

THE APPLIED POWER ELECTRONICS
CONFERENCE AND EXPOSITION

APEC[®] 2007

Sunday, February 25 – Thursday, March 1, 2007
Disneyland[®] Hotel, Anaheim, California

22nd Annual
Applied Power Electronics
Conference and Exposition

APEC 2007 Sponsored by



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*For the latest news and information,
access to on-line conference and hotel
registration and downloadable registration
forms, log onto www.apec-conf.org.*

APEC 2007

2025 M Street, NW, Suite 800
Washington, DC 20046
P: (202) 973-8664
F: (202) 331-0111
E-mail: apec@apec-conf.org

FOREWORD

Welcome to the 22nd annual Applied Power Electronics Conference and Exposition – the premiere event in applied power electronics. APEC has come a long way since the first conference in 1986. The world of power electronics has changed dramatically as well, and APEC has been there to document and facilitate the advances in the field. In 2007, APEC returns for a fourth time to wonderful Disneyland in Anaheim, California.

Disneyland has long been a favorite destination for APEC attendees. Every year we go to Disneyland, we break the conference record for attendance. Early indications are that this year will be another record-breaker. As you look through the program you will find an outstanding array of opportunities to pick up new ideas and learn about power electronics. There is something for individuals of all levels of experience and technical backgrounds, at a price that makes APEC the most affordable conference you can find. You can also take in the APEC Exhibition. The exhibit hall is sold out, with over 125 companies presenting a wide range of products and services for the power electronics designer.

The Disneyland Hotel is located in the Downtown Disney area – a favorite spot for locals and visitors as well. The Downtown Disney area connects the hotel with the entrances to Disneyland and California Adventure. It consists of numerous shops and restaurants in a traffic-free area, with that unique Disney look and ambience. It is a wonderful place to visit after a long day at the conference, and a great place to take guests and your family. Our traditional Wednesday evening social event will be held in Studio 17, a part of the Hollywood back lot in California Adventure. You will be entertained by an eclectic mix of musical acts from the local area, as you dine in this brand new Disney facility. We will keep the bar open until late, and we have the infamous Tower of Terror all to ourselves. It is going to be an APEC social activity that simply cannot be missed.

APEC has become an annual event for many of us – a time to catch up with old colleagues and make new friends. If you have never been to APEC before, I think you and your company will greatly benefit from the experience. I am sure you will find APEC to be one of the most exciting, educational, and informative conferences you will ever attend. I look forward to seeing you at Disneyland!

Russ Spyker
General Chair

APEC 2007 CONFERENCE COMMITTEE

CONFERENCE COMMITTEE

Russ Spyker
General Chair
U.S. Air Force

Ada Cheng
OEM Initiative Chair
International Rectifier

Steve Pekarek
Program Chair
Purdue University

Joshua Israelson
Asst. OEM Initiative Chair
International Rectifier

Kevin Parmenter
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Fairchild Semiconductor

Laura Steffek
Rap Program Chair
Texas Instruments

Bill Dillard
Finance Chair
Archangel Systems

David Otten
MicroMouse Chair
MIT

Don Woodard
Exposition Chair
Venable Industries

Patrick Chapman
Publications Chair
University of Illinois

John Bassett
Asst. Exposition Chair
Artesyn Technologies

Jane Wilson
Guest Program Chair

Chuck Mullett
Asst. Exposition Chair
ON Semiconductor

Jim Templeton
Member-At- Large
Maxim Integrated Products

Tim Haskew
Seminar Chair
University of Alabama

Van Niemela
Past General Chair
Fairchild Semiconductor

Bill Peterson
Asst. Seminar Chair
E&M Power

Greg Evans
Publicity Chair
Welcomm, Inc.

Matt McKinney
Asst. Publicity Chair
Texas Instruments

APEC 2007 CONFERENCE MANAGEMENT

CONFERENCE MANAGEMENT

Pamela Wagner

*Sr. Conference Manager
Courtesy Associates*

Kristin Goen

*Conference Manager
Courtesy Associates*

Tonya Freeland

*Conference Manager
Courtesy Associates*

Amy Roth

*Conference Manager
Courtesy Associates*

STEERING COMMITTEE

Russ Spyker

*U.S. Air Force (IAS,
General Chair)*

Mark Nelms

Auburn University (IAS)

Van Niemela

*Fairchild Semiconductor
(PSMA, APEC
Administrator)*

Dong Tan

Northrop Grumman (PELS)

Jerry Hudgins

*University of Nebraska
(PELS)*

Steve Pekarek

*Purdue University (PELS,
Next General Chair)*

Robert White

*Artesyn Technologies
(PSMA)*

Jim Kokernak

*Advanced Energy
Conversion (IAS)*

Bruce Miller

Dell, Inc. (PSMA)

CONFERENCE HIGHLIGHTS

PLENARY SESSION

Since APEC 2007 is in California, perhaps a good movie title is an appropriate description of the plenary. How about **BACK TO THE FUTURE?**

The plenary will open with Bob Mammano, who received PE Tech's 2005 Lifetime Achievement Award is considered by many as the "the father of the PWM controller IC industry." His presentation will take us back with a historical perspective on the power electronics industry. From there the plenary will head toward the future with Andrew Fanara, who manages the Energy Star Product Specifications Development Team at the US Environmental Protection Agency; co-director of the Colorado Power Electronics Consortium Dragan Maksimovic; Christopher James, Vice-President for Marketing at Cree, Inc.; CEO of one of the top power electronics semiconductor companies in the world Mark Thompson of Fairchild Semiconductor; and Vatche Vorperian of NASA's Jet Propulsion Laboratory will wrap up our Plenary. Detailed write-ups of each presentation can be found on page 20.

PROFESSIONAL EDUCATION SEMINARS

APEC is the premier event in applied power electronics. The APEC program addresses a broad range of topics in the use, design, manufacture and marketing of all kinds of power electronics equipment. If you are in the power electronics business, here is why you should make APEC a regular part of your career development: The combination of high quality professional education seminars, a full program of refereed papers and an overflowing Exhibit Hall consistently provides an invaluable education each year. The value of APEC to working power electronics professional is shown by the ever growing number of participants.

TECHNICAL SEMINARS & SESSIONS

Industry professionals just like you participated in a rigorous peer review process and have carefully selected 265 papers making up APEC's Technical Sessions. This process eliminates the commercial content from the technical sessions, and provides the highest quality possible. The technical program includes papers of broad appeal scheduled for oral presentation from Tuesday morning to Thursday afternoon. Papers with a more specialized focus are available for discussion with authors at the Dialogue Sessions on Thursday at 11:30 am. The various technical

venues cover all areas of technical interest to the practicing power electronics professional. The papers are sure to give you many new design ideas that you can return home with and apply to your work immediately.

EXHIBITOR SEMINARS & EXPOSITION

Looking for answers to the problems that are waiting for you when you get back to the office or lab? The APEC Exhibitor Seminars may have the answers you are looking for. These half hour presentations give you a more in-depth look at an Exhibitors products or services than you can get by just dropping by their booth. With presentations on so many topics, you are sure to find several of interest. The seminars will be held Tuesday afternoon and Wednesday morning.

Entrance to the Exhibition is open to all conference attendees, including holders of the free Exhibits Only registration! Stop by the registration desk for your complimentary "Exhibits Only" badge.

MICROMOUSE CONTEST



APEC will once again host the World-Famous APEC Micro-Mouse Competition, the only event of its kind in North America,

drawing contestants from all over the world. The contest will take place on Monday from 8:00 pm to 10:00 pm in the North Ballroom A.

CONFERENCE SOCIAL EVENT

The Wednesday evening Social Event will take place on Stage 17, located in the heart of the Hollywood Pictures Backlot in Disney's California Adventure Park. Dinner and "revolving" entertainment will take place from 6:30 pm to 11:00 pm. If you need to take a break, the Twilight Zone "Tower of Terror" will be available exclusively for APEC attendees.

SPOUSE AND GUEST PROGRAM

APEC welcomes the spouses and guests of the APEC conference participants into all conference activities, the Exhibit Hall receptions and the MicroMouse Contest. A welcome breakfast will be held on Monday, February 26 and the Spouse and Guest Hospitality room will be open each morning to provide a place to meet, have coffee and make plans for the day. APEC 2007 has also arranged for two optional tours. Details can be found on page 9.

GENERAL INFORMATION

CONFERENCE HOTEL & LOCATION

Disneyland® Hotel
1150 W. Magic Way
Anaheim, CA 92802
P: (714) 520-5005
F: (714) 520-6079
<http://disneyland.disney.go.com/>

The original Disney hotel has the feeling of magic wherever you turn. The fun and fantasy here will leave you with sweet dreams that always end happily ever after. The hotel is conveniently located adjacent to the Downtown Disney® District with a state-of-the-art business center and conference facilities unrivaled by many Anaheim hotels.

GROUND TRANSPORTATION

From Los Angeles International Airport (LAX)

Web Site: www.los-angeles-lax.com

For many traveling from outside the United States, the Los Angeles International Airport (LAX) may offer the most convenient access to the Disneyland Hotel.

Taxicab Service

Fare: Approximately \$45 - \$50.00
Available from curbside on the Lower Level

Super Shuttle

Fare: Approximately \$15.00 One Way / \$30.00 Round Trip
P: (714) 517-6600 / (800) 258-3826
Web Site: www.supershuttle.com

Airport Bus

Fare: \$16 One Way, \$25 Round Trip
P: (714) 938-8937 / (800) 772-5299
Web Site: www.airportbus.com

From John Wayne/Orange County Airport (SNA)

Web Site: www.ocair.com

For many traveling within the United States, the John Wayne/Orange County airport (SNA) will offer the most convenient access to the Disneyland Hotel. The airport's Ground Transportation Center (GTC) houses all Ground Transportation Services. The GTC is located in the center of the Thomas F. Riley Terminal.

Taxicab Service

Fare: Approximately \$20.00.

Super Shuttle

Fare: Approximately \$11.00 One Way / \$22.00 Round Trip

P: (714) 517-6600 / (800) 258-3826

Web Site: www.supershuttle.com

Airport Bus

Fare: \$11 One Way / \$18 Round Trip

P: (714) 938-8937 / (800) 772-5299

Web Site: www.airportbus.com

Parking at The Disneyland Hotel

The Disneyland Hotel offers complimentary self parking at the hotel for its guests. Attendees who are not registered guests with the hotel will be charged \$6.00/hr or a maximum of \$20.00/day.

TRANSPORTATION DISCOUNTS

Transportation discounts can be obtained through:

Avis: The rental car discount number is A606092. This offer is valid on cars rented at either John Wayne Orange County Airport or LAX.

American Airlines: This offer is valid February 22 through March 4. This offer is valid for flights in and out of either John Wayne or LAX. When calling you must reference the authorization number A5427AD.

CONFERENCE REGISTRATION

In order to participate in the 2007 APEC Conference you must be registered. Prepaid conference registration is required for the professional educational seminars, presentation sessions and dialogue sessions.

To obtain the early registration rate your registration must be received by Friday, January 26. To register or pick up your conference materials please visit the Conference Registration Center located in the La Strada Registration Area located on the ground level of the Marina Tower.

Registration Times

Saturday, February 24	3:00 pm - 6:00 pm
Sunday, February 25	8:00 am - 5:00 pm
Monday, February 26.....	8:00 am - 5:00 pm
Tuesday, February 27	8:00 am - 5:00 pm
Wednesday, February 28	8:00 am - 3:00 pm
Thursday, March 1	8:00 am - 12:00 pm

On-Line Registration

With the mere click of a button, you can register online at: www.apec-conf.org

Registering By Mail Or Fax

Registration forms can be downloaded from the APEC Web site, www.apec-conf.org. Completed forms are to be mailed or faxed to the below address. All forms must be received by February 20, 2006:

APEC 2007/ Badgeguys
1959 Jester Circle
Lawrenceville, GA 30043
F: (678) 407-3237

Registration policies can be found either on page 82 or online at www.apec-conf.org.

INFORMATION FOR PRESENTERS

For presenters in the Special Presentations and the Oral Technical Sessions, you must attend a mandatory speaker breakfast at 7:00 am in the Pavilion Room on the morning of your presentation. The Program Chair will host this breakfast at which you will be given your speaker ribbon and provided instructions.

If you have not provided your biography to your sessions chair beforehand, you can give it to him or her at the breakfast. Your presentation will have already been loaded onto the computer in the meeting room. Immediately after breakfast you will be able to review it and check out the room with your session chair.

For those presenters in the Dialogue Sessions, you will have a breakfast in the Exhibit Hall at 7:00 am on Thursday, March 1. After breakfast and brief instructions you will be able to mount your presentation to the poster boards in the same room, using thumb tacks we will provide. Please do not go straight to your poster.

MESSAGE CENTER

A bulletin board for messages will be placed near the main conference registration area in the La Strada Registration Area located on the ground level of the Marina Tower.

SPOUSE & GUEST PROGRAM

APEC welcomes the spouses and guests of the APEC conference participants into all conference activities, the Exhibit Hall receptions and the MicroMouse Contest.

Spouse and Guest Hospitality Room

Monday, February 26 – Thursday, March 1

8:00 am — 11:00 am

Cerritos Room

Spouse and Guest Welcome Breakfast

Monday, February 26

8:00 am — 9:00 am

Cerritos Room

OPTIONAL TOURS

Pickup for all tours will be in the Cerritos Room.

A Roman Holiday...the Getty Villa in Malibu

Monday, February 26, 2007

9:00 am — 4:00 pm

\$80/person (lunch included)

The classical world is recaptured at the Getty Villa through buildings and landscape inspired by ancient sites around the Bay of Naples. Perched on the cliffs above the Pacific Ocean in Malibu, the Villa was built by J. Paul Getty to recreate the ancient Roman villa of the Papyri in Herculaneum, near Pompeii, before its destruction by a volcanic eruption of Mt. Vesuvius in A.D.79.

The Getty Villa reopened on January 28, 2006 to house the Getty Center's magnificent antiquities collection of monumental marble sculptures and diminutive bronzes; Greek and Roman gems; Hellenistic silverware and Jewelry; one of the finest assemblages of Greek vases in the United States; and a wide variety of ancient glass.

Equally magnificent are the gardens...four of them creating a Mediterranean flower, shrub and tree show. Many of the plants were chosen because they were thought to be prevalent in the ancient Mediterranean world.

California Dreaming

Tuesday, February 27, 2007

10:00 am — 3:00 pm

\$70/person (lunch included)

The winter sun dances off the water and presents a golden vision of dramatic cliffs and ocean vistas rarely seen beyond the confines of picture postcards during your trip down the coast to beautiful Laguna Beach, the seaside community known as "the Riviera of the Pacific" because of its unique location and its special emphasis on all aspects of the arts.

You won't proceed more than a few steps along Forest Avenue or Pacific Coast Highway without passing an artist's studio or local gallery, with works on display from the chic and sleek to the romantic and whimsical. Whether it is the surreal marine prints of Wyland, the impressionistic masterpieces at the Redfern or even the tongue-in-cheek humor at the Sherwood, there is something to catch everyone's eye in Laguna.

Your tour guide will give you a Laguna Beach brochure and walking map of the downtown area to locate any special places that are on your "must see" list and will be happy to lead interested guests on a gallery tour near the Café.

PURCHASING OF CONFERENCE PROCEEDINGS AND SEMINAR WORKBOOKS

Only CD copies of the APEC Proceedings will be provided with the Full or Technical Sessions registration.

Conference registrants can purchase extra copies of the Conference Proceedings and Seminar Workbooks through Early Registration. APEC reserves the right to limit quantities of APEC Proceedings or Seminar Workbooks sold to any one person or institution.

A LIMITED NUMBER of copies of the Conference Proceedings and Seminar Workbooks may be available for sale at the Conference Registration Center, starting at 12:00 pm on Wednesday, February 28.

Workbook Pricing

	On or before January 26	Onsite
Conference Proceedings (<i>Hardcopy or CD-ROM</i>)	\$100	\$175
Seminar Workbook (<i>Hardcopy only</i>)	\$100	\$175

Publications purchased on or before January 26 will be available for pick-up when you register for the conference.

PURCHASING THROUGH THE IEEE

Post conference APEC Proceedings may be purchased through the IEEE.

IEEE Single Copy Sales

445 Hoes Lane

Piscataway, New Jersey 08854

P: (800) 678-4333 (USA & Canada) or (732) 981-0060

<http://shop.ieee.org/ieeestore/>

Conference-At-A-Glance

Saturday, February 24

Registration

Sunday, February 25

Registration

S1: Designing Your First Digitally Controlled Power Converter

S2: Matrix Converters.....

S3: Defining and Specifying Transformers and Inductors

S4: Power Electronics Analysis and Design Using Evolutionary Algorithms

S5: Practical Average-Value Modeling of Power Electronic Systems.....

S6: Robust Design - A Checklist of What Can Zap Power Electronics.....

S7: Power Design for Digital Designers

S8: Designing Power Systems for Electronic Equipment.....

S9: The Forward Converter: Isolated Gate Drives

S10: IC Implementation of High-Frequency Digitally Controlled SMPS

S11: Modeling and Simulation of Power Electronics/Machines.....

S12: Worst Case Circuit Analysis of Power Conversion Circuits.....

Monday, February 26

Registration

Spouse & Guest Welcome Breakfast

S13: Designing Intelligent Power Supplies.....

S14: Automotive Fuel Cell Power Electronic Converters.....

S15: Ultracapacitor Case Studies: Industrial,
Commercial, and Automotive.....

S16: Introduction to Power Electronics Packaging.....

S17: Accelerated Steady State Analysis for Switching Systems

KEY:

S – Professional
Education Seminars
R – Rap Sessions

SP – Special Presentations
T – Technical Sessions

..... 3:00 pm – 6:00 pm La Strada Registration Area

..... 8:00 am – 5:00 pm La Strada Registration Area

..... 9:30 am – 1:00 pm Marina Ballroom 1

..... 9:30 am – 1:00 pm Marina Ballroom 2

..... 9:30 am – 1:00 pm Marina Ballroom 3

..... 9:30 am – 1:00 pm Marina Ballroom 4

..... 9:30 am – 1:00 pm North Ballroom B

..... 9:30 am – 1:00 pm South Ballroom B

..... 2:30 pm – 6:00 pm Marina Ballroom 1

..... 2:30 pm – 6:00 pm Marina Ballroom 2

..... 2:30 pm – 6:00 pm Marina Ballroom 3

..... 2:30 pm – 6:00 pm Marina Ballroom 4

..... 2:30 pm – 6:00 pm North Ballroom B

..... 2:30 pm – 6:00 pm South Ballroom B

..... 8:00 am – 5:00 pm La Strada Registration Area

..... 8:00 am – 9:00 am Cerritos Room

..... 8:30 am – 12:00 pm Marina Ballroom 1

..... 8:30 am – 12:00 pm Marina Ballroom 2

..... 8:30 am – 12:00 pm Marina Ballroom 3

..... 8:30 am – 12:00 pm Marina Ballroom 4

..... 8:30 am – 12:00 pm North Ballroom B

Conference-At-A-Glance (Continued)

Monday, February 26 (Continued)

S18: An Introduction to Reliability and to Practical Design Practices for Designing Reliable Products

Plenary Session.....

Exhibit Hall Welcome Reception

MicroMouse Contest.....

Tuesday, February 27

Registration

SP1: Market Trends.....

T1: Digital Control Applications.....

T2: Passive Components

T3: Power Factor Correction

T4: Voltage Regulator Modules I

T5: Induction Motor Drives

T6: Lighting.....

Exhibition

Exhibitor Presentation – Session 1.....

Exhibitor Presentation – Session 2.....

Exhibitor Presentation – Session 3.....

R1: If It Ain't Broke, Why Go Digital?.....

R2: Power Electronics Education: Is it Meeting the Need?

R3: Satisfying Demand for High-Current at Low-Voltage:
Are We Addressing the Right Problems?

Wednesday, February 28

Registration

T7: PWM Techniques

KEY:

S - Professional
Education Seminars
R - Rap Sessions

SP - Special Presentations
T - Technical Sessions

..... 8:30 am – 12:00 pm..... South Ballroom B

..... 1:30 pm – 5:30 pm..... Grand Ballroom

..... 5:30 pm – 8:00 pm..... La Strada Registration Area

..... 8:00 pm – 10:00 pm..... North Ballroom A

..... 8:00 am – 5:00 pm..... La Strada Registration Area

..... 8:30 am – 12:00 pm..... North Ballroom B

..... 8:30 am – 12:00 pm..... Marina Ballroom 1

..... 8:30 am – 12:00 pm..... Marina Ballroom 2

..... 8:30 am – 12:00 pm..... Marina Ballroom 4

..... 8:30 am – 12:00 pm..... Marina Ballroom 3

..... 8:30 am – 12:00 pm..... South Ballroom A

..... 8:30 am – 12:00 pm..... South Ballroom B

..... 12:00 pm – 5:00 pm..... Exhibit Hall

..... 1:30 pm – 2:00 pm..... *See page 75*

..... 2:15 pm – 2:45 pm..... *See pages 75-76*

..... 3:15 pm – 3:45 pm..... *See page 76*

..... 5:00 pm – 6:30 pm..... North Ballroom B

..... 5:00 pm – 6:30 pm..... South Ballroom B

..... 5:00 pm – 6:30 pm..... South Ballroom A

..... 8:00 am – 3:00 pm..... La Strada Registration Area

..... 8:30 am – 10:15 am..... Marina Ballroom 1

Conference-At-A-Glance (Continued)

Wednesday, February 28 (Continued)

T8: Semiconductor Devices.....	
T9: Dc-Dc Converter Topics	
T10: Adjustable Speed Motor Drives	
T11: Packaging, Thermal, and Test	
T12: Modeling/Control of Power Electronic Systems	
SP2: Doing Business with Power Electronics.....	
Exhibition	
Exhibitor Presentation – Session 4.....	
SP3: System Design.....	
T13: Control Techniques.....	
T14: Alternative Energy Systems	
T15: Non-Isolated Dc-Dc Converters	
T16a: Modeling/Control of Motor Drives.....	
T16b: Z-Source Inverters.....	
T17: Single and Multi-Phase Inverters	
T18: Active Filters	
Evening Social Event.....	

Thursday, March 1

Registration	
SP4: Power Electronics for Greener World	
T19: Voltage Regulator Modules II	
T20: Isolated Dc-Dc Converters I	
T21: Ac-Dc Converters	
T22: Permanent Magnet Motor Drives	

KEY:

S – Professional
Education Seminars
R – Rap Sessions

SP – Special Presentations
T – Technical Sessions

8:30 am – 10:15 am	Marina Ballroom 2
8:30 am – 10:15 am	Marina Ballroom 3
8:30 am – 10:15 am	Marina Ballroom 4
8:30 am – 10:15 am	South Ballroom A
8:30 am – 10:15 am	South Ballroom B
8:30 am – 10:15 am	North Ballroom B
10:15 am – 2:00 pm	Exhibit Hall
10:30 am – 11:00 am	<i>See page 76</i>
2:00 pm – 5:30 pm	North Ballroom B
2:00 pm – 5:30 pm	Marina Ballroom 1
2:00 pm – 5:30 pm	Marina Ballroom 2
2:00 pm – 5:30 pm	Marina Ballroom 3
2:00 pm – 5:30 pm	Marina Ballroom 4
2:00 pm – 5:30 pm	Marina Ballroom 4
2:00 pm – 5:30 pm	South Ballroom A
2:00 pm – 5:30 pm	South Ballroom B
6:30 pm – 11:00 pm	Stage 17
8:00 am – 12:00 pm	La Strada Registration Area
8:30 am – 11:30 am	North Ballroom B
8:30 am – 11:30 am	Marina Ballroom 1
8:30 am – 11:30 am	Marina Ballroom 2
8:30 am – 11:30 am	Marina Ballroom 3
8:30 am – 11:30 am	Marina Ballroom 4

CONFERENCE PROGRAM

PLENARY SESSION

Monday, February 26

1:30 pm - 5:30 pm

Grand Ballroom

Since APEC 2007 is in California, perhaps a good movie title is an appropriate description of the plenary. How about **BACK TO THE FUTURE?** Huh? What the? Ok, let's just see the previews for you to judge for yourself.

Opening Remarks

1:30 pm - 1:45 pm

A Historical Perspective of the Power Electronics Industry

1:45 pm - 2:15 pm

Speaker: Bob Mammano, *Staff Technologist and a TI Fellow in Texas Instruments Power Management Products Group*



The plenary will open with Bob Mammano, an industry icon. His presentation will take us back with a historical perspective on the power electronics industry. Bob, who received PE Tech's 2005 Lifetime Achievement Award is considered by many as the "the father of the PWM controller IC industry." His IC design, the SG1524, ushered a revolutionary change in the switch-mode power supply industry.

Is there a person in the universe that is more qualified to make a presentation on the history of the power electronics industry? We don't think so.

Energy Efficiency, New Challenges for the Power Electronics Industry

2:15 pm - 2:45 pm

Speaker: Andrew Fanara, *of the U.S. Environmental Protection Agency, Energy Star Program*

Following Bob, we will head toward the future. Andrew Fanara, who manages the Energy Star Product Specifications



Development Team at the US Environmental Protection Agency will describe how energy efficiency standards will present new challenges for the power electronics industry. As power electronics engineers are always pressed to establish the tradeoff between cost, weight, volume, and efficiency, a presentation highlighting the impact of

energy efficiency on the balance could hardly come at a better time.

Boulder Digital Control of Power, A Researcher's Perspective

2:45 pm - 3:15 pm

Speaker: Dragan Maksimovic, *Professor at the Colorado Power Electronics Center, University of Colorado*



Reading any power electronics trade magazine within the last few years, a dominate buzzword is 'digital'. Digital power management has received much of the attention, and Dragan Maksimovic's program at the University of Colorado - Boulder has been at the forefront of this technology. As co-director of the Colorado Power

Electronics Consortium he leads a team of researchers investigating enabling technologies for smart and efficient utilization of conventional and renewable energy sources. Dragan will predict what to expect from the next generation of products and applications, as well as the prospects for widespread adoption of digital control.

Break

3:15 pm – 4:00 pm

Ultra High Brightness LED's – Disruptive Technology that's Changing the Lighting Industry

4:00 pm - 4:30 pm

Speaker: Christopher James, *Vice President of Cree, Inc.*

After a break to catch up with colleagues, we will be treated to the latest on ultra-high brightness LEDs from Christopher James, Vice-President for Marketing at Cree, Inc. This disruptive technology is poised to overturn a century of dominance by incandescent and fluorescent lighting technology, and Cree is leading the way. Major industries such as backlighting, LCD TV Monitors, exit and accent lighting,



automotive and even general purpose lighting are being transformed. Power electronics will be key in all of these applications, since highly efficiencies LED drivers will be a requirement. Christopher will share with us his vision of the opportunities in power electronics as ultra-high brightness LED technology makes further inroads into

the lighting business.

The Future of Power Semiconductors

4:30pm - 5:00 pm

Speaker: Mark Thompson, PhD, *President and CEO of Fairchild Semiconductor*



As the CEO of one of the top power electronics semiconductor companies in the world, Mark Thompson of Fairchild Semiconductor is uniquely positioned to understand the competitive pressures on global power electronics customers by their end users. Much of the innovation which enables power electronics systems to meet the

criteria required by their end markets rely on progress in semiconductor technologies and semiconductor packaging technologies. The world's resources are becoming scarcer and the demand to create higher efficiency systems is increasing. High energy efficiency is now expected, while still meeting the expectations on price, total cost of ownership, size, packaging performance, density, industry regulations, safety and EMI-RFI levels. Hear from one of the top experts, sitting in the driver's seat on how events in the power semiconductor industry will unfold in the near future and how this will impact advances in power electronics.

Power Electronics at the Extremes of Possibility

5:00 pm - 5:30 pm

Speaker: Vatche Vorperian, PhD, *of NASA's Jet Propulsion Laboratory, California Institute of Technology*

Vatche Vorperian of NASA's Jet Propulsion Laboratory wraps up our Plenary with a presentation on his work in power electronics circuits for space applications and applications of MEMS devices. His research over the years has enabled systems and solved problems previously thought to be impossible or unsolvable. We will hear how his recent efforts span the gamut of leading edge technologies



— applications that push the envelope of size, power density, energy density and voltage. Many of these systems are mission critical — not only are they state of the art in performance, they must also have high reliability since service calls for JPL-fielded equipment are usually impossible. We are sure you will find the presentation on

the “exotic” applications of power electronics informative, enlightening and thought provoking.

PROFESSIONAL EDUCATION SEMINARS

APEC strives to offer seminars with a practical mix of theory and application for the professional working in power electronics. APEC 2007 features 18 professional education seminars with a broad range of topics.

Session 1: Sunday, February 25

9:30 am – 1:00 pm

Designing for Digital Power

S1 Designing Your First Digitally Controlled Power Converter

Marina Ballroom 1

Speaker: Chris Young, *Zilker Labs*

Digital power conversion offers many advantages over analog power conversion in terms of design speed, agility, robustness, efficiency, and cost. With the number of digital controller offerings growing and the fact that changing from analog to digital control requires additional know-how, the power engineer is faced with an almost overwhelming task in developing his first digitally controlled power converter. This seminar explores the process of designing a digitally controlled power converter. The introduction will cover the differences and advantages of digital control relative to analog control. From there we will launch into a detailed design of a power converter using an off-the-shelf digital controller. Although geared towards engineers with intermediate levels of experience, both entry level and advanced level engineers will benefit from this seminar.

Converters and Systems

S2 Matrix Converters

Marina Ballroom 2

Speakers: Patrick Wheeler, Christian Klumpner, *University of Nottingham*; Johan Kolar, Frank Schafmeister, *Swiss Federal Institute of Technology Zurich*

Recently there has been considerable interest in the use of matrix converter technology for motor drive applications, in industrial drives as well as for aerospace applications. This tutorial will give an in depth introduction to full range of direct and matrix converter technologies and investigate the suitability and design of matrix converters. The potential advantages of matrix converter technology will be examined, and the factors that have so far limited commercial exploitation of the circuit are discussed. The tutorial is aimed at anybody interested in the area of direct (matrix) converters. It will start with a basic introduction to the topology and lead into in-depth discussion on the critical research developments and topical issues.

Power Electronic Components

S3 Defining and Specifying Transformers and Inductors

Marina Ballroom 3

Speaker: D. Monroe, *Torotel Products*

This seminar targets the entry level to intermediate level component engineer or circuit engineer who specifies transformers and inductors for use in power electronics. This engineer may have little understanding of the processes used to manufacture the component and its behavior under test conditions and operating conditions. This seminar provides guidelines for selecting a component type, defining a layout, specifying electrical test conditions and tolerances, and specifying dimensional measurement points and tolerances. The engineer can use this knowledge to select or define the most appropriate component and produce an effective specification document.

Electrical and Physical Design

S4 Power Electronics Analysis and Design Using Evolutionary Algorithms

Marina Ballroom 4

Speaker: S.D. Sudhoff, *Purdue University*

This seminar will introduce attendees to the use of evolutionary algorithms as an optimization approach for use in power electronics analysis and design. Evolutionary algorithms are an appropriate optimization method for use in problems in which the mathematical properties of the objective function are unknown, the objective being maximized is discontinuous, the problem cannot be shown to be convex, the search space is large, or any combination of these conditions. Optimization using evolutionary algorithms does not require gradients of the objective function, or an approximate initial solution. Further, the nature of the method makes it amenable to finding global solutions. This course will discuss the main concepts of evolutionary algorithms and apply them to a variety of power electronics problems. The level of the course is an overview intended for an entry-level audience.

Modeling and Simulation

S5 Practical Average-Value Modeling of Power Electronic Systems

North Ballroom B

Speaker: Juri Jatskevich, *University of British Columbia*

This seminar gives an overview of average-value modeling techniques and their application to power-electronic-based systems/modules/components such as those used in modern vehicles, ships, aircraft, wind turbines, PVs, etc. The seminar may be of interest to an audience of all levels who are in the field of power electronics, machines drives, renewable energy sources, and the modeling/simulation of such systems. Desirable properties of averaged models for large-signal time-domain transient studies and small-signal frequency-domain analyses are discussed. The notion of operational modes is defined and demonstrated on various systems. A computer-aided parametric methodology is presented as an approach to deal with the complexity and challenges of developing accurate dynamic average-value models. The example systems presented at the seminar include PWM Dc-Dc converters, synchronous machine rectifier sets, and brushless DC motor drives. For each example system, the methodology of establishing parametric average-value model is presented with discussion of results.

Designing for Reliability

S6 Robust Design — A Checklist of What Can Zap Power Electronics

South Ballroom B

Speaker: Art Brockschmidt, *Boeing Phantom Works*

Power electronics failures often occur due to a stress not taken into account during the design phase. Failures range from development test failures to long-term reliability concerns and can be spectacular, are often costly, or cascade to other hardware. This seminar is a survey of electrical environments and their impacts on power electronics, and it provides anyone from the novice to the experienced designer with an overview of electrical environments and a checklist of design environments.

Session 2: Sunday, February 25

2:30 pm – 6:00 pm

Designing for Digital Power

S7 Power Design for Digital Designers

Marina Ballroom 1

Speakers: Pat Hunter, Mike Claasseeen, Chris Cooper, Daniel Godfrey, *Avnet*

This seminar is intended as a comprehensive introduction to power supply design for digital design engineers that are faced with powering modern digital integrated circuits such as FPGAs, DSPs and microprocessors. Complex device design and shrinking die sizes have lead to increasing demands on board level power solutions. Also, an industry trend shows electronic design companies often relying on their digital designers to provide these solutions since they do not employ dedicated power designers. This seminar provides the digital designer with the knowledge necessary to effectively design point-of-load (POL) power supplies for the latest generation of digital circuits. The seminar will discuss the complexities and tradeoffs of selecting various POL power solutions. It will introduce the designer to the fundamentals of designing medium power linear regulators, buck switching power supplies and designing with point-of-load modules. It will describe topology selection, power supply tolerance specifications power supply transient performance, techniques for reducing noise, multiple rail sequencing, power supply decoupling, power supply layout techniques and thermal design. The presentation will focus on practical design techniques and will illustrate the “Dos and Don’ts” of digital power design with real design examples.

Converters and Systems

S8 Designing Power Systems for Electronic Equipment

Marina Ballroom 2

Speaker: Robert White, *Artesyn Technologies*

This seminar gives an overview of designing power systems for electronic equipment. The seminar starts with a problem statement: Convert power from a given source into power that can be used by a given load. The first step is to review the basic types and characteristics of power sources and electronic equipment loads. The next discussion is of the possible power system architectures that can be used to move power from source to load: central, distributed and hybrid. Then the various building blocks, AC-DC power supplies and Dc-Dc converters are reviewed to understand how to choose the best one for a given application. Reliability and availability are most important in today's equipment, and these get an extended review of the fundamentals. Important regulatory and agency standards are briefly reviewed. The discussion progresses to the fundamentals of power system protection and control methods. The emphasis is on understanding what is being protected, why it is being protected and choosing the best technique to achieve the needed performance. Distributed power systems are becoming common, and the seminar dedicates a section to distributed power system fundamentals. The seminar concludes with a survey of batteries in power systems and some miscellaneous design topics.

Power Electronic Components

S9 The Forward Converter: Isolated Gate Drives

Marina Ballroom 3

Speaker: F. Dong Tan, *NGST*

The forward converter remains an industrial workhorse in low-power Dc-Dc conversion. While previous presentations by the same author highlighted recent developments and performance comparisons in advanced circuit topologies (including current doublers and synchronous rectifiers) and input and output filter design, this seminar focuses on practical design aspects of isolated gate drives, including some most-recent developments in the field. With the constant demand for density, efficiency, and performance, a solid gate drive design is increasingly important for a robust product performance. A gate drive can make or break a design, especially under large transient conditions. This seminar is designed to address this particular challenge by providing a basic overall knowledge and practical design

guidelines. This seminar is intended for entry and intermediate-level design engineers who are facing increasingly stringent design requirements, often coupled together with constant pressure for cost and schedule.

Electrical and Physical Design

S10 IC Implementation of High-Frequency Digitally Controlled SMPS

Marina Ballroom 4

Speakers: Aleksander Prodic, Wai Tung Ng, *University of Toronto*

This educational seminar will show a systematic approach to the design and integration of digitally controlled switch-mode power supplies (SMPS) for Dc-Dc converters operating at high switching frequencies, ranging from a fraction of MHz to 20 MHz. It is expected that the audience attending the seminar has knowledge about basic switching converter topologies and understands the fundamentals of conventional feedback control theory. The seminar will consist of three main parts that cover the design and implementation of a complete SMPS, including the digital controller, power stage, and gate drivers.

Modeling and Simulation

S11 Modeling and Simulation of Power Electronics/Machines

North Ballroom B

Speaker: Jason Wells, *PC Krause and Associates*

Computer modeling, simulation, and analysis (MS&A) are used pervasively in the design of complex integrated systems often encountered in military and commercial applications. Such computer simulations can reduce risk, design costs, time-to-prototype, and overall life-cycle costs of such complex systems. To maximize the benefit of MS&A, it is critical to minimize the model development time, ensure model accuracy, maintain execution speeds necessary to allow useful engineering analysis and optimization, and provide an environment where component developers can share models while protecting proprietary information. The power electronics engineer faces particular difficulties in utilization of MS&A due to the numerically stiff nature of the systems generally of interest and the hybrid nature of continuous state systems with discrete switching events. This seminar will identify many of the pitfalls which typically hinder MS&A of power electronic systems and present solutions to these problems including modeling techniques and software packages which can accelerate model develop-

ment. Many of the issues addressed will be presented in the context of an integrated power and distribution system of a generic more electric aircraft (MEA) platform. Finally, a demonstration of such an integrated system simulation will be made to demonstrate the potential for high-fidelity integrated modeling efforts.

Designing for Reliability

S12 Worst Case Circuit Analysis of Power Conversion Circuits

South Ballroom B

Speakers: Steve Sandler, Charles Hymowitz, *AEi Systems*

This course is designed to provide the participant with the fundamental skills required to perform a Worst Case Circuit Analysis (WCCA). Participants learn the importance of this analysis and the different methods which can be utilized. The proper documentation format for communicating the analysis results is introduced with detailed and complete examples allowing the participant to gain a full understanding. Basic tolerance studies and their evaluation are presented for most common electronic components along with a variety of actual example analyses.

Session 3: Monday, February 26

8:30 am – 12:00 pm

Designing for Digital Power

S13 Designing Intelligent Power Supplies

Marina Ballroom 1

Speaker: Keith Curtis, *Microchip Technologies*

A wealth of information is available concerning the pros and cons of using microcontrollers in Switch-Mode Power Supply (SMPS) designs. However, little information is available on how microcontrollers can be designed into SMPSs; let alone how to choose an appropriate microcontroller. This workshop will address these issues by: 1) defining what a microcontroller does for an SMPS design, 2) presenting a framework of four standardized levels of microcontroller integration into power supplies, in order for designers to gauge what type of microcontroller and analog interface is needed to meet the requirements of their design, 3) providing examples of control and monitoring interface circuits for connecting digital microcontrollers to analog SMPS designs, and 4) demonstrating a simple method for designing the control software required to breathe intelligence into SMPS designs. To cover important information concerning the design process, software design methods will also be

presented. These methods include code reuse to shorten development times, hardware abstraction for more readable and maintainable code, a systematic methodology for easier design and testing, and a simple technique for building software that multitasks without the expense of an operating system. Attend this session to find out what a microcontroller can do for you and your power-supply design.

Converters and Systems

S14 Automotive Fuel Cell Power Electronic Converters

Marina Ballroom 2

Speakers: B. Fahimi, R. Jayabalan, *University of Texas at Arlington*

The seminar will introduce fuel cell systems and provide an overview of the technology drivers/developments in automotive fuel cell power electronic converters in the North American, European & Asia-Pacific markets. The presentation will focus and provide in depth analysis of operational constraints, design criteria and selection of fuel cell power conversion systems for automotive applications. This seminar will be valuable for Design/Inspection Engineers, Technical & Project Managers, System Designers, Researchers, Academicians and Graduate Students involved in fuel cell power converter design for vehicle products, renewable, distributed power generation and back-up power supplies.

Power Electronic Components

S15 Ultracapacitor Case Studies: Industrial, Commercial, and Automotive

Marina Ballroom 3

Speaker: John Miller, *Maxwell Technologies*

The purpose of this seminar is to acquaint the engineer and manager with illustrative examples of ultracapacitor applications and commercial benefits. In the commercial market ultracapacitors are finding application in uninterruptible power supply, telecommunications bridging power, wind turbine pitch adjusters, and as back-up power in the A380 door actuation electrical system. Automotive applications of ultracapacitors are emerging now as engine cold start aides and in the near term as energy recuperators in micro-hybrid vehicles. The presentation will be broken into three parts. Part 1 provides an overview of ultracapacitor technology, operating principles, safety and recycling, and concludes with a summary of the Maxwell Technologies development of a large signal, nonlinear, electrical equivalent model of the ultracapacitor cell and module. Part 2 covers industrial and commercial case studies of existing ultracapacitor in-

stallations. Part 3 will focus in more depth on the application of the ultracapacitor distributed module in automotive systems. Specifically, our focus will be on the cases of engine cold starting, micro-hybrid energy recuperation in a locally boosted dual voltage electrical architecture, and on plug-in hybridization and how ultracapacitors benefit this type of HEV. The presentation will be tailored to that of a practicing engineer and manager and will focus on the business and commercial aspects of the technology.

Electrical and Physical Design

S16 Introduction to Power Electronics Packaging

Marina Ballroom 4

Speaker: Douglas Hopkins, *University at Buffalo*

This seminar introduces the power electronics designer to packaging techniques useful in high-density board and box-level packaging design for power supplies, motor drives and lighting systems. Emphasis is placed on methods to density FR-4 systems and transition to higher density approaches, such as insulated-metal-substrates and metal-on-ceramic. The designer is introduced to five packaging methods, gain an understanding of packaging characteristics that limit current, voltage and density, gain familiarity with nomenclature and the origins of parasitics, and are presented guidelines for selecting and using several packaging processes. The study of thermal management techniques is an integral part of the discussions. Also included is a review of evolving integrated packaging approaches. A case study of a commercial power module will demonstrate an electro-physical circuit design and will be used to identify critical packaging issues. This is an essential course for those who must look at other packaging design approaches to further shrink their electronics. The seminar is intended for entry and intermediate level electrical engineers.

Modeling and Simulation

S17 Accelerated Steady State Analysis for Switching Systems

North Ballroom B

Speaker: Keng Wu, *Lockheed Martin*

An accelerated steady-state analysis and design confirmation technique is presented. The technique employs the concept of continuity of states and is capable of yielding extremely quickly the steady-state behaviors for dynamic systems driven by cyclic actions. Under the constraint of steady state operations, a switching system is understood to alter its structure among several distinctive topological

states. Each structural state is also understood to have a starting state and an end state. The end state of one structure serves as the starting state of the succeeding structure. For a system with finite topologies, the end state of the last topology wraps around as the starting state of the first. Two approaches are taken to explore the technique in depth: the conventional Laplace transformation and the state transition using linear algebra. By invoking the continuity of states and the wrapping around property, both yield the starting and the end states for each structure with a predetermined dwell time. As a result, the cyclic behavior of a switching system is obtainable in a single cycle. The technique bypasses transient settling that often bogs down conventional simulations which always start from zero state. In-depth treatment involving filter and Dc-Dc converter are given for intermediate audience.

Designing for Reliability

S18 An Introduction to Reliability and to Practical Design Practices for Designing Reliable Products

South Ballroom B

Speaker: Peter Bardos, *Commergy*

This seminar will lead to an understanding of the principles of reliability, and of the design, practices, test methods and procedures used in engineering to ensure a reliable product. Throughout this seminar the emphasis will be on practical knowledge and understanding (not just on information), and the use of mathematics will be avoided. The first half of the seminar will concentrate on understanding the concepts used in reliability, and the factors that affect them. The methods used in predicting, assessing and observing the failure rate are explored with practical examples. Confidence Limits and statistical methods are also introduced, as are the reliability of redundant (N+1) systems and the principles of Reliability Demonstration Testing (PRST). The second half will treat in some depth the rules and methods used in design and in testing the product to ensure reliability. These are "invisible" factors greatly affecting reliability, but seldom considered, and often ignored. Design rules and procedures to achieve a robust product are discussed; the principles of de-rating, of understanding the environment and design phase deliverables are introduced, and the importance of taking ownership of reliability emphasized. The correct testing procedures and techniques are shown, EVT, EQT and Technical Reviews are explored in some depth, HALT and HESS introduced. The seminar is intended for engineers with entry level to intermediate knowledge of Reliability, although specialists will benefit from some insights.

A couple of years ago APEC introduced the Special Presentations. Speakers were invited to make a presentation only without submitting a formal manuscript for the APEC Proceedings. This allowed APEC to present information on current topics in power electronics from sources that would not otherwise present at APEC. These sessions have been very popular. The target audience for these sessions differs from the engineers in typical technical sessions and may include business oriented people such as purchasing agents, information technologists, regulatory agencies, and other people who support the power electronics industry. These special presentations will not have papers in the APEC Proceedings and will be available online after the conference concludes at www.apec-conf.org.

SP1: Market Trends

Tuesday • 8:30 am – 12:00 pm • North Ballroom B

Session Chairs:

Ada Cheng, *International Rectifier*

Randhir Malik, *IBM Corporation*

Current market dynamics in the power-electronics sector are nearly as complex as the technologies underlying the industry's products. Regulation, consolidation, marketing strategies, distribution channels, and regional nuances cloud what otherwise appears as a reasonably clear market environment. This session provides a broad overview of various market trends in seven presentations for marketers, purchasing managers, product developers, and executives.

SP1.1: Demystifying Value Creation Through Pull Marketing Strategies

A. Alderman, *Anagenesis Inc.*; V. Panossian

SP1.2: Visible and Invisible Hands Demand Increased Efficiency

J. Bryant, *Darnell Group Inc.*

SP1.3: The Effect of Market Consolidation on the Dc-Dc Market

R. Ruiz, *Darnell Group Inc.*

SP1.4: Digital Power Packaging and How It Could Change the Power Industry

B. Narveson, *Texas Instruments*

SP1.5: Winning in China Through Understanding Its Power Needs & Cultural Dynamics

M. Towers, *IMS Research*

SP1.6: The Value of Distribution in Connecting Niche Power Solutions with a Diverse Customer Base

T. Makley, *Arrow Electronics, Inc.*

SP1.7: A New Marketing Tool for Power Supplies

M. Mankikar, *Micro-Tech Consultants (MTC)*

SP2: Doing Business with Power Electronics

Wednesday • 8:30 am – 10:15 am • North Ballroom B

Session Chair:

Joshua Israelsohn, *International Rectifier*

No matter how remote your sales, distribution, or marketing channels, two aspects of your customer relationship are always direct: product recalls and doing business online. This session features two presentations on recalls—their avoidance and responsible action plans when they become unavoidable. The session also includes a panel discussion that will offer the audience an opportunity to discuss on-line-business implementations with representatives of internet-savvy companies.

SP2.1: The Evil Six Letter “R” Word, Recall: How to Avoid It

A. Kamp

SP2.2: Lemonade from Lemons: The Dell Recall

J.B. Johnson, *Dell*

SP2.3: Doing Business Online Panel Discussion

M. Slovick, *Hearst Business Media*; S. Strickler, *Microchip*; M. Hall, *American Power Conversion*; K. Ness, *Mouser Electronics*

Note: The Doing Business Online Panel Discussion will start after the second speaker of the session and continue without a break until the end of the session (10:15 am). This allows a total of 45-50 minutes of discussion from both the panelists and questions from the audience.

SP3: System Design

Wednesday • 2:00 pm – 5:30 pm • North Ballroom B

Session Chair:

Ulrich Nonnenmacher, *Siemens*

Many applications have historically relegated the power subsystem to the end of the list of system-design considerations. Leading-edge systems in some sectors, by contrast, take advantage of advanced power technologies to differentiate themselves in highly competitive markets. This session's five presentations provide a forward-looking OEM perspective on power subsystems for system architects, product developers, marketers, and executives. A panel discussion will offer the audience an opportunity to discuss design tools in the context of OEM design.

SP3.1: Evolution of Hybrid Vehicle Electric System and Its Support Technologies

K. Hamada, *Toyota*

SP3.2: Advanced Parallel Operation & Control of PWM Inverters for Industrial and Commercial Applications

G. Reed, *Mitsubishi Electric Power Products*

SP3.3: Power Challenges in Vending Machines

L. Ellis, *National Automatic Merchandising Association*

SP3.4: Implications of Digital Control and Management for a High Performance Isolated Dc-Dc Converter – A Case Study

M. Appelberg, *Ericsson Power Modules*

SP3.5: Evaluating the Performance of High Density Board Mounted Converters

G. Potter, *Emerson Network Power*

SP3.6: Design Tools Panel Discussion

M. Vukicevic, *iSuppli Corp.*; J. Perry, *National Semiconductor Corporation*; N. Gabbert, *Transim Technology Corporation*; M. Englehardt, *Linear Technology*; M. Caruso, *Texas Instruments*

SP4: Power Electronics for Greener World

Thursday • 8:30 am – 11:30 am • North Ballroom B

Session Chairs:

Arnold Alderman, *Anagenesis*

Alex Levrán, *Power-One*

No single topic dominates the power-electronics sector across its full breadth of applications as does the demand for greener systems. This session's six presentations will provide a broad sampling of issues relating to energy efficiency, renewable energy, and environmental compatibility for OEMs and their suppliers.

SP4.1: Megawatts to Negawatts – Profiting from Energy Efficiency

P. Westbrook, *Texas Instruments*

SP4.2: Energy-Efficient Design from Consumer Electronics Great and Small

D. Carey, *Portelligent*

SP4.3: Enhancements of Drive Performance Using Matrix Converters in Open-Ended Drives

N. Mohan, *University of Minnesota*

SP4.4: Recent Advances in Wind Turbine Technology and the Contribution of Power Electronics to Wind Generated Electricity

A. Mikhail, *Clipper Windpower*

SP4.5: Environmental Law Impact on Design and Supply Chains

G. Bassett, *Avnet*

SP4.6: Energy Regulations and How They Will Affect the Future of Computing

S. Deuty, *Hewlett-Packard*

SP5: Current Topics in Power Electronics Research

Thursday • 2:00 pm – 5:30 pm • North Ballroom B

Session Chairs:

Mika Sippola, *Efore Plc.*

Dan Kinzer, *International Rectifier*

This session's seven invited presentations provide a broad and accessible sample of current unpublished applied and theoretical research underway on three continents. The presentations, geared for a general technical audience, give insight into topics at the leading edge of power electronics and identify the drivers that influence the power-sector's evolutionary direction. Presentations draw from a broad range of applications such as lighting, motor control, power conversion, and power management.

SP5.1: To Be Announced

SP5.2: To Be Announced

SP5.3: Research from Texas A & M University

M. Ehsani, *Texas A&M University*

SP5.4: From Asia Pacific Region: Seoul National University

B. H. Cho, *Seoul National University*

SP5.5: Research Vectors in Power Electronics at Swiss Federal Institute of Technology
J. Kolar, *Swiss Federal Institute of Technology (ETH)*

SP5.6: Get to Know Energy Systems Group — University of Toronto
A. Prodic, M.R. Iravani, *University of Toronto*

SP5.7: Energy Efficient Data Centers, Commercial Buildings, & Industrial Lighting
B. Fortenbery, *EPRI Solutions, Inc.*

RAP SESSIONS

We have three interesting and controversial topics lined up for this year. All sessions will take place on **Tuesday, February 27, from 5:00 pm to 6:30 pm**. Admission is free with an Exhibits Only registration and free refreshments will be available.

R1: If It Ain't Broke, Why Go Digital?

North Ballroom B

Moderator: Jeff Shepard, Publisher/President, *Darnell*

A look at the state of the art in digital power system management and digital PWM control. Is digital ready to take over from analog? Is it cost-effective? And can it meet the requirements of today's demanding applications? Join us for a dynamic discussion on the ever-popular topic of digital control.

R2: Power Electronics Education: Is it Meeting the Need?

South Ballroom B

Moderator: Martin Schlecht, CEO, *SynQor, Inc.*

Are universities doing a good job of preparing students for jobs in industry? What skills do new college graduates need to be successful in today's global economy? Are corporations doing an effective job of encouraging strong power electronics programs at the universities? Come join our panel of university and industry representatives, and bring your own opinions and ideas!

R3: Satisfying Demand for High-Current at Low-Voltage: Are We Addressing the Right Problems?

South Ballroom A

Moderator: Stephan Ohr, Research Director Analog Semiconductors, *Gartner Dataquest Research*

The movement towards smaller CMOS geometries encourages CPU designers to “pile on” ever more features and functions. But this forces voltage regulator and module manufacturers to come up with ever-new power management tricks in the effort to respond in nanoseconds to 60-Amp current surges. Will power management IC and module suppliers forever be shackled to the Pentium? Or are there alternatives which may be more efficient in their power use of dc power? Come share your thoughts on the future of point-of-load converters.

TECHNICAL SESSIONS

The following papers were selected through a rigorous peer review process and are represented by papers in the APEC Proceedings. Each digest was evaluated using an author-blind process by at least three members of the Program Committee, volunteers from around the world with expertise in the area of the specific digest.

T1: Digital Control Applications

Tuesday • 8:30 am - 12:00 pm • Marina Ballroom 1

Session Chairs:

Shamala Chickamenahalli, *Intel Corporation*

Phillip Cooke, *Infineon*

T1.1: Digital State Feedback Current Control Using the Pole Placement Technique and the 42V/14V Bi-Directional Dc-Dc Converter Application

Hyun Su Bae, Jeong Hwan Yang, Jae Ho Lee, Bo Hyung Cho, *Seoul National University*

T1.2: Predictive Digital Current Control Using Advanced Average Current Sampling Algorithm for Multi-Phase 2-Quadrant Dc-Dc Converters

Ingo Voss, *Infineon Technologies AG*; Stefan Schröder, *GE Global Research Europe*; Rik W. De Doncker, *RWTH Aachen University*

T1.3: Autotuning Techniques for Digitally Controlled Point-of-Load Converters with Wide Range of Capacitive Loads

Mariko Shirazi, Regan Zane, Dragan Maksimovic, *University of Colorado*; Luca Corradini, Paolo Mattavelli, *University of Padova*

- T1.4: Virtual Prototyping of Universal Control Architecture Systems by Means of Processor in the Loop Technology**
Gerald Francis, Rolando Burgos, Fred Wang, Dushan Boroyevich, *CPES*; Rong Liu, Antonello Monti, *University of South Carolina*; Pedro Rodriguez, *University of Catalunya*
- T1.5: High-Performance Mixed-Signal Voltage-Mode Control for Dc-Dc Converters with Inherent Analog Derivative Action**
Stefano Saggini, *DIEGM-University of Udine*; Paolo Mattavelli, *University of Padova*; Massimo Ghioni, *Politecnico of Milano*
- T1.6: Digital Controller Design for a Practicing Power Electronics Engineer**
Hussam Al-Atrash, *Advanced Power Electronics Corporation*; Issa Batarseh, *University of Central Florida*
- T1.7: Universal and Fault-Tolerant Multiphase Digital PWM Controller IC for High-Frequency Dc-Dc Converters**
Zdravko Lukic, Christopher Blake, Aleksandar Prodic, *University of Toronto*; Santa Concepcion Huerta Olivares, *Universidad Politécnic De Madrid (ETSII.Industriales)*

T2: Passive Components

Tuesday • 8:30 am - 12:00 pm • Marina Ballroom 2

Session Chairs:

John Bowers, *Sandia Nat. Labs*

Carl Blake, *International Rectifier*

- T2.1: A Fabrication Method for Integrated Filter Elements with Inductance Cancellation**
Brandon Pierquet, David Perreault, *Massachusetts Institute of Technology*; Timothy Neugebauer, *Draper Laboratory*
- T2.2: Thin Amorphous Films for Power Magnetic Components**
Waseem Roshen, *IBM Corporation, SSPower Tech, GE*
- T2.3: Magnetic Material Comparisons for High-Current Inductors in Low-to-Medium Frequency Dc-Dc Converters**
Brendan Lyons, John Hayes, Michael Egan, *University College Cork*

- T2.4: Aluminum Windings and Other Strategies for High-Frequency Magnetics Design in an Era of High Copper and Energy Costs**
Charles Sullivan, *Thayer School of Engineering At Dartmouth*
- T2.5: Modeling of an LTCC Inductor Capable of Improving Converter Light-Load Efficiency**
Michele Lim, Jacobus Daniel van Wyk, Khai Ngo, *Virginia Tech*
- T2.6: Loss Characterization and Calculation of Nanocrystalline Cores for High-Frequency Magnetics Applications**
Fred Wang, Wei Shen, Dushan Boroyevich, *CPES, Virginia Tech*; Wesley Tipton, *ARL*
- T2.7: Series-Coupling Test Characterization of On-Chip Silicon-Integrated and PWB-Integrated Transformers**
John Hayes, Michael Egan, *University College Cork*; Terence O'Donnell, Ning Wang, *Tyndall Research Institute*

T3: Power Factor Correction

Tuesday • 8:30 am - 12:00 pm • Marina Ballroom 4

Session Chairs:

Jim Spangler, *ON Semiconductor*

Kevin Parmenter, *Fairchild Semiconductor*

- T3.1: Output Impedance Oriented Design for Voltage Regulator with High Repetitive Rate Transient**
Wenkai Wu, George Schuellein, *International Rectifier*
- T3.2: Novel Coupled-Inductor Multi-Phase VRs**
Ming Xu, Ming Xu, Yucheng Ying, Fred Lee, *CPES, Virginia Tech*
- T3.3: Light Load Efficiency Improvement for Laptop VRs**
Julu Sun, Yuancheng Ren, Ming Xu, Fred Lee, *Virginia Tech*
- T3.4: 3D Power Delivery for Microprocessors and High-Performance ASICs**
Jian Sun, Jian-Qiang Lu, Dave Giuliano, Paul Chow, Ron Gutmann, *Rensselaer Polytechnic Institute*

- T3.5: A Novel Non-Isolated Full Bridge Topology for VRM Applications**
Sheng Ye, Wilson Eberle, Yan Fei Liu, *Queen's University*
- T3.6: Design and Performance of a Resonant LLC 48V Voltage Regulator Module with a Self-Sustained Oscillation Controller**
Mohamed Youssef, Praveen Jain, *Queen's University*
- T3.7: Novel Current Sharing Schemes for Multiphase Converters with Digital Controller Implementation**
Jaber Abu Qahouq, Lilly Huang, Doug Huard, Allan Hallberg, *Intel Corporation*

T4: Voltage Regulator Modules I

Tuesday • 8:30 am - 12:00 pm • Marina Ballroom 3

Session Chairs:

Laura M. Steffek, *Texas Instruments*

Greg Miller, *Intersil Corporation*

- T4.1: Isolated Efficient Wide Range Converter (I-EWiRaC): A New Low-Stress Single-Stage Isolated PFC Converter**
Henrik Schneider, Stefan Bergendorff, Michael Andersen, *Technical University of Denmark*; Lars Petersen, *Bang & Olufsen Icepter A/S*
- T4.2: Performance Evaluation of Bridgeless PFC Boost Rectifiers**
Laszlo Huber, Yungtaek Jang, Milan Jovanovic, *Delta Products Corporation*
- T4.3: A New 3-Phase Buck-Boost Unity Power Factor Rectifier with Two Independently Controlled Dc Outputs**
Yasuyuki Nishida, *Nihon University*; Johann Miniboeck, Round Simon, Johann Kolar, *PES, ETH Zurich*
- T4.4: New Architecture for MHz Switching Frequency PFC**
Chuanyun Wang, Ming Xu, Bing Lu, Fred Lee, *Eaton Innovation Center*

T4.5: A Unity Power Factor Correction Preregulator With Fast Dynamic Response Based on a Low-Cost Microcontroller

Diego González Lamar, Arturo Fernández, Manuel Arias, Miguel Rodríguez, Javier Sebastián, *Universidad de Oviedo*

T4.6: Quasi-Active Power Factor Correction Circuit for HB LED Driver

Kening Zhou, Jian Guo Zhang, *Zhejiang University of Science And Technology*; Da Weng, *Maxim Integrated Products*; Subbaraya Yuvarajan, *North Dakota State University*

T4.7: A Digital PFC Controller Without Input Voltage Sensing

Barry Mather, Bhaskar Ramachandran, Dragan Maksimovic, *University of Colorado*

T5: Induction Motor Drives

Tuesday • 8:30 am - 12:00 pm • South Ballroom A

Session Chairs:

Babak Fahimi, *Univ. of Texas-Arlington*

Hamid Toliyat, *Texas A&M University*

T5.1: Stator Flux Vector Control of Induction Motor Drives in the Field-Weakening Region

Michele Mengoni, Luca Zarri, Angelo Tani, Claudio Rossi, Giovanni Serra, Domenico Casadei, *University of Bologna*

T5.2: Adaptive Stator Resistance Estimation Method for Speed Sensorless DTC Controlled IM Drives

Nian Xiaohong, Wang Tao, Wang Jian, Gui Weihua, *School of Information Science and Engineering Central South University*; Huang Jirong, *Zhuzhou Electric Locomotive Research Institute*

T5.3: A New Method of Utilizing Ultra-Capacitor Energy Sources in Hybrid Electric Vehicles Over a Wide Speed Range

Shuai Lu, Keith Corzine, Mehdi Ferdowsi, *University of Missouri - Rolla*

T5.4: Speed Control of a Dual Stator Winding Machine

Joseph Ojo, *Tennessee Tech University*

- T5.5: Output Filters for Ac Adjustable Speed Drives**
Norbert Hanigovszki, Joern Landkildehus,
Danfoss Drives A/S; Frede Blaabjerg, *Aalborg University*
- T5.6: Low-Cost Motor Drive-Embedded Fault Diagnosis — A Simple Harmonic Analyzer**
Bilal Akin, Hamid Toliyat, *Texas A&M University*;
Umut Orguner, *Middle East Tech. University*;
Mark Rayner, *Toshiba*
- T5.7: An Improved Matrix Converter Fed Induction Motor Vector Control Drive with Output Voltage Error Cancellation**
Kai Sun, Lipei Huang, *Tsinghua University*; Kouki Matsuse, *Meiji University*

T6: Lighting

Tuesday • 8:30 am - 12:00 pm • South Ballroom B

Session Chairs:

Jim Templeton, *Zilker Labs*

Bill Peterson, *E&M Power*

- T6.1: Novel Dimmable Electronic Ballast for 250 W HPS Lamp in Street Lighting with Analog Dimming Interface Circuit**
Hankui Liu, Yijie Wang, Xiangjun Zhang, Dianguo Xu, *Department of Electrical Engineering Harbin Institute of Technology*; Lili Guo, *Department of Information And Communications Engineering Harbin Engineering University*
- T6.2: The Design of High Performance Protection — Functions for Electronic Ballasts**
Sui-Tsung Chen, L. L. Lee, *Industry Technology Research Institute*
- T6.3: High-Intensity-Discharge Lamp Ballast With Igniter Driven by Dual-Frequency Inverter**
Yuequan Hu, Milan Jovanovic, *Delta Power Electronics Lab*
- T6.4: A High-Power-Density Integrated Electronic Ballast for Low Wattage HID Lamps**
Yan Jiang, Wenduo Liu, Yan Liang, Daan van Wyk, Fred Lee, *Virginia Tech*

- T6.5: Digitally Addressable Digital Dimming Electronic Ballast Based on CAN Bus**
E. Rodriguez, J. Hurtado, J. Diaz, N. Vazquez, *Instituto Tecnológico de Celaya*; J. Correa, *Instituto Tecnológico de Morelia*
- T6.6: Digital Architecture for Driving Large LED Arrays with Dynamic Bus Voltage Regulation and Phase Shifted PWM**
Montu Doshi, Regan Zane, *University of Colorado at Boulder*
- T6.7: A Cost Effective PDP Sustainer Using Two-Winding Transformer with Hybrid Operation**
W.S. Kim, S.Y. Chae, B.C. Hyun, B.H. Cho, *Seoul National University*; D.Y. Lee, *International Rectifier*

T7: PWM Techniques

Wednesday • 8:30 am - 10:15 am • Marina Ballroom 1

Session Chair:

Philip Krein, *University of Illinois*

- T7.1: A PWM Strategy for Acoustic Noise Reduction**
Riming Shao, Zhenhong Guo, Liuchen Chang, *University of New Brunswick*
- T7.2: Elimination of Dead-Time in PWM Controlled Inverters**
Lihua Chen, Fang Peng, *Michigan State University*
- T7.3: Carrier-Based Modulation Method for Matrix Converter with Input Power Factor Control and Under Unbalanced Input Voltage Conditions**
Young-Doo Yoon, Seung-Ki Sul, *Seoul National University*
- T7.4: A New Generalized Discontinuous-PWM Strategy for Active Power Filters**
Lucian Asiminoaei, *Danfoss Drives A/S*; Pedro Rodriguez, *Universitat Politècnica De Catalunya*; Frede Blaabjerg, *Aalborg University*

T8: Semiconductor Devices

Wednesday • 8:30 am - 10:15 am • Marina Ballroom 2

Session Chair:

Jon Hancock, *Infineon Technologies*

- T8.1: Energy-Efficient Peak-Current Controlled Power Conversion IC Family Delivers 3 to 28 Watts in Universal-Input Flyback Power Supplies**
Kent Wong, John Jovalusky, *Power Integrations*
- T8.2: Performance Analysis of Trench Power MOSFETs in Synchronous Buck Converter Applications**
Xu Cheng, Yali Xiong, John Shen, *University of Central Florida*; Xiangcheng Wang, *C&D Technology*; Pavan Kumar, *Intel*
- T8.3: A Study on SiC Devices in Synchronous Rectification of Dc-Dc Converter**
Tsuyoshi Funaki, Tsunenobu Kimoto, Takashi Hikiyama, *Kyoto University*; Masashi Matsushita, Masashi Sasagawa, *Rohm Co. Ltd.*
- T8.4: Evaluation of SiC JFETs for a Three-Phase Current-Source Rectifier with High Switching Frequency**
Callaway Cass, Rolando Burgos, Fred Wang, Dushan Boroyevich, *Virginia Tech*; Yi Wang, T. Paul Chow, *Rensselaer Polytechnic Institute*

T9: Dc-Dc Converter Topics

Wednesday • 8:30 am - 10:15 am • Marina Ballroom 3

Session Chair:

Jim Walker, *Walker Power Design, Inc*

- T9.1: An Analog CMOS Double-Edge Multi-Phase Low-Latency Pulse Width Modulator**
Jianhui Zhang, Seth Sanders, *University of California Berkeley*
- T9.2: Multiple Load-Source Integration in a Multilevel Modular Capacitor Clamped Dc-Dc Converter Featuring Fault Tolerant Capability**
Faisal Khan, Leon Tolbert, *University of Tennessee*
- T9.3: A Novel Voltage-Boosting Converter: KY Converter**
K. I. Hwu, *National Taipei University of Technology*; Y. T. Yau, *Industrial Technology Research Institute*

T9.4: A Novel Three Level Full Bridge Resonant Dc-Dc Converter Suitable for High Power Wide Range Input Applications

Wei Chen, Yilei Gu, Zhengyu Lu, *Zhejiang University*

T10: Adjustable Speed Motor Drives

Wednesday • 8:30 am - 10:15 am • Marina Ballroom 4

Session Chair:

Leila Parsa, *RPI*

T10.1: Feedback-Based Mitigation of Torque Harmonics in Switched Reluctance Motor Drives

Andreas Koenig, Steven Pekarek, *Purdue University*

T10.2: An Investigation on Asymmetry Effects in Linear Induction Machines

Haidong Yu, Babak Fahimi, *University of Texas at Arlington*

T10.3: Very Low Speed Sensorless Vector Control of Synchronous Reluctance Motors with a Novel Startup Scheme

Ahmad Ghaderi, Tsuyoshi Hanamoto, *Kyushu Institute of Technology*

T10.4: Method for Estimating the Stroke of LPMSM Driven by PWM Inverter in a Linear Compressor

T. W. Chun, J. R. Ahn, Q. V. Tran, H. H. Lee, *University of Ulsan*; H. G. Kim, *University of Kyungpook*

T11: Packaging, Thermal, and Test

Wednesday • 8:30 am - 10:15 am • South Ballroom A

Session Chair:

Bruce Miller, *Dell Inc.*

T11.1: Thermal Design Considerations for Surface Mount Power ICs

Jinrong Qian, Charles Mauney, *Texas Instruments Inc.*

T11.2: Package Alternatives for High-Voltage Integrated Power Electronic Module

Jing Xu, J.D. van Wyk, Khai Ngo, *Virginia Tech*

T11.3: Power Management Device Characteristics for Semiconductor Test Instrumentation
William Bowhers, *Merrimack College*

T11.4: Rapid Construction of a 100 kW Three-Level Inverter for Synchronous Motor Based on a Universal Digital Platform, Software Building Blocks and PEBBs
Haibing Hu, Zhengyu Lu, *School of Electrical Engineering*; Wenxi Yao, *Zhejiang University*

T12: Modeling/Control of Power Electronic Systems

Wednesday • 8:30 am - 10:15 am • South Ballroom B

Session Chair:

Tim Groat, *Stored Energy Systems*

T12.1: The Spatial Effect and Compensation of Current Sensor Gain Deviation for Three-Phase Three-Wire Systems
Michael Harke, Hamilton Sundstrand; Robert Lorenz, *University of Wisconsin - Madison*

T12.2: Universal Approach to Modeling Current Mode Controlled Converters in Distributed Power Systems for Large-Signal Subsystem Interactions Investigation
Runxin Wang, Jinjun Liu, Hao Wang, *Xi'an Jiaotong University*

T12.3: Evolutionary Optimization of Power Electronics Based Power System
Ricky Chan, Scott Sudhoff, *Purdue University*; Yonggon Lee, Edwin Zivi, *U.S. Naval Academy*

T12.4: Black-Box Terminal Characterization Modeling of Dc-Dc Converters
Luis Arnedo, Rolando Burgos, Fred Wang, Dushan Boroyevich, *Virginia Tech*

T13: Control Techniques

Wednesday • 2:00 pm - 5:30 pm • Marina Ballroom 1

Session Chairs:

Chuck Mullett, *ON Semiconductor*

Juri Jatskevich, *University of British Columbia*

T13.1: SPLL Based Control for Active Filter with Reactive Power Compensation
Francisco Freijedo, Jesus Doval-Gandoy, Oscar Lopez, Carlos Martinez-Peñalver, Andres Nogueiras, *University of Vigo*

- T13.2: Design of a New Dc Link Voltage Controller for Universal Power Quality Controllers**
Hui Zhang, Jinjun Liu, Xinming Huang, Zhaoan Wang, *Xi'An Jiaotong University*
- T13.3: Improvement of One-Comparator Counter-Based PWM Control by Applying a Saw-toothed Wave Injection Method**
K. I. Hwu, *National Taipei University of Technology*; Y. T. Yau, *Industrial Technology Research Institute*
- T13.4: Nonlinear Average Current Control Using Partial Current Measurement**
Min Chen, Jian Sun, *Rensselaer Polytechnic Institute*
- T13.5: Unified Control Strategy Covering CCM and DCM for a Synchronous Buck Converter**
Dirk Hirschmann, Sebastian Richter, Christian Dick, Rik W. de Doncker, *RWTH Aachen University*
- T13.6: A Novel Control Scheme for MHz Range Interleaved Multiphase Resonant VRM**
Wei Chen, Zhengyu Lu, Zhaoming Qian, *Zhejiang University*; Shaoshi Ye, *Delta Electronics (Shanghai) Co. Ltd.*
- T13.7: Average Modeling and Analysis of a Flyback With Active Clamp Topology Based on a Very Simple Transformer**
Ahmed Bakkali, Pedro Alou, Jesus Angel Oliver, Jose Antonio Cobos, *Universidad Politecnica de Madrid (UPM)*

T14: Alternative Energy Systems

Wednesday • 2:00 pm - 5:30 pm • Marina Ballroom 2

Session Chairs:

Ron Harley, *Georgia Tech*

Ira Pitel, *Magna-Power Electronics*

- T14.1: Design of a 6 kW Multiple-Input Bi-Directional Dc-Dc Converter With Decoupled Current Sharing Control for Hybrid Energy Storage Elements**
Danwei Liu, Hui Li, *Center For Advanced Power Systems*; Laura Marlino, *National Transportation Research Center*

- T14.2: A New Control Strategy for Doubly-Fed Induction Generator for Wind Power Generation**
E. Nho, *Pukyong National University*; C. Su, C. Liao, Lihua Li, M. E. Davis-Marsh, Keyne Smedley, *University of California Irvine*
- T14.3: Portable Solar Systems Using a Step-Up Power Converter with a Fast-Speed MPPT and a Parallel-Configured Solar Panel to Address Rapidly Changing Illumination**
Lijun Gao, Roger Dougal, Shengyi Liu, Albena Iotova, *University of South Carolina*
- T14.4: An Integrative Control Scheme for Boost-Buck Inverter in Grid Connected Photovoltaic Systems**
Mi Dong, Lisha Bai, *Central South University*; An Luo, *Hunan University*; Jian Yang, *University of Central Florida*
- T14.5: Modeling and Control of Brushless Doubly-Fed Induction Generators in Wind Energy Applications**
Kostyantyn Protsenko, Dewei Xu, *Ryerson University*
- T14.6: New Converter Topologies for Two-Phase PMSG-Based Small Wind Turbine Systems**
Zhenhong Guo, Liuchen Chang, *University of New Brunswick*

T15: Non-Isolated Dc-Dc Converters

Wednesday • 2:00 pm - 5:30 pm • Marina Ballroom 3

Session Chairs:

Chris Young, *Zilker Labs*

Jason Lai, *Virginia Tech*

- T15.1: Highly Efficient VRM for Wide Load Range with Dynamic Non-Uniform Current Sharing**
Jaber Abu Qahouq, Lilly Huang, *Intel Corporation*
- T15.2: Transient Analysis of the Novel Voltage Divider**
Julu Sun, Ming Xu, Fred Lee, *Virginia Tech*

T15.3: A Digital Predictive On-Line Energy Optimization Scheme for Dc-Dc Converters

Olivier Trescases, Guowen Wei, Aleksandar Prodic, Wai Tung Ng, *University of Toronto*; Kaoru Takasuka, Tetsuro Sugimoto, *Asahi Kasei Microsystems*; Haruhiko Nishio, *Fuji Electric Advanced Technology Co. Ltd.*

T15.4: An Architecture without Current-Sensing Circuits for Digital Dc-Dc Controller to Achieve Adaptive Voltage Position

Peipei Gu, Wenhong Li, *Fudan University*

T15.5: Optimum Bias Calculation for Parallel Hybrid Switching-Linear Regulators

Jason Stauth, Seth Sanders, *University of California - Berkeley*

T15.6: Dual Path Internal Frequency Compensator in Dc-Dc Converter

Sang Hwa Jung, Dong Hee Kim, Dong Hun Lee, *Fairchild Semiconductor*

T15.7: A Low-Delay Digital PWM Control Circuit for Dc-Dc Converters

Yoichi Ishizuka, Ichiro Nishikawa, Akira Ichinose, Hirofumi Matsuo, *Nagasaki University*; Masao Ueno, *Sanken Electric. Co. Ltd.*

T16a: Modeling/Control of Motor Drives

Wednesday • 2:00 pm - 5:30 pm • Marina Ballroom 4

Session Chairs:

Fang Peng, *Michigan State University*

Leon Tolbert, *University of Tennessee*

T16.1: A Simple Flux Model Based Observer for Sensorless Control of Switched Reluctance Motor

Jinhui Zhang, *Ansoft Corporation*; Xiaohu Feng, Arthur Radun, *University of Kentucky*

T16.2: Modeling and Control of a Boost Chopper Linked to an Ac Drive System for Hybrid Electric Vehicle

Yu-Seok Jeong, *Myongji University*

T16.3: Design Oriented Analysis of Dc Link Current Observer of a Three-Phase Double Conversion Uninterruptible Power System or Adjustable Speed Drive

Kevin Lee, Ian Wallace, Atul Bhadkamkar, *Eaton Innovation Center*

T16.4: Balancing Hall Effect Signals in Low Precision Brushless Dc Motors

N. Samoylenko, Q. Han, J. Jatskevich, *University of British Columbia*

T16b: Z-Source Inverters

Wednesday • 2:00 pm - 5:30 pm • Marina Ballroom 4

Session Chairs:

Fang Peng, *Michigan State University*

Leon Tolbert, *University of Tennessee*

T16.5: A High-Performance Z-Source Inverter Operating with Small Inductor at Wide-Range Load

Xinping Ding, Z. M. Qian, Shuitao Yang, Bin Cui, F. Z. Peng, *Zhejiang University*

T16.6: Single-Phase Four Switches Z-Source Ac-Ac Converter

Yu Tang, Chaohua Zhang, Shaojun Xie, *College of Automation Engineering - Nanjing University of Aeronautics & Astronautics*

T16.7: Performance Evaluation of Three-Level Z-Source Inverters Under Semiconductor Failure Conditions

Feng Gao, Poh Chiang Loh, D Mahinda Vilathgamuwa, *Nanyang Technological University*; Frede Blaabjerg, *Aalborg University*

T17: Single and Multi-Phase Inverters

Wednesday • 2:00 pm - 5:30 pm • South Ballroom A

Session Chairs:

Zareh Soghomonian, *General Atomics*

Tim Haskew, *University of Alabama*

T17.1: New Three-Phase Inverter with Dual-Loop Compensator

Lihua Li, Keyue Smedley, Taotao Jin, *University of California Irvine*

T17.2: A D-Q Frame Controller for a Full-Bridge Single Phase Inverter Used in Small Distributed Power Generation (DG) Systems

Arman Roshan, Rolando Burgos, Andrew Baisden, Fred Wang, Dushan Boroyevich, *Virginia Tech*

- T17.3: A Direct Peak Dc-Link Boost Voltage Control Strategy in Z-Source Inverter**
Xinping Ding, Z. M. Qian, Shuitao Yang, Bin Cui, F. Z. Peng, *Zhejiang University*
- T17.4: Current Loop Control with Admittance Compensation for a Single-Phase Grid-Tie Fuel Cell Power Conditioning System**
Jason Lai, Sungyeul Park, Jian-Liang Chen, Seugnryul Moon, *Virginia Tech*
- T17.5: Applications of an Auxiliary Resonant Commutated Pole Converter**
Aaron Williams, Angelo Gattozzi, Robert Thelen, *The University of Texas at Austin*
- T17.6: A Novel High Density 100 kW Three-Phase Silicon Carbide (SiC) Multichip Power Module (MCPM) Inverter**
Edgar Cilio, Jared Hornberger, Brice Mcpherson, Roberto Schupbach, Alexander Lostetter, *Arkansas Power Electronics International Inc.;* John Garrett, *Apei, Inc*

T18: Active Filters

Wednesday • 2:00 pm - 5:30 pm • South Ballroom B

Session Chairs:

Kevin Parmenter, *Fairchild Semiconductor*

Dong Tan, *Northrup Gumman*

- T18.1: A Family of Control Methods for Parallel Active Power Filters Based on Current Detection**
Xiaoyu Wang, Jinjun Liu, Chang Yuan, Zhaoan Wang, *Xi'An Jiaotong University*
- T18.2: A Novel Control of Parallel Active Power Filter for Fast-Changing Dynamic Load**
Chang Yuan, Jinjun Liu, Xiaoyu Wang, Zhaoan Wang, *Xi'An Jiaotong University*
- T18.3: Control Strategy of Multi-Modular Shunt Active Power Filter System**
Jianyong Ju, Dehong Xu, Min Chen, *Zhejiang University;* Baiqiang Shen, *Hangzhou Municipal Electric Power Bureau;* Fan Zhang, *Hangzhou Dayou Science and Technology Development Co. Ltd.*

T18.4: Analysis and Design of a Novel Phase-Lead Compensation Control Strategy for Series Hybrid Active Power Filter

Liqing Tong, Zhaoming Qian, Yantao Song, Naixing Kuang, Fangzheng Peng, *Zhejiang University*

T18.5: Single-Phase Universal Active Filter Without Transformer

Cursino Jacobina, Welflen Santos, Alexandre Oliveira, Edison Da Silva, Euzeli Santos Jr, *UFCG-Brazil*

T19: Voltage Regulator Modules II

Thursday • 8:30 am - 11:30 am • Marina Ballroom 1

Session Chairs:

Siamak Abedinpour, *Freescale Semiconductor, Inc.*

Wenkai Wu, *International Rectifier*

T19.1: Experimental Validation of the Advantages Provided by Linear – Nonlinear Control in a Multi-Phase VRM

Jesus Quintero, Andres Barrado, Marina Sanz, Antonio Lazaro, Emilio Olias, *Universidad Carlos III de Madrid*

T19.2: Synchronous Buck Converter with Increased Efficiency

Rais Miftakhutdinov, Joseph Zbib, *Texas Instruments Inc.*

T19.3: A Digital Multi-Mode Multi-Phase IC Controller for VR Application

Jianhui Zhang, Seth Sanders, *University of California - Berkeley*

T19.4: A 100 MHz Eight-Phase Buck Converter Delivering 12A in 25mm² Using Air-Core Inductors

Gerhard Schrom, Peter Hazucha, Fabrice Paillet, Sung T. Moon, D. S. Gardner, Tanay Karnik, Ping Sun, Trang T. Nguyen Jr., Michael J. Hill, Kaladhar Radhakrishnan, Tolga Memioglu, *Intel Corp.*; David J. Rennie, *University of Waterloo*

T19.5: Multi-Phase Inductor Coupling Scheme with Balancing Winding in VRM Applications

Zengyi Lu, Wei Chen, *Delta Electronics (Shanghai) Co. Ltd.*

T19.6: Compensation Circuit Design Considerations for High Frequency Dc-Dc Buck Converters with Ceramic Output Capacitors

Ahmed Abou-Alfotouh, Ashraf Lotfi, *Empirion Inc.*;
Mohamed Orabi, *South Valley University*

T20: Isolated Dc-Dc Converters I

Thursday • 8:30 am - 11:30 am • Marina Ballroom 2

Session Chairs:

Frank Cirolia, *Artesyn Technologies*

Ed Stanford, *Intel Corporation*

T20.1: Design and Implementation of High Power Density Three-Level Parallel Resonant Converter for Capacitor Charger

Honggang Sheng, Fred Wang, *Virginia Tech*

T20.2: Modeling and Analysis of a High-Voltage Dc-Dc Converter with Vin/3-Voltage Stress on the Primary's Switches

Tingting Song, Henry S.H. Chung, *City University of Hong Kong*; Saad Tapuhi, *Beer Sheva College of Engineering*; Adrian Ioinovici, *Holon Institute of Technology*

T20.3: An Improved Synchronous Rectification Circuit in Active-Clamp Forward Converter

Yu Ma, Qian Ouyang, Xiaogao Xie, Zhaoming Qian, *Zhejiang University*

T20.4: A Bi-Directional Isolated Dc-Dc Converter for Energy Storage Systems

Shigenori Inoue, Hirofumi Akagi, *Tokyo Institute of Technology*

T20.5: Static and Dynamic Characteristics of Forward-Flyback Mixed Converter

Yoshito Kusuhara, *Kyushu Polytechnic College*; Tamotsu Ninomiya, Asahi Nakayama, *Kyushu University*; Shin Nakagawa, *Fidelix Co.*

T20.6: New Hybrid Driving Scheme for SRs to Improve the Efficiency of Active Clamped Forward Converters

Xie Xiaogao, Miao Lei, Zhang Junming, Qian Zhaoming, *Electrical Engineering College of Zhejiang University*

T21: Ac-Dc Converters

Thursday • 8:30 am - 11:30 am • Marina Ballroom 3

Session Chairs:

Annabelle Pratt, *Intel Corporation*

Rolando Burgos, *Center for Power Electronics Systems*

T21.1: Evaluation of 3-Phase to 9-Phase Transformer, 18-Pulse Converter, and Adjustable Speed Drive, Including Novel Third Harmonic Calculations

Kevin Lee, *Eaton Innovation Center*; James Armes, *Eaton Electrical*; Derek Paice, *Paice & Associates Inc.*

T21.2: A Universal Single-Stage Ac-Dc Front-End Resonant Converter with a New Active Current Mode Controller: Performance and Design

Mohamed Youssef, Praveen Jain,
Queen's University

T21.3: Reactive Power Control Realizations in Single-Phase Active-Front-End Converters

Konstantin Louganski, Jih-Sheng Lai, *Virginia Tech*

T21.4: A New Family of Rectification Topologies

Liangbin Yao, Issa Batarseh, *University of Central Florida*

T21.5: Three-Phase Isolated High-Power-Factor Rectifier Using Soft-Switched Two-Switch Forward Converter

Yungtaek Jang, David Dillman, Milan Jovanovic,
Delta Products Corp.

T21.6: Ultra Compact Three-Phase PWM Rectifier

Philipp Karutz, Simon Round, Marcelo Heldwein,
Johann Kolar, *ETH Zurich*

T22: Permanent Magnet Motor Drives

Thursday • 8:30 am - 11:30 am • Marina Ballroom 4

Session Chairs:

Babak Fahimi, *University of Texas Arlington*

James Cale, *Purdue University*

- T22.1: An On-Line Stator Turn Fault Detection Method for Interior PM Synchronous Motor Drives**
Youngkook Lee, Thomas Habetler, *Georgia Institute of Technology*
- T22.2: PM Generator Characteristics for Oscillatory Engine Based Portable Power System**
Aristidis Zachas, Long Wu, Ronald Harley, *Georgia Institute of Technology*; J. Rhett Mayor, *Powerix Technologies, LLC*
- T22.3: Minimization of Rotor Position Detection Error Due to Zero-Current-Clamping Effect in Pulsating Carrier-Signal Injection-Based Sensorless Drives**
Young-Su Kwon, Chan-Hee Choi, Jul-Ki Seok, *Yeungnam University*
- T22.4: Correction on Current Measurement Errors for Accurate Flux Estimation of Ac Drives at Low Stator Frequency**
Kyung-Rae Cho, Jul-Ki Seok, *Yeungnam University*
- T22.5: Novel Low-Cost Microstepping Driving Technique with Digital Current Estimation**
Andrea Pizzutelli, Massimo Ghioni, *DEI Politecnico di Milano*; Stefano Saggini, *I&PCD STMicroelectronics*
- T22.6: Rapid Control Prototyping of a Permanent Magnet Dc Motor Drive Using D-Space and Mathworks Simulink**
Kala Meah, Sadrul Ula, *University of Wyoming*; Steve Hietpas, *South Dakota State University*

T23: Digital Control Techniques

Thursday • 8:30 am - 11:30 am • South Ballroom A

Session Chairs:

Chuck Mullett, *ON Semiconductor*
Regan Zane, *University of Colorado*

- T23.1: Minimum Phase Response in Digitally Controlled Boost and Flyback Converters**
Vahid Yousefazadeh, Mariko Shirazi, Dragan Maksimovic, *University of Colorado at Boulder*
- T23.2: High Resolution Digital Duty Cycle Modulation Schemes for Voltage Regulators**
Jian Li, Yang Qiu, Yi Sun, Bin Huang, Ming Xu, Dong Ha, Fred Lee, *CPES, Virginia Tech*

- T23.3: FPGA Based Digital Pulse Width Modulator with Time Resolution Under 2 ns**
Santa C. Huerta, Oscar Garcia, Jose Cobos, *Universidad Politecnica de Madrid*; Angel de Castro, *Universidad Autonoma de Madrid*
- T23.4: Continuous-Time Digital Signal Processing Based Controller for High-Frequency Dc-Dc Converters**
Zhenyu Zhao, Vadim Smolyakov, Aleksandar Prodic, *University of Toronto*
- T23.5: Time Domain Design of Digital Compensators for PWM Dc-Dc Converters**
Mor Peretz, Sam Ben-Yaakov, *Ben-Gurion University*
- T23.6: Digital Predictive Feed-Forward Controller for a Dc-Dc Converter in Plasma Display Panel**
S.Y. Chae, B.C. Hyun, P. Agarwal, W.S. Kim, B.H. Cho, *Seoul National University*

T24a: Utility Interface Issues

Thursday • 8:30 am - 11:30 am • South Ballroom B

Session Chairs:

Cahit Gezgin, *International Rectifier*

Ernest H. Wittenbreder, *Technical Witts, Inc.*

- T24.1: Direct PWM Synchronization Using a Full Digital Phase-Locked Loop for High Power Grid-Interfacing Converters**
Dewei Xu, Yun Wei Li, Bin Wu, *Ryerson University*
- T24.2: Leakage Current Evaluation of a Single-Phase Transformerless PV Inverter Connected to the Grid**
Óscar López, Francisco Freijedo, Jesús Doval-Gandoy, *Vigo University*; Remus Teodorescu, *Aalborg University*
- T24.3: Fast Transient Control for Three-Phase Capacitor-Supported Dynamic Voltage Restorer (DVR)**
Carl Ho, Henry Chung, *City University of Hong Kong*

T24b: EMI

Thursday • 8:30 am - 11:30 am • South Ballroom B

Session Chairs:

Cahit Gezgin, *International Rectifier*

Ernest H. Wittenbreder, *Technical Writings, Inc*

T24.4: Common Mode Noise Reduction for Power Converters with Parasitic Capacitance Cancellation

Shuo Wang, Fred Lee, *Virginia Tech*

T24.5: Common Mode EMI Noise Suppression in Bridgeless Boost PFC Converter

Pengju Kong, Shuo Wang, Fred Lee, *Virginia Tech*

T24.6: Designing Common-Mode EMI Noise Cancellation without Y-Capacitor

Kevin Parmenter, Jinho Choi, *Fairchild Semiconductor*

T25: Soft-Switching Dc-Dc Converters

Thursday • 2:00 pm - 5:30 pm • Marina Ballroom 1

Session Chairs:

Rolando Burgos, *CPES, Virginia Tech*

David Strasser, *Texas Instruments*

T25.1: A New ZVS Bidirectional Dc-Dc Converter With Phase-Shift Plus PWM Control Scheme

Xiao Huafeng, Guo Liang, Xie Shaojun, *Nanjing University of Aeronautics and Astronautics*

T25.2: Zero-Voltage-Switching PWM Three-Level Converter with Interleaved Complementary Modulation

Wu Chen, Xinbo Ruan, Rongrong Zhang, *Nanjing University of Aeronautics and Astronautics*

T25.3: 1MHz-1kW LLC Resonant Converter with Integrated Magnetics

Yanjun Zhang, Dehong Xu, *College of Electrical Engineering - Zhejiang University*; Kazuaki Mino, Kiyooki Sasagawa, *Fuji Electric Advanced Technology Co. Ltd.*

T25.4: A 700 kHz High-Efficiency High-Power-Density Three-Level Parallel Resonant Dc-Dc Converter for High-Voltage Charging Applications

Dianbo Fu, Yang Qiu, Yi Sun, Fred Lee, *Virginia Tech*

- T25.5: Phase-Shifted Full Bridge Dc-Dc Converter with Energy Recovery Clamp and Reduced Circulating Current**
Milan Ilic, *Advanced Energy*; Dragan Maksimovic, *University of Colorado at Boulder*
- T25.6: Design of High Power Density LLC Resonant Converter with Extra Wide Input Range**
Yu Fang, Dehong Xu, Yanjun Zhang, Fengchuan Gao, Lihong Zhu, *College of Electrical Engineering - Zhejiang University*

T26: Isolated Dc-Dc Converters II

Thursday • 2:00 pm - 5:30 pm • Marina Ballroom 2

Session Chairs:

Jaber Abu Qahouq, *Intel Corporation*

Sang Hwa Jung, *Fairchild Semiconductor*

- T26.1: Design Considerations of Compensation Topologies in ICPT Systems**
Wenqi Zhou, Hao Ma, *Zhejiang University*
- T26.2: Improvement in Efficiency of the Phase-Shift Current-Doubler-Rectification ZVS Full-Bridge Dc-Dc Converter**
K. I. Hwu, *National Taipei University of Technology*; Y. T. Yau, *Industrial Technology Research Institute*; Tim-Ho Chen, *AcBel Polytech Inc.*
- T26.3: 200°C Operation of a Dc-Dc Converter with SiC Power Devices**
Biswajit Ray, *Bloomsburg University of Pennsylvania*; Hiroyuki Kosai, *UES Inc.*; James Scofield, Brett Jordan, *Air Force Research Laboratory*
- T26.4: Synchronous Rectification LLC Series-Resonant Converter**
Guan-Chyun Hsieh, *Tung-Nan Institute of Technology*; Cheng-Yuan Tsai, Wei-Li Hsu, *National Taiwan Univ. of Science And Tech*
- T26.5: Multiphase Isolated Dc-Dc Converters for Low-Voltage High-Power Fuel Cell Applications**
Seung-Ryul Moon, Jih-Sheng Lai, *Virginia Tech*

- T26.6: Self-Balanced Input-Series Two-Stage Dc-Dc Converter and Ripple Match Design**
Ting Qian, Brad Lehman, *Northeastern University*

T27a: Automotive Applications

Thursday • 2:00 pm - 5:30 pm • Marina Ballroom 3

Session Chairs:

John Miller, *Maxwell Technologies*

Johann Kolar, *ETH Zurich*

- T27.1: Novel Concepts for Integrating the Electric Drive and Auxiliary Dc-Dc Converter for Hybrid Vehicles**
H. Plesko, J. Biela, Johann Kolar, *ETH Zurich*; J. Luomi, *Helsinki University of Technology*

- T27.2: System Integration and Power Flow Management for a Series Hybrid Electric Vehicle Using Super-Capacitors and Batteries**
Hyunjae Yoo, Seung-Ki Sul, *School of Electrical & Computer Science - Seoul National University*; Yongho Park, Jongchan Jeong, *Samsung Techwin - Defense R&D Center*

- T27.3: Zero-Voltage Switched Multi-Phase Converter Utilizing Nonlinear and Coupled Inductors**
Michael Stadler, Johannes Pforr, *University of Applied Sciences Ingolstadt*

- T27.4: A Bidirectional, Triple-Voltage Dc-Dc Converter for Hybrid and Fuel Cell Vehicle Power Systems**
Gui-Jia Su, Lixin Tang, *Oak Ridge Associated Universities*

Session 27b: Components

Thursday • 2:00 pm - 5:30 pm • Marina Ballroom 3

Session Chairs:

John Miller, *Maxwell Technologies*

Johann Kolar, *ETH Zurich*

- T27.5: Super Barrier Rectifier - A New Generation of Power Diode**
Vladimir Rodov, Alexei Ankoudinov, *APD Semiconductor*; Taufik Taufik, *Cal Poly State University*

T27.6: Real-Time Condition Monitoring of the Electrolytic Capacitors for Power Electronics Applications
Afroz Imam, Deepakraj Divan, Ronald Harley,
Thomas Habetler, *Georgia Institute of Technology*

T27.7: EI Core Inductor Design Using Population-Based Algorithms
James Cale, Scott Sudhoff, *Purdue University*

T28: Multi-Level Inverters

Thursday • 2:00 pm - 5:30 pm • Marina Ballroom 4

Session Chairs:

Keith Corzine, *University of Missouri-Rolla*

Zareh Soghomonian, *General Atomics*

T28.1: Control Strategy for Fault-Tolerant Cascaded Multilevel Converter Based STATCOM
Wenchao Song, *NCSU*

T28.2: High Power Motor Drives Based on Hybrid Multilevel Converters and Direct Torque Control
Shuai Lu, Keith Corzine, *University of Missouri - Rolla*

T28.3: Solving the SHEPWM Nonlinear Equations for Three-Level Voltage Inverter Based on Computed Initial Values
Wanmin Fei, Xinbo Ruan, *Nanjing University of Aeronautics and Astronautics*; Yanli Zhang, *Nanjing Normal University*

T28.4: PWM Method of a Three-Level Neutral-Point-Clamped Converter Under Neutral Point Imbalance Condition
Jang-Hwan Kim, *Samsung Electronics Co. Ltd.*; Seung-Ki Sul, *Seoul National University*

T28.5: The Dynamic Equivalent Circuit Design in Three-Level High Voltage Inverters Based on Functional Model of IGCT
Hua Bai, Zhengming Zhao, *Tsinghua University*

T28.6: High Performance Control of Three-Phase Three-Level Rectifier Under Unbalanced Conditions
Joseph Ojo, *Tennessee Tech University*

T28.7: A Novel SPWM Method with Voltage Balancing Capability for Multilevel Rectifier/Inverter Systems

Zhiguo Pan, *Direct Drive Systems*; Fang Peng, *Michigan State University*

T29: Inverter Applications

Thursday • 2:00 pm - 5:30 pm • South Ballroom A

Session Chairs:

Kevin Lee, *Eaton Corporation*

Steve Pekarek, *Purdue University*

T29.1: Commercial Frequency Ac to High Frequency Ac Converter with Boost-Active Clamp Bridge Single Stage ZVS-PWM Inverter

Bishwajit Saha, H. Sugimura, H.W. Lee, M. Nakaoka, *Kyungnam University*; H. Omori, T Okude, *Matsushita Electric Industrial Co. Ltd.*

T29.2: Droop Control Method with Virtual Output Impedance for Parallel Operation of Uninterruptible Power Supply Systems in a Microgrid

Josep M. Guerrero, *UPC*

T29.3: Dual 1.5 MHz 3.5 kW Versatile Half-Bridge Series-Resonant Inverter Module for Inductive Load Characterization

Diego Puyal, Carlos Bernal, José Miguel Burdío, Ignacio Millán, Jesús Acero, *University of Zaragoza*

T29.4: High-Performance Programmable Ac Signal Power Amplifier Using DWP-Based Discrete-Time Sliding Mode Control Technique

Fei Xu, Hao Ma, *Zhejiang University*

T29.5: A PID Control Strategy for Dc-Link Voltage in Z-Source Inverter

Xinping Ding, Z. M. Qian, Shuitao Yang, Bin Cui, *Zhejiang University*; Fang Peng, *Michigan State University*

T30: Circuits and Systems

Thursday • 2:00 pm - 5:30 pm • South Ballroom B

Session Chairs:

Jinrong Qian, *Texas Instruments*

Mark Nelms, *Auburn University*

- T30.1: High-Speed Flywheel and Motor Drive Operation for Energy Recovery in a Mobile Gantry Crane**
Mark Flynn, *University of Texas*; Patrick McMullen, Octavio Solis, *Vycon Inc.*,
- T30.2: Kinetic Energy Storage Back-up for an Aircraft Recorder Independent Power Supply**
Alex Kyriakopoulos, Dara O'Sullivan, John G. Hayes, James Griffiths, Michael G. Egan, *University College Cork*
- T30.3: Development of a 350 kW 10 kV Pulse Power Converter for Capacitor Charging**
Amit Jain, *Peregrine Power LLC*; Christopher Henze, Cynthia Henze, *Analog Power Design Inc.*; Karl Conroy, *S&K Engineering*
- T30.4: Optimal Design of a Dc Reset Circuit for Pulse Transformers**
Dominik Bortis, Jürgen Biela, Johann Kolar, *ETH Zurich*
- T30.5: Sustainable Power Management for Mobile Computing**
Ali Muhtaroglu, Annette von Jouanne, *Oregon State University*
- T30.6: Configuring Systems for Operation from Three Phase Ac Power**
Robert White, Andreas Stiedl, *Astec-Artesynt*
- T30.7: Data Communications Issues for Digital Power Management**
Robert White, *Astec-Artesynt*; Dave Freeman, *Texas Instruments*

DIALOGUE SESSIONS

Dialogue Session papers have been selected through the same rigorous peer review process as papers in the Presentation Sessions. They are represented by papers in the APEC Proceedings.

In the Dialogue Sessions you will have the opportunity to talk at length with the authors about their work, something that is not possible in the oral presentation sessions.

Box lunches will be distributed from 11:30 am to 12:30 pm to those attending the Dialogue Sessions to encourage you to view as many of the dialogue papers as possible.

D1: EMI

D1.1: Impedance Interaction and EMI Attenuation in Converters with an Integrated Transmission-Line Filter

Andrew Baisden, Dushan Boroyevich, Jacobus Daan van Wyk, *Virginia Tech*

D1.2: Study on the Radiation Emissions of the Digital PCB

Limin Feng, Zhaoming Qian, Henglin Chen, *College of Electrical Engineering, Zhejiang University*

D1.3: A New Approach to Mitigate CM and DM Voltage dv/dt Value in PWM Inverter Drive Motor Systems

Gao Qiang, *Harbin Institute of Technology*

D1.4: Parametric Characterization of Differential-Mode Transmission Line EMI Filter

Yan Liang, Daan van Wyk, Khai Ngo, *Virginia Tech*

D1.5: A New Carrier-Based PWM for the Reduction of Common Mode Currents Applied to “Neutral-Point-Clamped” Inverters

Arnaud Videt, Philippe Le Moigne, *Ecole Centrale de Lille*; Nadir Idir, *Université des Sciences et Technologies de Lille (Ustl)*; Philippe Baudesson, *Schneider Toshiba Inverter Europe (STIE)*; Jacques Ecrabey, *Schneider Electric*

D2: Components

D2.1: Temperature Influence on Equivalent Impedance and Efficiency of Inductor Systems for Domestic Induction Heating Appliances

Claudio Carretero, Jesus Acero, Rafael Alonso, Jose Miguel Burdio, *University of Zaragoza*; Fernando Monterde, *Bosch and Siemens Home Appliances*

- D2.2: Long-Term Stability Test System for High-Voltage, High-Frequency SiC Power Devices**
Tam Duong, Keyue Smedley, *University of California - Irvine*; David Berning, Allen Hefner, *National Institute of Standards and Technology*
- D2.3: A Model of Losses in Twisted-Multistranded Wires for Planar Windings Used in Domestic Induction Heating Appliances**
Jesus Acero, Rafael Alonso, José Miguel Burdío, Luís Ángel Barragán, *University of Zaragoza*; Claudio Carretero, *BSH Bosch-Siemens Home Appliances Group*
- D2.4: Optimizing 1200 V IGBT Modules for High Frequency Applications**
Eric Motto, John Donlon, *Powerex Inc.*; Yoshikatsu Nagashima, *Mitsubishi Electric*
- D2.5: Design Considerations for High Power Inductors in Dc-Dc Converters**
Thomas Salem, *U.S. Naval Academy*; Damian Urciuoli, Greg Ovrebo, *U.S. Army Research Laboratory*; Vadim Lubomirsky, *Berkley Research Associates*
- D2.6: High Breakdown Voltage and Low Specific On-Resistance C-Doped GaN-On-Sapphire HFETs for Low-Loss and High-Power Switching Applications**
Young Chul Choi, M. Spencer, L. Eastman, *Cornell University*; M. Pophristic, *Velox Semiconductor*
- D2.7: Performance Evaluation of SiC MOSFET/BJT/Schottky Diode in a 1 MHz Single Phase PFC**
Xiaojun Xu, Alex Huang, Yan Gao, *North Carolina State University*; Anant Agarwal, Sumi Krishnaswami, Sei-Hyung Ryu, Xu Huang, *Cree, Inc.*

D3: Circuits and Systems

- D3.1: A Novel Self-Powered Supply for GCT Gate Drivers**
W. Hu, B. Wu, *Ryerson University*; N. Zargari, Z. Cheng, *Rockwell Automation Canada*

- D3.2: Arc Stability Criteria in Ac Arc Furnace and Optimal Converter Topologies**
Yongjoong Lee, Henrik Nordborg, *ABB Switzerland Ltd - Corporate Research*; Yongsug Suh, Peter Steimer, *ABB Switzerland Ltd - MV Drives and Power Electronics*
- D3.3: Frequency Tracking Control for a Capacitor-Charging Parallel Resonant Converter With Phase-Locked Loop**
Honggang Sheng, Yunqing Pei, Xu Yang, Fred Wang, *CPES, Virginia Tech*
- D3.4: Improved Performance of Half-Bridge Series Resonant Inverter for Induction Heating with Discontinuous Mode Control**
I. Millán, D. Puyal, J.M. Burdío, C. Bernal, J. Acero, *University of Zaragoza*
- D3.5: New Power Conditioning System for Battery-Free Satellite Buses with Maximum Power Point Tracking**
Enrique Maset, Esteban Sanchis Kilders, Juan Ejea, Agustín Ferreres, *University of Valencia*; Jose Blanes, Ausias Garrigós, José Carrasco, *University Miguel Hernández*; Alan Weinberg, *Weinberg Electronics Ltd.*

D4: Lighting

- D4.1: A Novel Single Stage Dimmable Electronic Ballast with High Efficiency and Unity Power Factor Using an Integrated Buck-Boost Current Source Resonant Inverter**
John Lam, Praveen K Jain, *Queen's University*
- D4.2: Solving High-Voltage Off-Line HB-LED Control Circuit Issues**
Giovanni Carraro, *International Rectifier*
- D4.3: Power Driver Topologies and Control Schemes for LEDs**
Heinz Van Der Broeck, *University of Applied Sciences Cologne*; Matthias Wendt, Georg Sauerlaender, *Philips Research Aachen*

D5: Alternative Energy

D5.2: Simulation Modeling and Experimental Validation of Generator Control Strategy in DFIG System

Seung-Ho Song, Ji-Hoon Im, Hyeong-Jin Choi, Seung-Gi Jeong, *Kwangwoon University*;
Byoung-Chang Jeong, *LS Industrial Systems*

D5.3: Development of a Variable-Speed Wind Energy Conversion System

Shuying Yang, Xing Zhang, Chongwei Zhang, Liuchen Chang, Renxian Cao, *Hefei University of Technology*

D6: Ac-Dc Converters

D6.1: Design and Implementation of a Novel Average Current Mode PFC Controller IC

Ning Zhu, Hongtao Mu, Xiaojun Xu, Alex Huang, *North Carolina State University*

D6.2: Integrated Circuits of a PFC Controller for Interleaved Critical-Mode Boost Converters

T. F. Wu, J. R. Tsai, Y. M. Chen, Z. H. Tsai, *National Chung Cheng University*

D6.4: Efficiency and EMI Analysis for a ZVS-SVM Controlled Three-Phase Boost PFC Converter

Rui Li, Dehong Xu, Bo Feng, *Institute of Power Electronics - Zhejiang University*; Kazuaki Mino, Hidetoshi Umida, *Fuji Electric Advanced Technology Co. Ltd.*

D6.5: Programmable PFC Based Hybrid Multipulse Power Rectifier with Sinusoidal Input Line Current Imposed by Digital Controller

Luiz Carlos Gomes De Freitas, Fabio Vincenzi, Marcos Freitas, Eraldo Fernandes, Roberlam Goncalves, *Federal Center of Technological Education of Goias*; Luiz Carlos de Freitas, *Federal University of Uberlandia*

D6.6: Research on Three-Phase High Power Factor Correction Based on Predictive Current Controller

Yu Fang, Yan Xing, Yuwen Hu, *Nanjing University of Aeronautics & Astronautics*; Xun Qiu, *Suzhou Vocational University*

D7: Utility Interface

- D7.1: A Novel Solid-State Bridge Type FCL for Three-Phase Three-Wire Power Systems**
Wanmin Fei, *Nanjing University of Aeronautics And Astronautics*; Yanli Zhang, Zhaojuan Meng, *Nanjing Normal University*
- D7.2: Simplified Voltage Notch Filler for Interactive Uninterruptible Power Supplies**
Manuel Pérez de Azpeitia, Arturo Fernández, Diego Lamar, Miguel Rodríguez, Marta María Hernando, *Universidad de Oviedo*
- D7.3: Analysis and Optimization of Active Frequency Drift Islanding Detection Method**
Furong Liu, Yong Kang, Shanxu Duan, *Huazhong University of Science and Technology*
- D7.4: Communicationless Parallel Inverters Based on Inductor Current Feedback Control**
Hong-Xin Ju, Ming Ding, Yan Du, Liuchen Chang, *Hefei University of Technology*

D8: Motor Drives

- D8.1: PWM Inverter Harmonics Contributions to the Inverter Fed IM Bearing Fault Diagnosis**
Bilal Akin, Hamid Toliyat, *Texas A&M University*; Umut Orguner, *Middle East Technical University*; Mark Rayner, *Toshiba*
- D8.2: BLDC Motor Control Algorithm for Low Cost Industrial Applications**
Namhun Kim, Hamid A. Toliyat, *Texas A&M University*; Issa M. Panahi, *University of Texas at Dallas*; Minhuei Kim, *Yeungnam College of Science & Technology*
- D8.3: Parameter and Speed Estimation for Implementing Low Speed Sensorless PMSM Drive System Based on an Algebraic Method**
Reginaldo Miranda, Cursino Jacobina, Eisenhaver Fernandes, Antonio Marcus Lima, Alexandre Oliveira, Mauricio Correa, *UFCCG*
- D8.4: Investigation of IPMSM's Position Estimation in Low Speed Region with Dc Link Current Detection**
Takayuki Kobayashi, Hisao Kubota, *Meiji University*

- D8.5: Optimum Control of Multi-Phase Permanent Magnet Machines Under Open-Circuit and Short-Circuit Faults**
Suman Dwari, Leila Parsa, *Rensselaer Polytechnic Institute*
- D8.6: EMF Feedback Control Strategy of Induction Motor for Wide Speed Range**
Lu Haifeng, Qu Wenlong, Cheng Xiaomeng, Fan Yang, Zhang Xing, *Tsinghua University*
- D8.8: Modified Direct Torque Control of Five-Phase Permanent Magnet Synchronous Motor Drives**
Yuan Gao, Leila Parsa, *Rensselaer Polytechnic Institute*
- D8.9: Combined Radial-Axial Magnetic Bearing for a 1 kW, 500,000 RPM Permanent Magnet Machine**
Philipp Imoberdorf, Christof Zwysig, Simon Round, Johann Walter Kolar, *ETH Zurich*

D9: Digital Control Techniques

- D9.1: PID Digital Control Using Microcontroller and FPGA Applied to a Single-Phase Three-Level Inverter**
Luiz Henrique Barreto, Paulo Praça, Cícero Marcos Cruz, René Torrico Bascopé, *Universidade Federal do Ceara*
- D9.2: Novel Digital Controller Improves Dynamic Response and Simplifies Design Process of Voltage Regulator Module**
Eric Meyer, Yan-Fei Liu, *Queen's University*;
Guang Feng, *Argonne National Lab*
- D9.3: Control of a Single-Phase PFC Preregulator Using an 8-Bit Microcontroller**
Yijing Chen, Mark Nelms, *Auburn University*;
Dake He, *Archangel Systems, Inc.*
- D9.4: Nonlinear PID in Digital Controlled Buck Converters**
He Mingzhi, Xu Jianping, *Southwest Jiaotong University*
- D9.5: Improved Digital Predictive Control of Switching Dc-Dc Converters**
He Mingzhi, Xu Jianping, *Southwest Jiaotong University*

D10: Analog Control Techniques

D10.1: Multi-Level Modeling of PFC Rectifier and Dc-Dc Converter Modules in Inter-Connected Switching Power Supply Systems

Runxin Wang, Jinjun Liu, Hao Wang, Qinsan Hou, *Xi'an Jiaotong University*

D10.2: Photovoltaic Maximum Power Point Tracking Based on an Adjustable Matched Virtual Load

Michael Sokolov, Doron Shmilovitz, *Tel Aviv University*

D10.3: A Unified Switching Model for VSC Validated by IGCTs and IGBTs

Zichao Fan, Wenhua Liu, Qiang Song, *Tsinghua University*

D10.4: A Novel Chaotification Control Scheme in Dc-Dc Converter

Ru Yang, Bo Zhang, Yongping Zhang, *South China University of Technology*

D11: Multi-Level Inverters

D11.1: A Diagnostic Technique for Multilevel Inverters Based on a Genetic-Algorithm to Select a Principal Component Neural Network

S. Khomfoi, L. Tolbert, *The University of Tennessee*

D11.3: A Five-Level Three-Phase Cascade Multilevel Inverter Using a Single Dc Source for a PM Synchronous Motor Drive

John Chiasson, *Boise State University*; Burak Ozpineci, *ORNL*; Leon Tolbert, *The University of Tennessee*

D11.4: A Fast and Universal Neuro-Based SVM Algorithm for Multi-Level Converters

Maryam Saeedifard, Reza Iravani, *University of Toronto*; Hamidreza Salighehrad, *Harvard University*; Alireza Bakhshai, *Queen'S University*

D11.5: Three-Level Three-Leg Converter for Single-Phase to Single-Phase Applications

Cursino Jacobina, Yuri Gomes, Isaac De Freitas, Edison Da Silva, *UFCEG*

D11.6: Switching Technique for Dual-Two Level Inverter
Claudio Rossi, Gabriele Grandi, Luca Zarri, Domenico Casadei, Alberto Lega, *University of Bologna*

D12: Dc-Dc Converters

D12.1: The Pinch-Off Circuit: Reducing Noise and Component Stresses by Eliminating Body Diode Conduction in Synchronous Rectifiers
Cameron Brown, Dwight Dewitt, Steven Robertson, *The Boeing Co.*

D12.2: LLC Dc-Dc Resonant Converter With PLL Control Scheme
Ray-Lee Lin, Wei-Cheng Ju, *National Cheng Kung University*

D12.3: Analysis and Design of Voltage Regulator with Adaptive FET Modulation to Improve Efficiency
Osama Abdel-Rahman, Issa Batarseh, *University of Central Florida*; Jaber Abu Qahouq, Lilly Huang, *Intel Corporation*

D12.4: Improvement of Transient Load Response for the ZVS Buck Converter Using FPGA-Based Control
K. I. Hwu, *National Taipei University of Technology*; Y. T. Yau, *Industrial Technology Research Institute*

D12.5: Dual Smartrectifier™ and Directfet Chipset Overcomes Package Source Inductance Effects and Provides Accurate Sensing for Synchronous Rectification in Dc-Dc Resonant Converters
Adnaan Lokhandwala, Maurizio Salato, Marco Soldano, *International Rectifier*

D12.6: A Novel Saturable Reactor Reset Circuit for Optimizing Soft Switching of Resonant Reset Dual Switch Forward Converter
Wei Chen, Zhenyu Lu, Zhaoming Qian, *Zhejiang University*; Shaoshi Ye, *Delta Electronics (Shanghai) Co. Ltd.*

D12.7: Adaptive Controller with Mode Tracking and Parametric Estimation
Jaber Abu Qahouq, Lilly Huang, *Intel Corporation*

- D12.8: Adaptive Modulation Control for Multiple-Phase Voltage Regulators**
Shangyang Xiao, Weihong Qiu, Greg Miller, *Intersil Corporation*; Thomas Wu, Issa Batarseh, *University of Central Florida*
- D12.9: The Light Load Issue of Coupled Inductor Laptop Voltage Regulators and Its Solutions**
Yan Dong, Julu Sun, Ming Xu, Fred Lee, *Virginia Tech*; Milan Jovanovic, *Delta Products Corporation*
- D12.10: Proposed DPWM Scheme with Improved Resolution for Switching Power Converters**
Yang Qiu, Jian Li, Ming Xu, Dong Ha, Fred Lee, *CPES, Virginia Tech*
- D12.11: Quantification of Power MOSFET Loss Mechanisms in a Synchronous Buck Converter**
Toni Lopez, Reinhold Elferich, *Philips Research*
- D12.12: Self-Balanced Dual Interleaved Active-Clamp Forward for High Input Voltage Application**
Ting Qian, Brad Lehman, *Northeastern University*
- D12.13: A Simple Approach to Design a Contact-Less Power Supply for a Low Power Moving Load**
Cristina Fernandez, Pablo Zumel, Antonio Lazaro, Andres Barrado, *Universidad Carlos III de Madrid*
- D12.14: Development of High Power Dc-Dc Converter for Metro Vehicle System**
Honnyong Cha, Qingsong Tang, Fangzheng Peng, *Michigan State University*
- D12.15: 390V Input Vrm for Server Power Architecture**
Y. Liu, M. Xu, Fred Lee, *Virginia Tech*; A. Pratt, P. Kumar, *Intel Corporation*
- D12.16: A Novel Topology of Secondary LLC Series Resonant Converter**
Eun-Soo Kim, Bong-Geun Chung, Sung-In Kang, *Jeonju University*; In-Su Cha, *Dongshin University*; Moon-Ho Kye, *Elpac Electronics*
- D12.17: Analysis and Design of LLC Resonant Converter with Integrated Transformer**
Hangseok Choi, *Fairchild Semiconductor*

- D12.18: Design of a Transient Voltage Clamp (TVC) Based on Output Impedance Analysis**
Sungkeun Lim, Alex.Q Huang, Xiaojun Xu, *North Carolina State University*
- D12.19: An Ultrasonic Electrically Isolated Channel Over PCB**
Denis Metz, Shaul Ozeri, Doron Shmilovitz, *Tel Aviv University*
- D12.20: Design Considerations and Comparison Between Two High-Frequency Resonant Drivers for Synchronous Rectification MOSFETs**
Giorgio Spiazzi, Paolo Mattavelli, Leopoldo Rossetto, *University of Padova*
- D12.21: Operating Characteristics in LCLC Resonant Converter with a Low Coupling Transformer**
Eun-Soo Kim, Hyun-Kwan Lee, *Jeonju University*; Young-Su Kong, *NISI*; Yoon-Ho Kim, *Chung-Ang University*
- D12.22: Multiple-Input Dc-Dc Converters to Enhance Local Availability in Grids Using Distributed Generation Resources**
Alexis Kwasinski, Philip Krein, *University of Illinois At Urbana-Champaign*
- D12.23: Analysis and Applications of a Current-Sourced Buck Converter**
Wayne Weaver, Philip Krein, *University of Illinois at Urbana-Champaign*

D13: Miscellaneous Power Electronic Topics

- D13.1: A Robust Repetitive Control Strategy for CVCF Inverters**
Shuitao Yang, Bin Cui, Fan Zhang, Zhaoming Qian, *Zhejiang University*
- D13.2: Design Considerations for PDM Ac-Ac Converter Implementation**
Abdelhalim Sandali, Ahmed Cheriti, Pierre Sicard, *Université Du Québec À Trois-Rivières*
- D13.3: Class D Amplifier with Ripple Steering**
Eric Mendenhall, *Extron Electronics*
- D13.4: A 2 MW Motor and ARCP Drive for High-Speed Flywheel**
Robert Thelen, Angelo Gattozzi, Doug Wardell, Aaron Williams, *The University of Texas at Austin*

- D13.5: Dc-Link Single-Phase to Single-Phase Full-Bridge Converter Operating with Reduced Ac Capacitor Voltage**
Isaac De Freitas, Cursino Jacobina, *UFCEG-Brazil*
- D13.6: A Current Reconstruction Scheme for Low-Cost PMSM Drives Using Shunt Resistors**
Song Chi, Xiaoyan Wang, Yingqin Yuan, Zheng Zhang, *Whirlpool*; Longya Xu, *The Ohio State Univervisty*
- D13.7: Fault Tolerant Ac-Ac Single-Phase to Three-Phase Dc-Link Converter**
Euzeli Santos Jr., Cursino Jacobina, Mauricio Correa, *UFCEG*
- D13.8: A Comprehensive Analysis of a Three-Phase Z-Source Dc-Ac Converter**
Joseph Ojo, *Tennessee Tech University*
- D13.9: Development and Test a 260 kVA Inverter with a Passive Soft-Switching Snubber**
Lihua Chen, Alan Joseph, Qingsong Tang, Fang Peng, *Michigan State University*
- D13.10: Experimental Analysis of a Six Phase Permanent Magnet Synchronous Generator in a Variable Speed Constant Frequency Generating System**
Elhadj Miliani, Mohamed-Yacine Ayad, Daniel Depernet, Jean Marie Kauffmann, *L2ES-UTBM*
- D13.11: Transformerless Photovoltaic Inverters Connected to the Grid**
Tamas Kerekes, Remus Teodorescu, *Aalborg University*; Uffe Borup, *Powerlynx A/S*

EXHIBITOR SEMINARS

Several exhibiting companies will be offering Exhibitor Seminars. Each 30-minute seminar will offer an in-depth look at solving one or more problems common to the industry using the products or services of the presenting Exhibitor.

Session #1

Tuesday, February 27
1:30 pm - 2:00 pm

Ansoft Corporation • Marina Ballroom 3

EMI/EMC Considerations for Electric Drive Systems

National Semiconductor • Marina Ballroom 4

High Voltage Buck Regulators Using
Emulated Current Mode Control

Ridley Engineering • North Ballroom B

Frequency Response Measurements
for Power Electronics

Texas Instruments • Marina Ballroom 2

Interleaved PFC Control Solutions for Transition
and Continuous Mode

Tyco Electronics • Marina Ballroom 1

Engineering Advantages of Stamped and Formed
Technologies in Power Connectors

Vishay Intertechnology • South Ballroom B

New SKYFET™ Technology (MOSFET with integrated
Schottky diode in monolithic die) Improves Efficiency
in Dc-Dc Applications

Session #2

Tuesday, February 27
2:15 pm - 2:45 pm

Chang Sung • South Ballroom B

Low Profile Solution for Ripple Suppression
with Magnetic Sheets

International Rectifier • Marina Ballroom 1

Strategies and Implementation of Robust Power Supplies
for High-Uptime Systems

Magnetics • Marina Ballroom 3

Inductor Design for Power Factor Correction

Powerex • Marina Ballroom 4

Latest Development in Integrated Power Modules
for Small Inverter Applications

Transim Technology • Marina Ballroom 2

SIMatrix/SIMPLIS 5.3 -- Power Electronics Simulation
for IC and System Designers

Venable Instruments • North Ballroom B

Stability Analysis and Impedance Measurement
Using a Frequency Response Analyzer

Session #3

Tuesday, February 27

3:15 pm - 3:45 pm

Actown Electrocoil • Marina Ballroom 2

New Technology Produces Smaller, Cooler, and Lighter Toroids

Freescale Semiconductor • Marina Ballroom 3

Simple Switching Voltage Converters Using Microcontrollers

LeCroy • North Ballroom B

Measurements and Analysis for Switchmode Design

Magsoft • Marina Ballroom 1

New Simulation Software Tools for System-Level and Fast Inductance Computations

Power Intergration • Marina Ballroom 4

Power Supply Design for Peak Audio Applications

Technical Materials • South Ballroom B

Engineering of Hybrid Metal Composites for Electrical Components

Session #4

Wednesday, February 28

10:30 am - 11:00 am

Collmer Components • Marina Ballroom 4

Electric Current Sensors Utilize Emerging Technology

Cree Power • Marina Ballroom 3

Silicon Carbide, The Revolution Starts Now!

Microsemi • Marina Ballroom 1

Power MOS 8, a Quiet Evolution

ON Semiconductor • Marina Ballroom 2

Bringing Efficient Power Supplies to Market Today

SB Electronics • North Ballroom B

Improvements in Pulse Film Capacitor Technology

APEC 2007 EXPOSITION

The Exposition will open on Monday, February 26 when the Plenary Session concludes.

Exhibit Hall Hours

Monday, February 26.....5:30 pm — 8:00 pm
Tuesday, February 27.....12:00 pm — 5:00 pm
Wednesday, February 2810:15 am — 2:00 pm

EXHIBIT HALL FUNCTIONS

Exhibitor's Reception

A Welcoming Reception will be held in the Exhibit Hall on Monday, February 26 from 5:30 pm until 8:00 pm. Registered spouses and guests are welcome.

Exhibit Hall Breaks

Tuesday and Wednesday light snacks will be offered in the exhibit hall from 11:30 am – 1:30 pm free of charge to all who have access to the exhibit hall.

EXPOSITION SURVEY & GIVEAWAY

During all three days of the Exhibition we will be giving away over \$5000 in prizes. At registration everyone (exhibits only registrants and exhibitors included) will be issued a raffle ticket that you will put in a drop box upon entering the Exhibit Hall. This will be good for all three days of raffles during the exhibition, but you must be present to win.

In an effort to get feedback on the Exhibition, we are asking that you complete and turn in a survey in the designated drop box in the Exhibit Hall. Those who do so are automatically entered in a special prize drawing to be held on Wednesday, February 28 at 1:30 pm.

EXHIBITOR LISTING

as of 1/2/2007

ACME Magnetics USA, Inc.
Actown Electrocoil, Inc.
AMETHERM
AMREL/American Reliance
Amulaire Thermal Technology
Analog Devices, Inc.
Anderson Power Products
Ansoft Corporation

Applied Power Systems, Inc.
Arnold Magnetic Technologies
Autotest
AVNET
AVX Corporation
Bergquist Company
BI Technologies
Bose Research PVT, LTD
C&D Technologies
CableCo / Methode
Central Semiconductor
Ceramic Magnetics, Inc. / Feriti
Champs Technologies
Chang Sung Corporation
Chroma Systems Solutions, Inc.
Coilcraft
Collmer Components
Component Distributors Inc.
Cornell Dubilier
Cramer Coil & Transformer Co., Inc.
Cree, Inc.
Darnell Group
Datatronics
Dau Thermal Solutions, Inc.
Dexter Magnetic Technologies, Inc.
EBG, LLC
ECI (Electronic Coils)
ECN Worldwide
Eldre Corporation
Electrocube
Electronic Concepts, Inc.
Elna Magnetics
Elytone Electronics
EMA Design Automation, Inc.
EPCOS
ERM Thermal Technologies, Inc.
Evox Rifa
Fairchild Semiconductor
Fair-Rite Products Corporation
Fengqui Magnetic Materials Co.
Ferroxcube USA, Inc.
Filter Concept, Inc.
Freescale Semiconductor, Inc.
FUJI Electric Device Technology America, Inc.
GMW Associates
Great Wall Semiconductor
Hengdian Group
HV Components / CKE
HVR Advanced Power Components, Inc.
ICE Components, Inc.
Illinois Capacitor, Inc.
Infineon Technologies

International Rectifier
Intersil Corporation
Isotek Corporation
ITW Paktron
Kaschke USA, Inc.
Kemet
Kester
LeCroy Corporation
Lodestone Pacific
Magnetic Metals
Magnetics
Magsoft Corporation
Maxim Integrated Products
MH&W International Corporation
Micrel, Inc.
Micrometals, Inc.
Microsemi Corporation
MMG
National Semiconductor
New England Wire Technologies
NH Research
NORWE, Inc.
NXP (Philips)
Ohmite Manufacturing Company
ON Semiconductor
Payton America
Pearson Electronics, Inc.
Pento Media / Electronics OEM
Planar Quality Corporation
Plexim
Positronic Industries, Inc.
Power Electronics Technology
Power Integrations
Power Systems Design Europe & China
Powerex, Inc.
Power-One, Inc.
Precision, Inc.
Primarion
Proton-Electrotex, LLC
RAF Technology, Inc.
Renco Electronics, Inc.
Ridley Engineering, Inc.

ROHM
R-Theta Thermal Solutions
Rubadue Wire Company, Inc.
SBE Electronics
Semtech
Shindengen
Silicon Laboratories
STMicroelectronics, Inc.
Tabtronics, Inc.

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All registrations sent by mail or fax must include payment. Payment methods include credit card, check or money order. Checks may be personal, business or certified. Checks and money orders must be payable in U.S. dollars and drawn on a U.S. bank.

Accepted credit cards: Master Card, Visa and American Express. Please include the correct credit card number and expiration date where indicated on the registration form. Please do not send cash. Checks and money orders returned unpaid or credit card payments for which payment was refused will be assessed an additional handling charge of \$50.00.

To receive the early registration rate, your registrations must be submitted no later than Friday, January 26, 2007. All requests for cancellation and refund of registration fees must be received in writing at the APEC offices no later than the close of business January 26, 2007.

All refunds will be processed after the conclusion of the conference and will be subject to a \$50.00 processing fee.

For those who register and are unable to attend the conference, any Proceedings, Seminar Workbooks or other printed materials to which you are entitled will be shipped to you within 30 days of the conclusion of the conference.

BADGES

Badges are required for admission to all Professional Education Seminars, Technical Sessions, Dialogue Sessions, Rap Sessions and the Exhibit Hall. Please wear your badge at all times so that you will not be delayed at the entrance to an event.

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the conference. For extra copies of the Seminar Workbook you are strongly encouraged to buy them through Early Registration.

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APEC 2007
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February 25 – March 1, 2007
Disneyland® Hotel
Anaheim, California