that we in power

electronics are already well down the path of revolution, but the overall point is clear: the need for expertise in semiconductor energy conversion is exploding. Each week I receive several calls from recruiters or companies seeking engineers with expertise in power electronics. Each company I talk to has multiple positions to fill. Automotive companies report needs for several hundred such engineers each. If we take the largest 2000 companies in the world, and guess their needs over the next few years to average about 50 power electronics engineers, rough numbers suggest a shortage of 100,000 knowledgeable people. Is this overstated? It is hard to tell. Most firms seem to have so much trouble filling these positions that they have stopped looking, try to outsource, or even assign power conversion design work more or less at random to other engineers. The news is full of similar levels of needs in several other engineering and information technology fields, but largely silent about power electronics and other infrastructure areas. How can we as the Power Electronics Society help? In the next couple of months, I intend to propose an Industrial Programs committee, with its first assignment to try to quantify needs for power electronics engineers. They will also be asked to recommend specific actions we can take both to help communicate the needs to the broader IEEE and engineering audience and

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IEEE XPLORE

The new IEEE web interface for information, IEEE XPlore, is now online at <http://ieeexplore.ieee.org> and ready for member use. This web page will be expanding as the general front end for all IEEE publications, and replaces the previous Opera system. As a Power Electronics Society member, you have access through XPlore to current and past issues of our Transactions back to 1988 (we will try to add all issues back to Vol. 1 in 1986 later on). XPlore provides powerful search interfaces that support full abstract searching of all articles. You can download PELS Transactions articles at no extra charge. Of course, not everyone has convenient electronic access, so rest assured that we remain committed to our printed Transactions too.

INTELEC® 2000 Coming to Phoenix Offers In-depth Tutorials

The International Telecommunications Energy Conference (INTELEC) 2000 will be held September 10-14, 2000 in Phoenix, Arizona, USA. The conference offers over 120 technical papers, an exhibition of all the latest power equipment from the world's leading companies and full social program for accompanying guests. INTELEC is the only global forum that addresses the technologies and practices for powering communications networks and the only conference where industry leaders, technical experts and international colleagues convene to discuss the challenges of powering telecommunications for the convergence of voice and data.

PELS is the sole sponsor of INTELEC when it is held in North America in even-numbered years, and is a technical supporter when the conference is held outside North America.

Colleagues planning to attend INTELEC 2000 should consider arriving a little earlier to attend one or more of the optional, in-depth tutorials being offered on Sunday September 10, 2000, prior to the formal opening of INTELEC 2000 that evening. Regardless of your particular area of interest, there is a tutorial for you. These tutorials will be taught by leading experts in their fields.

One full-day tutorial is planned to address the Principles of VRLA Battery Tech-

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Society Awards

Presented at PESC® 2000 Newell Award to Luigi Malesani

Dr. Luigi Malesani (F) of the Power Electronics Laboratory at the University of Padova, Italy, received the William E. Newell Power Electronics Award at the Annual Awards Banquet on 23 June at the 2000 Power Electronics Specialists Conference in Galway, Ireland. The award has been presented annually since 1977 for outstanding achievement in power electronics.



Dr. Luigi Malesani graduated from the University of Padova, Italy in 1962. Soon thereafter, he became involved in research on electronics for control and diagnostics

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Book Review: *Introduction to Power Electronics*

Daniel W. Hart, author
Prentice-Hall Inc., 1997
ISBN 0-02-351182-6
TK7881.15.H37

Reviewed by Daniel M. Mitchell

The three traditional pillars of power electronics are power semiconductors, control and magnetics (although practicing engineers may tell you that they have as much trouble with capacitors as anything else). Since each of these pillars is a field of study unto itself, it is no wonder that many of the excellent books that purport to cover the field of power electronics tend to be quite complex and lengthy. Daniel Hart of Valparaiso University has undertaken the challenge of attempting to cover the field of

power electronics in a concise textbook that is designed for a one-semester introductory course. The textbook is particularly suitable for schools that may not have an extensive power electronics program nor a professor with power electronics expertise per se, but nevertheless feel the need to expose students to the basic principles. The emphasis of this book is on the functional description of the various forms of switch-mode power converters with relatively detailed analyses of the associated waveforms. PSpice simulations are integrated throughout the textbook as a form of virtual laboratory experiments to give the reader a feel for how the circuits work in practice and how susceptible they may be to variations in component values. The mathematical treatment is understandable to anyone with a background in ordinary calculus and linear system transfer functions. The book includes an extensive set of examples, references and problems. I was not able to find any information on the availability of a solution set for the problems.

The flow of the book is very logical starting with an introductory chapter that addresses the behavior, but not the physics, of power semiconductor switching devices. This is followed by a chapter entitled "Power Computations", which includes power factor of nonlinear loads, distortion factor and total harmonic distortion. Chapters 3 and 4 cover ac-dc conversion, including SCR phase control, for both single-phase and three-phase systems. Chapter 4 also includes an interesting section on dc transmission systems. Chapter 5 discusses both single-phase and three-phase ac-ac conversion. However, only SCR phase control is addressed. Variable frequency conversion using matrix converters or cyclo-converters is not included. Chapter 6 covers the three basic dc-dc converter topologies quite thoroughly for both continuous and discontinuous conduction modes. The Cuk converter is also discussed but the SEPIC topology is noticeably absent. The concept of circuit averaging is introduced, and equivalent transformer and averaged switch models are presented for the simple buck converter. Following a very brief treatment of magnetics, Chapter 7 presents the basic transformer coupled dc power supply topologies, such as the flyback, forward and push-pull circuits. This chapter ends with a simplified small signal analysis of the PWM-controlled buck converter, where

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INTELEC 2000

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nology and Applications to Standby Uses (subtitle: Everything you wanted to know about VRLAs but were afraid to ask!). You will learn everything about VRLA batteries, from the fundamentals of battery chemistry to the details of manufacturing processes to criteria and considerations for applying these batteries in the real world. It is the perfect tutorial for anyone who has, or is considering, VRLA batteries.

A second full-day tutorial on Understanding Telephone Power Systems is the answer for anyone who is new to telephony power or is planning to offer telephony services over another medium such as Cable TV or a data network and needs to achieve the reliability of telephony power in their infrastructure. The tutorial will discuss all of the elements of telephone power system, including rectifiers, ac distribution, batteries, dc distribution, controllers and monitoring systems, inverters, converters, ringers and ac generators.

The third full-day tutorial is entitled Fundamentals of Electronic Cooling. This tutorial will be of particular interest to electrical and mechanical engineers who require an understanding of heat transfer principles, optimization of fins and heat sinks, thermal resistance, heat pipe concepts, refrigeration and cryogenic cooling and thermoelectric cooling.

Three half-day tutorials are also planned, to address timely and important design topics and application topics. The Electromagnetic Interference tutorial will provide an in-depth description of Telcordia's GR-1089-CORE standard, including emissions and immunity criteria and test procedures which apply to new telecommunications equipment. The tutorial on Grounding Fundamentals will provide attendees with an understanding of how grounding can be applied to assure reliable equipment performance in environments that are often hostile to electronic systems. The Planar Power Magnetics tutorial is suitable for practicing design engineers. The course will address a wide range of topics, including general guidelines for core selection, modification and custom design procedures as well as new innovative applications.

For all the latest information on INTELEC 2000 or to register online, visit our website: <http://www.intelec.org>. Don't miss this stimulating conference in the exotic southwestern USA venue of Phoenix Arizona!

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News items should be sent to: Gene Wester, Editor, *PELS Newsletter*, Jet Propulsion Laboratory, M/S 303-300, 4800 Oak Grove Drive, Pasadena, CA 91109-8099, USA; TEL: +1 818 354-3489; FAX: +1 818 393-4272; email: gwester@jpl.nasa.gov. Deadlines for copy are March 15, June 15, September 15 and December 15. Submission of items by email in plain-text format is preferred. Plain-text (straight ASCII) submissions on 3.5" diskettes are welcome, and should be accompanied by a backup printout. Fax submissions are acceptable, but are least desirable. Full-page calls for papers and announcements of PELS-sponsored conferences are welcome and should be sent as both high-quality hard copy and RTF format file.

The editor gratefully acknowledges the Jet Propulsion Laboratory for significant support of his editorial activities.

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Society Awards

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of plasma experiments at the Center of Plasma Physics of CNR in Padova.

In 1965 he began teaching Electronic Components at the University of Padova. In that period he also carried out research and teaching activities on electrical machines and published several papers and a book. In 1975 he became full professor at the University of Padova, first of Electrical Engineering, later, in 1982, of Electronics.

In 1968 he began research in the field of power electronics and drives, and in 1972 he started the Power Electronics Laboratory of his University. The activities of this Laboratory remain under his direction today. The research was oriented from the beginning to a tight connection with industry. This resulted in a reciprocal enhancement of industrial innovation and scientific productivity. The industrial connection was also related to the educational activities. Many experimental theses were performed, with the aim of producing engineers with direct knowledge of industrial problems and well experienced in the techniques of power electronics. A number of young researchers were also developed, and their activities continue both within the Laboratory and independently.

The major contributions of Dr. Malesani to power electronics are in the fields of active filters, soft switching inverters and current control techniques. The research on active filters was started when interest in this subject was just beginning. Innovative contributions were made to the theoretical fundamentals of reactive power compensation and to the applications aspects of control and of energy storage. In the field of soft switching converters, Dr. Malesani developed improved solutions that provided true PWM operation for resonant and quasi-resonant DC link converters. In the field of current control of PWM inverters, his work resulted in the development of a number of high-performance, multi-phase control techniques, suitable for both voltage source and current source inverters. These techniques, particularly oriented to hysteresis methods, overcome the main limitations of basic methods and result in practical and effective solutions.

Contributions by Dr. Malesani in other fields of power electronics include high frequency operation of power semiconductors (in particular GTO's), resonant systems, high power conversion for high performance DC and AC power supplies, and control techniques and design of synchronous reluctance motors.

In addition to his work at the Power Electronics Laboratory, Dr. Malesani has undertaken extensive professional activities that contributed to the introduction and diffusion of Power Electronics in his region. In particular, he promoted and was involved in the foundation of two new industries. Dr. Malesani has published more than 80 technical papers and has been granted 12 patents. He wrote two books and was co-editor of a special section on PWM current regulation of IEEE *Transactions on Industrial Electronics*. He is a Fellow of IEEE and chaired the IAS, IES and PELS Joint Chapter of North Italy. He is also a member of AEI and EPE, and was member of the executive council of EPE.

Richard Hoft Honored for Distinguished Service

Professor Richard G. Hoft (LF) received the Power Electronics Society Distinguished Service Award at the Annual Awards Banquet on 23 June at the 2000 Power Electronics Specialists Conference in Galway, Ireland. The award has been presented annually since 1997 to honor long and distinguished service to the welfare of the Power Electronics Society at an exceptional level of dedication and achievement.

Professor Richard G. Hoft was born in Wall Lake, Iowa on December 4, 1926. He grew up on a farm, attending a one-room country school for the first eight grades. He graduated from high school in 1944, number two in a class of about forty. He enlisted in the Navy V12 program and attended Depauw University in Greencastle, Indiana and then Purdue University, where he majored in electrical engineering.

In 1946 he was discharged from the Navy and he enrolled in electrical engineering at Iowa State University. In 1948, he received a BSEE degree from Iowa State and began working for General Electric in Schenectady, New York. From 1949 to 1956, he was a Development Engineer in the General Engineering Laboratory, where he worked with a number of famous General Electric engineers-including B. D. Bedford and Herbert F. Storm. During this time, he earned an MEE degree from Rensselaer Polytechnic Institute.

He later took a leave of absence from General Electric to return to Iowa State University to enter a Ph.D. program. He completed his studies in 1965 and then re-

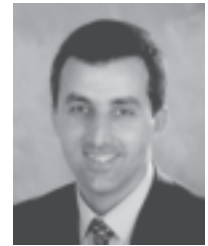
ceived an appointment as an Associate Professor of Electrical Engineering at the University of Missouri-Columbia. He remained there, attained the rank of Professor and retired at the end of December 1993.

Professor Hoft was the first recipient of the PELS William E. Newell Award in 1977. He was the second Editor of the IEEE *Transactions on Power Electronics*, serving in this position from the middle of 1990 until the end of 1999.

José A. Cobos Receives Richard M. Bass Award

Dr. José A. Cobos (M) received the Richard M. Bass Outstanding Young Power Electronics Engineer Award at the Annual Awards Banquet on 23 June at the 2000 Power Electronics Specialists Conference in Galway, Ireland. This award, renamed in 1999 in honor of Professor Bass, has been presented annually since 1997 to recognize outstanding achievement in the field of power electronics by an engineer less than 35 years of age.

Dr. José A. Cobos received his Electrical Engineering and Doctoral degrees from the Technical University of Madrid in Spain (Universidad Politécnica de Madrid, UPM) in 1989 and 1994. He is an Associate Professor at this university since 1996.



His contributions are mainly focused in the field of power supply systems for telecommunications, aerospace and medical applications. His research interests include architectures and topologies, low output voltage, magnetic components, power factor correction, converter modeling and control, piezoelectric transformers and transcutaneous energy transmission. Many of his contributions have been applied extensively in the industry. He has published over 75 technical papers, holds 3 patents, and has been actively involved in over 30 research and development projects.

Dr. Cobos cooperates regularly with IEEE and other professional associations, having a very active participation. He contributed in the organization of PESC'92 and EPE'95, and he is a regular reviewer of papers for technical journals, transactions and conferences. He has conducted many courses and professional seminars in Europe and America. He has served as thesis advisor for 20 master's theses and five doctoral dissertations. Recently, he received the

Continued on page 5

CALL FOR PAPERS32nd Annual**Power Electronics Specialists Conference**

June 17-22, 2001

Vancouver, Canada

Website: <http://www.conferences.ubc.ca/pesc2001>

This is the second time that this conference will be hosted at the University of British Columbia in Vancouver. In addition to providing papers and tutorials on the many topics related to power electronics, there will be a student competition and an industrial display area. Activities for partners will be organized and there will be numerous opportunities for delegates to meet in a relaxed setting. Subjects will include:

DC-DC Converters	Rectifiers and AC-AC Converters
Inverters and Inverter Control Techniques	Motor Drives
Automotive and Hybrid Electric Vehicles (HEV)	Power Quality and Utility Interface Issues
Power Semiconductor Devices	Passive Components
CAD Modeling	Integrated Diagnostics/Intelligent Systems
Integration, Packaging and Modules	Energy Storage
DSP Applications	Aerospace Power Applications
Alternative Energy Resources/Distributed Generation	

Call for Papers

The Call for Papers, conference registration and accommodation forms, will be available on the website by September 7, 2000. An email reminder will be sent to all those who submit their email address to the PESC 2001 Secretariat, either through the website or by emailing directly to PEESC2001@housing.ubc.ca.

Deadline for submission of abstracts and digests is October 15, 2000.

Student Competition: A new competition "The Wall Crawl" is being introduced to encourage the design of high-efficiency drive applications. Incentives include subsidized conference fees and prizes. Preliminary rules are posted on the website.

Industrial Displays: Space for approximately 80 exhibitor booths will be provided in an area shared with poster sessions and meals for delegates. The exhibition area will be open to non-delegates on Tuesday. Those interested in exhibiting are asked to contact the Secretariat or visit the website to be placed on a mailing list for further details.

For further information, visit the Conference Website or contact the Secretariat

PESC 2001 Secretariat

UBC Conference Centre, 5961 Student Union Boulevard

Vancouver, BC, Canada V6T 2C9

Telephone: 1 (604) 822-1050 Facsimile: 1 (604) 822-1069

Email: PEESC2001@housing.ubc.ca

Society Awards

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UPM Research and Development Award for professors less than 35 years of age.

Transactions Prize Paper Awards

Each year a selection committee comprising the Editor and the Associate Editors of the IEEE *Transactions on Power Electronics* selects three prize papers from those published in the transactions during the previous year. The following papers from the 1999 *Transactions on Power Electronics* were recognized at the Annual Awards Banquet on 23 June at the 2000 Power Electronics Specialists Conference in Galway, Ireland.

“Design of Microfabricated Inductors”

The authors are Luca Daniel (S) and Seth Sanders (M), both at the University of California, Berkeley, CA; and Charles Sullivan (M), then at the University of California, Berkeley, now at Dartmouth College, Hanover, NH.

“Simple Analytical and Graphical Methods for Carrier-Based PWM-VSI Drives”

The authors are Ahmet Hava (S), Yaskawa Electric America, Inc., Waukegan, IL; Russel J. Kerkman (F), Rockwell Automaton/Allen Bradley, Mequon, WI; and Thomas A. Lipo (F), University of Wisconsin, Madison, WI.

“Design of Smart Power Synchronous Rectifier”

The authors are Honglin Pan, Singapore Technologies, Singapore; and Yung C. Liang (M) and Ramesh Oruganti (M), both at the National University of Singapore, Singapore.

PELS Members Elected to IEEE Fellow Grade

The eleven members of PELS elected to IEEE Fellow Grade effective 1 January 2000 were listed with their citations in the April 2000 issue of the IEEE PELS Newsletter. Hirofumi Matsuo of Nagasaki University, Nagasaki City, Japan, elected to receive his Fellow Grade Certificate at the Annual Awards Banquet on 23 June at the 2000 Power Electronics Specialists Conference in Galway, Ireland.

IEEE Third Millennium Medals

As part of its celebration of the third Millennium, the IEEE has awarded 3000 IEEE Millennium Medals and Certificates to individuals nominated by IEEE Societies, Sections and Major Boards for outstanding contributions in their respective areas of activity. Twenty-four IEEE members nominated by PELS were recognized at the Annual Awards Banquet on 23 June at the 2000

Power Electronics Specialists Conference in Galway, Ireland.

The medal winners are: Fernando Aldana, William W. Burns III, Robert E. Corbett, Kevin J. Fellhoelter, Koosuke Harada, Richard G. Hoft, Philip L. Hower, Jerry L. Hudgins, Thomas M. Jahns, John G. Kassakian, Philip T. Krein, Fred C. Lee, Thomas A. Lipo, William McMurray, R. David Middlebrook, Harry A. Owen, Jr., William M. Portnoy, Robert L. Steigerwald, Joseph J. Suozzi, Pierre A. Thollot, J. Daan van Wyk, Robert V. White, Thomas G. Wilson, Sr., and Thomas G. Wilson, Jr.

PELS Best Chapter Award

A new PELS award, the Best Chapter Award, was established this year to recognize excellent service by a PELS Chapter to its members and to the power electronics

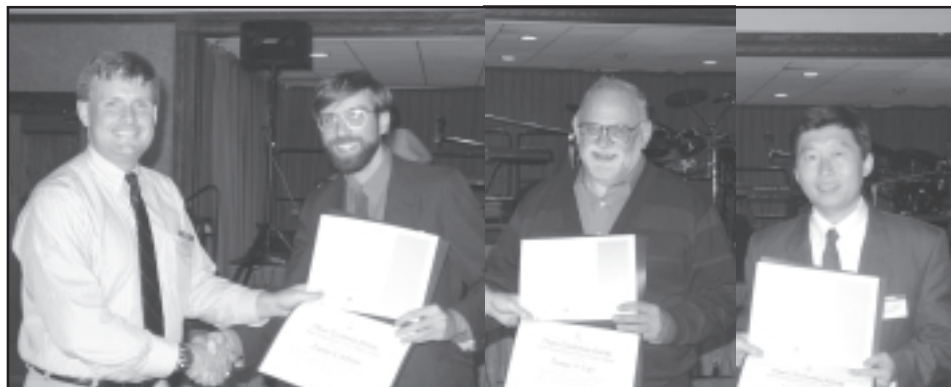
community. The award was given to the IEEE Morelos Section Power Electronics Chapter at Cuernavaca, Mexico for accomplishments of the 12 regular and 19 student members of this chapter during 1999. Chapter activities included a lecture program, planning for the IEEE International Power Electronics Conference – CIEP 2000 and the IEEE International Symposium on Industrial Electronics – ISIE 2000, and presentations by two Distinguished Lecturers.

The award was accepted by Hugo Calleja on behalf of the Chapter at the Annual Awards Banquet on 23 June at the 2000 Power Electronics Specialists Conference in Galway, Ireland.

Christopher O. Riddleberger
Awards Chair

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Awards Photos (from left): Top – Kelley presents three Best Paper awards to representative authors Charles Sullivan, Tom Lipo, and Yung Liang; Center –Third Millennium Medal winners Lipo, Kassakian, Fellhoelter, White, Steigerwald, Jahns, Harada, Owen, Hoft, Wilson Jr., Lee, van Wyk, and Wilson Sr.; Bottom – Riddleberger presents IEEE Fellow award to Hirofumi Matsuo with Fellhoelter looking on; Jahns presents Best Chapter award to Hugo Calleja representing Morelos Section Chapter.

ANNOUNCEMENT WPET 2000

The 6th Biennial

Workshop On Power Electronics in Transportation

42V Power Systems for the Next 100 Years

December 5 – 6, 2000

Hilton Novi

Novi, Michigan USA

NOTE NEW DATE AND LOCATION

WPET 2000 will address the 42 V systems that are being pursued from industry consortiums, standards organizations, individual suppliers and vehicle manufacturers. The need for a higher voltage system has gained prominence during the last decade and certainly will be implemented in vehicles during this decade.

This workshop will feature papers and panel sessions from industry experts. Workshop participants have the opportunity to network with other industry experts and contribute to the development of power electronics for future transportation systems.

For workshop registration and other information please contact the Conference coordinator: Susan Guinn, University of Michigan-Dearborn, Engineering Professional Development, 2200 Engineering Complex, 4901 Evergreen Road, Dearborn, MI 48128-1491; TEL: +1 313 593 4000, FAX: +1 313 593 4070, Email: sguinn@umich.edu

WPET is sponsored by the IEEE Power Electronics Society, IEEE Southeastern Michigan Section, in cooperation with the MIT/Industry Consortium on Advanced Automotive Electrical/Electronic Components and Systems, and the Society of Automotive Engineers

President's Column *from page 1*

to seek ways to generate interest among students. We will also be preparing tutorial papers, short video courses, and other educational materials for the benefits of mem-

PELS Nominates T. Jahns for Division II Director

The PELS Administrative Committee has nominated Thomas Jahns, PELS Past President, for the position of IEEE Division II Delegate/Director for 2001-2002. Dr. Jahns holds a Grainger Chair at the University of Wisconsin — Madison, and is widely known for his work in power electronics and adjustable-speed motor drives. Division II comprises PELS and three other Societies: Instrumentation and Measurement, Industry Applications, and Dielectrics and Insulation. There are two additional candidates — J. Keith Nelson and Stanley R. Booker — that have been nominated by these other Societies. More information about the Division II candidates can be found on the Web at <http://www.ieee.org/organizations/corporate/candidates.htm>. Please vote this fall in the annual IEEE election. Since only a small percentage of members typically participate, your vote will make a difference!

bers. These materials will be aimed both at those new to power electronics and to those with extensive experience. We are working to organize more technical committees to support specialized workshops and standards activities. One example is the upcoming Workshop on Power Electronics in Transportation. This meeting, to be held in Dearborn, Michigan, USA from October 19-20, will focus on emerging 42 V systems and standards for automotive power architecture. These efforts will be a helpful start, but are woefully inadequate to address a shortage of 100,000 engineers worldwide. I would be interested in your input. Is this shortage estimate accurate? Are companies encouraging students and new engineers to take an interest in power electronics? What should the Power Electronics Society and the IEEE as a whole be doing to help address the needs?

Student Competition

The student competition described in my April column is on track for the 2000-2001 academic year. In fact, the Society is discussing a follow-up in the form of an international competition for 2002. The dates reported in the April column have been extended. The specific dates and details can

be found at the competition web site, <http://energy.ece.uiuc.edu/energychallenge>. I am pleased to announce that the Industry Applications Society and the Industrial Electronics Society have joined us as sponsors of the 2001 Future Energy Challenge.

New Joint Publication

A series of cooperation meetings has been taking place between the Power Electronics Society, the Power Engineering Society, the Industry Applications Society, and the Industrial Electronics Society. Starting in 2001, we have agreed to establish a new product for members: electronic access to all six journals published by these four societies, at a substantial discount price. Look for information in your 2001 membership renewal package, which will arrive late this year. We have also set up cooperative programs for chapter development and support and are discussing various joint publications and technical activities. Electronic products are a major future trend for us. Look for other new electronic product initiatives during 2001 and into 2002.

Philip T. Krein
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Email: krein@ece.uiuc.edu

Tricks of the Trade

Using Logic for Dead Time and Synchronous-Rectifier Control[®]

Contributed by Phil Krein

University of Illinois at Urbana-Champaign

In many high-performance converters, precise synchronization is required among multiple switches. This requirement by itself is simple enough, but in addition we require a timing gap or *dead time* to make absolutely sure that there is no chance of two switching devices turning on simultaneously. In both inverters and synchronous rectifier dc-dc converters, the dead time is to be generated between two complementary switch control signals. There are many PWM chips that support dead time between *alternating* switch signals, as is needed for double-ended switching in push-pull forward conversion. This is not the same as the complementary case. More recently, a few vendors have started producing synchronous rectifier PWM controllers [1] with complementary signals and dead time. I have yet to see a nice, simple switch driver with built-in dead time protection. Most bench designers who work on inverters or full-bridge forward converters have their own tricks for dead time. In this article, a logic approach (which would be very easy to integrate) and a sensor approach are provided. The logic approach gives a direct way to generate complementary signals with dead time from a single switch command signal.

Consider the circuit in Fig. 1. The input is a pulse waveform, such as might be generated out of a closed-loop PWM control process. This pulse is inverted, then subjected to a short delay determined by the RC time constant. The result is the delayed waveform $Q'(t)$. In the circuit as drawn, the delay can be increased with parallel C or decreased with parallel R. When the delayed

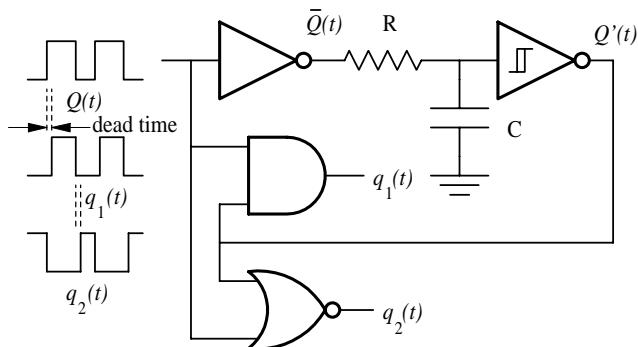


Figure 1. Delay logic for dead time in complementary switch signals

signal is AND'ed with the original signal, the result has delayed turnon. When the two are NORed, the result is a complementary switching waveform that also delays turnoff. The outputs are switching functions $q_1(t)$ and $q_2(t)$. In this circuit, a single symmetric turn-on and turn-off dead time is generated, but multiple gates and delays can be used for independent adjustment of turn-on and turn-off dead times. The circuit involves very few gates, so perhaps a gate drive manufacturer will consider producing such a circuit for direct application? This would be especially beneficial for small motor controllers, switching audio amplifiers, or other applications in which simplicity is important.

A sensor-based alternative for synchronous rectifiers is given in [2], and repeated in Fig. 2. This circuit uses logic based on local

terminal characteristics rather than based on timing. In this case, a *diode emulator* circuit is proposed. Because of the comparator, the MOSFET switches on and acts as a synchronous rectifier whenever its internal reverse diode becomes forward biased. The net action

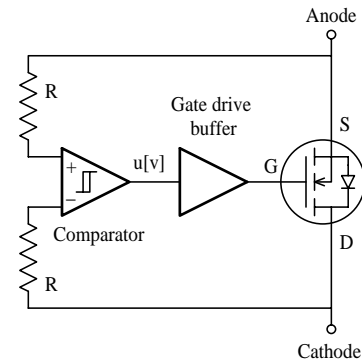


Figure 2. Comparator method for automatic synchronous rectification (from [2])

of the circuit is to emulate the terminal behavior of a conventional passive diode, so dead time becomes a less important issue. This circuit is limited more by the speed of the comparator than by the behavior of the MOSFET. The comparator offset trim can be used to set a definite positive breakover voltage that prevents simultaneous switch turn-on.

- [1] "UCC3882 data sheets," in *Unitrode Power Supply Control Products Data Book*. (Dallas: Texas Instruments, 2000).
- [2] P. T. Krein, R. M. Bass, "Autonomous control techniques for high-performance switches," *IEEE Trans. Industrial Electronics*, vol. 39, no. 3, pp. 215-222, 1992.

Editor's note: You are invited to send your own favorite Trick of the Trade for publication in the PELS Newsletter. Just send it in any convenient medium, spelling out symbols such as Greek letters. Also, send along a recent photo, color or b/w of any size, for insertion along with your favorite Trick.

Letters to the Editor

I just read the April "Tricks of the Trade" column contributed by Phil Krein - "Isolated Feedback with Optocouplers and Integration."

His points are well taken, but the design might work a little better if the feedback polarity is inverted. Assuming the optocoupler LED is powered from the isolated output voltage, [with the original polarity the initial] start-up condition would mandate zero LED current which would command zero duty cycle to the input side PWM controller, which of course, precludes startup.

Additionally, inverting the polarity (more LED current = reduced duty cycle) can lead to a feedback implementation as simple as the LED, a zener, and a resistor in series and connected across the output. This might sound a bit crude but it actually works surprisingly well at higher output voltages (>~12V).

Dave Bennefeld
Graco Inc.

#

The author's reply:

Good suggestion. A similar point was made by another reader [Ed Weber of *SC Electronics*], and I have suggested to the Newsletter Editor that he include this idea as a letter. I'm glad to hear that some people are looking closely at the column!

Phil Krein
Univ. of Illinois at Urbana-Champaign



ANNOUNCING
An NSF Workshop Entitled
MULTIMEDIA DELIVERY OF MODERN
POWER ELECTRONICS CURRICULUM



November 11-13, 2000

Orlando, Florida

WORKSHOP FOCUS

The National Science Foundation is sponsoring a workshop to discuss educational issues related to teaching power electronics. The objective of this workshop is to assess current multimedia efforts and explore new means to develop multimedia-based instruction in the area of power electronics. The workshop will discuss various delivery technologies available and how to implement them into power electronics courses. Moreover, the workshop will focus on detailed course offerings, at both undergraduate and graduate levels, and will explore the current industry needs for power electronics engineers. The workshop will provide the opportunity to make use of the collective experiences of many experts in the field in regard to using the web technology in education.

The workshop will focus on the following Topics:

1. *Multimedia enhancement tools for power electronics*
2. *Web-based delivery environments.*
3. *Hardware and software laboratory support.*
4. *Innovative industry-university partnerships in power electronics education.*
5. *Multidisciplinary team projects in power electronics (addressed in the Future Energy Challenge Kickoff).*

Other related topics are welcome.

WORKSHOP PARTICIPATION

Workshop participation is open to people from academia and industry. The workshop registration fee of \$150 covers costs of meal events and includes copies of the presentations. Partial travel support to presenters will be available based on the level of contribution. If you are interested to attend or participate in the workshop, please request an application form and email or fax it to Dr. Batarseh at the address below.

FUTURE ENERGY CHALLENGE KICKOFF

The 2001 Future Energy Challenge competition is sponsored by the U.S. Departments of Energy and Defense, by the IEEE Power Electronics Society, Industry Applications Society, and Industrial Electronics Society, and by other sponsors. Schools participate on a proposal basis. See the web site <http://energy.ece.uiuc.edu/energychallenge> for more information. In collaboration with this NSF Workshop, there will be additional sessions for schools whose proposals have been accepted. Sessions will address the technology issues of the 2001 competition, reach consensus on rule requirements, and provide an open forum for participants. Potential faculty advisors are encouraged to register for and participate in the NSF Workshop. Arrangements will be made for student team leaders to attend the Kickoff following the proposal review process during Fall 2000.

Please send your registration form and fee to:

Prof. Issa Batarseh, School of Electrical Engineering and Computer Science, PO Box 162993, University of Central Florida, Orlando, FL 32816 Tel. (407) 823-0185, Fax. (407) 823-6334 batarseh@mail.ucf.edu

For individuals interested in presenting papers at the workshop, please submit a two-page summary by September 15th, 2000. Please make your submission to:

Prof. Malik Elbuluk, Department of Electrical and Computer Engineering, University of Akron, Akron, OH 44325-3904 Tel. (330) 972-6531, Fax. (330) 972-6487 melbuluk@uakron.edu

If an abstract is accepted, a maximum five-page summary will be due no later than October 15, 2000.

Sponsors: National Science Foundation; IEEE Power Electronics Society;
 Center for Power Electronics and Systems, Blacksburg, VA; and The University of Central Florida.

IEEE Press Books

IEEE Press publishes books—as distinct from periodicals and conference proceedings—to meet the professional and educational needs of IEEE members, potential members, and others in the fields of interest to IEEE. This includes texts, references, handbooks, and monographs. Their mission is to produce the best and most up-to-date materials in the field, whether these are works originated by the Press or published in cooperation with another entity. By emphasizing consistent quality, the Press strives to attract the leading authors in the profession.

According to a marketing study reported by Simba, IEEE ranks eighth in terms of 1998 publishing revenues among scientific and technical publishers. This ranking is based on all units of the IEEE; including Press, Standards, Publications and Journals, and Magazines and Transactions.

The IEEE Press Liaison acts in the

interest of the society of which he/she is a member, assisting in the development of books that the Society, in one form or another, has sponsored. IEEE Press Liaisons also attend the Annual Press Board meeting, providing information as to the societies activities relevant to the Press and, in turn, carry back information to the Society as to what is going on with IEEE Press.

The Liaison also acts on Press requests, assisting in the review of proposals submitted to the press and categorizing these proposals as to their acceptability for further development and publication.

A Society may also provide Technical Sponsorship and/or Marketing Support for a Press Book, and the Liaison will assist the Press in consummating a Press Book Participation Agreement, wherein the Society agrees to help in the development and marketing of a book. The Society is then rewarded with a percentage of Press sales, depending on level of sponsorship

and/or support.

The list of books shown in the table below was compiled by Robert Bedford, Assistant Acquisitions Editor, IEEE Press. A complete inventory can be found at the IEEE Online Store at <http://shop.ieee.org/store/>.

Although the table shows only list pricing, these texts are available to IEEE members at favorable discounts. The member discount is normally 15% for books published solely by IEEE Press, and 10% for co-published books. At conferences the discount for titles on display ranges from 10% for non-members to 25% for members.

William J. Hazen

PELS Liaison to IEEE Press

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Website: www.bhpr.com

Author	Title	Stock No.	Publication Date	List \$\$	Co-Publisher
Bartnikas/ Srivastava	<i>Power and Communication Cables: Theory and Applications</i>	PC5665	10/12/1999	\$129.95	none
Bollen	<i>Understanding Power Quality Problems: Voltage Sags and Interruptions</i>	PC5764	09/24/1999	\$99.95	none
Bose	<i>Power Electronics and Variable Frequency Drives: Technology and Applications</i>	PC4382	09/21/1996	\$99.95	none
Krein	<i>Elements of Power Electronics</i>	PC5845	11/09/1999	\$81.95	Oxford (OUP)
Lenk	<i>Practical Design of Power Supplies</i>	PC5715	07/16/1998	\$79.95	none
Mohan et al.	<i>Power Electronics, 2nd Edition Converters, Applications, and Design</i>	PC5640	10/18/1995	\$99.95	Wiley
Talukdar/Gellings	<i>Load Management</i>	PC2063	03/01/1987	\$29.95	none

COMPEL® Enjoys A Strong Program

The IEEE Computers in Power Electronics Workshop (COMPEL) was held from July 16 to 18 on the campus of Virginia Tech in Blacksburg, Virginia, USA. Over 75 attendees from 21 nations had a lively interactive program about simulation, computer-based device and circuit models, and digital control approaches. A panel session format throughout the meeting provided extra time for group discussion of the 52 papers in the technical program. Industry participation was strong, and many companies are making major commitments to simulation and design tools for power electronics. A demonstration session on the final day highlighted both advanced commercial simulation tools and new ideas from university teams.

This year COMPEL used an innovative “on the spot” print format. Papers to be presented were due in PDF format at noon the

day before the workshop began. Less than 24 hours later, as attendees registered they received bound, printed proceedings with page numbers! These printed copies are considered preliminary, and authors were encouraged to update papers based on the discussion. The final workshop proceedings will be available in September through IEEE after final updates are processed. An accompanying CD ROM that includes presentation materials in addition to papers will be available to members through the Power Electronics Society office. In the past, COMPEL has used a “final paper due on arrival” process, and has provided a complete printed proceedings towards the end of the workshop.

Candid photos of the workshop can be viewed at fip://laipc.ee.vt.edu/compel2000/photos.

Jason Lai

COMPEL 2000 Chair

Virginia Polytechnic Institute

TEL: 540-231-4741

Email: lajis@vt.edu

Professional Activities

An additional PACE activity not mentioned in the article “PACE Activities Now Within PELS” in the April '00 *PELS Newsletter* is to develop information exhibits for any IEEE conference. These could describe past or future activities in the Society that enhance the professional standing of the members (e.g., refresher courses, or liaison with the local engineering student body).

I would like to present a talk at PRODEVCON (the national PACE Conference) in September 2000 describing a Chapter activity that enhanced the standing of the engineering profession. Do any Chapters have such an activity, whether already in force, or planned? Can I help to set up such an activity?

Robert Bruce, PELS PACE Chair

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The APEC® Micromouse: an Inside View

APEC's secret weapon—revealed at last! Although the quality and quantity of seminars and technical sessions are continually improving, the “hook” in obtaining media attention at APEC is our annual Micromouse competition.

David Chandler of the *Boston Globe* had a story and photo of that year's contest which appeared in the Monday, March 2, 1992 issue.

On March 8, 1993, ABC TV reporter Lisa Lake, channel 10, San Diego, interviewed the “handlers” from the Cal. State Long Beach team and broadcast part of the contest on their 6:30 PM newscast.

The front page of the Business Section of the March 6, 1996, *San Jose Mercury News* included a large color photo of Harit Singh picking up his micromouse, *Zeetah II*, from the maze.

David Otten, staff member of MIT, is the unsung hero who organizes this annual event and deserves a lot of credit and praise. While most of us are attending seminars and technical sessions, David and his son are busy setting up the maze and preparing the ballroom for the contest. He is often joined

by John Kassakian and David Torrey who function as the moderator or timekeeper.

One of the many reasons to attend the annual APEC conference is to attend the free micromouse competition which has drawn very large audiences every year. You may be able to purchase the conference proceedings, but you can only see the micromouse contest on-site or in Asia.

The goal of the contest is to design and build a robot that can navigate from a corner of a 10 foot square maze to the center in the shortest time. Cash prizes are awarded to the mouse with the best score as well as the best student entry.

Several different designs have been entered in this annual international competition. These miniature electromechanical marvels, which contain sensors, batteries and EPROM technology, must find their way into the center of the maze and return to the starting line in the fastest time without human contact. General information on three of the many entries follows.

Kwa Gwang is a stepper motor design utilizing an AMD 188 ES processor. It is powered by 16 250mAh NiCd cells. Six infrared side-wall sensors guide the mouse. Special features of the mouse include non-

stop, high speed searching, and diagonal operation when tracing its path during the search.

Damian Zdenek Mousekinsen is another entry that is powered by four 350mAh NiCd cells. Two 3 volt, 1319 MicroMo DC motors are driven by analog PWM current controllers. The processor is an MC68HC912B32 with 32k of flash memory, 768 bytes of EEPROM, and 1k of RAM. Two infrared side-wall sensors are located on each side of the mouse with an additional sensor forward.

Zeetah IV is a 4-wheel-drive, 4-wheel-steering mouse. It has DC motors for drive and steering and is powered by 7 NiMH cells. Intelligence comes from a Motorola 68386 processor clocked at 22 MHz with 256 bytes of RAM and ROM. It uses 14 side-wall sensors.

Plan to see our next contest at the Disneyland Hotel on Monday, March 5, 2001. We just might invite another famous mouse named “Mickey.” For additional information on APEC or micromouse, simply visit our website at <http://www.apec-conf.org>

Larry Gilbert
Chair, APEC Publicity
LGPWR@aol.com

Book Review

from page 2

advantage is taken of the separation of the switching function from the filtering function. Although a very understandable graphical presentation of the open-loop gain function for this particular topology is provided, a more general analysis that would identify the right-half-plane zeroes of the boost topology, for example, is not included. Chapter 8 discusses dc-ac inversion, including a very thorough section on the analysis of sinusoidally distributed PWM waveforms for reduced harmonics. A variable frequency ac-ac converter, using a dc link, for variable speed induction motor control is briefly discussed. Chapter 9 treats the operation of a wide variety of resonant converters very nicely, including the ZCS and ZVS quasi-resonant converters, and the series, parallel and LCC resonant inverters. Chapter 10 includes drive and snubber circuits. Appendices are provided on Fourier analysis and state-space averaging, including linearization.

I selected this book for review because I thought it would be interesting to see what topics were covered in a relatively short book that still attempts to address the entire field of power electronics. Although the

integrated PSpice simulations are a valuable and critical element of the book, there are instances where a little more discussion of theory, particularly in the case of semiconductors and magnetics, and perhaps a little less discussion of PSpice files would have been beneficial. Also, intentionally absent from this book is an analysis of switch-mode regulators from a systems viewpoint, where parameters such as input/output impedance and the input voltage to output voltage transfer function would be important. In this regard, the concept of the switching regulator as a special case of a generalized nonlinear control system is lacking. Nevertheless, the book provides excellent functional descriptions of a wide variety of circuits, with detailed waveform analyses, and, as such, would be a valuable reference to the practicing engineer as well as serving to introduce the undergraduate student to the diverse field of power electronics.

This book is available for approximately \$100 from multiple on-line suppliers listed at <http://www.prenhall.com/cgi-bin/catalog/onlinemagnet.pl> Examination copies for instructors and professors are available upon request.

Daniel M. Mitchell, guest reviewer
Cedar Rapids, Iowa
dmmitch@home.com

Mr. Mitchell has authored several IEEE papers and wrote the book *DC-DC Switching Regulator Analysis*, McGraw-Hill, 1988. He was an Adjunct Instructor at the University of Iowa for 15 years and has twelve patents. Mr. Mitchell recently retired as head of the Advanced Subsystems and Signal Processing Department within the Advanced Technology Center of Rockwell Collins. He is currently doing business as DM Mitchell Consultants, specializing in power conversion design and analysis.

Editor's note: Believing there is value from personal referrals in selecting great books from among the good, we are launching a new series of technical book reviews in the PELS Newsletter. You are invited (“begged” is probably a better description) to contribute a book review to the series. Please send the editor a short prioritized list of outstanding technical books that you would be willing to review and share with your colleagues. See page 2 for address.

An engineer is someone who does well with one dollar what anyone else can do with ten!



CALL FOR PAPERS AND SEMINARS

SIXTEENTH ANNUAL

Applied Power Electronics Conference and Exhibition

☆ MARCH 4-8, 2001 • THE DISNEYLAND HOTEL • ANAHEIM, CALIFORNIA ☆

The Sixteenth Annual Applied Power Electronics Conference and Exposition (APEC 2001) will address the application of new components and circuits, design-oriented analysis techniques, and current trends in the design and manufacture of power electronic products and systems.

CONFERENCE HIGHLIGHTS

- Full technical program of presented papers.
- Professional Education Seminars on important topics for power electronics professionals including anyone involved in marketing, quality and manufacturing.
- Exposition featuring component, equipment and service leaders in the power electronics industry.

Participation is solicited in all areas of power electronics, including those listed below. Suggestions for other related topics are welcomed and encouraged.

- | | | |
|-----------------------------------|---|--------------------------------------|
| • DC-DC Converters | • Aerospace/Defense Systems | • EMI & EMC Issues |
| • AC-DC Converters | • ICs for Power Electronics | • Market Analysis & Strategies |
| • Inverters & Cycloconverters | • Design & Analysis of Magnetic Devices | • Product & Technology Roadmaps |
| • Soft Switching Techniques | • New Developments in Capacitors | • The Voice of the Customer |
| • Lamp Ballasts | • High Density Packaging | • Identifying New & Emerging Markets |
| • Adjustable Speed Drives | • Thermal Management | • Benchmarking Results |
| • Power Factor Correction | • Distributed Power Systems | • Quality Programs & Data |
| • Design for High Efficiency | • Uninterruptible Power Systems | • JIT & Material Management |
| • Modeling & Analysis | • Battery Systems | • Vendor Qualification |
| • High Frequency Design | • Electric Traction Systems | • Manufacturing Processes |
| • Control of Converters & Systems | • Automotive Applications | • Design for Manufacturability |
| • Simulation Tools & Techniques | • Protection of Converters & Systems | • Technology Transfer |
| • CAD/CAE Tools & Techniques | • Preventing & Controlling EMI | • Standardizing Specifications |
| • Power Semiconductors | | • Regulatory Requirements |

DEADLINE FOR SUBMISSION OF ABSTRACT AND DIGEST IS AUGUST 10, 2000

Notification that a paper was accepted or declined will be mailed no later than October 6, 2000

Manuscripts in final camera-ready form will be due at the publishers no later than December 8, 2000

Prospective authors are asked to submit a 50-word Abstract and a three-to-five page Digest of their planned presentation. Both the Abstract and Digest should be typed double-spaced on 8.5"x11" paper. The heading of the Abstract must include: Title of the presentation, Corresponding Author(s), Affiliation(s), Mailing address, and Daytime telephone, Fax number and email address. The heading of the Digest should include **the title only**. The Digest should clearly state: a) The purpose of the paper, b) The approach used, and c) The specific results. **Eight copies of all materials should be mailed to:**

APEC 2001

2000 L Street, N.W., Suite 710, Washington, DC 20036 • (202) 973-8664 • FAX: (202) 331-0111
 For more information on exhibiting at the Exposition, call: (202) 973-8664 or FAX: (202) 331-0111
 or E-mail apec@courtesyassoc.com • Website: www.apec-conf.org

APEC is sponsored by the IEEE Power Electronics and Industry Applications Societies and the Power Sources Manufacturers Association

Meetings of Interest to PELS Members

IECEC, 35th Intersociety Energy Conversion Engineering Conference, will be held July 24-28 in Las Vegas, NV. Sponsored by AIAA, ASME, IEEE, AIChE, ANS, and SAE, the 2000 theme is "Energy and Power in Transition." Visit <http://www.aiaa.org/calendar/iecec00cftp.html> for information.

INTELEC[®] 2000, the 22nd International Telecommunications Energy Conference, is set for September 10-14, 2000 in Phoenix, Arizona. Visit <http://www.intelec.org> for additional information.

IAS 2000, the 35th Annual Meeting of the IEEE Industry Applications Society, will be held in Rome, Italy, October 8-12, 2000. This world conference is organized by AEI and IEEE/IAS, and co-sponsored by IEE, IEEE/IAS, and IEEE/PELS, in cooperation with EPE. See <http://www.aei.it/ias2000.html> for details.

CIEP 2000, the 7th IEEE International Power Electronics Congress, will be held October 15-19, 2000 in Acapulco, Mexico. For additional information visit <http://www.cenidet.edu.mx/ciep2000/>.

WPET 2000, the 6th Workshop on Power Electronics in Transportation,

takes place December 5-6 at the Hilton Novi in Novi, Michigan. Note new date and location. For further information, see page 6 of this *Newsletter*.

A Workshop on Multimedia Delivery of Modern Power Electronics Curriculum is planned for November 11-13, 2000 in Orlando, Florida, USA. PELS is a co-sponsor. Presentation summaries are due September 15. See page 8 of this *Newsletter* for details.

POWERCON 2000 International Conference on Power System Technology, is set for December 4-7, 2000 in Perth, Western Australia. Organized by IEEE Power Engineering Society, Western Australia Chapter. See <http://www.ee.uwa.edu.au/~aips/powercon/> for further information.

ISIE 2000, the IEEE International Symposium on Industrial Electronics, will take place December 4-8, 2000 in Puebla, Mexico. Visit the website at <http://www.udlap.mx/~centia/isie2000/> for further information.

APEC[®] 2001, the 16th Annual IEEE Applied Power Electronics Conference, sponsored by the IEEE Power Electronics Society, the IEEE Industry Applications Society, and the Power

Sources Manufacturers Association, will be held at the Disneyland Hotel, Los Angeles, CA, USA, March 4-8, 2001. Digests are due August 10. See the call for papers on page 11 of this *Newsletter* for details.

E-TEM2 is scheduled March 14-16, 2001 in Liege, Belgium. Sponsored by the European Power Electronics Association, the conference theme is tomorrow's education in electrical engineering. The deadline for digests is May 15. See page 9 of this *Newsletter* for further information.

PESC[®] 2001, the 32nd Annual IEEE Power Electronics Specialists Conference, will be held June 17-22 at the University of British Columbia in Vancouver, Canada. PESC is sponsored exclusively by the IEEE Power Electronics Society. See the call for papers on page 4 of this *Newsletter* for details.

EPE 2001, the 9th European Power Electronics Conference, will be held at Grazer Congress Center in Graz, Austria on August 27-29, 2001. Abstracts are due September 18, 2000. For complete information, see <http://epe2001.unileoben.ac.at>.

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