



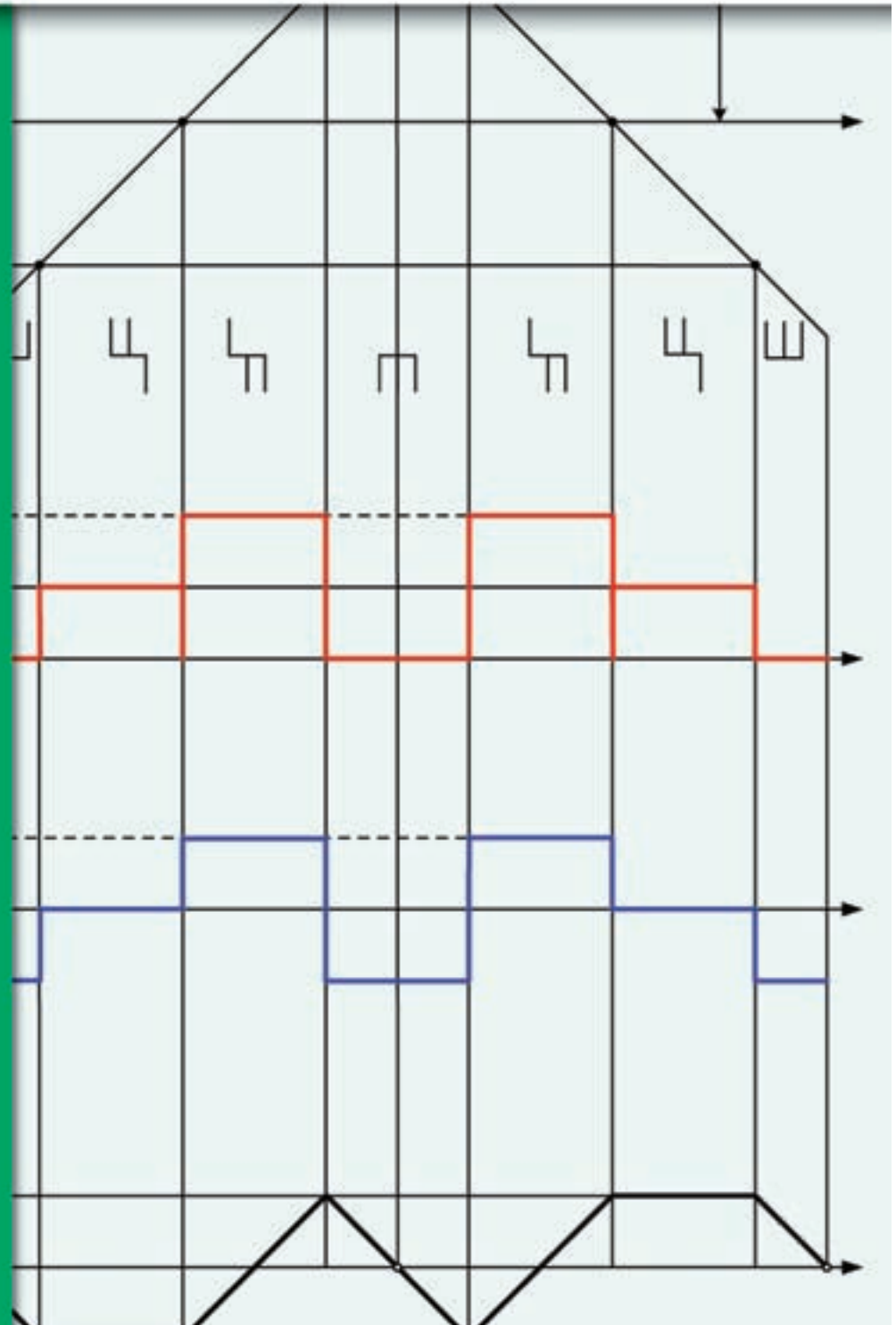
POWER ELECTRONICS SOCIETY NEWSLETTER

President's Message

APEC2009 Summary

Understanding PWM Current Ripple

ECCE2009 Student Travel





SWITCHING POWER SUPPLIES

- Outputs to 135V; AC-DC & DC-DC
- Constant voltage/constant current
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- Screw terminals or solder pins
- Rugged encapsulated construction



HIGH VOLTAGE POWER SUPPLIES

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- AC-DC & DC-DC; Modular and Rack Mounting
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- 0-5V control voltage input



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News Items should be sent to: Dr. John M. Miller, PELS Newsletter, Editor-in-Chief, 4022 W. Creedance Blvd., Glendale, AZ USA; TEL:+1 623 518 4438; EMAIL: pelsnews@ieee.org. Deadlines for copy are March 15, June 15, September 15 and December 15. Email submission of items in MS-Word or

plain-text format are preferred. Include caption with all photos identifying event and individuals in a back-row, left to right, front-row, left to right, etc method. Full-page call for papers and announcements of PELS-supported conferences are welcome and should be sent as MS-Word files. Please indicate all trademarked items, such as INTELEC®, APEC® with the registered trademark symbol, "®".

Technical items should be sent to associate technical editors: Prof Babak Fahimi, University of Texas at Arlington, 416 S. College St., Arlington, TX 76019, USA; TEL: +1 817 272 2667; EMAIL: fahimi@uta.edu. Or, to Prof. Chris S. Edrington, Florida State University, 2000 Levy Avenue, Suite 140, Tallahassee, FL 32310, USA; TEL: +1 850 645 7213; EMAIL: edrinch@eng.fsu.edu.

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From The Editor

John M. Miller



The past six years as editor-in-chief for the Power Electronics Society newsletter have been a rewarding and enjoyable experience and now its time to hand the reins over to our next EIC, Dr. Arthur Kelley. Dr. Kelley is principal R&D engineer at 3RDi Product Development Inc. in Morrisville, NC, and he is now the EIC in transition for PELS. I invite all the PELS membership to give Dr. Kelley a warm welcome and to extend to him all the assistance you can provide to keep the PELS newsletter growing. The transition period will run most of the remainder of this year, and by the time of the 4th quarter issue, Dr. Kelley will have full control. We both look forward to this transition as a time to look back at the progress made and more importantly to look forward to expanding our newsletter.

Speaking of expanding the newsletter I am also pleased to welcome a new associate technical editor, Prof. Chris S. Edrington. Chris will join Prof. Babak Fahimi in the role of associate technical editor for PELS newsletter and with his help we will see more content appear in future issues. The role of associate technical editor is to solicit technical content for the issue according to themes put in place by the EIC. In their respective roles, Prof. Fahimi has done an excellent job of providing timely and interesting technical articles for each issue, overseeing their critical review, editing and submission. At this past APEC meeting in Washington D.C. the PELS ADCOM welcomed a new vice president to the society, Prof. John Shen, as VP products. Chris will invite contributions from our three VP's so that in each issue we can look forward to four contributions per year, one per issue, from our president and each VP. Readers are invited to read our incoming president's message for his 2009-2010 tenure in this issue.

I wish to also acknowledge the long standing contributions from our sales team, Mr. Walter Chalupa and Mr. Tom Flynn. Walter covers the Eastern U.S. and Tom works Central and Western U.S. and both work together to develop our advertisement base and from this to provide revenue to keep the newsletter financially afloat. And what a great job they both do. The number of ad inserts in the last issue was the best ever, and in an economic downturn no less. Kudo's to them both. It is also my pleasure to acknowledge our electronic media editor,

continued on page 4

*PWM current ripple
(see article on pp. 14-17)*



Presidents Message



Dear PELS Members and Friends,

It is a great honor and privilege to be representing the IEEE Power Electronics Society as President for 2009 and 2010. Thanks to the efforts of all our volunteers and our past presidents – Hiro Akagi, Rik DeDoncker to name the last two, our society is in good shape. We have expanded our global reach through cooperation and partnerships. PELS currently cosponsors 17 major international conferences and workshops, and is technical cosponsor for an additional 10 conferences. Starting in 2009, our ECCE conference series replaces our flagship PESC conference, and will be held in the US in San Jose, CA, and in China as IPEMC. This is the first step in establishing a series of major rotating conferences in energy conversion that will be held annually in the US, Europe, Asia and elsewhere, and I am pleased to see that years of hard work are beginning to bear fruit.

I would like to welcome Ralph Kennel as VP Meetings, Dong Tan as VP Operations and John Shen as VP Products. These three, along with Donna Florek (PELS Administrator) and Braham Ferreira (Treasurer) have primary responsibility for society operations. I would also like to extend a warm welcome to the new elected members of the society's administrative committee or Adcom. I cannot emphasize enough the role that existing committee chairs and office bearers in the society play in keeping our many conferences, publications and activities functioning so smoothly. Our society only succeeds through volunteer/member participation, and I would like to encourage all PELS members to participate more actively in society activities. Please contact Donna or myself if you would like to become more actively involved in PELS activities.

These are times of turmoil and change. Globally, the markets and industry are mired in a recession – a fact that will have significant impact on IEEE, our society and on our individual lives. But this is also a time of great opportunity. Climate change, GHG emissions and depleting fossil fuel reserves are providing unprecedented resolve in moving society towards a sustainable energy future. With increasing emphasis on renewable energy generation, energy efficiency and carbon free transportation, it is clear that the future will be increasingly electrified – perhaps an 'electron economy'. Power electronics will play an even more important role in ensuring that all facets of the energy infrastructure – from energy generation and delivery to utilization – all function with maximum efficiency and lowest cost.

At the same time, power electronics technology has reached a fork in the road. Over the last 30 years, we have developed critical power electronics technologies that have enabled a plethora of applications – ranging from a few watts to hundreds of megawatts. Today, power conversion technology has matured to the point where

over 90% of applications can be covered with existing technology. While a few applications will still continue to drive the cutting edge of technology, for the vast majority, the question now becomes one of achieving the desired cost, functionality, size and features. This is akin to what has happened in other market segments, including microprocessors. In a fast moving technology area, with global players, the IEEE has an important role to play.

Our conferences, workshops and publications provide a mechanism to promote worldwide information sharing and cooperation. By coupling our technical work output with powerful search engines such as IEEE Xplore, we facilitate and speed up the technology development process. Finally, as the largest technical membership organization in the world, we have a responsibility to help our members achieve their professional objectives, providing them with opportunities for continued professional growth and personal development.

In a world that is increasingly 'wired' and 'flat', we need to increasingly create and disseminate our information online. For instance, we are offering the presentations recorded at the recent IEEE Energy 2030 Conference, using a Voice on Power Point (VoPPT) format. The presentations are available for view from the IEEE PELS website (www.pels.org). This is one example of a web-based product we will be offering for our members in the near future. We are also planning on creating a process for submission and posting of similar editorially reviewed VoPPT tutorials that are created by our members. Industries that desire to upload technology briefs, white papers and new product information will also be able to avail of the new web based content delivery system. This is an expensive and important initiative for PELS, and we welcome feedback from our members and industrial partners on features and benefits that are important to them. Please send your comments to Donna Florek at D.Florek@ieee.org or to me at D.Divan@ieee.org.

We are seeking volunteers who would like to become actively involved with PELS. This can happen through technical committees and through chapter activity. We support over 63 chapters around the world. Chapter meetings provide a focal point for PELS activities, including presentations by our slate of Distinguished Lecturers, topical presentations by experts, workshops and activities of regional interest, and social gatherings that provide opportunities for networking with your peers as well as industry leaders. We welcome enthusiastic PELS members who would like to serve as the initiators of new chapter based activity around the world.

I am looking forward to meeting many of you over the next two years, and am hoping to continue the process of building the society and delivering value to our members.

Deepak Divan

From The Editor

continued from page 3

Prof. Issa Batarseh and our webmaster, Mr. Robert Bilic. When each new issue is complete the EIC forwards all the content to IEEE for layout and publishing. However, there is a final step after that, and for that we thank Mr. Bilic who makes sure the electronic copy is posted to the PELS web page, www.pels.org.


Let me close by thanking the very able assistance and guidance of the PELS editorial board, and especially Prof. Ron Harley who has been a friend and mentor over all these years. Ron is PELS

publication chair and together with Dr. Ira Pitel, Prof. Phil Krein, Ms. Donna Florek and our society president, Prof. Deepak Divan oversee the activities of the newsletter staff. To all I extend my sincere regards and best wishes as the newsletter again steps up to another level in its on-going development.

John M. Miller, EIC
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24
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APEC 2009 Rewards Attendees with Quality Conference

Submitted by Greg Evans, WelComm, Inc.

In these uncertain economic times, it was particularly gratifying to see the power electronics technology community come out in such numbers to participate in APEC 2009, in Washington DC last February. The final counts are in and there were over 2,100

registrants representing 41 countries; over 300 peer-reviewed papers were presented; the sold-out exhibit space provided an important venue for the 172 exhibiting companies to present their latest technical innovations.



Joshua Isrealsohn chaired one of the perennially popular RAP sessions - this one covering market adoption of Silicon Carbide Technology



Arnold Alderman gave an informative presentation on PSMA's global energy standards database project



The APEC 2009 Plenary Sessions draw a large and receptive attendance

Kevin Parmenter, General Chairman of APEC 2009, filed this report: "Once again APEC delivered the goods. Our customers voted with their attendance. Return on Investment seems to have been the motivation. All are watching their investments of time and money in more than ever. We heard stories of engineers whose companies had issued directives restricting travel. Engineers being what we are – innovate, get creative and find a way, many took it upon themselves to accept responsibility for their own training and development to take vacation time, carpool with other engineers and found a way to attend APEC. Many told us that if they have to pick one event for the year to attend, an event which makes a difference and matters, to them it's APEC and has been for years. We promise the best power electronics exhibits, professional development courses taught by world class experts, peer reviewed papers from a wide range of topics, and time to enjoy networking opportunities with fellow power electronics experts in a beautiful setting – APEC once again provided this and much more. The key to success in this environment is exceeding customer's



Kevin Parmenter was pleased with the exceptional turnout for APEC 2009 despite the difficult economic circumstances

comments that the plenary session was, perhaps the best ever line up of speakers. The Micro Mouse Competition was packed and participants from all over the world competed. Most importantly attendees and exhibitors took away information they could put to use immediately to make a significant difference in their work or business and exhibitors had qualified leads and inputs. The networking activities

expectations and this goal was achieved.”

“We appreciate the vote of confidence from our exhibitors and rewarded their commitment to APEC with consistent qualified high quality traffic through the exhibit areas plus non-stop analyst and press interviews and announcements from the conference.”

“Every event I attended during the conference was in many cases packed and sometimes standing room only. Seminars were full, rap sessions were full, attendees really liked Washington, DC and the weather was perfect for us. I had



Ada Chang, Chairperson of the Special Presentations Programs was pleased with the range of topics covered

ence in power electronics in the Americas if not in the world. Plan now to attend APEC 2010, our 25th anniversary event in Palm Springs, California. And please join me in supporting Babak Fahimi who will be our General Chair in 2010.

If you are planning to exhibit the spaces are filling up quickly. The call for papers for next years' conference is already open. Go to www.apec-conf.com for more information.

were strong – many new relationships were formed, existing ones strengthened and sustained – relationships are so very important in challenging economic times to keep the wheels of innovation going.”

Kevin went on to say that he wished to express my appreciation to the members of the APEC 2009 Committee, “These men and women volunteered their time and skills to make the APEC Conference a resounding success.”

For those of you who missed APEC you missed the most relevant confer-

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ECCE2009 Student Travel

The IEEE Power Electronics Society has a travel reimbursement program for student members who present a paper at the Energy Conversion Congress & Expo (ECCE) in San Jose, CA, USA Sept 20-24, 2009. This program will reimburse up to \$800 of travel expenses associated with the conference for up to 75 students. To be eligible for this program, students must:

- Have a paper accepted at ECCE 2008 and present the paper.
- Be an IEEE student member and a PELS member.

Interested students should complete the application found online at the PELS new web site at <http://www.pels.org/>. This form is to be completed and sent by e-mail to the chair of the Education Activities Committee. Reimbursement of costs will be done after the conference has concluded and students have sent in the necessary reimbursement forms and receipts. The application deadline is May

30, 2009. Students will be notified if they have been approved for travel reimbursement on June 15, 2009.

In case there are more than 75 applicants for travel reimbursement, preference will be given to the best papers according to the review rating and to students who have not previously been part of this travel program.

Dr. Hui Li
 Chair, IEEE PELS Education Activities Committee
 Electrical and Computer Engineering Department
 FAMU-FSU College of Engineering
 2525 Pottsdamer St.
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Call for Papers

Special Issue on Modeling and Advanced Control in Power Electronics, 2009

Scheduled Publication Time: November 2009

Prospective authors are invited to submit original contributions or survey papers for review for publication in this special issue. Topics of interest include (but are not limited to):

- Reduced-order and behavioral modeling of devices, components, circuits, and systems
- Integrated electro-magneto-thermal modeling; EMI modeling, multilevel and multi-physics modeling
- Model validation, model certification; model identification, model development tools
- Parallel and distributed simulation of complex power electronic systems; multilevel simulation
- Hardware-in-loop simulation, mixed-signal simulation, interactive simulation; virtual prototyping
- Digital and mixed-signal control of high-frequency converters; digital pulse-width modulation
- Geometric, ripple-based, and other nonlinear control methods for power converters
- Modular converter control, current and voltage sharing control; sensorless and adaptive control
- Large- and small-signal methods for complex dc, ac, and hybrid dc/ac power electronic systems
- Modeling and control of mobile and autonomous power electronic systems
- Modeling and control of renewable energy systems

All manuscripts must be submitted through Manuscript Central at <http://mc.manuscriptcentral.com/tpel-ieee>. Submissions must be clearly marked "Special Issue on Modeling and Advanced Control in Power Electronics, 2009" on the cover page. When uploading your paper, please indicate, under step 4 – *Details & Comments*, that it is for the "Special Issue on Modeling and Advanced Control in Power Electronics, 2009." Refer to <http://www.pels.org> for general information about electronic submission through Manuscript Central. Manuscripts submitted for the special issue will be reviewed separately and will be handled by the guest editorial board noted below.

Deadline for Submission of Manuscript: February 28, 2009

Guest Editor


Jian Sun, Rensselaer Polytechnic Institute, USA (jsun@rpi.edu)

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- Bingsen Wang, Arizona State University, USA

Proposed Timeline

- June 2008 – Proposal Approval by PELS AdCom
- July & September 2008 – Call for Papers in the Transactions
- July – December 2009 – Call for Papers in PELS Newsletter and Distribution at Conferences
- February 28, 2009 – Manuscripts Submission Deadline
- May 31, 2009 – First Review Complete
- June 30, 2009 – Revised Manuscripts Due
- August 15, 2009 – Final Acceptance Notification
- September 15, 2009 – Final Manuscripts Due
- September 30, 2009 – Manuscripts Forwarded to IEEE for Publication
- November 2009 – Special Issue Appears in Transactions




MAGNA-POWER ELECTRONICS


3.3 KW TO 900 KW AC/DC POWER SUPPLIES

Specification	PQ Series III	TS Series II	MS Series II	MT Series III
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Power	3.3 to 10 kW	15 to 45 kW	30 to 75 kW	100 to 900 kW
Voltage	0-1000 Vdc	0-1000 Vdc	0-1000 Vdc	0-2500 Vdc
Current	0-900 Adc	0-2700 Adc	0-4500 Adc	0-6000 Adc

Applications

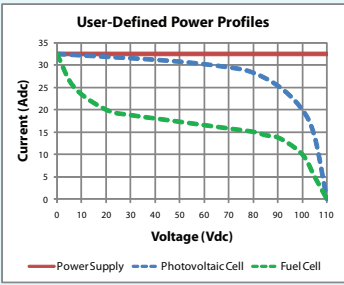
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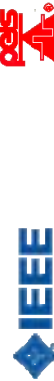
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The 4th International Telecommunication Energy Special Conference teleson[®]2009 will be held at the Hotel Golden Tulip – Modul in Vienna, Austria from May 10 – 13, 2009.

teleson[®]2009 is an international forum, where experts appreciate the exchange of information on the state of the art of telecommunications power supply systems. State of the art lectures on installation, modernisation and operation of power supply systems for telecommunications networks will be held.



The motto for 2009 will be:

POWER SUPPLY QUALITY AND EFFICIENCY

Therefore the call for papers is taking into account the specific conditions of the fast growing telecommunication networks in the world. The presentations given in the conference, or the products and components exhibited in the exhibition area will demonstrate the expertise and know-how in telecom power supply systems including latest developments.

Experts from all over the world will participate and contribute with lectures and presentations about new strategies, developments, system design and operational problems including their technical solutions.

Main emphasis of this conference will be the important Power Quality of the mains connections for a high reliability and availability of the fast increasing wire- and wireless information communication.

There will be presented papers via plenary sessions, oral presentations and discussion forums. More than 300 international, European and National representatives are expected to attend.

SCOPE OF THE CONFERENCE

1. **AC/DC Power Supplies – Power Quality and Efficiency**
 - High reliable Power systems for telecommunication equipment
 - Power system architectures, distribution, monitoring and reliability
 - New technology power generation and energy storage systems
 - Behaviour of power supply systems in distributed or faulty networks
 - Mechanical design and environmental requirements
 - Powering cable TV, multimedia networks, internet and wireless applications
2. **UPS and Converters**
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Understanding PWM current ripple in star-connected AC motor drive

Alex Ruderman
Elmo Motion Control Ltd.

ABSTRACT

Understanding origins of current ripple in Pulse Width Modulation (PWM) drives is important for current feedback, control and protection circuitry design, drive system components selection, motor losses and EMI evaluation etc. Frequency domain approach to PWM effects analysis is the preferred method in the drives literature. AC motor PWM voltage waveform harmonic content evaluation by double Fourier integral analysis is not easy and does not provide exact information about peak-to-peak current ripple, worst case etc. Time domain PWM analysis may provide meaningful practical results by relatively simple and instructive means. The paper presents a time domain PWM current ripple study for a three-phase star-connected AC motor fed by conventional two-level inverter. PWM current ripple is assumed quasi-steady state piece-wise linear (pure inductive motor winding impedance). Current ripple shape and envelope examples are given. Peak-to-peak PWM current ripple values are presented as a function of modulation index and phase voltage electrical angle. Worst case peak-to-peak PWM current ripple condition is figured out and PWM current ripple separation experiment suggested. Theoretical results are found to be in a good agreement with experiment.

DIGEST

AC motor PWM current ripple gives an important indication about drive performance. It is an accepted practice to use frequency domain approach while studying PWM voltage and current waveforms related phenomena. Strict analytical determination of AC

PWM voltage waveform harmonic content is quite a complex task that requires double Fourier integral analysis [1]. PWM current harmonics used for total current harmonic distortion factor calculation are typically obtained assuming pure inductive winding. Frequency domain approach is also a preferred method for other PWM phenomena analysis [2].

So far no comprehensive AC motor PWM current ripple analysis in time domain was reported. Frequency domain analysis does not provide exact information about peak-to-peak and worst case ripple current while time domain methods can deliver such by relatively simple and instructive means. In this paper, we present analytical time domain derivation of PWM current ripple in a symmetric three-phase star-connected AC motor fed by a conventional two-level inverter.

AC motor controlled by PWM inverter and power stage representation using ideal switches is shown in Fig.1. In Fig.1, b normally only one switch of leg A, B, C is closed connecting each phase to either upper (positive) or lower (negative) DC bus rail.

The presented analysis covers a three-phase sinusoidal PWM carrier based generation by triangular wave scanning of three sinusoidal phase voltage commands with the third harmonic style correction to reduce current ripple and push overmodulation limit [1]. The major assumptions:

A1. DC bus voltage is ideally stiff, transistor switching – infinitely fast.

A2. Motor winding impedance equivalent circuit is constant inductance. This way, we neglect winding resistance, core eddy current, rotor saliency and magnetic saturation effects.

A3. Motor voltage fundamental frequency is essentially lower than PWM switching frequency.

PWM voltage is viewed as a superposition of averaged one on a PWM period (“instantaneous” fundamental voltage) and voltage ripple. Voltage ripple is an instantaneous PWM voltage on a switching period reduced by its mean value. Thus ripple voltage is zero on average on a switching period.

“Instantaneous” fundamental voltage together with sinusoidal motor back EMF generates fundamental motor current. PWM current ripple superimposed on fundamental one is produced by PWM voltage ripple (superposition principle). Due to assumption A1, PWM voltage ripple is piece-wise constant. Therefore, PWM current ripple is piece-wise linear according to A2, A3 with zero average. In accordance with the above reasoning, instantaneous motor phase PWM current ripple is a function of phase voltage - modulation index M and phase angle θ - and does not depend on motor current.

Assumption A3 allows considering phase voltage commands constant on PWM period. Sinusoidal phase voltage commands “frozen” values are scanned by triangular wave carrier. The crossing points define switching moments of respective inverter legs. As long as phase voltage command is higher (more positive) than scanning carrier wave, upper switch of respective bridge leg is closed (connected to positive DC bus rail). Instantaneous phase voltages are calculated using voltage divider rules.

Note that modulation index M is defined as $M = \sqrt{3}v_M/(2V_T)$, v_M – normalized sinusoidal phase voltage command peak value. $M = 1$ ($v_M = 1.155V_T$) means ideal voltage saturation (overmodulation limit). Overmodulation phenomena that cause fundamental voltage (current) distortion are not considered here.

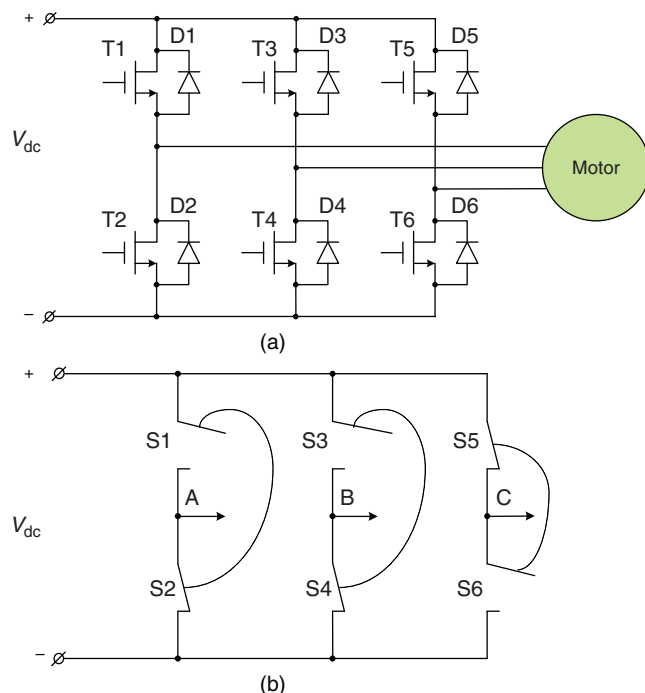


Figure 1. Two-level PWM inverter (a) and its idealized representation (b)

Given modulation index and phase voltage (command) electrical angle, piece-wise constant phase voltage ripple (dependent on DC bus voltage and switching frequency) is found and (using equivalent phase inductance) piece-wise linear current ripple shape is elaborated. Some useful general observations that are correct for all modulation indices and phase voltage angles are:

1. PWM voltage ripple shows even (“mirror”) symmetry with respect to triangular wave peak and valley points.
2. PWM current ripple is voltage ripple integral and, therefore, shows “opposite” – odd – symmetry with respect to triangular wave peak and valley points and is zero-valued at these points (the known fact used for theoretically ripple-free current sampling).

PWM current ripple examples for some modulation indices and electrical angles 0°; 30°; 60°; 90° are given in Fig.2, 3. For 0° angle (Fig.2, a) phase voltage is zero on average and, therefore, voltage ripple is identical to phase voltage. In general, current ripple period is equal to the switching one (carrier period).

For 30° angle (Fig.2, b), note a 3rd harmonic style correction by zero sequence voltage addition shown in the upper left corner. It makes voltage pulses “center based” on their respective halves of PWM period. For this specific phase angle, PWM frequency seen by motor is twice a switching frequency. For selected modulation index $M = 1/\sqrt{3} = 0.577$ “duty ratio” is exactly 50% meaning maximal PWM current ripple.

90° angle case (Fig.3, b) is similar to 30° with twice increased current ripple. For 60° angle (Fig.3, a), presented is a “boundary” case of modulation index $M = 2/3 = 0.667$. For smaller modulation indices, peak current takes place at the first switching moment (switching in phase C). For larger modulation indices, peak current takes place at the second switching instant (switching in phase B).

Normalized peak-to-peak current ripple for different modulation indices and angles:

$$0^\circ : i_{pp} = \frac{2}{3}M;$$

$$15^\circ : i_{pp} = 0.646M - 0.136M^2;$$

$$30^\circ : i_{pp} = \left(\frac{1}{\sqrt{3}}M - \frac{1}{2}M^2 \right);$$

$$45^\circ : i_{pp} = \left\{ \begin{array}{l} 0.816M - 0.788M^2, M \leq 0.817 \\ -0.128M + 0.368M^2, M > 0.817 \end{array} \right\};$$

$$60^\circ : i_{pp} = \left\{ \begin{array}{l} M(1 - M), M \leq 2/3 \\ \frac{M}{3}, M > 2/3 \end{array} \right\};$$

$$75^\circ : i_{pp} = \left\{ \begin{array}{l} 1.116M - 1.078M^2, M \leq 0.597 \\ 0.944M - 0.790M^2, M > 0.597 \end{array} \right\}$$

$$90^\circ : i_{pp} = \left(\frac{2}{\sqrt{3}}M - M^2 \right).$$

To obtain peak-to-peak current ripple in Amps, multiply the above normalized values by the base current

$$I_B = \frac{V_{DC}}{2L_{pp}f_{PWM}}$$

V_{DC} – DC bus voltage; L_{pp} – motor phase-to-phase inductance; f_{PWM} – carrier frequency.

PWM current ripple graphs are shown on Fig.4, 5.

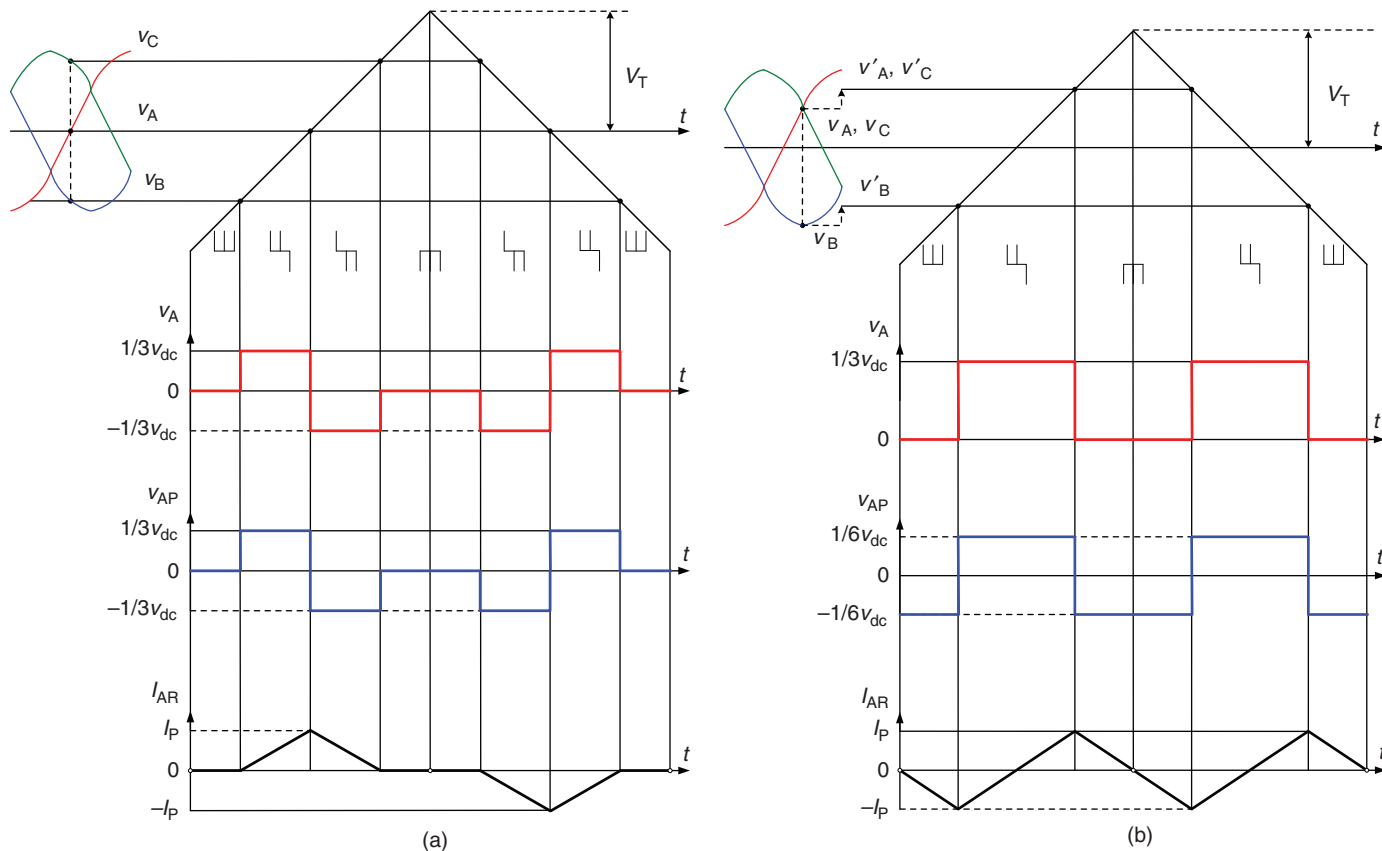


Figure 2. PWM current ripple, $M = 1/\sqrt{3} = 0.577$: a – angle 0°; b – angle 30°

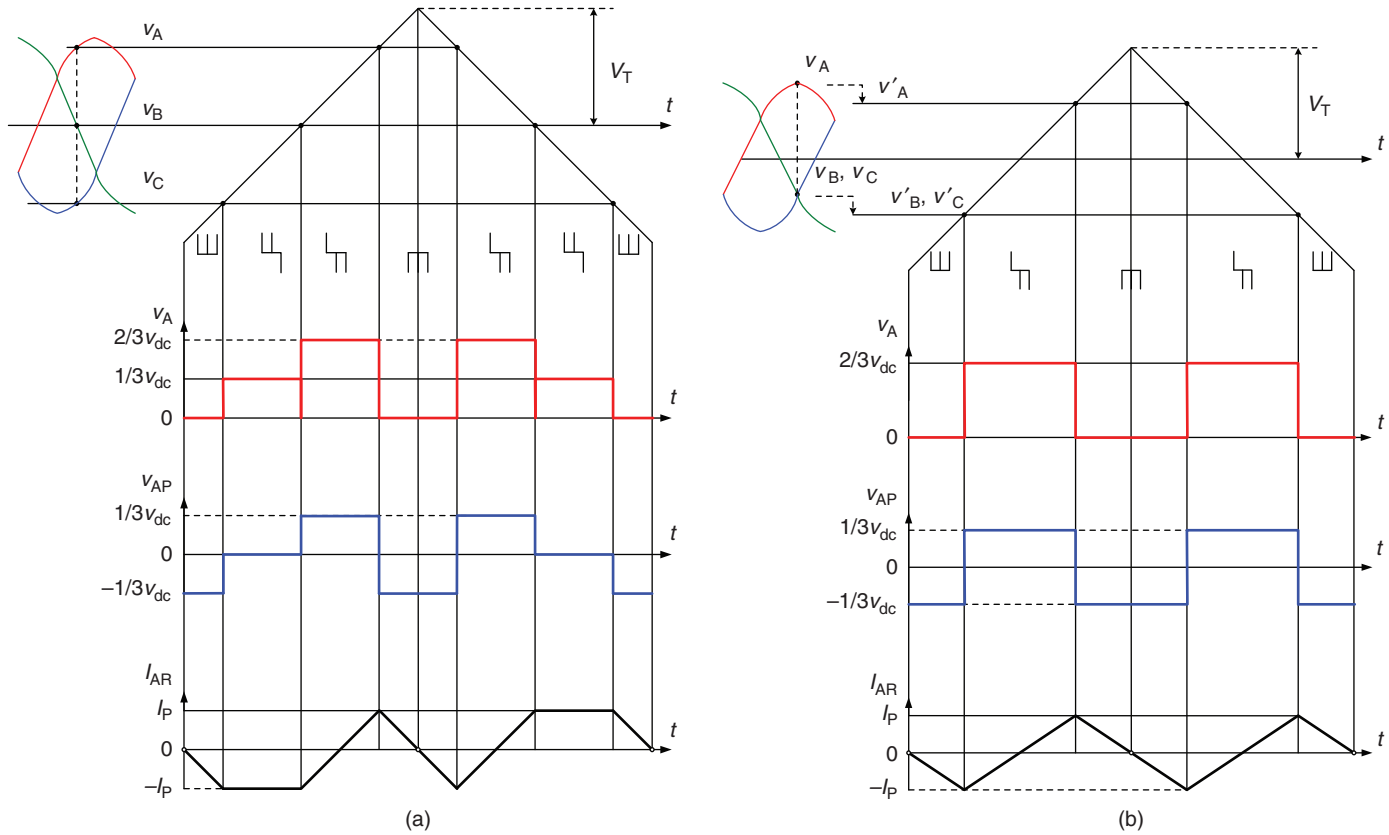


Figure 3. PWM current ripple: a – $M = 0.666$, angle 60° ; b – $M = 0.577$, angle 90°

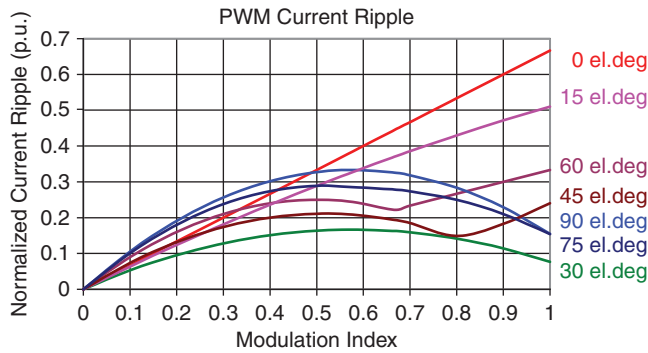


Figure 4. PWM current ripple as a function of modulation index

The worst-case PWM current ripple takes place for $M = 1$ at phase angles $0^\circ, 180^\circ, \dots$ (Fig.4, Fig.5, b). This is because zero average motor voltage has carrier frequency (no frequency doubling effect) and is obtained in a “bipolar” manner by positive and negative voltages cancellation (Fig.2, a).

Let’s compare worst-case peak-to-peak PWM current ripple for sinusoidal and trapezoidal commutation

$$\Delta I_{\text{SINE}} = \frac{V_{\text{DC}}}{3L_{\text{PP}}f_{\text{PWM}}}; \quad \Delta I_{\text{TRAP}} = \frac{V_{\text{DC}}}{8L_{\text{PP}}f_{\text{PWM}}}$$

Theoretical worst-case PWM current ripple for sinusoidal commutation is $8/3 = 2.66$ times that for trapezoidal commutation with unipolar DC type PWM (worst case takes place for 50% duty ratio).

To experimentally check motor PWM current ripple, it is suggested to have a motor under test back-driven at a constant speed by a prime mover and controlled by a drive configured in current mode with zero current command. To provide zero average motor current, the drive will ideally develop fundamental sinusoidal voltage

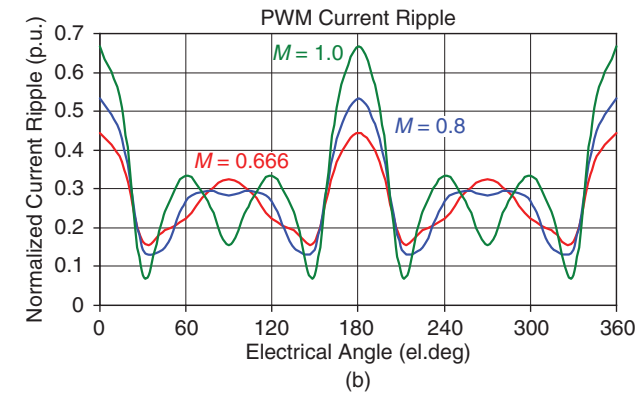
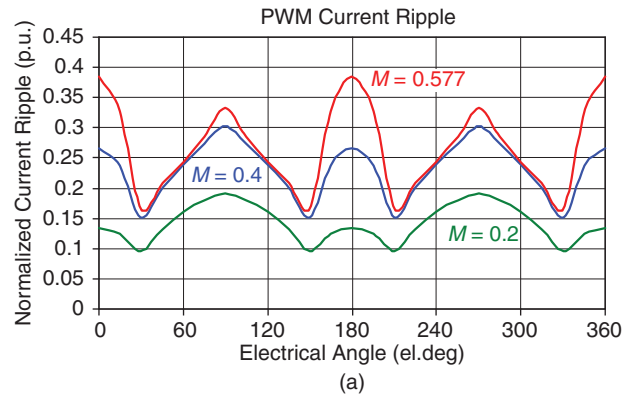


Figure 5. PWM current ripple as a function of electrical angle

equal to motor back EMF. This way, the current into the motor will theoretically all be pure PWM current ripple. Modulation index is defined by selected motor speed and DC bus voltage.

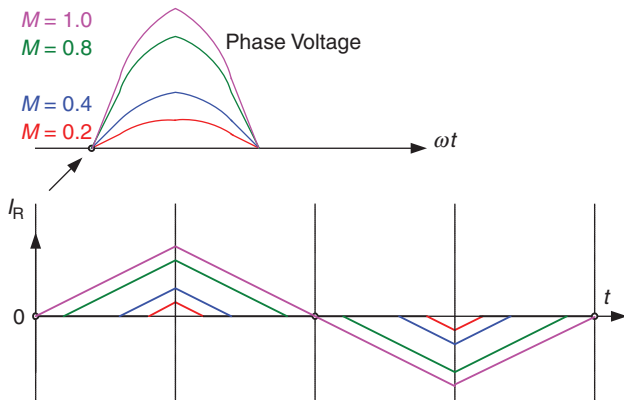


Figure 6. Theoretical current ripple shape for zero motor phase voltage

Current ripple shape for zero motor phase voltage and different modulation indices is shown in Fig.6.

In conducted experiments with a permanent magnet AC motor having voltage constant of 43 Vrms/KRPM and phase-to-phase inductance $L_{pp} = 2.76mH$ with DC bus voltage of $V_{DC} = 180V$ and transistor switching frequency $f_{PWM} = 11KHz$, measured worst case peak-to-peak current ripple (Fig.6) was 5-10% higher than predicted by the theory for different modulation indices.

References

- [1] D.G. Holmes and T.A. Lipo, *Pulse Width Modulation for Power Converters: Principles and Practice*, Hoboken, NJ: John Wiley, 2003.
- [2] F.D. Kieferndorf, M. Foerster, and T.A. Lipo, "Reduction of DC Bus Capacitor Ripple Current with PAM/PWM Converter", *IEEE-IAS Conference Record*, vol. 4, pp. 2371-2377, 2002.

Biography



Alex Ruderman (M'2007) received his PhD degree in electromechanical engineering from Polytechnic University (Leningrad, former USSR) in 1987. From 1995 to 2004, he worked as a research engineer at Intel Microprocessor Design Center, Haifa, Israel, investigating into advanced VLSI power delivery, power reduction, static timing calculation, and testing related issues. Since 2005, Alex is Chief Scientist at Elmo Motion Control Ltd. His current research interests include multilevel PWM converter topologies and modulation strategies, asymptotic time domain voltage quality and load PWM loss evaluation; flying capacitor converters voltage balance dynamics; non-linear, adaptive, and robust motion control algorithms for cogging, friction, and backlash compensation; motor drives automatic tuning/self-commissioning etc.

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TESTS FOR PREDICTIVE MAINTENANCE: Partial discharge analysis, tests, new instruments for diagnostics </td> </tr> </table> <p>Regular Papers: Submit provisional versions of full papers in English as follows. Limitation to 6 full pages, including paper title, authors and affiliations, figures and references (maximum size 2MB). Authors are requested to prepare the manuscripts in the IEEE two-column format, using the template available in the SDEMPED Website and to translate it in PDF using the IEEE PDF eXpress™ facility.</p> <p>Special Sessions: A special session is a group of 6 papers which are solicited by a session organizer on the basis of a special topic. All the papers are collected in the same way as regular ones and they pass in the same review process.</p> <p>Industrial Forum: This forum is organized during the first day of the conference to present the actual industry preoccupations in front of engineers and researchers coming from academia. The aim is to set strong exchanges in between what is done in research labs and what is really needed by companies to improve the industrial acceptance of diagnostic techniques.</p> <p>All submissions should be in electronic form. Instructions will be posted in due course on the web at: www.sdemped09.iut-amiens.fr</p> <p>Venue: IESC Menasina – Cargèse – France (www.iesc.univ-corse.fr)</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th colspan="2" style="background-color: #ffffcc;">Deadlines for paper digest and special session proposals</th> </tr> </thead> <tbody> <tr> <td style="background-color: #ffffcc;">Submission:</td> <td style="background-color: #ffffcc;">March 2, 2009</td> </tr> <tr> <td style="background-color: #ffffcc;">Notification of acceptance:</td> <td style="background-color: #ffffcc;">April 27, 2009</td> </tr> <tr> <td style="background-color: #ffffcc;">Final manuscript due:</td> <td style="background-color: #ffffcc;">June 22, 2009</td> </tr> </tbody> </table>	I. ELECTRICAL MACHINES: Failure detection and location in electrical machines using vibration, audible noise, electrical or mechanical variables, sensors, insulation failures, electrical, mechanical and thermal models	II. POWER ELECTRONICS: Diagnostics in power converters using input-output monitoring, thermal and/or electrical measurements on power semiconductors, control supervision, signal processing	III. ADJUSTABLE SPEED DRIVES: Monitoring and diagnostics for ASDs using electrical machines, power converters and control systems supervision, computer-based signal processing and data analysis	IV. TOOLS FOR DIAGNOSTICS: Neural networks, fuzzy logic, artificial intelligence, genetic algorithms, expert systems, identification, signal processing techniques, observers	V. MATERIALS FOR ELECTRICAL MACHINES: Insulating and magnetic materials, remaining life models, ageing tests	VI. TESTS FOR PREDICTIVE MAINTENANCE: Partial discharge analysis, tests, new instruments for diagnostics	Deadlines for paper digest and special session proposals		Submission:	March 2, 2009	Notification of acceptance:	April 27, 2009	Final manuscript due:	June 22, 2009
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IV. TOOLS FOR DIAGNOSTICS: Neural networks, fuzzy logic, artificial intelligence, genetic algorithms, expert systems, identification, signal processing techniques, observers															
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2009 IEEE ENERGY CONVERSION CONGRESS AND EXPOSITION

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Call For Papers

ECCE 2009 combines the former IEEE Power Electronics Specialists Conference (PESC) with the technical sessions of the Industrial Power Conversion Systems Department (Electrical Machines Committee, Industrial Drives Committee, Industrial Power Converter Committee and the Power Electronics Devices and Components Committee) previously presented at the IEEE Industry Applications Society Annual Meeting. Papers are solicited on any subject pertaining to the scope of the conference, including but not limited to the following:

Energy Conversion Systems

Renewable and Alternative Energy Systems: Solar and Photovoltaic Energy Systems and Interface, Wind Energy Systems and Interface, Water Energy Systems and Interface, Energy Harvesting, Fuel Cells and Conversion, Solid State Generation & Interface (e.g., Thermoelectric, Thermophotovoltaic, Thermionic), Energy Storage and Interface (e.g., Battery, Flywheel, SMES, Thermal)

Control Issues: Power Converter and Motor Control Algorithms; Real-Time Control Implementation; Digital Control Techniques; Sensors and Sensor Elimination Techniques for Power Electronics, Machines, and Drives; Measurement and Instrumentation

Thermal Management and Efficiency: Thermal Management of Electric Machines, Power Converters, and Drives; Energy Efficiency of Power Electronics, Electric Machines, and Drive Systems.

Electrical Power Systems: Electrical Power System Architectures and Management; Distributed Resources and MicroGrid Power Systems

Power Quality, Grid Interface and EMI: EMI-EMC, Power Quality including Harmonics and Active Filters, Power Factor Correction

Reliability and Diagnostics: Reliability, Fault Management, Protection, and Fault Tolerance; Power Converter and Machine Diagnostics and Prognostics.

Modeling, Analysis and Simulation: Modeling, Analysis and Simulation Methods for Power Electronics and Motor Drives; Optimization Techniques for Electric Machines and Power Electronics

Other topics: Education Methodology and Tools for Power Electronics, Electric Machines, and Drives; Development and Harmonization of Standards for Electric Machines, Power Converters, and Drives

Components, Subsystems, and Applications

Power Converters: DC-DC; DC-AC; AC-AC; AC-DC; Soft Switching and Resonant Converters; Inverters and Converters for Motor Drives; Multilevel Converters

Power Electronics Components and Packaging: Power Semiconductor Devices and Integrated Circuits; Passive Components: Inductors, Capacitors, Transformers, etc.; Energy Storage including Batteries and Ultracapacitors; Packaging and Modules; Integration at the Component, Power Converter, and Motor Drive Levels; New Materials Utilization in Power Electronics; Operation under Extreme Environmental Conditions

Electric Machines and Actuators: Permanent Magnet Machines; Induction Machines; Reluctance Machines; Linear Electric Machines; Electromechanical Energy Storage Systems (Flywheels); Special Machines, Actuators and Transducers; New Materials Utilization in Electric Machines and Actuators.

Electric Drives: Drive Configurations for All Types of Electric Machines and Actuators; All Issues Related to the Performance, Control, Reliability, and Cost of Electric Drives; Drives of All Performance Levels Ranging from General-Purpose to High-Performance Servos; System Interactions between Drives, Machines, and Sources; Machine—Drive Integration Issues

Applications: Transportation Applications for Automotive, Rail, Aerospace, and Marine, including Hybrid-Electric Drivetrains and Accessories; Lighting and Displays; Uninterruptible Power Supplies (UPS); Industrial, Residential, and Commercial Applications of Power Converters and Motor Drives; Servos, Robotics, and Mechatronics Systems; Utility Applications in Transmission and Distribution including HVDC; Biomedical Applications; Other Applications of Power Electronics, Electric Machines, and Drives

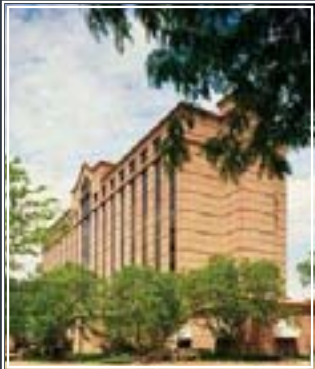
ECCE 2009 Author Deadlines and Requirements (see web site for more details)

January 15, 2009 Abstracts and digests of proposed papers must be submitted via the ECCE web site

May 25, 2009 Notification to authors of acceptance or rejection of papers selected for presentation

July 20, 2009 Completed papers and IEEE Copyright forms received.

- The one page abstract must be fifty to one hundred words with fully headed paper title, names of all authors, area of interest, and name and address of the corresponding author, including phone, fax, and e-mail address.
- Digest of up to five (5) pages, including key equations, figures, tables, and references, headed by the paper title only. The digest must state: purpose of work, manner in which it advances engineering and/or science, and specific results and their significance in sufficient detail for undergoing a review process.



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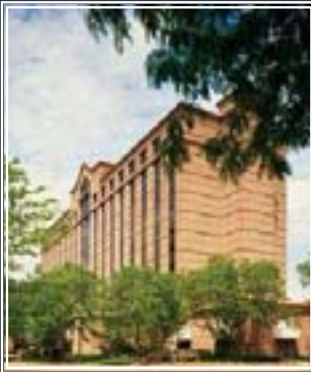
<http://www.vppc09.org/>



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Some of the Keynote Speakers



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Team Leader,
US Army TARDEC,
Hybrid Electric Program



Peter Cho
Program Manager,
All-Electric Ship Program,
Office of Naval Research



Robert Lee
Vice President
Powertrain Product
Engineering, Chrysler, LLC



Larry Burns
Vice President,
Engineering,
General Motors



Frank Barnes
Fellow of National
Academy of Engineering,
Distinguished Professor,
University of Colorado at
Boulder



Ann Marie Sastry
Arthur F. Thurnau Professor
of Mechanical, Biomedical
and Materials Science and
Engineering, University of
Michigan

Additional Keynotes from Academia, Government and Industry:

- > Haukur Asgeirsson, P.E. Manager, Detroit Edison, Power Systems Technologies, DTE Energy
- > Professor CC. Chan, University of Hong Kong
- > Larry Dickerman, Director of Distribution Engineering Services, American Electric Power
- > Professor Mark Ehsani, Texas A&M University
- > Nancy Gioia, Director, Sustainable Mobility Technology and Hybrid Vehicle Program, Ford Motor Company
- > Patricia Hoffman, Principal Deputy Assistant Secretary, DOE, Office of Electricity Delivery and Energy Reliability
- > Alex Q. Huang, Professor, Director of NSF FREEDM Systems Center, NC State University
- > Jay Iyengar, Director, Hybrid Powertrain Systems, Chrysler, LLC
- > Jason Lai, Professor, Virginia Tech
- > John Miller, Vice President, Maxwell Technologies



The Eighth International Conference on Power Electronics and Drive Systems

November 2-5, 2009, Taipei, Taiwan, R.O.C.

Website: <http://www.peds09.ntust.edu.tw>

Call for Papers

Organizers:

National Taiwan University of Science and Technology
Singapore Section IAS/PEL Joint Chapter

Technical Co-Sponsors:

IEEE Power Electronics Society - PELS
IEEE Industry Applications Society - IAS
IEEE Industrial Electronics Society - IES
Taipei Section IE/PEL Joint Chapter
National Science Council - NSC
Ministry of Education
Taiwan Power Electronics Association



The 8th International Conference on Power Electronics and Drive Systems (PEDS'09) will be held in Taipei, Taiwan, from 2 to 5 November 2009. The conference is a biennial event and is recognized as one of the major series of conferences in power electronics and drive systems. PEDS'09 continues to retain its tradition of high quality conference and will open up an opportunity for academics and industrial professionals worldwide to exchange their knowledge of the state-of-the-art power electronics and drive technologies and applications. The conference site, Taiwan, has not only a long-standing history but also an outstanding modern community, where past, present and future live harmoniously together. The 4-day program will feature tutorials, technical paper presentations and an exhibition. Papers presented in conference will be included in IEEE Xplore Digital Library and indexed by EI Compendex. **The Technical Program Committee would be selecting the top 10% of the papers to be forwarded to the IEEE Trans. on IAS, and the next 10% to the IJPElec for consideration for publication.**

Technical Papers - the range of topics includes, but not limited to:

- Power semiconductors, passive components and packaging technologies
- Motor drives and motion control
- Analysis and design of electrical machines
- Hard-switching and soft-switching static power converters
- Switch-mode power supplies and UPS
- Applications of power electronics in power system and generation/FACTS
- Power quality issues, harmonic problems and solutions
- EMI/EMC
- Power electronics in traction and automotive
- Bearingless drive technologies
- Applications of power electronics in home appliance, industry and aerospace
- Renewable energy technologies
- Modeling and simulation in power electronics
- Power electronics education/professional development
- Bio-medical power electronics
- Telecommunications power supplies
- Micro-electromechanical systems (MEMS)
- Power integrated circuits (PIC)
- Power engineering related technologies

Prospective authors are invited to submit an extended summary of not more than 5 pages including figures. The first page should include the title, the names of author (s), affiliation, mailing address, fax number, e-mail address, preferred topic area, and an abstract of not more than 100 words. A peer review process will be used to evaluate all papers submitted for consideration. The submission is web-based at <http://www.peds09.ntust.edu.tw>. For more information please contact the PEDS'09 Secretariat.

Author's Schedule

Prospective authors should note the following deadlines:

- | | |
|--|-----------------|
| ● Extended summary submission deadline | April 10, 2009 |
| ● Notification of paper acceptance | July 19, 2009 |
| ● Final paper submission deadline | August 14, 2009 |
| ● Authors' registration deadline | August 14, 2009 |

Tutorials

Several tutorials will be held prior to the technical presentations.

Exhibition

A comprehensive exhibition will be held during the conference. Exhibitors will include participants from commercial firms and organizations involved in the manufacturing, sales or distribution of power electronics equipment and professional or technical services. If interested in exhibiting, please contact PEDS'09 Secretariat.

For further information, please contact

PEDS'09 Secretariat.
Prof. Chung-Hsien Kuo
Department of Electrical Engineering, National Taiwan University of Science and Technology
43, Section 4, Keelung Rd., Taipei, Taiwan, R.O.C.
Fax: +886-2-2737-6699

Email: peds09@mail.ntust.edu.tw / Web site: <http://www.peds09.ntust.edu.tw>



25th Annual IEEE Applied Power Electronics Conference and Exposition
February 21st–February 25th, 2010 at the Palm Springs Convention Center, Palm Springs, CA

Announcement and Call for Papers

APEC 2010 continues the long-standing tradition of addressing issues of immediate and long-term interest to the practicing power electronic engineer. Outstanding technical content is provided at one of the lowest registration costs of any IEEE conference. APEC 2010 will provide a) the best power electronics exposition, b) professional development courses taught by world-class experts, c) presentations of peer-reviewed technical papers covering a wide range of topics, and d) time to network and enjoy the company of fellow power electronics professionals in a beautiful setting. Activities for guests, spouses, and families are abundant in the Washington area.

Papers of value to the practicing engineer are solicited in the following topic areas:

AC-DC and DC-DC Converters

Single- and Multi-Phase AC-DC Power Supplies, DC-DC Converters (Hard- and Soft-Switched)

Power Electronics for Utility Interface

Power Factor Correction, Power Quality, Electronics and Controls for Distributed Energy Systems

Motor Drives and Inverters

AC and DC Motor Drives, Single- and Multi-Phase Inverters, PWM Techniques, sensor integration, Fault tolerant operation

Devices and Components

Semiconductor Devices, Magnetic Components, Capacitors, Batteries, Sensors, Interconnects, Device Integration

System Integration

Packaging, Thermal Management, EMI and EMC

Modeling, Simulation, and Control

Device, Component, Parasitics, Circuit and System, CAD /CAE Tools, Sensor and Sensor-less Control, Digital Control

Manufacturing and Business Issues

Production Processes, Quality, Design for Manufacturability, Material Procurement, Supplier Qualification

Power Electronics Applications

Automotive and Transportation, Aerospace, renewable energy harvesting, Lighting (incl. LED), UPS, Power Generation and Transmission, Telecommunications, Military, Portable Power

Please note the following dates:

July 17, 2009

Deadline for submission of digests

October 2, 2009

Notification that a paper was accepted or declined

November 27, 2009

Final papers and author registrations are due

Digest Preparation: Prospective authors are asked to submit a digest explaining the problem that will be addressed by the paper, the major results, and how this is different from the closest existing literature. Papers presented at APEC must be original material and not have been previously presented or published. The principal criteria in selecting digests will be the usefulness of the work to the practicing power electronic professional. Reviewers value evidence of completed experimental work. Authors should obtain any necessary company and governmental clearance prior to submission of digests. Please visit www.apec-conf.org for all details on digest and final manuscript format.

If a digest is accepted, authors must submit a final manuscript before the deadline or the manuscript cannot be published in the Proceedings or presented at the conference. Final manuscripts may be subject to charges if their papers are over the page or file-size limit. At least one of the authors listed on a paper must be registered for either a Full Registration or for the Technical Sessions Only registration. A person registered at the Student rate may claim registration credit for only one paper. Authors registering at any non-Student rate, including the IEEE Life Member Rate, may claim registration credit for as many papers they wish.

Reviews: APEC relies upon a peer review process to ensure the quality of the technical content. To help maintain the high quality of the program, please contribute a few hours to review digests in your area of expertise by registering at www.apec-conf.org (under "Participating in APEC").

Calls for Special Presentations, Professional Education Seminars, and Exhibitor Seminars will be posted at www.apec-conf.org.

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IEEE ECCE 2010 Call for Papers

The Second IEEE Energy Conversion Congress and Exposition (ECCE2010) will be held in Atlanta, Georgia, USA, September 12-16, 2010. This conference combines the former IEEE Power Electronics Specialists Conference (PESC) with the technical sessions of the Industrial Power Conversion Systems Department (Electrical Machines Committee, Industrial Drives Committee, Industrial Power Converter Committee and the Power Electronics Devices and Components Committee) previously presented at the IEEE Industry Applications Society Annual Meeting. Papers are solicited on any subject pertaining to the scope of the conference that includes but is not limited to the following.

Energy Conversion Systems

Renewable and Alternative Energy Systems: Solar and Photovoltaic Energy Systems and Interface, Wind Energy Systems and Interface, Water Energy Systems and Interface, Energy Harvesting, Fuel Cells and Conversion, Solid State Generation & Interface (e.g., Thermoelectric, Thermophotovoltaic, Thermionic), Energy Storage and Interface (e.g., Battery, Flywheel, SMES, Thermal)

Control Issues: Power Converter and Motor Control Algorithms; Real-Time Control Implementation; Digital Control Techniques; Sensors and Sensor Elimination Techniques for Power Electronics, Machines, and Drives; Measurement and Instrumentation

Thermal Management and Efficiency: Thermal Management of Electric Machines, Power Converters, and Drives; Energy Efficiency of Power Electronics, Electric Machines, and Drive Systems

Electrical Power Systems: Electrical Power System Architectures and Management; Distributed Resources and MicroGrid Power Systems

Power Quality, Grid Interface and EMI: EMI-EMC, Power Quality including Harmonics and Active Filters, Power Factor Correction

Reliability and Diagnostics: Reliability, Fault Management, Protection, and Fault Tolerance; Power Converter and Machine Diagnostics and Prognostics.

Modeling, Analysis and Simulation: Modeling, Analysis and Simulation Methods for Power Electronics and Motor Drives; Optimization Techniques for Electric Machines and Power Electronics

Other topics: Education Methodology and Tools for Power Electronics, Electric Machines, and Drives; Development and Harmonization of Standards for Electric Machines, Power Converters, and Drives

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Power Electronics Components and Packaging: Power Semiconductor Devices and Integrated Circuits; Passive Components: Inductors, Capacitors, Transformers, etc.; Energy Storage including Batteries and Ultracapacitors; Packaging and Modules; Integration at the Component, Power Converter, and Motor Drive Levels; New Materials Utilization in Power Electronics; Operation under Extreme Environmental Conditions

Electric Machines and Actuators: Permanent Magnet Machines; Induction Machines; Reluctance Machines; Linear Electric Machines; Electromechanical Energy Storage Systems (Flywheels); Special Machines, Actuators and Transducers; New Materials Utilization in Electric Machines and Actuators

Electric Drives: Drive Configurations for All Types of Electric Machines and Actuators; All Issues Related to the Performance, Control, Reliability, and Cost of Electric Drives; Drives of All Performance Levels Ranging from General-Purpose to High-Performance Servos; System Interactions between Drives, Machines, and Sources; MachineDrive Integration Issues

Applications: Transportation Applications for Automotive, Rail, Aerospace, and Marine, including Hybrid-Electric Drivetrains and Accessories; Lighting and Displays; Uninterruptible Power Supplies (UPS) Industrial, Residential, and Commercial Applications of Power Converters and Motor Drives; Servos, Robotics, and Mechatronics Systems; Utility Applications in Transmission and Distribution including HVDC; Biomedical Applications; Other Applications of Power Electronics, Electric Machines, and Drives

ECCE 2010 Author Deadlines:

July 1, 2009: Special Session Proposals

September 1, 2009: Notification of Special Session Acceptance

September 1, 2009: Tutorial Proposals

December 1, 2009: Notification of Tutorial Acceptance

January 15, 2010: Abstract and a digest of proposed papers must be submitted via the ECCE web site.

May 25, 2010: Notification to authors of acceptance or rejection of papers selected for presentation.

July 20, 2010: Completed papers and IEEE Copyright forms received.

The digest must be formatted as follows:

- ❖ File format: PDF
- ❖ Paper: US Letter (8.5 x 11 inches)
- ❖ Margins: 1 inch (2.5 cm) on top, bottom, left and right sides
- ❖ Single column, font size 12pt
- ❖ Please include page numbering in the header or footer

The recommended structure of the digest is as follows:

- ❖ Title
- ❖ Abstract of up to 150 words
- ❖ Digest of the proposed paper: The digest should contain a brief introduction that describes why the topic is important and how it relates to other work already found in the literature. The proposed approach and results should be presented in sufficient detail to permit a thorough and fair review. The body of the digest should end with a conclusion summarizing the key results and contribution of the proposed paper.
- ❖ References: A list of key references should be prepared that includes key past works that are directly relevant to the new contribution.

The above parts of the digest all need to be included in the single 5 page PDF file. Please do *NOT* include any author names or affiliations in the digest.

PROBLEMS WITH PREPARING AND SUBMITTING YOUR EXTENDED ABSTRACT? For further information, please contact the Conference Secretariat:

Dr. Peter Wung, A. O. Smith Electrical Products Company
Technical Program Co-Chairs - IEEE ECCE 2010
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Meetings of Interest

International Electric Machines and Drives Conference, IEMDC2009, will be held 3-6 May 2009 in Miami, FL. For more information please visit the conference website: <http://www.iemdc2009.org> or contact the General Chair, Prof. O.A. Mohammed at Chair@iemdc2009.org

The 4th International Telecommunication Energy Special Conference, TELESCON® 2009, with focus on Power Supply Quality and Efficiency, a satellite conference to INTELEC®, will be held 10-13 May, 2009 at the Hotel Golden Tulip, Vienna, Austria.

Symposium on Power Electronics and Machines in Wind Applications, PEMWA2009 will be held 24-26 June at the University of Nebraska-Lincoln. For more information please contact Prof. Hudgins j.hudgins@ieee.org or Prof. Patterson, patterson@ieee.org.

IEEE 7th International Symposium on Diagnostics for Electrical Machines, Power Electronics & Drives, SDEMPED2009, 31 August to 3 September 2009 in Cargese, France. For more information visit the website: www.sdemped09.iut-amiens.fr

IEEE Vehicle Power and Propulsion Conference, VPPC2009, will be held 7-10 September 2009 at the University of Michigan-Dearborn, Dearborn, MI. For more information visit www.vppc09.org or contact the General Chair, Prof. Chris Mi at mi@ieee.org

European Power Electronics, EPE2009, is planned for 8-10 September 2009 in Barcelona, Spain. Call for papers to be released in

May 2008 with deadline for receipt of synopses Nov. 2008. For more information visit: <http://www.epe2009.com>

1st Annual Energy Conversion Congress and Exposition (ECCE2009) is announced for 20-24 September 2009 at the Double Tree Hotel at 2050 Gateway Place in San Jose, CA. For more information on ECCE2009 visit the conference website: www.ecce2009.org

44th Industry Applications Society annual meeting is announced for 4-9 October 2009 in Houston, Texas. This will be a new meeting format following the transition of IAS committees to ECCE2009 with more emphasis on tutorials and workshops. For more information visit the website at: www.ieee.org/ias2009

The 8th International Conference on Power Electronics and Drives Systems, PEDS2009, will be held 2-5 November 2009 in Taipei, Taiwan ROC. PELS is technical co-sponsor for PEDS'09. For more information visit <http://www.peds09.ntust.edu.tw>

25th Annual IEEE Applied Power Electronics Conference and Exposition, APEC'10, will be held 21-25 Feb. 2010 at the Palm Springs Convention Center, Palm Springs, CA. For further details please visit www.apec-conf.org

2nd Annual Energy Conversion Congress and Exposition (ECCE2010) is announced for 12-16 September 2010 at the Hilton Atlanta hotel, 255 Courtland St. NE, Atlanta, GA. For more information on ECCE2009 visit the conference website: www.ecce2010.org

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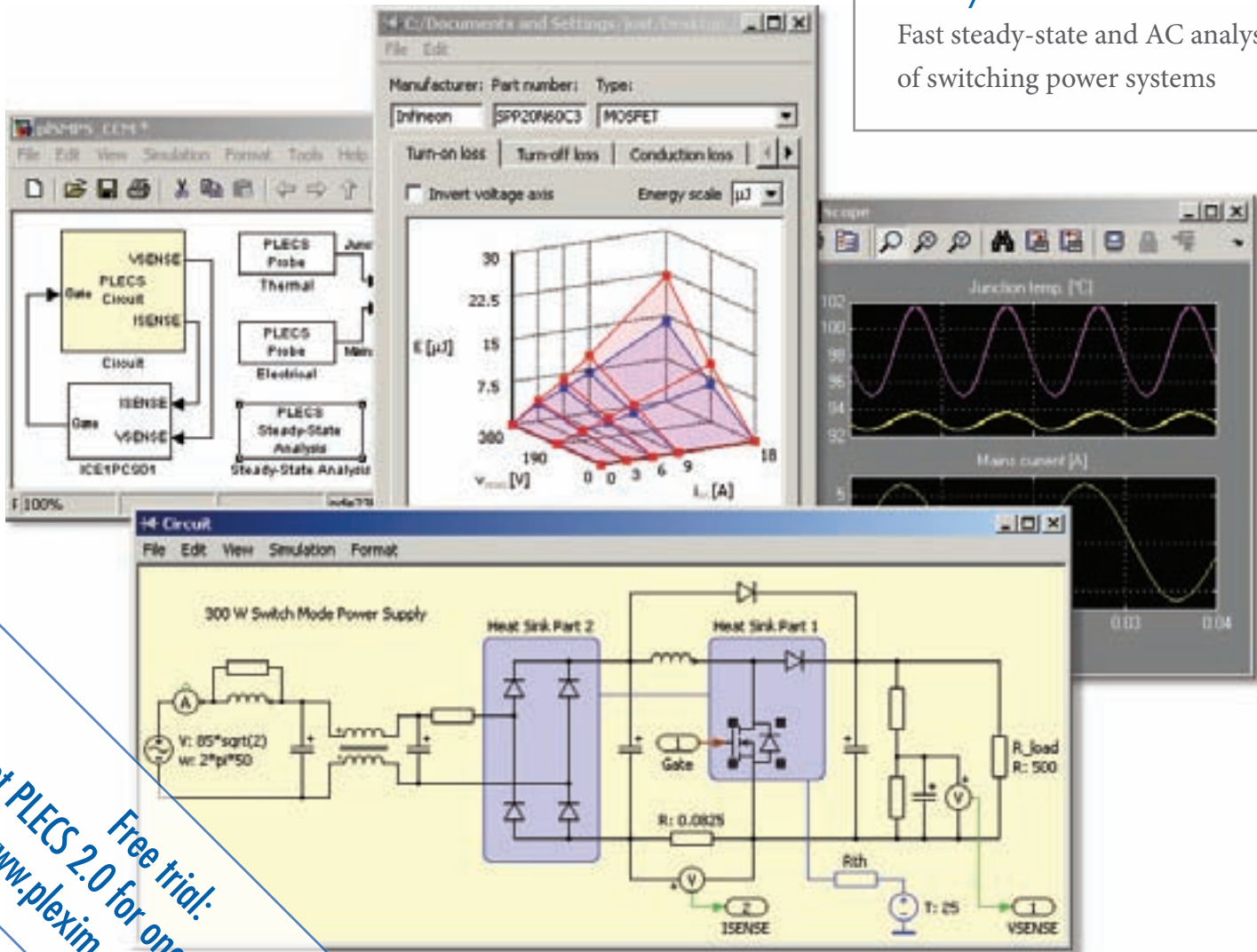
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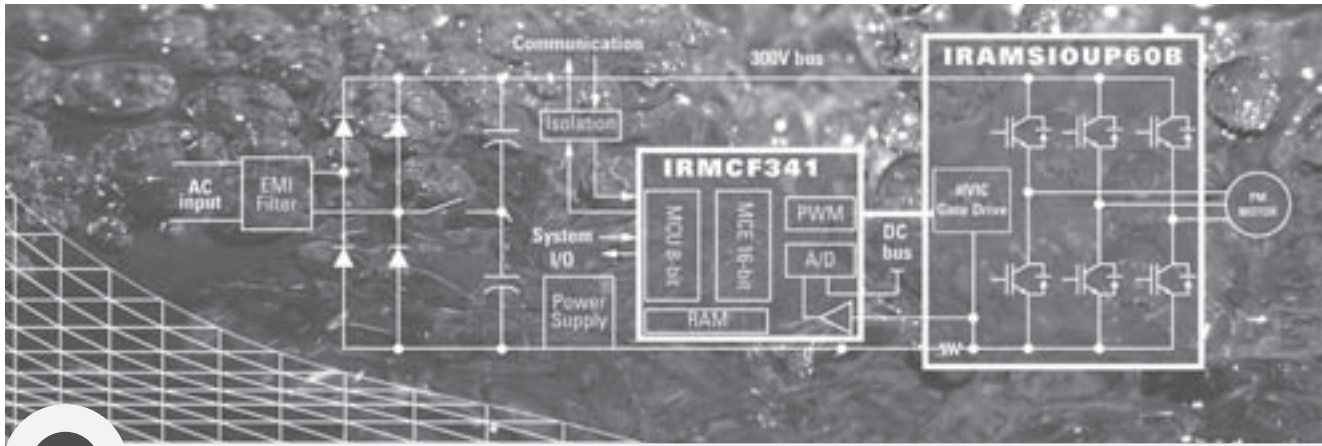
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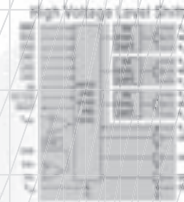
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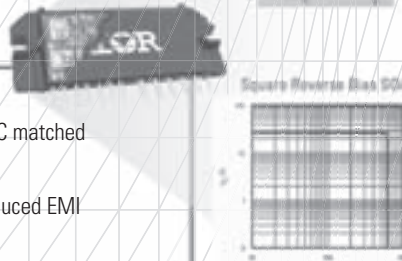
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