

Conference Program
19th Annual Applied Power Electronics
Conference And Exposition
February 22-26, 2004
Disneyland Hotel
Anaheim, California
www.apec-conf.org

APEC
2004

CoSponsored By
IEEE Power Electronics Society
IEEE Industry Applications Society
Power Sources Manufacturer's
Association (PSMA)

**Applied Power Electronics Conference
And Exposition
February 22-26, 2004
The Disneyland Hotel, Anaheim, California**

**Co-Sponsored By
IEEE Industry Applications Society
IEEE Power Electronics Society
Power Sources Manufacturer's Association**

APEC returns to Disneyland in 2004! The Disneyland Hotel in Anaheim is a favorite of APEC attendees, as demonstrated by a record number of technical submissions for the upcoming conference and exposition. If you have never attended APEC at Disneyland, consider making it a family event! The Disneyland Hotel, located in the Downtown Disney complex features traffic-free walking access to many shops and restaurants, and of course, the Disneyland and California Adventure theme parks. There will be a spouse program for those looking to explore beyond Disney and our Wednesday Banquet is set to take place in the California Adventure Park.

But, alas, there is business to tend to. The APEC conference committee has worked hard this year restructuring the conference to better meet the needs of you, the attendees. Updated features include handpicked Seminars, timely and controversial Rap Session Topics, an outstanding line-up of Plenary Speakers and expanded exposition hours. Join us on Monday night for the annual MicroMouse competition and see some of the best mice in the world vie for this year's title.

New events this year include the OEM Initiative and the University Research Showcase. The OEM Initiative, designed to address timely issues facing the dc power supply community, represents a fresh direction for APEC. The University Research Showcase offers an opportunity to see the direction the leading University programs are heading. Both will provide opportunities for lively interaction with colleagues, both new and old, from all facets of the power electronics community.

On behalf of the conference committee, I invite you to participate in what promises to be the best APEC yet. The mix of technical content, social events, industry exposure and networking opportunities make APEC 2004 an event that you and your company cannot afford to miss. See you in Anaheim!

James Kokernak
General Chair

APEC WEB SITE

For the latest information on APEC, please consult the APEC Web site at www.apec-conf.org. The Web site has the latest news and information, access to on-line registration and downloadable registration forms.

FOR MORE INFORMATION

If the information you need is not in this program or on the APEC Web site, inquiries can also be directed to:

APEC 2004
2025 M Street, NW, Suite 800
Washington DC 20046 USA
Telephone: +1-202-973-8664
Facsimile: +1-202-331-0111
Email: APEC@courtesyassoc.com

NEW FOR APEC 2004

MORE OF WHAT YOU WANT TO SEE

The APEC Committee has worked hard this year to bring you more of the content that you want to see. The paper review process was overhauled to better guide the reviewers to select papers with a more applied and practical focus. All of the papers in the Plenary Session were specially solicited to bring you the latest information on several important areas in power electronics. A special task force, the APEC OEM Initiative Working Group, sought out leaders in power electronics to bring you seminars and presentations of current interest. The APEC Committee is excited about these innovations and believes you will be also. As you attend the conference, please let us know if we have succeeded in bringing your more of the information you want and need—and don't hesitate to let us know how we can do better!

MORE PAPERS THAN EVER BEFORE!

This year the APEC program committee accepted 297 high quality papers – a 50% increase from previous years. The technical program consists of 33 oral Presentation Sessions with 206 papers on a wide range of topics including ac-dc power supplies, dc-dc converters, motor drives, inverters, lamp ballasts, magnetics, EMI/EMC, modeling and control and applications on automotives and energies. Furthermore, in response to the record number of quality papers submitted this year, 7 Dialogue Sessions have been added on Thursday to accommodate additional 91 papers. These Dialogue Sessions are of equal quality but more appropriate for face-to-face discussions, providing attendees with greater breath of published materials plus a lively dialogue environment.

BEST PLENARY EVER

The APEC Committee has planned the Plenary Session to bring you important information on the latest development in several areas of power electronics. With presentations like:

- The power electronics technology roadmap for the next five years,
- A review of developments in digital control,

- A call to action from a leading OEM to meet the ever more demanding power needs of electronic equipment,
- A forecast of how the power electronics business will look in the future,
- The role of power electronics in alternative energy supplies, and
- How the need to conserve energy will drive requirements for higher and higher power supply efficiency,

You can't afford to miss the best APEC Plenary Session ever.

SPECIAL PRESENTATION SESSIONS

There are three special presentation sessions to address issues of current interest. One session will look at how the changes in semiconductor and IC technology will affect the power requirements for new devices. This is your chance to get an early warning on the power challenges that will arrive in the next three to five years.

Another session gives a broad look at current research in power electronics at leading power electronics research institutions. This session will offer a fascinating look into seven different laboratories working on power from microwatts to megawatts.

In the third session, six leading suppliers of semiconductors to the power electronics industry review how changes in silicon technology will offer improved discrete and integrated devices on the next three to five years. After hearing about the challenges the IC makers will be bringing, here is the chance to learn about the new devices that will help us meet those challenges.

EXPANDED SEMINAR PROGRAM

For years, APEC has offered fifteen Professional Education Seminars. This has been the best and broadest seminar program available at any power electronics conference in the world.

This year, APEC takes the Seminars to a new level, adding two tracks—six seminars—for the power electronics professional who is not a designer. Topics include

- An introduction to the power supply business,
- A seminar on alternate business models for the power supply business,

- An overview of worldwide regulatory requirements with an emphasis on knowing what your product has to meet and how to get it approved,
- A look at what “lead free” means for power electronics manufacturers,
- Four leading OEMs discussing the best practices for qualifying power supplies and power suppliers (this is a rare opportunity to learn from the best of the best and is not to be missed!) and
- A seminar on quality that emphasizes getting right in production in order to minimize failures in the field.

With a total of 21 seminars, there is certainly something for everyone in the power electronics business. And APEC charges less to attend any and all of these seminars than most conferences to attend just one. This makes the APEC Professional Education Seminar program a value that can't be beat!

NEW CONFERENCE SCHEDULE

The Conference Committee has also made some slight changes to the conference schedule. The net effect is that Tuesday evening is now open time and our Exhibitors are encouraged to host hospitality events after the Rap Sessions. Be on the lookout for the chance to talk with your favorite Exhibitors in depth on Tuesday evening in their hospitality suites. To make sure the overall time you have in the Exposition Hall is not reduced, the Wednesday morning sessions have been shortened and the Exhibit Hall will open at 10:30 AM.

OTHER APEC HIGHLIGHTS

EXPOSITION

The Exhibition is a key part of APEC 2004, and you will see, touch and learn about the newest products and services from the leading companies in the power electronics industry. APEC's Exhibitors are also offering a series of seminars on Tuesday afternoon and Wednesday morning, where you can gain in-depth knowledge of the latest solutions to your power electronics challenges.

The Exposition Hall is also the social center of APEC. Whether it is during one of the conference receptions or during the luncheons, the Exposition Hall is the place to be. APEC's Exhibitors are also offering a series of seminars on Tuesday afternoon so that you can get an in-depth look at the latest solutions to your power electronics challenges.

MICROMOUSE CONTEST

APEC will once again host the premier MicroMouse contest in North America, drawing contestants from all over the world. Come by the Grand Ballroom room at 8:00 PM on Monday to cheer your favorite mouse to victory.

If you are interested in entering a MicroMouse in the contest, please see the APEC Web site for information and instructions. Information is also available from the APEC 2004 offices.

RAP SESSIONS

LET YOUR OPINION BE HEARD!

Come join one of three Rap Sessions being held this year; we will be discussing the hottest, most current, and highly controversial topics:

- Digital Power Supply Control - Real Or “Virtual”?
- Who Needs Power Supply Companies, When The Semiconductor Company Can Do It All?
- Who's Driving The Power Electronics Roadmap?

APEC is pleased to showcase the industry's most well known contributors in a free for all discussion that's sure to leave you wanting more.

CONFERENCE BANQUET

Lights, Cameras, ACTION!!

Attendees to APEC 2004 will spend the evening of Wednesday, February 25th, behind the scenes on a closed set of Hollywood Pictures Backlot. Beginning with a scrumptious dinner served on the northern section of the backlot, attendees will experience the magic of Hollywood.

You will have the chance to “Soar over California”, play Who Wants to be a Millionaire and even tour Disney's Animation Building!

SPOUSE AND GUEST PROGRAM

APEC welcomes the spouses and guests of the APEC conference participants. A welcoming breakfast will be held on Monday, February 23rd. Afterwards, the *Colors of the Coast: Huntington Beach and Newport Beach* tour is available. This tour starts with a visit to the pristine beaches of Main Beach. From there you can take a stroll on the Huntington Beach Pier while enjoying breathtaking views of coastline or shop along Main Street. The tour will then head over to the harbor in Newport Beach, where you will learn about the history of the harbor and hear stories about some of their most infamous residents. The tour will end with a fabulous lunch served at the Newport Landing Restaurant.

On Tuesday, February 24th, a guided tour will take you from Bowers to Flowers, visiting the famous Bowers Museum of Cultural Art and the gorgeous Sherman Gardens. Experience this fun and fascinating tour that will conclude with lunch served at Café Jardin in the midst of a magical oasis in the Sherman Gardens.

Spouses and guests are also welcome at conference activities like the Exhibit Hall receptions and the MicroMouse Contest.

FOR MORE INFORMATION

Information on Disneyland events and activities, please see their Web site at www.disneyland.com.

Information on events taking place in and around Anaheim can be found on the Orange County Convention and Visitor's Bureau Web site, www.anaheimoc.org.

REGISTRATION

In order to participate in APEC 2004 activities, one must register with the conference. Attendance of the Professional Education Seminars Presentation Sessions and Dialogue Sessions requires payment of the appropriate registration fees.

Admission to the Exposition Hall is complimentary, but one must register at the Conference Registration Center and receive a badge that allows entrance. Exposition Only

registrations are only done at the conference and cannot be done in advance.

Spouses and guests who wish to participate in the Spouse And Guest Hospitality Program are required to register with the conference but there is no charge.

REGISTRATION FEES

Membership

Member registration rates are available to all current IEEE members and employees of companies that are current members of the Power Sources Manufacturer's Association (PSMA, www.pdma.com).

To make sure there is no delay in processing your registration or checking in at the Conference, please indicate on the registration form how you qualify for the Member rates by providing either your IEEE membership number or the name of your employer in the space provided.

Advance Registration

Professional Education Seminars

Member\$350.00
Non-Member\$425.00

Conference Registration

Member\$450.00
Non-Member\$550.00

Late Or On-Site Registration

Professional Education Seminars

Member\$425.00
Non-Member\$500.00

Conference Registration

Member\$550.00
Non-Member\$650.00

IEEE Life Members And Students

Professional Education Seminars\$150.00
Conference Registration\$225.00

When registering at the conference, you will be required to show identification to receive the Life Member and Student rates. Student rates require full time registration at an accredited institution.

ADVANCE REGISTRATION DEADLINE

Registrations must be received at the APEC registration offices or on the on-line registration system no later than the close of business on **Monday, January 26, 2004** to be eligible for the Advance Registration rates.

WHAT'S INCLUDED

Professional Education Seminars

Registration for the Professional Education Seminars includes one copy of the Seminar Workbook in hard copy and admission to any or all of the Professional Education Seminars. Unlike some conferences that require a separate registration fee for each seminar, APEC gives you your choice of as many seminars as you can attend for one low registration fee.

Also included in the registration fee for the Professional Education Seminars is admission to the:

- Exposition Hall,
- Exposition Hall receptions,
- Exhibitor's Seminars,
- MicroMouse Contest and
- Rap Sessions.

Conference Registration

Registration for the conference includes one copy of the Proceedings on CD-ROM and admission to any or all of the Presentation and Dialogue Sessions.

Also included in the Conference Registration fee is admission to the:

- Conference Banquet,
- Exposition Hall,
- Exposition Hall receptions,
- Exhibitor's Seminars,
- MicroMouse Contest and
- Rap Sessions.

Please note that printed, paper copies of the APEC Proceedings are NOT included with this year's Conference Registration. If you want or need a printed copy, a limited number will be available for purchase with an Advance Registration. Copies may or may not be available for purchase at the conference.

Exposition Only

Included in the no-charge Exposition Only registration is admission to the:

- Exposition Hall,
- Exposition Hall receptions,
- Exhibitor's Seminars,
- MicroMouse Contest and
- Rap Sessions.

Exposition Only registrations must be done at the conference; they cannot be done in advance.

Spouse And Guest Registration

Spouses and guests accompanying APEC attendees are encouraged to register with the conference. Spouses and Guests who register with the conference will receive a badge allowing admission to the:

- APEC Spouse And Guest Hospitality Room,
- Welcoming Breakfast,
- Exposition Hall,
- Exposition Hall receptions,
- Exposition Hall luncheons (with separately purchased ticket),
- MicroMouse Contest and
- Rap Sessions.

Those Spouses and Guests registering in advance will also receive a welcoming packet when checking in at the conference. This packet will include:

- Registration badge,
- Tickets for the spouse and guest tours for which registration was received in advance and space permitted and
- A listing of all APEC Spouse and Guest Hospitality Program events.

HOW TO REGISTER

On-Line Registration

To register on-line, visit the APEC Web site, www.apec-conf.org. A Master Card, Visa or American Express credit card will be required.

Registering By Mail Or Fax

A registration form is included in this Advance Program or one in Adobe® Acrobat® format can

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be downloaded from the APEC Web site,
www.apec-conf.org.

Complete this form and send it by mail or fax to
the APEC Registration Center:

APEC 2004/Badgeguys
1959 Jester Circle
Lawrenceville, GA 30043
Facsimile: +1-678-407-3237

For registrations that are sent by mail, payment must be included. You may make payment by credit card, check or money order. Checks may be personal, business or certified. Checks and money orders must be payable in United States dollars and drawn on a United States bank. If you wish to pay with a credit card, APEC accepts Master Card, Visa and American Express. Be sure to include your credit card number and expiration date where indicated on the registration form. Please do not send cash.

Registrations sent by fax must include payment by credit card. APEC accepts Master Card, Visa and American Express. Be sure to include your credit card number and expiration date where indicated on the registration form.

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.

Register At The Conference

You may also register at the conference. For your convenience, the Conference Registration Center will be open each day, starting on Saturday afternoon.

For payments at the conference, APEC can accept credit cards (Master Card, Visa or American Express), or checks or money orders (payable in U.S dollars and drawn on an U.S. bank). Checks and money orders returned unpaid will be assessed an additional handling charge of \$50.00.

CONFERENCE REGISTRATION CENTER

When you arrive at the conference, please go the Conference Registration Center, located in the Center Lounge, to register and pick up your conference materials. The Conference Registration Center will be open:

Saturday, February 213:00 PM - 6:00 PM
Sunday, February 22.....8:00 AM - 5:00 PM
Monday, February 238:00 AM - 5:00 PM
Tuesday, February 248:00 AM - 5:00 PM
Wednesday, February 25.....8:00 AM - 3:00 PM
Thursday, February 268:00 AM - Noon

CONFIRMATION OF REGISTRATION

All Advance Registrants will be sent an email confirming that their registration has been received. The email will include your name and address, events for which you registered, any extra items purchased and amounts paid. However, to protect your privacy, it will not contain any information about the method of payment.

Registrations received after the advance registration deadline will not receive a confirmation email.

CANCELLATION & REFUND POLICY

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 **Monday, January 26, 2004**. 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.

TRAVEL AND ACCOMMODATIONS

CONFERENCE HOTEL

The Disneyland Hotel in Anaheim, California will be the center of activity for APEC 2004. Your conference experience will be enhanced if you stay in the conference hotel. The Disneyland Hotel is located at 1150 Magic Way, Anaheim, California 92802.

Hotel Room Rates

A block of rooms has been reserved for the APEC 2004 participants at the Disneyland Hotel at special conference rates. Be sure to mention that

you are with the "IEEE APEC" when making a reservation to qualify for this rate:

Single\$160.00

Current resort fees, city taxes and state taxes are additional.

In order to receive the preferred conference rates listed above, **it is imperative that you make your reservations before January 29, 2004.** After January 29, 2004, reservations will be confirmed only on a space available basis.

Reservations

To make a reservation, please call the hotel directly and reference "IEEE APEC". You may also complete the hotel reservation form and mail or fax it with *one night's payment* (check or major credit card) to:

**The Disneyland Hotel
Reservations
1150 Magic Way
Anaheim, California 92802**

A hotel registration form is included in this Conference Program or one in Adobe® Acrobat® format can be downloaded from the APEC Web site, www.apec-conf.org.

Contacting The Disneyland Hotel

To reach the Disneyland Hotel by phone or fax:

Reservations Only

Phone: 714-520-5005
Facsimile: 714-520-6079

All Other Inquiries

Phone: 714-778-6600

AIRLINE DISCOUNT PROGRAM

American Airlines will be the official airline for APEC 2004. They are offering a number of discount fares for APEC attendees traveling to APEC. The earlier you make your reservations, the better the discount. To take advantage of these low fares, give the IEEE Applied Power Electronics Conference identifier number, 5924AC, to your travel agent or call American Airlines at their special Meeting Services Desk Toll Free Number: 1-800-433-1790.

GROUND TRANSPORTATION

The Disneyland Hotel, in Anaheim, CA, is served by all the cab and shuttle services operating at the Santa Ana/Orange County International Airport (SNA) or Los Angeles International Airport (LAX).

From The Los Angeles International Airport (LAX) To The Disneyland Hotel

For many traveling from outside the United States, the Los Angeles International Airport (LAX) (www.los-angeles-lax.com/) may offer the most convenient access to the Disneyland Hotel.

Taxicab service is available from curbside on the Lower Level. The typical fare from the airport to the Disneyland Hotel is approximately \$45-50.00.

There are a number of shared ride (buses and shuttle vans) that offer service from the Los Angeles Airport to the Disneyland Hotel, including:

Super Shuttle:

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

Airport Bus

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

Outbound buses, shuttles, hotel or rental cars and courtesy vans can be picked up from the designated areas on the Lower/Arrival Level islands in front of each terminal. The areas are signed Van, LAX Shuttle, Bus Stop and Courtesy Tram.

From The John Wayne/Orange County/Santa Ana Airport (SNA) To The Disneyland Hotel

For many traveling within the United States, the John Wayne/Orange County airport (SNA) (www.oair.com) will offer the most convenient access to the Disneyland Hotel.

The airport's Ground Transportation Center (GTC) houses all Ground Transportation Services including buses, taxis, shuttles and car rental return. The GTC is located in the center of the

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East Parking Structure directly across from the Thomas F. Riley Terminal.

Taxicab service is available from the John Wayne Airport to the Disneyland Hotel. The fare is approximately \$20.00.

There are a number of shared ride (buses and shuttle vans) that offer service from the John Wayne/Orange County Airport to the Disneyland Hotel, including:

Super Shuttle:

Phone: 714-517-6600
Phone: 800-258-3826
Web Site: www.supershuttle.com
Fare: Approximately \$11.00 One Way, \$22.00 Round Trip

Airport Bus

Phone: 714-938-8937
Phone: 800-772-5299
Web Site: www.airportbus.com
Fare: \$11 One Way, \$18 Round Trip

Car Rental

Once again this year, AVIS will offer attendees a special conference rate. To take advantage of this special rate, call the AVIS Meeting Reservation and Information Desk at 1-800-331-1600 or contact them online at www.avis.com. Identify yourself as eligible for the APEC rate by the giving the AWD discounts number, A606092.

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.

ANAHEIM WEATHER IN FEBRUARY

The weather in the Anaheim and Disneyland area in February is quite mild. The average daily high temperature is 21 °C (69 °F) and the average daily low temperature is 8 °C (47 °F). February is the wettest month of the year with an average rainfall of 73 mm (2.9 in) so be prepared for the occasional rain shower. Severe weather is very rare in the Anaheim area.

SPOUSE & GUEST PROGRAM

Spouses and guests are encouraged and invited to attend the APEC 2004 Conference. Aside from the APEC activities and the Disneyland Resort area, the Anaheim area offers an enormous range of cultural, sightseeing and shopping activities.

In addition to the Spouse and Guest specific activities, spouses and guests are welcome at all APEC social and dining events. Please be sure to register for a badge in order to participate.

In particular, spouses and guests are welcome at the Exhibitor Receptions (badge required), Exhibition Hall Luncheons (ticket required), the Conference Banquet (ticket required), Rap Sessions (badge required) and the MicroMouse Contest.

To make your visit rewarding and enjoyable, APEC has put together a Spouse and Guest Hospitality Program for registered spouses and guests including:

- A Hospitality Room that will be open each morning,
- A complimentary, welcoming continental breakfast,
- Two tours to give a teasing glimpse of the offerings of southern California and
- Information on a number of tours available through commercial tour companies.

HOSPITALITY ROOM

APEC 2004 has arranged the Coronado Room as a daily meeting place for the spouses and guests of APEC attendees. The room will be open and coffee served Monday through Thursday from 8:00 AM to 10:00 AM.

TOURS AND EVENTS

Monday, February 23rd, 8:00 – 9:30 AM
Welcoming Breakfast
Coronado Room

To help you start off what will be an exciting week, APEC is serving a continental breakfast for spouses and guests on Monday morning. This is a great time to meet old friends and make new ones. This event is complimentary to registered

spouses and guests but you must have your name badge to be admitted.

Monday, February 23rd

Colors of the Coast: Huntington And Newport Beaches

Start off your week in California with a walk in the sand and beautiful views of “Surf City USA”, Huntington Beach. You can dig your toes into the pristine sand, take a walk along Huntington’s Pier and even do a little shopping along Main Street. Next you will travel to Newport Beach, described by many as a seaside Garden of Eden. While in Newport Beach you will take a 45 minute sightseeing cruise of the harbor and learn about its fascinating history and some more it’s more infamous residents. Once back on dry land you will enjoy an exquisite meal served at the Newport Landing Restaurant where only the freshest seafood specialties are available.

The cost is \$59.00 per person.

Please check at the Conference Registration Center for information on the specific pick-up time and location.

Tuesday, February 24th

From Bowders to Flowers: The Bowers Museum of Cultural Art and Sherman Gardens

Visit one of California’s finest architectural treasures as you tour the Bowers Museum. This historic hacienda was build by the wealthy cattle ranchers from Mexico and today it is home to one of the preeminent collections of cultural art and antiquities from Pre Columbian and Indian cultures, Africa and the Pacific Islands. It has been voted one of the country’s Top 10 “must see” museums. From here you will be transported to the Sherman Foundation Gardens located in the seaside community of Corona del Mar. You will enjoy everything from lush rose gardens, tropical flowers and orchids to the Sherman Discovery garden where you will be encouraged to savor the touch and smell of the flowers. Lunch will be served in the midst of this tropical oasis at the Sherman’s Café Jardin by some of California’s finest French chefs.

The cost is \$69.00 per person.

Please check at the Conference Registration Center for information on the specific pick-up time and location.

OTHER TOURS

Orange County and Los Angeles have such a variety of places of interest that we were unable to choose tours or attractions that would appeal to all. APEC will have available information on a number of different tours, sightseeing expeditions and attractions so that you can choose the ones that best suit your needs and interests. These tours are offered through regular tour companies. The cost varies depending on the tour but typically cost from \$20 to \$50 each. There are too many to list here, but a sampling of the tours that are available includes:

- The Getty Museum,
- Rodeo Drive,
- Hollywood studios,
- Homes of the stars and
- The beaches.

APEC encourages the Spouses, Guests and Attendees to be creative and adventurous in exploring the Los Angeles, Orange County and San Diego areas.

CONFERENCE BANQUET

Wednesday, February 25, 2004

Have you ever wanted to be an “extra” on a movie set, well here is your chance? A portion of the Hollywood Pictures Backlot has been designated a closed set for APEC attendees only. As you enter the area you will be credentialed as an “extra” for the evening. A fabulous dinner will be served while being entertained by Jim Henson’s Muppet 3-D attraction. From there you will be able to experience the exhilarating adventure of “Soarin’ Over California”, take part in “Who Wants to be a Millionaire” and even tour the famous Disney Animation Building where the true magic of Disney takes place. You do not want to miss out on this magical evening that will tempt all your senses and want you coming back for more!

The Banquet is included in registration fee for the Conference Registration. Additional tickets can be purchased for \$125.00.

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Please check at the Conference Registration Center for information on the specific time and departure location.

DINING AT APEC

RESTAURANTS IN AND NEAR THE HOTEL

There are more than 20 dining locations in and around the Disneyland Resort. From Italian to Japanese to American there is something here to suit any craving you may have during your stay. For restaurants in the Disneyland Hotel, in Downtown Disney or in the theme parks, you can make reservations up to 30 days in advance time by calling 714-781-DINE.

Restaurants located in the Disneyland Hotel complex include:

- The Coffee Shop
- Goofy's Kitchen - Character Dining Experience.
- Granville Steak House
- Hooke's Pointe and
- The Lost Galley.

Nearby dining in Downtown Disney, just a few steps from the hotel, includes:

- Catal Restaurant
- ESPN Zone
- House Of Blues
- La Brea Bakery Café
- Rain Forest Café
- Ralph Brennan's Jazz Kitchen
- Naples Ristorante e Pizzeria
- Napolini

In addition to several other restaurants within the Disney parks, the area around the Disneyland Hotel has a number of restaurants within a moderate walk to suit a wide range of taste and budgets.

LUNCH WITH THE EXHIBITORS

Lunch will be served in the Exhibition Hall on Tuesday and Wednesday. Advance purchase of a ticket is required. Tickets are available for \$10.00/person.

DIALOGUE SESSION LUNCH

Box lunches will be provided to those attending the Dialogue Session on Thursday.

PURCHASING ADDITIONAL CONFERENCE PROCEEDINGS AND SEMINAR WORKBOOKS

THROUGH ADVANCE REGISTRATION

Those registering for the technical sessions will **ONLY** be provided a CD-ROM copy of the proceedings. Should you wish to have a printed copy, you **MUST** order one in advance for an additional charge of \$100.00.

Conference registrants can purchase extra copies of the Conference Proceedings and Seminar Workbooks through Advance Registration. Those wishing extra copies are strongly encouraged to purchase them while registering in advance.

APEC reserves the right to limit quantities of APEC Proceedings or Seminar Workbooks sold to any one person or institution.

Advance purchase prices with registration for the conference:

Conference Proceedings..... \$100.00
(Hardcopy **or** CD-ROM)

Seminar Workbook..... \$95.00
(Hardcopy only)

Both Proceedings (Hardcopy **or** CD-ROM) &
Seminar Workbook..... \$175.00

These prices are only available when your order is received with your paid conference registration by January 26, 2004. Publications purchased with advance registration will be available for pick-up when you register for the conference.

ADVANCE PURCHASE WITHOUT CONFERENCE REGISTRATION

You may order copies of the APEC publications in advance of the conference without registering for the conference. Please use the *APEC 2004 Pre-Conference Publications Order Form*, included in this program and available for download from the APEC Web site. Your order

with payment must be received at the APEC offices by January 26, 2004.

Conference Proceedings\$100.00
(Includes Hardcopy or CD-ROM)

Seminar Workbook\$95.00
(Hardcopy only)

Both Proceedings (Hardcopy or CD-ROM) &
Seminar Workbook\$175.00

The books will be shipped after the conference and requires payment of a shipping and handling charge. Shipping to locations in the United States and Canada is \$25.00 per order. Shipping to locations other than the United States or Canada is \$80.00 per order.

APEC reserves the right to limit quantities of APEC Proceedings or Seminar Workbooks sold to any one person or institution.

AT THE CONFERENCE

A LIMITED NUMBER of copies of the Conference Proceedings and Seminar Workbooks **MAY** be available for sale at the Conference Registration Center, starting at noon on Wednesday, February 25. If there are any extra copies available, the prices will be:

Conference Proceedings\$100.00
(Includes Hardcopy or CD-ROM)

Seminar Workbook\$95.00
(Hardcopy only)

Both Proceedings (Hardcopy or CD-ROM) &
Seminar Workbook\$175.00

For payments at the conference, APEC can accept credit cards (Master Card, Visa or American Express), or checks or money orders (payable in U.S dollars and drawn on an U.S. bank). Checks and money orders returned unpaid will be assessed an additional handling charge of \$50.00.

THROUGH THE IEEE

After the conference, the APEC Proceedings may be purchased through the IEEE. Contact:

IEEE Single Copy Sales
445 Hoes Lane
Piscataway, New Jersey 08854 USA

Telephone: +1-800-678-4333 (USA &
Canada)
+1-732-981-0060

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SPECIAL NOTE ON SEMINAR WORKBOOKS

The APEC Professional Seminar Education Workbook will not be available through the IEEE or any other source after the conference. If you want extra copies of the Seminar Workbook, you are strongly encouraged to buy them through Advance Registration.

ADDITIONAL INFORMATION

SPONSOR MEMBERSHIP DESK

Each of the organizations sponsoring APEC will have membership desks. Individuals can inquire about membership in the **IEEE** and the two societies that sponsor APEC, the **Power Electronics Society** and **Industry Applications Society**. The **Power Sources Manufacturers Association (PSMA)** will also have a membership desk where organizations interested in joining can obtain information.

MESSAGE CENTER

A bulletin board for messages will be placed near the main conference registration area. Messages can be received and posted whenever the Conference Registration Center is open. Please advise any callers who may wish to reach you to call the main number of the Disneyland Hotel 714-778-6600 and ask for the IEEE APEC 2004 Registration Desk. APEC participants are encouraged to regularly check the message board.

SACK SITTERS

Sack Sitters will be on site from Monday, February 23 through Thursday, February 26. Sack Sitters offers packaging and shipping of APEC Proceedings, Seminar Workbooks and conference materials to any destination. The Sack Sitters desk will be near the main registration area. Please check at the conference for Sack Sitters' operating hours.

IMPORTANT NOTICES

BADGES

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

RECRUITING

IEEE Policy #10.18 prohibits recruiting at IEEE sponsored conferences. Consequently, recruiters and recruiting advertisements will not be permitted in the APEC 2004 hotel space, meeting facilities or Exposition Hall.

DISTRIBUTION OF COMMERCIAL MATERIAL

Distribution of commercial material by organizations not participating in the Exposition is prohibited in the APEC 2004 hotel space, meeting space and Exposition Hall.

PROFESSIONAL EDUCATION SEMINARS

APEC 2004 features 21 professional education seminars with a broad range of topics. The conference committee has worked hard to make sure there is something of interest to all APEC attendees during each of the seminar time periods. As always, APEC seminars offer a practical mix of theory and application for the professional working in power electronics. Unlike other conferences that charge by the seminar, at APEC one low fee gains you access to any and all of the seminars, along with the notes for every seminar. Whether you want to review an important topic area, broaden your understanding of a neighboring discipline, or take advantage of the practical experiences of experts in the field, the APEC 2004 seminars are a must for every conference attendee.

Please note that the room assignments are tentative and subject to change. Please check with the registration desk at the conference for the latest information.

PROFESSIONAL EDUCATION SEMINARS SESSION ONE

Sunday, February 22, 9:30 AM – 1:00 PM

S.1 The Business of Power—An Introduction to the Power Industry for the Non-Technical Professional

**F. Marshall Miles, Belfuse Power,
Oklahoma City, OK
South Ballroom A**

This seminar presents a broad overview of the power industry for the non-technical professional. It is intended to provide a foundational understanding of the power industry necessary for today's project manager, commodity manager, sales person or anyone involved in the business of power conversion. While some technical concepts are presented, they are done so with the non-technical audience in mind.

The first part of the seminar is an introduction to power technology. This provides an acquaintance with types of power supplies, power supply functionality,

and concepts of volts and amps. The history of power technology is briefly reviewed. With this basis, the discussion moves on to powering an electronic system. First, the historical requirements are reviewed. The newer requirements, such as the proliferation of the number of voltages in a system and dealing with low voltages at high currents, are presented. This section concludes with an introduction to various power system architectures.

The third part of the seminar tries to help make sense of the bewildering array of power options. For example, power supplies are available as standards, modified standards and full custom. And in the power world, standard has its own meaning. The discussion will then move to comparing specifications, which never seem to lend themselves to an apples-to-apples comparison. This leads to interesting challenges in product compatibility and assuring product from more than one supplier are interchangeable enough for your application. This section concludes with a discussion of cost versus performance versus flexibility.

The fourth and last section of the seminar is an introduction to the power business, starting with the economics of the power supply industry. Sourcing strategies are presented. The cost, time and risk associated with a power supply development project are presented. The seminar concludes with a presentation of some industry resources that can be of help.

S.2 SMPS Design Basics

Marty Brown, Sierra Energy Management Systems, LLC, Phoenix, AZ
Avalon Room

This seminar is aimed at the novice switching power supply designer who seeks a further intuitive understanding of the design of switching power supplies. Information will be conveyed on the intuitive level with very few equations.

The content will include: how does a switching power supply differ from a linear

power supply, descriptions of how basic switching power supplies work, what are topologies and how does one know which is the right one for the application, designing or selecting some of the key components, What are losses and how does one identify them, feedback compensation, and descriptions of the new developments within the power field.

The anticipated outcome of attending this seminar will be a greater appreciation of the operation of switching power supplies and a basic knowledge of their design. A list of literature will show the attendee how to get more information involving the design and understanding of switching power supplies.

S.3 Lead Free Manufacturing And Industry Preparedness

Seminar Chair: Chris Reynolds, AVX Corporation, Myrtle Beach, SC

Participants: E. Patrick McCluskey, University of Maryland; Dimosthenis Katsis, U.S. Army Research Labs; John Flannery, Artesyn Technologies and Scott Strand, IBM.

South Ballroom B

In his introduction to the seminar, Chris Reynolds will briefly outline the motivation behind the various lead free imperatives, and the legislative requirements being imposed on the industry.

Drs. McCluskey and Katsis will outline the impact that the lead free legislation has on conventional electronic materials, chemistries and processes. They will then outline the state of research and development of new processes, and the projected impact on manufacturing quality and field reliability.

Dr. Flannery will outline the practical impact of lead free legislation on component availability, product design, and product manufacturing processes. He will also outline conflicts that the higher soldering temperatures create with specific component and substrate technologies. In addition, he will analyze the impact for both

new designs, and for situations where existing designs may have to be converted to lead free.

Dr. Strand of IBM will represent the customer perspective. He will discuss what lead free means to them with respect to marketing impact, product differentiation, and commercial necessity. Also presented will be their expectations for the impact on product cost, cycle time, quality and reliability. For new products, the speaker will present a timetable for when all new development must be compatible to the legislation, and for existing products the speaker will discuss the circumstances under which products must be converted into a compatible design.

The seminar will conclude with open discussion, including the audience, on whether or not the power supply industry is ready to adopt lead-free manufacturing.

S.4 Power Electronics Packaging With An Emphasis On High Current Applications
Douglas Hopkins, State University Of New York, Buffalo, NY
North Ballroom A

This seminar provides the power electronics designer with a comprehensive description of leading and next generation power packaging techniques for power supplies and drives with emphasis on high current applications. An update is given on lead-free soldering issues and how designs are impacted by component availability and compatibility. Recent results in reliability testing of high-current density solder interconnects is also given. Attributes, processes and design rules for packaging techniques, such as multi-layered heavy-copper FR-4, copper-on-ceramic, bus bar and molded interconnect, are presented. The material is co-presented from electrical, thermal and physical perspectives.

The designer will gain familiarity with nomenclature, electrical and material characteristics, and guidelines for mixed-use of several packaging techniques. Designers will gain sufficient information to consider

and select alternate packaging techniques that optimally meet their needs. Several product reviews will demonstrate electrical/physical design and identify critical packaging issues. This is an essential course for the designers who must look at other packaging design approaches to further shrink their electronics.

S.5 Permanent Magnet And Induction Motor Drives

David A. Torrey, Advanced Energy Conversion LLC, Ballston Spa, NY
Marina 1

This course is intended for those who work with either permanent magnet or induction motor drives and desire a better understanding of how they can be controlled. The presentation will be broken up into five parts that address the operation of these machines, and how they may be controlled. Part 1 provides an overview of the basic principles of how permanent magnet motors operate. Part 2 provides similar information for the induction machine. With a basic understanding of machine operation providing the motivation, Part 3 discusses the converters used to operate the machines at variable speed. Switch specification, snubber circuits and clamps and thermal issues are addressed. Part 4 revisits the control of permanent magnet motors, discussing issues such as system modeling, control loop design, and enhancements that can improve or extend performance of the drive. Part 5 revisits control of the induction machine, also addressing modeling, control design and enhancements.

S.6 PWM Switch Modeling Historical Review and New Developments

Ray Ridley, Ridley Engineering, Roswell, GA and Vatche Vorperian, Jet Propulsion Laboratory, Pasadena, CA
North Ballroom B

1. Original PWM Model - The PWM switch model became the standard for analysis of dc-dc converters in the late 1980s. Its simple and elegant form allowed a single circuit

model to be used for all dc-dc converters, replacing more tedious and cumbersome methods of analysis. The PWM switch model also allowed the proper analysis of DCM converter operation that was previously impossible, giving substantial benefits over other analysis methods. The seminar will present a brief review of the PWM switch model, and examples of its application.

2. Extension to Current-Mode Control - Within a few years of publication of the switch model, its application was extended to cover current-mode control, while leaving the switch model itself unchanged. This allowed a single model to be used for both voltage-mode and current-mode control. Since the publication of the current-mode version, numerous other papers have been published with different approaches, and some of these will be reviewed in the seminar, and compared for the first time to the original model.

3. New Ripple Extension of the PWM Switch Model – A premise of the original switch model was the averaging of the switching ripple in the inductor. While this led to a powerful analytical tool for small-signal analysis, it did not allow the user to predict ripple currents and voltages. This seminar will present for the first time a new variation of the PWM switch model which accurately predicts current ripple in converters, including “zero-ripple” converters which have eluded accurate analytical predictions.

Attendees at this seminar will leave with a powerful set of tools which will cover their small-signal modeling needs in the area of PWM power conversion, presented by the researchers who did the original work. Numerous examples will be used to highlight the practical applications of the models.

S.7 Hybrid Vehicle Propulsion—Electrical And Mechanical Matching

John Miller, J-N-J Miller Design Services, PLC, Cedar, MI

Marina 4

The character of automotive propulsion systems is again going through evolutionary change as gasoline-electric hybrids and diesel technologies become more accepted and compete against ever more sophisticated ICE propulsion. Today's hybrid vehicle propulsion technology is seen as a bridging action by some until affordable fuel cell propulsion becomes available in the mass market. Other, more visionary companies view hybrid technologies as essential steps leading to fuel cell hybrids and the hydrogen economy. This seminar will acquaint the motor drive and power electronics system designer with the specifications, challenges and demands of designing traction power processing systems for vehicle propulsion. The seminar will be divided into three major subsections, each addressing key attributes of the propulsion system challenge: 1) Hybrid architecture choices and their impact on vehicle performance, 2) An update on energy storage systems and sizing criteria, and 3) Electrical and mechanical system matching methodology. Vehicle driveline architectures presented will range from series, through direct and indirect parallel, to power split and electric four wheel drive. Energy systems of choice include advanced batteries, ultra-capacitors and flywheel systems. The hypothesis posed by the author is that hybrid propulsion architectures that today cost from \$66 to \$93/kW do not fully meet vehicle performance and economy targets.

At the conclusion of the seminar, attendees will learn why hybridization is viewed as electric supercharging and will have acquired the knowledge to more fully appreciate the methodology of designing, modeling and simulation of hybrid propulsion systems at the vehicle level.

PROFESSIONAL EDUCATION SEMINARS SESSION TWO

Sunday, February 22, 2:30 – 6:00 PM

S.8 Writing Specifications For Power Supplies And DC-DC Converters

**Robert V. White, Artesyn Technologies,
Westminster, CO**

South Ballroom A

One of the most dreaded tasks in the industry is writing a specification for a new power supply or dc-dc converter. For the equipment OEM, errors in a procurement specification often lead to delays in new product development. For the power supplier, errors in a datasheet lead to unhappy customers. Both of these can be very expensive for all concerned.

Writing a good specification or data sheet is complicated by several factors, starting with the need to fully describe the product in four different domains: electrical, mechanical, environmental and compliance. A common hindrance is the lack of widely accepted, common terminology and test procedures.

This seminar will give you the fundamentals needed to write a specification or data sheet that is useful to both power supplier and power user.

The first part of the seminar discusses the basics of creating a specification. The first item is the importance of identifying the purpose and the audience of your creation. The discussion continues with the differences between a procurement specification and a data sheet, the pros and cons of different ways of presenting requirements and creating excellent documents using common word-processing, diagramming and spreadsheet programs.

The second part of the seminar describes how to structure the document for completeness and ease of use. The importance of specification elements such as a revision table, tables of contents and figures and referenced documents will be presented. Suggestions on structuring the electrical, mechanical, physical,

environmental and procurement/business sections will be presented.

The third part gives a mid- to high-level look at the best ways to write specifications for electrical parameters, protection and housekeeping functions including signal interfaces, compliance to safety and EMI regulations and standards, environmental requirements and other items as time allows.

S.9 Digital Signal Processor Basics For Power Supply Design

**Rakesh Dhawan, Wavecrest
Laboratories, Dulles, VA**

Avalon Room

This seminar will cover the fundamentals of DSPs and what makes digital signal processors effective for power supply design.

For power supplies, which require real-time performance, DSPs are a great choice. DSPs offer a great deal more in terms of increased functionality, features, flexibility and reliability. DSP based design can offer reduced component cost in addition to modular and scalable designs.

DSP based power supply designs open the door to a host of new design opportunities such as enhanced fault tolerance, enhanced fault indication, real-time adaptability, and most of all upgrade-ability. However, the design methodology for the use of DSPs in power supplies introduces a significant complexity. Power supply and system grounds, RFI and EMI design considerations, Feedback and stability etc. pose new challenges. This seminar addresses some of those challenges.

The seminar discusses examples of DSP based power supply design for buck, boost, buck-boost, flyback, push-pull, half-bridge and full-bridge topologies. Texas Instrument's TMS320LF2402A DSP is used for these examples. The seminar also discusses some PSPICE based simulation results for these designs. How such

simulation results can be used for proper algorithm development.

S.10 Alternate Power Business Models

**Seminar Chair: Cristian Marin,
Consultant**

Participants: Walt Benecki, Industry
Consultant, Elgin, IL and Frank Ferber,
Celestica, Toronto, Ontario

South Ballroom B

Drawing from years of experience guiding clients in their move to China, Walt Benecki will give his perspectives on the economic and operational issues of moving power manufacturing to China. Specific case studies will be cited to illustrate both the opportunities and challenges that this transition can create for a power supplier, and also on the critical success factors in making a successful transition. Walt will focus specifically on the geographic move from domestic to Asia manufacturing.

Frank Ferber is involved in actively transitioning power companies with captive domestic manufacturing capacity to an outsourced business model in China. Frank will outline the opportunities and challenges created by such a change in business models, citing case studies and actual customer situations where applicable. He will focus specifically on the conceptual move from captive to outsourced manufacturing, and also on the critical success factors in making this transition.

The seminar will conclude with an interactive discussion on whether or not North American and European manufacturing can be competitive in the global marketplace.

S.11 Design-Oriented Feedback Analysis—A Final Solution

**R. David Middlebrook, California Institute
Of Technology, Pasadena, CA**

North Ballroom A

This intermediate level tutorial introduces the General Feedback Theorem (GFT), which is the culmination of design-oriented

analysis approaches presented in five previous APEC Seminars.

Feedback systems are usually designed with the familiar single-loop block diagram in mind. Various nonidealities, such as unavoidable minor loops and direct forward transmission, make the single-loop block diagram progressively less useful, especially at higher frequencies.

The GFT defines a “natural” block diagram model that is identical in format to the single-loop model that is conventionally assumed, thus providing a desirable link between general feedback theory and a detailed circuit diagram analyzed in terms of factored pole-zero transfer functions.

The GFT is illustrated on a potentially unstable Darlington emitter/ source follower stage, and leads to design criteria that limit the maximum peaking regardless of the value of the load capacitance.

Another example is a two-stage feedback amplifier having various nonidealities, including loading interactions at all points, direct forward transmission, and two minor loops.

The GFT is computer friendly, and emphasis is on the numerical and graphical results obtained by use of an Intusoft ICAP/4 circuit simulator.

S.12 Efficient Development Of Adjustable Speed Motor Drive Controls By Hardware In The Loop

**Mehrdad Ehsani, Texas A&M, College
Station, TX**

Marina 1

A new technology, for quick and low cost development of controllers for adjustable speed motor drives, is presented and demonstrated. The technique of using commercially available off line and real time simulation packages for motors and their drive converters is taught. This technology is used for hardware in the loop to develop actual controllers for the drive, before the construction of the actual drive or its load. The applications of this new design

technology are in short development cycle products, high cost motor drives, critical mission motor drives, drives and loads not yet developed, such as in automotive traction, manufacturing, military, aerospace, and in research and education.

The course includes review of controls for dc, induction, brushless dc, and switched reluctance motor drives. Development of various motor drive models in MATLAB/Simulink™ is presented. Conversion of these off line models to real time simulation using RT-LAB™ is taught, including issues of high fidelity and real time sampling rate. Example cases are developed theoretically and demonstrated experimentally in real time. The course ends with audience applications clinic and hands on participation in class. This is an in depth course suitable for motor drives engineers of all levels and applications.

S.13 A Systematic Method For Developing SPICE Models For PWM Converters

**Rob Martinelli, Analytic Artistry,
Temecula, CA**

North Ballroom B

A systematic method is presented for building a SPICE model for a PWM converter that is capable of accurately representing the behavior of the converter in continuous and discontinuous conduction modes at frequencies up to one-half the switching frequency. The seminar describes five valuable analysis techniques for building accurate models: Averaging Circuits, Circuit Solvers, Equations Solvers, Time Delays, and separation of the dependent variable (ΔI_L) from the independent variable (I_L).

The five techniques are then demonstrated through two examples: A forward converter with current mode control and a discontinuous mode flyback regulator.

The CD for the seminar will also include models for a flyback converter and a two phase push-pull converter with a current doubler output filter.

S.14 Power Semiconductors And Control For Automotive Applications

**Dorin O. Neacsu, Consultant,
Lexington, MA**

Marina 4

More and more features are added to modern automobiles and almost all of them rely on a power electronics system. This tutorial analyzes the market of automotive low voltage power electronics systems used in body system control, chassis control, driver information systems, electronic power steering, powertrain systems, and safety/security systems.

The main focus is on understanding each application with all mechanical details necessary to define the specific requirements for the power and control system. The impact of converting from 14 V to 42 V automotive systems is outlined with examples based on the first systems to benefit from this conversion such as the electric power steering systems, electric brakes and engine cooling fans. Finally, auxiliary on-board sources of energy are analyzed.

This seminar will benefit all power electronics engineers regardless of their levels of experience. For both novice and experienced engineers, the challenges of modern automotive applications can represent an interesting topic.

PROFESSIONAL EDUCATION SEMINARS SESSION THREE

Monday, February 23, 8:30 AM – Noon

S.15 Best Practices In Qualifying Power Supplies And Power Suppliers

Kevin Granlund, EMC; Ron Guly, HP; Jeff Layton, Dell; Gary Fernandez, Cisco Systems and Ken Piper, Cisco Systems

South Ballroom A

In today's business environment, with ever decreasing development time, decreasing cost and increasing quality, an "Oops!" can be very expensive. Products introductions to the market are no longer ramps, they are

step functions. A problem in a power supply is expensive not just for the cost of replacing or repairing the defective product but also in the cost of a large number of field replacements and lost opportunity for the OEM. This makes it most important that power supplies—and power suppliers—are properly qualified to minimize the chance that defective or inadequate product reaches the field.

In this seminar, four of the electronics industry's leading OEMs will speak on their leading edge practices for qualifying power supplies and power suppliers. Kevin Granlund of EMC and Ron Guly of HP will speak their company's processes for qualifying power supplies. Jeff Layton of Dell and Scott Wilson of Cisco Systems will speak on qualifying power suppliers. This is an unprecedented and unequalled opportunity to learn from the "best of the best" what it takes to succeed in today's demanding global markets. If you are either a power supplier or power consumer, this seminar is not to be missed.

S.16 Digital Control Of High Frequency Switching Power Converters

Dragan Maksimovic and Regan Zane, University Of Colorado, Boulder, CO and Aleksandar Prodic, University Of Toronto, Toronto, Ontario

Avalon Room

The purpose of the seminar is to introduce practical digital controller design and implementation techniques for high-frequency switching power converters. Starting from standard analog controller architectures and design principles, sampling effects and basics of discrete-time analysis and modeling in time and frequency domains are introduced. Examples are used to illustrate simple digital compensator design techniques, as well as characterization, selection and implementation of A/D converters and digital modulators. Quantization effects and limit-cycling issues are also discussed. Three complete design examples are used to present practical design and implementation

options, CAD tools, simulation techniques, and experiments: (1) a high-performance DSP controlled PFC, (2) an FPGA-based development system for a digitally-controlled ballast, and (3) a custom digital IC for a high-frequency switching power supply. The seminar will be presented at a basic to intermediate level. Knowledge of basic converter operation and standard analog controller design will be assumed.

S.17 What You See (On Your Line) Is What You Get (In The Field)

Seminar Chair: Chris Stratas, Celestica, Toronto, Ontario

Participants: Cristian Marin, Consultant; Nick Antonacci, Delta Energy Systems and Ron Guly, HP

South Ballroom B

Cris Marin will open the seminar with an analysis from a theoretical and statistical point of view the impact that different levels of incoming inspection, in process inspection, test, burn-in, and highly accelerated stress screening can have on field reliability, and the level of defects passed on to a customer. This analysis will be based on typical process capabilities, inspection efficiencies, and test coverage, as well as customer requirements for a variety of different power technologies. If a problem is seen at any point within the factory, can it truly be contained?

In his discussion, Nick Antonacci will outline the practical approaches being used within power supplies today to meet customers' quality and reliability requirements. In addition, Nick will analyze the relative quality impacts caused by design issues, incoming parts, process defects, and workmanship, and the effectiveness of conventional screening techniques to contain these defects within the factory. Finally, Nick will discuss the relative costs involved in preventing, screening and containing quality issues at various points in the total fulfillment process.

In the third section of the seminar Ron Guly will discuss the requirements he demands

as a power customer, and the typical ways in which suppliers are striving to meet those requirements today. Ron will illustrate examples of how defects found in the factory environment have been passed through to the field by way of incapable manufacturing processes, insufficient test processes, or incomplete closed loop quality programs that prevent suppliers from properly containing and correcting these issues. Finally Ron will extrapolate forward in time as complexities and densities increase, to discuss how suppliers must step up to improve quality performance under more demanding technical and market conditions.

The seminar will conclude with open discussion, including the audience, on whether or not field reliability goals can be achieved without factory stress screening?

S.18 The Forward Converter—Practical Design Of Input And Output Filters

F. Dong Tan, Northrup-Grumman Space Technology, Redondo Beach, CA
North Ballroom A

The forward converter remains an industrial workhorse in low-power dc-dc conversion. While previous discussions by the same author presented recent developments and performance comparison in advanced circuit topologies, current doublers, and synchronous rectifiers, this seminar focuses on practical design aspects of input and output filters, including some most-recent developments in the field.

This seminar is intended for entry- and intermediate-level design engineers who are facing increasingly tight EMI/EMC requirements, often coupled together with constant pressure for cost and schedule. A solid knowledge about practical filter design that ensures first-pass design success is increasingly appealing to engineers at all levels.

This seminar starts with an overview of basic one-stage and two-stage input filter configurations. It then introduces an important concept of power filter damping. Optimal single-resistor damping and non-

dissipative damping techniques are then introduced. Two useful configurations for input filter design are then discussed and simple design steps are provided. These are applicable for many high-performance designs, including military and space applications. Practical output filter designs for capacitive and inductive loads are then discussed. The issue of potential instability introduced by interaction between an input filter and a switching regulator is discussed with practical design guidelines.

The coupled inductor, as a general technical means for ripple steering, is then introduced, enabling a designer to achieve zero ripple in both input and output. Practical limitations of this technique are also presented. Common-mode filter design is also discussed.

S.19 An Introduction To EMC And Good Design Practices For Successful High Frequency Inverter Design

Peter Bardos, Artesyn Technologies, Youghal, Ireland
Marina 1

After a brief introduction to EMC concepts, the seminar will treat in some depth the EMI characteristics and behaviour of components, including that of PWBs.

Throughout this seminar the emphasis will be on practical knowledge and understanding, not just on information, avoiding complicated mathematics.

Magnetic and electric fields, and their sources, victims and transmission paths in power supplies will be explored. The problems and solutions will be illustrated by real components and examples from actual power supply designs.

The characteristics and effects of invisible components and strays are also explored, and this will lead to a point-by-point method of laying out optimal PWBs that work first time.

The principles of EMC fault-finding, filter design and layout, and methods of

calculating, measuring consistently, and characterising EMI are introduced.

This seminar will lead to an understanding of the engineering principles of EMC design, and provide practical solutions to EMC problems.

S.20 Stability Analysis Made Simple

**Dean Venable, AblePower Corporation,
Westwood, MA**

Marina 4

This is a seminar for people who actually have to stabilize feedback loops and want them to be "all that they can be". The approach is primarily graphical but equations will be presented for those who require them. Emphasis will be on the "big picture" and the goals, but enough detail will be included so that any attendee should be able to optimize a feedback loop at the conclusion of the seminar. Voltage mode and current mode control will be covered, for both buck-derived and boost-derived circuits. The concept of "K-Factor" for optimizing loop performance will be covered in detail. New material will be presented on modeling, optimizing, and testing digital feedback loops, and how PI and PID compensation in digital loops relate to analog feedback loop design.

S.21 High Efficiency Rectification

**Dan Jitaru, Delta Energy Systems,
Tucson, AZ**

North Ballroom B

The seminar will present a comprehensive overview of the rectification techniques for low and high voltage application. A full section is dedicated to the synchronized rectification a major step forward in the quest for higher efficiency. There will be presented different methods of drive and control for synchronized rectifiers. There will be presented driven and self-driven synchronized rectification methods applied to different topologies. The seminar will also show some future trends in improving the efficiency of the synchronized rectification.

Another key chapter is dedicated to high efficiency rectification wherein the limiting factor is the reverse recovery of the rectifiers. A focal point will be the soft commutation technology applied to the rectifiers with applications not only in high voltage but also in low voltage, using synchronized rectification and higher frequency of operation.

The presentation will be highlighted with design guidance, design example and experimental results.

SEMINARS AT A GLANCE			
TRACK	SESSION I Sunday, February 22 9:30 AM - 1:00 PM	SESSION II Sunday, February 22 2:30 – 6:00 PM	SESSION III Monday, February 23 8:30 AM – Noon
BUSINESS	S.1 The Business of Power—An Introduction to the Power Industry for the Non-Technical Professional F. Marshall Miles, Belfuse Power South Ballroom A	S.8 Writing Specifications For Power Supplies And DC-DC Converters Robert White, Artesyn Technologies South Ballroom A	S.15 Best Practices In Qualifying Power Supplies And Power Suppliers Kevin Granlund, EMC; Ron Guly, HP; Jeff Layton, Dell; Gary Fernandez, Cisco Systems and Ken Piper, Cisco Systems South Ballroom A
FUNDAMENTALS	S.2 SMPS Design Basics Marty Brown, Sierra Energy Management Systems, LLC Avalon Room	S.9 Digital Signal Processor Basics For Power Supply Design Rakesh Dhawan, Wavecrest Laboratories Avalon Room	S.16 Digital Control Of High Frequency Switching Power Converters Dragan Maksimovic And Regan Zane, University Of Colorado, Boulder And Aleksandar Prodic, University Of Toronto, Toronto Avalon Room
MANUFACTURING	S.3 Lead Free Manufacturing And Industry Preparedness Seminar Chair: Chris Reynolds, AVX Corporation South Ballroom B	S.10 Alternate Power Business Models Seminar Chair: Cristian Marin, Consultant South Ballroom B	S.17 What You See (On Your Line) Is What You Get (In The Field) Seminar Chair: Chris Stratas, Celestica South Ballroom B
ANALYSIS & DESIGN	S.4 Power Electronics Packaging With An Emphasis On High Current Applications Douglas Hopkins, State University Of New York, Buffalo North Ballroom A	S.11 Design-Oriented Feedback Analysis—A Final Solution R. David Middlebrook, California Institute Of Technology North Ballroom A	S.18 The Forward Converter—Practical Design Of Input And Output Filters F. Dong Tan, Northrup Grumman Space Technology North Ballroom A
DRIVES & EMC	S.5 Permanent Magnet And Induction Motor Drives David A. Torrey, Advanced Energy LLC Marina 1	S.12 Efficient Development Of Adjustable Speed Motor Drive Controls By Hardware In The Loop Mehrdad Ehsani, Texas A&M Marina 1	S.19 An Introduction To EMC And Good Design Practices For Successful High Frequency Inverter Design Peter Bardos, Artesyn Technologies Marina 1
MODELING & DESIGN	S.6 PWM Switch Modeling—Historical Review And New Developments Ray Ridley, Ridley Engineering and Vatche Vorperian, Jet Propulsion Laboratory North Ballroom B	S.13 A Systematic Method For Developing SPICE Models For PWM Converters Rob Martinelli, Analytic Artistry North Ballroom B	S.20 Stability Analysis Made Simple Dean Venable, AblePower Corporation North Ballroom B
AUTOMOTIVE & SEMI-CONDUCTOR APPLICATIONS	S.7 Hybrid Vehicle Propulsion—Electrical And Mechanical Matching John Miller, J-N-J Design Services Marina 4	S.14 Power Semiconductors And Control For Automotive Applications Dorin O. Neacsu, Consultant Marina 4	S.21 High Efficiency Rectification Dan Jitaru, Delta Energy Systems Marina 4

EXPOSITION

EXPOSITION HOURS

The Exposition, located in the Terrazzo Room/ Exhibit Hall of the Disneyland Hotel, will be open as follows:

Monday, February 23..... 5:30 PM - 8:00 PM

Tuesday, February 24..... Noon - 5:00 PM

Wednesday, February 25.... 10:30 AM - 2:00 PM

EXPOSITION DIRECTORY

The Exposition Directory, which will be available at the conference, will give a complete listing of the Exhibitors, a map of the Exposition Hall, details of the Exhibitor Seminars and other events in the Exposition Hall.

EXHIBITOR SEMINARS

On the afternoon of Tuesday, February 24th, from 2:30 PM – 4:15 PM and Wednesday morning, from 11:00 AM – 11:45 AM, several of the companies participating in the Exposition will offer technical seminars. Descriptions of the seminars will be listed in the Exposition Directory, available at the conference.

EXHIBITOR'S RECEPTIONS

A **Welcoming Reception** will be held in the Exposition Hall on Monday, February 23, from 5:30 PM until 8:00 PM. Join us for hors d'oeuvres while visiting with the Exhibitors and other conference participants.

On Tuesday, light refreshments will be served during an **Exhibitors' Reception** from 4:00 PM until 5:00 PM.

Registered spouses and guests are welcome at these receptions.

EXHIBITION SURVEY & GIVEAWAY

To help the exhibitors and us continually improve the APEC Exposition, a survey is taken each year. Those who complete the survey form and return it no later than early Tuesday afternoon are entered in a drawing for one of several fabulous prizes.

The drawing will take place in the Exhibition Hall during the afternoon of Tuesday, February 24th and you *must* be present to win!

EXPOSITION HALL LUNCHEONS

On Tuesday, February 24 and Wednesday, February 25, enjoy your lunch in the Exposition Hall. Tickets are \$10.00 each and are available through Advance Registration. Tickets may also be purchased at the Conference Registration Desk at least 24 hours in advance. The number of tickets is limited and may sell out. It is recommended that if you are interested in lunch in the Exposition Hall that you buy them with your Advance Registration. Tickets will not be available at the luncheons.

Registered spouses and guests are welcome at the Exhibit Hall luncheons – ticket required, of course.

EXHIBITORS

The Exhibitors that are confirmed at the time of publication of this Advance Program are listed below. Please check the Exposition Directory at the conference for the final listing of companies participating in the APEC Exposition.

APEC 2004 Exhibitors

The Exhibitors that are confirmed at the time of publication of this Program are listed below. Please check the Exposition Directory at the conference for the final listing of companies participating in the APEC Exposition.

ACME Magnetics USA, Inc.	Elna Magnetics	Ohmite Manufacturing
Allstar Magnetics	ERM Thermal Technologies, Inc.	Okaya Electric America
Alpha Electronics	Eupec, Inc.	ON Semiconductor
Ametherm	Evox--Rifa, Inc.	Payton America Inc.
Anderson Power Products	Fairchild Semiconductor	PEI Technologies
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APTronic AG	FerroxCube USA Inc.	Picor Corporation
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Ault Incorporated	Fuji Semiconductor, Inc.	Positronic Industries
Autotest	GMW	Power Electronics Technology
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BI Technologies	Henkel Loctite	Precision Inc.
Broadband Telcom Power, Inc.	Infineon Technologies	Primarion
Bussco Division of CCI	International Rectifier	RAF Technologies Inc.
CableCo Technologies Corp.	Intersil Corporation	Ridley Engineering, Inc.
Celestica Power Systems	Intusoft	Rogers Corporation
Center For Power Electronics Systems (CPES)	Isotek Corporation	Shenzen Sanma Electric Appliance Co., Ltd.
Ceramic Magnetics, Inc.	ITW Paktron	Simulation Research Caspoc
Chang Sung Corporation	Kaschke USA Inc.	Solid State Devices, Inc.
Chroma ATE Inc.	Kemet Electronics Corporation	STMicroelectronics
CKE & HV Component Associates	LEM USA, Inc.	Sumida
Coilcraft	Lodestone Pacific	Sypris Test And Measurement
Collmer.com	Magnelab Inc.	TDI Power Systems
Commergy Technologies, Ltd.	Magnetics, Inc.	Tektronix, Inc
Cornell Dubilier	Magsoft Corporation	Texas Instruments
CWS	Methode Electronics, Inc.	Thermagon, Inc.
Darnell Group	MH&W International	Tier Electronics
Datatronic	Micrel Semiconductor	Tocos America
Delta Energy Systems	MicroMetals, Inc.	Transim Technology Corporation
Dexter Magnetic Technologies	Microsemi Corporation	TSC Ferrite International
EBG, LLC	Miles-Platts, Inc.	TT Electronics MMG
ECI/Electronic Coils	Molex, Incorporated	United Chemi-Con Corporation
ECN Magazine	National Semiconductor Corporation	VAC Magnetics Corporation
Elcon Products International Co.	New England Electric	Venable Industries, Inc.
Eldre Corporation	Wire Technologies	Vishay Intertechnology
ElectroCube, Inc.	NH Research	Voltage Multipliers, Inc.
Electronic Concepts, Inc.	NORWE, Inc.	Wurth Electronics, Inc.
Electronic Products Magazine		

RAP SESSIONS

Tuesday, February 24, 5:00 – 6:30 PM

Rap Session #1 North Ballroom A

**Power Supply Digital Control:
Real Or “Virtual”?
The War Goes On**

Moderator: Arnold Alderman,
Anagenesis, Inc.

What is your opinion about one of the controversial issues in power supply design at the moment? Is it feasible for broad base use in power supplies or will it be a monument to engineering that nobody can afford? Will we get main switcher regulation control PLUS the other bells and whistles promised for that low expected price? Come on and hear the "experts: speak and share your unbiased opinion.

Rap Session #2 North Ballroom B

**Who Needs Power Supply Companies,
When The Semiconductor Company
Can Do It All?**

Moderator: Alex Craig,
Fairchild Semiconductor

Before Switch Mode power supply was the main stay of power supply design, Magnetics, ruled the power conversion process. Power supplies were dominated by the transformers, many magnetic companies became more than a component supplier when they transformed themselves into power supply manufactures. Is history about to repeat is self? How is today different from yesterday? With the advancement of power packaging are the Semiconductor Companies ready and is the time right to TAKE OVER?

Rap Session #3

South Ballroom B

**We're On The Power Electronics
Roadmap, But Who's Driving:
Passives, Silicon, Topologies,
Packaging or Controls?**

Moderator: Bill Dillard,
Auburn University

These five technology engines have driven our industry to its present status. What's your take on where they will take us next? Where are breakthroughs expected and where are they needed? How will designs, careers, education, technical innovation and business opportunities be affected? Come and share your opinions with our expert panel in what is sure to be an engaging debate.

SPECIAL PRESENTATION SESSIONS

The Special Presentation Sessions are new to APEC this year. These presentations have been solicited from the leaders in the power electronics industry especially to address topics of current interest. These special presentations do not have papers in the APEC Proceedings. Like the Professional Education Seminars, they were chosen for their specific topics and were not selected through the peer review process. These presentations will be available on the APEC Web site for a limited time after the conference is over.

Session SP1 **Wednesday, February 25**
Future Directions In **Marina 4**
Silicon And Nano **8:30 – 10:15 AM**
Technologies

Session Chair: Bob White, Artesyn Technologies

- SP1.1 Device Requirements For Future CPU Voltage Regulators**
E. Stanford, Intel Corporation, DuPont, WA
- SP1.2 Power Supply Considerations For High-Speed DSPs**
W. Gass and T. Tran, Texas Instruments, Dallas, TX
- SP1.3 Power Supply Trends In ASIC Products**
P. Zuchowski, C. Kilmer and T. Bednar, IBM Microelectronics, Essex Junction, VT
- SP1.4 Nanotechnology: A New Frontier For Power Electronics**
A. Laviano, Wescon/Nanoworld, Anaheim, CA



Session SP2 **Wednesday, February 25**
Current Topics In Power **Marina 4**
Electronics Research **2:00 - 5:30 PM**

Session Chairs: Trey Burns, Artesyn Technologies and Joseph Thottuvelil, Tyco Electronics Power Systems

- SP2.1 Power Electronics System Integration**
F. C. Lee, Center For Power Electronics Systems, Virginia Polytechnic Institute And State University, Blacksburg, VA
- SP2.2 Diagnostics And Intelligent Controls In Electrical Systems**
T. Habetler, Georgia Institute Of Technology, Atlanta, GA

SP2.3 Power Electronics, Machines And Drives Research At WEMPEC/WisPERC
T. Jahns, University Of Wisconsin At Madison, Madison, WI

SP2.4 Advancing Digital Control
B. Erickson, Colorado Power Electronics Center, University Of Colorado, Boulder, CO

SP2.5 Design Of Interdisciplinary Power Electronic Sources And Systems Through Virtual Prototyping
A. Monti, University of South Carolina, Columbia, SC

SP2.6 Supplying Mobile Electronics
J. A. Cobos, Universidad Politécnica de Madrid, Madrid, SPAIN

SP2.7 Power Electronics For Automobiles
J. G. Kassakian and S. Leeb, Massachusetts Institute Of Technology, Cambridge, MA



Session SP3 **Thursday, February 26**
Future Directions In **Marina 4**
Semiconductors For **8:30 – 11:30 AM**
Power Electronics

Session Chairs: Kevin Parmenter, ON Semiconductor and Alex Craig, Fairchild Semiconductor

- SP3.1 Integration Challenges In DC-DC Converters**
D. Briggs, Texas Instruments, Dallas, TX
- SP3.2 Impacts Of IC And Discrete Technology Development On The Power Processing Industry**
D. Dalal and B. Johnson, ON Semiconductor, Phoenix, AZ
- SP3.3 Advancements In Power Semiconductor Solutions**
C. Rexer, Fairchild Semiconductor, Mountaintop, PA
- SP3.4 Silicon Advancement To Enable A New Generation Of Power Converters**
G. Sheridan, International Rectifier, El Segundo, CA
- SP3.5 Digital vs. Analog Power Control For Microprocessor Core Regulation**
Z. Moussaoui and G. Miller, Intersil Corporation, Palm Bay, FL
- SP3.6 Applications Challenges For High Voltage Semiconductors**
J. Hancock, Infineon Technologies NA, San Jose, CA



PRESENTATION SESSIONS

These are the traditional APEC presentations. These papers have been selected through a rigorous peer review process and they are represented by papers in the APEC Proceedings. These papers were selected for oral presentation by the APEC Program Committee because they generally have a broader appeal than the papers selected for the Dialogue Sessions.

Session 1 **Monday, February 23**
Plenary **Grand Ballroom**
1:30 – 5:00 PM

Session Chair: Jason Lai, Virginia Polytechnic Institute And State University

- 1.1 A 5-Year Power Technology Roadmap**
C. Mullett, ON Semiconductor, Phoenix, AZ
- 1.2 Future Power Technology In The Global Marketplace**
S. Strand, IBM, Rochester, MN and R. Malik, IBM, Raleigh, NC
- 1.3 A Strategy To Encourage Improved Efficiency Of Power Supplies**
A. Fanara, U.S. Environmental Protection Agency, Washington, DC
- 1.4 Power Electronics Futures**
J. Shepard, Darnell Group, Corona, CA
- 1.5 Putting Profit Into Power Electronic Products With Digital Control**
S. Leeb, MIT, Cambridge, MA
- 1.6 Alternative Energy: State Of The Art And Implications On Power Electronics**
V. Vlatkovic, GE Global Research, Niskayuna, NY



Session 2 **Tuesday, February 24**
Digital Control **North Ballroom A**
8:30 AM – Noon

Session Chairs: Steven Leeb, Massachusetts Institute Of Technology and Karl Rinne, University Of Limerick

- 2.1 A Programmable Digital Pulse Width Modulator Providing Versatile Pulse Patterns And Supporting Switching Frequencies Beyond 15 MHz**
O Malley, E., Rinne, K., University of Limerick, Ireland

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- 2.2 Digital PWM Controller With Feed-Forward Compensation**
Syed, A., Ahmed, E., Maksimovic, ., University of Colorado, Boulder
- 2.3 DSP Implementation Of Predictive Control Strategy For Power Factor Correction (PFC)**
Zhang, W.1, Feng, G.1, Liu, Y.-F.1, Wu, B2., 1Dept. of Electrical & Computer Eng., Queen's University, Canada, 2Dept. of Electrical & Computer Eng., Ryerson University, Canada
- 2.4 Digital Control Of DC-DC Boost Converters With Inductor Current And Disturbance Estimations**
Mattavelli, P., Stefanutti, W., DIEGM, University of Udine, Italy
- 2.5 Digitally Controlled DC-DC Converter For RF Power Amplifiers**
Yousefzadeh, V., Wang, N. Popovic, Z., Maksimovic, D., University of Colorado, Boulder
- 2.6 Withdrawn By The Authors**
- 2.7 Slope Approximation Control Method In The AC-AC Converter Control**
Zhang, Q., Zou, J.B., Liang, W.Y., 1Harbin Institute of Technology, China



Session 3 **Tuesday, February 24**
Inverter Design and **North Ballroom B**
Applications **8:30 AM – Noon**

Session Chairs: Rakesh Dhawan, WaveCrest Labs and Tim Haskew, University Of Alabama

- 3.1 Improved Load Disturbance Rejection Method For 400 Hz GPU Inverters**
Mihalache, L., Power Conversion Technologies Inc.
- 3.2 Withdrawn By The Authors**
- 3.3 An Augmented Phase-Leg Configuration With Shoot-Through Immunity And Improvements For High-Current Operation**
Park, S., Jahns, T., University of Wisconsin, Madison, Wisconsin
- 3.4 Using Current-Fed Parallel-Resonant Inverters For Electro-Discharge Applications: A Case Of Study**
Alonso, J.M., Cardesin, J., Martín-Ramos, J.A., García, J., Rico-Secades, M., University of Oviedo, Spain

- 3.5 A Silicon Carbide JFET Gate Driver Circuit Allowing Short Commutation Times For Sparse Matrix Converter Applications**
Heldwein, M.L., Kolar, J.W., Swiss Federal Institute of Technology (ETH), Switzerland
- 3.6 On-Line Dead-Time Compensation Method For Voltage Source Inverter Fed Motor Drives**
Urasaki, N.1, Senjyu, T.1, Uezato, K.1, Funabashi, T.2, 1University of the Ryukyus, 2Meidensha Corporation, Japan
- 3.7 Research On Three-Phase Inverter With Unbalanced Load**
Peng, L., Bai, D., Kang, Y., Chen, J., Huazhong University of Science & Technology, China



Session 4 **Tuesday, February 24**
Lamp Ballast **South Ballroom A**
8:30 AM – Noon

Session Chairs: Bill Peterson, E & M Power and Tsai-Fu Wu, National Chung Cheng University

- 4.1 Custom Spectral Shaping For EMI Reduction In Electronic Ballasts**
Johnson, S., Yin, Y., Zane, R., University of Colorado at Boulder
- 4.2 A New Proposal Of Switched Power Oscillator With Soft-Commutation Applied As A HPF Electronic Ballast**
Gomes de Freitas, L.C.1, Simoes, M.G.2, de Freitas, L.C.1, 1Universidade Federal de Uberlandia, Brazil, 2Colorado School of Mines, USA
- 4.3 A High Power Factor Ballast With Single Switch And A Single Power Stage**
Morais, A., Coelho, E., Farias, V., Freitas, L., Oliveira, J., Vieira Jr., JB, Federal University of Uberlandia, Brazil
- 4.4 Digital-Dimming Controller With Current Spikes Elimination Technique For LCD Backlight Electronic Ballast**
Lin, C.H., Pai, K.J., Hsu, K.C.H., St. John's & St. Mary's Institute of Technology, Taiwan
- 4.5 Analysis And Design Of A Dimming Control Using Sliding Mode Control Strategy For Electronic Ballast Free Of Acoustic Resonances**
Osorio, R., Ponce, M., Oliver, M., CENIDET, Mexico

- 4.6 A Single Stage PFC Applied As An Electronic Ballast For Fluorescent Lamps**
Gomes de Freitas, L.C.1, Simoes, M.G.2, de Freitas, L.C.1, 1Universidade Federal de Uberlandia, Brazil, 2Colorado School of Mines, USA

- 4.7 An Electronic Ballast With High Power Factor Employing A Boost Half Bridge Topology**
Morais, A., Coelho, E., Farias, V., Oliveira, J., Freitas, L., Vieira Jr., JB, Federal University of Uberlandia, Brazil



Session 5 **Tuesday, February 24**
Active Power Filters **South Ballroom B**
8:30 AM – Noon

Session Chairs: Fang Zheng Peng, Michigan State University and Mariesa Crow, University Of Missouri, Rolla

- 5.1 A New Method For Instantaneous Reactive Power Compensation In Three-Phase Four-Wire Systems**
Busada, C.1, Balda, J.C.2, 1Universidad Nacional del Sur, 2University of Arkansas
- 5.2 Active Zero-Sequence Cancellation Technique In Unbalanced Commercial Building Power System**
Kim, S., Lite-On, Inc.
- 5.3 Wideband Harmonic Compensation With A Voltage-Source Hybrid Active Power Filter**
Routimo, M., Salo, M., Tuusa, H., Tampere University of Technology, Finland
- 5.4 Control And Design Issues Of A DSP-Based Shunt Active Power Filter For Utility Interface Of Diode Rectifiers**
Chen, Z., Xu, D.H., Department of Electrical Engineering, Zhejiang University, China
- 5.5 A Three-Phase Comprehensive Reactive Power And Harmonics Compensator Based On A Comparatively Small Rating APF**
Yang, J., Wang, Y., Zeng, Z.D., Wang, Z.A., Xi'an Jiaotong University, Canada
- 5.6 Adaptive Learning Based Current Control Of Active Filters Needless To Detect Current Harmonics**
Fukuda, S., Kanayama, T., Graduate School of Engineering, Hokkaido University, Japan

- 5.7 Novel Control Scheme Of Minimizing Active Filter Size And Its Digital Implementation For Hybrid Series Active Power Filter**
Zhong, H., Lu, Z., Qian, Z.M., College of Electrical Engineering, Zhejiang University, China



Session 6 **Tuesday, February 24**
Semiconductor Devices **Avalon**
8:30 AM – Noon

Session Chairs: Allen Heffner, National Institute Of Standards And Technology and Ali Salih, Power-One

- 6.1 Lateral Discrete Power MOSFET: Enabling Technology For Next-Generation, MHz-Frequency, High-Density DC/DC Converters**
Shen, J.1,2, Okada, D.1, Lin, F.1, Tintikakis, A.1, Anderson, S.1, 1Great Wall Semiconductor, USA, 2University of Michigan-Dearborn, USA
- 6.2 Power Supply Industry And The Challenge Ahead**
R. Malik, IBM Corporation, Raleigh, NC
- 6.3 The Latest Advances In Industrial IGBT Module Technology**
Motto, E., Donlon, J., Powerex
- 6.4 Optimization And Fabrication Of Planar Edge Termination Techniques For A High Breakdown Voltage And Low Leakage Current P-I-N Diode**
Chao, D.S.1, Hung, C.C.1, Shu, D.Y.1, Kao, M.J.1, Wang, B.2, Teng, B.2, Tsai, H.P.2, Lin, R.2, Hsieh, W.Y.1, Tsai, M.J.1, 1ERSO/ITRI, Taiwan, ROC, 2Vishay General Semiconductor Taiwan Ltd., Taiwan, ROC
- 6.5 Six Pack IGBT Dynamic Electro-Thermal Model, Parameter Extraction And Validation**
Reichl, J.1, Berning, D.2, Hefner, A.2, Lai, J.1, 1Virginia Polytechnic Institute and State University, 2National Institute of Standards and Technology
- 6.6 Voltage Scaled Integrated Circuit Technologies Enable A New Generation Of Power Supply Control IC's**
Benson, B., Gutierrez, N., Pace, D., National Semiconductor Corporation
- 6.7 A High-Voltage, Temperature Compensated Logarithmic Amplifier Suitable For Integration In A BiCMOS Power Controller IC**
Dillard, W.C., Auburn University

Session 7 VRM Design Considerations

Tuesday, February 24
Feb 04
Marina 1
8:30 AM – Noon

Session Chairs: Gerry Moschopoulos, University
Of Western Ontario and José Cobos, Universidad
Politécnica De Madrid

- 7.1 **A Novel VRM Control With Direct Load
Current Feedback**
Zhang, X., Yao, K., Huang, A., Virginia
Polytechnic Institute and State University
- 7.2 **Adaptive Voltage Position Design For
Voltage Regulators**
Yao, K., Lee, K., Ren, Y., Xu, M., Lee, F.C.,
Virginia Polytechnic Institute and State
University
- 7.3 **1 MHz Self-Driven DC-DC Converter For
Non-Isolated 12 V VRM**
Zhou, J., Xu, M., Lee, F., Virginia Polytechnic
Institute and State University
- 7.4 **The Analysis Of The Power Delivery Path
From 12 V VR To The Microprocessor**
Ren, Y., Xu, M., Lee, F., Yao, K., Virginia
Polytechnic Institute and State University
- 7.5 **Characterization Of Cdv/dt Induced Power
Loss In Synchronous Buck DC-DC
Converters**
Stojic, G., Zhao, Q., International Rectifier
- 7.6 **A Regenerative Load System For The Test
Of Intel VRM 9.1 Compliant Modules**
O'Sullivan, B., Slowey, J., Morrison, R., Egan,
M.G., Barry, B., PEI Technologies, University
College Cork, Ireland
- 7.7 **Design Voltage Regulator Output
Capacitors For High Slew-Rate Load
Current Transients Based On Output
Impedance**
Wei, J., Lee, F., Virginia Polytechnic Institute
and State University

Session 8A Power Supply Efficiency Standards

Tuesday, February 24
Marina 4
8:30 – 10:15 AM

Session Chair: Arnold Alderman, Anagenesis, Inc.

- 8A.1 **Optimizing Efficiency On Conventional
Transformer Based Low Power AC/DC
Standby Power Supplies**
Nielsen, N., Oersted DTU, Technical University
of Denmark, DTU, Denmark
- 8A.2 **Federal Purchasing: Leading The Market
Towards Lower Standby Power**
Thomas, A.1, Glickman, J.1, Harris, J.2, Meier,
A.3, 1US Department of Energy, 2Lawrence
Berkeley National Laboratory, 3International
Energy Agency/OECD, FRANCE
- 8A.3 **High Efficiency Power Supplies In Active
Mode**
Mansoor, A.1, Calwell, C.2, Aumann, D.3,
Keefe, R.4, 1EPRI PEAC, 2Ecos Consulting,
3California Energy Commission, 4Electricity
Innovation Institute
- 8A.4 **European Code Of Conduct To Improve
Energy Efficiency Of Power Supply: The
First Policy Action Around The Worldwide
Addressing External Power Supplies
Energy Efficiency**
Bertoldi, P., European Commission DG JRC,
Italy

Session 8B Marketing

Tuesday, February 24
Marina 4
10:45 AM – Noon

Session Chair: Ada Cheng, Gartner, Inc.

- 8B.1 **Why The Market Is Ready For A Non-
Isolated DC/DC Power Module Standard**
Narveson, B., Jones, G., Texas Instruments,
Inc.
- 8B.2 **Distributed Power Architecture Demand
Characteristics**
Brush, L.C.1, 1Darnell Group
- 8B.3 **An Engineer's Guide To Technical Writing**
Mullett, C., ON Semiconductor

Session 9 **Wednesday, February 25**
Fuel Cell Power **North Ballroom A**
Conversions **8:30 – 10:15 AM**

Session Chair: Troy Nergaard, AeroVironment

- 9.1 Development Of An Equivalent Circuit Model For A Fuel Cell Stack To Evaluate The Effects Of Inverter Ripple Current**
Choi, W.1, Joung, G., Howze, J., Enjeti, P.,
1Texas A&M University, 2Woosuk University
- 9.2 A Novel Circuit Model For PEM Fuel Cells**
Yu, D., Yuvarajan, S., ECE Dept., North
Dakota State University, Fargo
- 9.3 Low Cost Fuel Cell Inverter System For Residential Power Generation**
Wang, J., Peng, F.Z., Anderson, J., Joseph,
A., Buffenbarger, R., Michigan State University
- 9.4 Design Of A Wide Input Range DC-DC Converter With A Robust Power Control Scheme Suitable For Fuel Cell Power Conversion**
Harfman Todorovic, M., Palma, L, Enjeti, P.,
Texas A&M University



Session 10 **Wednesday, February 25**
Control of DC-DC **North Ballroom B**
Converters **8:30 – 10:15 AM**

Session Chair: Jian Sun, Rensselaer Polytechnic Institute

- 10.1 An Ultra-Low-Power Digitally-Controlled Buck Converter IC For Cellular Phone Applications**
Xiao, J., Peterchev, A., Zhang, J., Sanders, S.,
University of California, Berkeley
- 10.2 Power Supply For A Radio Transmitter With Modulated Supply Voltage**
Soto, A.1, Oliver, J.1, Cezón, J.2, Arévalo, F.2,
Cobos, J.A.1, 1Universidad Politécnica de
Madrid, 2Indra, Spain
- 10.3 A New PWM Control Scheme Using A Triangle Waveform Modulated By Output Voltage**
Zhao, J., Sato, T., Nabeshima, T., Nakano, T.,
Oita University, Japan
- 10.4 Combined Lossless Current Sensing For Current Mode Control**
Chang, C., Semtech Corporation



Session 11 **Wednesday, February 25**
Standby Power **South Ballroom A**
 8:30 – 10:15 AM

Session Chair: Russell Spyker, U.S. Air Force Research Laboratories

- 11.1 A New Soft-Switched PFC Boost Rectifier With Integrated Flyback Converter For Stand-By Power**
Jang, Y., Dillman, D., Jovanovic, M., Delta
Products Corporation
- 11.2 Loss Optimizing Low Power 50 Hz Transformers Intended For AC/DC Standby Power Supplies**
Nielsen, N., Oersted DTU, Technical University
of Denmark, DTU, Denmark
- 11.3 Improved Burst Mode In The Stand-By Operation**
Choi, J.H.2, Park, C.I.2, Huh, D.Y.2, 1Fairchild,
2fairchild semiconductor, 3Inha university,
Korea
- 11.4 Efficiency Improvement In Redundant Power Systems By Means Of Thermal Load Sharing**
Nesgaard, C., Andersen, M., Technical
University of Denmark



Session 12 **Wednesday, February 25**
Uninterruptible Power **South Ballroom B**
Systems **8:30 – 10:15 AM**

Session Chair: Dengming Peng, Whirlpool Corporation

- 12.1 Full Digital Control Of A Single-Phase Series-Parallel Uninterruptible Power Supply**
Nasiri, A., Emadi, A., Illinois Institute of
Technology, USA
- 12.2 Adaptive Digital Control For UPS Inverter Applications With Compensation Of Time Delay**
Deng, H., Oruganti, R., Srinivasan, D.,
National University of Singapore, Singapore
- 12.3 A Master And Slave Control Strategy For Parallel Operation Of Three-Phase UPS Systems With Different Ratings**
Lee, S.H.1, Lee, W.C.2, Kim, K.H.1, Hyun,
D.S.1, 1Hanyang University, 2Hankyong
National University. Korea

- 12.4 A High-Performance DSP-Controller For Parallel Operation Of Online UPS**
Guerrero, J.M., Garcia de Vicuña, L., Matas, J., Miret, J., Castilla, M., Universitat Politecnica de Catalunya, Spain



Session 13 **Wednesday, February 25**
PWM Techniques **Avalon**
8:30 – 10:15 AM

Session Chair: Hongwei Gao, Montana State University

- 13.1 A Novel Random PWM Technique With Minimum Computational Overhead And Constant Sampling Frequency For High-Volume Low-Cost Applications**
Trzynadlowski, A.M., Borisov, K., Li, Y., Qin, L., University of Nevada, Reno
- 13.2 Switching Loss Characteristics Of Sequences Involving Active State Division In Space Vector Based PWM**
Zhao, D.1, Narayanan, G.2, Ayyanar, R.1, 1Arizona State University, 2Indian Institute of Science
- 13.3 Simple PWM Modulator Topology With Excellent Dynamic Behavior**
Poulsen, S., A. E. Andersen, M, Technical University of Denmark, Denmark
- 13.4 Fully-Digital Hysteresis Modulation With Switching Time Prediction**
Mattavelli, P., Cuttini, F., DIEGM, University of Udine, Italy



Session 14 **Wednesday, February 25**
Modeling of Parasitics **Marina 1**
and Interconnects **8:30 – 10:15 AM**

Session Chair: Andrzej Wojtasik, Ericsson Power Modules

- 14.1 Controlling The Parasitic Parameters To Improve The EMI Filter Performance**
Wang, S., Lee, F.C., Odendaal, W.G., Virginia Polytechnic Institute and State University
- 14.2 The Role Of Parasitic Inductance In High-Power Planar Transformer Design And Converter Integration**
Ferrell, J., Nergaard, T., Lai, J., Huang, X., Zhu, L., Davis, R., 1Northrop Grumman, 2Aero Vironment, 3Virginia Tech, 4Ballard Electric Drives and Power Conversion

- 14.3 Modeling And Evaluation Of Impacts Of Interconnection Parasitic Inductance On MOSFET Switching Characteristics**
Xiao, Y., Shah, H., Chow, T.P., Gutmann, R.J., Rensselaer Polytechnic Institute

- 14.4 Modeling And Measurements Of Parasitic Parameters For Power Electronics Modules**
Chen, J. Z., Yang, L., Boroyevich, D., Odendaal, W. G., Virginia Polytechnic Institute and State University



Session 15 **Wednesday, February 25**
AC Motor Drives **North Ballroom A**
2:00 - 5:30 PM

Session Chairs: Tim Lewis, United Defense LP and Ali Emaldi, Illinois Institute Of Technology

- 15.1 A Hybrid Converter System For High Performance Large Induction Motor Drives**
Kwak, S., Toliyat, H.A., Texas A&M University
- 15.2 Withdrawn By The Authors**
- 15.3 Prediction Of Rotor Position At Standstill And Flying Shaft Conditions In Switched Reluctance Machines**
Fahimi, B., Krishnamurthy, M., University of Missouri-Rolla
- 15.4 Analysis Of A Traction Induction Motor Drive Operating Under Maximum Efficiency And Maximum Torque Per Ampere Conditions**
Kouns, H.E., Lai, J.-S., Virginia Polytechnic Institute and State University
- 15.5 Nonlinear Sensorless Speed Control For The Induction Machine Utilizing A High-Performance Embedded DSP**
Boukas, T.K., Habetler, T.G., Georgia Institute of Technology
- 15.6 Low Speed Performance Improvement Of A Direct Torque Controlled Interior Permanent Magnet Synchronous Machine Drive**
Tang, L., Rahman, F., The University of New South Wales, Australia
- 15.7 Implementation Of Complete AC Servo Control In A Low Cost FPGA**
Takahashi, T.T., Goetz, J.G., International Rectifier



Session 16 **Wednesday, February 25**
Power Quality and Utility **North Ballroom B**
Interface **2:00 - 5:30 PM**

Session Chairs: Arshad Mansoor, EPRI PEAC Corporation and Dimosthenis Katsis, U.S. Army Research Laboratory

- 16.1 Calculation For The Compensation Voltages In Dynamic Voltage Restorers By Use Of PQR Power Theory**
Kim, H.1, Lee, S.J.2, Sul, S.K.2, 1Cheonan National Technical College, Korea, 2Seoul National University, Korea
- 16.2 A New Control Structure For Grid-Connected LCL PV Inverters With Zero Steady-State Error And Selective Harmonic Compensation**
Teodorescu, R.1, Blaabjerg, F.1, Liserre, M.2, Borup, U.3, 1Aalborg University, Institute for Energy Technology, 2Polytechnic of Bari, Electrotechnical and Electrobic Dpt., 3PowerLynx A/S, Denmark
- 16.3 Three-Phase Four-Leg Active Power Quality Conditioner Without Compensation References Calculation**
Chen, G.Z., Chen, Y., Smedley, K.Y., Dept. of EECS, University of California Irvine, CA92697, USA
- 16.4 A Universal Vector Controller For Three-Phase APF, Statcom, And Grid-Connected Inverters**
Jin, T.J., Smedley, K.S., University of California, Irvine
- 16.5 Practical Approaches And Novel Control Schemes For A Three-Phase Three-Wire Series-Parallel Compensated Universal Power Quality Conditioner**
Dai, K.D., Liu, P.L., Wang, G.W., Duan, S.D., Chen, J.C., Huazhong University of Science and Technology
- 16.6 Transient Performance Improvement Of Static Series Compensator By Double Vector Control**
Awad, H.1, Blaabjerg, F.2, 1Chalmers University of Technology, Sweden, 2Aalborg University, Denmark
- 16.7 A Novel Control Method For The Compensation Voltages In Dynamic Voltage Restorers**
Lee, S.J.1, Kim, H.2, Sul, S.K.1, 1Seoul National University, Korea, 2Cheonan National Technical College, Korea

Session 17 **Wednesday, February 25**
DC-DC Converter Circuits **South Ballroom A**
2:00 - 5:30 PM

Session Chairs: John Bassett, Artesyn Technologies and Tamotsu Nimomiya, Kyushu University

- 17.1 Optimum Design Of Interleaved Buck Converters**
Oliver, J.1, Zumel, P.2, Garcia, O.1, Cobos, J.1, Uceda, J.1, 1Universidad Politecnica de Madrid, 2Universidad Carlos III de Madrid, Spain
- 17.2 An Advanced Integrated Filter Converter (IFC) With Full-Bridge Configuration For Off-Line High-Power Applications**
Leu, C.1, Lee, F. , Liang, J., 1Virginia Polytechnic Institute and State University, 2Skynet Electronic Co., Ltd.
- 17.3 Current Fed Multi-Output Power Conversion**
O'Driscoll, S., Artesyn Technologies, Ireland
- 17.4 Interleaved Current Doublers With Parallel Connected Transformers' Primary And Secondary Sides**
Abu-Qahouq, J., Mao, H., Batarseh, I., University of Central Florida (UCF)
- 17.5 New Synchronizing Circuit Suitable For Paralleled Converter System With Automatic Interleaving Operation**
Kohama, T1, Endo, G1, Shimamori, H2, Ninomiya, T3, 1Fukuoka University, 2Fujitsu Limited, 3Kyushu University
- 17.6 New Triple DC-DC Converter Topologies With A High Frequency Zig-Zag Transformer**
Kim, S, Lite-On, Inc.
- 17.7 Improved Wide Range Dual Switch Flyback DC/DC Converters**
Gu, G., Gu, G., Hang, H., Lu, L., Qian, Q., College of Electrical Engineering of Zhejiang University, China

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Session 18 EMI & EMC

Wednesday, February 25
South Ballroom B
2:00 - 5:30 PM

Session Chairs: Tim Groat, Stored Energy Systems and Johann Kolar, Swiss Federal Institute Of Technology

- 18.1 Optimizing EMI Filter Design For Motor Drives Considering Filter Component High-Frequency Characteristics And Noise Source Impedance**
Shen, W.1, Wang, F. 1, Boroyevich, D.1, Stefanovic, V.2, Arpilliere, M.3, 1CPES, Virginia Tech, 2V-S Drives, 3Schneider Toshiba Inverter Europe
- 18.2 Active Analog Power Filters Provide Solutions For EMC & EMI**
Dumas, J , Lanoue, R, Tahhan, B, Picor Corporation
- 18.3 Analytical Evaluation Of Modulation Effect On Three-Phase Inverter Differential Mode Noise Prediction**
Huang, X.1, Pepa, E.1, Lai, J.1, Chen, S.2, Nehl, T.2, 1Virginia Polytechnic Insitute and State University, 2Delphi Research Labs
- 18.4 EMI Reduction By Interleaving Of Power Converters**
Zumel, P., Garcia, O., Cobos, J., Uceda, J., Universidad Politecnica de Madrid, Spain
- 18.5 Analysis EMI Of A PFC On The Band Pass 150 kHz-30 MHz For A Reduction Of The Electromagnetic Pollution**
BREHAUT, S, OULD EL BECHIR, M, LE BUNETEL, J, SCHELLMANN, A, MAGNON, D, PUZO, A, 1Laboratoire de micro électronique de puissance, 2SAFT Power Systems Group, France
- 18.6 A Method To Control EMI Noises Generated By Micro-Surges Appearing At Terminals Of Electric Machines Connected To Power Converters Via Electric Power Wirings**
Mutoh, NM, Kanesaki, MK, Nakashima, JN, Graduate School of Tokyo Metropolitan Institute of Technology, Japan
- 18.7 Modeling The EMI Coupling Paths Of An Off-Line Converter**
He1, J., Jianguo, J.1, Wei, C.2, 1Department of Electrical Engineering, Tsinghua University, 2Power Electronics R&D Center, Delta Company, China



Session 19 Single-Phase Power Factor Correction

Wednesday, February 25
Avalon
2:00 - 5:30 PM

Session Chairs: Michael Andersen, Technical University Of Denmark and Milan Jovanovic, Delta Products Corporation

- 19.1 Association Of A High Power Factor Power Supply Using An Interleaved Boost-Flyback Converter And A Soft - Switching Full Bridge Topology**
Gallo, C.A., Vieira Jr, J.B., Universidade Federal de Uberlândia, Brazil
- 19.2 Size And Cost Reduction Of The Energy - Storage Capacitors**
Lázaro, A., Barrado, A., Pleite, J., Vázquez, J., Olías, E., Universidad Carlos III de Madrid, Spain
- 19.3 A Soft Switched AC-To-DC Converter Operating In DCM: Analysis, Design, Simulation And Experimental Results**
Chen, P, Bhat, A.K, University of Victoria, Canada
- 19.4 Design Considerations For A Novel Single-Stage AC-DC PWM Full-Bridge Converter**
Li, S., Moschopoulos, G., University of Western Ontario, Canada
- 19.5 A DC Bus Voltage Reduction Technique For Single-Stage AC-DC Forward Converters**
Liu, Y., Moschopoulos, G., University of Western Ontario, Canada
- 19.6 Novel Current-Loop Feed Forward Compensation For Boost PFC Converter**
Lee, F.C., Xie, M., Virginia Polytechnic Institute and State University
- 19.7 A High Power Factor Symmetrical Switched-Mode Power Supply**
Gallo, C.A., Tofoli, F.L., Vieira Jr., J.B., Federal University of Uberlandia, Brazil



Session 20 Modeling of DC-DC Converters

Wednesday, February 25
Marina 1
2:00 - 5:30 PM

Session Chairs: Dong Tan, Northrop Grumman and Tom Wilson, Jr., Transim

- 20.1 High Frequency Modeling And Characterization For EMI Simulation Of CCM PFC Converter**
Yang, L., Lu, B., Dong, W., Lu, Z., Lee, F., Odendaal, W., Virginia Polytechnic Institute and state University

- 20.2 Small-Signal Measurement Issues In Switching Power Supplies**
Panov, Y., Jovanovic, M., Delta Products Corporation
- 20.3 Small-Signal Analysis And Design Of Isolated Power Supplies With Feedback Amplifier Biased From The Output Voltage**
Panov, Y., Milanovic, M., Delta Products Corporation
- 20.4 Unified DC Model And Analysis Of Half Bridge DC-DC Converters With Current Doubler Rectifier**
Mao, H., Deng, S., Abu-Qahouq, J., Wen, Y., Batarseh, I., University of Central Florida
- 20.5 Ripple Cancellation Filter For Magnetic Resonance Imaging Gradient Amplifiers**
Sabate, J. A., Schutten, M. J., Steigerwald, R. L., Li, Q., Wirth, W. F., General Electric Global Research Center, 2General Electric Medical Systems
- 20.6 A Large Signal Dynamic Model For DC-To-DC Converters With Average Current Control**
Lu, Y.W., Guang, F., Liu, Y.F., Queen's University, Canada
- 20.7 Frequency Domain Analyses Of Uncontrolled Rectifiers**
Chen, M., Qian, Z.M., Electrical Engineering College, Zhejiang University, China

Session 21 **Thursday, February 26**
Multilevel and Matrix **North Ballroom A**
Converters **8:30 – 11:30 AM**

Session Chairs: Sliva Hilti, General Motors Advanced Technology and Fred Wang, Virginia Polytechnic Institute And State University

- 21.1 Control And Implementation Of A New Modular Matrix Converter**
Angkititrakul, S., Erickson, R., Colorado Power Electronics Center, Department of Electrical and Computer Engineering, University of Colorado at Boulder
- 21.2 A Diode-Clamped Multilevel Converter With Reduced Number Of Clamping Diodes**
Pan, Z.1, Peng, F.1, Stefanovic, V.2, Leuthen, M.3, 1Michigan State University, 2V-S Drives, 3Centrilift / Baker-Hughes

- 21.3 Multilevel Inverters With Equal Or Unequal Sources For Dual-Frequency Induction Heating**
Diong, B.1, Corzine, K.2, Basireddy, S.1, 1University of Texas at El Paso, 2University of Wisconsin - Milwaukee
- 21.4 A Novel Multi-Level Matrix Converter**
Yang, X., Shi, Y., Qun, H.E, Wang, Z., Xi'an Jiaotong University, China
- 21.5 Overview Of Pi-Based Control Solutions For The Balancing Of DC Buses Of Single-Phase H-Bridge Multilevel Active Rectifier**
Dell'Aquila, A., Liserre, M., Monopoli, V. G., Rotondo, P., DEE Politecnico di Bari, Italy
- 21.6 Implementation Of DSP-Based Three-Phase AC-AC Matrix Converter**
Xie, Y., Ren, Y., Department of Electrical Engineering and Automation, SJTU, China

Session 22 **Thursday, February 26**
Synchronous Rectifiers **North Ballroom B**
8:30 – 11:30 AM

Session Chairs: Robert Steigerwald, General Electric Global Research and Qun Zhao, International Rectifier

- 22.1 A New Method To Drive Synchronous Rectifiers In Forward Converter Topologies For Extended Input Voltage Applications**
Plesnik, M., Nortel Networks, Canada
- 22.2 Optimization Of A Self-Driven Synchronous Rectification System For Converters With A Symmetrically Driven Transformer**
Fernandez, A., Sebastian, J., Hernando, M., Villegas, P., Universidad de Oviedo, Spain
- 22.3 Resonant Synchronous Rectification For High Frequency DC/DC Converter**
Xu, M., Lee, F., Virginia Polytechnic Institute and State University
- 22.4 Combining Synchronous Rectification And Post Regulation For Multiple Isolated Outputs**
Havanur, S. S., Semtech Corporation
- 22.5 Analysis And Design Consideration Of Using Current Sensing Transformer In Forward Converter With Synchronous Rectification**
Yang, J., Hua, L., Semtech Corporation

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- 22.6 Small Duty Cycle Concept Reducing The Conduction Losses In Synchronous Rectifier And Its Implementations**
 Xu, M., Lee, F., Virginia Polytechnic Institute and State University



Session 23 **Thursday, February 26**
Soft-Switching and High South Ballroom A
Density DC-DC 8:30 – 11:30 AM
Converters

Session Chairs: Frank Cirolia, Delta Energy Systems and Chi Mak, L-3 Communications

- 23.1 Quasi-Resonant Converters For High-Frequency Voltage Regulator Applications**
 Yao, K., Xu, M., Lee, F.C., Virginia Polytechnic Institute and State University
- 23.2 A Way To Fast Response And High Power Density -- Synthesis Of Soft-Switching Dual-Quasi-Square-Wave (DQSW) DC-DC Converters**
 Chen, G., Wang, F., Boroyevich, D., Virginia Polytechnic Institute and State University
- 23.3 Soft-Switching Series-Resonant Converter To Generate High Output Voltage For Processing Microbes**
 Tseng, S., Wu, T., Yang, H., Guo, J., Hung, J., National Chung Cheng University, Taiwan
- 23.4 Novel Integrated Transformer For Self-Driven ZVS Interleaved Asymmetrical Half-Bridge For Telecommunications Quarter Brick**
 Sterk, D., Xu, M., Ren, Y., Lee, F., CPES, Virginia Polytechnic Institute and State University
- 23.5 Applications Of Soft-Switching Full-Bridge Converter And Rotational Electric Field To Transdermal Drug Delivery**
 Wu, T., Tseng, S., Su, D., Chen, Y., National Chung Cheng University, Taiwan
- 23.6 A 2 MHz Low Noise Switching DC-DC Converter With Current Mirror Driver**
 Matsunaga, S., Sugahara, S., Fuji Electric, Japan



Session 24
Magnetics

Thursday, February 26
South Ballroom B
8:30 – 11:30 AM

Session Chairs: John Hayes, University College, Cork and Ed Bloom, e/j Associates

- 24.1 Orthogonal Winding Structures And Design For Planar Integrated Magnetics**
 Sun, J.1, Mehrotra, V.2, 1Rensselaer Polytechnic Institute, 2Rockwell Scientific Company
- 24.2 Thin Film Micro-Transformer For Future Power Conversion**
 O Mathuna, C., N.N. Wang, C., Brunet, M., Connell, A., Roy, S., McCloskey, P., O'Brien, J., Reynolds, K., Power, J., O'Donnell, T., NMRC, Ireland
- 24.3 Planar Embedded Rogowski Sensor For Integrated Power Electronic Modules**
 Zhao, L., Xiao, C., van Wyk, J.D., Odendaal, W.G., Virginia Polytechnic Institute and State University
- 24.4 A Full Procedure To Model Integrated Magnetics Based On FEA**
 Prieto, R., Asensi, R., Cobos, J.A., Uceda, J., UPM, Spain
- 24.5 Design And Evaluation Of Integrated Electromagnetic Power Passives With Vertical Surface Interconnections**
 Liu, W., van Wyk, J., Odendaal, W., Virginia Polytechnic Institute and State University
- 24.6 Effects In Magnetic Components For Switched Mode Applications In The MHz Range**
 Wallmeier, Wa, Ide, Id, Kunze, Ku, Margaritis, Ma, Delta Energy Systems (Germany) GmbH



Session 25
HID Lamp Ballasts

Thursday, February 26
Avalon
8:30 – 11:30 AM

Session Chairs: Tom Hopkins, ST Microelectronics and Sam Ben-Yaakov, Ben-Gurion University

- 25.1 A High Efficiency MHD Lamp Ballast With A Frequency Controlled Synchronous Rectifier**
 Lee, I.K., Cho, B.H., Seoul National University, Korea
- 25.2 Aging Effects On The Stability Performance Of Small Wattage MH Lamps**
 Yan, W., Hui, S.Y.R., City University of Hong Kong, China

- 25.3 New Control Strategy In Square-Wave Inverters For Low Wattage Metal Halide Lamps Supply To Avoid Acoustic Resonances**
Garcia-Garcia, J., Cardesin, J., Ribas, J., Calleja, A.J., Corominas, E.L., Rico-Secades, M., Alonso, J. M., GEI-ATE Universidad de Oviedo, Spain
- 25.4 Optimized Design Of Commercialized Electronic Ballast For Metal Halide Lamps**
Chen, S. 1, Lin, C.2, 1Industry Technology Research Institute, 2Kuang Wu Institute of Technology ,Taisui, Taiwan
- 25.5 Reliability Improvement Of High Frequency LCL-Type Electronic Ballast For Hid Lamps Using An Auxiliary Resonant Tank**
Cao, X.H., Hui, S.Y.R., 1Zhejiang University, 2City University of Hong Kong, China
- 25.6 Low-Frequency Sine Wave Modulation Of 250w High-Frequency Metal Halide Lamp Ballasts**
Jianqiang, W., Dianguo, Xu, Harbin Institute of Technology, China



Session 26A Thursday, February 26
Distributed Power Marina 1
Systems 8:30 – 9:45 AM

Session Chair: Juan Sabate, General Electric Corporate R&D

- 26A.1 Accurate Loop Gain Prediction For Load DC-DC Converters In On-Board Distributed Power Systems**
Li, P.1, Lehman, B.2, 1Performance Motion Devices, Inc., 2Northeastern University
- 26A.2 Stability Problems And Input Impedance Improvement For Cascaded Power Electronic Systems**
Zhang, J.M., Xie, X.G., Jiao, D.Z., Qian, Z.M., College of Electrical Engineering, Zhejiang University, China
- 26A.3 Advanced Power Supply Architecture For UMTS Networks**
Esteve, V., Dede, E.J., Jordán, J., Sanchis-Kilders, E., Ejea, J.B., Ferreres, A., University of Valencia, Spain



Session 26B Thursday, February 26
Gate Drives and Power Marina 1
ICs 10:15 – 11:30 AM

Session Chair: Eric Persson, International Rectifier

- 26B.1 Dual Low Voltage IC Based High And Low Side Gate Drive**
Yin, Y., Zane, R., University of Colorado at Boulder
- 26B.2 A High Performance Integrated Boost DC-DC Converter For Portable Power Supply**
Duan, X., Deng, H., Sun, N., Huang, A., Chen, D., Virginia Polytechnic Institute and State University
- 26B.3 Fundamental Considerations For Gate-Driver Selection Based On Operating Conditions**
Strydom, JT1,3, De Rooij, MA2, Van Wyk , JD3, 1International Rectifier, 2GE Global Research Center, 3NSF Engineering Research Center for Power Electronic Systems



Session 27 Thursday, February 26
Practical DC-DC North Ballroom A
2:00 - 5:30 PM

Session Chairs: Edward Ong, Emerson Network Power/Astec and Ron Hui, City University Of Hong Kong

- 27.1 A Soft-Switched Secondary-Side Post Regulator**
Steigerwald, R.J., Glaser, J., GE Global Research
- 27.2 Modified Forward Converter Yields Best In Class Performance For Isolated DC/DC Bricks**
Domb, M., Cherokee International Corporation
- 27.3 A Soft-Switching Active-Clamp Scheme For Isolated Full-Bridge Boost Converter**
Park, E.S., Choi, S.J., Lee, J.M., Cho, B.H., Seoul National University, Korea
- 27.4 A Zero-Voltage And Zero-Current Switching Three-Level DC-DC Converter With Reduced Rectifier Voltage Stress**
Song, T.T.1, Huang, N.C.1, Ioinovici, A.2, 1Department of Electrical Engineering, Sichuan University , 2Holon Academic Institute of Technology ,Israel

27.5 Zero-Voltage-Switching (ZVS) Two-Stage Approaches With Output Current Sharing For 48 V Input DC-DC Converter
Mao, H., Abu-Qahouq, J., Wen, Y., Batarseh, I., University of Central Florida

27.6 An Overall Study Of The Asymmetrical Half-Bridge With Unbalanced Transformer Turns Under Current Mode Control
Eberle, W., Liu, Y.F., Ye, S., Queen's University, Canada

27.7 Interleaved Three-Level Boost Converter With Zero Diode Reverse-Recovery Loss
Yao, G., Hu, L., Liu, Y., He, X., Power Electronics Research Institute of Zhejiang University, China



Session 28 PM Machine Drives **Thursday, February 26 North Ballroom B 2:00 - 5:30 PM**

Session Chairs: Babak Fahimi, University Of Missouri, Rolla and Art Lyons, BAE Systems

28.1 A Reduced Inverter Size For Multi-Phase Brushless Synchronous Motor
Dhawan, R.D., Soghomonian, ZS, Wavecrest Laboratories

28.2 Sensorless Control For DC Inverter-Fed Compressors
Chen, H.C., Chang, Y.C., Huang, C.M., Chen, Y.C., Liang, K.Y., Compressors Department, ERL/ITRI, Taiwan

28.3 Sensorless Control Of PMSM In High Speed Range With A Sliding Mode Observer
Kang, K.L.1, Kim, J.M.1, Hwang, G.B.2, Kim, K.H.2, 1Department of Electrical Engineering, Pusan National Univ., 2DAC Research Lab., LG Electronics Inc., Korea

28.4 Axial Flux Plastic Multi-Disc Brushless Pm Motors: Performance Assessment
Profumo, F.1, Tenconi, A.1, Cerchio, M.1, Eastham, J. F.2, Coles, P. C.2, 1Politecnico di Torino, 2EnigmaTEC Ltd, Italy

28.5 Practical Control For Improving Power Density And Efficiency Of The BLDC Generator
Lee, H.W., Ehsani, M., Texas A&M University

28.6 A Low Torque Ripple PMSM Drive For EPS Applications
Liu, G., Kurnia, A., de Larminat, R., Desmond, P., O'Gorman, T., Motorola Inc.

28.7 An Innovative Low-Cost Drive For Permanent Magnet Motors: A Future Energy Challenge Experience
Monti, A., Patterson, D., Santi, E., Ponci, F., Student Team, USC, Univ. of South Carolina



Session 29 Transporation Applications **Thursday, February 26 South Ballroom A 2:00 - 5:30 PM**

Session Chairs: Jim Nagashima, General Motors Advanced Technology and Balarama Murty, General Motors R&D

29.1 Design Of Multiple-Input Power Converter For Hybrid Vehicles
Solero, L.1, Lidozzi, A.1, Crescimbin, F.1, Pomilio, J.A2, 1Dept. of Mechanical and Industrial Eng., University of ROMA TRE, 2Fac. Eng. Elétrica e de Computação, Univ. Estadual de Campinas, Italy

29.2 12-Pulse Rectifier For Aircraft Application
Gong, G.H, Drofenik, U., Kolar, J.W, Swiss Federal Institute of Technology (ETH) Zurich, Switzerland

29.3 A Purely Ultracapacitor Energy Storage System For Hybrid Electric Vehicles Utilizing A Microcontroller Based DC-DC Boost Converter
Cegnar, E.J., Johnson, B.K., Hess, H.L., University of Idaho

29.4 Inductive Power Transferring In Maglev Using Harmonic Injection Method
Chen, M, Xu, D, Zhou, D, college of electrical engineering

29.5 Withdrawn By The Authors

29.6 Power Electronic Interface And Motor Control For A Fuel Cell Electric Vehicle
Hasan, SM, Kim, S, Husain, I, The University of Akron

29.7 The Use Of Ultracapacitors As The Sole Power Plant In An Autonomous, Electric Rail-Guided Vehicle
Beale, S.R., Gerson, R, Brooks Automation, Inc.



Session 30 **Thursday, February 26**
PFC Control Techniques **South Ballroom B**
2:00 - 5:30 PM

Session Chair: Keyue Smedley, University Of California, Irvine

- 30.1 Feedforward Current Control Of Boost Single-Phase PFC Converters**
Chen, M., Sun, J., Rensselaer Polytechnic Institute
- 30.2 A DSP-Controlled Four-Quadrant AC-DC Matrix Converter With High-Frequency Isolation**
García-Gil, R., Espí, J.M., Esteve, V., Jordán, J., Ejea, J.B., 1L.E.I.I. Dpto. Ingeniería Electrónica, University of Valencia, Spain
- 30.3 IPEM Based High Frequency PFC**
Lu, B, Lu, Z, Yang, L, Dong, W, Lee, F C, Liang, Z, Van Wyk, J D, Chen, C, Boroyevich, D,
- 30.4 Design Optimization For Steady State And Dynamic Performance Of A Single-Stage Power Factor Corrected AC-DC Converter**
Guo, W., Jain, P., Queen's University, Canada
- 30.5 Utilizing The Free Running Current Programmed Control As A Power Factor Correction Technique For The Two Switch Buck-Boost Converter**
Andersen, G.K.A.2, Blaabjerg, F.B.L.2, 1Aalborg University, 2Aalborg University, Denmark
- 30.6 Withdrawn By The Authors**
- 30.7 1kw PFC Converter With Minimum-Voltage Active-Clamping**
Feng, B., Xu, D., College of Electric Engineering Zhejiang University, China



Session 31 **Thursday, February 26**
Thermal Management **Avalon**
2:00 - 5:30 PM

Session Chairs: Don Adams, Oak Ridge National Laboratory and Dusan Graovac, Atena

- 31.1 A Novel Integrated Packaging Technique For High Density DC-DC Converters Providing Enhanced Efficiency And Thermal Management**
Wanes, J., Celestica Power Systems, Canada
- 31.2 Comparing Predicted Failure Rates With Observed**
Petersson, A., Ericsson Power Modules AB, Sweden

- 31.3 Comparative Thermal And Thermo-mechanical Analyses Of Solder-Bump And Direct-Solder Bonded Power Device Packages Having Double-Sided Cooling Capability**
Bai, J.G.1,2, Calata, J.N.1, Lu, G.Q.1,2, 1Department of Materials and Engineering, Virginia Tech, 2Center for Power Electronics Systems, Virginia Tech
- 31.4 New High Temperature Polymer Thin Coating For Power Electronics**
Kumar, R., Molin, D., Young, L., Ke, F., Cookson Electronics Equipment, Specialty Coating Systems
- 31.5 Performance Evaluation And Reliability Of Thermal Vias**
McCoy, B.S., Zimmermann, MA, Rockwell Collins
- 31.6 New Power MOSFET Selection Method To Avoid Failures**
Jordán, J., Esteve, V., Maset, E., Sanchis-Kilders, E., Ejea, J.B, García-Gil, R, University of Valencia, Spain
- 31.7 Preventing Fire And Smoke In Power Supplies**
Singh, P, Mazzuca, S, Lloyd, J, 1International Business Machines Corp, Poughkeepsie, NY, 2International Business Machines Corp, Yorktown Heights, NY



Session 32 **Thursday, February 26**
Multiphase and **Marina 1**
Multistage VRMs **2:00 - 5:30 PM**

Session Chairs: Shamala Chickamenahalli, Intel Corporation and Ray Ridley, Ridley Engineering, Inc.

- 32.1 Multiphase Voltage Regulator Module With Current Amplification And Absorption Technique**
Senanayake, T., Ninomiya, T., Kyushu University
- 32.2 Multiphase VRM Based On The Symmetrical Half-Bridge Converter**
Visairo, H.1, Sánchez, A.1, Rodríguez, E.2, Arau, J.1, Cobos, J.A3, 1CENIDET, Mexico, 2Instituto Tecnológico de Celaya, 3Universidad Politécnica de Madrid, Spain

- 32.3 Input Voltage Influence On Voltage Regulator Modules Based On Multiphase Buck And Multiphase Half Bridge Topologies**
Alou, P., Cobos, J.A, Garcia, O., Prieto, R., Uceda, J., Universidad Politecnica de Madrid, Spain
- 32.4 Using Coupled Inductors To Enhance Transient Performance Of Multi-Phase Buck Converters**
Li, J.1, Stratakos, A.J.1, Schultz, A.1, Sullivan, C.R.2, 1Volterra Semiconductor Corp., 2Dartmouth College
- 32.5 Two-Stage Voltage Regulator For Laptop Computer CPUs And Corresponding Advanced Control Schemes To Improve Light Load Performance**
Wei, J., Lee, F., Virginia Polytechnic Institute and State University
- 32.6 Comparison Of Two 12 V Voltage Regulator Module Topologies**
Barry, B.2, Morrison, R.2, Egan, M.2, Kelleher, K.1, O'Sullivan, B.2, 1Power-One, Ireland, 2PEI Technologies, University College Cork, Ireland
- 32.7 Two-Stage Approach For 12 V VR**
Ren, Y., Xu, M., Yao, K., Meng, Y., Lee, F., Center for Power Electronics Systems



Session 33A **Thursday, February 26**
Modeling of Buck DC-DC **Marina 4**
2:00 - 3:45 PM

Session Chair: Bill Dillard, Auburn University

- 33A.1 Output Impedance Of High Performance Current Mode DC-DC Buck Converters, With Applications To Voltage-Regulator Module Control Combinations**
Mossoba, J.T., Krein, P.T., University of Illinois at Urbana-Champaign
- 33A.2 Multi-Frequency Modeling For Multiphase Interleaving Buck Converters**
Qiu, Y., Meng, Y., Ye, M., Yao, K., Lee, F., Center for Power Electronics Systems, Virginia Tech
- 33A.3 Linear-Non-Linear Control (LNLC) For DC-DC Buck Converters: Stability And Transient Response Analysis**
Barrado, A., Lazaro, A., Pleite, J., Vazquez, R., Vazquez, J., Olias, E., Universidad Carlos III de Madrid, Spain

- 33A.4 Predicting Load Transient Response Of Output Voltage In DC-DC Converters**
Gezgin, C., Tyco Electronics



Session 33B **Thursday, February 26**
Sensorless and On-Line **Marina 4**
Tuning **4:15 - 5:30 PM**

Session Chair: Yong Li, International Rectifier

- 33B.1 On-Line Calibration Of Lossless Current Sensing**
Zhang, Y., Prodic, A., Zane, R., Maksimovic, D., University of Colorado, Boulder
- 33B.2 Sensorless Position Control Of Active Magnetic Bearings Based On High Frequency Signal Injection With Digital Signal Processing**
Yim, J.S.1,3, Sul, S.K.1,3, Ahn, H.J.2,3, Han, D.C.2,3, 1School of Electrical Engineering and Computer Science, 2School of Mechanical and Aerospace Engineering, 3Seoul National University, Korea
- 33B.3 Virtual Auto-Tuning Position And Torque Sensors For Switched Reluctance Motor Drives**
Salmasi, F.R., Sepe, R., ElectroStandards Laboratories



DIALOGUE SESSIONS

Dialogue Sessions are new at APEC this year. These papers have been selected through a rigorous peer review process and they are represented by papers in the APEC Proceedings. These papers were selected for a dialogue presentation by the APEC Program Committee because while they are of the same high quality as the orally presented papers, they are generally narrower in scope or more specialized than papers in the oral presentation sessions. 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.

Session D1 **Thursday, February 26**
DC-DC and Power Supply **Exhibit Hall**
11:30 AM – 2:00 PM

Session Chair: Dayu Qu, Power-One

- D1.1 A Novel Three-Phase High-Power Soft Switched DC/DC Converter For Low Voltage Fuel Cell Applications**
Liu, C., Johnson, A., Lai, J.-S., Virginia Polytechnic Institute and State University
- D1.2 A New AC/AC Voltage Regulator**
Bissochi Jr, C.A., Farias, V.J., de Freitas, L.C., Vieira Jr, J.B., Coelho, E.A.A., de Oliveira, J.C., Brazil
- D1.3 Forward Type DC-DC Converter With LC Clamp For Steep Load Transitions**
Senanayake, T., Ninomiya, T., Kyushu University, Japan
- D1.4 Proposal Of A Switched-Mode Power Supply Employing A Quadratic Boost Converter And A New Topology Of Soft-Switched Two-Switch Forward Converter**
Gallo, C.A., Tofoli, F.L., Vincenzi, F.R., Vieira Jr., J.B., Federal University of Uberlandia, Ireland
- D1.5 Design Issues In Regulated And Unregulated Intermediate Bus Converters**
Barry, M., Artesyn Technologies
- D1.6 An Adaptive Sliding Mode Controller For Buck Converter In Continuous Conduction Mode**
Tan, S.C., Lai, Y.M., Tse, C.K., Cheung, K.H., The Hong Kong Polytechnic University, China

- D1.7 Soft Switched Interleaved Boost Converters Used As High-Power Battery Discharge Regulator For Space Power Systems**
Sanchis-Kilders, E.1, Ferreres, A.1, Maset, E.1, Esteve, V.1, Carrasco, J.A.2, Garcia-Gil, R., 1Dpt. Ingenieria Electronica, Universitat de Valencia, 2Div. Tec. Elec., Universidad Miguel Hernandez, Spain
- D1.8 A Novel Microprocessor-Based Battery Charger Circuit With Power Factor Correction**
Demian Jr., A., Tofoli, F.L., Gallo, C.A., Vieira Jr., J.B., Coelho, E.A.A., Federal University of Uberlandia, Brazil
- D1.9 Withdrawn By The Authors**
- D1.10 Self-Sustained Oscillation Series-Parallel Resonant Converter With The High Frequency Effects: Analysis, Modeling, And Design**
Youssef, M.1, Jain, P.2, 1Queen's University, 2Queen's University, Canada
- D1.11 A Double-Closed Loop DC/DC Converter Based On A Piezoelectric Transformer**
Díaz, J., José, M.A., Linera, F.M., Martín, J., Nuño, F., GEI University of Oviedo, Spain
- D1.12 A New Isolated Current-Fed PWM DC-DC Converter With Small Inductance And No Deadtime Operation**
Song, W., Lehman, B., Northeastern University
- D1.13 A Modified ZVS Half Bridge DC-DC Converter**
Mao, H., Deng, S., Abu-Qahouq, J., Batarseh, I., University of Central Florida



Session D2 **Thursday, February 26**
PFC and Ballast **Exhibit Hall**
11:30 AM – 2:00 PM

Session Chair: Yaow-Ming Chen, National Chung Cheng University

- D2.1 Withdrawn By The Authors**
- D2.2 Evaluation Of Shunt And Series Power Conditioning Strategies For Feeding Sensitive Loads**
Wang, B., Venkataramanan, G., University of Wisconsin - Madison
- D2.3 Reference Wave Generation In Dynamic Voltage Restorers By Use Of PQR Power Theory**
Kim, H.1, Lee, S.J.2, Sul, S.K.2, 1Cheonan National Technical College, Korea, 2Seoul National University, Korea

- D2.4 A New Single-Phase ZCS-PWM Boost Rectifier With High Power Factor And Low Conduction Losses**
Wang, C.-M., Lunghwa University of Science and Technology, Taiwan
- D2.5 Direct And Efficient Neuro-Controlled Three-Phase PFC In ABC Frame**
Yazdani, D., Bakhshai, A., Jain, P., Department of ECE, Queen's University, Kingston, Canada
- D2.6 Non-Causal Current Predictor For Active Power Filter**
Sozanski, K. P., University of Zielona Gora, Poland
- D2.7 A New Control Approach For Multi-Level Rectifiers**
Jin, T.J., Smedley, K.S., University of California, Irvine
- D2.8 High Frequency Investigation Of Single-Switch CCM Power Factor Correction Converter**
Lu, B, Dong, W, Wang, S, Lee, F C, Virginia Polytechnic Institute and State University
- D2.9 Study Of Alternative Regimes To Analyze Two-Stage PFC Converter**
Orabi, M., Ninomiya, T., Kyushu University, Japan
- D2.10 Withdrawn By The Authors**
- D2.11 Analysis Of Large-Signal And Small-Signal Instabilities In Piezoelectric Transformers Driving Cold Cathode Fluorescent Lamps**
Spiazzi, G., Buso, S., Department of Information Engineering - University of Padova, Italy
- D2.12 Photovoltaic System For Supply Public Illumination In Electrical Energy Demand Peak**
Mineiro, E.M.S., Daher, S.D., Tavares, C.M.T., Antunes, F.M.A., Federal University of Ceara, Brazil
- D2.13 Withdrawn By The Authors**



Session D3 Distributed Generation

Thursday, February 26
Exhibit Hall
11:30 AM – 2:00 PM

Session Chair: Sewan Choi, Seoul National University Of Technology

- D3.1 Dual-Module Based Maximum Power Point Tracking Control Of PV Systems**
Ahn, J.Y., Park, J.H., Yu, G.J., Cho, B.H., 1Seoul National University, 2Korea Institute of Energy Research, Korea
- D3.2 Solid-Oxide-Fuel-Cell (SOFC) Power-Conditioning Systems Interaction Analysis: Resolution Of The Electrical-Feedback Effects On SOFC Performance And Durability**
Acharya, K., Mazumder, S.K, Burra, R.K, University of Illinois, Chicago
- D3.3 Analysis Of Losses In Cables And Transformers Under Power Quality Related Issues**
Tofoli, F.L., Sanhueza, S.M.R., Gallo, C.A., Oliveira, A., Federal University of Uberlandia, Brazil
- D3.4 A New Method Of On-Line Grid Impedance Estimation For PV Inverters**
Asiminoaei, L.1, Teodorescu, R.1, Blaabjerg, F.1, Borup, U.2, 1Aalborg University, Institute of Energy Technology, Denmark, 2PowerLynx A/S, Sonderborg, Denmark
- D3.5 Development Of A Robust Anti-Islanding Algorithm For Utility Interconnection Of Distributed Fuel Cell Powered Generation**
Jeraputra, C., Enjeti, P., Hwang, I., Power Electronics and Power Quality Lab, Texas A&M University
- D3.6 Novel Power Conditioning Circuits For Piezoelectric Micro Power Generators**
Han, J., von Jouanne, A., Le, T., Mayaram, K., Fiez, T., Oregon State University
- D3.7 Withdrawn By The Authors**
- D3.8 Withdrawn By The Authors**
- D3.9 Three-Phase To Single-Phase Direct Connection For Rural Co-Generation Systems**
Machado, R.Q.1, Buso, S.2, Marafao, F.P.1, Pomilio, J.A.1, 1University of Campinas, 2University of Padova, Brazil
- D3.10 An Advanced Fuel Cell Simulator**
Acharya, P.1, Palma, L.1, Enjeti, P.1, Pitel, I.J.1,2, 1Department of Electrical Engineering, Texas A&M University, 2Magna-Power Electronics

- D3.11 An Integrated Inverter With Maximum Power Tracking For Grid-Connected PV Systems**
Ho, B.M.T., Chung, H.S.H., Hui, S.Y.R., City University of Hong Kong, China
- D3.12 A Single-Phase Two-Wire Grid-Connection PV Inverter With Active Power Filtering And Nonlinear Inductance Consideration**
Wu, T.1, Nei, H.1, Shen, C.2, Li, G.1, 1National Chung Cheng University, 2Nan-Jeon Institute of Technology, Taiwan
- D3.13 Optimum Fuel Cell Utilization With Multilevel Converters**
Ozpineci, B.1, Tolbert, L.M.1,2, Su, G.1, Du, Z.2, Miller, C.W.2, 1Oak Ridge National Laboratory, 2The University of Tennessee



Session D4 **Thursday, February 26**
Motor Drives and Power **Exhibit Hall**
Electronics Applications **11:30 AM – 2:00 PM**

Session Chair: Heath Koons, Moog Components Group

- D4.1 Low-Cost Single-Phase Powered Induction Machine Drive For Residential Applications**
Wells, J.R., Nee, B.M., Amrhein, M., Krein, P.T., Chapman, P.L., University of Illinois at Urbana-Champaign
- D4.2 Performance Analysis Of Linear Permanent Magnet Motors For Optimal Design Considerations**
Chen, Y.2, Fan, S.2, Lu, W.1, 1Dept. of Electrical Engineering, Wufeng Institute of Technology, 2Dept. of Electrical Engineering, National Chung Cheng Univ., Taiwan
- D4.3 No-Coupling Sacs Motor Testing**
Xu D., Li, Y., Shi, J., Zhang Q., Harbin Institute of Technology, China
- D4.4 A Novel, Low-Cost, High-Performance Single-Phase Adjustable-Speed Motor Drive Using Pm Brush-Less DC Machine: IIT's Design For 2003 Future Energy Challenge**
Aboul-Naga, A., Desai, P., Rodriguez, F., Cooke, T., Emadi, A., Illinois Institute of Technology, USA
- D4.5 FPGA Implementation Of The High-Performance Vector-Controlled Speed Servo Controller For AC Drives**
Zhou, Z.Y., Yang, G.J., Li, T.C., Harbin Institute of Technology, China

- D4.6 A Multilevel Converter Topology With Fault Tolerant Ability**
Chen, A.L., Hu, L., Chen, L.F., He, X.N., College of Electrical Engineering, Zhejiang University, China
- D4.7 A MTPA Control Scheme For An IPM Synchronous Motor Considering Magnet Flux Variation Caused By Temperature**
Kang, G., Lim, J., Nam, K., Ihm, H., 1POSTECH University, 2Hyundai Motor Company, Korea
- D4.8 Efficiency Optimizing Control Of Induction Motor Using Natural Variables**
Ojo, Olo, Dong, G., Tennessee Technological University
- D4.9 Harmonic Calculation Toolbox In Industry Application For Adjustable Speed Drive**
Asiminoaei, L.1, Hansen, S.2, Blaabjerg, F.1, 1Institute of Energy Technology, Aalborg University, Denmark, 2Danfoss Drives A/S, Graasten, Denmark
- D4.10 High Performances Supercapacitors Recovery System For Industrial Drive Applications**
Attaiabese, C., Nardi, V., Tomasso, G., University of Cassino, Italy
- D4.11 Load Resonant Type Power Supply Of The Ozonizer Based On A Closed-Loop Control Strategy**
Huang, Y.S., Wang, L.Q., Zhang, Z.C., Zhejiang University, China
- D4.12 Three Level LLC Series Resonant DC/DC Converter**
Gu, G., Lu, L., Qian, Q., College of Electrical Engineering of Zhejiang University, China
- D4.13 Quasi-Resonant Flyback Converter For Transdermal Drug Delivery Applications**
Tseng, S., Huang, Y., Hsieh, H., Wu, T., National Chung Cheng University, Taiwan



Session D5 **Thursday, February 26**
Inverters **Exhibit Hall**
11:30 AM – 2:00 PM

Session Chair: Bill Diong, University Of Texas, El Paso

- D5.1 Higher Efficiency Three-Level Inverter Employing IEGTs**
Ichikawa, K., Toshiba Corporation, Japan

- D5.2 A Novel Digital Modulator For Voltage Source Inverter With Adaptive Switching Frequency Selection**
Attaianese, C., Nardi, V., Tomasso, G., University of Cassino, Italy
- D5.3 A Carrier-Based PWM Scheme For Neutral-Point Voltage Balancing In Three-Level Inverters**
Tallam, R.M., Naik, R., Nondahl, TA, Rockwell Automation
- D5.4 A New Single-Phase Multilevel Current-Source Inverter**
Xiong, Y.1, Chen, D.J.1, Deng, S.Q.2,, Zhang, .Z.C1,, 1Zhejiang University, P.R.China, 2University of Central Florida, USA
- D5.5 A Generic PWM Control Method For Flying Capacitor Inverter**
Liu, W., Yan, G., Chen, Y., Zhang, X., Han, Y., FACTS and DFACTS Institute, Tsinghua University, China
- D5.6 A Single To Three Phase Converter For Home Appliance Featuring Four Switches And Active Power Factor Control**
Consoli, A.1, Cacciato, M.2, De Caro, S.3, Testa, A.3, 1DIEES - University of Catania, 2DIE - University of Rome, 3DFMTFA - University of Messina, Italy
- D5.7 Design Of A Universal Space Vector PWM Controller Based On FPGA**
Zhou, Z.Y., Li, T.C., Harbin Institute of Technology, China
- D5.8 Design And Implementation Of An FPGA-Based 3-Phase Sinusoidal PWM VVVF Controller**
Zhou, Z.Y., Li, T.C., Harbin Institute of Technology, China
- D5.9 Withdrawn By The Authors**
- D5.10 Digital Voltage Regulation With Flux Balance Control For Sine Wave Inverters**
Li, M.Z., Xing, Y., Nanjing University of Aeronautics and Astronautics, China
- D5.11 Research Of Capacitor Voltage Balance Control Method For H-Bridge Inverter Of Hybrid 9-Level Inverter**
Chen, Y., Liu, W., Yan, G., Song, Q., FACTS and DFACTS Institute, Tsinghua University, China
- D5.12 Three-Level SVPWM Method Based On Two-Level PWM Cell In DSP**
Yao, W., Lu, Z., Fei, W., Qian, Z., Electrical Engineering College, Zhejiang University

- D5.13 Voltage Sharing Of The Divided Capacitors In Non-Isolated Three-Level Converters**
Ruan, X.1, Wei, J.2, Xue, Y.1, 1Nanjing University of Aero. & Astro., 2E-Power Co. Ltd, China



**Session D6
Modeling & Control**

**Thursday, February 26
Exhibit Hall
11:30 AM – 2:00 PM**

Session Chair: Byeong-Mun Song, Sorrento Electronics

- D6.1 Modeling And Driving Piezoelectric Resonant Blade Elements**
Ben-Yaakov, S., Krihely, N., Ben-Gurion University, Israel
- D6.2 The DSP-Based Controller Design For Flying Capacitor Converters**
Feng, C., Agelidis, V., University of Glasgow, UK
- D6.3 Pulse Regulation Control Technique For Flyback Converter**
Ferdowsi, M., Emadi, A., Illinois Institute of Technology, USA
- D6.4 Input Series, Output Series Connected Modular DC-DC Converters, With Active Input-Voltage And Output-Voltage Sharing**
Ayyanar, R.1, Giri, R.2, 1Arizona State University, 2Maxim Integrated Products, Inc
- D6.5 A Multi-Processor Control System Architecture For A Cascaded Statcom With Energy Storage**
Qian, C., Crow, M., Cheng, Y., University of Missouri-Rolla
- D6.6 Robust Delta Operator-Based Discrete Systems For Fixed-Point DSP Implementations**
Marafão, F.P., Deckmann, S.M., Lopes, A., University of Campinas, Brazil
- D6.7 A New Current Feedback Fuzzy Logic Controller With Extended State Observer For DC-To-DC Converters**
Feng, G., Zhang, W., Liu, Y.F, Dept. of Electrical and Computer Engineering, Queen's Univ., Canada
- D6.8 Modeling And Control Of Single-Stage Voltage-Source And Current-Source PFC Converters**
Uan-Zo-li, A.B, Lee, F.C, Noon, J.P, 1Virginia Polytechnic Institute and State University, 2Texas Instruments

- D6.9 Power Losses Estimation Platform For Power Converters**
Songquan, D., Hong, M., Jaber, A., Jinggen, Q., Bartarseh, I., University of Central Florida
- D6.10 Sensorless Current-Mode Control Of A Digital Dead-Beat DC-DC Converter**
Kelly, A1, Rinne, K2, 1Analog Devices, Limerick, Ireland, 2PEI, Dept.of ECE, University of Limerick, Ireland
- D6.11 Modeling And Analysis Of An Off-Line Battery Charger For Single Cell Lithium Batteries**
Zhang, W.Z., Martinez, R.M., Skelton, D.S., Texas Instruments Inc.
- D6.12 Simplified Modeling And Control Of A Synchronous Machine With Variable-Speed Six-Step Drive**
Senesky, MK, Tsao, P, Sanders, SR, University of California, Berkeley
- D6.13 Transient Analysis And Fault Compensation During Module Failure In Paralleled Power Modules**
CHENG, Y.J., SNG, E.K.K., School of EEE, Nanyang Technological University, Singapore



Session D7 **Thursday, February 26**
Power Electronics **Exhibit Hall**
Applications **11:30 AM – 2:00 PM**

Session Chair: Xiaoyan Wang, Whirlpool Corporation

- D7.1 A Novel Pulse Power Supply For Magnetron Using High Voltage Capacitor Embedded High Frequency Transformer**
Jeong, B.H.1, Cho, J.S., Park, K.H., Mok, H.S., Choe, G.H., Department of Electrical Engineering Konkuk University, Korea
- D7.2 Design Of A Novel Low-Loss Fault Current Limiter For Medium-Voltage Systems**
Meyer, C., Köllensperger, P., De Doncker, R.W., RWTH Aachen University, Institute for Power Electronics (ISEA)
- D7.3 A Self-Adjusting Sinusoidal Power Source Suitable For Driving Capacitive Loads**
Ben-Yaakov, S., Peretz, M.M, Ben-Gurion University, Israel
- D7.4 Innovative Efficient Gradient Coil Driver Circuit Topology**
Spanjaard, S.1, Ferreira, J.A.F.1, Bauer, P.1, Hollander, M.2, 1Delft University of Technology, 2Philips Medical Research, Netherlands

- D7.5 Control System Of Ultra Sonic Motors For Multiple Control System Of Ultra Sonic Motors For Multiple Joints Of Robotic Arm**
Jang, JMS1, Dawson, FD1, Bailak, GB2, 1University of Toronto, 2MD Robotics, Canada
- D7.6 Development Of An Opto-Electrical Probe For Measuring Impulse High-Voltage Across Thyristors In HVDC Valve Of Three-Gorges Project**
Zhao, Z., 1, Lu, Z., 1, Qiu, Y., 2, 1State key laboratory of power electronics, 2State key lab of electrical insulation for power equipment, China
- D7.7 Powering Solid State Radar T/R Module Arrays From A Fuel Cell Using An Isolated Cúk Converter**
McGee, B.R., Nelms, R.M., Auburn University
- D7.8 An Optimal Selection Of Induction Heater Capacitance Considering Dissipation Loss Caused By ESR**
Lee, J., Lim, S., Nam, K., Choi, D., 1POSTECH University, 2POSCO, Korea
- D7.9 Modeling The Benefits Of Using A Thick Bottom Oxide Gated MOSFET (WFET) With Increased Switching Performance In The High Side Of A Non-Isolated Synchronous Buck Converter**
Brown, J., Vishay Siliconix, UK
- D7.10 Withdrawn By The Authors**
- D7.11 PCB Layout Inductance Modeling Based On A Time Domain Measurement Approach**
López, T., Duerbaum, T., Tolle, T., Elferich, R., Philips Research, Germany
- D7.12 Resonant Frequency Selectable Induction Heating Targets**
Rodriguez, J. I, Leeb, S. B., M.I.T. Laboratory for Electromagnetic and Electronic Systems, Cambridge, MA
- D7.13 A Structured Approach For Product Demand Forecasting**
Shepard, J.D., Darnell Group, Corona, California



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APEC 2004 — CONFERENCE AT A GLANCE

Saturday, February 21

Registration Desk Open	3:00 PM – 6:00 PM	Center Lounge
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Sunday, February 22

Registration Desk Open	8:00 AM – 5:00 PM	Center Lounge
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Seminar 1	The Business of Power---An Introduction to the Power Industry for the Non-Technical Professional	9:30 AM – 1:00 PM	South Ballroom A
Seminar 2	SMPS Design Basics	9:30 AM – 1:00 PM	Avalon Room
Seminar 3	Lead Free Manufacturing and Industry Preparedness	9:30 AM – 1:00 PM	South Ballroom B
Seminar 4	Power Electronics Packaging With An Emphasis On High Current Applications	9:30 AM – 1:00 PM	North Ballroom A
Seminar 5	Permanent Magnet and Induction Motor Drives	9:30 AM – 1:00 PM	Marina 1
Seminar 6	PWM Switch Modeling Historical Review & New Developments	9:30 AM – 1:00 PM	North Ballroom B
Seminar 7	Hybrid Vehicle Propulsion: Electrical & Mechanical Matching	9:30 AM – 1:00 PM	Marina 4
Seminar 8	Writing Specifications For Power Supplies And DC-DC Converters	2:30 PM – 6:00 PM	South Ballroom A
Seminar 9	Digital Signal Processor Basics for Power Supply Design	2:30 PM – 6:00 PM	Avalon Room
Seminar 10	Alternate Power Business Models	2:30 PM – 6:00 PM	South Ballroom B
Seminar 11	Design-Oriented Feedback Analysis: A Final Solution	2:30 PM – 6:00 PM	North Ballroom A
Seminar 12	Efficient Development Of Adjustable Speed Motor Drive Controls By Hardware In The Loop	2:30 PM – 6:00 PM	Marina 1
Seminar 13	A Systematic Method for Developing SPICE Models for PWM Converters	2:30 PM – 6:00 PM	North Ballroom B
Seminar 14	Power Semiconductors and Control for Automotive Applications	2:30 PM – 6:00 PM	Marina 4

Monday, February 23

Registration Desk Open	8:00 AM – 5:00 PM	Center Lounge
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Seminar 15	Best Practices in Qualifying Power Supplies and Power Suppliers	8:30 AM – Noon	South Ballroom A
Seminar 16	Digital Control of HF Switching Power Converters	8:30 AM – Noon	Avalon Room
Seminar 17	What You See (On Your Line) is What You Get (In the Field)	8:30 AM – Noon	South Ballroom B
Seminar 18	The Forward Converter: Practical Design of Input and Output Filters	8:30 AM – Noon	North Ballroom A
Seminar 19	An Introduction To EMC And Good Design Practices For Successful High Frequency Inverter Design	8:30 AM – Noon	Marina 1
Seminar 20	Stability Analysis Made Simple	8:30 AM – Noon	North Ballroom B
Seminar 21	High Efficiency Rectification	8:30 AM – Noon	Marina 4

Session 1	Plenary	1:30 PM – 5:00 PM	Grand Ballroom
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Spouse & Guest Welcoming	8:30 AM – 9:30 AM	Coronado Room
Spouse & Guest Tour- Colors of the Coast: Huntington Beach and Newport Beach	Time To Be Announced	Coronado Room
Welcoming Reception—Exposition Hall Open	5:30 PM – 8:00 PM	Terrazzo Room/Exhibit Hall
Micro Mouse Contest	8:00 PM – 10:00 PM	Grand Ballroom

APEC 2004 — CONFERENCE AT A GLANCE

Tuesday, February 24

Registration Desk Open		8:00 AM – 5:00 PM	Center Lounge
Session 2	Digital Control	8:30 AM – Noon	North Ballroom A
Session 3	Inverter Design and Applications	8:30 AM – Noon	North Ballroom B
Session 4	Lamp Ballasts	8:30 AM – Noon	South Ballroom A
Session 5	Active Power Filters	8:30 AM – Noon	South Ballroom B
Session 6	Semiconductor Devices	8:30 AM – Noon	Avalon
Session 7	VRM Design Considerations	8:30 AM – Noon	Marina 1
Session 8A	Power Supply Efficiency Standards	8:30 AM – 10:30 AM	Marina 4
Session 8B	Marketing	10:45 AM – Noon	Marina 4
Spouse & Guest Tour - From Bowders to Flowers: The Bowers Museum of Cultural Art and Sherman Gardens			
Exposition Hall Open		Time To Be Announced Noon – 5:00 PM	Coronado Room Terrazzo Room/Exhibit Hall
Exhibitor Seminars—See Exposition Directory For Seminar Descriptions		2:30 PM – 4:15 PM	North & South Ballroom's
Rap Session I	Power Supply Digital Control: Real Or "Virtual"?	5:00 PM – 6:30 PM	North Ballroom A
Rap Session II	Who Needs Power Supply Companies, When The Semiconductor Company Can Do It All?	5:00 PM – 6:30 PM	North Ballroom B
Rap Session III	We're On The Power Electronics Roadmap, But Who's Driving?	5:00 PM – 6:30 PM	South Ballroom B

Wednesday, February 25

Registration Desk Open		8:00 AM – 3:00 PM	Center Lounge
Session 9	Fuel Cell Power Conversions	8:30 AM – 10:15 AM	North Ballroom A
Session 10	Control of DC-DC Converters	8:30 AM – 10:15 AM	North Ballroom B
Session 11	Standby Power	8:30 AM – 10:15 AM	South Ballroom A
Session 10	Uninterruptible Power Systems	8:30 AM – 10:15 AM	South Ballroom B
Session 12	PWM Techniques	8:30 AM – 10:15 AM	Avalon
Session 14	Modeling of Parasitics and Interconnects	8:30 AM – 10:15 AM	Marina 1
Special Presentation Session 1 - Future Directions In Silicon And Nano Technologies		8:30 AM – 10:15 AM	Marina 4
Exposition Hall Open		10:30 AM – 2:00 PM	Terrazzo Room/Exhibit Hall
Exhibitor Seminars See Exposition Directory For Seminar Descriptions		11:00 AM – 11:45 AM	North & South Ballroom's
Session 15	AC Motor Drives	2:00 PM – 5:30 PM	North Ballroom A
Session 16	Power Quality and Utility Interface	2:00 PM – 5:30 PM	North Ballroom B
Session 17	DC-DC Converter Circuits	2:00 PM – 5:30 PM	South Ballroom A
Session 18	EMI and EMC	2:00 PM – 5:30 PM	South Ballroom B
Session 19	Single-Phase Power Factor Correction	2:00 PM – 5:30 PM	Avalon
Session 20	Modeling of DC-DC Converters	2:00 PM – 5:30 PM	Marina 1
Special Presentation Session 2 - Current Topics In Power Electronics Research		2:00 PM – 5:30 PM	Marina 4
Conference Banquet		TBD – 10:00 PM	Disney California Adventure

APEC 2004 — CONFERENCE AT A GLANCE

Thursday, February 26

Registration Desk Open		8:00 AM – Noon	Center Lounge
Session 21	Multilevel and Matrix Converters	8:30 AM – 11:30 AM	North Ballroom A
Session 22	Synchronous Rectifiers	8:30 AM – 11:30 AM	North Ballroom B
Session 23	Soft-Switching and High Density DC-DC Converters	8:30 AM – 11:30 AM	South Ballroom A
Session 24	Magnetics	8:30 AM – 11:30 AM	South Ballroom B
Session 25	HID Lamp Ballasts	8:30 AM – 11:30 AM	Avalon
Session 26A	Distributed Power Systems	8:30 AM – 9:45 AM	Marina 1
Session 26B	Gate Drives and Power ICs	10:15 AM – 11:30 AM	Marina 1
Special Presentation Session 3- Future Directions In Semiconductors For Power Electronics		8:30 AM – 11:30 AM	Marina 4
Dialogue Sessions See Advance Program for Details on Specific Sessions		11:30 AM – 2:00 PM	Terrazo Room/Exhibit Hall
Session 27	Practical DC-DC Converters	2:00 PM – 5:30 PM	North Ballroom A
Session 28	PM Machine Drives	2:00 PM – 5:30 PM	North Ballroom B
Session 29	Transportation Applications	2:00 PM – 5:30 PM	South Ballroom A
Session 30	PFC Control Techniques	2:00 PM – 5:30 PM	South Ballroom B
Session 31	Thermal Management	2:00 PM – 5:30 PM	Avalon
Session 32	Multiphase and Multistage VRMs	2:00 PM – 5:30 PM	Marina 1
Session 33A	Modeling of Buck DC-DC Converters	2:00 PM – 3:45 PM	Marina 4
Session 33B	Sensorless and On-Line Tuning	4:15 PM – 5:30 PM	Marina 4

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APEC 2004

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