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## CONFERENCE PROGRAM

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**APEC Mobile App & Internet Access**

For the latest news and information, access to on-line conference and hotel information download the **APEC2017 mobile app** on your mobile device. The app is accessible by scanning the below QR code, and can also be found directly through Google Play (Android) and App Store (IOS devices) when searching keyword “APEC”.

![QR Code]

Internet is available throughout the Tampa Convention Center to APEC attendees and can be accessed by connecting to the APEC 2017 Attendee wireless network. After selecting the **APEC 2017 Attendee** wireless network, open your web browser and you will be prompted to input a password. The password is **TAMPA**.
Foreword

I am honored to personally welcome you to the 2017 IEEE Applied Power Electronics Conference and Exposition (APEC 2017), at the Tampa Convention Center, in Tampa, Florida.

APEC allows power electronics professionals from all sectors to gather annually and participate in a rewarding exchange of technical knowledge, gaining valuable industry connections. This is an opportunity which is truly only possible at APEC, the Premier Event in Applied Power Electronics. I look forward to APEC every year as a time to meet colleagues, see what new directions are emerging in our field, and find new solutions to the problems I face—or sometimes find new problems to solve.

This event is made possible through the tireless efforts of the APEC 2017 organizing committee and APEC’s sponsors: IEEE Industry Applications Society (IAS), IEEE Power Electronics Society (PELS), and Power Sources Manufacturers Association (PSMA). It is their dedication, expertise, and support which drives this conference to be a showcase of exceptional advances in power electronics.

APEC 2017 will provide an unmatched technical program and exposition experience, highlighting the best our industry has to offer. The exposition will feature cutting edge technologies and products from 266 companies. Attendees will be able to easily navigate the exposition by using the APEC Mobile App, which will feature an interactive directory and map of the floor.

The technical program will touch on the latest concerns in power electronics. With presenters from industry, government, and academia, and from all around the globe, the Technical Sessions and Dialogue Sessions are sure to offer something for everyone. From Industry Sessions to Professional Educational Seminars, you will be able to witness in-depth discussions of topics which combine theory with practical application. Initiatives such as the Micro Mouse Competition and Travel Grants will draw a global crowd of innovative thinkers that represent the future of power electronics. As always, the Plenary Session and Rap Sessions will feature hot topics affecting not only our industry, but society today.

Tampa is a stunning location which I’m sure you will enjoy as you experience all the city has to offer. I hope you take advantage of this by visiting Busch Gardens, the New York Yankees spring training facility, or one of the nearby world class beaches. Your families will have endless options to explore, including the Florida Aquarium, Lowry Park Zoo, SS American Victory, Henry B. Plant Museum, and Glazer Children’s Museum. In addition there are extensive dining destinations and entertainment venues for you to visit with old friends and new colleagues at the conclusion of the day’s programming.

I cannot thank the APEC attendees, exhibitors, sponsors, organizing & steering committee members, reviewers, and volunteers, enough. It is your passion and knowledge which makes APEC a memorable event year after year. I look forward to meeting you at APEC 2017 and sharing in this experience together.

Warmest Regards,

Jonathan W. Kimball
General Chair
2017 IEEE Applied Power Electronics Conference and Exposition
Conference Committee

Members-at-Large

Doug Hopkins  
Member At Large  
North Carolina State University

Gerry Moschopoulos  
Member at Large  
University of Western Ontario

Conference Management

David Weil  
Conference Director  
Courtesy Associates

Bobbie Praske  
Conference Manager  
Courtesy Associates

Ingrid Qualls  
Exposition and Partner Manager  
Courtesy Associates

Tricia Chiamas  
Education Manager  
Courtesy Associates

Tonya Stanback  
Registration Manager  
Courtesy Associates

Kendra Speak  
Special Events Coordinator  
Courtesy Associates

Kristen Covine  
Exposition Coordinator  
Courtesy Associates

Tom Wehner  
Abstracts Management  
Epapers LLC

Steering Committee

Ali Reza Khaligh  
Steering Committee Chair  
IAS  
University of Maryland at College Park

Siamak Abedinpour  
IAS  
Dialog Semiconductor Inc.

Frank Cirolia  
PSMA  
Artesyn Embedded Technologies

Jose Cobos  
PELS  
University of Texas at Dallas

Jonathan Kimball  
PELS  
Missouri University of Science & Technology

Eric Persson  
PSMA  
Infineon Technologies

Russell Spyker  
IAS  
Wright Patterson AFB

Aung Thet Tu  
PSMA  
Infineon Technologies

Jonathan Kimball
General Chair  
Missouri University of Science & Technology

Eric Persson
Program Chair  
Infineon Technologies

Ernie Parker
Assistant Program Chair  
Crane Aerospace & Electronics

Siamak Abedinpour
Publications Chair  
Dialog Semiconductor Inc.

Berker Bilgin
Rap Sessions Co-Chair  
McMaster University

Frank Cirolia
Web & Social Media Chair  
Artesyn Embedded Technologies

José Cobos
Exposition Chair  
Universidad Politécnica de Madrid

Greg Evans
Publicity Chair  
WeiComm, Inc.

Ali Khajehoddin
Grants and Awards Chair  
University of Alberta

Ali Reza Khaligh
Past General Chair  
University of Maryland at College Park

Mark Nelms
Finance Chair  
Auburn University

Van Niemela
Exposition Co-Chair  
GE Energy

Tony O’Gorman
Industry Session Chair  
PESC Inc.

Omer C. Onar
Rap Sessions Chair  
Oak Ridge National Laboratory

David Otten
MicroMouse Chair  
Massachusetts Institute of Technology

Kevin Parmenter
Exposition Co-Chair  
Excelsys

Adam Pitel
Web & Social Media Co-Chair  
Magna-Power Electronics

Conor Quinn
Industry Session Co-Chair  
Artesyn Embedded Technologies

Pradeep Shenoy
Marketing Chair  
Texas Instruments

Aung Thet Tu
Seminar Chair  
Infineon Technologies

John Vigars
Finance Co-Chair  
Allegro MicroSystems

Jin Wang
Seminar Co-Chair  
Ohio State University

Jane Wilson
Spousal Hospitality Chair

Indumini Ranmuthu  
Member At Large  
Texas Instruments
## Schedule-at-a-Glance

*Room assignments are tentative and subject to change. *Please check for updates on APEC Mobile App.

**KEY:**  
- **S** = Professional Education Seminars  
- **R** = Rap Sessions  
- **IS** = Industry Sessions  
- **D** = Dialogue Sessions  
- **T** = Technical Sessions

### Sunday, March 26, 2017

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 a.m. – 5:00 p.m.</td>
<td>Registration                                           2ND FLOOR CONCOURSE</td>
</tr>
<tr>
<td>8:00 a.m. – 9:00 a.m.</td>
<td>Presenter Breakfast                                               BALLROOM A</td>
</tr>
<tr>
<td>9:30 a.m. – 1:00 p.m.</td>
<td>S01: Bidirectional DC-DC Converters: Fundamentals and Advances     ROOM 13/14</td>
</tr>
<tr>
<td></td>
<td>S02: Silicon Carbide MOSFETs — A Deep Dive to Accelerate Your Next Power Converter Design ROOM 15/16</td>
</tr>
<tr>
<td>9:30 a.m. – 1:00 p.m.</td>
<td>S03: Direct Digital Design of Compensators for Power Electronics Control ROOM 18/19</td>
</tr>
<tr>
<td>9:30 a.m. – 1:00 p.m.</td>
<td>S04: High Power Si and SiC Module Technology and Application Considerations ROOM 24/25</td>
</tr>
<tr>
<td>9:30 a.m. – 1:00 p.m.</td>
<td>S05: EMI Causes, Measurement, and Reduction Techniques for Switch-Mode Power Converters ROOM 20/21</td>
</tr>
<tr>
<td>2:30 p.m. – 6:00 p.m.</td>
<td>S06: Practical Design of Wireless Electric Vehicles: Dynamic &amp; Stationary Charging Technologies ROOM 22/23</td>
</tr>
<tr>
<td>2:30 p.m. – 6:00 p.m.</td>
<td>S07: A Comprehensive Introduction to Implementing a Fully Digital LLC Resonant Converter. ROOM 13/14</td>
</tr>
<tr>
<td>2:30 p.m. – 6:00 p.m.</td>
<td>S08: Practical Implementation of SiC Power Devices on Using Best Practices with a Focus on Electrification of Motor Vehicles. ROOM 15/16</td>
</tr>
<tr>
<td>2:30 p.m. – 6:00 p.m.</td>
<td>S09: Small-Signal Stability and Subsystem Interactions in Distributed Power Systems with Multiple Converters: DC Systems and 1-Phase AC Systems ROOM 18/19</td>
</tr>
<tr>
<td></td>
<td>S10: Advanced Packaging Technologies for Fully Exploiting Attributes of WBG Power Electronics ROOM 24/25</td>
</tr>
<tr>
<td></td>
<td>S11: Introduction to EMC                                               ROOM 20/21</td>
</tr>
<tr>
<td></td>
<td>S12: High Frequency Magnetics Design and Modeling                      ROOM 22/23</td>
</tr>
</tbody>
</table>

### Monday, March 27, 2017

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00 a.m. – 8:00 a.m.</td>
<td>Presenter Breakfast                                               BALLROOM A</td>
</tr>
<tr>
<td>7:30 a.m. – 5:00 p.m.</td>
<td>Registration                                           2ND FLOOR CONCOURSE</td>
</tr>
<tr>
<td>8:00 a.m. – 9:00 a.m.</td>
<td>Spouse and Guest Breakfast                                         MARRIOTT – MEETING ROOM 4</td>
</tr>
<tr>
<td></td>
<td>Spouse and Guest Hospitality Room Open                             MARRIOTT – MEETING ROOM 4</td>
</tr>
<tr>
<td>8:30 a.m. – 12:00 p.m.</td>
<td>S13: Input Filter Interactions with Switching Regulators        ROOM 13/14</td>
</tr>
<tr>
<td>8:30 a.m. – 12:00 p.m.</td>
<td>S14: SiC Power Devices and MV Power Converter Applications      ROOM 15/16</td>
</tr>
<tr>
<td>8:30 a.m. – 12:00 p.m.</td>
<td>S15: Current-Mode-Control Modeling – 3 Decades of Progress        ROOM 18/19</td>
</tr>
<tr>
<td>8:30 a.m. – 12:00 p.m.</td>
<td>S16: Google Little Box Reloaded: How to Achieve 200W/in³ &amp; Beyond? Concepts – Evaluation – Barriers – Future ROOM 24/25</td>
</tr>
<tr>
<td>8:30 a.m. – 12:00 p.m.</td>
<td>S17: Design for Reliability: From Components to Systems          ROOM 20/21</td>
</tr>
<tr>
<td>8:30 a.m. – 12:00 p.m.</td>
<td>S18: High Frequency Planar Magnetics for Power Conversion        ROOM 22/23</td>
</tr>
<tr>
<td></td>
<td>Spouse and Guest Tour “St. Pete Chihuly Collection and Glassblowing Demonstration” departs (Registration Required) MARRIOTT – MEETING ROOM 4</td>
</tr>
<tr>
<td></td>
<td>Opening Plenary Session                                               BALLROOM B/C</td>
</tr>
</tbody>
</table>

*Please check for updates on APEC Mobile App.*
### Tuesday, March 28, 2017

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>T01</td>
<td>Soft-switching DC-DC Converters</td>
<td>8:30 a.m. – 12:00 p.m.</td>
<td>Room 1/2</td>
</tr>
<tr>
<td>T02</td>
<td>AC-DC Converters I</td>
<td>8:30 a.m. – 12:00 p.m.</td>
<td>Room 18/19</td>
</tr>
<tr>
<td>T03</td>
<td>Multilevel Converters for Utility Applications</td>
<td>8:30 a.m. – 12:00 p.m.</td>
<td>Room 20</td>
</tr>
<tr>
<td>T04</td>
<td>Control of Motor Drives I</td>
<td>8:30 a.m. – 12:00 p.m.</td>
<td>Room 21</td>
</tr>
<tr>
<td>T05</td>
<td>Power Device Performance &amp; Gate Drivers</td>
<td>8:30 a.m. – 12:00 p.m.</td>
<td>Room 22</td>
</tr>
<tr>
<td>T06</td>
<td>Control of DC-DC Converters</td>
<td>8:30 a.m. – 12:00 p.m.</td>
<td>Room 23</td>
</tr>
<tr>
<td>T07</td>
<td>Converters for Renewable Energy</td>
<td>8:30 a.m. – 12:00 p.m.</td>
<td>Room 24</td>
</tr>
<tr>
<td>T08</td>
<td>Lower Power Applications</td>
<td>8:30 a.m. – 12:00 p.m.</td>
<td>Room 25</td>
</tr>
<tr>
<td>IS01</td>
<td>High Frequency Magnetics – Transforming the Black Magic to Engineering</td>
<td>8:30 a.m. – 11:55 a.m.</td>
<td>Room 15/16</td>
</tr>
<tr>
<td>IS02</td>
<td>Component, Reliability and Manufacturing Innovations for 3D Power Packaging</td>
<td>8:30 a.m. – 11:55 a.m.</td>
<td>Room 14</td>
</tr>
<tr>
<td>IS03</td>
<td>Electric Vehicles, Aerospace &amp; Other Harsh Environments</td>
<td>8:30 a.m. – 11:55 a.m.</td>
<td>Room 13</td>
</tr>
<tr>
<td>IS04</td>
<td>PMBus Implementation and Applications</td>
<td>8:30 a.m. – 11:55 a.m.</td>
<td>Room 11</td>
</tr>
</tbody>
</table>

### Wednesday, March 29, 2017

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>R01</td>
<td>Power Electronic Topologies — Do We Need More or Any Benefit to Others?</td>
<td>5:00 p.m. – 6:30 p.m.</td>
<td>Room 15/16</td>
</tr>
<tr>
<td>R02</td>
<td>Do We Need to Progress Towards GHz Switching in High Power Systems and Applications</td>
<td>5:00 p.m. – 6:30 p.m.</td>
<td>Room 18/19</td>
</tr>
<tr>
<td>R03</td>
<td>3D Printing and Power Supply on Chip (PwrSoC)/Power Supply in Package (PSIP) vs. Discrete Designs</td>
<td>5:00 p.m. – 6:30 p.m.</td>
<td>Room 20/21</td>
</tr>
<tr>
<td>KEY</td>
<td>S = Professional Education Seminars</td>
<td>R = Rap Sessions</td>
<td>IS = Industry Sessions D = Dialogue Sessions</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------</td>
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<td>-------------------------------------------</td>
</tr>
<tr>
<td>IS06</td>
<td>Regulatory and Compliance Considerations for Power Electronics</td>
<td>8:30 a.m. – 10:10 a.m.</td>
<td>ROOM 14</td>
</tr>
<tr>
<td>IS07</td>
<td>Offline Power Supplies</td>
<td>8:30 a.m. – 10:10 a.m.</td>
<td>ROOM 13</td>
</tr>
<tr>
<td>IS08</td>
<td>Transactive Energy and the Electric Power Grid</td>
<td>8:30 a.m. – 10:10 a.m.</td>
<td>ROOM 11</td>
</tr>
<tr>
<td>T09</td>
<td>High Power AC-DC Converters</td>
<td>8:30 a.m. – 10:10 a.m.</td>
<td>ROOM 1/2</td>
</tr>
<tr>
<td>T10</td>
<td>Non-isolated DC-DC Converters</td>
<td>8:30 a.m. – 10:10 a.m.</td>
<td>ROOM 18/19</td>
</tr>
<tr>
<td>T11</td>
<td>Power Converter Topologies</td>
<td>8:30 a.m. – 10:10 a.m.</td>
<td>ROOM 20</td>
</tr>
<tr>
<td>T12</td>
<td>Power Device Reliability</td>
<td>8:30 a.m. – 10:10 a.m.</td>
<td>ROOM 21</td>
</tr>
<tr>
<td>T13</td>
<td>Design Optimization for High Reliability</td>
<td>8:30 a.m. – 10:10 a.m.</td>
<td>ROOM 22</td>
</tr>
<tr>
<td>T14</td>
<td>Reliability</td>
<td>8:30 a.m. – 10:10 a.m.</td>
<td>ROOM 23</td>
</tr>
<tr>
<td>T15</td>
<td>Batteries for Renewable Energy</td>
<td>8:30 a.m. – 10:10 a.m.</td>
<td>ROOM 24</td>
</tr>
<tr>
<td>T16</td>
<td>LED Applications</td>
<td>8:30 a.m. – 10:10 a.m.</td>
<td>ROOM 25</td>
</tr>
<tr>
<td></td>
<td>Exhibit Hall Open</td>
<td>10:00 a.m. – 2:00 p.m.</td>
<td>EXPOSITION (WEST/EAST HALL)</td>
</tr>
<tr>
<td></td>
<td>Exhibitor Seminars – Session #5 (Concurrent Sessions)</td>
<td>10:30 a.m. – 11:00 a.m.</td>
<td>SEE PAGE 188</td>
</tr>
<tr>
<td></td>
<td>Exhibitor Seminars – Session #6 (Concurrent Sessions)</td>
<td>11:15 a.m. – 11:45 a.m.</td>
<td>SEE PAGE 191</td>
</tr>
<tr>
<td></td>
<td>Exhibitor Seminars – Session #7 (Concurrent Sessions)</td>
<td>12:00 p.m. – 12:30 p.m.</td>
<td>SEE PAGE 194</td>
</tr>
<tr>
<td>IS09</td>
<td>Silicon and WBG Power Devices for High Frequency Topologies</td>
<td>2:00 p.m. – 5:25 p.m.</td>
<td>ROOM 15/16</td>
</tr>
<tr>
<td>IS10</td>
<td>Server Power Topics</td>
<td>2:00 p.m. – 5:25 p.m.</td>
<td>ROOM 14</td>
</tr>
<tr>
<td>IS11</td>
<td>Vehicle Electrification – Not just the Powertrain</td>
<td>2:00 p.m. – 5:25 p.m.</td>
<td>ROOM 13</td>
</tr>
<tr>
<td>IS12</td>
<td>IGBTs / Gate Drives</td>
<td>2:00 p.m. – 5:25 p.m.</td>
<td>ROOM 11</td>
</tr>
<tr>
<td>T17</td>
<td>High Frequency DC-DC Converters</td>
<td>2:00 p.m. – 5:30 p.m.</td>
<td>ROOM 1/2</td>
</tr>
<tr>
<td>T18</td>
<td>Magnetics</td>
<td>2:00 p.m. – 5:30 p.m.</td>
<td>ROOM 18/19</td>
</tr>
<tr>
<td>T19</td>
<td>Multilevel Converters</td>
<td>2:00 p.m. – 5:30 p.m.</td>
<td>ROOM 20</td>
</tr>
<tr>
<td>T20</td>
<td>Grid-Connected Inverter Control</td>
<td>2:00 p.m. – 5:30 p.m.</td>
<td>ROOM 21</td>
</tr>
<tr>
<td>T21</td>
<td>Device Modeling &amp; Simulation</td>
<td>2:00 p.m. – 5:30 p.m.</td>
<td>ROOM 22</td>
</tr>
<tr>
<td>T22</td>
<td>Control Strategies for Inverters &amp; Motor Drives</td>
<td>2:00 p.m. – 5:30 p.m.</td>
<td>ROOM 23</td>
</tr>
<tr>
<td>T23</td>
<td>Renewable Energy System Considerations</td>
<td>2:00 p.m. – 5:30 p.m.</td>
<td>ROOM 24</td>
</tr>
<tr>
<td>T24</td>
<td>Medium/High Power Applications</td>
<td>2:00 p.m. – 5:30 p.m.</td>
<td>ROOM 25</td>
</tr>
<tr>
<td></td>
<td>“Little Havana” Evening Social Event (Ticket Required)</td>
<td>7:00 p.m. – 10:00 p.m.</td>
<td>CURTIS HIXON WATERFRONT PARK</td>
</tr>
</tbody>
</table>

**Thursday, March 30, 2017**

- Presenter Breakfast | 7:00 a.m. – 8:00 a.m. | BALLROOM A
- Registration | 8:00 a.m. – 12:00 p.m. | 2ND FLOOR CONCOURSE
- Spouse and Guest Breakfast | 8:00 a.m. – 9:00 a.m. | MARRIOTT – MEETING ROOM 4
- Spouse and Guest Hospitality Room Open | 8:00 a.m. – 11:00 a.m. | MARRIOTT – MEETING ROOM 4
- IS13: GaN Topics and Applications | 8:30 a.m. – 11:30 a.m. | ROOM 15/16
- IS14: Isolation Barrier Technologies for Power Electronics | 8:30 a.m. – 11:30 a.m. | ROOM 14
- IS15: Industrial Power Applications of Silicon Carbide Semiconductors | 8:30 a.m. – 11:30 a.m. | ROOM 13
- IS16: Energy Harvesting | 8:30 a.m. – 11:30 a.m. | ROOM 11
- T25: DC-DC Converter Applications | 8:30 a.m. – 11:20 a.m. | ROOM 1/2
<table>
<thead>
<tr>
<th>KEY</th>
<th>S = Professional Education Seminars</th>
<th>R = Rap Sessions</th>
<th>IS = Industry Sessions</th>
<th>T = Technical Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>T26</td>
<td>Renewable Energy Using Advanced Devices</td>
<td>8:30 a.m. – 11:20 a.m.</td>
<td>ROOM 18/19</td>
<td></td>
</tr>
<tr>
<td>T27</td>
<td>Power Modules</td>
<td>8:30 a.m. – 11:20 a.m.</td>
<td>ROOM 20</td>
<td></td>
</tr>
<tr>
<td>T28</td>
<td>Packaging Innovation for High Reliability</td>
<td>8:30 a.m. – 11:20 a.m.</td>
<td>ROOM 21</td>
<td></td>
</tr>
<tr>
<td>T29</td>
<td>Systems &amp; Components Modeling &amp; Simulation</td>
<td>8:30 a.m. – 11:20 a.m.</td>
<td>ROOM 22</td>
<td></td>
</tr>
<tr>
<td>T30</td>
<td>Control of Motor Drives II</td>
<td>8:30 a.m. – 11:20 a.m.</td>
<td>ROOM 23</td>
<td></td>
</tr>
<tr>
<td>T31</td>
<td>DC-DC Conversion &amp; Other Transportation Applications</td>
<td>8:30 a.m. – 11:20 a.m.</td>
<td>ROOM 24</td>
<td></td>
</tr>
<tr>
<td>T32</td>
<td>Power Electronic Applications</td>
<td>8:30 a.m. – 11:20 a.m.</td>
<td>ROOM 25</td>
<td></td>
</tr>
<tr>
<td>D01</td>
<td>AC-DC Converters II</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D02</td>
<td>Miscellaneous Topics in DC-DC Converters I</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D03</td>
<td>Miscellaneous Topics in DC-DC Converters II</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D04</td>
<td>Power Electronics for Utility Interface</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D05</td>
<td>Operation &amp; Control of Motor Drives</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D06</td>
<td>Converter Topologies &amp; Control</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D07</td>
<td>Devices &amp; Reliability</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D08</td>
<td>Devices &amp; Components</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D09</td>
<td>Magnetic Components</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D10</td>
<td>Packaging &amp; Design Optimization</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D11</td>
<td>Component Modeling &amp; Simulation</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D12</td>
<td>Modeling and Analysis of Circuits &amp; Systems</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D13</td>
<td>Control for Power Electronics &amp; Energy Systems</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D14</td>
<td>DC Renewable Energy</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D15</td>
<td>AC Renewable Energy</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D16</td>
<td>Transportation Power Electronics</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D17</td>
<td>AC-DC, DC-AC, Grid and LED Applications</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>D18</td>
<td>Power Electronics Applications</td>
<td>11:30 a.m. – 2:00 p.m.</td>
<td>BALLROOM B/C</td>
<td></td>
</tr>
<tr>
<td>IS17</td>
<td>Silicon Carbide Device Applications</td>
<td>2:00 p.m. – 5:25 p.m.</td>
<td>ROOM 15/16</td>
<td></td>
</tr>
<tr>
<td>IS18</td>
<td>Capacitor Technologies for Evolving Power Electronic Applications</td>
<td>2:00 p.m. – 5:25 p.m.</td>
<td>ROOM 14</td>
<td></td>
</tr>
<tr>
<td>IS19</td>
<td>Circuits and Applications</td>
<td>2:00 p.m. – 5:25 p.m.</td>
<td>ROOM 13</td>
<td></td>
</tr>
<tr>
<td>IS20</td>
<td>Energy Management – Smart Microgrid</td>
<td>2:00 p.m. – 5:25 p.m.</td>
<td>ROOM 11</td>
<td></td>
</tr>
<tr>
<td>T33</td>
<td>Active Var &amp; Harmonic Compensation</td>
<td>2:00 p.m. – 5:30 p.m.</td>
<td>ROOM 1/2</td>
<td></td>
</tr>
<tr>
<td>T34</td>
<td>DC-DC Converter Control Methods</td>
<td>2:00 p.m. – 5:30 p.m.</td>
<td>ROOM 18/19</td>
<td></td>
</tr>
<tr>
<td>T35</td>
<td>Control Strategies for Power Converters</td>
<td>2:00 p.m. – 5:30 p.m.</td>
<td>ROOM 20</td>
<td></td>
</tr>
<tr>
<td>T36</td>
<td>Converter Modeling &amp; Analysis</td>
<td>2:00 p.m. – 5:30 p.m.</td>
<td>ROOM 21</td>
<td></td>
</tr>
<tr>
<td>T37</td>
<td>Control Applications</td>
<td>2:00 p.m. – 5:30 p.m.</td>
<td>ROOM 22</td>
<td></td>
</tr>
<tr>
<td>T38</td>
<td>Grid-Tied Renewable Energy</td>
<td>2:00 p.m. – 5:30 p.m.</td>
<td>ROOM 23</td>
<td></td>
</tr>
<tr>
<td>T39</td>
<td>High Power Charging &amp; Control Technology for Vehicular Power Systems</td>
<td>2:00 p.m. – 5:30 p.m.</td>
<td>ROOM 24</td>
<td></td>
</tr>
<tr>
<td>T40</td>
<td>Wireless Power Applications</td>
<td>2:00 p.m. – 5:30 p.m.</td>
<td>ROOM 25</td>
<td></td>
</tr>
</tbody>
</table>
General Information

Conference Location

Tampa Convention Center
333 S Franklin St
Tampa, FL 33602
Phone: +1-813-274-8511

APEC has several host hotels in the area which will be accommodating our participants.

> Tampa Marriott Waterside Hotel & Marina
700 S Florida Ave
Tampa, FL 33602
Phone: +1-813-221-4900

> Embassy Suites by Hilton Tampa Downtown Convention Center
513 S Florida Ave
Tampa, FL 33602
Phone: +1-813-769-8300

> Sheraton Tampa Riverwalk
200 N Ashley Dr
Tampa, FL 33602
Phone: +1-813-223-2222

Transportation

AREA AIRPORT
Tampa International Airport – TPA
Distance: 8 miles from Tampa Convention Center and APEC hotels.
Estimated taxi fare: $30.00-$35.00 USD (one way)
Alternate transportation: Super Shuttle, Uber and Lyft.

PARKING
There are numerous parking options throughout downtown Tampa and at/near the Tampa Convention Center. The following link shows you all of the parking options and rates for Tampa.

http://www.tampagov.net/parking

The closest lots for the convention center are: the Tampa Convention Center Garage and the South Regional Parking Garage.

Parking is also available at all (3) APEC hotels for $24.00 USD per night at each hotel.

GETTING AROUND TOWN
Visit your hotel concierge desk or the visitors desk at the convention center for details regarding the numerous ways to get around town. To include the TECO Line Street Car, Water Taxi, Coast Bike, and The Downtowner.

Conference Registration

In order to participate in the APEC 2017 Conference you must be registered. Prepaid conference registration is required for the professional educational seminars, presentation sessions and dialogue sessions.

To register or pick up your conference materials please visit the APEC Registration Center at the Tampa Convention Center (2nd Floor Concourse).

Saturday, March 25 ................. 4:00 p.m. – 7:00 p.m.
Sunday, March 26 ................. 8:00 a.m. – 5:00 p.m.
Monday, March 27 ................. 7:30 a.m. – 5:00 p.m.
Tuesday, March 28 ................. 7:30 a.m. – 5:00 p.m.
Wednesday, March 29 ............ 8:00 a.m. – 3:00 p.m.
Thursday, March 30 .............. 8:00 a.m. – 12:00 p.m.
Information for Presenters

Professional Education Seminar Presenters:
Breakfast will be provided for you the morning of your presentation. You should attend the breakfast only on the morning of your seminar. During breakfast, you will receive brief instructions from the Professional Education Seminar Chairs.

> Professional Education Seminar Presenter Breakfast
LOCATION: Ballroom A, Tampa Convention Center
DAY/TIME: Sunday at 8:00 a.m. and Monday at 7:00 a.m.

Industry Sessions and the Oral Technical Session Presenters:
You must attend a mandatory breakfast on the morning of your session. The Program Chair will host this breakfast at which you will be given your speaker ribbon and provided instructions. Immediately after breakfast you will be able to review your previously uploaded presentation with your session chair.

> Industry and Oral Technical Session Presenter Breakfast
LOCATION: Ballroom A, Tampa Convention Center
DAY/TIME: Tuesday-Thursday at 7:00 a.m.

Dialogue Technical Session Presenters:
You must attend a mandatory breakfast on the morning of your session. During breakfast you will receive brief instructions and will be able to mount your presentation on the poster boards in the room next door after the breakfast. Thumb tacks will be provided.

> Dialogue Technical Session Presenter Breakfast
LOCATION: Ballroom A, Tampa Convention Center
DAY/TIME: Thursday at 7:00 a.m.

Speaker Ready Room:
The Speaker Ready room is available to Professional Education Seminar, Industry Session and Oral Technical Session speakers should you need to review your presentation in advance of your session or make any edits.

LOCATION: Room 4, Tampa Convention Center
HOURS:
Sunday, March 26 . . . . . . . . . . . . . . . . . . 8:00 a.m. – 5:00 p.m.
Monday, March 27 . . . . . . . . . . . . . . . . . 7:30 a.m. – 5:00 p.m.
Tuesday, March 28 . . . . . . . . . . . . . . . . . 7:30 a.m. – 5:00 p.m.
Wednesday, March 29 . . . . . . . . . . . . . . 7:30 a.m. – 5:00 p.m.
Thursday, March 30 . . . . . . . . . . . . . . . . . 7:30 a.m. – 12:00 p.m.

Purchasing of Conference Proceedings and Seminar Workbooks

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

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

Conference Proceedings & Seminars on USB Payment Policy

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 a U.S. bank). Checks and money orders returned unpaid will be assessed and an additional handling charge of $50.00 USD.

A LIMITED NUMBER of copies of the Conference Proceedings and Seminar Workbooks may be available for sale at the Conference Registration Center, starting at 12:00 p.m. on Wednesday, March 29.

<table>
<thead>
<tr>
<th>On-site</th>
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</thead>
<tbody>
<tr>
<td>Conference Proceedings (USB Only)</td>
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<tr>
<td>Seminar Workbook (USB only)</td>
</tr>
</tbody>
</table>

Publications purchased can be picked up at the registration desk.

> PURCHASING THROUGH THE IEEE
Post conference APEC Proceedings may be purchased through the IEEE.

> IEEE Single Copy Sales
445 Hoes Lane
Piscataway, New Jersey 08854 USA
P: +1-800-678-4333 (USA & Canada) or +1-732-981-0060
Web site: http://shop.ieee.org/ieeestore/
Showcase Policy – NO SUITCASING!

Please note that while all meeting attendees are invited to the showcase, any attendee who is observed to be soliciting business in the aisles or other public spaces, in another company’s booth, or in violation of any portion of the Exhibition Policy, will be asked to leave immediately. Additional penalties may be applied. Please report any violations you may observe to Show Management. Show Management recognizes that suitcasing may also take the form of commercial activity conducted from a hotel guest room or hospitality suite; a restaurant, club, or any other public place of assembly. For the purposes of this policy, suitcasing violations may occur at venues other than the exhibition floor and at other events. Show Management must be informed of any hospitality suites, and expressed consent must be received prior to the event.

No Recruiting! No Recruiters!

IEEE Policy #10.1.24 prohibits recruiting at IEEE sponsored conferences. Consequently, recruiters and recruiting advertisements will not be permitted in the APEC 2017 hotel space, meeting facilities or Exhibit Hall.

Distributing Commercial Material at APEC

Rules For Non-Exhibitors

Distribution of commercial material in the APEC 2017 hotel space (including directly to the hotel rooms of APEC participants), meeting space and Exhibit Halls by people or organizations not participating in the Exposition is prohibited.

APEC reserves the right to remove without notice any materials not in compliance with this policy.

Rules For Exhibitors

Exhibitors may only distribute commercial materials in their booth, at Exhibitor Seminars they are conducting and at press conferences they are holding. APEC reserves the right to remove without notice any materials not in compliance with this policy.

Important Rules, Notices, & Conference Policies

Registration Cancellation & Refund Policy

All registrations sent by mail or fax must include payment. Payment methods include credit card, check or money order. Checks may be personal, business or certified. Checks and money orders must be payable in United States dollars and drawn on a United States bank. Accepted credit cards: Master Card, Visa and American Express. Please do not send cash. Checks and money orders returned unpaid or credit card payments for which payment was refused will be assessed an additional handling charge of $50.00 USD.

Registrations must be submitted by March 24, after March 24 you must register on-site.

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 February 17, 2017. All refunds will be processed after the conclusion of the conference and will be subject to a $50.00 USD processing fee.

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

Badges Required for Admission

Badges are required for admission to all APEC events and activities. Badges are obtained by registering with the conference. APEC reserves the right to deny admission to any APEC event or activity to any person not showing an appropriate badge for that activity or event.

Recording & Photography at APEC

Video and audio recording may be conducted in the Exhibit area, the MicroMouse contest, and public areas of APEC, but nowhere else except with written permission from the Conference Chair.

Still photography at APEC is permitted, but with limitations. The general principle is that people may be photographed but photographing presentations and other content is prohibited unless permission from the presenter(s) is obtained in advance. For more details, please see show management.
Privacy Policy

Information Provided During Registration
Contact information, which includes your name, affiliation, and mailing address, may be provided upon request to any partners and/or supporting publication participating in the APEC 2017 Exposition. In addition APEC may use the information you provide to contact you with information about APEC 2017 or any future APEC. No other use will be made of the information you provide. Your information will not be sold, distributed, leased or provided to any other person or organization except as described above.

Information Provided Other Than Through Registration
People who provide their names to APEC through the APEC Web site, direct contact, submitting a digest, volunteering to review or in any way other than registering for the conference, will not have their names and contact information distributed to any one or any organization, including APEC’s sponsors. APEC will use the contact information only for transmitting information related to APEC. Conference registrants names and contact information, including name, affiliation, and mailing address will be provided to the exhibitors and media partners. Emails will only be provided to exhibitors through the Lead Retrieval systems used on the show floor. Registering for APEC gives permission for your name and contact information to be provided to the exhibitors and media partners and for the exhibitors and media partners to contact you during or after the conference. APEC will not otherwise distribute names and contact information received through the registration process.

Conference Highlights

Plenary Session
APEC 2017 Plenary Session is designed to cover the history of power, the current needs in energy efficiency and the future possibilities. The plenary is made up of six presentations from respected industry leaders. Each presentation is 30 minutes in length and allows for interactive Q&A at the end of each presentation.

Professional Education Seminars
This year APEC will offer 18 Professional Education Seminars to take place on Sunday, March 26 and Monday, March 27. Seminars will be given within the following tracks: Design; SiC; Control; Components & Systems; EMI & Reliability; and Wireless Charging & Magnetics.

Technical Sessions
APEC professionals like you participated in a rigorous peer review process and have carefully picked over 500 papers making up APEC’s Technical Sessions. The review process highlights the most innovative technical solutions, and provides the highest quality possible. The technical program includes papers of broad appeal scheduled for oral presentation from Tuesday morning through Thursday afternoon. Papers with a more specialized focus are available for discussion with authors at the dialogue session on Thursday at 11:30 a.m. The various technical venues cover all areas of technical interest to the practicing power electronics professional. The papers are sure to give you many new design ideas that you can apply to your work immediately.

Industry Sessions
At APEC 2017, the Industry Sessions track continues to expand. This track runs in parallel with the traditional Technical Sessions Track. Speakers are invited to make a presentation only, without submitting a formal manuscript for the APEC Proceedings. This allows APEC to present information on current topics in power electronics from sources that would not otherwise be present at an industry conference. While many of these sessions are technical in nature, some also target business-oriented people such as purchasing agents, electronic system designers, regulatory engineers, and other people who support the power electronics industry.
Rap Sessions

We have three exciting and contentious topics lined up for this year. Rap sessions allow for exciting dialogue amongst attendees and presenters. Admission to all Rap Sessions is free with an Exhibits Only Registration and free refreshments will be available.

Exhibitor Seminars & Exposition

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

Entrance to the Exhibition is open to all conference attendees, including holders of the free Exhibits Only registration!

MicroMouse Contest

APEC will once again host the World-Famous APEC Micro-Mouse Competition, the only event of its kind in North America, drawing contestants from all over the world. The contest will take place at the Tampa Convention Center, in the Exposition, on the evening of Monday, March 27 starting at 8:00 p.m. All are welcome!

Conference Social Event

Escape to Little Havana! The APEC social event is sure to provide the perfect venue for you and your colleagues to relax, unwind and enjoy great food, entertainment, antique cars, games, and a cigar roller. Join us on Wednesday, March 29 at 7:00 p.m. at Curtis Hixon Waterfront Park located a short walk from the Tampa Convention Center and APEC hotels. Visit the APEC Registration desk for a walking map to the park. Limited bus transportation will also be available starting at 6:45 p.m. departing from the Tampa Convention Center. The event begins at 7:00 p.m. and food is available throughout the evening.

Young Professionals & Students Reception

(All Young Professionals and Students Welcome)

Sponsored by IEEE Power Electronics Society and Industrial Applications Society

LOCATION: Tampa Bay History Center

DAY/TIME: Tuesday, March 28, 6:30 p.m. – 8:30 p.m.

PELS and IAS Young Professionals invite students and young professionals to an evening of networking and fun. Interact with your fellow young professionals and leaders of industry and academia over food and drinks. For more details please visit http://www.ieee-pels.org/membership/student-members-and-young-professionals
Spouse & Guest Program

APEC welcomes the spouses and guests of the APEC conference participants into conference activities including the Plenary, Rap Sessions, the Exhibit Hall receptions and the MicroMouse Contest.

> Spouse and Guest Hospitality Room
Monday, March 27 – Thursday, March 30
8:00 a.m. – 11:00 a.m.

**Breakfast available 8:00 a.m. – 9:00 a.m.**
MEETING ROOM 4, TAMPA MARRIOTT WATERSIDE HOTEL & MARINA

Optional Tours

Registration is required for the following tours. If you did not register in advance, a few seats may still be available. Visit the APEC Registration desk at the Tampa Convention Center at least 2 hours before the tour to purchase tickets.

> ST. PETE CHIHULY COLLECTION AND GLASSBLOWING DEMONSTRATION

**DATE:** Monday, March 27
**COST:** $95.00 USD/per person
**TIME/LENGTH:** 10:00 a.m. – 4:30 p.m. (6.5 hour tour)

You will begin with a quick trip across the bay to beautiful downtown St Petersburg; an area quickly becoming an art meccca in the southeast. Your tour will take you through town and along the beautiful waterfront to the Morean Art Chihuly Collection in its new home on Central Ave. Chihuly is credited with transforming the methods of creating glass art, however his contributions extend well beyond the boundaries of the studio glass movement and even the field of glass: his achievements have influenced contemporary art in general. After enjoying this fine collection of Chihuly you will walk across the street to the Hot Shop where you will enjoy a glass blowing demonstration. This narrated demonstration enables you to better understand the skills of this fabulous art form.

**INCLUSIONS:**
Round-trip motor coach transportation with a professional tour guide
Lunch at the Parkshore Grille on Beach Drive
All admissions

> TREASURES OF TAMPA BY WATER AND LAND

**DATE:** Tuesday, March 28
**COST:** $85.00 USD/per person
**TIME/LENGTH:** 9:30 a.m. – 4:30 p.m. (7 hour tour)

Guests will begin their journey by land for a guided motor coach tour of the downtown area, across the Hillsborough River to see the Tampa landmark building, the former Tampa Bay Hotel where you’ll feel as if you’ve been transported back into the 1980’s. We’ll continue on by boarding the water taxi to explore coastline of Hillsborough Bay and the Hillsborough River where there are sometimes whales (manatees) and gators. We will disembark and after a brief stroll past the springs (formerly Tampa’s fresh water supply) step on board our motor coach and travel quickly into Ybor City, an important link in Tampa’s history and former Cigar Capital of the World. While in Ybor City guests will hear about this former hub of the Latin community with its vibrant cigar stories.

**INCLUSIONS:**
Round trip motor coach transportation with a professional tour guide
Lunch at the famous Columbia Restaurant in Ybor City
All admissions
### Sponsor Meetings

#### APEC Meetings

**Wednesday, March 29, 2017**

- **APEC 2017 Organizing/Steering Committee Luncheon**: 11:30 a.m. – 1:00 p.m., ROOM 10
- **APEC 2017 Steering Committee Meeting**: 1:00 p.m. – 2:30 p.m., ROOM 10

#### IAS Meetings

**Tuesday, March 28, 2017**

- **IEEE PELS/IAS Young Professional Reception**: 6:30 p.m. – 8:30 p.m., OFFSITE – TAMPA BAY HISTORY CENTER

#### PELS Meetings

**Sunday, March 26, 2017**

- **IEEE International Future Energy Challenge (IFEC) Workshop**: 8:00 a.m. – 6:00 p.m., ROOM 12
- **New Administrative Committee Member Training**: 12:00 p.m. – 2:00 p.m., ROOM 7
- **FEPPCON Organizing Committee Meeting**: 2:00 p.m. – 3:30 p.m., ROOM 6
- **PELS Constitution and Bylaws Committee**: 5:00 p.m. – 6:00 p.m., ROOM 6

**Monday, March 27, 2017**

- **ITRW Meetings**: 8:00 a.m. – 1:00 p.m., ROOM 9
- **ETTC Electronics Transformers Technical Committee**: 8:30 a.m. – 12:00 p.m., ROOM 6
- **IEEE PELS Chapter Officer’s Forum & Membership Meeting (Students/Liaisons & Chapter Chairs)**: 9:00 a.m. – 1:30 p.m., ROOM 7
- **PELS Technical Committee Chair Lunch**: 12:00 p.m. – 1:00 p.m., ROOM 5

**Tuesday, March 28, 2017**

- **WIE Breakfast**: 8:00 a.m. – 9:00 a.m., ROOM 12
- **PELS Digital Media and Education Committee Meeting**: 9:00 a.m. – 10:00 a.m., ROOM 5
- **PELS Standards Committee Meeting**: 9:00 a.m. – 12:30 p.m., ROOM 7
- **PELS Southern Conference Steering Committee (SPEC)**: 9:00 a.m. – 10:00 a.m., ROOM 6
- **PELS Exec & CPSS Team Meeting**: 10:00 a.m. – 11:00 a.m., ROOM 9
- **PELS TC6 – High Performance and Emerging Technologies**: 10:30 a.m. – 12:00 p.m., ROOM 6
- **PELS Fellows Committee (Members Only)**: 12:00 p.m. – 1:00 p.m., ROOM 7
- **PELS TC1 – Power and Control Core Technologies**: 12:00 p.m. – 2:00 p.m., ROOM 9
- **PELS Humanitarian Adhoc Committee**: 1:30 p.m. – 3:00 p.m., ROOM 6
- **PELS TC2 – Power Conversion Systems and Components**: 2:00 p.m. – 4:00 p.m., ROOM 5
- **PEDG Steering Committee Meeting**: 3:00 p.m. – 4:00 p.m., ROOM 6
- **PELS Vehicle and Transportation Systems Meeting**: 3:00 p.m. – 4:00 p.m., ROOM 7
- **PELS TC3 – Motor Drives and Actuators**: 5:30 p.m. – 6:30 p.m., ROOM 7
- **PELS Industry Board and Magazine Advisory Meeting (Members Only)**: 5:30 p.m. – 7:00 p.m., ROOM 6

*All meetings held at the Tampa Convention Center unless otherwise indicated.*
# Conference and Exposition

**Tuesday, March 28, 2017 (continued)**

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
<th>Location</th>
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<tbody>
<tr>
<td>IEEE PELS/IAS Young Professional Reception</td>
<td>6:30 p.m. – 8:30 p.m.</td>
<td>OFFSITE – TAMPA BAY HISTORY CENTER</td>
</tr>
<tr>
<td>PELS TC5 – Sustainable Energy Technical Committee</td>
<td>6:30 p.m. – 7:30 p.m.</td>
<td>ROOM 12</td>
</tr>
<tr>
<td>PELS Industry Board and Magazine Advisory Dinner</td>
<td>7:30 p.m. – 10:00 p.m.</td>
<td>OFFSITE – TBD</td>
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**Wednesday, March 29, 2017**

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<thead>
<tr>
<th>Event</th>
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<th>Location</th>
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<tbody>
<tr>
<td>PELS Exec Team Meeting FinCom</td>
<td>9:00 a.m. – 10:00 a.m.</td>
<td>ROOM 6</td>
</tr>
<tr>
<td>PELS Editorial Board – IEEE Transactions on Power Electronics</td>
<td>11:30 a.m. – 1:30 p.m.</td>
<td>ROOM 12</td>
</tr>
<tr>
<td>PELS Technical Operations</td>
<td>1:30 p.m. – 3:30 p.m.</td>
<td>ROOM 12</td>
</tr>
<tr>
<td>PELS Products Committee</td>
<td>3:30 p.m. – 6:30 p.m.</td>
<td>ROOM 12</td>
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**Thursday, March 30, 2017**

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
<th>Location</th>
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<tbody>
<tr>
<td>PELS Conference Committee Breakfast</td>
<td>8:00 a.m. – 9:00 a.m.</td>
<td>ROOM 5</td>
</tr>
<tr>
<td>PELS Conference Committee Meeting</td>
<td>9:00 a.m. – 12:00 p.m.</td>
<td>ROOM 12</td>
</tr>
<tr>
<td>eT&amp;D Steering Committee Meeting</td>
<td>12:00 p.m. – 1:30 p.m.</td>
<td>ROOM 5</td>
</tr>
<tr>
<td>PELS JESTPE Editorial Board Meeting</td>
<td>2:00 p.m. – 4:00 p.m.</td>
<td>ROOM 5</td>
</tr>
<tr>
<td>PELS Administrative Committee Dinner</td>
<td>6:00 p.m. – 9:30 p.m.</td>
<td>OFFSITE – JACKSON’S BISTRO</td>
</tr>
</tbody>
</table>

**Friday, March 31, 2017**

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>PELS Administrative Committee Breakfast (Companions Welcome)</td>
<td>8:00 a.m. – 9:00 a.m.</td>
<td>MARRIOTT – FLORIDA BALLROOM IV</td>
</tr>
<tr>
<td>PELS Administrative Committee Meeting</td>
<td>9:00 a.m. – 3:00 p.m.</td>
<td>MARRIOTT – FLORIDA BALLROOM VI</td>
</tr>
<tr>
<td>PELS Administrative Committee Lunch (Companions Welcome)</td>
<td>11:30 a.m. – 12:30 p.m.</td>
<td>MARRIOTT – FLORIDA BALLROOM IV</td>
</tr>
</tbody>
</table>

**PSMA Meetings**

**Saturday, March 25, 2017**

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSMA/PELS Workshop on High Frequency Magnetics</td>
<td>7:00 a.m. – 5:00 p.m.</td>
<td>ROOM 15/16</td>
</tr>
</tbody>
</table>

**Monday, March 27, 2017**

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSMA Annual Meeting - followed by March BoD Meeting</td>
<td>7:30 a.m. – 1:00 p.m.</td>
<td>ROOM 10/11</td>
</tr>
</tbody>
</table>

**Tuesday, March 28, 2017**

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSMA Industry-Education / APEC Travel Support Committee Meeting</td>
<td>9:00 a.m. – 10:00 a.m.</td>
<td>ROOM 32</td>
</tr>
<tr>
<td>PSMA Semiconductor Committee Meeting</td>
<td>10:00 a.m. – 12:00 p.m.</td>
<td>ROOM 33</td>
</tr>
<tr>
<td>PSMA Marketing Committee Meeting</td>
<td>12:00 p.m. – 2:00 p.m.</td>
<td>ROOM 33</td>
</tr>
<tr>
<td>PSMA Power Technology Roadmap Committee Meeting</td>
<td>12:00 p.m. – 2:00 p.m.</td>
<td>ROOM 32</td>
</tr>
<tr>
<td>PSMA Transportation Power Electronics Committee Meeting</td>
<td>2:00 p.m. – 4:00 p.m.</td>
<td>ROOM 33</td>
</tr>
<tr>
<td>PSMA Energy Efficiency/ Alternative Committee Meeting</td>
<td>2:00 p.m. – 4:00 p.m.</td>
<td>ROOM 32</td>
</tr>
</tbody>
</table>

**Wednesday, March 29, 2017**

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSMA Magnetics Committee Meeting</td>
<td>8:00 a.m. – 10:00 a.m.</td>
<td>ROOM 33</td>
</tr>
<tr>
<td>PSMA Energy Harvesting Committee Meeting</td>
<td>8:00 a.m. – 10:00 a.m.</td>
<td>ROOM 32</td>
</tr>
<tr>
<td>PSMA Capacitor Committee Meeting</td>
<td>10:00 a.m. – 12:00 p.m.</td>
<td>ROOM 33</td>
</tr>
<tr>
<td>PSMA Power Electronics Packaging Committee Meeting</td>
<td>10:00 a.m. – 12:00 p.m.</td>
<td>ROOM 33</td>
</tr>
<tr>
<td>PSMA Safety &amp; Compliance Committee Meeting</td>
<td>1:00 p.m. – 3:00 p.m.</td>
<td>ROOM 32</td>
</tr>
</tbody>
</table>
Conference Program
Sunday
March 26, 2017

8:00 a.m. – 5:00 p.m.

Registration
2ND FLOOR CONCOURSE

8:00 a.m. – 9:00 a.m.

Presenter Breakfast
BALLROOM A

9:30 a.m. – 1:00 p.m.

Professional Education Seminars
(for detailed information see page 113)

S01: Bidirectional DC-DC Converters: Fundamentals and Advances
Zhe Zhang, Riccardo Pittini
Technical University of Denmark, Denmark
ROOM 13/14

S02: Silicon Carbide MOSFETs – A Deep Dive to Accelerate Your Next Power Converter Design
Sujit Banerjee, Kevin Matocha, Xuning Zhang
Monolith Semiconductor INC., United States
ROOM 15/16

S03: Direct Digital Design of Compensators for Power Electronics Control
Hamish Laird
ELMG Digital Power Inc, United States
ROOM 18/19

S04: High Power Si and SiC Module Technology and Application Considerations
John Donlon, Eric Motto, Mike Rogers, Mark Steiner
Powerex, Inc., United States
ROOM 24/25

S05: EMI Causes, Measurement, and Reduction Techniques for Switch-Mode Power Converters
Michael Schutten
General Electric Global Research Center, United States
ROOM 20/21

S06: Practical Design of Wireless Electric Vehicles: Dynamic & Stationary Charging Technologies
Chun T. Rim
GIST, Korea, South
ROOM 22/23
Monday
March 27, 2017

7:00 a.m. – 8:00 a.m.

Presenter Breakfast
BALLROOM A

7:30 a.m. – 5:00 p.m.

Registration
2ND FLOOR CONCOURSE

8:00 a.m. – 9:00 a.m.

Spouse and Guest Breakfast
MARRIOTT – MEETING ROOM 4

8:00 a.m. – 11:00 a.m.

Spouse and Guest Hospitality Room Open
MARRIOTT – MEETING ROOM 4

8:30 a.m. – 12:00 p.m.

Professional Education Seminars
(for detailed information see page 121)

S13: Input Filter Interactions with Switching Regulators
Christophe Basso
ON Semiconductor, France
ROOM 13/14

S14: SiC Power Devices and MV Power Converter Applications
Subhashish Bhattacharyu, Victor Veliadis
North Carolina State University, United States
ROOM 15/16

S15: Current-Mode-Control Modeling – 3 Decades of Progress
Fred Lee
CPES-Virginia Tech, United States
ROOM 18/19
Johann W. Kolar, Dominik Neumayr, Dominik Bortis
Eidgenössische Technische Hochschule Zürich, Switzerland
ROOM 24/25

S17: Design for Reliability: From Components to Systems
Frede Blaabjerg, Francesco Iannuzzo, Huai Wang
Aalborg University, Denmark
ROOM 20/21

S18: High Frequency Planar Magnetics for Power Conversion
William Gerard Hurley¹, Ziwei Ouyang²
¹National University of Ireland, Ireland; ²Technical University of Denmark (DTU), Denmark
ROOM 22/23

10:00 a.m.
Spouse and Guest Tour “St. Pete Chihuly Collection and Glassblowing Demonstration” (Registration Required) departs
MARRIOTT – MEETING ROOM 4

1:30 p.m.–5:00 p.m.
Opening Plenary Session
(for detailed information see page 126)
BALLROOM B/C

1:30 p.m. – 2:00 p.m.
USB Power Delivery – Opportunity for Today and Tomorrow
Ahmad Bahai, TI, Chief Technologist and Sr. VP

2:00 p.m. – 2:30 p.m.
Empowering the Electronics Industry: A Power Technology Roadmap
Conor Quinn, Artesyn Embedded Technologies & PSMA, PSMA Power Technology Roadmap Co-Chair

2:30 p.m. – 3:00 p.m.
A Historical Perspective on the Development of the PWM Switch Model
Vatché Vorperian, Jet Propulsion Laboratory, Principal Engineer & Fellow of the IEEE

3:00 p.m. – 3:30 p.m.
Break

3:30 p.m. – 4:00 p.m.
Google 48V Power Architecture
Shuai Jiang, Google, Sr. DC-DC Power Architect for Data Centers
Xin Li, Google, Technical Lead Manager for Power Team

4:00 p.m. – 4:30 p.m.
The Gap Between High Power and Low Power Converters and How It Is Closing
Hamish Laird, ELMG Digital Power, Inc., CTO

4:30 p.m. – 5:00 p.m.
From SiC MOSFET Devices to MW-scale Power Converters
Ljubisa Stevanovic, GE Global Research, CTO Silicon Carbide Works

5:00 p.m.–8:00 p.m.
Exhibit Hall Welcome Reception
EXPOSITION (WEST/EAST HALL)

8:00 p.m.–10:00 p.m.
MicroMouse Contest
BACK OF EXPOSITION (WEST/EAST HALL)
Tuesday  
March 28, 2017

7:00 a.m. – 8:00 a.m.
Presenter Breakfast  
BALLROOM A

7:30 a.m. – 5:00 p.m.
Registration  
2ND FLOOR CONCOURSE

8:00 a.m. – 9:00 a.m.
Spouse and Guest Breakfast  
MARRIOTT – MEETING ROOM 4

8:00 a.m. – 11:00 a.m.
Spouse and Guest Hospitality Room Open  
MARRIOTT – MEETING ROOM 4

8:30 a.m. – 11:55 a.m.
IS01: High Frequency Magnetics – Transforming the Black Magic to Engineering  
ROOM 15/16

Session Chairs:
Ed Herbert, Independent  
Steve Carlsen, Raytheon

8:30 a.m. – 8:55 a.m.
IS01.1: Power Magnetics @ High Frequency Where We Are and Where We Need to Go  
Johann Kolar, Swiss Federal Institute of Technology, Switzerland

8:55 a.m. – 9:20 a.m.
IS01.2: New Materials and Design Tools for Magnetic Materials Suitable for GaN and SiC Switching Frequencies  
Christopher Oliver, Micrometals, Inc., United States

9:20 a.m. – 9:45 a.m.
IS01.3: Thin Amorphous Core Material for Power Applications  
Paul McCloskey, Santosh Kulkarni, Ansar Masood, Cian O’Mathuna, Tyndall National Institute, Ireland

9:45 a.m. – 10:10 a.m.
IS01.4: Core Loss Initiative: Technical  
Charles Sullivan, Dartmouth College, United States

10:40 a.m. – 11:05 a.m.
IS01.5: Introduction to the IMA Working Group  
Chuck Wilde, Dexter Magnetics, United States

11:05 a.m. – 11:30 a.m.
IS01.6: Magnetics Modeling in Spice: Proximity Loss  
Ray Ridley, Ridley Engineering, United States

11:30 a.m. – 11:55 a.m.
IS01.7: Core Loss Modeling  
Ed Herbert, Independent, United States

8:30 a.m. – 11:55 a.m.
IS02: Component, Reliability and Manufacturing Innovations for 3D Power Packaging  
ROOM 14

Session Chairs:
Ernie Parker, Crane Aerospace  
Brian Narveson, Independent

8:30 a.m. – 8:55 a.m.
IS02.1: Reliability of 3D Integrated Power Packaging  
Patrick McCluskey, University of Maryland, College Park, United States

8:55 a.m. – 9:20 a.m.
IS02.2: Innovations in Chip Embedding for Power Packaging  
Ct Chiu, ASE Global, Taiwan

9:20 a.m. – 9:45 a.m.
IS02.3: 3D Sip with Embedded Chip Supply Chain Integration  
Lee Smith1, Steve Anderson2, AT&S, United States; 2UTAC Group – United Test and Assembly Center, United States

9:45 a.m. – 10:10 a.m.
IS02.4: Development Challenges for DC-Link Capacitors for Wide Band Gap Semiconductor Applications  
John Bultitude, Kemet Corporation, United States

10:40 a.m. – 11:05 a.m.
IS02.5: Thin Film Inductors for Integrated Power Conversion  
Noah Sturcken, Ferric, Inc., United States

11:05 a.m. – 11:30 a.m.
IS02.6: Challenges and Considerations for 3D Packaging of Self-Powered IoT Devices  
Michael Hayes, Tyndall National Institute, Ireland
8:30 a.m. – 11:55 a.m.

**IS03: Electric Vehicles, Aerospace & Other Harsh Environments**
ROOM 13

**SESSION CHAIR:**
Pierric Gueguen, *Yole Developpement*
Indumini Ranmuthu, *Texas Instruments, Inc.*

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**IS03.1:** SiC and GaN Devices in High-Performance Harsh-Environment Applications: From Hybrid Electric-Turbo Chargers to Cryogenic Power Systems
Troy Beechner, *Mainstream Engineering, United States*

**IS03.2:** Are Power Electronics Ready for High Temperature?
Pierric Gueguen, *Yole Developpement, France*

**IS03.3:** HIL Prototyping of Intelligent Power Systems for More Electric Aircrafts
Shweta Sanjeev, Patrick Franks, *Microsemi, United States*

**IS03.4:** Powering Electric Motors on Airplanes with Variable Frequency Systems
Kaz Furmanczyk, *Crane Aerospace & Electronics, United States*

**IS03.5:** Extending Battery Life in Electric Buses with Supercapacitor Technology
Ramdev Kanapady, Kyle Kim, Jason Lee, *Eaton, United States*

**IS03.6:** Si vs SiC Power Modules in HEV Integration: A Cost Point of View
Elena Barbarini, *SystemPlus Consulting, France*

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8:30 a.m. – 11:55 a.m.

**IS04: PMBus Implementation and Applications**
ROOM 11

**SESSION CHAIRS:**
Ramesh Balasubramaniam, *Infineon Technologies*
Travis Summerlin, *Texas Instruments, Inc.*

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**IS04.1:** The Circle of Life: Using PMBus from Start to Finish
Ramesh Balasubramaniam, *PMBus & Infineon, United States*

**IS04.2:** PMBus Application Profiles for PoLs
Chris Eckhoff, *Maxim Integrated, United States*

**IS04.3:** Direct Format Usage for PMBus Data Transfer
Jeff Klaas, *Intersil Corp, United States*

**IS04.4:** Ericsson’s Config File Format and Loading Method for PMBus Devices
Björn Olsson, *Ericsson AB, Sweden*

**IS04.5:** Enabling In-Circuit Programming of Power Solutions via PMBus
Peter Miller, *Texas Instruments, United States*

**IS04.6:** Monitoring and Optimizing AC/DC Power Supply Performance for Different Applications using PMBus™
Chris Jones, *PMBus & Artesyn, United States*

**IS04.7:** Challenges and Solutions for Multi-Master / Multi-Slave PMBus Systems
Peter Miller, *Texas Instruments, United States*
8:30 a.m. – 12:00 p.m.

**T01: Soft-switching DC-DC Converters**

**ROOM 1/2**

**Track: DC-DC Converters**

**Session Chairs:**
Khurram Afridi, *University of Colorado Boulder*
Pradeep Shenoy, *Texas Instruments, Inc.*

8:30 a.m. – 8:50 a.m.

**T01.1: Sheppard-Taylor Isolated High Boost DC-DC Converter**
Andrii Chubootnote{2}, Yam Siwakotiootnote{1}, Dmitri Vinnikovootnote{2}, Frede Blaabjergootnote{1},\*Aalborg University, Denmark; \*Tallinn University of Technology, Estonia

8:50 a.m. – 9:10 a.m.

**T01.2: A Low-Cost Soft-Switching High Step-Up Flyback Converter with Stacked Output Cells**
Morteza Moosavi, Ajay Morya, Hamid A. Toliyat,\*Texas A&M University, United States

9:10 a.m. – 9:30 a.m.

**T01.3: Single-Stage Switched-Resonator Converter Topology with Wide Conversion Ratio for Volume-Sensitive Applications**
Alon Cervera, Shmuel Ben-Yaakov, Mor Mordechai Peretz,\*Ben-Gurion University of the Negev, Israel

9:30 a.m. – 9:50 a.m.

**T01.4: A Family of Resonant Two-Switch Boosting Switched-Capacitor Converter with ZVS Operation and a Wide Voltage-Gain Range**
Shouxiang Liootnote{1}, Yifei Zhengootnote{1}, Keyue Smedleyootnote{1}, Bin Wuootnote{2},\*University of California, Irvine, United States; \*University of Maryland, College Park, United States

9:50 a.m. – 10:10 a.m.

**T01.5: A LLC Type Resonant Converter based on PWM Voltage Quadrupler Rectifier with Wide Output Voltage**
Ming Shang, Haoyu Wang,\*ShanghaiTech University, China

10:40 a.m. – 11:00 a.m.

**T01.6: Three-Phase Isolated Soft-Switching DC-DC Converter with Secondary Phase Shift Modulation**
Tao Li, Rohit Suryadevara, Leila Parsa,\*Rensselaer Polytechnic Institute, United States

11:00 a.m. – 11:20 a.m.

**T01.7: Isolated Resonant Full-Bridge Converter with Magnetic Integration**
Stefano Sagginiootnote{2}, Osvaldo Zambettiootnote{1}, Roberto Rizzolattiootnote{2}, Alessandro Zafaranaootnote{1}, Paolo Sacconootnote{1},\*STMicroelectronics, Italy; \*Università degli Studi di Udine, Italy

11:20 a.m. – 11:40 a.m.

**T01.8: Analysis and Design of a Series Resonant Converter with Constant Current Input and Regulated Output Current**
Hongjie Wang, Tarak Saha, Regan Zane,\*Utah State University, United States

11:40 a.m. – 12:00 p.m.

**T01.9: Detailed Analysis of a Current-Doubler Rectifier for an LLC Resonant Converter with High Output Current**
Simon Nigschootnote{2}, Manfred Schlenkootnote{1}, Kurt Schenkootnote{2},\*Infineon Technologies AG, Germany; \*University of Applied Sciences NTB Buchs, Switzerland

8:30 a.m. – 12:00 p.m.

**T02: AC-DC Converters I**

**ROOM 18/19**

**Track: AC-DC Converters**

**Session Chair:**
Gerry Moschopoulos, \*Western University

8:30 a.m. – 8:50 a.m.

**T02.1: Adaptive Constant Power Control and Power Loss Analysis of a MHz GaN-based AC/DC Converter for Low Power Applications**
Chengcheng Yao, Yue Zhang, Xuan Zhang, He Li, Huanyu Chen, Jin Wang,\*Ohio State University, United States

8:50 a.m. – 9:10 a.m.

**T02.2: Adaptive Zero-Voltage-Switching Control and Hybrid Current Control for High Efficiency GaN-based MHz Totem-Pole PFC Rectifier**
Qingyun Huang, Ruiyang Yu, Alex Huang, Wensong Yu,\*North Carolina State University, United States

8:50 a.m. – 10:10 a.m.

**T02.3: A Conduction Band Control AC-DC Buck Converter for a High Efficiency and High Power Density Adapter**
Sangcheol Moon, Bonggeun Chung, Gwanbong Koo, Jason Guo, Laszlo Balogh,\*Fairchild Semiconductor, United States; \*Fairchild Semiconductor, Korea, South
<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:30 a.m. – 9:50 a.m.</td>
<td>T02.4: A Novel Simplified Variable On-Time Method for CRM Boost PFC Converter</td>
<td>Zhehui Guo, Xiaoyong Ren, Yu Wu, Zhi-Liang Zhang, Qianhong Chen, Nanjing University of Aeronautics and Astronautics, China</td>
</tr>
<tr>
<td>9:50 a.m. – 10:10 a.m.</td>
<td>T02.5: Digital Controller with Integrated Valley Switching Control for Light Load Efficiency and THD Improvements in PFC Converter</td>
<td>Hrishikesh Nene, Chen Jiang, Shamim Choudhury, Georgia Institute of Technology, United States; Texas Instruments Inc., United States</td>
</tr>
<tr>
<td>10:40 a.m. – 11:00 a.m.</td>
<td>T02.6: High-Frequency Isolated AC-DC Converter with Stacked Architecture</td>
<td>Seungbum Lim, Saurav Bandyopadhyay, David Perreault, Massachusetts Institute of Technology, United States; Texas Instruments Inc., United States</td>
</tr>
<tr>
<td>11:00 a.m. – 11:20 a.m.</td>
<td>T02.7: Analysis and Design Considerations for an Improved BCM Buck AC-DC LED Driver with High Output Voltage and Low Total Harmonic Distortion</td>
<td>Haijun Lv, Jinxu Yang, Xinke Wu, Zhejiang University, China</td>
</tr>
<tr>
<td>11:20 a.m. – 11:40 a.m.</td>
<td>T02.8: Multi-Phase Coupled and Integrated Inductors for Critical Conduction Mode Totem-Pole PFC Converter</td>
<td>Yuchen Yang, Zhengyang Liu, Fred C. Lee, Qiang Li, Virginia Polytechnic Institute and State University, United States</td>
</tr>
<tr>
<td>11:40 a.m. – 12:00 p.m.</td>
<td>T02.9: Universal Line Input Power Factor Preregulator using VFX Technique</td>
<td>Lei Gu, Wei Liang, Max Praglin, Sombuddha Chakraborty, Juan Rivas-Davila, Stanford University, United States; Texas Instruments Inc., United States</td>
</tr>
<tr>
<td>9:30 a.m. – 12:00 p.m.</td>
<td>T03: Multilevel Converters for Utility Applications</td>
<td></td>
</tr>
<tr>
<td>8:30 a.m. – 8:50 a.m.</td>
<td>T03.1: A Generalized Discontinuous PWM based Neutral Point Voltage Balancing Method for Three-Level NPC Voltage Source Inverter with Switching Losses Reduction</td>
<td>Kai Li, Min Wei, Chuan Xie, Fujin Deng, Josep M. Guerrero, Juan Carlos Vásquez, Aalborg University, Denmark; University of Electronic Science and Technology of China, China</td>
</tr>
<tr>
<td>8:50 a.m. – 9:10 a.m.</td>
<td>T03.2: Capacitor Voltage Balancing Control of Modular Multilevel Converters with Energy Storage System by using Carrier Phase-Shifted Modulation</td>
<td>Yajun Ma, Hua Lin, Zhe Wang, Tao Wang, Huazhong University of Science and Technology, China</td>
</tr>
<tr>
<td>9:10 a.m. – 9:30 a.m.</td>
<td>T03.3: Capacitor Voltage Ripple Reduction with State Trajectory Analysis for Modular Multilevel Converter</td>
<td>Yadong Lyu, Chen Li, Yi-Hsun Hsieh, Fred C. Lee, Qiang Li, Rong Xu, Virginia Polytechnic Institute and State University, United States</td>
</tr>
<tr>
<td>9:30 a.m. – 9:50 a.m.</td>
<td>T03.4: An Equivalent Power Test Scheme for Modular Multilevel Converters (MMCs)</td>
<td>Junsong Tang, Yafei Dong, Heya Yang, Wuhua Li, Xiangning He, Jun Ma, Guodong Chen, Ye Tian, Enxing Yang, Shanghai Electric, China; Zhejiang University, China</td>
</tr>
<tr>
<td>9:50 a.m. – 10:10 a.m.</td>
<td>T03.5: Unequal Damping of the Average Sub-Module Capacitor Voltages in Modular Multilevel Converters</td>
<td>Teja Bandaru, Tanmoy Bhattacharya, Dheeman Chatterjee, Indian Institute of Technology Kharagpur, India</td>
</tr>
<tr>
<td>10:40 a.m. – 11:00 a.m.</td>
<td>T03.6: Methodology of Reliability and Power Density Analysis of SST Topologies</td>
<td>Kuan Wang, Qin Lei, Chunhui Liu, Arizona State University, United States</td>
</tr>
</tbody>
</table>
11:00 a.m. – 11:20 a.m.
T03.7: **Modulation and Control of a Single-Stage HVDC/AC Solid State Transformer using Modular Multilevel Converter**
Ashish Kumar Sahoo, Ned Mohan, *University of Minnesota, United States*

11:20 a.m. – 11:40 a.m.
T03.8: **Analysis and Experimental Validation of a Modular Multilevel Converter with 3-Level T-Type Submodules**
Ashish Kumar Sahoo, Ned Mohan, *University of Minnesota, United States*

11:40 a.m. – 12:00 p.m.
T03.9: **Fault-Tolerant Operation of Multilevel Diode-Clamped Converters for a Device Open-Circuit Fault**
Aparna Saha, Ali Elrayyah, Marina Sital-Dahone, Yilmaz Sozer, *University of Akron, United States*

8:30 a.m. – 12:00 p.m.
**T04: Control of Motor Drives I**
ROOM 21

**Track: Motor Drives and Inverters**

**Session Chairs:**
Siavash Pakdelian, *University of Massachusetts Lowell*
Julia Zhang, *Oregon State University*

8:30 a.m. – 8:50 a.m.
T04.1: **Model Predictive Control for Permanent Magnet Synchronous Motor Drives Considering Cross-Saturation Effects**
Panagiotis Kakosimos2, Minos Beniakari1, Yushan Liu2, Haiitham Abu-Rub2, 1ABB, Sweden; 2Texas A&M University at Qatar, Qatar

8:50 a.m. – 9:10 a.m.
T04.2: **A Mini-Ripple Control Method for Doubly Salient Electromagnetic Motor Control System**
Wan Ying Jia2, Lan Xiao2, Deming Zhu1, 1Electronic Technology Institute, China; 2Nanjing University of Aeronautics and Astronautics, China

9:10 a.m. – 9:30 a.m.
T04.3: **New Sensorless Vector Control of PMSM by Discrete-Time Voltage Injection of PWM Carrier Frequency – Positive- and Negative-Phase Amplitudes Extraction Method**
Ryu Hosooka, Shinji Shinmaka, Naoto Nakamura, Kanagawa University, Japan

9:30 a.m. – 9:50 a.m.
T04.4: **A Novel Commutation Correction Method for High-Speed PM Brushless DC Motor**
Xiaqing Shi, Xiaolin Wang, Cong Gu, Zhiquan Deng, *Nanjing University of Aeronautics and Astronautics, China*

9:50 a.m. – 10:10 a.m.
T04.5: **Angle Compensation based Rotor Position Estimation for Sensorless Vector Control of the Permanent Magnet Synchronous Motor**
Jeevan Adhikari, Sanjib K Panda, *National University of Singapore, Singapore*

10:40 a.m. – 11:00 a.m.
T04.6: **Voltage Error Phase Locked Loop (PLL) based Model Adaptive Sensorless Vector Control Algorithm for Induction Motors**
Sadik Ozdemir1, Yilmaz Sozer1, Nurettin Umurkan2, 1University of Akron, United States; 2Yildiz Technical University, Turkey

11:00 a.m. – 11:20 a.m.
T04.7: **An Active Front-End V/Hz Induction Machine Drive with a Tiny DC Link Capacitor**
Mahima Gupta, Giri Venkataramanan, *University of Wisconsin–Madison, United States*

11:20 a.m. – 11:40 a.m.
T04.8: **Torque Ripple Minimization of a Five-Phase Permanent Magnet Assisted Synchronous Reluctance Motor under Open Phase Faults**
Akm Arafat, Seungdeog Choi, *University of Akron, United States*

11:40 a.m. – 12:00 p.m.
T04.9: **Power Factor Control for High Efficiency Operation of an Open-Ended Winding Motor using a Dual Inverter Drive with a Floating Bridge**
Ian Smith, Reaz Ul Haque, Atrin Tavakoli, John Salmon, *University of Alberta, Canada*
**T05: Power Device Performance & Gate Drivers**
ROOM 22

**Track: Devices and Components**

**Session Chairs:**
Arun Kadavelugu, *ABB Inc.*
Qiang Li, *Virginia Polytechnic Institute and State University*

8:30 a.m. – 8:50 a.m.

**T05.1:** Power Loss of GaN Transistor Reverse Diodes in a High Frequency High Voltage Resonant Rectifier
Sanghyeon Park, Juan Rivas-Davila, *Stanford University, United States*

8:50 a.m. – 9:10 a.m.

**T05.2:** Dv/dt Immunization Limit of LV MOSFET in Cascode GaN FET and dv/dt Safe Chart for MOSFETs
Zhiyang Chen, Jaume Roig, *ON Semiconductor, United States; ON Semiconductor, Belgium*

9:10 a.m. – 9:30 a.m.

**T05.3:** A Novel 4H-SiC Pinched Barrier Rectifier
Na Ren, Kang L. Wang, Zheng Zuo, Ruigang Li, Kuang Sheng, *AZ Power Inc., United States; University of California, Los Angeles, United States; Zhejiang University, China*

9:30 a.m. – 9:50 a.m.

**T05.4:** Analytical and Experimental Optimization of External Gate Resistance for Safe Rapid Turn On of Normally off GaN HFETs
Ansel Barchowsky, Joseph Kozak, Michael Hontz, William Stanchina, Gregory Reed, Zhi-Hong Mao, Raghav Khanna, *University of Pittsburgh, United States; University of Toledo, United States; Virginia Polytechnic Institute and State University, United States*

9:50 a.m. – 10:10 a.m.

**T05.5:** Characterization of High-Voltage High-Speed Switching Power Semiconductors for High Frequency Cryogenically-Cooled Application
Zheyu Zhang, Craig Timms, Jingyi Tang, Ruirui Chen, Jordan Sangid, Fred Wang, Leon M. Tolbert, Benjamin Blalock, Daniel Costinett, *University of Tennessee, United States*

10:40 a.m. – 11:00 a.m.

**T05.6:** Reducing Qrr in High-Voltage SuperJunction MOSFETs by using the Cascade Configuration
Juan Rodriguez, Alberto Rodriguez, Diego G. Lamar, Jaume Roig, Filip Bauwens, *ON Semiconductor, Belgium; Universidad de Oviedo, Spain*

**T06: Control of DC-DC Converters**
ROOM 23

**Track: Control**

**Session Chairs:**
Jaber Abu Qahouq, *University of Alabama*
Hrishikesh Nene, *Texas Instruments, Inc.*

8:30 a.m. – 8:50 a.m.

**T06.1:** Hardware Efficient Auto-Tuned Linear-Gain based Minimum Deviation Digital Controller for Indirect Energy Transfer Converters
Shadi Dashmiz, Behzad Mahdavikhah, Aleksandar Prodic, Brent McDonald, *Texas Instruments Inc., United States; University of Toronto, Canada*

8:50 a.m. – 9:10 a.m.

**T06.2:** Method for Online Battery AC Impedance Spectrum Measurement using DC-DC Power Converter Duty-Cycle Control
Zhiyong Xia, Jaber Abu Qahouq, *University of Alabama, United States*
**TUESDAY**

8:30 a.m. – 12:00 p.m.

**T07: Converters for Renewable Energy**

**ROOM 24**

**Track: Renewable Energy Systems**

**SESSION CHAIR:**

Xiong Li, Texas Instruments, Inc.

---

**T07.1: A Resonant Double Stage Flyback Microinverter for PV Applications**

Rasedul Hasan, Saad Mekhilef, University of Malaya, Malaysia

8:30 a.m. – 8:50 a.m.

**T07.2: A Three-Port Converter based DC Grid-Connected PV System with Autonomous Output Voltage Sharing Control**

Yangjun Lu1, Hongfei Wu1, Xiaofeng Dong1, Yan Xing1, Kai Sun2, 1Nanjing University of Aeronautics and Astronautics, China; 2Tsinghua University, China

8:50 a.m. – 9:10 a.m.

**T07.3: An Asymmetrical Three-Level Dual-Input Bidirectional DC/AC Converter with Improved Conversion Efficiency for Vehicle-to-Grid Application**

Lei Zhu1, Hongfei Wu1, Tiantian Mu1, Fan Yang1, Xudong Ma2, 1Nanjing University of Aeronautics and Astronautics, China; 2Southeast University, China

9:10 a.m. – 9:30 a.m.

**T07.4: Grid Tied Solar Micro-Converter with Optimizer-Mode Operation for Weak-Grid Operation**

Naila Ramzan, Zeinab Jamal Khan, Palwasha Naseer, Arooj Akbar, Nauman Zaffar, Lahore University of Management Sciences, Pakistan

9:30 a.m. – 9:50 a.m.

**T07.5: A Fast and Accurate Maximum Power Point Tracker for a Multi-Input Converter with Wide Range of Soft-Switching Operation for Solar Energy Systems**

Kajanan Kanathipan, Sanjida Moury, John Lam, York University, Canada

9:50 a.m. – 10:10 a.m.

**T07.6: A Fixed-Frequency Bidirectional Resonant DC-DC Converter Suitable for Wide Voltage Range**

Yanfeng Shen1, Huai Wang1, Frederik Blaabjerg1, Ahmed Al Durra2, Xiaofeng Sun3, 1Aalborg University, Denmark; 2Petroleum Institute, UAE; 3Yanshan University, China

10:40 a.m. – 11:00 a.m.
8:30 a.m. – 12:00 p.m.

**T08: Lower Power Applications**

**ROOM 25**

**Track: Power Electronics Applications**

**SESSION CHAIRS:**
Olivier Trescases, University of Toronto
Jeff Nilles, Texas Instruments, Inc.

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**T08.1: A Universal Topology based on Buck-Boost Converter with Optimal Resistive Impedance Tracking for Energy Harvesters in Battery Powered Applications**
Mahmoud Shousha, Dragan Dinulovic, Martin Haug, Würth Elektronik eiSos GmbH, Germany

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**T08.2: Taking Advantage of the Output Voltage Ripple of a Two-Phase Buck Converter to Perform Quadrature Amplitude Modulation for Visible Light Communication**
Juan Rodriguez², Diego G. Lamar², Javier Sebastian², Pablo F. Miaja¹, ¹European Space Agency, Netherlands; ²Universidad de Oviedo, Spain

---

**T08.3: Two-Stage Sinusoidal Generator with Calibration and Pulse Train Amplitude Feedback for Ultrasonic Applications**
Michael Evzelman², Hongjie Wang², Regan Zane², Xiaoliang Zhao¹, ¹Intelligent Automation Incorporation, United States; ²Utah State University, United States

---

**T08.4: A Modular and Reconfigurable Battery System**
Fa Chen, Wei Qiao, Liyan Qu, University of Nebraska-Lincoln, United States

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**T08.5: Toward Dynamic Programming-based Management in Reconfigurable Battery Packs**
Ni Lin, Song Ci, University of Nebraska-Lincoln, United States

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**T08.6: Structurally Supportive RF Power Inverter for a CubeSat Electrothermal Plasma Micro-Thruster with PCB Inductors**
Wei Liang², Luke Raymond², Juan Rivas Davila², Christine Charles¹, Rod Boswell¹, ¹Australian National University, Australia; ²Stanford University, United States

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**T08.7: A 10MHz, 40V-to-5V Clock-Synchronized AOT Hysteretic Converter with Programmable Soft Start Technique for Automotive USB Chargers**
Xugang Ke, Kang Wei, D. Brian Ma, University of Texas at Dallas, United States

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**T08.8: Highly Efficient Linear Power Amplifier for Driving Fast Slew Rate Capacitive Loads**
Miroslav Vasic¹, Eric Boere¹, Oscar Garcia², Pedro Alou², Jesús Angel Oliver², Jens Eltze¹, José Antonio Cobos², ¹Apex Microtechnology, United States; ²Universidad Politécnica de Madrid, Spain

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**T08.9: Linear Motion System Cable Elimination via Multiphase Capacitive Power Transfer through Sliding Journal Bearings**
Jiejian Dai, Skyler Hagen, Daniel Ludois, University of Wisconsin–Madison, United States
9:30 a.m.
**Spouse and Guest Tour “Treasures of Tampa by Water and Land”** (Registration Required)
departs
MARRIOTT – MEETING ROOM 4

12:00 p.m. – 5:00 p.m.
**Exhibit Hall Open**
EXPOSITION (WEST/EAST HALL)

1:30 p.m. – 2:00 p.m.
**Exhibitor Seminars – Session #1**
(for detailed information see page 176)

- **STMICROELECTRONICS**
  Digital Control IC for PFC and L-C Resonant Converter
  ROOM 1/2

- **PLEXIM**
  Real-time simulation using the PLECS RT Box
  ROOM 11

- **MOUSER ELECTRONICS WITH TEXAS INSTRUMENTS**
  Wireless Power Telemetry
  ROOM 13

- **MERSEN**
  Safety and Reliability for Power Electronics
  ROOM 14

- **VENABLE INSTRUMENTS**
  Portable Frequency Response Analyzer for Field Application Engineers
  ROOM 22

- **DANFOSS SILICON POWER GMBH**
  Gamechanging Power Modules by Danfoss
  ROOM 23

- **COGNIPower**
  The Origins and Implications of Predictive Energy Balancing (PEB)
  ROOM 24

- **RENESAS ELECTRONICS AMERICA**
  Simplifying Li-ion Battery Powered BLDC Motor Driver Design
  ROOM 25

2:15 p.m. – 2:45 p.m.
**Exhibitor Seminars – Session #2**
(for detailed information see page 179)

- **STMICROELECTRONICS**
  Synchronous Rectification in PoE Bridge for Improved Efficiency
  ROOM 1/2

- **UNITED CHEMI-CON, INC**
  State of Art for Automotive Application Capacitor
  ROOM 11

- **POWERREX INC.**
  7th Generation IGBT Modules Featuring Lower Losses and Higher Reliability
  ROOM 13

- **MAGNETICS**
  New Material Performance and Analysis of E-U Geometries
  ROOM 14

- **SIMPPLIS TECHNOLOGIES, INC**
  Performing AC Analyses on PFC Converters
  ROOM 22

- **EXXELIA USA**
  High Power Solutions
  ROOM 23

- **LINEAR TECHNOLOGY**
  Designing & Optimizing Power Supplies in Several Simple Steps with the LTpowerCAD Design Tool
  ROOM 24

- **ZES ZIMMER**
  Latest Trends in Precision Power Analyzers and Sensors
  ROOM 25

3:00 p.m. – 3:30 p.m.
**Exhibitor Seminars – Session #3**
(for detailed information see page 182)

- **INFINEON TECHNOLOGIES**
  Gate-Driven ICS Enabling Highly Efficient Power Management Systems
  ROOM 1/2

- **MICROMETALS, INC.**
  Online Design Tools for MHz Inductors
  ROOM 11
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<td>Exhibitor Seminars – Session #4 (for detailed information see page 185)</td>
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<td>5:00 p.m. – 6:30 p.m.</td>
<td>Rap Sessions (for detailed information see page 132)</td>
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### Exhibitor Seminars – Session #4

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<td>New Design Tools for Power Supplies</td>
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<tr>
<td>KEMET ELECTRONICS</td>
<td>Design Tools for Selecting Your Passive Components</td>
<td>11</td>
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<tr>
<td>MYWAY PLUS</td>
<td>Integrated Digital Platform for Power Electronics Model Based Design</td>
<td>13</td>
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<tr>
<td>“All-in-One package for Advanced R&amp;D”</td>
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<tr>
<td>ARTIC SAND TECHNOLOGIES INC.</td>
<td>Next Generation DC-DC Converter Architecture Brings Significant Improvements in Efficiency &amp; Size</td>
<td>14</td>
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<tr>
<td>FTCAP GMBH</td>
<td>Capacitor Solutions for Severe Conditions</td>
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<tr>
<td>MOUSER ELECTRONICS WITH TDK CORPORATION OF AMERICA AND PANASONIC INDUSTRIAL DEVICES</td>
<td>GaN Based Power Electronics and New Requirements for Passive Components</td>
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<td>PANASONIC CORPORATION</td>
<td>X-GaN Reliability and Robust Design</td>
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<td>OPAL-RT TECHNOLOGIES</td>
<td>Lab-Scale MMC Test Bench for Power Hardware-in-the-Loop (PHIL) Application</td>
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<td>DIALOG SEMICONDUCTOR</td>
<td>High Efficiency Inductor-Less Power Converter Technology</td>
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<td>TAIYO KOGYO CO., LTD</td>
<td>Introduction to Optimal PCBs for Next Generation Power Electronics</td>
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<td>SCHUNK HOFFMANN CARBON TECHNOLOGIES AG</td>
<td>Graphite-Based Solutions for (Power) Electronics Cooling</td>
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<tr>
<td>ABSTRACT POWER ELECTRONICS</td>
<td>Primate Power™ Sources Use SiC Devices to Improve Efficiency &amp; Response Time</td>
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<td>WOLVERINE TUBE INC. – MICROCOOL DIVISION</td>
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<td>PACIFIC SOWA CORPORATION C/O EPSON ATMIX CORPORATION</td>
<td>High U Super Low Core Loss Nanocystalline Power “KUAMET NCI”</td>
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### Rap Sessions

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<th>Power Electronic Topologies – Do We Need More or Any Benefit to New Ones?</th>
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<td>R02:</td>
<td>Do We Need to Progress Towards GHz Switching in High Power Systems and Applications?</td>
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<tr>
<td>R03:</td>
<td>3D Printing and Power Supply on Chip (PwrSoC)/Power Supply in Package (PSiP) vs. Discrete Designs</td>
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Wednesday
March 29, 2017

7:00 a.m. – 8:00 a.m.
Presenter Breakfast
BALLROOM A

8:00 a.m. – 3:00 p.m.
Registration
2ND FLOOR CONCOURSE

8:00 a.m. – 9:00 a.m.
Spouse and Guest Breakfast
MARRIOTT – MEETING ROOM 4

8:00 a.m. – 11:00 a.m.
Spouse and Guest Hospitality Room Open
MARRIOTT – MEETING ROOM 4

8:30 a.m. – 10:10 a.m.
IS05: Mobile Applications
ROOM 15/16
Session Chair:
Peter Miller, Texas Instruments, Inc.

8:30 a.m. – 8:55 a.m.
IS05.1: Significant Efficiency Improvements for Linear DC-DC Converters Based on Supercapacitor Energy Recovery
Nihal Kularatna, The University of Waikato, New Zealand

8:55 a.m. – 9:20 a.m.
IS05.2: Cascaded Fly-Back
Chris Notsch, Infineon Technologies Austria AG, Austria

9:20 a.m. – 9:45 a.m.
IS05.3: Emerging USB-PD/Type-C Standard Places New Demands on Power Supplies
Rahul Joshi, Shyam Dujari, Ishminder Dhanjal, Power Integrations, United States

9:45 a.m. – 10:10 a.m.
IS05.4: State-of-the-Art Mobile Charging: Topologies, Technologies and Performance
Tom Ribarich, Stephen Oliver, Navitas Semiconductor, United States

8:30 a.m. – 10:10 a.m.
IS06: Regulatory and Compliance Considerations for Power Electronics
ROOM 14
Session Chairs:
Kevin Parmenter, Excelsys Technologies
Jim Spangler, Independent

8:30 a.m. – 8:55 a.m.
IS06.1: EMI Filter Safety
Herbert Blum, Schurter Electronics, Switzerland

8:55 a.m. – 9:20 a.m.
IS06.2: Mitigating EMI Problems & Filter Selection
Rafik Stepanian, Inter-Technical, LLC, United States

9:20 a.m. – 9:45 a.m.
IS06.3: Design Considerations for Power Supplies in High-Altitude Applications
Kevin Parmenter, Excelsys Technologies, United States

9:45 a.m. – 10:10 a.m.
IS06.4: What Doesn’t a Power Supply Have to Comply with These Days
Sinziana Cionca, Christopher Siegl, Excelsys Technologies Ltd, Ireland; Excelsys Technologies Ltd, United States

8:30 a.m. – 10:10 a.m.
IS07: Offline Power Supplies
ROOM 13
Session Chair:
Chris Jones, Artesyn Embedded Technologies

8:30 a.m. – 8:55 a.m.
IS07.1: Cross Regulation Challenges of Multi-Output Power Supplies
David Chen, Power Integrations, United States

8:55 a.m. – 9:20 a.m.
IS07.2: Extremely Low Ripple Ballast Topology for High Power Discharge Lamps
Ekrem Karaman, Warner Power, United States
### Prof. Education Seminars

**Conference and Exposition**

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<td>9:20 a.m.</td>
<td>IS07.3</td>
<td>Analytic Expressions for Currents in the CCM PFC Stage</td>
<td>Colin Gillmor, Texas Instruments, Ireland</td>
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<td>9:45 a.m.</td>
<td>IS07.4</td>
<td>Design for Manufacturability – A Paradigm Shift</td>
<td>Fred Lee, CPES-Virginia Tech, United States</td>
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<td>8:30 a.m.</td>
<td>IS08</td>
<td>Transactive Energy and the Electric Power Grid</td>
<td>ROOM 11</td>
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<tr>
<td>8:30 a.m.</td>
<td>T09</td>
<td>High Power AC-DC Converters</td>
<td>ROOM 1/2</td>
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#### Track: AC-DC Converters

**Session Chairs:**

Davide Giacomini, Infineon Technologies  
Xin Zhang, IBM T.J. Watson Research Center

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<tr>
<td>8:30 a.m.</td>
<td>T09.1</td>
<td>New 1000V SiC MOSFETs Enable Improved Efficiency, Density, and Cost Tradeoff Space for PFCs</td>
<td>Adam Barkley, Marcelo Schupbach, Binod Agrawal, Scott Allen, Wolfspeed / Cree, United States; Wolfspeed / Cree, India</td>
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<tr>
<td>8:50 a.m.</td>
<td>T09.2</td>
<td>99.3% Efficient Three-Phase Buck-Type All-SiC Swiss Rectifier for DC Distribution Systems</td>
<td>Lukas Schrittwieser², Michael Leibl², Michael Haider², Friedrich Thöny², Johann Walter Kolar², Thiago Soeiro¹, ¹ABB, Switzerland; ²Eidgenössische Technische Hochschule Zürich, Switzerland</td>
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<tr>
<td>9:10 a.m.</td>
<td>T09.3</td>
<td>Analysis of Three-Phase Rectifier Systems with Controlled DC-Link Current Under Unbalanced Grids</td>
<td>Dinesh Kumar², Pooya Davari¹, Firuz Zare³, Frede Blaabjerg¹, ¹Aalborg University, Denmark; ²Danfoss Power Electronics A/S, Denmark; ³University of Queensland, Australia</td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>T09.4</td>
<td>An Isolated Medium-Voltage AC/DC Power Supply based on Multi-Cell Converter Topology</td>
<td>Yugo Kashihara, Yuji Nemoto, Wang Qichen, Satoru Fujita, Ryuji Yamada, Yasuhiro Okuma, Fuji Electric Co., Ltd., Japan</td>
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<td>9:50 a.m.</td>
<td>T09.5</td>
<td>A 500 kHz, 3.3 kW Boost PFC with Low Loss Coupled Auxiliary ZVT Circuit</td>
<td>Siddharth Kulasekaran, Nikhil Korada, Raja Ayyanan, Arizona State University, United States</td>
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## T10: Non-isolated DC-DC Converters
### Session Chairs:
Cahit Gezgin  
Ayman Fayed, Ohio State University

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<td>8:30 a.m.</td>
<td>T10.1</td>
<td>New ZVT Topology for Switched Inductor High Gain Boost</td>
<td>Tong Yao, Chenhao Nan, Raja Ayyanar, Arizona State University, United States</td>
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<td>8:50 a.m.</td>
<td>T10.2</td>
<td>High-Efficiency High-Power-Density 48/1V Sigma Converter Voltage Regulator Module</td>
<td>Mohamed Ahmed, Chao Fei, Fred C. Lee, Qiang Li, Virginia Polytechnic Institute and State University, United States</td>
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<tr>
<td>9:10 a.m.</td>
<td>T10.3</td>
<td>A Novel Quasi-SEPIC High-Voltage Boost DC-DC Converter</td>
<td>Yam Siwakoti(^1), Mohsen Soltani(^1), Frede Blaabjerg(^1), Ali Mostaan(^2), (^1)Aalborg University, Denmark; (^2)Iranian Central Oil Field Company, Iran</td>
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<tr>
<td>9:30 a.m.</td>
<td>T10.4</td>
<td>Design of Area-Efficient Multiple-Output Switched-Capacitor DC-DC Converters</td>
<td>Zhe Hua, Hoi Lee, University of Texas at Dallas, United States</td>
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<tr>
<td>9:50 a.m.</td>
<td>T10.5</td>
<td>Low-Volume Hybrid Tap-Connected SC-Buck Converter with Shared Output Capacitor</td>
<td>Tim McRae, Nenad Vukadinović, Aleksandar Prodić, University of Toronto, Canada</td>
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## T11: Power Converter Topologies
### Session Chairs:
Liming Liu, ABB USCRC  
Frede Blaabjerg, Aalborg University

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<td>8:30 a.m.</td>
<td>T11.1</td>
<td>An Asymmetrical Multi-Level Dual-Input Dual-Buck Inverter for Multi-Source Interface Applications</td>
<td>Fan Yang, Hongjuan Ge, Jingfan Yang, Runyun Dang, Hongfei Wu, Nanjing University of Aeronautics and Astronautics, China</td>
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<tr>
<td>9:10 a.m.</td>
<td>T11.2</td>
<td>Multiple-Output ZCS Resonant Inverter for Multi-Coil Induction Heating Appliances</td>
<td>Hector Sarnago, Oscar Lucia, José Miguel Burdio, Universidad de Zaragoza, Spain</td>
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<td>9:30 a.m.</td>
<td>T11.3</td>
<td>A Minimized DC-Bus Capacitor with Active Combinalional Decoupling Method for DC-AC Application</td>
<td>Xiaofeng Lyu, Yanchao Li, Ze Ni, Dong Cao, North Dakota State University, United States</td>
</tr>
<tr>
<td>9:50 a.m.</td>
<td>T11.4</td>
<td>Demonstration of a 50 kW and 100 kHz SiC High Power Density Converter with Gate Assisted Circuit</td>
<td>Shan Yin(^2), King Jet Tseng(^1), Yong Liu(^1), Rejeki Simanjorang(^3), Chandana J. Gajanayake(^3), (^1)Nanyang Technological University, Singapore; (^2)Nanyang Technological University / Rolls-Royce Singapore Pte. Ltd., Singapore; (^3)Rolls-Royce Singapore Pte. Ltd., Singapore</td>
</tr>
</tbody>
</table>
| 9:50 a.m.  | T11.5   | Comprehensive Evaluation of Interleaved Zero Current Switching Inverter against Interleaved Hard Switching Inverters in Terms of Efficiency, Power Density and EMI Spectrum | Yingzhuo Chen, Arvind Shanmuganatha  
Sathyanarayanan, Balaji Narayanasamy, Wenda Feng, Fang Luo, Ohio State University, United States |
### T12: Power Device Reliability

**ROOM 21**

**Track: Devices and Components**

**Session Chairs:**
- Tim McDonald, *Infineon*
- Rolando Burgos, *Virginia Polytechnic Institute and State University*

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30 a.m. – 8:50 a.m.</td>
<td>T12.1</td>
<td>First Automotive Reliability Assessment and Drive-Train Performance of Large-Area 900V, 10mOhm SiC MOSFETs</td>
<td>Jeff Casady, Brett Hull, Jon Zhang, Don Gajewski, Gangyao Wang, Scott Allen, John Palmour, Kraig Olejniczak, <em>Wolfspeed / Cree, United States</em></td>
</tr>
<tr>
<td>8:50 a.m. – 9:10 a.m.</td>
<td>T12.2</td>
<td>Robustness of SiC MOSFET Under Avalanche Conditions</td>
<td>Ilyas Dchar(^2), Marion Zolkos(^2), Cyril Buttay(^1), Hervé Morel(^1), (^1)Institut National des Sciences Appliquées de Lyon, France; (^2)SuperGrid Institute, France</td>
</tr>
<tr>
<td>9:10 a.m. – 9:30 a.m.</td>
<td>T12.3</td>
<td>Prognosis of Power MOSFET in Continuous Time Framework</td>
<td>Moinul Shahidul Haque, Seungdeog Choi, <em>University of Akron, United States</em></td>
</tr>
<tr>
<td>9:30 a.m. – 9:50 a.m.</td>
<td>T12.4</td>
<td>Lifetime Prediction of IGBT Modules Based on Linear Damage Accumulation</td>
<td>Ui-Min Choi, Frede Blaabjerg, Ke Ma, <em>Aalborg University, Denmark</em></td>
</tr>
<tr>
<td>9:50 a.m. – 10:10 a.m.</td>
<td>T12.5</td>
<td>Large Scale Test Bed for In-Circuit Reliability Testing of Silicon Carbide Diodes and MOSFETs Emulating Real Life Voltage and Current Stress</td>
<td>Gin Sheh, Xuning Zhang, Levi Gant, Kevin Matocha, Kiran Chatty, Sujit Banerjee, <em>Monolith Semiconductor Inc., United States</em></td>
</tr>
</tbody>
</table>

### T13: Design Optimization for High Reliability

**ROOM 22**

**Track: System Integration**

**Session Chairs:**
- John Vigars, *Allegro Microsystems*
- Ernie Parker, *Crane Aerospace & Electronics*

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30 a.m. – 8:50 a.m.</td>
<td>T13.1</td>
<td>A Turn-Off Delay Time Measurement and Junction Temperature Estimation Method for IGBT</td>
<td>Lei Li, Puqi Ning, Xuhui Wen, Yaohua Li, Qiongxuan Ge, Dong Zhang, Xiang Tai, <em>Chinese Academy of Sciences, China</em></td>
</tr>
<tr>
<td>8:50 a.m. – 9:10 a.m.</td>
<td>T13.2</td>
<td>Switching Performance Comparison of 1200 V and 1700 V SiC Optimized Half Bridge Power Modules with SiC Antiparallel Schottky Diodes versus MOSFET Intrinsic Body Diodes</td>
<td>Daniel Martin, W. Austin Curbow, Brett Sparkman, Lauren Kegley, Ty McNutt, <em>Wolfspeed / Cree, United States</em></td>
</tr>
<tr>
<td>9:10 a.m. – 9:30 a.m.</td>
<td>T13.3</td>
<td>Impacts of Ripple Current to the Loading and Lifetime of Power Semiconductor Device</td>
<td>Ke Ma(^2), Ui-Min Choi(^1), Frede Blaabjerg(^1), <em>Aalborg University, Denmark</em>; (^2)Shanghai Jiao Tong University, China</td>
</tr>
<tr>
<td>9:30 a.m. – 9:50 a.m.</td>
<td>T13.4</td>
<td>A New Optically-Isolated Power Converter for 12 V Gate Drive Power Supplies Applied to High Voltage and High Speed Switching Devices</td>
<td>Masanori Ishigaki(^2), Simon Fafard(^1), Denis Masson(^1), Matthew Wilkins(^3), Christopher Valdivia(^3), Karin Hinzer(^3), (^1)Azastra Opto, Canada; (^2)Toyota Research Institute of North America, United States; (^3)University of Ottawa, Canada</td>
</tr>
<tr>
<td>9:50 a.m. – 10:10 a.m.</td>
<td>T13.5</td>
<td>Thermal Characterization of an IGBT Power Module with On-Die Temperature Sensors</td>
<td>Badr El Boudour Bidouche(^2), Yvan Avenas(^2), Mouslim Essakili(^2), Laurent Dupont(^1), (^1)Institut Français des Sciences et Technologies des Transports, de l’Aménagement et des Réseaux, France; (^2)Université Grenoble Alpes, France</td>
</tr>
</tbody>
</table>
8:30 a.m. – 10:10 a.m.
**T14: Reliability**
ROOM 23

**Track: Manufacturing, Quality, and Business Issues**

**Session Chair:**
Jim Marinos, Payton America Inc.

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**T14.1:** Failure Prediction using Low Stability Phenomenon of Digitally Controlled SMPS by Electrolytic Capacitor ESR Degradation
Hiroshi Nakao\(^2\), Yu Yonezawa\(^1\), Yoshiyasu Nakashima\(^1\), Fujio Kurokawa\(^3\), \(^1\)Fujitsu Laboratories LTD., Japan; \(^2\)Fujitsu Laboratories LTD. / Nagasaki University, Japan; \(^3\)Nagasaki University, Japan

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**T14.2:** A Cost Effective Magnetic/Electronic Design for the Water Pump Application Drive: Analysis, Design, and Experimentation
Ahmed Abdelrahman, Mohamed Youssef, University of Ontario Institute of Technology, Canada

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**T14.3:** Defining Humidity Test Duration for Microinverter Reliability Assessment: A Physics-of-Failure Approach
Arvind Vasan, Laszlo Laskai, Milan Ilic, Empower Micro Systems, United States

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**T14.4:** Proactive Fault-Tolerant IGBT-based Power Converters for Mission Critical Applications in MW Range
Victor N. Ferreira\(^2\), Braz J. Cadoso Filho\(^2\), Anderson V. Rocha\(^1\), \(^1\)Centro Federal de Educação Tecnológica de Minas Gerais, Brazil; \(^2\)Universidade Federal de Minas Gerais, Brazil

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**T14.5:** Controller Robustness Analysis of Grid-Tied AC-Stacked PV Inverter System Considering Manufacturing Inaccuracies
Hamidreza Jafarian, Mehrdad Biglarbegan, Babak Parkhdeh, University of North Carolina at Charlotte, United States

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8:30 a.m. – 10:10 a.m.
**T15: Batteries for Renewable Energy**
ROOM 24

**Track: Renewable Energy Systems**

**Session Chair:**
Haoyu Wang, ShanghaiTech University

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**T15.1:** Battery Energy Storage Emulation in a Converter-based Power System Emulator
Jessica Boles, Yiwei Ma, Wenchao Cao, Leon M. Tolbert, Fred Wang, University of Tennessee, United States

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**T15.2:** A Correlation based Detection Method for Internal Short Circuit in Battery Packs
Bing Xia\(^1\), Yunlong Shang\(^2\), Truong Nguyen\(^3\), Chris Mi\(^1\), \(^1\)San Diego State University, United States; \(^2\)Shandong University and San Diego State University, United States; \(^3\)University of California, San Diego, United States

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**T15.3:** Electro-Thermal Modeling of High-Performance Lithium-Ion Energy Storage Systems including Reversible Entropy Heat
Stefan Skoog, Chalmers University of Technology, Sweden

---

**T15.4:** A High-Fidelity Hybrid Lithium-Ion Battery Model for SOE and Runtime Prediction
Kaiyuan Li\(^1\), Boon Hee Soong\(^1\), King Jet Tseng\(^2\), \(^1\)Nanyang Technological University, Singapore; \(^2\)Singapore Institute of Technology, Singapore

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**T15.5:** Cell-Level Hybrid Architectures for Active Balancing of Serially-Connected Batteries
Nadav Dahan\(^1\), Mor Mordechai Peretz\(^2\), Ilya Zeltser\(^2\), \(^1\)Ben-Gurion University of the Negev, Israel; \(^2\)Rafael Advanced Defense Systems Ltd., Israel
8:30 a.m. – 10:10 a.m.
**T16: LED Applications**
ROOM 25

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**Track: Power Electronics Applications**

**Session Chairs:**
Jim Spangler, Spangler Prototype Inc.
Sombuddha Chakraborty, Texas Instruments, Inc.

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8:30 a.m. – 8:50 a.m.
**T16.1: A New Bleeder Circuit for TRIAC Dimmable LED Driver based on Single-Stage Topology with a Capacitor Input Rectifier**
Mitsuhiro Kadota², Hiroyuki Shoji², Hiroyuki Hirose¹, Atsushi Hatakeyama¹, ¹Hitachi Appliances, Inc., Japan; ²Hitachi, Ltd., Japan

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8:50 a.m. – 9:10 a.m.
**T16.2: An Integrated Multilevel Converter with Sigma Delta Control for LED Lighting**
Daniel L. Gerber², Mitchell Kline², Seth R. Sanders², Chengrui Le¹, Peter R. Kinget¹, ¹Columbia University, United States; ²University of California, Berkeley, United States

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9:10 a.m. – 9:30 a.m.
**T16.3: A High Power Factor LED Driver based on Improved Forward-Flyback without Electrolytic Capacitor**
Hanqing Dong², Xiaogao Xie¹, Huazhong Chen², Zheliang Jin², ¹Hangzhou Dianzi University, China; ²Zhejiang Industry Polytechnic College, China

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9:30 a.m. – 9:50 a.m.
**T16.4: A Switched-Capacitor-based Current Compensator for Mitigating the Effect of Long Cable Connecting between LED Driver and Light Source**
Ryan Shun-Cheung Yeung, John Yau-Chung Chan, Rui Zhou, Henry Shu-Hung Chung, Norman Chung-Fai Tse, City University of Hong Kong, Hong Kong

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9:50 a.m. – 10:10 a.m.
**T16.5: On the Role of the Power Electronics on Visible Light Communication**
Javier Sebastián², Daniel G. Aller², Juan Rodríguez², Diego G. Lamar², Pablo F. Miaja¹, ¹European Space Agency, Netherlands; ²Universidad de Oviedo, Spain

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10:00 a.m. – 2:00 p.m.
**Exhibit Hall Open**
EXPOSITION (WEST/EAST HALL)

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10:30 a.m. – 11:00 a.m.
**Exhibitor Seminars – Session #5**
(for detailed information see page 188)

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**HITACHI AMERICA, LTD**
Next High Power Density Dual Module with Next Generation Chip Beneficial in Low Inductance Application
ROOM 1/2

**TYPOHON HIL, INC**
Controller Hardware-in-the-Loop (CHIL) Nanosecond Resolution “Flight Simulator” for Future Microgrids
ROOM 11

**COILCRAFT, INC.**
New Power Inductor Selection Process for Best Power Converter Performance
ROOM 13

**TELEDYNE LECROY**
Using the Teledyne LeCroy Motor Drive Analyzer to Optimize Motor/Drive Performance During a Single Semiconductor Device Switching Period
ROOM 14

**WURTH**
Exploring and Designing in PoE Magnetics
ROOM 20

**TRANSFHORM, INC.**
How to Design with GaN in an Hour or Less
ROOM 21

**SP CONTROL TECHNOLOGIES**
The Innovation in SP Control Technologies
ROOM 22
11:15 a.m. – 11:45 a.m.
**Exhibitor Seminars – Session #6**
*(for detailed information see page 191)*

- **SEMIKRON**
  Power Converter Development: Reducing Time to Market
  ROOM 1/2

- **IWATSU ELECTRIC**
  Power Loss Measurement for High Phase Angle Magnetics Core
  ROOM 11

- **EFFICIENT POWER CONVERSION CORPORATION**
  GaN Transistors for Efficient Power Conversion
  ROOM 13

- **SBE, INC.**
  Advancements in DC Link Design for the Next Gen Inverters
  ROOM 14

- **ZIPALOG, INC**
  System and Fault Scenario Analysis for Power Management IC’s
  ROOM 20

- **POWERSIM INC.**
  Integrating PSIM & SPICE for System Level to Device Level Simulation
  ROOM 21

- **SYNOPSYS, INC.**
  Saber Periodic AC (PAC) Analysis and Power MOSFET Tool
  ROOM 22

- **ALTAIR**
  Multiphysics Modeling – Optimizing current input to cancel torque ripple
  ROOM 23

2:00 p.m. – 5:25 p.m.
**IS09: Silicon and WBG Power Devices for High Frequency Topologies**
ROOM 15/16

**SESSION CHAIRS:**
Ritu Sodhi, Empower Semiconductor
Tim McDonald, Infineon Technologies

- 2:00 p.m. – 2:25 p.m.
  **IS09.1:** Standardization for Wide Bandgap Devices: GaNSPEC DWG
  Stephanie Butler, Texas Instruments, United States

- 2:25 p.m. – 2:50 p.m.
  **IS09.2:** Silicon Technologies Enabling High Frequency Operation in SMPS
  David Jauregui, Texas Instruments, United States

- 2:50 p.m. – 3:15 p.m.
  **IS09.3:** Moore’s Law Is Alive with GaN
  Alex Lidow, Efficient Power Conversion Corporation, United States

- 3:15 p.m. – 3:40 p.m.
  **IS09.4:** GaN Power ICs at 1 MHz+: Topologies, Technologies and Performance
  Dan Kinzer, Navitas Semiconductor, United States

- 4:10 p.m. – 4:35 p.m.
  **IS09.5:** Fast Charging EV with the Latest 1kV 3rd Generation SiC MOSFET
  John Mookken, Wolfspeed, United States

- 4:35 p.m. – 5:00 p.m.
  **IS09.6:** Towards Medium Voltage (3.3 –15kV) SiC Devices
  Ranbir Singh, Siddharth Sundaresan, GeneSiC Semiconductor Inc., United States

- 5:00 p.m. – 5:25 p.m.
  **IS09.7:** Heterogeneously Integrated Power Stages Enable Breakthrough Power Density and Speed
  Greg Miller, Sarda Technologies, United States

12:00 p.m.-12:30 p.m.
**Exhibitor Seminars – Session #7**
*(for detailed information see page 194)*

- **LTEC CORPORATION**
  Improve New Product Positioning, Reduce Time to Market, Protect Your IP through Benchmarking and Deep Analysis
  ROOM 1/2

- **MICROCHIP TECHNOLOGY, INC.**
  Using Core Independent Peripherals (CIPs) to Build a Custom Control
  Presented by: Keith Curtis
  ROOM 11
2:00 p.m. – 5:25 p.m.
**IS10: Server Power Topics**

**ROOM 14**

**SESSION CHAIRS:**
Wisam Moussa, Infineon Technologies
Nick Gruendler, Celestica

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**IS10.1:** Re-Evaluating 48 VIN Server Architectures with High Performance GaN Transistors
David Reusch, John Glaser, Alex Lidow, Efficient Power Conversion Corporation

**IS10.2:** Cost and Accuracy Optimized VR Thermal Sensing Methodology for Server Platform
Wei Shen, Jiangqi He, Weixia Liang, Yuehong Fan, Joy Yuan, Jinsong Zhu, Intel corporation, United States; Intel Corporation, China

**IS10.3:** Current Sharing: the New Challenge in Enterprise Server Power Supply
Mark Muccini, Mehran Mirjafari, Pat Gharpure, Stuart Berke, Lei Wang, Dell EMC, United States

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**IS11: Vehicle Electrification – Not Just the Powertrain**

**ROOM 13**

**SESSION CHAIRS:**
Ralph Taylor, Delphi
Fred Weber, Future Technology Worldwide

---

**IS11.1:** Electrified Transportation Challenges
Shahram Zarei, Ford Motor Co., United States

**IS11.2:** Wireless Power Transfer: A Developers Guide
John Miller¹, Andy Daga², Bruce Long³, Peter Schrafel⁴, ¹J-N-J Miller Design Svcs PLLC, United States; ²Momentum Dynamics Corp., United States

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**IS12: IGBTs / Gate Drives**

**ROOM 11**

**SESSION CHAIR:**
Alex Craig, ON Semiconductor

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**IS12.1:** Choosing the Right IGBT Module for Mil/Aerospace Applications
Paul Schimel, IR HiRel, United States
2:25 p.m. – 2:50 p.m.

**IS12.2:** Addressing Challenges in Modelling and Measuring IGBT’s Power Losses in Industrial and Domestic Applications
Leon Zhang, Vittorio Crisafulli, ON Semiconductor, China; ON Semiconductor, Germany

2:50 p.m. – 3:15 p.m.

**IS12.3:** Direct Pressed Die Technology: Increased Power Density and Reliability in Standard Power Module Packages
Stefan Häuser, SEMIKRON Elektronik GmbH & Co. KG, Germany

3:15 p.m. – 3:40 p.m.

**IS12.4:** EV/HEV Market Impact on Packaging Technology
Mattin Grao Txapartegi, Yole Développement, France

4:10 p.m. – 4:35 p.m.

**IS12.5:** Navigating through Quality Traps of Circuit Design using Resistors in Series to High Voltage Diodes
Wolfgang Frank, Infineon Technologies Germany, Germany

4:35 p.m. – 5:00 p.m.

**IS12.6:** Silicon on Isolator Gate Driver Technology, Its Features and Advantages
David Divins, Infineon Technologies, United States

5:00 p.m. – 5:25 p.m.

**IS12.7:** High-Speed GaN Gate-Drivers
Mike Wens, Jef Thoné, MinDCet NV, Belgium

2:00 p.m. – 5:30 p.m.

**T17:** High Frequency DC-DC Converters
ROOM 1/2

**Track: DC-DC Converters**

**SESSION CHAIRS:**
Olivier Trescases, University of Toronto
Xin Zhang, IBM T.J. Watson Research Center

2:00 p.m. – 2:20 p.m.

**T17.1:** High-Efficiency High-Power-Density 380V/12V DC/DC Converter with a Novel Matrix Transformer
Chao Fei, Fred C. Lee, Qiang Li, Virginia Polytechnic Institute and State University, United States

2:20 p.m. – 2:40 p.m.

**T17.2:** A High-Frequency High-Step-Down Converter with Coupled Inductor for Low Power Applications
Xiaonan Zhao, Chih-Shen Yeh, Lanhua Zhang, Jih-Sheng Lai, Virginia Polytechnic Institute and State University, United States

2:40 p.m. – 3:00 p.m.

**T17.3:** Active Clamp Flyback using GaN Power IC for Power Adapter Applications
Lingxiao Xue, Jason Zhang, Navitas Semiconductor, United States

3:00 p.m. – 3:20 p.m.

**T17.4:** On-Chip Inductor DCR Self-Calibration Technique for High Frequency Integrated Multiphase Switching Converters
Bumkil Lee2, Minkyu Song1, D. Brian Ma2, 1Linear Technology Inc., United States; 2University of Texas at Dallas, United States

3:20 p.m. – 3:40 p.m.

**T17.5:** A 12-Volt-Input Hybrid Switched Capacitor Voltage Regulator based on a Modified Series-Parallel Topology
Christopher Schaefer, Jason Stauth, Dartmouth College, United States

4:10 p.m. – 4:30 p.m.

**T17.6:** Evaluation of Gate Drive Overvoltage Management Methods for Enhancement Mode Gallium Nitride Transistors
David Reusch, Michael de Rooij, Efficient Power Conversion Corp, United States

4:30 p.m. – 4:50 p.m.

**T17.7:** High-Frequency ZVS Cuk Converter for Automotive LED Driver Applications Using Planar Integrated Magnetics
Alihossein Sepahvand2, Montu Doshi1, Vahid Yousefzadeh1, James Patterson1, Khurram K. Afridi2, Dragan Maksimovic2, 1Texas Instruments Inc., United States; 2University of Colorado Boulder, United States

4:50 p.m. – 5:10 p.m.

**T17.8:** Analysis and Design of Resonant Rectifier for High-Frequency DC-DC Converters
Kyung-Hwan Lee, Jung-Ik Ha, Seoul National University, Korea, South

5:10 p.m. – 5:30 p.m.

**T17.9:** Analysis, Design, and Performance Evaluation of Asymmetrical Half-Bridge Flyback Converter for Universal-Line-Voltage-Range Applications
Laszlo Huber, Milan M. Jovanović, Delta Products Corporation, United States
2:00 p.m. – 5:30 p.m.

**T18: Magnetics**

**ROOM 18/19**

**Track: Devices and Components**

**SESSION CHAIRS:**
Stephan Carlsten, Raytheon Co
Matt Wilkowski, Altera

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**T18.1**
**High Frequency, Single/Dual Phases, Large AC/DC Signal Power Characterization for Two Phase On-Silicon Coupled Inductors**
Cristina Fernandez\(^2\), Zoran Pavlovic\(^1\), Santosh Kulkarni\(^3\), Paul McCluskey\(^1\), Cian O’Mathuna\(^1\), \(^1\)Tyndall National Institute and University College Cork, Ireland; \(^2\)Universidad Carlos III de Madrid, Spain

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**T18.2**
**Analysis and Reduction of the Near Magnetic Field Radiation from Magnetic Inductors**
Boyi Zhang, Shuo Wang, University of Florida, United States

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**T18.3**
**Electrical Shielding of MV/MF Transformers Subjected to High dv/dt PWM Voltages**
Thomas Guillod, Florian Krismer, Johann Walter Kolar, Eidgenössische Technische Hochschule Zürich, Switzerland

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**T18.4**
**Techniques of the Modeling, Measurement and Reduction of Common Mode Noise for a Multi-Winding Switching Transformer**
Yiming Li\(^2\), Huan Zhang\(^2\), Shuo Wang\(^2\), Honggang Sheng\(^1\), Srikanth Lakshmikanthan\(^1\), Choon Ping Chng\(^1\), \(^1\)Google Inc., United States; \(^2\)University of Florida, United States

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**T18.5**
**High-Q Resonator with Integrated Capacitance for Resonant Power Conversion**
Phyo Aung Kyaw, Aaron Stein, Charles Sullivan, Dartmouth College, United States

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**T18.6**
**Multi-Domain Design of Inverter-Side Inductor for LCL Filter with 50kW 60 kHz High Power Density Converter**
Yong Liu\(^1\), Kye-Yak See\(^1\), Rejeki Simanjarang\(^2\), Shan Yin\(^2\), Chin-Foong Tong\(^4\), Arie Nawawi\(^4\), Jih-Sheng Lai\(^5\), \(^1\)Nanyang Technological University, Singapore; \(^2\)Nanyang Technological University / Rolls-Royce Singapore Pte. Ltd., Singapore; \(^3\)Rolls-Royce Singapore Pte. Ltd., Singapore; \(^4\)Rolls-Royce Singapore Pte. Ltd. / Nanyang Technological University, Singap

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4:30 p.m. – 4:50 p.m.

**T18.7**
**High-Frequency Transformer Design for the Soft-Switching Solid State Transformer (S4T)**
Hao Chen, Deepak Divan, Georgia Institute of Technology, United States

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4:50 p.m. – 5:10 p.m.

**T18.8**
**An AC Resistance Optimization Method Applicable for Inductor and Transformer Windings with Full Layers and Partial Layers**
Zhan Shen\(^1\), Zhiguang Li\(^2\), Long Jin\(^3\), Huai Wang\(^1\), \(^1\)Aalborg University, Denmark; \(^2\)Guodian Nanjing Automation Co., Ltd., China; \(^3\)Southeast University, China

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5:10 p.m. – 5:30 p.m.

**T18.9**
**Printed Circuit Board Planar Current Transformer for GaN Active Diode**
Godwin Kwun Yuan Ho, Yaoran Fang, M.H. Pong, Shu-Yuen Ron Hui, University of Hong Kong, Hong Kong

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2:00 p.m. – 5:30 p.m.

**T19: Multilevel Converters**

**ROOM 20**

**Track: Motor Drives and Inverters**

**SESSION CHAIRS:**
Mohammed Agamy, GE Global Research
Suman Debnath, Oak Ridge National Laboratory

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**T19.1**
**A New Five-Level Nested Neutral Point Clamped (NNPC) Voltage Source Converter**
Mehdi Narimani\(^1\), Bin Wu\(^3\), Navid Zargari\(^2\), \(^1\)McMaster University, Canada; \(^2\)Rockwell Automation, Canada; \(^3\)Ryerson University, Canada

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2:00 p.m. – 2:20 p.m.

**T19.2**
**Switched-Capacitor Multilevel Inverters for High Frequency AC Microgrids**
Raghu Raman S., Yuanmao Ye, Ka Wai Eric Cheng, Hong Kong Polytechnic University, Hong Kong

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2:20 p.m. – 2:40 p.m.

**T19.3**
**A Hybrid Multilevel Inverter Employing Series-Parallel Switched-Capacitor Unit**
Yat Chi Fong, Yuanmao Ye, Raghu Raman S., Ka Wai Eric Cheng, Hong Kong Polytechnic University, Hong Kong

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2:40 p.m. – 3:00 p.m.

**T19.4**
**An Improved Ripple Suppression Method Based on Flying-Capacitor Modular Multilevel Converter for High Performance MV Drivers**
Ze Wang\(^2\), Kaiwen Liao\(^2\), Kai Zhang\(^2\), Xin Huang\(^2\), Zenghui Kong\(^1\), \(^1\)China Ship Development and Design Center, China; \(^2\)Huazhong University of Science and Technology, China
3:20 p.m. – 3:40 p.m.  T19.5:  Power and Frequency Controllable Multi-Level MHz Inverter with Soft Switching
Hamed Tebianian, John Quaicoe, Benjamin Jeyasurya, Memorial University of Newfoundland, Canada

4:10 p.m. – 4:30 p.m.  T19.6:  Design of a GaN-based, 9-Level Flying Capacitor Multilevel Inverter with Low Inductance Layout
Tomas Modeer, Christopher Barth, Nathan Pallo, Won Ho Chung, Thomas Foulkes, Robert C.N. Pilawa-Podgurski, University of Illinois Urbana-Champaign, United States

4:30 p.m. – 4:50 p.m.  T19.7:  Carrier based Three-Level PWM for Improving Flying Capacitor Balancing of Nested Neutral-Point-Clamped (NNPC) Converter
Hao Tian, Yun Wei Li, University of Alberta, Canada

4:50 p.m. – 5:10 p.m.  T19.8:  Phase Current Reconstruction of Three-Level Neutral-Point-Clamped(NPC) Inverter with a Neutral Shunt Resistor
Jae-Jun You, Jun-Hyung Jung, Chang-Hwan Park, Jang-Mok Kim, Pusan National University, Korea, South

5:10 p.m. – 5:30 p.m.  T19.9:  Multiple Device Open Circuit Fault Diagnosis for Neutral-Point-Clamped Inverters
Marina Sital-Dahone2, Aparna Saha2, Yilmaz Sozer2, Augustin Mpanda1, 1ESIEE Amiens, France; 2University of Akron, United States

2:00 p.m. – 5:30 p.m.  T20:  Grid-Connected Inverter Control
ROOM 21

**Track: Power Electronics for Utility Interface**

**SESSION CHAIRS:**
Ali Khajehoddin, University of Alberta
Babak Parkhideh, University of North Carolina Charlotte

2:00 p.m. – 2:20 p.m.  T20.1:  H-Bridge Transformerless Inverter with Common Ground for Single-Phase Solar-Photovoltaic System
Yam Siwakoti, Frede Blaabjerg, Aalborg University, Denmark

2:20 p.m. – 2:40 p.m.  T20.2:  Analysis of an Offset Error on a Single-Phase Grid-Connected Inverter based on a Proportional-Resonant Controller
Gwang Hyun Shin, Seon-Hwan Hwang, Jae-Suk Lee, Kyungnam University, Korea, South

2:40 p.m. – 3:00 p.m.  T20.3:  Improving Weak Grids Adaptability of LCL-Filtered Grid-Connected Converters with Delay-Compensated Capacitor-Voltage Feedforward Control
Xiaoqiang Li2, Jingyang Fang2, Yi Tang2, Yiwen Geng1, Xiaojie Wu1, 1China University of Mining and Technology, China; 2Nanyang Technological University, Singapore

3:00 p.m. – 3:20 p.m.  T20.4:  A Robust Grid Current Controller with Grid Harmonic and Filter Resonance Damping Capabilities using a Closed-Loop Admittance Shaping
Jorge Pérez2, Santiago Cóbreces2, Xiongfei Wang1, Frede Blaabjerg1, Robert Griñó3, 1Aalborg University, Denmark; 2Universidad de Alcalá, Spain; 3Universitat Politècnica de Catalunya, Spain

3:20 p.m. – 3:40 p.m.  T20.5:  Compensation of Dead Time Effects in Grid-Tied Single-Phase Inverter using SOGI
Eun-Soo Kim, Ui-Seok Seong, Jae-Suk Lee, Seon-Hwan Hwang, Kyungnam University, Korea, South

4:10 p.m. – 4:30 p.m.  T20.6:  An Adaptive Algorithm for Grid-Connected Inverter to Suppress Current Harmonics and Instabilities Due to Grid Impedance and Distortion
Jinming Xu, Qiang Qian, Binfeng Zhang, Huizhen Wang, Shaojun Xie, Nanjing University of Aeronautics and Astronautics, China

4:30 p.m. – 4:50 p.m.  T20.7:  Analysis and Optimization of BCM Peak Current Mode Control Techniques for Microinverters
Seyed Milad Tayebi2, Nasser Kutkut1, Issa Batarseh2, 1Advanced Charging Technologies / University of Central Florida, United States; 2University of Central Florida, United States

4:50 p.m. – 5:10 p.m.  T20.8:  Systematic Design of Grid-Current-based Active Damping for Grid-Connected LCL Filters
Mahmoud Gaafar2, Gamal Dousoky3, Emad Ahmed1, Masahito Shoyama2, 1Aswan University, Egypt; 2Kyushu University, Japan; 3Minia University, Egypt

5:10 p.m. – 5:30 p.m.  T20.9:  A Multi-Loop Controller for LCL-Filtered Grid-Connected Converters Integrated with a Hybrid Harmonic Compensation and a Novel Virtual Impedance
Yonghwan Cho, Maziar Mobarrez, Subhashish Bhattacharya, North Carolina State University, United States
2:00 p.m. – 5:30 p.m.

**T21: Device Modeling & Simulation**

**ROOM 22**

**Track: Modeling and Simulation**

**SESSION CHAIRS:**
Marco Meola, Integrated Device Technology
Hadi Malek, Ford Motor Company

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**T21.1: Estimating Switching Losses for SiC MOSFETs with Non-Flat Miller Plateau Region**
Bharat Agrawal\(^1\), Matthias Preindl\(^1\), Berker Bilgin\(^2\), Ali Emadi\(^2\), \(^1\)Columbia University, United States; \(^2\)McMaster University, Canada

2:20 p.m. – 2:40 p.m.

**T21.2: Modeling of a Silicon-Carbide MOSFET with Focus on Internal Stray Capacitances and Inductances, and its Verification**
Yasushige Mukunoki\(^1\), Takeshi Horiguchi\(^1\), Yasushi Nakayama\(^1\), Akinori Nishizawa\(^1\), Yuta Nakamura\(^2\), Kentaro Konno\(^2\), Masaki Kuzumoto\(^2\), Hirofumi Akagi\(^2\), \(^1\)Mitsubishi Electric Corporation, Japan; \(^2\)Tokyo Institute of Technology, Japan

2:40 p.m. – 3:00 p.m.

**T21.3: A Physically based Scalable SPICE Model for Silicon Carbide Power MOSFETs**
Canzhong He\(^2\), James Victory\(^1\), Mehrdad Baghaie Yazdi\(^2\), Kwangwon Lee\(^2\), Martin Domeij\(^2\), Fredrik Allerstam\(^2\), Thomas Neyer\(^2\), \(^1\)Fairchild Semiconductor / ON Semiconductor, Germany; \(^2\)ON Semiconductor, Sweden; \(^2\)ON Semiconductor, Germany

3:00 p.m. – 3:20 p.m.

**T21.4: A Physics-based Compact Gallium Nitride Power Semiconductor Device Model for Advanced Power Electronics Design**
Ramchandra Kotecha, Yuzhi Zhang, Arman Rashid, Nan Zhu, Tom Vrotsos, H. Alan Mantooth, \(^1\)University of Arkansas, United States

3:20 p.m. – 3:40 p.m.

**T21.5: Analysis of the dv/dt Transient of Enhancement-Mode GaN FETs**
Edward Jones, Zheyu Zhang, Fred Wang, \(^1\)University of Tennessee, United States

4:10 p.m. – 4:30 p.m.

**T21.6: Quasi-Square Wave Converters-Modeling and Performance Benefits of GaN over Silicon**
Saurav Bandyopadhyay, Jeffrey Morroni, \(^1\)Texas Instruments Inc., United States

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2:00 p.m. – 5:30 p.m.

**T22: Control Strategies for Inverters & Motor Drives**

**ROOM 23**

**Track: Control**

**SESSION CHAIRS:**
Bilal Akin, \(^1\)University of Texas at Dallas
Serkan Dusmez, \(^2\)Texas Instruments, Inc.

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**T22.1: Rotor Position Estimation of PMSM Using Square-Wave Voltage Injection with Asymmetric Space Vector Modulation**
Hang Zhang\(^2\), Weiguo Liu\(^2\), Zhe Chen\(^3\), Guangzhao Luo\(^2\), Jianxing Liu\(^1\), Dongdong Zhao\(^2\), \(^1\)Harbin Institute of Technology, China; \(^2\)Northwestern Polytechnical University, China; \(^3\)Technische Universität München, Germany

2:00 p.m. – 2:20 p.m.

**T22.2: Compensation of Dead-Time Effects Based on Revised Repetitive Controller for PMSM Drives**
Zhuangyao Tang, Bilal Akin, \(^1\)University of Texas at Dallas, United States

2:20 p.m. – 2:40 p.m.

**T22.3: Fault-Tolerant Controller Architecture for Cascaded Multi-Level Converters**
Ali Azidehak\(^1\), Mark Hwang\(^1\), Rajat Agarwal\(^1\), Subhashish Bhattacharya\(^1\), Nima Yousefpoor\(^2\), \(^1\)North Carolina State University, United States; \(^2\)Quanta Technology, United States

2:40 p.m. – 3:00 p.m.

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4:30 p.m. – 4:50 p.m.

**T21.7: Effects of Parasitic Parameters on Electromagnetic Interference of Power Electronic Modules**
Atanu Dutta, Simon Ang, \(^1\)University of Arkansas, United States

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5:10 p.m. – 5:30 p.m.

**T21.8: Reliability Study and Modelling of IGBT Press-Pack Power Modules**
Hongyao Long\(^2\), Mark Sweet\(^2\), Ekkanath Madathil S. Narayanan\(^2\), Gangru Li\(^1\), \(^1\)IXYS Westcode Ltd, United Kingdom; \(^2\)University of Sheffield, United Kingdom

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4:50 p.m. – 5:10 p.m.

**T21.9: Bayesian Remaining Useful Lifetime Prediction of Thermally Aged Power MOSFETs**
Mehrdad Heydarzadeh, Serkan Dusmez, Mehrdad Nourani, Bilal Akin, \(^1\)University of Texas at Dallas, United States

2:00 p.m. – 5:30 p.m.

**T21: Device Modeling & Simulation**

**CONFERENCE AND EXPOSITION**

**SESSIONS**

**SESSIONS**

**T21: Device Modeling & Simulation**

**ROOM 22**

**Track: Modeling and Simulation**

**SESSION CHAIRS:**
Marco Meola, Integrated Device Technology
Hadi Malek, Ford Motor Company

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2:00 p.m. – 2:20 p.m.

**T21.1: Estimating Switching Losses for SiC MOSFETs with Non-Flat Miller Plateau Region**
Bharat Agrawal\(^2\), Matthias Preindl\(^1\), Berker Bilgin\(^2\), Ali Emadi\(^2\), \(^1\)Columbia University, United States; \(^2\)McMaster University, Canada

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Yasushige Mukunoki\(^1\), Takeshi Horiguchi\(^1\), Yasushi Nakayama\(^1\), Akinori Nishizawa\(^1\), Yuta Nakamura\(^2\), Kentaro Konno\(^2\), Masaki Kuzumoto\(^2\), Hirofumi Akagi\(^2\), \(^1\)Mitsubishi Electric Corporation, Japan; \(^2\)Tokyo Institute of Technology, Japan

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3:00 p.m. – 3:20 p.m.

**T21.4: A Physics-based Compact Gallium Nitride Power Semiconductor Device Model for Advanced Power Electronics Design**
Ramchandra Kotecha, Yuzhi Zhang, Arman Rashid, Nan Zhu, Tom Vrotsos, H. Alan Mantooth, \(^1\)University of Arkansas, United States

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Edward Jones, Zheyu Zhang, Fred Wang, \(^1\)University of Tennessee, United States

4:10 p.m. – 4:30 p.m.

**T21.6: Quasi-Square Wave Converters-Modeling and Performance Benefits of GaN over Silicon**
Saurav Bandyopadhyay, Jeffrey Morroni, \(^1\)Texas Instruments Inc., United States

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Hongyao Long\(^2\), Mark Sweet\(^2\), Ekkanath Madathil S. Narayanan\(^2\), Gangru Li\(^1\), \(^1\)IXYS Westcode Ltd, United Kingdom; \(^2\)University of Sheffield, United Kingdom

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5:10 p.m. – 5:30 p.m.

**T21.9: Bayesian Remaining Useful Lifetime Prediction of Thermally Aged Power MOSFETs**
Mehrdad Heydarzadeh, Serkan Dusmez, Mehrdad Nourani, Bilal Akin, \(^1\)University of Texas at Dallas, United States

2:00 p.m. – 5:30 p.m.

**T22: Control Strategies for Inverters & Motor Drives**

**ROOM 23**

**Track: Control**

**SESSION CHAIRS:**
Bilal Akin, \(^1\)University of Texas at Dallas
Serkan Dusmez, \(^2\)Texas Instruments, Inc.

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2:00 p.m. – 2:20 p.m.

**T22.1: Rotor Position Estimation of PMSM Using Square-Wave Voltage Injection with Asymmetric Space Vector Modulation**
Hang Zhang\(^2\), Weiguo Liu\(^2\), Zhe Chen\(^3\), Guangzhao Luo\(^2\), Jianxing Liu\(^1\), Dongdong Zhao\(^2\), \(^1\)Harbin Institute of Technology, China; \(^2\)Northwestern Polytechnical University, China; \(^3\)Technische Universität München, Germany

2:20 p.m. – 2:40 p.m.

**T22.2: Compensation of Dead-Time Effects Based on Revised Repetitive Controller for PMSM Drives**
Zhuangyao Tang, Bilal Akin, \(^1\)University of Texas at Dallas, United States

2:40 p.m. – 3:00 p.m.

**T22.3: Fault-Tolerant Controller Architecture for Cascaded Multi-Level Converters**
Ali Azidehak\(^1\), Mark Hwang\(^1\), Rajat Agarwal\(^1\), Subhashish Bhattacharya\(^1\), Nima Yousefpoor\(^2\), \(^1\)North Carolina State University, United States; \(^2\)Quanta Technology, United States
3:00 p.m. – 3:20 p.m.

**T22.4:** Cascaded Bridgeless Totem-Pole Multilevel Converter with Model Predictive Control for 400 V DC-Powered Data Centers
Yuzhi Zhang, Ramchandra Kotecha, H. Alan Mantooth, Juan Balda, Yue Zhao, Chris Farnell, University of Arkansas, United States

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3:20 p.m. – 3:40 p.m.

**T22.5:** Discrete State-Space Voltage Controller for Voltage Source Inverters with LC Filter Based on Direct Pole-Zero Placement Design
Hyeon-Sik Kim, Hyun-Sam Jung, Seung-Ki Sul, Seoul National University, Korea, South

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4:10 p.m. – 4:30 p.m.

**T22.6:** Reduced Order Generalized Integrators with Phase Compensation for Three-Phase Active Power Filter
Chuan Xie, Kai Li, Xin Zhao, Juan Carlos Vásquez, Josep M. Guerrero, Aalborg University, Denmark;
1University of Electronic Science and Technology of China, China

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4:30 p.m. – 4:50 p.m.

**T22.7:** Observer-based Predictive Current Controller for Grid-Connected Single-Phase Wind Converter
Haider Mohomad A R, Saleh A Saleh, Liuchen Chang, Shuang Xu, University of New Brunswick, Canada

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5:10 p.m. – 5:30 p.m.

**T22.9:** A Modified Division-Summation Digital Control for Grid-Connected Inverter with Wide Inductance Variation of LCL Filter
Tsai-Fu Wu, Mitradatta Misra, Li-Chiun Lin, Yen-Hsiang Huang, National Tsing Hua University, Taiwan

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2:00 p.m. – 5:30 p.m.

**T23: Renewable Energy System Considerations**

**ROOM 24**

**Track: Renewable Energy Systems**

**SESSION CHAIR:**
Xiong Li, Texas Instruments, Inc.

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2:00 p.m. – 2:20 p.m.

**T23.1:** Discharge Rate Balancing Control Strategy Based on Dynamic Consensus Algorithm for Energy Storage Units in AC Microgrids
Yajuan Guan, Lexuan Meng, Chendan Li, Juan Carlos Vásquez, Josep M. Guerrero, Aalborg University, Denmark

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2:20 p.m. – 2:40 p.m.

**T23.2:** Smart Resistor: Dynamic Stabilization of Constant Power Loads in DC Microgrids with High Bandwidth Power Converters and Energy Storage
Karun Arjun Potty, Eric Bauer, He Li, Boxue Hu, Jin Wang, Ohio State University, United States

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2:40 p.m. – 3:00 p.m.

**T23.3:** FRT Capability of Single-Phase Grid-Connected Inverter with Minimized Interconnected Inductor
Satoshi Nagai, Keisuke Kusaka, Jun-Ichi Itoh, Nagaoka University of Technology, Japan; Nagaoka University of Technology, Japan

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3:00 p.m. – 3:20 p.m.

**T23.4:** Current and Rotor Position Sensor Fault Detection and Isolation for Permanent Magnet Synchronous Generators in Wind Applications
Haibo Li, Liyan Qu, Wei Qiao, Chun Wei, University of Nebraska-Lincoln, United States

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3:20 p.m. – 3:40 p.m.

**T23.5:** Generation Cost Minimization based Distributed Coordination Control in DC Microgrids
Mohamed Zaery, Emad Mohamed Ahmed, Mohamed Orabi, Aswan University, Egypt

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4:10 p.m. – 4:30 p.m.

**T23.6:** A Fast and Accurate MPPT Control Technique using Boundary Controller for PV Applications
Yang Zhou, Carl Ngai Man Ho, Ken King Man Siu, University of Manitoba, Canada
**Wednesday**

**T23.7:** Proposal of a Control Scheme for an Active Filter on PV Micro-Inverter Applications  
Marcus Anderson A. Bezerra, Jorge Luiz L. W. Oliveira Jr., Paulo Praga, Demercil Oliveira Jr., Luiz Henrique S.C. Barreto, *Universidade Federal do Ceará, Brazil*

4:30 p.m. – 4:50 p.m.

**T23.8:** Analysis and Optimization of a High-Efficiency Residential Energy Harvesting System with Dual Half-Bridge Converter  
Shuang Zhao, Janviere Umulhuza, Yuzhi Zhang, Joe Moquin, Chris Farnell, H. Alan Mantooth, *University of Arkansas, United States*

4:50 p.m. – 5:10 p.m.

**T23.9:** Lifetime Evaluation of PV Inverters Considering Panel Degradation Rates and Installation Sites  
Ariya Sangwongwanich, Yongheng Yang, Dezso Sera, Frede Blaabjerg, *Aalborg University, Denmark*

5:10 p.m. – 5:30 p.m.

**T24: Medium/High Power Applications**

**ROOM 25**

**Track: Power Electronics Applications**

**Session Chairs:**  
Kent Wanner, *John Deere*  
Serkan Dusmez, *Texas Instruments, Inc.*

2:00 p.m. – 5:30 p.m.

**T24.1:** High Power PWM Amplifier with Coupling Inductor based Parallel Structure for Magnetic Resonance Imaging  
Lixi Chen¹, Tao Zhang², Jianping Xu¹, ¹Southwest Jiaotong University, China; ²University of Electronic Science and Technology of Chengdu, China

2:00 p.m. – 2:20 p.m.

**T24.2:** High Power and Low Voltage Power Supply for Low Frequency Pulsed Load  
Xinze Huang, Xinbo Ruan, Fangjun Du, Fei Liu, Li Zhang, *Nanjing University of Aeronautics and Astronautics, China*

2:20 p.m. – 2:40 p.m.

**T24.3:** An Intelligent IGBT Module for Quasi-Resonant Converter Applications  
Wonjin Cho, Bum-Seok Suh, Son Tran, *Alpha and Omega Semiconductor, United States; Alpha and Omega Semiconductor, Korea, South*

2:40 p.m. – 3:00 p.m.

**T24.4:** Control Scheme and Characteristics Analysis of Three-Phase Series Resonant Converter Suitable for Contactless Slipping System  
Xin Chen², Qianhong Chen², Guangming He², Xiaoyong Ren², Siu-Chung Wong¹, ¹Hong Kong Polytechnic University, China; ²Nanjing University of Aeronautics and Astronautics, China

3:00 p.m. – 3:20 p.m.

**T24.5:** A Phase-Shift Dual-Frequency Selective Harmonic Elimination for Multiple AC Loads in a Full Bridge Inverter Configuration  
Chongwen Zhao, Daniel Costinett, *University of Tennessee, United States*

3:20 p.m. – 3:40 p.m.

**T24.6:** Novel Control Architecture for Programmable Electronic AC Load to Achieve Harmonic Load Profiles  
Zhi Geng, Dazhong Gu, Tianqi Hong, Jiaxin Teng, Dariusz Czarkowski, *New York University Tandon School of Engineering, United States*

4:10 p.m. – 4:30 p.m.

**T24.7:** High Frequency Transformer Design for Modular Power Conversion from Medium Voltage AC to 400V DC  
Shishuo Zhao, Qiang Li, Fred C. Lee, *Virginia Polytechnic Institute and State University, United States*

4:30 p.m. – 4:50 p.m.

**T24.8:** Modelling and Design of Active Thermal Controls for Power Electronics of Motor Drive Applications  
Ionut Vernica, Frede Blaabjerg, Ke Ma, *Aalborg University, Denmark*

4:50 p.m. – 5:10 p.m.

**T24.9:** Modeling and Damping Strategy for Active Power Oscillation of Static Var Generator  
Jianjun Sun², Ying He², Jinwu Gong², Xiaoming Zha², Wei Hu¹, ¹State Grid Hubei Electric Power Company Electric Power Research Institute, China; ²Wuhan University, China

5:10 p.m. – 5:30 p.m.

7:00 p.m. – 10:00 p.m.

**“Little Havana” Evening Social Event**  
*(Ticket Required)*  
CURTIS HIXON WATERFRONT PARK

Visit the APEC Registration desk for a walking map to the park. Limited bus transportation will also be available starting at 6:45 p.m. departing from the Tampa Convention Center.
Thursday
March 30, 2017

7:00 a.m. – 8:00 a.m.
**Presenter Breakfast**
BALLROOM A

8:00 a.m. – 12:00 p.m.
**Registration**
2ND FLOOR CONCOURSE

8:00 a.m. – 9:00 a.m.
**Spouse and Guest Breakfast**
MARRIOTT – MEETING ROOM 4

8:00 a.m. – 11:00 a.m.
**Spouse and Guest Hospitality Room Open**
MARRIOTT – MEETING ROOM 4

8:30 a.m. – 11:30 a.m.
**IS13: GaN Topics and Applications**
ROOM 15/16
**Session Chair:**
Peter Di Maso, GaN Systems

**IS13.1:** Advancements in Reliability Evaluation of eGaN® Fets and ICs Demonstrates Readiness for Mainstream Adoption
Chris Jakubiec, Robert Strittmatter, Efficient Power Conversion Corporation, United States

**IS13.2:** Deadtime Losses in eGaN® Fets and Silicon MOSFETs – How Freedom from Reverse Recovery Can Cut Your Losses
John Glaser, David Reusch, Efficient Power Conversion Corporation

**IS13.3:** System-Level Reliability Validation of GaN Devices for Power Management
Sandep Bahl, Lixing Fu, Jungwoo Joh, Angela Lam, Anup Sasikumar, TI, United States

9:45 a.m. – 10:10 a.m.
**IS13.4:** Preventing GaN Device VHF Oscillation
Jason Cuadra, Zan Huang, Transphorm Inc., United States

10:40 a.m. – 11:05 a.m.
**IS13.5:** Gan E-HEMTs Enable Innovation in Power Switching Applications
Peter Di Maso, Lucas Lu, GaN Systems Inc., Canada

11:05 a.m. – 11:30 a.m.
**IS13.6:** Low Cost Digital Totem Pole PFC with Single Shunt Current Sensing and Differential AC Voltage Sensing
Wei Wu, Infineon Technologies North America, United States

8:30 a.m. – 11:30 a.m.
**IS14: Isolation Barrier Technologies for Power Electronics**
ROOM 14
**Session Chairs:**
Kevin Parmenter, Excelsys Technologies
Jim Spangler, Independent

**IS14.1:** Gate Driver Selection
Mitchell Van Ochten, ROHM Semiconductor, United States

8:30 a.m. – 8:55 a.m.
**IS14.2:** Isolation in Industrial Motor Drives
Xiong Li, Anant Kamath, Texas Instruments, United States

8:55 a.m. – 9:20 a.m.
**IS14.3:** Next-Generation GaN Isolators for High Frequency, High Efficiency Power Conversion
Stephen Oliver, Marco Giandalia, Navitas Semiconductor, United States

9:20 a.m. – 9:45 a.m.
**IS14.4:** Logic Level Signal Isolation Technology Review
Mark Cantrell, Analog Devices Inc., United States

9:45 a.m. – 10:10 a.m.
**IS14.5:** Importance of Measuring Parasitic Capacitance in Isolated Gate Drive Applications
Wolfgang Frank, Infineon Technologies Germany, Germany

10:40 a.m. – 11:05 a.m.
**IS14.6:** Mitigating Common Mode Transient Effects with Best in Class Isolators
Rudye McGlothian, Silicon Laboratories

8:30 a.m. – 11:30 a.m.
**IS14.7:** Isolation Barrier Technologies for Power Electronics
ROOM 14
**Session Chairs:**
Kevin Parmenter, Excelsys Technologies
Jim Spangler, Independent

8:30 a.m. – 8:55 a.m.
**IS14.8:** Gate Driver Selection
Mitchell Van Ochten, ROHM Semiconductor, United States

8:55 a.m. – 9:20 a.m.
**IS14.9:** Isolation in Industrial Motor Drives
Xiong Li, Anant Kamath, Texas Instruments, United States

9:20 a.m. – 9:45 a.m.
**IS14.10:** Next-Generation GaN Isolators for High Frequency, High Efficiency Power Conversion
Stephen Oliver, Marco Giandalia, Navitas Semiconductor, United States

9:45 a.m. – 10:10 a.m.
**IS14.11:** Logic Level Signal Isolation Technology Review
Mark Cantrell, Analog Devices Inc., United States

10:40 a.m. – 11:05 a.m.
**IS14.12:** Importance of Measuring Parasitic Capacitance in Isolated Gate Drive Applications
Wolfgang Frank, Infineon Technologies Germany, Germany

11:05 a.m. – 11:30 a.m.
**IS14.13:** Mitigating Common Mode Transient Effects with Best in Class Isolators
Rudye McGlothian, Silicon Laboratories
8:30 a.m. – 11:30 a.m.

**IS15: Industrial Power Applications of Silicon Carbide Semiconductors**

ROOM 13

**Session Chair:**
Jim LeMunyon, PowerAmerica

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8:30 a.m. – 8:55 a.m.

**IS15.1:** Rugged 1.2 KV SiC MOSFETs Fabricated in High-Volume 150mm CMOS Fab
Sujit Banerjee, Kevin Matocha, Xuning Zhang, Gin Sheh, Levi Gant, Monolith Semiconductor Inc., United States

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8:55 a.m. – 9:20 a.m.

**IS15.2:** Life Testing of Wolfspeed Industry Standard Modules
Mrinal Das, Marcelo Schupbach, Adam Barkley, Wolfspeed, A Cree Company, United States

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9:20 a.m. – 9:45 a.m.

**IS15.3:** Market and Technology Roadmaps for Silicon Carbide Technology
John Muth, PowerAmerica, United States

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9:45 a.m. – 10:10 a.m.

**IS15.4:** SiC MOSFETs and Power Modules for Industrial Applications
John Palmour, Wolfspeed, United States

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10:40 a.m. – 11:05 a.m.

**IS15.5:** 200 kW 1050 VDC SiC Dual Inverter for Heavy-Duty Vehicles
Brij N. Singh, John Deere, Inc., United States

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11:05 a.m. – 11:30 a.m.

**IS15.6:** Silicon Carbide Device-Based Commercial PV Inverters
Peter Liu, Toshiba International, United States

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8:30 a.m. – 11:20 a.m.

**T25: DC-DC Converter Applications**

ROOM 1/2

**Track: DC-DC Converters**

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**Session Chairs:**
Hoi Lee, University of Texas at Dallas
Lingxiao Xue, Navitas Semiconductor

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8:30 a.m. – 8:50 a.m.

**T25.1:** A Novel PCB Winding Transformer with Controllable Leakage Integration for a 6.6kW 500kHz High Efficiency High Density Bi-Directional On-Board Charger
Bin Li, Qiang Li, Fred C. Lee, Virginia Polytechnic Institute and State University, United States

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8:50 a.m. – 9:10 a.m.

**T25.2:** Design and Implementation of a Low-Cost and Compact Floating Gate Drive Power Circuit for GaN-based Flying Capacitor Multi-Level Converters
Zichao Ye, Yutian Lei, Wen-Chuen Liu, Pradeep S. Shenoy, Robert C.N. Pilawa-Podgurski, Texas Instruments Inc., United States; University of Illinois Urbana-Champaign, United States

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8:30 a.m. – 9:20 a.m.

**IS16.2:** Chip Scale TEG and its Use for a Wireless Machine Health Monitoring System
Baoxing Chen, Jane Cornett, Analog Devices, Inc., United States

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9:20 a.m. – 9:45 a.m.

**IS16.3:** Energy Harvesting with Thin-Film GaAs Solar Cells
Rodney Amen, Alta Devices, United States

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9:45 a.m. – 10:10 a.m.

**IS16.4:** Ultra Low Power Energy Harvesting and Power Management IC (PMIC) Design
Seamus O’Driscoll, Tyndall National Institute, Ireland

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10:40 a.m. – 11:05 a.m.

**IS16.5:** IoT – Power Challenge – How Low Can We Go?
Ajinder Singh, Texas Instruments, United States

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11:05 a.m. – 11:30 a.m.

**IS16.6:** Interactive Energy Harvesting Demonstrations
Mike Hayes, Tyndall National Institute, Ireland

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8:30 a.m. – 11:30 a.m.

**IS16: Energy Harvesting**

ROOM 11

**Session Chair:**
Mike Hayes, Tyndall National Institute

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8:30 a.m. – 8:55 a.m.

**IS16.1:** The Reality about Energy Harvesting
Lorandt Fölkel, Wurth Elektronik eiSos, Germany

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8:55 a.m. – 9:20 a.m.

**IS16.2:** Chip Scale TEG and its Use for a Wireless Machine Health Monitoring System
Baoxing Chen, Jane Cornett, Analog Devices, Inc., United States

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9:20 a.m. – 9:45 a.m.

**IS16.3:** Energy Harvesting with Thin-Film GaAs Solar Cells
Rodney Amen, Alta Devices, United States

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9:45 a.m. – 10:10 a.m.

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Seamus O’Driscoll, Tyndall National Institute, Ireland

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10:40 a.m. – 11:05 a.m.

**IS16.5:** IoT – Power Challenge – How Low Can We Go?
Ajinder Singh, Texas Instruments, United States

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11:05 a.m. – 11:30 a.m.

**IS16.6:** Interactive Energy Harvesting Demonstrations
Mike Hayes, Tyndall National Institute, Ireland
T26.4: A GaN based Doubly Grounded, Reduced Capacitance Transformer-Less Split Phase Photovoltaic Inverter with Active Power Decoupling
Yinglai Xia, Jinia Roy, Raja Ayyanan, Arizona State University, United States

T26.5: Forward Dual-Active-Bridge Solid State Transformer for a SiC-based Cascaded Multilevel Converter Cell in Solar Applications
Thiago Parreiras\(^2\), Alysson Machado\(^2\), Fernando Amaral\(^2\), Gideon Lobato\(^2\), José Brito\(^1\), Braz Cardoso F.\(^2\), COELBA S.A., Brazil; \(^2\)Universidade Federal de Minas Gerais, Brazil

T26.6: Split-Winding Type Three Limb Core Structured HF Transformer for Integrating PV and Energy Storage(E)
Ritwick Chattopadhay, Ghanshyamsinh Gohil, Subhashish Bhattacharya, North Carolina State University, United States

T26.7: A Modular Silicon Carbide (SiC)-based Single-Stage Three-Phase AC/DC Step-Up Medium Voltage Converter with Extended Soft-Switching Operations for DC Grid in Wind Systems
Mehdi Abbasi, John Lam, York University, Canada

8:30 a.m. – 11:20 a.m.

T27: Power Modules
ROOM 20

Track: Devices and Components

SESSION CHAIRS:
Douglas Hopkins, North Carolina State University
Jared Hornberger, Wolfspeed, A Cree Company

T27.1: A Phase-Leg IGBT Module using DBC Substrate without Ag Finish by Pressureless Sintering of Nanosilver Paste
Haidong Yan\(^1\), Yun-Hui Mei\(^1\), Xin Li\(^1\), Gang Chen\(^1\), Guo-Quan Lu\(^2\), Tianjin University, China; \(^2\)Virginia Polytechnic Institute and State University, United States

T27.2: A Current Sensorless IGBT Junction Temperature Extraction Method via Parasitic Parameters between Power Collector and Auxiliary Collector
Wei Shi\(^2\), Xiang Wang\(^2\), Yu Zhou\(^2\), Haoze Luo\(^2\), Wuhua Li\(^2\), Xiangning He\(^2\), Jun Ma\(^1\), Guodong Chen\(^1\), Ye Tian\(^1\), Enxing Yang\(^1\), Shanghai Electric, China; \(^2\)Zhejiang University, China
### T27.3: Hybrid Si IGBT-SiC Schottky Diode Modules for Medium to High Power Applications
Leif Amber, Kevork Haddad, SEMIKRON Inc, United States

### T27.4: Medium Voltage Power Module based on SiC JFETs
Xueqing Li, Hao Zhang, Anup Bhalla, United Silicon Carbide, Inc., United States

### T27.5: Performance of a 1.2kV, 288A Full-SiC MOSFET Module based on Low Inductance Packaging Layout
Liang Qiao¹, Xu Yang¹, Yu Ren¹, Fan Zhang¹, Laili Wang², Xin Ma¹, Shenhua Zhang¹, ¹Xi’an Jiaotong University, China; ²Xi’an Jiaotong University / Sumida Corporation, China

### T27.6: Series-Connected GaN Transistors for Ultra-Fast High-Voltage Switch (>1kV)
Jaume Roig¹, German Gomez¹, Filip Bauwens¹, Basil Vlachakis¹, Juan Rodríguez², Maria Rodríguez Rogina², Alberto Rodríguez², Diego G. Lamar², ¹ON Semiconductor, Belgium; ²Universidad de Oviedo, Spain

### T27.7: Paralleling GaN E-HEMTs in 10kW-100kW Systems
Juncheng Lu, Di Chen, GaN Systems Inc, Canada

### T28.3: Thermal Design of a Dual Sided Cooled Power Semiconductor Module for Hybrid and Electric Vehicles
Yangang Wang, Yun Li, Xiaoping Dai, Shiwu Zhu, Steve Jones, Guoyou Liu, Dynex Semiconductor Ltd., China; Dynex Semiconductor Ltd., United Kingdom

### T28.4: A New Multi-Functional Compact IPM for Low Power Industrial Application
Yazhe Wang¹, Kosuke Yamaguchi¹, Kiyoto Watabe¹, Tomofumi Tanaka¹, Mike Rogers², Eric R. Moto², ¹Mitsubishi Electric Corporation, Japan; ²Powerex Inc., United States

### T28.5: 300 W 4Q PV Inverter using New High Density Control Integrated Circuits
Tanya Gachovska, Gabriel Scarlatescu, Chris Gerolami, Tudor Lipan, Nikolay Radimov, Christian Cojocaru, Peter Preston-Thomas, Mihai Varlan, Solantro Semiconductor Corp., Canada

### T28.6: Low-Temperature, Organics-Free Sintering of Nanoporous Copper for Reliable, High-Temperature and High-Power Die-Attach Interconnections
Kashyap Mohan, Ninad Shahane, Pulugurthu M. Raj, Antonia Antoniou, Vanessa Smet, Rao Tummala, Georgia Institute of Technology, United States

### T28.7: Silver Sintering Die Attach Process for IGBT Power Module Production
Yimin Zhao¹, Paul Mumby-Croft¹, Steve Jones¹, Xiaoping Dai¹, Zechun Dou², Yafei Wang², Feng Qin², ¹Dynex Semiconductor Ltd., United Kingdom; ²Zhuzhou CRRC Times Electric Co. Ltd, China

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### T28: Packaging Innovation for High Reliability
**ROOM 21**

**Track: System Integration**

**Session Chairs:**
John Vigars, Allegro Microsystems
Ernie Parker, Crane Aerospace & Electronics

### T28.1: Design of a Low Parasitic Inductance SiC Power Module with Double-Sided Cooling
Fei Yang², Zhenxian Liang¹, Zhiqiang Wang¹, Fred Wang², ¹Oak Ridge National Laboratory, United States; ²University of Tennessee, United States

### T28.2: Novel Cooling Technology to Reduce Thermal Impedance and Thermomechanical Stress for SiC Application
Borong Hu¹, Zheng Zeng¹, Weihua Shao¹, Qing Ma¹, Hai Ren¹, Hui Li¹, Li Ran¹, Zhijun Li², ¹Chongqing University, China; ²Global Power Technology (Beijing) Co. Ltd., China
8:30 a.m. – 11:20 a.m.

**T29: Systems & Components Modeling & Simulation**

ROOM 22

**Track: Modeling and Simulation**

**Session Chairs:**
Martin Ordonez, University of British Columbia
Marco Meola, Integrated Device Technology

8:30 a.m. – 8:50 a.m.

**T29.1: Investigation and Simulation Model Results of High Density Wireless Power Harvesting and Transfer Method**
Jaber Abu Qahouq, Zhigang Dang, University of Alabama, United States

8:50 a.m. – 9:10 a.m.

**T29.2: Modeling of Wireless Power System with Giant Magnetostrictive Material Load under Multi-Field Coupling**
Xuling Chen, Xinglei Gong, Nanjing University of Aeronautics and Astronautics, China

9:10 a.m. – 9:30 a.m.

**T29.3: A Novel Equivalent Circuit Thermal Model for Integrated Power Modules**
Wenbo Liu1, Yan-Fei Liu1, Laili Wang2, Doug Malcolm2, 1Queen’s University, Canada; 2Sumida Corporation, Canada;

9:30 a.m. – 9:50 a.m.

**T29.4: Verification of Control Design and Implementation for Power Supplies by FPGA-in-the-Loop Simulation**
Misha Kumar, Laszlo Huber, Milan M. Jovanović, Delta Products Corporation, United States

9:50 a.m. – 10:10 a.m.

**T29.5: A Neural Network based Method for Instantaneous Power Estimation in Electric Vehicles’ Li-Ion Batteries**
Ala Hussein, Yarmouk University, Jordan

10:40 a.m. – 11:00 a.m.

**T29.6: Modeling of Domestic Induction Heating Systems with Non-Linear Saturable Loads**
Javier Serrano2, Jesús Acero2, Ignacio Lope1, Claudio Carretero2, José Miguel Burdío2, Rafael Alonso2, 1BSH Home Appliances Group, Spain; 2Universidad de Zaragoza, Spain

11:00 a.m. – 11:20 a.m.

**T29.7: Simplified Modeling of Ultracapacitors for Bidirectional DC-DC Converter Applications**
Saichand Kasicheyanula, Vinod John, Indian Institute of Science, India

8:30 a.m. – 11:20 a.m.

**T30: Control of Motor Drives II**

ROOM 23

**Track: Motor Drives and Inverters**

**Session Chairs:**
Bulent Sarlioglu, University of Wisconsin-Madison
Ali Bazzi, University of Connecticut

8:30 a.m. – 8:50 a.m.

**T30.1: Simple Analytical Derivation of Magnetic Flux Profile Eliminating Source Current Ripple and Torque Ripple of Switched Reluctance Motors for Electric Vehicle Propulsion**
Takayuki Kusumi, Takuto Hara, Kazuhiro Umetani, Eiji Hiraki, Okayama University, Japan

8:50 a.m. – 9:10 a.m.

**T30.2: Stator-Current-based MRAS Observer for the Sensorless Control of the Brushless Doubly-Fed Induction Machine**
Guanguan Zhang2, Jian Yang2, Mei Su1, Weiyi Tang2, Frede Blaabjerg1, 1Aalborg University, Denmark; 2Central South University, China

9:10 a.m. – 9:30 a.m.

**T30.3: A New LMS based Algorithm to Suppress Dead-Time Effects in PMSM V/f Drives**
Zhuangyao Tang, Bilal Akin, University of Texas at Dallas, United States

9:30 a.m. – 9:50 a.m.

**T30.4: Performance Analysis of Grid Connected Induction Motor using Floating H-Bridge Converter**
Reaz Ul Haque2, Siyu Leng1, Ian Smith2, John Salmons2, 1Petroleum Institute, U.A.E.; 2University of Alberta, Canada

9:50 a.m. – 10:10 a.m.

**T30.5: Performance Evaluation of Electronic Inductor based Adjustable Speed Drives with Respect to Line Current Interharmonics**
Hamid Soltani1, Pooya Davari1, Frede Blaabjerg1, Firuz Zare2, 1Aalborg University, Denmark; 2University of Queensland, Australia

10:40 a.m. – 11:00 a.m.

**T30.6: Novel Frequency Determination Method for Dynamic Magnet Temperature Estimation of a Five Phase PMa-SynRM using Signal Injection Method**
Joseph Herbert, Akh Arafat, Seungdeog Choi, University of Akron, United States
T30.7: Permanent-Magnet-Free-Synchronous Motor with Self-Excited Wound-Field Technique Utilizing Space Harmonics
Masahiro Aoyama2, Toshihiko Noguchi1, 1Shizuoka University, Japan; 2Suzuki Motor Corporation, Japan

8:30 a.m. – 11:20 a.m.

T31: DC-DC Conversion & Other Transportation Applications
ROOM 24

Track: Transportation Power Electronics

SESSION CHAIRS:
Kent Wanner, John Deere
Navid Zargari, Rockwell Automation

8:30 a.m. – 8:50 a.m.

T31.1: A Model-based Buck-Type Active Filter using Proportional-Resonant Controller and GaN HEMTs
Allan Taylor2, Juncheng Lu2, Hua Kevin Bai1, Alan Brown1, Matt McAmmond1, 1Hella Corporate Center USA Inc., United States; 2Kettering University, United States

8:50 a.m. – 9:10 a.m.

T31.2: A Low Cost Gate Driver with Dynamic Turn-Off Transient Control for HEV/EV Traction Inverter Application
Yan Zhou, Lihua Chen, Shuitao Yang, Fan Xu, Mohammed Khorshed Alam, Ford Motor Company, United States

9:10 a.m. – 9:30 a.m.

T31.3: A DLL/PLL based Multi-Phase Interleaved DC-DC Converter with Digital Off-Time Control and Active Series Balancing for Electric Vehicles
Steven Chung, Shuze Zhao, Olivier Trescases, University of Toronto, Canada

9:30 a.m. – 9:50 a.m.

T31.4: Vehicle Side Predictive Power-Flow Control of Bidirectional WPT System for EV Ancillary Services
Ahmed Mohamed, Tarek Youssef, Osama Mohammed, Florida International University, United States

9:50 a.m. – 10:10 a.m.

T31.5: An Automatic Battery Equalizer based on Forward and Flyback Conversion for Series-Connected Battery Strings
Yunlong Shang3, Bing Xia1, Chenghui Zhang2, Naxin Cui2, Jufeng Yang1, Chris Mi1, 1San Diego State University, United States; 2Shandong University, China; 3Shandong University and San Diego State University, China

11:00 a.m. – 11:20 a.m.

T31.6: Balancing Strategy of Lithium-Ion Batteries based on Change Rate of SOC
Yang Yang, Zhi-Liang Zhang, Dong-Jie Gu, Xiang Cheng, Nanjing University of Aeronautics and Astronautics, China

11:00 a.m. – 11:20 a.m.

T31.7: Bi-Directional PSFB DC-DC Converter with Unique PWM Control Schemes and Seamless Mode Transitions using Enhanced Digital Control
Hrishikesh Nene2, Toshiyuki Zaitsu1, 1Omron Corporation, Japan; 2Texas Instruments Inc., United States

8:30 a.m. – 11:20 a.m.

T32: Power Electronic Applications
ROOM 25

Track: Power Electronics Applications

SESSION CHAIRS:
Mike Seeman, Eta One Power
Hanh-Phuc Le, University of Colorado Boulder

8:30 a.m. – 8:50 a.m.

T32.1: A Novel Distributed Control Strategy for Modular Multilevel Converters
Shunfeng Yang1, Yi Tang1, Michael Zagrodnik2, Gupta Amit2, Peng Wang1, 1Nanyang Technological University, Singapore; 2Rolls-Royce Singapore Pte. Ltd., Singapore

8:50 a.m. – 9:10 a.m.

T32.2: Modulation Strategy for Highly Reliable Cascade H-Bridge Inverter based on Discontinuous PWM
Youngjong Ko1, Markus Andresen1, Giampaolo Buticchi1, June-Seok Lee2, Marco Lisserre1, 1Christian-Albrechts-Universität zu Kiel, Germany; 2Korea Railroad Research Institute, Korea, South

9:10 a.m. – 9:30 a.m.

T32.3: A High Frequency Isolated Resonant Gate Driver for SiC Power MOSFET with Asymmetrical On/Off Voltage
Juzheng Yu2, Qinsong Qian2, Peng Liu2, Weifeng Sun2, Shengli Lu2, Yangbo Yi1, 1Chipown Microelectronics, China; 2Southeast University, China

9:30 a.m. – 9:50 a.m.

T32.4: A Comparative Analysis of Two Approaches in EER based Envelope Tracking Power Supplies
Vladan Lazarević2, Miroslav Vasic2, Oscar García2, Qian Jin1, Pedro Alou2, Jesús Angel Oliver2, José Antonio Cobos2, 1Nanjiang University of Aeronautics and Astronautics, China; 2Universidad Politécnica de Madrid, Spain
THURSDAY

T32.5: **Equivalency Analysis of Primary Series- and Series-Parallel-Compensated Contactless Resonant Converter**
Wei Gao, Qianhong Chen, Yuchuan Geng, Xiaoyong Ren, Siu-Chung Wong, Hong Kong Polytechnic University, China; Nanjing University of Aeronautics and Astronautics, China

T32.6: **A Simple and Accurate Efficiency Measurement Method for Power Converters**
Arun Kadavelugu, Harish Suryanarayana, Liming Liu, Zach Pan, Christopher Belcastro, Esa-Kai Paatero, ABB, United States; ABB, Finland

T32.7: **Comparative Evaluation of IPT Resonant Circuit Topologies for Wireless Power Supplies of Implantable Mechanical Circulatory Support Systems**
Oliver Knecht, Johann Walter Kolar, Eidgenössische Technische Hochschule Zürich, Switzerland

11:30 a.m. – 2:00 p.m.

**Dialogue Session**
(for detailed information see page 136)
BALLROOM B/C

2:00 p.m. – 5:25 p.m.

**IS17: Silicon Carbide Device Applications**
ROOM 15/16

**SESSION CHAIR:**
David Levett, Infineon Technologies

2:00 p.m. – 2:25 p.m.

**IS17.1: SIC MOSFET Performance in a Bidirectional DC-DC Converter**
Luigi Abbatelli, Vittorio Giuffrida, STMicroelectronics, Italy

2:25 p.m. – 2:50 p.m.

**IS17.2: Driving Silicon Carbide Power Modules: Efficiency & Reliability**
Nitesh Satheesh, AgileSwitch, United States

2:50 p.m. – 3:15 p.m.

**IS17.3: New DIPIPM™ Featuring High Threshold Voltage SiC MOSFETs**
Michael Rogers, Powerex, United States

3:15 p.m. – 3:40 p.m.

**IS17.4: Advanced SiC MOSFET Technologies for Power Circuit Applications**
Rahul Radhakrishnan, Richard Woodin, Global Power Technologies Group, United States

4:10 p.m. – 4:35 p.m.

**IS17.5: SiC Trench MOSFETs and Intelligent Power Modules (IPMs)**
Kengo Ohmori, Nobuhiro Hase, Yuji Ishimatsu, ROHM Co., Ltd., Japan; ROHM Semiconductor, United States

4:35 p.m. – 5:00 p.m.

**IS17.6: Module and PCB Layout and Design to Optimize Performance of SiC Trench Gate MOSFETs**
David Levett, Maximilian Slawinski, Infineon North America, United States; Infineon Technologies Germany, Germany

5:00 p.m. – 5:25 p.m.

**IS17.7: Strategic Guidance to Accelerate Large-Scale Adoption of Wide Band Gap Power Semiconductors**
Victor Veliadis, North Carolina State University

2:00 p.m. – 5:25 p.m.

**IS18: Capacitor Technologies for Evolving Power Electronic Applications**
ROOM 14

**SESSION CHAIRS:**
Ralph Kerrigan, NWL, Inc.
Fred Weber, Future Technology Worldwide

2:00 p.m. – 2:25 p.m.

**IS18.1: Dry Film Capacitors for High-Frequency Power Electronics**
Joseph A. Bond, Electronic Concepts Inc., United States

2:25 p.m. – 2:50 p.m.

**IS18.2: Embedding Aluminum Polymer Elements**
James Lewis, KEMET Electronics Corporation, United States

2:50 p.m. – 3:15 p.m.

**IS18.3: Metallized Polypropylene Capacitors for Electrification of Larger Vehicles**
Ralph Kerrigan, NWL, United States

3:15 p.m. – 3:40 p.m.

**IS18.4: Aluminum Electrolytic vs. Polymer –Two Technologies – Various Opportunities**
Pierre Lohrber, Würth Elektronik eiSos GmbH & Co. KG, Germany
4:10 p.m. – 4:35 p.m.

**IS18.5:** Ceramic Capacitors with Base Metal Electrodes for Power Electronics Applications  
Abhijit Gurav, KEMET Electronics Corporation, United States

4:35 p.m. – 5:00 p.m.

**IS18.6:** Downhole Tools in the Oilfield Services Industry: Transformation to Improve Reliability  
Robert Haywood, W.L. Gore & Associates, Inc., United States

5:00 p.m. – 5:25 p.m.

**IS18.7:** Benefits of Million Times Larger Capacitance in EDLCs: Supercapacitor Assisted Novel Circuit Topologies  
Nihal Kularatna, The University of Waikato, New Zealand

2:00 p.m. – 5:25 p.m.

**IS19: Circuits and Applications**  
ROOM 13

**Session Chair:**  
Laszlo Balogh, ON Semiconductor

2:00 p.m. – 2:25 p.m.

**IS19.1:** Design of Multi-MHz Series Capacitor Buck Converters used as Voltage Regulators  
Pradeep Shenoy, Texas Instruments, United States

2:25 p.m. – 2:50 p.m.

**IS19.2:** How to Choose the Best Pulse Load Surface Mount Resistors?  
Breno Albuquerque, Vishay Intertechnology, Inc., United States

2:50 p.m. – 3:15 p.m.

**IS19.3:** Wireless Power Class E Amplifier using a eGaN® FET and eGaN Gate Driver IC  
Yuanzhe Zhang, Michael de Rooij, Efficient Power Conversion

3:15 p.m. – 3:40 p.m.

**IS19.4:** Fast Switching Transistors Extend Applications for Wireless Power Across All Markets  
Larry Spaziani¹, Paul Mitcheson², Geoff Haynes¹, Sam Aldhaher², George Kkelis², Juan Arteaga², David Yates², ¹GaN Systems, United Kingdom; ²GaN Systems, Canada; ²Imperial College London, United Kingdom

4:10 p.m. – 4:35 p.m.

**IS19.5:** Position & Features of Wireless Power Coil Matters  
Raghu Narayanan, Wurth Electronik eiSos, United States

4:35 p.m. – 5:00 p.m.

**IS19.6:** Design Tips for Selection of Power Inductors  
Alexander Gerfer, Wurth

2:00 p.m. – 2:25 p.m.

**IS20.1:** What is a Micro-Grid?  
Dusty Becker¹, Alexis Kwasinski², ¹Power Sources Manufacturers Association, United States; ²University of Pittsburgh, United States

2:25 p.m. – 2:50 p.m.

**IS20.2:** The Objectives of Energy Management in Micro Grids  
Eric Gallant, GS Battery Inc., United States

2:50 p.m. – 3:15 p.m.

**IS20.3:** Current and Future Applications for the Smart Micro-Grid  
Bharat Shah, -, United States

3:15 p.m. – 3:40 p.m.

**IS20.4:** Smart Grid Security: Is Your Smart Grid Secured?  
Patrick Le Fèvre, Powerbox, Sweden

4:10 p.m. – 4:35 p.m.

**IS20.5:** Micro Grids – Test & Compliance Challenges for Distributed Energy Resource (DER) Manufacturers  
Mike Hawes, Keysight Technologies, Inc., United States

4:35 p.m. – 5:00 p.m.

**IS20.6:** Energy Storage is more than Batteries and Capacitors  
Johathan Kimball, Missouri University of Science and Technology, United States

5:00 p.m. – 5:25 p.m.

**IS20.7:** Connecting the Dots: How Inverters Have, Can, and Should Be Used for Ancillary Services  
Donny Zimmerman, Enphase, United States
2:00 p.m. – 5:30 p.m.

**T33: Active Var & Harmonic Compensation**
ROOM 1/2

**Track: Power Electronics for Utility Interface**

**Session Chairs:**
Yunwei Li, *University of Alberta*
Martin Ordonez, *University of British Columbia*

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**2:00 p.m. – 2:20 p.m.**

**T33.1:** A Novel LCL-Filtered Single-Phase Half-Bridge Distributed Static Compensator with DC-Link Filter Capacitors and Reduced Passive Component Parameters  
Jingyang Fang, Xiaoqiang Li, Yi Tang,  
*Nanyang Technological University, Singapore*

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**2:20 p.m. – 2:40 p.m.**

**T33.2:** An Improved Method of SAPF for Harmonic Compensation and Resonance Damping with Current Detection of Power Capacitors and Linear/Nonlinear Loads  
Yuxiao Zhang¹, Ke Dai¹, Xinwen Chen¹, Yong Kang¹,  
Ziwei Dai², ¹Huazhong University of Science and Technology, China; ²Rensselaer Polytechnic Institute, United States

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**2:40 p.m. – 3:00 p.m.**

**T33.3:** Design of a Center-Point-Clamped AC-AC Converter based Power-Line Conditioner  
Pankaj Kumar Bhowmik, Somasundaram Essakiappan, Madhav Manjrekar, *University of North Carolina at Charlotte, United States*

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**3:00 p.m. – 3:20 p.m.**

**T33.4:** Harmonic Analysis and Mitigation of Low-Frequency Switching Voltage Source Inverter with Series LC Filtered VSI  
Haofeng Bai, Xiongfei Wang, Poh Chiang Loh, Fred Blaabjerg, *Aalborg University, Denmark*

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**3:20 p.m. – 3:40 p.m.**

**T33.5:** A Transformerless Reduced Switch Counts Three-Phase APF-Assisted Smart EV Charger  
Wajahat Tareen, Saad Mekhilef, Mutsuo Nakaoka,  
*University of Malaya, Pakistan; University of Malaya, Japan; University of Malaya, Algeria*

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**4:10 p.m. – 4:30 p.m.**

**T33.6:** A Soft-Switching Dynamic VAr Compensator  
Hao Chen, Deepak Divan, *Georgia Institute of Technology, United States*

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2:00 p.m. – 5:30 p.m.

**T34: DC-DC Converter Control Methods**
ROOM 18/19

**Track: DC-DC Converters**

**Session Chairs:**
Jason Stauth, *Dartmouth*
David Reusch, *Efficient Power Conversion Corporation*

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**2:00 p.m. – 2:20 p.m.**

**T34.1:** A New Adaptive Output Voltage Controller for Fast Battery Charger  
Kai-Hui Chen, Tsorng-Juu Liang, Bin-Kun Huang, *National Cheng Kung University, Taiwan*

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**2:20 p.m. – 2:40 p.m.**

**T34.2:** Improved Dynamics in DC-DC Converters for IoT Applications with Repetitive Load Profiles using Self-Calibrated Preemptive Current Control  
David King Wai Li², Zhe Gong², Matthias Rose¹, Henk Jan Bergveld¹, ¹NXP Semiconductors, Netherlands; ²University of Toronto, Canada
THURSDAY

2:40 p.m. – 3:00 p.m.
T34.3:  Modulation Strategy for Wide-Range ZVS Operation of a Three-Level Three-Phase Dual Active Bridge DC-DC Converter
Nico Baars, Jordi Everts, Korneel Wijnands, Elena Lomonova, Technische Universiteit Eindhoven, Netherlands

3:00 p.m. – 3:20 p.m.
T34.4:  Control Methods to Achieve Soft-Transition of Gains for a Variable (n/m)X Converter
Deepak Gunasekaran¹, Gujing Han², Fang Zheng Peng³, ¹Michigan State University, United States; ²Wuhan Textile University/Michigan State University, China

3:20 p.m. – 3:40 p.m.
T34.5:  Unequal PWM Control for a Current-Fed DC-DC Converter for Battery Application
Deshang Sha, Xiao Wang, Yaxiong Xu, Beijing Institute of Technology, China

4:10 p.m. – 4:30 p.m.
T34.6:  A Family of Series-Resonant DC-DC Converter with Fault-Tolerant Capability
Levy Costa, Giampaolo Buticchi, Marco Liserre, Christian-Albrechts-Universität zu Kiel, Germany

4:30 p.m. – 4:50 p.m.
T34.7:  Sliding Mode Control of Bi-Directional Dual Active Bridge DC/DC Converters for Battery Energy Storage Systems
Yoon-Cheul Jeung, Dong-Choon Lee, Yeungnam University, Korea, South

4:50 p.m. – 5:10 p.m.
T34.8:  Design and Evaluation of a Reconfigurable Stacked Active Bridge DC/DC Converter for Efficient Wide Load-Range Operation
Rose Abramson¹, Samantha Gunter¹, David Otten¹, Khurram K. Afridi², David Perreault¹, ¹Massachusetts Institute of Technology, United States; ²University of Colorado Boulder, United States

5:10 p.m. – 5:30 p.m.
T34.9:  An Enhanced Adaptive Frequency Locked Loop for Variable Frequency Controls
Syed Barri, Qiang Li, Fred Lee, Virginia Polytechnic Institute and State University, United States

2:00 p.m. – 5:30 p.m.
T35: Control Strategies for Power Converters
ROOM 20

Track: Motor Drives and Inverters

SESSION CHAIRS:
Mahshid Amirabadi, Northeastern University
Hui Li, Florida State University

2:00 p.m. – 2:20 p.m.
T35.1:  An Improved Resonant Frequency based LCL Filter Design Method for Grid-Connected Inverters
Tsai-Fu Wu, Mitradatta Misra, Li-Chiun Lin, Chih-Wei Hsu, National Tsing Hua University, Taiwan

2:20 p.m. – 2:40 p.m.
T35.2:  An Optimized Switching Scheme for DC-Link Current Ripple Reduction in Three-Level T-Type Inverter
In Jung Won¹, Kyo-Beum Lee¹, Yongsoo Cho², ¹Ajou University, Korea, South; ²LG Electronics, Korea, South

2:40 p.m. – 3:00 p.m.
T35.3:  Fault-Tolerant Control Strategy for T-Type Three-Level Inverter with Neutral-Point Voltage Balancing
Jie Chen, Alian Chen, Xiangyang Xing, Chenghui Zhang, Shandong University, China

3:00 p.m. – 3:20 p.m.
T35.4:  Power Decoupling Method for Single-Phase Buck-Boost Inverter with Energy-based Control
Shuang Xu, Liuchen Chang, Riming Shao, Haider Mohamad A R, University of New Brunswick, Canada

3:20 p.m. – 3:40 p.m.
T35.5:  Integrated Isolated Power Converter using Active Rectification and Closed-Loop CRM Control for Secondary Side Regulation in E-Meters
Yingping Chen, Xugang Ke, D. Brian Ma, University of Texas at Dallas, United States

4:10 p.m. – 4:30 p.m.
T35.6:  Zero-Voltage-Switching SPWM Method for Three-Phase Four-Wire Inverter
Ning He, Yingfeng Zhu, Dehong Xu, Zhejiang University, China

4:30 p.m. – 4:50 p.m.
T35.7:  Inductor Feedback ZVT based, Low THD Single Phase Full Bridge Inverter with Hybrid Modulation Technique
Yinglai Xia, Raja Ayyanar, Arizona State University, United States
THURSDAY

2:00 p.m. – 5:30 p.m.

**T36: Converter Modeling & Analysis**

**ROOM 21**

**Track: Modeling and Simulation**

**Session Chairs:**
Chris Bridge, SIMPLIS Technologies, Inc.
Sheldon Williamson, University of Ontario Institute of Technology

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**2:00 p.m. – 2:20 p.m.**

**T36.1: Modeling and Analysis of Droop based Hybrid Control Strategy for Parallel Inverters in Islanded Microgrids**
Shike Wang, Zeng Liu, Jinjun Liu, Baojin Liu, Xin Meng, Ronghui An, Xi’an Jiaotong University, China

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**2:20 p.m. – 2:40 p.m.**

**T36.2: Reduced Order Modeling Method of Inverter-based Microgrid for Stability Analysis**
Yelun Peng², Zhikang Shuai², John Shen², Jun Wang², Chunming Tu², Ying Cheng¹, ¹Hunan Electric Power Maintenance Corporation, China; ²Hunan University, China; ³Illinois Institute of Technology, United States

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**2:40 p.m. – 3:00 p.m.**

**T36.3: An Efficient Impedance Stability Analysis Method for High-Frequency Stability of Hybrid Networking Islanded-Microgrid**
Wei Zhao, Lei Qi, Xiaofeng Sun, Xin Li, Yanshan University, China

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**3:00 p.m. – 3:20 p.m.**

**T36.4: Accurate Mathematical Steady-State Models of Arm and Line Harmonic Characteristics for Modular Multilevel Converter**
Fangzhou Zhao, Guochun Xiao, Min Liu, Shuai Su, Daoshu Yang, Fujian Li, Xi’an Jiaotong University, China

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**3:20 p.m. – 3:40 p.m.**

**T36.5: A Cascaded Hybrid Phase Shift-PWM and Asymmetric Selective Harmonic Mitigation-PWM Modulation Technique for Grid-Tied Converter to Reduce the Switching Frequency and Meet the Grid Current Harmonic Requirement**
Amirhossein Moeini, Shuo Wang, University of Florida, United States

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**4:10 p.m. – 4:30 p.m.**

**T36.6: The Unified Model and Optimal Operation Analysis for a Modular Multilevel Converter**
Lang Huang², Xu Yang², Fan Zhang², Peng Xu², Xin Ma², Tao Liu¹, Xiang Hao¹, Weizeng Liu¹, ¹TBEA Xinjiang Sunoasis Co., Ltd., China; ²Xi’an Jiaotong University, China

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**4:50 p.m. – 5:10 p.m.**

**T36.7: Simplified Carrier-based Modulation Scheme for Three-Phase Three-Switch Rectifier for DC Fast Charging Applications**
Chung Pui Tung, Henry Shu-Hung Chung, City University of Hong Kong, Hong Kong

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**5:10 p.m. – 5:30 p.m.**

**T36.8: An Enhanced Control Design Scheme for Multiple-Input Converters based on Time-Sharing Switching**
Ruichen Zhao³, Sheng Yang Yu³, Shunlong Xiao³, Ke Xu¹, ¹AR Devices, United States; ²Texas A&M University, United States; ³Texas Instruments Inc., United States; ⁴University of Texas at Austin, United States

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**2:00 p.m. – 5:30 p.m.**

**T37: Control Applications**

**ROOM 22**

**Track: Control**

**Session Chairs:**
Bilal Akin, University of Texas at Dallas
Jaber Abu Qahouq, University of Alabama

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**2:00 p.m. – 2:20 p.m.**

**T37.1: An Enhanced Control Design Scheme for Multiple-Input Converters based on Time-Sharing Switching**
Ruichen Zhao³, Sheng Yang Yu³, Shunlong Xiao³, Ke Xu¹, ¹AR Devices, United States; ²Texas A&M University, United States; ³Texas Instruments Inc., United States; ⁴University of Texas at Austin, United States
THURSDAY

2:20 p.m. – 2:40 p.m.
T37.2: Adaptability of Weighted Average Current Control to the Weak Grid Considering the Effect of Grid-Voltage Feedforward
Jianjun Sun², Yi Wang², Jinwu Gong², Xiaoming Zha², Shangsheng Li¹, ¹Wuhan Keliyuan Electric Co. Ltd., China; ²Wuhan University, China

2:40 p.m. – 3:00 p.m.
T37.3: A Decentralized Control Strategy with DC Fault Handling Capability for Smart DC Buildings
Amin Ghazanfari, Yasser A.-R. I. Mohamed, University of Alberta, Canada

3:00 p.m. – 3:20 p.m.
T37.4: State Observer Design for a High Frequency Distributed Power System
Nikhil Kumar, Debanjan Chatterjee, Ankit Gupta, Sudip. K Mazumder, University of Illinois Chicago, United States

3:20 p.m. – 3:40 p.m.
T37.5: Containment and Consensus-based Distributed Coordination Control for Voltage Bound and Reactive Power Sharing in AC Microgrid
Renke Han¹, Lexuan Meng¹, Giancarlo Ferrari Trecate³, Ernane Antônio Alves Coelho², Juan Carlos Vásquez¹, Josep M. Guerrero¹, ¹Aalborg University, Denmark; ²SiC MOSFETs;
³Universidade Federal de Uberlândia, Brazil; ³Università degli Studi di Pavia, Italy

4:10 p.m. – 4:30 p.m.
T37.6: A New Active Gate Driver for Improving the Switching Performance of SiC MOSFET
Alejandro Paredes, Hamidreza Ghorbani, Vicent Sala, Efren Fernandez, Luis Romeral, Universitat Politècnica de Catalunya, Spain

4:30 p.m. – 4:50 p.m.
T37.7: Optimized dv/dt, di/dt Sensing for a Digitally Controlled Slope Shaping Gate Driver
Johannes Groeger¹, Alexis Schindler¹, Bernhard Wicht¹, Karl Norling³, ¹Hochschule Reutlingen / Robert Bosch GmbH, Germany; ²Infineon Technologies Austria AG, Austria

4:50 p.m. – 5:10 p.m.
T37.8: 10ns Variable Current Gate Driver with Control Loop for Optimized Gate Current Timing and Level Control for In-Transition Slope Shaping
Alexis Schindler¹, Benno Koepl³, Bernhard Wicht¹, Johannes Groeger¹, ¹Hochschule Reutlingen / Robert Bosch GmbH, Germany; ²Infineon Technologies Austria AG, Austria

5:10 p.m. – 5:30 p.m.
T37.9: A Method for Online Ageing Detection in SiC MOSFETs
Feyzullah Erturk, Bilal Akin, University of Texas at Dallas, United States

2:00 p.m. – 5:30 p.m.
T38: Grid-Tied Renewable Energy
ROOM 23

Track: Renewable Energy Systems

SESSION CHAIR:
Xiaoqiang Guo, Yanshan University

2:00 p.m. – 2:20 p.m.
T38.1: Low Voltage Ride-Through of Two-Stage Grid-Connected Photovoltaic Systems through the Inherent Linear Power-Voltage Characteristic
Yongheng Yang¹, Ariya Sangwongwanich¹, Hongpeng Liu², Frede Blaabjerg¹, ¹Aalborg University, Denmark; ²Harbin Institute of Technology, China

2:20 p.m. – 2:40 p.m.
T38.2: Performance Comparison of Single-Phase Transformerless PV Inverter Systems
Yuba Raj Kafle¹, Graham E. Town¹, Guochun Xiao², Samir Gautam², ¹Macquarie University, Australia; ²Xi’an Jiaotong University, China

2:40 p.m. – 3:00 p.m.
T38.3: Analysis of Smart Inverter Functions of Decentralized Grid-Connected AC-Stacked PV Inverter Architecture
Hamidreza Jafarian², Namwon Kim², Babak Parkhideh², Johan Enslin¹, ¹Clemson University, United States; ²University of North Carolina at Charlotte, United States

3:00 p.m. – 3:20 p.m.
T38.4: A Single Phase Transformer-Less String Inverter with Integrated Magnetics and Active Power Decoupling
Jinia Roy, Raja Ayyanar, Arizona State University, United States

3:20 p.m. – 3:40 p.m.
T38.5: An Active Capacitor Converter for Improving Robustness of the LCL-Type Grid-Connected Inverter against Grid Impedance Variation
Qingfeng Zhou¹, Xuehua Wang¹, Xinbo Ruan², Yu Teng¹, Fuxin Liu², ¹Huazhong University of Science and Technology, China; ²Nanjing University of Aeronautics and Astronautics, China

4:10 p.m. – 4:30 p.m.
T38.6: Model Predictive Control for Single Phase T-Type Neutral Point Clamping LCL-Filtered Inverters
Qiang Qian, Shaojun Xie, Jinming Xu, Kunshan Xu, Lin Ji, Binfeng Zhang, Nanjing University of Aeronautics and Astronautics, China
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<td>4:30 p.m. – 4:50 p.m.</td>
<td>T38.7</td>
<td>Robust Control and Design based on Impedance-based Stability Criterion for Improving Stability and Harmonics Rejection of Inverters in Weak Grid</td>
<td>Jinming Xu, Binfeng Zhang, Qiang Qian, Xiaoli Meng, Shaojun Xie, Nanjing University of Aeronautics and Astronautics, China</td>
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<td>4:50 p.m. – 5:10 p.m.</td>
<td>T38.8</td>
<td>Modeling and Oscillation Analysis of Flexible Multi-Terminal HVDC System</td>
<td>Yuchao Liu¹, Jian Wu¹, Ali Raza², Dianguo Xu¹, ¹Harbin Institute of Technology, China; ²University of Lahore, Pakistan</td>
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<td>5:10 p.m. – 5:30 p.m.</td>
<td>T38.9</td>
<td>Sensorless Active Damping Strategy for Parallel Interleaved Voltage Source Power Converters with LCL Filter</td>
<td>Javier Samanes, Eugenio Gubía, Universidad Pública de Navarra, Spain</td>
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<td>2:00 p.m. – 5:30 p.m.</td>
<td>T39</td>
<td>High Power Charging &amp; Control Technology for Vehicular Power Systems</td>
<td>ROOM 24</td>
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<td>T39.1</td>
<td>FEA Assisted Design and Optimization for a Highly Efficient 22 kW Inductive Charging System for Electric Vehicles with Large Air Gap and Output Voltage Variation</td>
<td>Janosch Marquart, Falk Kyburz, Clemens Mathis, Kurt Schenk, University of Applied Sciences NTB Buchs, Switzerland</td>
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<td>T39.2</td>
<td>Design and Control of Inductive Power Transfer System for Electric Vehicles Considering Wide Variation of Output Voltage and Coupling Coefficient</td>
<td>Minkook Kim², Dong-Myoung Joo², Byoung Kuk Lee², Dong-Gyun Woo¹, ¹Hyundai Motor Company, Korea, South; ²Sungkyunkwan University, Korea, South</td>
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<td>T39.3</td>
<td>Synergetic Optimization of Efficiency and Stray Magnetic Field for Planar Coils in Inductive Power Transfer using Matrix Calculation</td>
<td>Ming Lu, Khai Ngo, Virginia Polytechnic Institute and State University, United States</td>
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<td>T39.4</td>
<td>Frequency-Division Power Sharing and Hierarchical Control Design for DC Shipboard Microgrids with Hybrid Energy Storage Systems</td>
<td>Zheming Jin, Lexuan Meng, Juan Carlos Vásquez, Josep M. Guerrero, Aalborg University, Denmark</td>
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<td>3:00 p.m. – 3:20 p.m.</td>
<td>T39.5</td>
<td>A High Efficiency and Compact Inductive Power Transfer System Compatible with Both 3.3kW and 7.7kW Receivers</td>
<td>Fei Lu⁴, Hua Zhang⁵, Tianze Kan², Heath Hofmann⁴, Ying Mei¹, Li Cai¹, Chris Mi³, ¹LG Electronics China R&amp;D Center, China; ²Northwestern Polytechnical University, China; ³San Diego State University, United States; ⁴University of Michigan, United States</td>
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<td>4:00 p.m. – 4:20 p.m.</td>
<td>T39.6</td>
<td>A &gt;98% Efficient &gt;150 kRPM High-Temperature Liquid-Cooled SiC VFD for Hybrid-Electric Turbochargers</td>
<td>Troy Beechner, Andrew Carpenter, Mainstream Engineering, United States</td>
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<td>4:30 p.m. – 4:50 p.m.</td>
<td>T39.7</td>
<td>Half-Bridge Full-Bridge AC-DC Resonant Converter for Bi-Directional EV Charger</td>
<td>Behnam Kouski, Praveen Jain, Alireza Bakhshai, Queen’s University, Canada</td>
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<td>5:00 p.m. – 5:20 p.m.</td>
<td>T39.8</td>
<td>Bi-Directional On-Board Charger Architecture and Control for Achieving Ultra-High Efficiency with Wide Battery Voltage Range</td>
<td>Bin Li, Fred C. Lee, Qiang Li, Zhengyang Liu, Virginia Polytechnic Institute and State University, United States</td>
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<td>6:00 p.m. – 6:20 p.m.</td>
<td>T39.9</td>
<td>Design Method for Low Radiated Emission of 85 kHz Band 44 kW Rapid Charger for Electric Bus</td>
<td>Masatoshi Suzuki, Kenichi Hiroi Ogawa, Fumi Moritsuka, Tetsu Shijo, Hiroaki Ishihara, Yasuhiro Kanekiyo, Koji Ogura, Shuichi Obayashi, Masaaki Ishida, Toshiba Corporation, Japan</td>
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2:00 p.m. – 5:30 p.m.

**T40: Wireless Power Applications**

ROOM 25

**Track: Power Electronics Applications**

**Session Chairs:**
Indumini Ranmuthu, *Texas Instruments, Inc.*
David Reusch, *Efficient Power Conversion Corporation*

2:00 p.m. – 2:20 p.m.

**T40.1: A Maximum Power Point Tracking Control Scheme for Magnetically Coupled Resonant Wireless Power Transfer System by Cascading SEPIC Converter at the Receiving Side**

Yong Yang, Fuxin Liu, Xuling Chen, *Nanjing University of Aeronautics and Astronautics, China*

2:20 p.m. – 2:40 p.m.

**T40.2: Optimization of Coils for a Three-Phase Magnetically Coupled Resonant Wireless Power Transfer System Oriented by the Zero-Voltage-Switching Range**

Xiewei Fu, Fuxin Liu, Xuling Chen, *Nanjing University of Aeronautics and Astronautics, China*

2:40 p.m. – 3:00 p.m.

**T40.3: Modeling and Analysis of Phase-Shift Controlled LCL Resonant Converter in Wireless Charging Systems**

Hao Feng, Tao Cai, Shanxu Duan, Xiaoming Zhang, Hongsheng Hu, *Huazhong University of Science and Technology, China*

3:00 p.m. – 3:20 p.m.

**T40.4: Analytical Method for Mutual Inductance and Optimum Frequency Calculation in a Series-Series Compensated Inductive Power Transfer System**

Yabiao Gao¹, Zion Tse², Antonio Ginart³, ¹*Kennesaw State University, United States; ²*University of Georgia, United States*

3:20 p.m. – 3:40 p.m.

**T40.5: High-Q Self-Resonant Structure for Wireless Power Transfer**

Aaron Stein, Phyo Aung Kyaw, Charles Sullivan, *Dartmouth College, United States*

4:10 p.m. – 4:30 p.m.

**T40.6: Six Degrees of Freedom Wide-Range IPT for Multiple IoT by DQ Rotating Magnetic Field**

Jin S. Choi¹, Eun S. Lee¹, Byeung G. Choi¹, Seung H. Han², Chun T. Rim³, ¹*Korea Advanced Institute of Science and Technology, Korea, South; ²Teslas Co., Ltd., Korea, South*

4:30 p.m. – 4:50 p.m.

**T40.7: Evaluation of H-Bridge and Half-Bridge Resonant Converters in Capacitive-Coupled Wireless Charging**

Weiqiang Chen², Paul Han¹, Ali Bazzi³, ¹*Glastonbury High School, United States; ²University of Connecticut, United States*

4:50 p.m. – 5:10 p.m.

**T40.8: Single-Stage 6.78 MHz Power-Amplifier Design using High-Voltage GaN Power ICs for Wireless Charging Applications**

Lingxiao Xue, Jason Zhang, *Navitas Semiconductor, United States*

5:10 p.m. – 5:30 p.m.

**T40.9: ZVS-PWM Bridgeless Active Rectifier-Applied GaN-HFET Zero Voltage Soft-Switching Multi-Resonant Converter for Inductive Power Transfers**

Tomokazu Mishima, Eitaro Morita, *Kobe University, Japan*
APEC strives to offer seminars with a practical mix of theory and application for the professional working in power electronics. APEC 2017 features 18 professional education seminars with a broad range of topics.

**Sunday, March 26**

9:30 a.m. – 1:00 p.m.

**S01: Bidirectional DC-DC Converters: Fundamentals and Advances Session**

**Track: Design**

Zhe Zhang

ROOM 13/14

Nowadays, applying clean and renewable energies, such as wind, solar and hydrogen, has become a research focus in academia and industry. Due to the intermittent feature of renewable energy sources, energy storage systems are needed to fill up the gap between electricity generation and consumption, hereby smooth out the active-power flow on the utility grid. Therefore, bidirectional or reversible dc-dc converters, as the interface between storage elements and power conversion stages, gain growing applications in fuel cell, photovoltaic or automotive systems. Various bidirectional dc-dc converters have been proposed to couple two dc links having large voltage difference, to provide galvanic isolation, and to regulate the reversible power flow. Given that, this professional educational seminar will introduce the fundamentals, analysis methods and design criteria of bidirectional dc-dc converters including both non-isolated and isolated manners. Then, two popular converter topologies i.e. isolated full-bridge boost converter and dual-active-bridge converter are compared by component stress factor (CSF) method. Emerging of wide-bandgap (WBG) devices provide power electronic converters with a huge potential of enhancing efficiency as well as increasing power density; however, new challenges associated with the even faster commutations, such as minimizing loop impedance, reducing stress on magnetic components and limiting thermal stress, come center stage. Hereby, the design of bidirectional dc converters equipped with WBG devices and the technical trends e.g. soft-switching and dead-time optimization are presented in this seminar. Finally,
modeling and control of bidirectional converters, in particular the DAB converter is given accordingly. This professional education seminar is suitable for intermediate- or advanced-level researchers, engineers and students in power electronics field, who are interested in reversible DC-DC converters.

**S02: Silicon Carbide MOSFETs – A Deep Dive to Accelerate Your Next Power Converter Design Session**

**Track: SiC**

Sujit Banerjee, Kevin Matocha, Xuning Zhang

ROOM 15/16

Silicon Carbide (SiC) MOSFETs improve the power density of various converters by shrinking the size of passive components and improving the power conversion efficiency. This seminar presents an in-depth summary of SiC MOSFETs to accelerate a power converter design with these devices. It will provide a brief survey of devices available today from various suppliers and examples of improvements they enable in power converters. A brief introduction to internal device structure and principle of operation of planar vs trench MOSFETs will be provided to understand the differences. Reliability of SiC MOSFETs will be discussed in detail explaining various stress tests that are done by manufacturers to ensure reliability. Detailed static and dynamic characteristics, thermal performance and device ruggedness will be discussed and related to datasheet parameters. Gate driving techniques are also discussed from the aspects of driving voltage selection, protection design and gate driver EMI noise propagation control. Design examples are presented to verify the benefit of using SiC device in system size/weight/ cost reduction compared with Si devices. A customized in-circuit reliability test for real application emulation will be proposed and its implementation will be explained.

**S03 Direct Digital Compensator Design for Power Electronics**

**Track: Control**

Hamish Laird

ROOM 18/19

This presentation, aimed at intermediate to advanced level power engineers, details a simple yet powerful method to design the compensators for digitally controlled power converters. Firstly a library of digital control blocks is presented. These blocks include the integrator, high pass filter, low pass filter and the phase lead and phase lag blocks. Each of the blocks can be implemented as a simple pole zero combination that allows the familiar and powerful frequency domain loop shaping control design approach to be used with a fully digitally controlled power converters. For each block the form and design equations are presented in detail along with a number of examples. The aim of this approach is to avoid the analogue design translated to digital controller approach. The design of a number of digital compensators of controllers for a variety of different power converters is then presented and the results compared with traditional analogue translation approaches. The library of direct digital controller design building blocks is then detailed along with how and when to use each block.

**S04 High Power Si & SiC Module Technology & Application Considerations**

**Track: Components & Systems**

John Donlon, Eric Motto, Toshiya Nakano

ROOM 24/25

High Power Semiconductor modules are the workhorse power switch for industrial applications. This seminar will discuss the issues a designer must deal with in using these devices including interpretation of device ratings, gate drive requirements, and providing device and system protection. The intent of this seminar is to aid the designer in choosing and applying a power module to a new product. Questions and concerns a designer might have will be addressed by the various techniques and circuit examples that will be presented. Chip technology and packaging options will be discussed with special attention to the tradeoffs between silicon and silicon carbide. The practical application of SiC power devices today and in the future will be discussed. The attendee should leave the course with a better understanding of the power module, specifically as a device and how it functions in an application. The goal will be to impart an understanding of desirable features, characteristics, and limitations. This will include the application in power circuits, protection from internal and external disturbances, and an understanding of thermal design, handling, and reliability considerations. The seminar is intended for design engineers having to deal with confusing and conflicting information on device data sheets.

**S05 EMI Causes, Measurement, and Reduction Techniques for Switch-Mode Power Converters**

**Track: EMI & Reliability**

Michael Schutten

ROOM 20/21

This seminar provides a comprehensive introduction for engineers desiring a fundamental understanding of electromagnetic interference (EMI) issues associated with switch-mode power converters, and also for experienced engineers eager
for a detailed understanding of EMI noise creation mechanisms and design fixes for power converters. The seminar begins with an introduction to the fundamental EMI coupling mechanisms and their electrical properties. The concept of impedance mismatch is presented as a basis to understand filtering theory. Differential-mode (DM) and common mode (CM) separation and filtering approaches are derived, with measurement and separation techniques presented. DM & CM measurement and reduction techniques are presented using an experimental fly-back converter example. Converter layout techniques and principles are derived, and experimentally confirmed. The seminar presents how DM and CM currents are created in power converters, with layout and construction techniques to minimize the need for costly filtering. Several practical EMI reduction techniques and construction methods are provided throughout the seminar.

**S06 Practical Design of Wireless Electric Vehicles: Dynamic & Stationary Charging Technologies**

**Track: Wireless Charging & Magnetics**

Chun T. Rim
ROOM 22/23

The analysis and design of wireless charging electric vehicles (WEVs) is extensively covered in this seminar. First, dynamic charging of roadway-powered electric vehicles (RPEVs) is widely explored. The research and development heritage of RPEVs is fully reviewed, including on-line electric vehicles (OLEVs), firstly commercialized in 2013. Practical design issues such as coil structure, resonant circuits, lateral tolerance, efficiency, EMF cancel, and commercialization issues are discussed in detail. Second, stationary charging of plug-in hybrid EVs (PHEVs) and battery EVs (BEVs) is explained. Innovative design examples for large tolerances and low EMF are also provided in detail. Magnetic mirror models (IM3) and gyrator models are introduced for the advanced audiences. Intended audiences include entry and intermediate levels.

**Sunday, March 26**
2:30 p.m. – 6:00 p.m.

**S07A Comprehensive Introduction to Implementing a Fully Digital LLC Resonant Converter**

**Track: Design**

Joel Steenis, Alex Dumais
ROOM 13/14

The purpose of this presentation is to provide an in-depth introduction to an LLC resonant converter using a digital implementation. The presenters will cover all the necessary steps to develop the control system for a fully digital LLC converter operating in the inductive region. The presentation will start by introducing the concept of an LLC and its theory of operation, show a design methodology based on the fundamental harmonic analysis (FHA), show three methods of deriving a small signal model — the envelope model, the extended describing function (EDF), and system identification (system ID), show how controller design for the LLC differs from controller design for most DC-to-DC converters, then conclude with a thorough discussion of the digital implementation. A large portion of the presentation focuses on deriving a model for the power stage that is conducive to controller design, designing the controller, and implementing the controller in a fixed point processor. This presentation will end with additional algorithms that may improve overall performance such as an adaptive algorithm that facilitates uniform loop gain over the operating region. Attendees who do not have experience with digital power or designing resonant converters should be able to leverage this material to develop their own digital LLC platform with a reduced time to market.

**S08 Practical Implementation of SiC Power Devices on Using Best Practices with a Focus on Electrification of Motor Vehicles**

**Track: SiC**

Edgar Ayerbe, Adam Barkley
ROOM 15/16

This PES focuses on practical implementation of SiC power device technology utilizing the latest techniques and best practices for high performance and reliable power designs. The seminar will use the electrification of transportation as a practical example of various topologies commonly being used in designs today. The seminar will highlight three specific examples where SiC devices provide system-level advantages: (1) 20kW 380/480V AC/DC PFC circuit; (2) 20kW isolated DC/DC LLC circuit; (3) 480V motor drive. The seminar is
intended for intermediate audiences with a good understanding of power electronics wanting to find out if SiC MOSFET technology could help address their design challenges. The seminar covers the following topics: 1) Difference between SiC MOSFET, Si MOSFET and highspeed IGBT: how to down-select amongst them for a give application. 2) High frequency power electronics system with SiC MOSFET: advantages and challenges. 3) SiC MOSFET: What should you know about them (types of SiC MOSFETs, gate drive, protections, reliability: gate oxide, short-circuit, body diode, Vth shift, power cycle, thermal shock, cost: present and future). 4) Circuit design aspects to consider when using SiC MOSFET at high frequency (dv/dt and di/dt control implications, protections, EMI, PCB design, magnetic component and how to achieve cost reductions). 5) Use of composite SiC MOSFET reliability data to conduct a fully predictive lifetime model for known wear-out mechanisms. Lastly, the highlighted topics will be reviewed once again when discussing the design and testing of following three hardware prototypes: a) 20hp 380/480V motor drive, b) 20kW 380/480V PFC, and c) 20kW isolated DC/DC. In the end, the attendee will gain practical knowledge of SiC MOSFET technology and how it can be used in three different EV relevant hardware examples.

S09 Small-Signal Stability and Subsystem Interactions in Distributed Power Systems with Multiple Converters (I): DC Systems and 1-Phase AC Systems

Dushan Borojevich, Jinjun Liu, Paolo Mattavelli
ROOM 18/19

One of the major developing trends of distributed power systems, no matter in stand-alone form or in public grid form, is that more and more electronic power converters are adopted for the purpose of power conditioning or performance improving. This will lead to quite a few technical challenges, one of them being the system small-signal stability issue, which is caused by the dynamic interactions among subsystems/converters and is quite different from the stability issue with conventional power grids. A review of existing analytical approaches to deal with this issue is presented, including traditional power system approach and some power electronics background approaches proposed recently. It turns out that the impedance-based approach is an appropriate analytical approach for such stability issue. An in-depth review of existing and recent work of impedance-based approach for DC systems is then delivered. Topics that will be covered include impedance-based stability criterion for 2 cascaded subsystems and corresponding load specification and stability monitoring methods, stability criteria for 2 parallel subsystems, stability criteria for multiple subsystems, and how to handle situations when interactions through communications also exist. Finally how these methods and techniques can be extended to 1-phase AC systems will be introduced in detail too.

Level of intended audience shall be intermediate or above.

S10 Advanced Packaging Technologies for Fully Exploiting Attributes of WBG Power Electronics

Track: Components & Systems

Zhenxian Liang
ROOM 24/25

The wide bandgap (WBG) power semiconductors, such as SiC and GaN, can process electric power with smaller die area and less power losses. In turn, it will ultimately lead to superior power conversion with higher efficiency, compact volume and low cost. However, the packages of these devices bring parasitic effects to limit their superior power switching features — high current density, high switching speed and high operation temperature. These limitations can be characterized by a set of technical metrics such as electric parasitic impedance, thermal impedance, thermo-mechanical properties, etc. A set of innovative techniques in SiC power module packaging, focused on improvements of these technical parameters, have been developed to promote successfully application of the WBG power semiconductors. The technical advances include integrating gate driver, integrated direct cooling, threedimensional (3-D) planar interconnection, and integrated, double sided direct cooling. The further integration of these features into one packaging process improves the manufacturability of highly integrated power electronics systems. The comprehensive improvements in module’s electrical, thermal performance and manufacturability help utilize fully the attributes provided exclusively by the WBG power semiconductors. The technical advancements lead to cost-effective, high efficiency, high power density in power conversion systems. This seminar is aimed at providing the fundamental and specific knowledge for professionals to design, manufacture, use, apply, or specify advanced WBG power electronics modules and systems.

S11 Introduction to EMC

Track: EMI & Reliability

Darryl Ray
ROOM 20/21

This seminar provides an introduction to EMC engineering for electronic equipment. Compliance to the relevant EMC regulations is required to sell electronic equipment in many geographies. There are many subtleties dealing with EMC that can make a significant difference in the electromagnetic
emissions and immunity performance of electronic equipment. EMC design is often considered as magic. This course however will aim to demystify the magic and present a number of proven design methods that will enable a product to achieve compliance to the relevant standards and minimize strange and often unrepeatable problems experienced in the field. The seminar will provide an overview of the various EMC standards, design basics, testing issues and troubleshooting.

**S12 High-Frequency Magnetics Design, Measurement and Modeling**

**Track: Wireless Charging & Magnetics**

Ray Ridley
ROOM 22/23

This seminar will present an in-depth discussion of the issues involved in designing magnetics components for high-frequency power supplies. It will cover both fundamentals and advanced concepts of rugged transformer and inductor design, highlighting the areas that need work if the industry is to keep up with semiconductor advances. Topics will include core loss, winding loss, saturation, frequency response measurements, circuit modeling, leakage inductance, winding layout arrangements, and materials. The usually-difficult topic of proximity loss will be greatly simplified with some new circuit models that make results accessible to even beginning designers. The course is recommended to all levels of engineers who work with switching power supplies at power levels from less than 1 W to 100 kW.

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**Monday, March 27**

8:30 a.m. – 12:00 p.m.

**S13 Input Filter Interactions with Switching Regulators**

**Track: Design**

Christophe Basso
ROOM 13/14

ElectroMagnetic Interference (EMI) filters are an essential part of a power supply structure. Designed to filter out switching noise and build an isolation barrier between the noisy converter and the power source, its impact on the converter’s performance is often overlooked. If naturally-present damping elements often hide potential problems, the interaction of the filter and the switching converter is a reality which shall be considered at the first stage of power supply design. Failure to understand and counteract filter effects at an early design stage can affect the converter overall performance and stability in particular. This seminar will start by explaining why teaming an inductive filter with a switching converter can be a problem and how some of the closed-loop parameters are impacted. Fast Analytical Circuits Techniques will be applied along the seminar and briefly introduced as one of the tools used by the author. Optimum damping techniques will then be explained in a second part, exemplified with a design example. Finally, practical experiments will show damping at work on a typical case. Using mathematical analysis and different tools such as SPICE and Mathcad®, the author maintains a permanent link between theory and practical reality. Balancing analytical aspects and real case examples, the seminar targets an audience with an intermediate background in the presented subject.

**S14 SiC Power Devices and MV Power Converter Application**

**Track: SiC**

Subhashish Bhattacharya, Victor Veliadis
ROOM 15/16

The tutorial will stress in-depth the advantages of SiC over other power electronic materials, and will introduce SiC devices currently developed for power applications. ESD, high-voltage testing, and packaging considerations will be outlined. SiC JFETs, MOSFETs, BJTs, IGBTs, Thyristors, and Schottky, Junction Barrier Schottky, and PiN diodes will be discussed with an emphasis on their performance advantages over those of their Si counterparts. Aspects of device fabrication will be taught with an emphasis on the processes that do not carry over from the mature Si manufacturing world and are thus tailored to SiC. Device reliability will be reported through
exemplary hard switching and unclamped inductive load results. Prototype SiC-based power electronics systems will be shown and their numerous advantages will be articulated. The opportunities for HV SiC devices for MV Power Converters and utility applications and the challenges to apply these HV SiC devices successfully will be presented in-depth with SiC device voltage ranges from 1200 V to 1700 V MOSFETs, and HV 10 kV – 15 kV MOSFETs, JBS diodes, and 15 kV SiC IGBTs. The potential and challenges of the HV 10-15 kV devices to enable MV power conversion systems, including MV motor drives, FACTS and MVDC grids will be explored. Challenges in adopting these HV SiC devices for MV power conversion in terms of magnetics, capacitors, and insulation materials will be discussed. This tutorial is intended for entry level and intermediate audiences.

S15 Current Mode Control and Modeling- 3 Decades of Progress

Track: Control

Fred Lee
ROOM 18/19

The presentation starts with a review of the history of development of current mode control and various modeling attempts. The topic of modeling for current mode control, although seemingly settled, still left many unsolved issues. In light of recent surge of interest in constant on-time variable frequency control for improved light load efficiency and V2 control for its fast transients and simplicity, the existing modeling tools were not quite suitable for these popular controls. The desire for more unified approach of modeling has motivated Dr. Jian Li to attack this difficult modeling task with an entirely different approach, i.e. from a continuous time framework using the extended describing function techniques. The developed modeling is accurate beyond switching frequency and is applicable to constant frequency peak current/valley mode control, average current mode, charge control as well as variable frequency constant Ton and Constant Toff control. Furthermore a reduced-order model was presented with pin-point accuracy at half of the switching frequency. The model was further simplified by Dr. Ying Yi Yang into a unified equivalent circuit model, namely, “three-terminal current-mode control cell” which can be applied any converter topologies employing a current mode control. More recently, his modeling approach has been further extended by Dr. Shuilin Tien to V2 control employing Constant Ton and Constant frequency controls.

S16 Google Little Box Reloaded – How to Achieve 200 W/in^3 and Beyond

Track: Components & Systems

Johann W. Kolar, Dominik Neumayr, Dominik Bortis
ROOM 24/25

The GOOGLE Little Box Challenge was aiming to build the worldwide smallest air-cooled 2kVA DC/AC converter, created a huge interest in the power electronics community, and resulted in a massive performance improvement compared to state-of-the-art technology systems. This seminar explains the approach selected by the authors along with a detailed discussion and comparative evaluation of the concepts presented by other finalists. First, the target specifications of the challenge are explained and basic options available for the realization of the main power circuit topology, the buffering of the power pulsation with twice the output frequency, the EMI filter and the modulation and control of the converter stages are discussed. Subsequently, GaN and SiC power semiconductor technology are evaluated for the power switches including hints for accurate soft-switching loss measurements. Furthermore, the realization of high-frequency inductors with multi-airgap magnetic cores and low high-frequency loss winding arrangements is detailed. In this context also the increase of the core losses by mechanical stress resulting from the cutting process is discussed. In a next step, the mechanical designs of several finalists are presented including details of the heat management. Subsequently, the corresponding power density and efficiency figures are comparatively evaluated. Finally, based on a multi-objective optimization “absolute” performance barriers as e.g. resulting for ideal switches are analyzed and technological requirements concerning active and passive components as well as cooling and integration technologies mandatory for enabling further performance improvements are identified. The seminar would like to convey the main results and findings of the GOOGLE Little Box Challenge and is tailored to serve the interests of a broad audience with academic or industrial background.

S17 Design for Reliability: from Components to Systems

Track: EMI & Reliability

Francesco Iannuzzo, Frede Blaabjerg, Huai Wang
ROOM 20/21

The aim of this tutorial is to give a framework of the design for reliability process of power electronic systems, together with the recent research activities and paradigm shifts in this research area. It will cover the reliability requirements in different industry sectors, reliability and lifetime of semi-
conductor modules and capacitors used in power electronic converters, testing of power components, and the specific design for reliability procedure for power electronic systems. A case study on the design for reliability of a fuel cell inverter is also presented. Finally, cutting edge active thermal control and condition monitoring principles of power converters will conclude the tutorial. The approaches presented are also the common interest for the companies involved in the Center of Reliable Power Electronics (CORPE) at Aalborg University (http://www.corpe.et.aau.dk/). The tutorial will also present the views of the instructors on the future research opportunities in the area of reliability of power electronics. Researchers and engineers who seek the basic knowledge for entering in this field, ranging from component level to system level, from physic of failure to statistical analysis are the main target audience of the seminar. Prerequisites are: power electronics basics and statistics basics.

**S18 High Frequency Planar Magnetics for Power Conversion**

**Track: Wireless Charging & Magnetics**

Ziwei Ouyang, William Gerard Hurley

ROOM 22/23

Today, high efficiency and high power density converters are fundamental to the continued profitable growth of the telecommunications, automotive, aerospace and data processing industries. High-frequency operation can lead to a reduction in magnetics size and an increase in power density. The momentum towards high efficiency, high frequency, and high power density in power supplies limits wide use of conventional wire-wound magnetic component structures. Planar magnetics fabrication and assembly processes have several advantages over conventional magnetics:

- **Low profile** — planar magnetic components has a lower profile that their wire wound counterparts due to the fabrication process;
- **Automation** — based on advanced computer aided manufacturing techniques;
- **High power densities** — planar inductors and transformers are spread out and this gives them a bigger surface-to-volume ratio than conventional components, this enhances the thermal performance;
- **Predictable parasitics** — with planar magnetics, the windings are precise and consistent, yielding magnetic designs with highly controllable and predictable characteristic parameters.

Planar magnetic components take advantage of microelectronic processing. In general the number of turns in planar device tends to be limited by the manufacturing process. The low profile tends to lead to a larger footprint compared with its conventional counterpart. Planar magnetic components are particularly suited to wireless power transfer because of their low profile. In multilayer devices the interlayer capacitance introduces resonance at high frequencies. This seminar covers the basic analytical model of planar structures based on impedance method, and also includes several design considerations such as high frequency winding resistance, high frequency leakage inductance, winding capacitance and magnetic core loss etc.
Plenary Session

Monday, March 27
1:30 p.m. – 5:00 p.m.
BALLROOM B/C

This year’s plenary provides an exciting look at both where power electronics is headed as well as where it has been from a distinguished line up of presenters. Ahmad Bahai’s presentation discusses how today’s power management solutions offer powerful new optimization tools for the power system designer, including an increased focus on system flexibility. He continues with examination of the state of semiconductor power management technology and provides some predictions for how the world of power electronics may evolve over the coming years. Conor Quinn continues this view toward the future with his presentation of the 2017 PSMA Power Technology Roadmap. Conor discusses both predictions at component and topology level for power conversion and driving trends and metrics within power applications. Vatche Voperian takes us back to the roots of modern power electronics with his presentation on the historical development of the PWM switch model. He presents the foundational work that preceded its discovery, using some of the original artifacts, and the advances in control and modelling that followed.

After Intermission, Shuai Jiang and Xin Li present the 48V data center power architecture that Google has deployed to address efficiency and scalability for this application where the demand for data is driving power needs ever higher. In addition to the 48V-to-POL technology underlying this approach, the presentation covers other key system level considerations and areas for future exploration. Hamish Laird’s presentation looks at how the focus on minimizing the financial cost of power loss in high power converters is now migrating to high volume, low power applications. He examines the implication of this shift on how the gap between the design and control of high and low power converters is shrinking. The plenary session concludes with Ljubisa Stevanovic’s presentation of advances in the reliability and power ratings of SiC devices over the last few years. He shows how these devices have enabled power modules capable of deployment in MW scale solar and PV applications, and discusses the financial benefits derived from the higher efficiency they allow.

Power Semiconductor Technology – Flexibility for Tomorrow’s Solution
1:30 p.m. – 2:00 p.m.

Speaker:
Ahmad Bahai
TI, Chief Technologist and Sr. VP

The demand for smart, high-efficiency power management is outpacing the average growth rate of the semiconductor industry. Advanced power switching technologies, new power semiconductor materials, power monitoring and control technologies, and new system adaptive power optimization techniques are providing system designers with new and powerful tools to optimize power system solutions. Of course, solution size, efficiency, and cost are well-established metrics for power technology advances and trends for these metrics are discussed. System flexibility, also an important consideration, is more difficult to quantify in general. However, we see new technologies emerging now in which flexibility is a key system goal. USB Power Delivery (USB-PD), for example, provides system-level power control capability that allows a great deal of flexibility for interconnected systems to negotiate power flow based on available power providers and the needs of connected power consumers. And as system power availability and power needs change over time, USB-PD allows system power flow to be optimized on the fly. Hence, we see new capabilities emerging in which power may be utilized more flexibly and effectively for specific system use cases and configurations. This talk examines the state of semiconductor power technology from multiple perspectives, including materials, devices, and systems; and provides some predictions for how the world of power electronics may evolve over the coming years.
Empowering the Electronics Industry: 
A Power Technology Roadmap
2:00 p.m. – 2:30 p.m.

**Speaker:**
Conor Quinn
Artesyn Embedded Technologies &
PSMA, PSMA Power Technology
Roadmap Co-Chair

Every 2 years, the Power Sources Manufacturers Association (PSMA) publishes its Power Technology Roadmap. This release of this cycle’s roadmap coincides with APEC 2017. The theme for this version is “Empowering the Electronics Industry” and the presentation will focus on newer and emerging roles for power electronics circuits and technologies. This is a time when our industry has an opportunity to showcase the technologies behind the curtain. The growth of the alternative energy industry, the internet as it is used today, the proliferation of mobile devices and many other technologies wouldn’t be possible without continued advances in power conversion technology. This presentation will highlight the technological advances in power electronics that empower these applications and set the stage for more advances to come.

A Historical Perspective on the Development of the PWM Switch Model
2:30 p.m. – 3:00 p.m.

**Speaker:**
Vatché Vorperian
Jet Propulsion Laboratory,
Principal Engineer & Fellow of the IEEE

In this presentation, I will talk about the earliest instances in the published literature that I am aware of, which include the works of Cuk, Landsman, Meares and Tymersky among others, of the appearance of a sub-circuit of a dcto-dc converter as a building block of dc-to-dc converters and its connection to the conversion ratio of that converter. I will then present the subsequent emergence of the PWM switch as the smallest sub-circuit of a converter with invariant structural and electrical characteristics which bestow it with an invariant equivalent circuit model. To render the model of the PWM switch easily accessible to all those studying power electronics, from the beginning it was promoted by pointing out its similarity to the model of the transistor and its utilization in amplifier circuit analysis since both, the PWM switch and the transistor, are three-terminal non-linear devices. From a pedagogical point of view, the idea has caught on well and today the model of the PWM switch is being taught at Universities and to industry. Some examples of the application of the PWM switch model to the analysis of modern converters such the coupled SEPIC and Cuk converters will be presented.

Break
3:00 p.m. – 3:30 p.m.

Google 48V Power Architecture
3:30 p.m. – 4:00 p.m.

**Speakers:**
Shuai Jiang
Google, Sr. DC-DC Power Architect for Data Centers

Xin Li
Google, Technical Lead Manager for Power Team

Global data center/cloud power market is exploding at over 10 percent annually to an estimation of 2 trillion kWh by 2020. Efficient power delivery from utility to the point of load could result in an astronomical amount of energy and expenditure savings. Today’s datacenter payloads generally use traditional 12V for sub-rack power distributions, but the exponentially increased distribution losses jeopardizes efficiency and scalability as power grows rapidly. Google has deployed a compelling 48V rack ecosystem in its data centers for several years, which promised to provide better efficiency, performance and scalability for more power-hungry computing systems enabled by high-end CPUs, accelerators and ASICs. The 48V to point-of-load conversion technology is one of the key enablers. Beyond the fundamental goals of higher efficiency, higher density and faster response for voltage regulator designs, some other key metrics should also be considered; such as the electrical and physical interaction between the voltage regulator and the motherboard system, implication of integration and power integrity, criticalness of design scalability, cost and ease of design, are some other essential elements driving the directions of technology evolution as well. In this presentation, we will explore together with you the 48V system architectures, 48V-to-PoL conversion technologies and challenges, and future exploration opportunities.
The Gap Between High Power and Low Power Converters And How it is Closing
4:00 p.m. – 4:30 p.m.

**Speaker:**
Hamish Laird
*ELMG Digital Power, Inc., CTO*

Large power converters have in the past had different constraints to small power converters. The first is that large converters have a lower surface area to volume ratio. The second is that capitalized cost of the lifetime power losses dominates the total cost of ownership. The third constraint is that the large converter control is necessarily constrained by the grid that it is connected to. Looking at the differences between the high power area and low power area there are now big leaps in efficiency that have brought the two together in terms of the problems that are being encountered. There are now grid or other converter interaction issues, low control margin converters and large converter behavior change with operating point at power levels as low as 500W. In order to manage these issues, techniques from the high power converter space are now useful and necessary. The presentation will explore the gap between high power and low power and the techniques that are useful to fill the gap.

From SiC MOSFET Devices to MW-scale Power Converters
4:30 p.m. – 5:00 p.m.

**Speaker:**
Ljubisa Stevanovic
*GE Global Research, CTO Silicon Carbide Works*

This presentation will provide an overview of GE’s vertically integrated activities from SiC devices and modules to converters for MW-scale industrial applications. GE has developed a new generation of high performance SiC MOSFETs with voltage ratings from 1.2 to 3.3kV and current ratings up to 100A per die. Significant progress has been made towards the goal of demonstrating the MOSFET reliability comparable to mature silicon IGBTs. Extensive stress testing has also mapped out the device’s safe operating area, including avalanche capability, short circuit ruggedness, body diode surge and stability, and terrestrial cosmic radiation hardness. In addition, a portfolio of low inductance half-bridge modules has been developed and optimized for fast-switching SiC MOSFETs. By taking advantage of the MOSFET’s body diode, the modules do not require anti-parallel diodes, saving cost and floor-space for additional MOSFETs. When compared to silicon modules with the same mechanical footprint and voltage ratings (e.g. 1.7kV), the SiC modules deliver twice as much current (500Arms), even when operating at three times higher switching frequency (7.5kHz). Such performance advantage is also due in part to robust gate drivers with fast control and protection features. These efforts have culminated with the launch of the World’s first MW-scale all-SiC product at the Solar Power International tradeshow in September 2016. The 2.5MW utility scale SiC PV Inverter offers the best in class 99.0% EU weighted efficiency, delivering between 1 and 2% more energy to customers. The single-stage inverter features a simple two-level topology switching at 8kHz and offers higher reliability due to reduced parts count.
Rap Sessions

**Tuesday, March 28**
5:00 p.m. – 6:00 p.m.

**R01: Power Electronic Topologies – Do We Need More or Any Benefit to New Ones?**
ROOM 15/16

**Moderator:**
Kevin Parmenter, *Excelsys*

**Speakers:**
> Babak Fahimi, *University of Texas at Dallas*
> Diarmuid Hogan, *Excelsys*
> Dan Jitaru, *Rompower*
> Johan Kolar, *ETH Zurich*
> Dragan Maksimovic, *University of Colorado*
> Bob Mammano, *Texas Instruments Retiree*
> Ray Ridley, *Ridley Engineering*

While the signal level electronics experienced substantial size reduction and compactness, power electronics field has not reached to the same level of improvements just yet. New power electronics architectures are usually proposed in order to reduce the cost, weight, and volume of the power electronic converters while adding more functionalities and improving efficiency. This rap session will discuss the recent power electronics architecture inventions and the future possibilities and limitations that our industry may experience. Although some opponents express that new inventions in power electronics topologies can never end, some defenders argue that we are at the edge of physical limitations in power electronics innovations and new topologies may not be the key for improvement. This panel will also provide an insight if we need more topologies or if we need to invest more on the power electronics materials, packaging, thermal management, etc. in order to achieve the ideal power converter.

**R02: Do We Need to Progress Towards GHz Switching in High Power Systems and Applications?**
ROOM 18/19

**Moderator:**
Alix Paultre, *Power Systems Design Editorial Director*

**Speakers:**
> David Levett, *Infineon*
> Eric R. Motto, *Mitsubishi/Powerex*
> Ty McNutt, *CREE/Wolfspeed*
> Gene Sheridan, *Navitas Semiconductor*

High frequency switching has always been attractive since it can reduce the volume and weight of the power electronic converter components. Particularly, magnetic components such as inductors and high-frequency isolation transformers and filter sizes can be significantly reduced. However, for the mainstream power converter applications, there is an inverse relationship between the switching frequency capability and the power rating. This rap session will discuss if we need to progress towards GHz switching frequencies or if there are physical limitations that would prevent high-frequency devices being ideal candidates for high power applications.
R03: 3D Printing and Power Supply on Chip (PwrSoC)/Power Supply in Package (PSiP) vs. Discrete Designs

ROOM 20/21

MODERATOR:
Indumini Ranmuthu, Texas Instruments

SPEAKERS:
> Madhu Chinthavali, ORNL
> Doug Hopkins, North Carolina State University
> Arnold Alderman, Anagenisis, Inc.
> Albert Charpentier, Agile Switch

We have experienced significant miniaturization and increased level of functionalities in our electronic devices including personal computers, cell phones, tablets, and other pieces of equipment. This size reduction was possible mostly due to an effort taken by the power source industry to reduce the size and volume of the power supply units while improving their power density. While providing size reduction, integrated devices can potentially increase reliability and decrease the cost due to reduced number of parts. However, there are also opposite opinions arguing that reliability and maturity of the integrated devices are not field proven on a larger scale and the cost to the manufacturer will be higher due to the new assembly approaches and the cost of inventory. These ideas also defend that discrete devices also experience significant improvements and discrete designs can also provide same functionalities while keeping the cost down and having high reliability.
Dialogue Session

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

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

Thursday, March 24
11:30 a.m. – 2:00 p.m.
BALLROOM B/C

D01: AC-DC Converters II

Track: AC-DC Converters

Chair:
Haihua Zhou, Infineon Technologies

D01.1: Current Sensorless Control for Dual-Boost Full-Bridge PFC Converter
Hung-Chi Chen, Che-Yu Lu, Chien-Fu Chen, National Chiao Tung University, Taiwan

D01.2: Novel Voltage-Mode Control for DCM/CCM Boundary PFC Boost Converters Achieves High Efficiency and Low THD
Giovanni Gritti, Claudio Adragna, STMicroelectronics, Italy

D01.3: Analysis and Design of a Single-Stage Buck-Type AC-DC Adaptor
Ying-Ting Huang, Chia-Hao Li, Yaow-Ming Chen, Yung-Ping Tong, 1Lite-On Technology Corporation, Taiwan; 2National Taiwan University, Taiwan

D01.4: Improved Hybrid Rectifier for 1-MHz LLC-based Universal AC-DC Adapter
Yang Chen, Hongliang Wang, Yan-Fei Liu, Queen’s University, Canada

D01.5: A Special Application Criterion of Nine-Switch Converter with Improved Thermal Performance
Kawser Ali, Pritam Das, Sanjib Kumar Panda, National University of Singapore, Singapore

D01.6: Implementing Low Power Consumption in Standby Mode in the Case of Power Supplies with Power Factor Correction
Kevin Martín, Pablo F. Miajá, Diego G. Lamar, Javier Sebastián, Santiago Álvarez, 1Santiago Engineering Design Ltd., Hong Kong; 2Universidad de Oviedo, Spain; 3University of Oviedo, Spain

D01.7: Real DC Capacitor-Less Active Capacitors
Yunting Liu, Fang Zheng Peng, Michigan State University, United States

D01.8: Design, Implementation and Analysis of an Advanced Digital Controller for Active Virtual Ground-Bridgeless PFC
Ken King Man Siu, Yuanbin He, Carl Ngai Man Ho, Henry Shu-Hung Chung, River Tin-Ho Li, 1ABB, China; 2City University of Hong Kong, Hong Kong; 3University of Manitoba, Canada

D01.9: Isolated Matrix Current Source Rectifier in Discontinuous Conduction Mode
Dongdong Lan, Pritam Das, National University of Singapore, Singapore

D01.10: Design and Implementation of a 1.3 kW, 7-Level Flying Capacitor Multilevel AC-DC Converter with Power Factor Correction
Intae Moon, Carl Haken, Erik Saathoff, Ethan Bian, Yutian Lei, Shibin Qin, Derek Chou, Steven Sedig, Won Ho Chung, Robert C.N. Pilawa-Podgurski, University of Illinois Urbana-Champaign, United States

D01.11: An Isolated, Bridgeless, Quasi-Resonant ZVS-Switching, Buck-Boost Single-Stage AC-DC Converter with Power Factor Correction (PFC)
Markus Scherbaum, Manfred Reddig, Ralph Kennel, Manfred Schlenk, 1Hochschule Augsburg, Germany; 2Infineon Technologies AG, Germany; 3Technische Universität München, Germany

D01.12: A Control Architecture for Low Current Distortion in Bridgeless Boost Power Factor Correction Rectifiers
Usama Anwar, Robert Erickson, Dragan Maksimović, Khurram K. Afridi, University of Colorado Boulder, United States
D02: Miscellaneous Topics in DC-DC Converters I

Track: DC-DC Converters

Chair: Liming Liu, ABB USCRC

D02.1: Multilevel Modular Switched-Capacitor Resonant Converter with Voltage Regulation
Yanchao Li, Boris Curuvija, Xiaofeng Lyu, Dong Cao, North Dakota State University, United States

D02.2: Design and Magnetics Optimization of LLC Resonant Converter with GaN
Runruo Chen, Paul Brohin, Don Dapkus, Texas Instruments Inc., United States

D02.3: Asymmetrical (n/m)X DC-DC Converter for Finer Voltage Regulation
Gujing Han, Deepak Gunasekaran, Liang Qin, Fang Zheng Peng, Michigan State University, United States; Wuhan Textile University/Michigan State University, China; Wuhan University, China

D02.4: A Bidirectional Push-Pull DC-DC Converter with PWM Plus Phase-Shift Control Strategy
Shouxiang Li, Keyue Smedley, Kang Xiangli, Northwestern Polytechnical University, China; University of California, Irvine, United States

D02.5: High Step-Up Isolated DC-DC Converter with Multi-Cell Diode-Capacitor Network
Yan Zhang, Xinying Li, Zhuo Dong, Yan-Fei Liu, Jinyun Liu, Queen’s University, Canada; Xi’an Jiaotong University, China

D02.6: A Wire-Embedded Converter Used for Wearable Devices
Mofan Tian, Naizeng Wang, Kangping Wang, Haiyang Jia, Zhenwei Li, Xu Yang, Laili Wang, Xi’an Jiaotong University, China; Xi’an Jiaotong University / Sumida Corporation, China

D02.7: Quantization Mechanisms in Digital LLC Converters for Battery Charging Applications
Ya-Qi Wu, Zhi-Liang Zhang, Han-Dong Gui, Dong-Jie Gu, Nanjing University of Aeronautics and Astronautics, China; University of Tennessee, United States

D02.8: SiC-MOSFET Composite Boost Converter with 22 kW/L Power Density for Electric Vehicle Application
Hyeokjin Kim, Hua Chen, Dragan Maksimovic, Robert Erickson, Zach Cole, Brandon Passmore, Kraig Olejniczak, University of Colorado Boulder, United States; Wolfspeed / Cree, United States

D02.9: A Low-Volume Multi-Phase Interleaved DC-DC Converter for High Step-Down Applications with Auto-Balancing of Phase Currents
Samuel Da Silva Carvalho, S. M. Ahsanuzzaman, Aleksandar Prodić, University of Toronto, Canada

D02.10: 2-MHz GaN PWM Isolated SEPIC Converters
Zhi-Wei Xu, Zhi-Liang Zhang, Ke Xu, Zhou Dong, Xiaoyong Ren, Nanjing University of Aeronautics and Astronautics, China

D02.11: High Step-Up Full Bridge DC-DC Converter with Multi-Cell Diode-Capacitor Network
Yan Zhang, Xinying Li, Zheyu Miu, Kunal Kundanam, Jinyun Liu, Yan-Fei Liu, Queen’s University, Canada; Xi’an Jiaotong University, China

D02.12: A Resonant Modular Multilevel DC-DC Converter with Zero Current Switching for MVDC Application
Yanchao Li, Xiaofeng Lyu, Dong Cao, North Dakota State University, United States

D02.13: Analysis on Half-Bridge LLC Resonant Converter by using Variable Inductance for High Efficiency and Power Density Server Power Supply
Yeonho Jeong, Gun-Woo Moon, Jae-Kuk Kim, Inha University, Korea; Korea Advanced Institute of Science and Technology, Korea, South

D02.15: 5V-to-4V Integrated Buck Converter for Battery Charging Applications with an On-Chip Decoupling Capacitor
Gabriel Gabian, Benjamin Blalock, Daniel Costinett, University of Tennessee, Argentina; University of Tennessee, United States

D02.16: Highly Efficient and Reliable DC-DC Converter for Smart Transformer
Levy Costa, Giampaolo Buticchi, Marco Liserre, Christian-Albrechts-Universität zu Kiel, Germany

D02.17: High-Efficiency Multiphase DC-DC Converters for Powering Processors with Turbo Mode based on Configurable Current Sharing Ratios and Intelligent Phase Management
Yipeng Su, Kuang-Yao Cheng, Wenkai Wu, Texas Instruments Inc., United States

D02.18: 2 W Gate Drive Power Supply Design with PCB-Embedded Transformer Substrate
Bingyao Sun, Rolando Burgos, Dushan Boroyevich, Virginia Polytechnic Institute and State University, United States

D02.19: EMI Characterization of a GaN Switched-Capacitor based Partial Power RF SEPIC
Junjian Zhao, Di Han, Yehui Han, University of Wisconsin—Madison, United States

D02.20: Planar Transformers with No Common Mode Noise Generation for Flyback and Forward Converters
Mohammad Ali Saket, Martin Ordonez, Navid Shafiei, University of British Columbia, Canada

D02.21: Enhanced Power Efficiency DC-DC Converters with dsPIC Digital Controller for HVDC
Hisashi Yamanaka, Shotaro Karasuyama, Shogo Hirotta, Yoichi Ishizuka, Hideaki Domoto, Takuya Sasamura, Hayato Yamaoka, Nagasaki University, Japan
D03: Miscellaneous Topics in DC-DC Converters II

Track: DC-DC Converters

Chair:
Khurram Afridi, University of Colorado Boulder

D03.1: A 12V-to-0.9V Active-Clamp Forward Converter Power Block with Planar Transformer, Standing Slab Inductor and Direct Edge Solder to Motherboard
Xin Zhang, Andrew Ferencz, Todd Takken, Bai Nguyen, Paul Coteus, IBM, United States

D03.2: A High Step-Down Dual Output Non-Isolated DC/DC Converter
Ayan Mallik, Alireza Khaligh, University of Maryland, United States

D03.3: An Inductor-Less Hybrid Step-Down DC-DC Converter Architecture for Future Smart Power Cable
Gab-Su Seo, Hanch-Phuc Le, University of Colorado Boulder, United States

D03.4: A Time-Length Compensation Algorithm for Sub-Harmonic Oscillation Elimination in Digital Controlled Primary-Side Regulation Flyback Converter
Chong Wang, Shen Xu, Shengli Lu, Weifeng Sun, Southeast University, China

D03.5: Design Optimization and Performance Evaluation of High-Power, High-Frequency, Bidirectional Buck-Boost Converter with SiC MOSFETs
Yuri Panov, Yungtaek Jang, Milan M. Jovanović, Brian T. Irving, Delta Products Corporation, United States

D03.6: An Average Input Current Sensing Method of LLC Resonant Converters for Precise Overload Protection
Jian Chen1, Takahide Sato2, Koji Yano2, Hironobu Yamamoto2, Makoto Ōwa1, Masayuki Yamada1, 1Fuji Electric Co., Ltd., Japan; 2Yamanashi University, Japan

D03.7: GaN-based High Efficiency Bidirectional DC-DC Converter with 10 MHz Switching Frequency
Kristian Kruse, Mads Elbo, Zhe Zhang, Danmarks Tekniske Universitet, Denmark

D03.8: Wide-Input-Voltage-Range Dual-Output GaN-based Isolated DC-DC Converter for Aerospace Applications
Xingye Liu, Rolando Burgos, Bingyao Sun, Dushan Boroyevich, Virginia Polytechnic Institute and State University, United States

D03.9: Soft-Switched Bidirectional Buck-Boost Converters
Yungtaek Jang, Milan M. Jovanović, Delta Products Corporation, United States

D03.10: Conducted Common Mode Noise Reduction for Boost Converters using Leakage Inductance of Coupled Inductor
Katsuya Nomura1, Takashi Kojima1, Atsuhiro Takahashi1, Yoshihiko Hattori1, Kaoru Torii2, 1Toyota Central R&D Labs., Inc., Japan; 2Toyota Motor Corporation, Japan

D03.11: A Voltage Doubler Circuit to Extend the Soft-Switching Range of Dual Active Bridge Converters
Zian Qin, Yanfeng Shen, Huai Wang, Frede Blaabjerg, Aalborg University, Denmark

D03.12: 48V to 12V Isolated Resonant Converter with Digital Controller
Osvaldo Zambetti1, Mattia Colombo1, Salvatore D’angelo1, Stefano Saggini2, Roberto Rizzolatti2, 1STMicroelectronics, Italy; 2Università degli Studi di Udine, Italy

D03.13: A Novel Three-Phase LLC Resonant Converter with Integrated Magnetics for Lower Turn-Off Losses and Higher Power Density
Mostafa Noah3, Shota Kimura3, Shun Endo3, Masayoshi Yamamoto3, Jun Imaoka1, Kazuhiro Umetani2, Wilmar Martinez4, 1Kyushu University, Japan; 2Okayama University, Japan; 3Shimane University, Japan; 4Universidad Nacional de Colombia, Colombia

D03.14: High Step-Up Z-Source DC-DC Converter with Flyback and Voltage Multiplier
Arash Torkan, Mehrdad Ehsani, Texas A&M University, United States

D03.15: Bidirectional High Voltage Conversion Ratio DC/DC Converter with Full ZVS Range
Jianliang Chen, Deshang Sha, Xiaozhong Liao, Southeast University, China

D03.16: A Reconfigurable Series Resonant DC-DC Converter for Wide-Input and Wide-Output Voltages
Yanfeng Shen1, Huai Wang1, Zian Qin1, Frede Blaabjerg1, Ahmed Al Durra2, 1Aalborg University, Denmark; 2Petroleum Institute, U.A.E.
D03.21: High Power Density High Efficiency Wide Input Voltage Range LLC Resonant Converter Utilizing E-Mode GaN Switches
Ahmadreza Amirahmadi, Moshe Domb, Eric Persson, Infineon Technologies AG, United States

D03.22: A Hybrid Bidirectional DC-DC Converter for Dual-Voltage Automotive Systems
Shouxiang Li, Keyue Smedley, Diego Reis Caldas, Yan Watanabe Martins, 1CAPES Foundation / Ministry of Education of Brazil, Brazil; 2University of California, Irvine, United States

D03.23: ZVS Operation Range Analysis of Three-Level Dual Active Bridge DC-DC Converter with Phase-Shift Control
Li Jin, Bangyin Liu, Shanxu Duan, Huazhong University of Science and Technology, China

D03.24: A 48V:2V Flying Capacitor Multilevel Converter using Current-Limit Control for Flying Capacitor Balance
Jan Rentmeister, Jason Stauth, Dartmouth College, United States

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D04: Power Electronics for Utility Interface
Track: Power Electronics for Utility Interface

Chair:
Ali Khajehoddin, University of Alberta

D04.1: An Integrated Inverter Output Passive Sinewave Filter for Eliminating Both Common and Differential Mode PWM Motor Drive Problems
Todd Shudarek, Tin Luu, MTE Corporation, United States

D04.2: Leakage Current Reduction of Z-Source Four-Leg Inverter for Transformerless PVsystem
Xiaoqiang Guo, Ran He, Yanshan University, China

D04.3: A 320kV Hybrid HVDC Circuit Breaker based on Thyristors Forced Current Zero Technique
Lei Feng, Ruifeng Gou, Xiaoping Yang, Feng Wang, Fang Zhuo, Shuhuai Shi, Xi’an Jiaotong University, China; Xi’an XD Power Systems Co., Ltd, China

D04.4: A Semi-Two-Stage Dual-Buck Transformerless PV Grid-Tied Inverter
Tao Zhu, Li Zhang, Ranran Gao, Litao Qu, Hohai University, China

D04.5: Open-End Unidirectional Topologies with Reduced Controlled Switch Count
Reuben Palmer R. de Sousa, Cursino Brandão Jacobina, Universidade Federal de Campina Grande, Brazil

D04.6: A Unidirectional Snubber Less Partially Soft-Switched High Frequency Link Three Phase Inverter
Anirban Pal, Kaushik Basu, Indian Institute of Science, Bangalore, India

D04.7: HVDC Converter Transformer Saturation in Hybrid AC/DC System Caused by Coupled Transmission Lines
Shuoting Zhang, Yalong Li, Bo Liu, Xiaojie Shi, Leon M. Tolbert, Fred Wang, University of Tennessee, United States

D04.8: Analysis and Implementation of a Bridgeless Sepic AC/DC Converter with Power Factor Correction and Extended Gain
Yi-Hung Liao, Jia-Yi Jhu, National Penghu University of Science and Technology, Taiwan

D04.9: Virtual RLC Active Damping for Grid-Connected Inverters with LCL Filters
Qicheng Huang, Kaushik Rajashekara, University of Houston, United States

D04.10: A Unified AC-DC Microgrid Architecture for Distribution of AC and DC Power on the Same Line
Akshatha Shetty, Arun Nair, Abhijith V.S, Baylon G. Fernandes, Indian Institute of Technology Bombay, India

D04.11: A Prototype of Modular Multilevel Converter with Integrated Battery Energy Storage
Zhe Wang, Hua Lin, Yajun Ma, Tao Wang, Huazhong University of Science and Technology, China

D04.12: Control and Performance Analysis Methodology for Scale-Up of MMC Submodules for Back-to-Back HVDC Applications
Mohammed Alharbi, Miazar Mobarrez, Subhashish Bhattacharya, North Carolina State University, United States

D04.13: Estimation of Parameters in Single Phase Grid Connected and Stand-Alone Inverter System
Subhajyoti Mukherjee, Pourya Shamsi, Mehdi Ferdowsi, Missouri University of Science and Technology, United States

D04.14: Resonant Controller based Power-Angle Synchronization Control in Low Voltage Grids
Subhajyoti Mukherjee, Pourya Shamsi, Mehdi Ferdowsi, Missouri University of Science and Technology, United States

D04.15: A Novel Bi-Directional AC/DC Converter used for Energy Storage Systems (ESSs)
Snehal Bagawade, Hossein Mousavian, Praveen Jain, Majid Pahlevani, Queen’s University, Canada; University of Calgary, Canada

D04.16: Design of a SiC-based Modular Multilevel Converter for Medium Voltage DC Distriution System
Jianghui Yu, Rolando Burgos, Niloofar Rashidi Mehrabadi, Dushan Boroyevich, Virginia Polytechnic Institute and State University, United States
**D05.1:** Indirect Matrix Converter DTC for Induction Motor using a Single Current Sensor  
Brahim Metidji, Brahim Metidji, Université de Boumerdes - Université de M'hamed Bougara, Algeria

**D05.2:** Optimal Generalized Overmodulation for Multiphase PMSM Drives  
Paul Young, Matthias Preindl, Columbia University, United States

**D05.3:** Optimal Reset Controller Designed for Induction Machine Drive with Hardware in the Loop Test  
Jianyang Zhai¹, Youyi Wang¹, Xiong Liu²,  
¹Nanyang Technological University, Singapore;  
²Rolls-Royce Singapore Pte. Ltd., Singapore

**D05.4:** Speed-Sensorless Drive for Induction Machines using a Novel Hybrid Observer  
Jia Li, Anup Thapa, Keith Corzine, Clemson University, United States

**D05.5:** Improved Loss Model and Loss Minimization Control Strategy for Linear Induction Machine  
Dong Hu, Wei Xu, Renjun Dian, Yi Liu, Huazhong University of Science and Technology, China

**D05.6:** Multistep Model Predictive Control for Permanent Magnet Synchronous Machine  
Jianqiao Zou¹, Wei Xu¹, Yi Liu¹, Chaoxu Mu²,  
¹Huazhong University of Science and Technology, China;  
²Tianjin University, China

**D05.7:** Torque Ripple Suppression Method for Brushless DC Motor based on Instantaneous-Bus-Voltage Control Strategy  
Cong Gu, Xiaolin Wang, Zhiquan Deng, Nanjing University of Aeronautics and Astronautics, China

**D05.8:** Observer-based Estimation Improvement for Servo Control of PMSM with Binary-Type Hall Sensors  
Qinan Ni, Ming Yang, Jiang Long, Dianguo Xu, Harbin Institute of Technology, China

**D05.9:** Torque Ripple and Copper Loss Minimization for a Family of Mutually Coupled Switched Reluctance Machines  
Jin Ye, Forest Hensley, San Francisco State University, United States

**D05.10:** A Novel Predictive Current Control for Open-End Winding Induction Motor Drive with Reduced Computation Burden and Enhanced Zero Sequence Current Suppression  
Bohang Zhu¹, Kaushik Rajashekara², Hajime Kubo¹,  
¹Meidensha Corporation, Japan; ²University of Texas at Dallas, United States

**D05.11:** Regenerated Energy Recycling between Two Motors of Asynchronous Mode Driven by Hexagonal Cascaded Multilevel Converter  
Pan Wang², Fei Liu¹, Jinwu Gong¹, Wenjun Liu¹, Feiyan Zhu¹, Zhe Chen¹,  
¹Wuhan University, China; ²Wuhan University / Wuhan Electric Power Technical College, China

**D05.12:** Dynamic Decoupling Control Method for PMSM Drive with Cross-Coupling Inductances  
Kahyun Lee, Jung-Ik Ha, Seoul National University, Korea, South

**D05.13:** On-Line Fault Diagnosis of Multi-Phase Drives using Self-Recurrent Wavelet Neural Networks with Adaptive Learning Rates  
Nilofar Torabi, Vivek Meenakshi Sundaram, Hamid A. Toliyat, Texas A&M University, United States

**D05.14:** Design and Implementation of Position Sensorless Starting Control in Industrial Drives with Output Filter and Transformer for Oil/Pump Applications  
Jingbo Liu, Jinya Dai, Semyon Royak, Peter Schmidt, Ehsan Al-Nabi, Thomas Nondahl, Rockwell Automation, United States

**D05.15:** Fault Tolerance Performance of Two Hybrid Six-Phase Drive Systems under Single-Phase Open-Circuit Fault Operation  
Victor Melo², Cursino Brandão Jacobina², Nady Rocha¹, Edgar Filho²,  
¹Universidade Federal de Paraíba, Brazil; ²Universidade Federal de Campina Grande, Brazil

**D05.16:** Common-Mode Resonance Suppression for Parallel CSC-fed High Power Medium Voltage Drives with Multilevel Modulation  
Li Ding, Zhongyi Quan, Yun Wei Li, University of Alberta, Canada
D06.1:  5 kW Bidirectional Grid-Connected Drive using Silicon-Carbide Switches:  Control
Alireza Kouchaki1, Radu Lazar1, Jacob Pedersen2, Morten Nymand2, 1Danfoss Drives, Denmark; 2University of Southern Denmark, Denmark

D06.2:  Control and Design of a Four-Switch Inverter with Reduced Low-Frequency Input Current Ripple and Capacitance Requirement:  a Comparative Study
Youjie Shi, Bangyin Liu, Shanxu Duan, Huazhong University of Science and Technology, China

D06.3:  Impact of Application of SiC Devices in Motor Drive on EMI
Zhixiao Fang, Dong Jiang, Zewei Shen, Ronghai Qu, Huazhong University of Science and Technology, China

D06.4:  Feedback Linearization based Current Control Strategy for Modular Multilevel Converters
Shunfeng Yang1, Yi Tang1, Zhu Xu2, Michael Zagrodnik2, Gupta Amit2, Peng Wang1, 1Nanyang Technological University, Singapore; 2Rolls-Royce Singapore Pte. Ltd., Singapore; 3Southwest Jiaotong University, China

D06.5:  Control of the Hybrid Modular Multilevel Converter in Motor Drive Applications
Shaoze Zhou, Mingxu Guan, Binlin Li, Shacong Zhou, Dianguo Xu, Harbin Institute of Technology, China

D06.6:  DC-Link Capacitor Voltage Balancing Technique for Phase-Shifted PWM-based Seven-Switch Five-Level ANPC Inverter
Lei Kou, Hongliang Wang, Yan-Fei Liu, Paresh C. Sen, Queen’s University, Canada

D06.7:  Application of the Time-Frequency Analysis using Wavelet Transform to Harmonics Analysis in the Power Conversion Systems
Hiroki Nagano1, Ryota Kimikado1, Masakazu Michihira1, Keiji Akamatsu2, Makoto Ozone2, Takaaki Norisada2, 1Kobe City College of Technology, Japan; 2Panasonic Corporation, Japan

D06.8:  Topology of Modified Switched-Capacitor Z-Source Inverters with Improved Boost Capability
Anh-Vu Ho1, Si-Gyeong Yang2, Tae-Won Chun2, Hong-Hee Lee2, 1Eastern International University, Vietnam; 2University of Ulsan, Korea, South

D06.9:  DC Voltage Control of a Reduced Switching Losses Converter for High Speed Drives
Vito Giuseppe Monopoli, Pierluigi Sidella, Francesco Cupertino, Politecnico di Bari, Italy

D06.10:  Simple Algorithm with Fast Dynamics for Cascaded H-Bridge Multilevel Inverter based on Model Predictive Control Method
Ro Chan1, Jaehoon Baek2, Sangshin Kwak1, 1Chung-ang University, Korea, South; 2Korea Railroad Research Institute, Korea, South

D06.11:  Common-Mode Voltage Suppression based on Auxiliary Leg for Three-Level NPC Inverters
Quoc Anh Le, Dong-Choon Lee, Yeungnam University, Korea, South

D06.12:  Dual Buck-Boost Inverter
Ashraf Ali Khan1, Honnyong Cha1, Fazal Akbar1, Kim Kisu1, Jih-Sheng Lai2, 1Kyungpook National University, Korea, South; 2Virginia Polytechnic Institute and State University, United States
D06.14: Experimental Evaluation of a 1 kW, Single-Phase, 3-Level Gallium Nitride Inverter in Extreme Cold Environment
Christopher Barth², Juan Colmenares¹, Thomas Foulkes², Keith Coulson², Jesus Sotelo², Tomas Modeer², Nenad Miljkovic², Robert C.N. Pilawa-Podgurski², ¹KTH Royal Institute of Technology, Sweden; ²University of Illinois Urbana-Champaign, United States

D06.15: A Segmented Power Distribution Control System based on Hybrid Regenerative Cascaded Multilevel Converter
Pan Wang², Fei Liu¹, Xiaoming Zha¹, Feiyang Zhu¹, Jinwu Gong¹, Kun Feng¹, ¹Wuhan University, China; ²Wuhan University / Wuhan Electric Power Research Institute, China

D06.16: Cascaded Modular H7 Current Source Inverter
Weiqi Wang¹, Feng Gao¹, Yudun Li², ¹Shandong University, China; ²State Grid Shandong Electric Power Research Institute, China

D06.17: A Compact 110 kVA, 140°C Ambient, 105°C Liquid Cooled, All-SiC Inverter for Electric Vehicle Traction Drives
Kraig Olejniczak, Tom Flint, David Simco, Sergei Storkov, Brad McGee, Robert Shaw, Brandon Passmore, Kenny George, W. Austin Curbow, Ty McNutt, Wolfspeed / Cree, United States

D06.18: Comprehensive Comparison of THD and Common Mode Leakage Current of Bipolar, Unipolar and Hybrid Modulation Schemes for Single Phase Grid Connected Full Bridge Inverters
Yinglai Xia, Raja Ayyanar, Arizona State University, United States

D07: Devices & Reliability
Track: Devices and Components

D07.1: A Temperature-Independent Method for Monitoring the Degradation of Bond Wires in IGBT Modules based on Transfer Characteristics
Yingzhou Peng, Pengju Sun, Luowei Zhou, Xiong Du, Jie Cai, Chongqing University, China

D07.3: Failure Mechanism Analysis of a Discrete 650V Enhancement Mode GaN-on-Si Power Device with Reverse Conduction Accelerated Power Cycling Test
Sungyoung Song, Stig Munk-Nielsen, Christian Uhrenfeldt, Ionut Trintis, Aalborg University, Denmark

D07.4: A Lifetime Extension Strategy for Power Devices in the Wind Power Converters based on the Distribution Characteristics of Consumed Lifetime
Jun Zhang¹, Xiong Du¹, Cheng Zeng¹, Pengju Sun¹, Heng-Ming Tai², ¹Chongqing University, China; ²University of Tulsa, United States

D07.5: Miniaturized Design of a Piezoelectric Thermal Sensor Optimized for the Integration to Wide Bandgap Power Modules Operating at High Temperatures
Min-Ki Kim, Sang Won Yoon, Hanyang University, Korea, South

D07.6: Dynamic Junction Temperature Estimation via Built-in Negative Thermal Coefficient (NTC) Thermistor in High Power IGBT Modules
Yu Zhou², Wei Shi², Junsong Tang², Xiang Wang², Wuhua Li², Xiangning He², Chaoshan Zhang¹, Zhuzhi Li¹, ¹Xi’an Kaitian Power Electronics Technical Co., Ltd., China; ²Zhejiang University, China

D07.7: Reliability of SiC Power MOSFETs under High Repetitive Pulse Current Conditions
Vamsi Mulpuri, Seungdeog Choi, University of Akron, United States

D07.8: Protection and Temperature-Dependent Switching Characterization of Latest Generation 10 kV SiC MOSFETs
Shiqi Ji, Sheng Zheng, Zheyu Zhang, Fred Wang, Leon M. Tolbert, University of Tennessee, United States

D07.9: Detection of Aging Related IGBT Bond-Wire Lift-Off using Spread Spectrum Time Domain Reflectometry (SSTDR)
Swagat Das², Faisal Khan², Mohammed Khoshed Alam¹, Preetham Goli², ¹Ford Motor Company, United States; ²University of Missouri-Kansas City, United States
D08: Devices & Components

**Track:** Devices and Components

**Chairs:**
Jean-Luc Schanen, University of Grenoble
Dong Cao, North Dakota State University

**D08.1:** A Novel Active Gate Driver for Static and Dynamic Current Balancing of Parallel-Connected IGBTs
Ying Chen, Fang Zhuo, Wenjie Pan, Fan Zhang, Lei Feng, Xi’an Jiaotong University, China

**D08.2:** Balancing of Peak Currents between Paralleled SiC MOSFETs by Source Impedances
Yincan Mao², Zichen Miao², Khai Ngo², Chi-Ming Wang¹, ¹Toyota Motor Engineering & Manufacturing, United States; ²Virginia Polytechnic Institute and State University, United States

**D08.3:** Thyristors for Commutation of Current Impulse with Extremely High Amplitude
Anatoly Chernikov², Vladimir Goncharenko¹, Alexandr Mizintsev¹, Dmitriy Titushkin², Alexey Surma², ¹NIIEFA-ENERGO, LLC, Russia; ²Proton-Electrotex, Russia

**D08.4:** DC Link Bus Design for High Frequency, High Temperature Converters
Josh Stewart, Jason Neely, Jarod Delhotal, Jack Flicker, Sandia National Laboratories, United States

**D08.5:** Impacts of Unbalanced Grid Voltages on Lifetime of DC-Link Capacitors of Back-to-Back Converters in Wind Turbines with Doubly-Fed Induction Generators
Holger Jedtberg¹, Marius Langwasser¹, Rongwu Zhu¹, Gionampaolo Buticchi⁰, Thomas Ebel², Marco Liserre¹, ¹Christian-Albrechts-Universität zu Kiel, Germany; ²FTCAP GmbH, Germany

**D08.6:** A Novel Solid-State DC-Breaker based on Cascaded SiC MOSFETs
Yu Ren¹, Xu Yang¹, Liang Qiao¹, Fan Zhang¹, Laili Wang², Xi’an Jiaotong University, China; ²Xi’an Jiaotong University / Sumida Corporation, China

**D08.7:** Fuse Modeling for Reliability Study of Power Electronic Circuits
Amir Sajjad Bahman, Francesco Iannuzzo, Frede Blaabjerg, Aalborg University, Denmark

**D08.8:** Common Source Inductance Introduced Self-Turn-On in MOSFET Turn-Off Transient
Wen Zhang, Zheyu Zhang, Fred Wang, Daniel Costinett, Leon M. Tolbert, Benjamin Blalock, University of Tennessee, United States

**D08.9:** Trade-Off between Switching Loss and Common Mode EMI Generation of GaN Devices—Analysis and Solution
Di Han, Silong Li, Woongkul Lee, Wooyoung Choi, Bulent Sarlioglu, University of Wisconsin–Madison, United States

D09: Magnetic Components

**Track:** Devices and Components

**Chairs:**
Stephan Carlsen, Raytheon Company
Edward Herbert, Power Sources Manufacturers Association

**D09.1:** Analysis and Design of Tubular Coils for Wireless Inductive Power Transfer Systems
Jesús Acero², Javier Serrano², Claudio Carretero², Ignacio Lope¹, José Miguel Burdio², ¹BSH Home Appliances Group, Spain; ²Universidad de Zaragoza, Spain

**D09.2:** Realization of High-Current Variable AC Filter Inductors using Silicon Iron Powder Magnetic Core
Yusi Liu, H. Alan Mantooth, Juan Balda, Chris Farnell, University of Arkansas, United States

**D09.3:** A Step-by-Step Guide to Extracting Winding Resistance from an Impedance Measurement
Benedict Foo, Aaron Stein, Charles Sullivan, Dartmouth College, United States

**D09.4:** A Compensation Winding Structure for Balanced Three-Phase Coupled Inductor
Le Yang, Shuo Wang, University of Florida, United States

**D09.5:** New Method for Error Compensation in High Frequency Loss Measurement of Powder Cores
Farideh Javidi Niroumand², Morten Nymand², Andrew J. Forsyth¹, ¹University of Manchester, United Kingdom; ²University of Southern Denmark, Denmark

**D09.6:** Control on Coercivity of Fe/Co and Co/Fe Ferromagnetic Bilayers by Thermal Annealing
Xiaowei Hou, Dacheng Ni, Fei Wang, Liangguang Zheng, Ningbo CRRC Times Transducer Technology Co., LTD., China

**D09.7:** Next Generation Ferrite Material for SiC & GaN Applications
Herbert Jungwirth, Michael Schmidhuber, Michael Baumann, SUMIDA Components & Modules GmbH, Germany
**D10: Packaging & Design Optimization**

**Track:** System Integration

**Chairs:**
Ernie Parker, Crane Aerospace & Electronics
John Vigars, Allegro Microsystems

**D10.2:** A 3D Stacked Step-Down Intergrated Power Module
Wenbo Liu¹, Yan-Fei Liu¹, Laili Wang², Doug Malcolm²,  
¹Queen’s University, Canada; ²Sumida Corporation, Canada

**D10.3:** Two Core Implementation of Coupled Inductor for Parallel Three-Phase Power Converters
Sunghae Ohn, Xuning Zhang, Rolando Burgos, Dushan Boroyevich, Virginia Polytechnic Institute and State University, United States

**D10.4:** DC-Link RMS Current Reduction by Increasing Parallelized 3-Phase Inverter Module Number for Segmented Traction Drive
Xiaofeng Lyu, Haolin Zhou, Boris Curuvija, Dong Cao, North Dakota State University, United States

**D10.5:** Active Hot Spot Cooling of GaN Transistors with Electric Field Enhanced Jumping Droplet Condensation
Thomas Foulkes², Junho Oh², Patrick Birbarah²,  
Jason Neely¹, Nenad Miljkovic², Robert C.N. Pilawa-Podgurski², ¹Sandia National Laboratories, United States; ²University of Illinois Urbana-Champaign, United States

**D10.6:** High-Frequency Modulated Secondary-Side Self-Powered Isolated Gate Driver for Full Range PWM Operation of SiC Power MOSFETs
Jorge Garcia¹, Emre Gürpınar², Alberto Castellazzi², ¹Universidad de Oviedo, Spain; ²University of Nottingham, United Kingdom

**D10.7:** Distributed µ-STATCOM for Voltage Support and Harmonic Mitigation on Low Voltage Networks
Ehab Shoubaki², Somasundaram Essaiappan²,  
Pankaj Kumar Bhowmik³, Madhav Manjrekar², ³Duke Energy, United States; ²University of North Carolina at Charlotte, United States

**D10.8:** Impact of Cable and Motor Loads on Wide Bandgap Device Switching and Reflected Wave Phenomenon in Motor Drives
Balaji Narayanasamy, Arvind Shanmuganathan, Sathyaranayanan, Amol Deshpande, Fang Luo,  
Ohio State University, United States

**D11: Component Modeling & Simulation**

**Track:** Modeling and Simulation

**Chair:**
Fei Gao, Université de technologie de Belfort-Montbéliard

**D11.1:** Non-Ideal Model of the Common Mode Choke for EMI Filters
Illia Manushym¹, Lucas Monogios Koleff², Gerd Griepentrog¹, ¹Technische Universität Darmstadt, Germany; ²Universidade de São Paulo, Brazil

**D11.2:** Battery Life Estimation Model and Analysis for Electronic Buses with Auxiliary Energy Storage Systems
Ramdev Kanapady, Kim Kyle, Jason Lee, Eaton Corporation, United States

**D11.3:** A Simple and Upgradable Autonomous Battery Aging Evaluation and Test System with Capacity Fading and AC Impedance Spectroscopy Measurement
Zhiyong Xia, Jaber Abu Qahouq, Evan Phillips, Rachel Gentry, University of Alabama, United States

**D11.4:** Optimization of Transmitter Magnetic Structures for Roadway Applications
Emanuel Marques, André Mendes, Universidade de Coimbra, Portugal

**D11.5:** A Fast Electro-Thermal Co-Simulation Modeling Approach for SiC Power MOSFETs
Lorenzo Ceccarelli, Amir Sajjad Bahman, Francesco Iannuzzo, Frede Blaabjerg, Aalborg University, Denmark

**D11.6:** Analysis and Practical Method of Determining WBG FET Switching Losses Associated with Nonlinear Coss
Rais Miftakhutdinov, Texas Instruments Inc., United States

**D11.8:** Probability-based Circuit Breaker Modeling for Power System Fault Analysis
Chengwei Lei¹, Weisong Tian³, Yucheng Zhang⁴,  
Ruiyun Fu³, Ruting Jia², Robb Winter⁵, ¹California State University, Bakersfield, United States; ²California State University, Northridge, United States; ³Mercer University, United States; ⁴Old Dominion University, United States; ⁵South Dakota School of Mines and Technology, United States

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Chun Sing Cheng, Henry Shu-Hung Chung, Ricky Wing-Hong Lau, City University of Hong Kong, Hong Kong

**D11.10:** Diagnostic Cell for Large-Scale Battery Bank
Alex Chun-For Liu¹, Henry Shu-Hung Chung¹, Wenguan Wang¹, Ricky Wing-Hong Lau¹, Jun Zhang², ¹City University of Hong Kong, Hong Kong; ²Sun Yat-sen University, China
D11.11: Device Identification from Mixture of Measurable Characteristics
Michihiro Shintani, Kazuki Oishi, Rui Zhou, Masayuki Hiromoto, Takashi Sato, Kyoto University, Japan

D11.12: Review of SiC MOSFET based Three-Phase Inverter Lifetime Prediction
Ze Ni, Xiaofeng Lyu, Om Yadav, Dong Cao, North Dakota State University, United States

D12: Modeling and Analysis of Circuits & Systems
Track: Modeling and Simulation
Chair: Santanu Mishra, Indian Institute of Technology Kanpur

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Puqi Ning, Xuhui Wen, Yaohua Li, Qiongxuan Ge, Chinese Academy of Sciences, China

D12.2: Coupled Inductor based Multi-Phase Buck Converter for Magnet Power Supply
Hwasoo Seok, Sooa Kim, Min-Jae Kim, Jin S. Lee, Minsung Kim, 1Agency for Defense Development, Korea, South; 2LS Industrial Systems, Korea, South; 3Pohang University of Science and Technology, Korea, South

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Zhuyu Zhong, Shengqi Zhang, Jianfeng Zhao, Southeast University, China

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Kangping Wang, Mofan Tian, Laili Wang, Xu Yang, 1Xi’an Jiaotong University, China; 2Xi’an Jiaotong University / Sumida Corporation, China

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Jacob Mueller, Jonathan Kimball, Missouri University of Science and Technology, United States

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Yi Huang, Chun Cheung, Keerthi Varman Anna Jayaprakash, Intersil Corporation, United States

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Vahid Dargahi, Arash Khoshkbar Sadigh, Keith Corzine, 1Clemson University, United States; 2Extron Electronics, United States

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Niloorfar Rashidi Mehrabadi, Rolando Burgos, Christopher Roy, Jianghui Yu, Dushan Boroyevich, Virginia Polytechnic Institute and State University, United States

D12.9: Modeling a Hysteretic Modulator’s PFM and PWM Modes
Yi Huang, Chun Cheung, Intersil Corporation, United States

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Zhuoqiang Li, Yue Wang, Ling Shi, Jun Huang, Yao Cui, Wanjun Lei, Xi’an Jiaotong University, China

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Track: Control
Chair: Hrishikesh Nene, Texas Instruments, Inc.
Indumini Ranmuthu, Texas Instruments, Inc.

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Kinam Song, Wonhi Oh, Jinkyu Choi, ON Semiconductor, Korea, South

D13.4: Ripple Minimizing Digital Controller for Flying Capacitor DC-DC Converters based on Dynamic Mode Levels Switching
Nenad Vukadinovic, Aleksandar Prodic, Brett Miwa, Cory B. Arnold, Michael W. Baker, 1Maxim Integrated, United States; 2University of Toronto, Canada

D13.5: Model Predictive Control of a Grid-Connected Inverter to Reduce Current Ripples and Computation Loads
Hyun Chul Moon, June-Seok Lee, June-Hee Lee, Kyo-Beum Lee, 1Ajou University, Korea, South; 2Korea Railroad Research Institute, Korea, South

D13.6: Optimized Control Strategy for Minimum Ohmic Loss of Dual Active Bridge Converter
Anping Tong, Lijun Hang, Guojie Li, 1Hangzhou Dianzi University, China; 2Shanghai Jiao Tong University, China

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Hamid Mahmoudi, Parvin Moamaei, Mohsen Aleenejad, Reza Ahmadi, 1Southern Illinois University, United States; 2University of Kansas, United States
Tim McRae, Aleksandar Prodić, University of Toronto, Canada

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Yuan Cao, Jaber Abu Qahouq, University of Alabama, United States

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Miad Nasr1, Shahab Poshkouhi2, Nikolay Radimov1, Christian Cojocaru1, Olivier Trescases2, 1Solantro Semiconductor Corp., Canada; 2University of Toronto, Canada

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Hooman Ghaffarzadeh, Ali Mehrizi-Sani, Washington State University, United States

D13.13: A Control Method of Digital Active EMI Filter
Junpeng Ji1, Wenjie Chen1, Zhuobin Gu2, Xu Yang1, Xingxia Zhang2, 1Xi’an Jiaotong University, China; 2Xi’an University Of Technology, China

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Pramod Kumar Prasobhu, Vivek Raveendran, Giampaolo Buticchi, Marco Liserre, Christian-Albrechts-Universität zu Kiel, Germany

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Hidemine Obara1, Keiji Wada1, Koutaro Miyazaki2, Makoto Takamiya2, Takayasu Sakurai2, 1Tokyo Metropolitan University, Japan; 2University of Tokyo, Japan

D13.16: Droop-Free Distributed Control with Event-Triggered Communication in DC Micro-Grid
Renke Han1, Nelson Leonardo Diaz Aldana1, Lexuan Meng1, Josep M. Guerrero1, Qiuye Sun2, 1Aalborg University, Denmark; 2Northeastern University, China

D13.17: Adaptive Control Strategy for Ultracapacitor based Bidirectional DC-DC Converters
Saichand Kasicheyanula, Vinod John, Indian Institute of Science, India

D13.18: Large & Small Signal Modeling of Dual Active Bridge Converter using Improved First Harmonic Approximation
Suyash Sushilkumar Shah, Subhashish Bhattacharya, North Carolina State University, United States

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Cristina Fernandez, Pablo Zumel, Marlon Alberto Granda, Marina Sanz, Antonio Lazaro, Andres Barrado, Universidad Carlos III de Madrid, Spain

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Silong Li, Di Han, Bulent Sarlioglu, University of Wisconsin-Madison, United States

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S M Rakhiul Islam, Shawn Maxwell, Sung-Yeul Park, Shaobo Zheng, Tao Gong, Song Han, University of Connecticut, United States

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Xiaoqing Yong, Matthias Preindl, Columbia University, United States

D13.23: Fast Transient Current Control for Three-Phase Dual-Active-Bridge DC-DC Converters with Variable Duty Cycles
Zhuoqiang Li, Yue Wang, Yao Cui, Ling Shi, Jun Huang, Wanjun Lei, Xi’an Jiaotong University, China

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Track: Renewable Energy Systems

Chair:
Xiaoqiang Guo, Yanshan University

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Jufeng Yang2, Bing Xia2, Yunlong Shang3, Wenxin Huang1, Chris Mi2, 1Nanjing University of Aeronautics and Astronautics, China; 2San Diego State University, United States; 3Shandong University and San Diego State University, United States

D14.3: Forward-Flyback Resonant Converter for High-Efficient Medium-Power Photovoltaic Applications
Oscar Andres Montes, Sungho Son, Sooa Kim, Hwasoo Seok, Jin S. Lee, Minsung Kim, Pohang University of Science and Technology, Korea, South

D14.4: Online Estimation of Capacity Fade and Impedance of Lithium-Ion Batteries based on Impulse Response Technique
Zhuo Yang, Devendra Patil, Babak Fahimi, University of Texas at Dallas, United States

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Ol Kirshenboim1, Mor Mordechai Peretz1, Ilya Zeltser2, 1Ben-Gurion University of the Negev, Israel; 2Rafael Advanced Defense Systems Ltd., Israel
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Yun Yang, Siew-Chong Tan, Shu-Yuen Ron Hui, University of Hong Kong, Hong Kong

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Maziar Mobarrez, Subhashish Bhattacharya, Daniel Fregosio, North Carolina State University, United States

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Min-Kwon Yang, Myung-Chul Lee, Woo-Young Choi, Chonbuk National University, Korea, South

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Jingxin Hu, Philipp Joebges, Rik W. De Doncker, Rheinisch-Westfälische Technische Hochschule Aachen, Germany

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Yue Zheng¹, Yuan Li³, Su Sheng¹, Brad Scandrett², Brad Lehman¹, ¹Northeastern University, United States; ²PowerFilm, INC, United States; ³Sichuan University, China

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Hyunjun Lee², Jounghu Park², Jonghoon Kim¹, ¹Chungnam National University, Korea, South; ²Soongsil University, Korea, South

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Muhammad Muneeb Ur Rehman², Fan Zhang¹, Regan Zane², Dragan Maksimovic¹, ¹University of Colorado Boulder, United States; ²Utah State University, United States

**D14.15:** Model Predictive Control of Multi-String PV Systems with Battery Back-up in a Community DC Microgrid
Shunlong Xiao, Mohammad B. Shadmand, Robert S. Balog, Texas A&M University, United States

**D14.16:** A Decentralized Voltage Regulation Method for DC Distribution System with Self-Consumption Characteristic
Moonhyn Lee², Wooin Choi¹, Jih-Sheng Lai², Bo-Hyung Cho¹, ¹Seoul National University, Korea, South; ²Virginia Polytechnic Institute and State University, United States

**D14.17:** Coupled Inductor based ZVS High Step-Up DC/DC Converter in Photovoltaic Applications
Cheng Li, Haoyu Wang, ShanghaiTech University, China

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Satoshi Sawano², Fumiuki Yoneda², Atsushi Okita², Masahiro Makino², Jun-Ichi Itoh¹, ¹Nagaoka University of Technology, Japan; ²Panasonic Corporation, Japan

**D15.2:** An Experimental Study of MAF-SRF-PLL with Comb Compensator
Menxi Xie¹, Canyan Zhu¹, Liqun He¹, Huiqing Wen², ¹Soochow University, China; ²Xi’an Jiaotong-Liverpool University, China

**D15.3:** SRF-PLL with in-Loop Differentiator Decouple Filter for Unbalanced Three-Phase Systems
Menxi Xie¹, Canyan Zhu¹, Yong Yang¹, Huiqing Wen², ¹Soochow University, China; ²Xi’an Jiaotong-Liverpool University, China

**D15.4:** Distributed Maximum Power Point Tracking using Model Predictive Control for Solar Photovoltaic Applications
Sally Sajadian, Reza Ahmadi, University of Kansas, United States

**D15.5:** Dynamic Performance Analysis of Paralleled Virtual Synchronous Generators under Grid-Connected and Islanded Mode
Zhenxiong Wang, Hao Yi, Jiaqi Wu, Fang Zhuo, Feng Wang, Zhirong Zeng, Xi’an Jiaotong University, China

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Damián Sal y Rosas, David Frey, Jean-Luc Schanen, Jean-Paul Ferrieux, Université Grenoble Alpes, France

**D15.8:** An Adaptive Control Strategy for Power Balance and the Intermittency Mitigation in Battery-PV Energy System at Residential DC Microgrid Level
Junviere Umahuoa, Yuzhi Zhang, Shuang Zhao, H. Alan Mantooth, University of Arkansas, United States

**D15.9:** A State-of-Charge Balance Method for Distributed Energy Storage Units in Microgrid
Qingfeng Wu, Xiaofeng Sun, Yanan Wang, Xin Li, Chunjiang Zhang, Yanshan University, China

**D15.10:** Pulse Width Amplitude Modulation based Single-Phase Quasi-Z-Source Photovoltaic Inverter with Energy Storage Battery
Yushan Liu¹, Baoming Ge², Yichang Wu¹, Panagiotis Kakosimos³, Haitham Abu-Rub³, ¹China Unicom Fuxin Branch, China; ²Texas A&M University, United States; ³Texas A&M University at Qatar, Qatar
D16: Transportation Power Electronics

Track: Transportation Power Electronics

Chairs:
Navid Zargar, Rockwell Automation
Hadi Malek, Ford Motor Company

D16.1: Experimental Determination of Inverter Losses and Sound Consequences of using DPWM in an HEV
Andreas Andersson, Torbjörn Thiringer, Chalmers University of Technology, Sweden

D16.2: Inductive Power Transfer for Electric Bicycles Charging based on Variable Compensation Capacitor
Yang Chen, Ruikun Mai, Youyuan Zhang, Yong Li, Zhengyou He, Southwest Jiaotong University, China

D16.3: Design of a Secondary Side Regulated LLC based Integrated PEV Onboard Charger with Full ZVS Range
Zhiqin Li, Haoyu Wang, ShanghaiTech University, China

D16.4: Determining Coil Distance of Cross-Segmented IPT System for Constant Output Voltage
Mingkai Yang2, Yanling Li2, Ruikun Mai2, Zhengyou He2, Bin Wang1, 1China Railway Construction Heavy Industry Co., Ltd., China; 2Southwest Jiaotong University, China

D16.5: A Three-Phase Wireless Charging System for Lightweight Autonomous Underwater Vehicles
Tianze Kan1, Ruikun Mai2, Patrick Mercier3, Chris Mi1, 1San Diego State University, United States; 2Southwest Jiaotong University, China; 3University of California, San Diego, United States

D16.6: Mitigating Power Systems Variability in More Electric Aircraft Utilizing Power Electronics Implemented Dynamic Thermal Storage
Yue Cao, Matthew Williams, Philip Krein, Andrew Alleyne, University of Illinois Urbana-Champaign, United States

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Ming Lu, Khai Ngo, Virginia Polytechnic Institute and State University, United States

D16.8: A Switched-Coupling-Capacitor Equalizer for Series-Connected Battery Strings
Yunlong Shang3, Fei Lu4, Bing Xia1, Chenghui Zhang2, Naxin Cui2, Chris Mi1, 1San Diego State University, United States; 2Shandong University, China; 3Shandong University and San Diego State University, China; 4University of Michigan, United States

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Hulong Zeng, Fang Zheng Peng, Michigan State University, United States

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Mohammed Khorsheed Alam, Lihua Chen, Yan Zhou, Fan Xu, Shuitao Yang, Ford Motor Company, United States

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Yeran Liu, Ruikun Mai, Pengfei Yue, Yong Li, Zhengyou He, Southwest Jiaotong University, China

D16.12: A Novel Zero Voltage Switching Inductive Power Transfer Topology using Current-Fed Converter for EV Battery Charging Applications
Suvendu Samanta, Akshay Kumar Rathore, Concordia University, Canada

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Amr Ibrahim, Hassan Abdelgabir, Matthew G. Granger, Yilmaz Sozer, Alex De Abreu-Garcia, University of Akron, United States

D16.14: A Voltage Stress Optimization Method of Capacitive Power Transfer Charging System
Bo Luo, Ruikun Mai, Yangqi Chen, Youyuan Zhang, Zhengyou He, Southwest Jiaotong University, China
D17: AC-DC, DC-AC, Grid and LED Applications

Track: Power Electronics Applications

CHAIRS:
Tilak Gopalarathnam, LG Technology Center America
Jim Moss, Texas Instruments, Inc.

D17.2: Effects of Circuit Nonlinearities on Dynamic Dead Time Optimization for a Three-Phase Microinverter
Seyed Milad Tayebi, Nasser Kukut1, Issa Batarseh2,
1Advanced Charging Technologies / University of Central Florida, United States; 2University of Central Florida, United States

D17.3: An Adaptive Discontinuous Pulse Width Modulation (DPWM) Method for Three Phase Inverter
Fangcheng Liu, Kai Xin, Yunfeng Liu, Huawei Technologies Co., Ltd, China

D17.4: A Unity Power Factor Single-Stage Contactless Power Transfer System using Variable Frequency-Phase Shift Control
Xiaowei Sun, Guangzhu Wang, Xuan Wang, Shandong University, China

D17.5: An IGCT Anode Current Detecting Method based on Rogowski Coil
Hong Zeng, Xiulin Chen, Shunbiao Zhang, Yongshan Huang, Sanhu Wang, Fuguang Wang, Bin Liu, Danhua Hu, Honglin Tan, CRRC Zhuzhou Institute Co., Ltd., China

D17.6: Experimental Validation of Linear AC LED Driver with Quantitative Design Method
Yuichi Noge1, Hiroyuki Fuse2, Takeshi Shimizu3,
1Tokyo Institute of Technology, Japan; 2Tokyo Metropolitan College of Industrial Technology, Japan; 3Yokohama National University, Japan

D17.8: Modeling, Analysis and Design of a Dual-Input ZVS DC/DC Converter
Liang Yu, Haoyu Wang, ShanghaiTech University, China

D17.9: Active Elimination of DC Bias Flux in Series DC Active Filter Coupling Transformer
Richard Beddingfield, David Storelli, Subhashish Bhattacharya, North Carolina State University, United States

D17.10: Off-Line Buck LED Driver for Series Connected LED Segments
Jong-Bok Baek, Su-Yong Chae, Korea Institute of Energy Research, Korea, South

D17.11: Individual DC Voltage Balancing Method at Zero Current Mode for Cascaded H-Bridge based Static Synchronous Compensator
Zezhou Yang1, Jianjun Sun2, Shangsheng Li2, Zhiqiang Liao3, Gangqiang Du1, Xiaoming Zha3, Jiawen Fu3,
1Dongfang Electronics Co., Ltd., China; 2Wuhan Keliyuan Electric Co. Ltd., China; 3Wuhan University, China

D17.12: Performance Analysis of RCD and MOV Snubber Circuits in Low-Voltage DC Microgrid System
Feiyang Zhu, Fei Liu, Wenjun Liu, Kun Feng, Xiaoming Zha, Wuhan University, China

D17.13: Advanced Control Strategies for Balancing LED Usage of AC LED Driver
Seung-Woo Baek2, Soo-Bin Han1, Hag-Wone Kim3, Su-Yong Chae1, Jong-Bok Baek1, 1Korea Institute of Energy Research, Korea, South; 2Korea Institute of Energy Research / Korea National University of Transportation, Korea, South; 3Korea National University of Transportation, Korea, South

D17.14: Delta Interconnected Hybrid Three-Leg Converters
Edgard Fabricio1, Cursino Brandão Jacobina2, Mauricio B. R. Corrêa2, Reuben Palmer R. de Sousa2, 1Instituto Federal da Paraíba, Brazil; 2Universidade Federal de Campina Grande, Brazil

D17.15: An Unidirectional Single-Phase AC-DC-AC Three-Level Three-Leg Converter
Nustenil Marinus2, Cursino Brandão Jacobina2, Nady Rocha1, Reuben Palmer R. de Sousa2, 1Universidade Federal da Paraíba, Brazil; 2Universidade Federal de Campina Grande, Brazil

D17.16: Isolated Single-Phase AC Grid Connected Converter with Small Inductors and Capacitors for Micro-Inverters
Hiromi Watanabe, Jun-Ichi Itoh, Nagaoka University of Technology, Japan

D17.17: Stand-Alone Low-Cost Wave Energy Generation with Energy Storage Integration
Prathamesh Kamat, Samir Hazra, Subhashish Bhattacharya, North Carolina State University, United States

D17.18: A Simplified Control Strategy to Precisely Control the Reactive Power through Bi-Directional Switching in Single Phase Bidirectional AC/DC Converter for V2G Techniques
Maohang Qiu, Min Chen, Bo Liu, Lei Jing, Zhejiang University, China

D17.19: Buck-Type Wide-Range Dimmable LED Driver
Po-Yen Lin1, Tsong-Juu Liang3, Che-Wei Chang1, Kai-Hui Chen3, Bin-Kun Huang3, 1Macroblock, Inc., Taiwan; 2National Cheng Kung University, Taiwan; 3National Cheng Kung University, Taiwan

D17.20: High Performance Multiple String LED Driver with Flexible and Wide Range PWM Dimming Capability
Mohammad Tahan, Tingshu Hu, University of Massachusetts Lowell, United States
D18: Power Electronics Applications

Track: Power Electronics Applications

CHAIRS:
Hoi Lee, University of Texas at Dallas
Yingying Kuai, Caterpillar Inc.

D18.1: Stabilization and Performance Preservation of DC-DC Cascaded Systems by Diminishing Output Impedance Magnitude
Ahmed Aldhaheri, Amir Etemadi, George Washington University, United States

D18.2: A Novel Resonant-Linear Hybrid Converter Applied in Microwave Wireless Power Transmission System
Rui Tan, Ke Jin, Nanjing University of Aeronautics and Astronautics, China

D18.3: Design and Implement an Adaptive Position Adjustment Coupler for Coil-Misaligned Inductive Contactless Power Transfer System
Pingan Tan, Liangwei Ye, Saiqi Cao, Bo Zhang1, 2
1 South China University of Technology, China; 2Xiangtan University, China

D18.4: 6.78 MHz Self-Oscillating Parallel Resonant Converter based on GaN Technology
Ricardo Bonache-Samaniego1, Carlos Olalla1, Luis Martínez-Salamero1, Dragan Maksimovic2, 1Universitat Rovira i Virgili, Spain; 2University of Colorado Boulder, United States

D18.5: An Optimal Parameters Design Methodology of Series-Series Resonant Tank of Wireless Power Transmission System for Battery Charging
Yongbin Jiang, Yue Wang, Junwen Liu, Xufang Hu, Shiyuan Yin, Zhang Wang, Laili Wang, 1Xi’an Jiaotong University, China; 2Xi’an Jiaotong University / Sumida Corporation, China

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Cong Deng, Guangqi Zhu, Robert Lorenz, University of Wisconsin–Madison, United States

D18.7: Real-Time Integratable Isolated Voltage Monitoring Unit of Semiconductor Power Switch to Improve Power Converter Reliability
Hui-Chen Yang, Kye-Yak See, King Jet Tseng, Rejeki Simanjorang, 1Nanyang Technological University, Singapore; 2Rolls-Royce Singapore Pte. Ltd., Singapore

D18.8: High Performance Boost Inverter Featuring GaN-based Devices for Electro Surgical Units
Hector Sarnago, Oscar Lucia, José Miguel Burdio, Universidad de Zaragoza, Spain

D18.9: Evaluation of Maximum System Efficiency and Maximum Output Power in Two-Coil Wireless Power Transfer System by using Modeling and Experimental Results
Yuan Cao, Jaber Abu Qahouq, University of Alabama, United States

D18.10: Unregulated Bus Operation of Server-to-Virtual Bus Differential Power Processing for Data Centers
Enver Candan, Pradeep S. Shenoy, Robert C.N. Pilawa-Podgurski, 1Texas Instruments Inc., United States; 2University of Illinois Urbana-Champaign, United States

D18.11: Analysis of a Low Power, High Voltage and High Gain Capacitor Charger with Output Sourcing Behavior
Ilya Zeltser, Rafael Advanced Defense Systems Ltd., Israel

D18.12: A Battery Equalizer with Zero-Current Switching and Zero-Voltage Gap among Cells based on Three-Resonant-State LC Converters
Yunlong Shang, Naxin Cui, Qi Zhang, Chenghui Zhang, 1Shandong University, China; 2Shandong University and San Diego State University, China

D18.13: High Frequency GaN-based Ultrasound Pulse Generator for High Energy Delivery
Han Peng, Juan Sabate, Kieran Wall, 1GE Global Research, United States; 2GE Healthcare, Norway

D18.14: A Novel Dual Voltage Source Converter for Magnetic Material Characterization with Trapezoidal Excitation
Richard Beddingfield, David Storelli, Subhashish Bhattacharya, North Carolina State University, United States

D18.15: Performance Comparison of Two Controllers for a Modular Voltage Balancing Circuit
Atrin Tavakoli, Ian Smith, Ali Khajehoodin, John Salmon, University of Alberta, Canada

D18.16: Omnidirectional Wireless Power Transfer for Portable Devices
Junjie Feng, Qiang Li, Fred C. Lee, 1Virginia Polytechnic Institute and State University, United States; 2GE Healthcare, Norway

D18.17: A Single Stage AC/RF Converter for Wireless Power Transfer Applications
Ling Jiang, Daniel Costinnett, Aly Fathy, Songnan Yang, 1Intel Corporation, United States; 2University of Tennessee, United States

Yichen Cai, Andrew J. Forsyth, Rebecca Todd, University of Manchester, United Kingdom
2017 Exhibitor Directory
APEC 2017 Exposition

The APEC 2017 Exposition will provide conference attendees an exceptional opportunity to examine and touch the product offerings of the leading suppliers to the power electronics industry. The newest components, power supplies, design tools and services will be on display, and you can meet and talk to application experts at each booth. The exhibition is sold out again this year, so you will be sure to find something of interest in every corner of the hall.

For in-depth product details, the Exhibitor Seminars on Tuesday afternoon and Wednesday morning will offer product presentations and a question and answer forum for present and future products and services. Additional highlights of the conference include the Exhibit Hall Welcome Reception on Monday evening followed immediately at 8 p.m. by the 26th Annual MicroMouse Contest, then on Tuesday at 5 p.m. the Rap Sessions covering topics of interest in power electronics.

A thank you goes to our long-term APEC sponsors the IEEE Industrial Applications & Power Electronics Societies (IAS & PELS), and the Power Sources Manufacturers Association (PSMA) for their commitment and support of APEC 2017. In addition, a special thanks goes to our eight conference partners whose logos appear on the next page, who have provided additional financial support to make your conference experience even better.

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Admission

Entry is granted to persons 18 or older with any APEC badge, including the free “Exhibits Only” badge which also grants admission to the exhibitor seminars, plenary session, micromouse contest and rap sessions.

Exposition Functions

EXHIBIT HALL WELCOME RECEPTION

A Welcoming Reception will be held in the Exhibit Hall on Monday, March 27, from 5:00 p.m. until 8:00 p.m. Come join us for a Taste of Tampa! Registered spouses and guests are welcome.

EXPOSITION LUNCH AND BREAKS

Lunch will be served in the Exhibit Hall on Tuesday from 12:00 – 1:30 pm and on Wednesday from 12:00 p.m. – 2:00 p.m. free of charge to all who have access to the exhibit hall.

On Tuesday afternoon from 2:30 p.m. – 3:30 p.m., we will be having an ice cream social in the Exhibit hall.

The Wednesday morning coffee break will be served in the Exhibit Hall from 10:00 a.m. to 11:00 a.m.

Exposition & Giveaway

During all three days of the Exposition we will be giving away over $3000 in prizes. At registration everyone (exhibits only registrants and exhibitors included) will be issued a raffle ticket that you will put in a drop box upon entering the Exhibit Hall. This will be good for all three days of raffles during the exposition.
Exhibitor Seminars

Exhibitor Seminars – Session #1
Tuesday, March 28 – 1:30 p.m. – 2:00 p.m.

STMicroelectronics
ROOM 1/2

Digital Control IC for PFC and L-C Resonant Converter
Presented by: Gianni Vitale
Digitally controlled combo IC delivers high performance in a 90W adapter with Transition Mode PFC and Primary Side Regulated L-C resonant based DC-DC stage.

Plexim
ROOM 11

Real-time Simulation using the PLECS RT Box
Presented by: Kris Eberle
Plexim develops and markets tools for the design of power electronic systems. The company’s software PLECS is for complete system-level modeling. The RT Box is a new real-time simulation platform designed for Hardware-in-the-Loop (HIL) testing of a control system and Rapid Control Prototyping (RCP). This presentation will explore an example design life cycle for a solar inverter system application. The workflow uses PLECS for model development in conjunction with the RT Box to verify a real controller. Discretized code for the power stage will be generated and deployed onto the RT Box to test a TI C2000-based control system.

Mouser Electronics with Texas Instruments
ROOM 13

Wireless Power Telemetry
Presented by: George Lakkas and Cameron LaFollette, Texas Instruments
Imagine checking parameters and fault statuses for your power system wirelessly on your smartphone.

No Server, Storage, or Switch Chassis to open, no meters to hook up for measurement of the power supply parameters like input/output voltage, current, power, or temperature. No GUI to launch and no PC/tablet needed to read the data. Imagine having “touchless” checking of system power health as you stand in front of your server and switch rack and read the data on your smartphone app. The implementation is here now. Join us as we review Texas Instrument’s p.m.Bus power supply, FRAM data logging and NFC proximity monitoring project to see how you can implement this capability.

Mersen
ROOM 14

Safety and Reliability for Power Electronics
Presented by: Kian Sanjari and Jason Gibson
Session presents Mersen’s commitment to develop industry-leading technologies to improve efficiency and reliability of power electronics equipment.

Key topics are:
- An Overview of Fast Acting Power Semiconductor Protection Fuses, plus an introduction to innovative hybrid DC overcurrent protection devices for EV applications.
- Air and Liquid Cooling solutions to provide thermal protection for semiconductor components. Efficient cooling is key to long term reliability and performance of fast switching semiconductor components.
- Laminated bus bars providing most efficient connection between various components, thus limiting parasitic inductance, improving ease of assembly and integration while minimizing wiring errors and costs.

Venable Instruments
ROOM 22

Portable Frequency Response Analyzer for Field Application Engineers
Presented by: Michael Gray
Venable Instruments introduces the portable Model 5140 Frequency Response Analyzer for field applications.

In this seminar, Venable will walk through the steps to measure and display Bode or Nyquist plots, analyzing the data for stability. An actual design example for a power supply will be shown. Measuring components or networks and creating complex models using Venable RLC software will also be demonstrated.

The Model 5140 is a scaled-down, economically-priced version of its lab instrument predecessors. The 2-channel, 4 lb. FRA measures up to 100V Peak (AC+DC), with increased built-in protection not found with other portable units.
**Danfoss Silicon Power GmbH**  
ROOM 23

**Gamechanging Power Modules by Danfoss**

**Presented by:** Ole Muhlfeld

Nowadays, power grids need sufficient extra capacity to meet short-duration peaking demand and reliability requirements. Battery energy storage systems (BESS) help to provide this power and facilitate the integration of variable wind and solar resources. Conversion efficiency of BESS is key for cost attractiveness and customer acceptance. Danfoss Silicon Power offers experience in designing and manufacturing of power modules for this industry. Within this seminar, Danfoss introduces a small-size, three-level SiC power module to accomplish the mission for BESS applications and grid-connected renewable.

**Cognipower**  
ROOM 24

**The Origins and Implications of Predictive Energy Balancing (PEB)**

**Presented by:** Tom Lawson

The development process for PEB is described, from the initial concept to details of implementation. Strengths and weaknesses of PEB are considered. Once the principles are appreciated, PEB becomes another tool in the designer’s toolbox. How does PEB change the preferred approach to switched mode power conversion challenges? A single-stage AC/DC converter with PFC is shown as an example.

**Renesas Electronics America**  
ROOM 25

**Simplifying Li-ion Battery Powered BLDC Motor Driver Design**

**Presented by:** Tad Keeley

This seminar will describe a simplified robust solution for battery power BLDC motor drive applications. We will show how to utilize Renesas Lithium Ion (Li-ion) Battery Management IC in conjunction with a BLDC Motor Control and Driver IC. We will explore enhancements to the functionality and performance which includes authentication features to ensure Li-ion battery safety. The BLDC Motor Control and Driver IC is a single package solution which incorporates features for both sensor and sensor-less control for a three-phase BLDC motor. We will discuss advanced features such as self-aligned dead-time generator and programmable gate current adjustment.

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**United Chemi-Con, Inc**  
ROOM 11

**State of Art for Automotive Application Capacitor**

**Presented by:** Mr. Tony Olita and Mr. Toshi Furukawa

Introduction of full line up for advanced automotive application and the strategic products.

Technical presentation about short duration of 2 ~3 times higher than the rated ripple current to demonstrate how to meet the durability of 15 years vehicle operation.

Typical EPS application will be discussed by using the thermal model of the products from the system design viewpoint and demonstrate the cost effective solution.

**Powerrex Inc.**  
ROOM 13

**7th Generation IGBT Modules Featuring Lower Losses and Higher Reliability**

**Presented by:** Eric R. Motto

This presentation will review Mitsubishi’s newest industrial IGBT modules featuring revolutionary high reliability packaging and state-of-the-art high efficiency 7th generation power chips. Modules with current ratings ranging from 75A to 1000A and voltage ratings of 650V, 1200V and 1700V will be presented. The new modules employ packages with industry standard outlines that utilize matched CTE materials to eliminate solder layers and provide a dramatic improvement in thermal cycling reliability.

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**Exhibitor Seminars – Session #2**

Tuesday, March 28 – 2:15 p.m. – 4:15 p.m.

**STMicroelectronics**  
ROOM 1/2

**Synchronous Rectification in PoE Bridge for Improved Efficiency**

**Presented by:** Rosario Attansio

Synchronous rectification in PoE bridge significantly improved available power to the devices and reduced thermal issues.

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**Powerex Inc.**

**Synchronous Rectification in PoE Bridge for Improved Efficiency**

**Presented by:** Eric R. Motto

This presentation will review Mitsubishi’s newest industrial IGBT modules featuring revolutionary high reliability packaging and state-of-the-art high efficiency 7th generation power chips. Modules with current ratings ranging from 75A to 1000A and voltage ratings of 650V, 1200V and 1700V will be presented. The new modules employ packages with industry standard outlines that utilize matched CTE materials to eliminate solder layers and provide a dramatic improvement in thermal cycling reliability.
New Material Performance and Analysis of E-U Geometries

Presented by: Sam Davis

A comparison of Inductance, Watt Loss, and DC Bias performance differences seen over geometry. The study is intended to aid in geometry selection when choosing cores for high current inductors. Specific geometries include E-core, U-core, and round leg U-core test sets. Also a comparison of one and two leg winding configurations on the U-core sets. Updates to Magnetics material offerings will also be discussed.

Magetics
ROOM 14

SIMPLIS Technologies, Inc
ROOM 22

Performing AC Analyses on PFC Converters

Presented by: Christopher Bridge and Tom Wilson

Because the SIMPLIS Periodic Operating Point (POP) & AC analyses are performed at a single operating frequency, performing AC analyses on time-domain simulation models of PFC converters is challenging, since the circuit typically has no true steady-state when the line voltage is sinusoidal. In this seminar, we present and compare the results of three methods for measuring the loop gain, input and output impedance of a PFC converter generated with either an AC line voltage or a DC input employing either the SIMPLIS POP & AC analysis or the SIMPLIS DVM Multi-tone AC analysis.

Linear Technology
ROOM 24

Designing & Optimizing Power Supplies in Several Simple Steps with the LTpowerCAD Design Tool

Presented by: Sam Young, Senior Applications Engineer, Linear Technology Corp.

System boards today have an increasing number of power rails and supplies. It is often more efficient and cost effective to design a customized onboard power solution for a given application. To simply the design task and improve design quality and productivity, the LTpowerCAD design tool package will be introduced in this presentation. The system level LTpowerPlaner tool helps system engineers to plan and optimize a power management system. The converter design tool further enables engineers to design and optimize each power supply in five simple steps with good results. The LTspice tool provides powerful simulation capability for details.

ZES ZIMMER
ROOM 25

Latest Trends in Precision Power Analyzers and Sensors

Presented by: Robert Emerson

This presentation will critically examine the increasing requirements placed on DC & AC power measuring systems and equipment in light of advancing technology in research and applications. Subjects covered will include high-frequency switching, efficiency, uncertainty characterization, impact of synchronization, waveform analysis, regulations and more.

Exxelia USA
ROOM 23

High Power Solutions

Presented by: James Tabbi

Exxelia is a global designer and manufacturer of high-reliability passive components and high-precision electromechanical solutions, with extensive experience in providing extremely reliable standard and custom high power solutions for power electronics, power generation and energy storage. The presentation will detail Exxelia’s high power solutions with a focus on metallized and impregnated polypropylene and polyester Film capacitors; the new range of high voltage ceramic capacitors manufactured from a new ceramic dielectric material; long life-time, miniature and low ESR aluminum capacitors; and power transformers and inductors including water cooling products that keep your electronics cool when things get hot!
Exhibitor Seminars – Session #3
Tuesday, March 28 – 3:00 p.m. – 3:30 p.m.

Infineon Technologies
ROOM 1/2
Gate-Driver ICs Enabling Highly Efficient Power Management Systems
Presented by: Hubert Baierl
Gate-Driver ICs used in SMPS are crucial links between control ICs and MOSFETs where gate-driving voltage, current and robustness requirements exceed control IC’s capabilities. Gate-Driver ICs are key to attain high power-density and consistent robustness of the power supply solution. This session focuses on critical requirements of gate-driver ICs from an application perspective and highlights gate-driver IC solutions from Infineon. The audience will benefit from this session by gaining an understanding of the selection criteria to choose the right gate-driver IC solution for their particular use-case.

Micrometals, Inc.
ROOM 11
Online Design Tools for MHz Inductors
Presented by: Christopher Oliver
New online inductor design software will be discussed and demonstrated. The software is a free tool that functions within a web-based interface. The software will help the user select the most appropriate inductor powder core material and winding based on the application conditions that are provided by the user. The available core materials are well suited for applications with operating frequencies ranging from 50/60 Hz up to 25 MHz or higher. The software calculations include many non-linear effects, enabling accurate modelling of inductor performance. The demonstration will focus on designs in the MHz range.

Mouser Electronics with TDK Corporation of America and Panasonic Industrial Devices
ROOM 13
GaN Based Power Electronics and New Requirements for Passive Components
GaN Systems e-mode GaN transistors are powering many of the electronics that are resulting in size, weight and cost reduction while saving energy. Applications include wireless charging, data center power supplies, industrial motor drives, energy storage systems, automotive traction inverters, and onboard EV battery chargers. More compact, higher frequency designs require new characteristics for passive components like magnetics and capacitors. TDK CeraLink capacitors are essential in meeting those needs. While less capacitance is required due to higher frequency, current ratings per microfarad, resonant frequency, and maximum temperature all need to increase significantly, and are uniquely fulfilled by this new technology.

Panasonic Corporation
ROOM 14
X-GaN Reliability and Robust Design
Presented by: Tom Higuchi
The characteristics of GaN FETs to achieve high efficiency, downsizing and new topologies are well known. A less well known, though of very high interest benefit is the Reliability of GaN FETs for the Power Electronics market. Panasonic’s HD-GIT FET achieves not only the JEDEC standard of static testing, but also beyond the JEDEC standard with dynamic testing. Panasonic will present how the counter measure to Current Collapse, proof of 10 year aging, Gate Robust design and so on was achieved.

OPAL-RT Technologies
ROOM 22
Lab-Scale MMC Test Bench for Power Hardware-in-the-loop (PHIL) Application
Presented by: Christophe Brayet Eng. p.m.P
OPAL-RT provides a complete Power Hardware-in-the-Loop (PHIL) solution for the entire V-Cycle Development to help engineers develop and test new MMC control algorithms (Rapid Control Prototyping, RCP).

The new OP1200 Lab-Scale MMC Test Bench is dedicated for research into innovative HVDC, AAC, FACTS, STATCOM and other interconnections that require flexible hardware architecture and allows testing of new topologies and switch configurations.

Using the complete software simulation environment RT-LAB MATLAB/Simulink® and XILINX System Generator with built-in models, this turnkey test bench is safe, easy-to-use and ideal for control development of MMC systems with Microgrid real-time simulation.
Dialog Semiconductor
ROOM 23
High Efficiency Inductor-less Power Converter Technology
Presented by: Patrick Fournier
Current trends in mobile devices like slimmer design and longer battery life is demands compact PCB design with less low profile components, improved power efficiency to address thermal challenges and increased reliability. In this session, a standalone high current inductor-less power management IC (DA9313) from Dialog Semiconductor will be introduced. DA9313 is suitable for applications supplied by voltages from 5V to 10.5V. It integrates industry’s first inductor-less power converter. It provides best in-class efficiency over a very wide range of output current. Participants will gain knowledge on how to effectively use this solution to minimize PCB board space, increase efficiency, and reduce thermal stress in their design.

Taiyo Kogyo Co., Ltd
ROOM 24
Introduction to Optimal PCBs for Next Generation Power Electronics
Presented by: Ms. Mai Izumi
We will introduce High Current PCB which can run 1000A as PCB suitable for higher power handling power devices like latest SiC and Combination PCB which can solve both high current handling and fine pitches caused by miniaturization of the power device as PCB suitable for latest GaN.
We will also introduce Copper Inlay PCB which is suitable for countermeasures against heat of components like latest SiC and GaN.

Schunk Hoffmann Carbon Technologies AG
ROOM 25
Graphite-Based Solutions for (Power) Electronics Cooling
Presented by: Dr. Sandra Reisinger
Schunk Hoffmann Carbon Technology provides two graphite-based solutions for the electronics cooling industry.
The composite material, Aluminium Graphite, combines the low coefficient of thermal expansion, low density, and ready machinability of graphite with the excellent thermal properties of aluminium to create an ideal thermal management material for high-reliability applications. Customized parts in various quantities and different platings are readily produced.
Our new, innovative phase change material is a novel approach to latent heat storage units. Its self-encapsulating nature means no additional casing is required. Its expand-to-shape production process allows for custom designs at attractive cost with optimal thermal properties.

Exhibitor Seminars – Session #4
Tuesday, March 28 – 3:45 p.m. – 4:15 p.m.

Ridley Engineering Inc
ROOM 1/2
New Design Tools for Power Supplies
Presented by: Dr. Ray Ridley
The new SPICELaunch feature of POWER 4-5-6 fully automates spice model generation, greatly accelerating your design process with revolutionary new accuracy for magnetics.
Powerful new tools are now available to generate realistic winding loss models for transformers and inductors. Define your magnetics winding structure, and with the push of a button, advanced spice models are generated. This allows any engineer to take advantage of proximity loss analysis without having to do any difficult math. The results are profound — winding losses can be ten times higher than predicted with conventional models and you can see this early in your design cycle.

KEMET Electronics
ROOM 11
Design Tools for Selecting Your Passive Components
Presented by: Wilmer Companioni
The electronics industry is highly competitive and fast-paced. To keep up with the demands of the market, engineers and designers must push cycle times down without sacrificing quality. For component manufactures, it is no longer enough to provide just components and datasheets. For anyone using components, design and simulation tools are essential in staying competitive and responsive. KEMET has developed a set of design tools that engineers can rely on and assist with their needs.
Myway Plus
ROOM 13

Integrated Digital Platform for Power Electronics
Model Based Design

“All-in-One package for Advanced R&D”

Presented by: Noriyasu Matsuno

Myway Plus Corporation is known as the most popular R&D tool and inverter provider in Japan, placing full emphasis focusing on only Power Electronics. Introducing PE-Expert4, the control and measurement platform with user friendly GUI for C programing and FPGA design, it’s perfectly suitable for advanced Power Electronics applications, such as motor control and analysis, MMC (Multi Module Converter) with multiple many gate controls and any type of complex system. In addition, measurement features such as power meter and oscilloscope are integrated in a single box coming with scripting functions so that most of the operations can be automated to optimize various parameters.

Artic Sand Technologies Inc.
ROOM 14

Next Generation DC-DC Converter Architecture
Brings Significant Improvements in Efficiency & Size

Presented by: Stephen Allen

Artic Sand will introduce ground breaking new DC-DC converters using a unique power architecture based on IP originating from MIT, which provides dramatic improvements in efficiency, solution footprint, profile, EMI, and ripple compared with traditional power solutions today. Arctic Sand will present their first products using this technology – LED boosts for LCD displays for notebooks, tablets and smartphones — that typically halve the power losses, and enable ultra-thin platforms. We will also explain some of the fundamentals of the architecture, and present examples of where Artic Sand will be employing the technology and the significant advantages over existing solutions.

FTCAP GmbH
ROOM 22

Capacitor Solutions for Severe Conditions

Presented by: Dr. Thomas Ebel

A clear trend in power electronics is to increase the power density of the passive components. That means to increase the ripple current load or to increase lifetime and/or to operate the components at higher switching frequencies.

FTCAP has developed new concepts e.g. cubic axial capacitors with entire laser welded Al-metal housing to increase significantly the ripple current load, having a 28% bigger surface and allowing a better heat sink connection and a significant lifetime enhancement.

The patented Fischer-Link concept reduces the parasitic inductances to a minimum value below 10 nH/capacitor, allowing low loss operation at higher switching frequencies.

Abstract Power Electronics
ROOM 23

Primate Power™ Sources Use SiC Devices to Improve Efficiency & Response Time

Presented by: Jeff Reichard

High efficiency, high bandwidth power sources are what engineers need in the labs and what OEMs can use to improve products. Primate Power™ achieves this and more with the use of SiC devices. Reduced losses allow for higher switching speeds that improve load and source management. The Primate Power™ Sources are compact, rugged and versatile with power ranges of 4 kW through 300 kW and voltages up to 690 VAC / 1200 VDC. Abstract Power Electronics introduces the power source that is ideal for testing batteries and high-speed motors, simulating grids, and much more.

Wolverine Tube Inc. – MicroCool Division
ROOM 24

MicroCool Presentation

Presented by: Mike Holland

Wolverine Tube has been in business for 100 years providing innovative thermal solutions to the automotive and HVAC industries with enhanced copper tube. The MicroCool® Division has leveraged the company’s proprietary MDT technology to produce novel cold plates and integrated base plates for optimal liquid cooling solutions for the Electronics Industry.
Epson Atmix KUAMET® series is high performing amorphous powder. NC1 is nanocrystalline powder. The u increases by 10% and core loss decreases by 25% 9A4 is amorphous powder with 15% higher saturation properties. They contribute to longer battery life, prevention of a fever and downsizing in devices.

*Compared to our conventional amorphous powder.

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**Exhibitor Seminars – Session #5**

**Wednesday, March 29 – 10:30 a.m. – 11:00 a.m.**

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**Hitachi America, Ltd**

**ROOM 1/2**

**next High Power Density Dual Module with Next Generation Chip Beneficial in Low Inductance Application**

Presented by: Katsuaki Saito

In this presentation, next generation IGBT technologies suitable for next generation packaging with low inductance are shown. Hitachi have shown nHPD2; “next High Power Density Dual” can reduce inductances by 75% that can eliminate undesirable oscillation which realizes the benefit of wide band gap semiconductors. IGBT structure having low feedback capacitance can improve the trade-off relation between low switching loss and switching dv/dt especially in the low inductance circuit. Furthermore, the resulting benefits of SiC SBD in nHPD2 combined with the next generation small feedback capacitance IGBT are explored.

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**Typhoon HIL, Inc**

**ROOM 11**

**Controller Hardware-in-the-Loop (CHIL) nanosecond resolution “flight simulator” for future Microgrids**

Presented by: Dr. Ivan Celanovic, Co-Founder and Director of Typhoon HIL, Inc.

Significant and growing penetration of smart inverters represents both challenges and incipient opportunities to increase utility grid agility and stability. In addition to inherently fast dynamic control capabilities, these power electronics systems interact with increasingly diverse physical systems in complex ways. Indeed, grid is becoming a true cyber physical system with a layered architecture comprising both power processing and control and communications. In this talk we will present a new approach to power electronics and power system controls testing and validation based on ultra-high fidelity Controller Hardware-in-the-Loop (CHIL) real-time simulation.

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**Coilcraft, Inc.**

**ROOM 13**

**New Power Inductor Selection Process for Best Power Converter Performance**

Presented by: Len Crane

Coilcraft introduces powerful enhancements to the highly popular web-based suite of power inductor selection and analysis tools. New data-driven views of power inductor performance enable designers to rapidly and effectively optimize converter performance. The Coilcraft tools provide for quick selection based on desired parameters and enhanced graphical results for analysis under a variety of operating conditions. This seminar demonstrates the use of the new tool features for optimizing inductor selection and understanding performance in realistic application conditions.

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**Teledyne LeCroy**

**ROOM 14**

**Using the Teledyne LeCroy Motor Drive Analyzer to Optimize Motor/Drive Performance During a Single Semiconductor Device Switching Period**

Presented by: Ken Johnson, Director of Marketing, Product Architect

Optimization of control systems and drive performance requires calculation of power activity during very short time periods that correspond to the power semiconductor device switching period. The Teledyne LeCroy Motor Drive Analyzer (MDA) provides such power analysis with correlation of power activities to typical control system signals. This session will showcase testing done using the MDA for variable flux electric machine analysis, volt-second sensing control analysis in a Deadbeat-Direct Torque and Flux (Motor) Control (DB-DTFC) and comparison of dynamic losses for various DTFC and Vector field-oriented controlled (FOC) surface and interior permanent magnet motors (SPM and IPM).
Exploring and Designing in PoE Magnetics

**Presented by:** Stephen Scharlman

The need for both sourcing power and filtering radiated noise from either the system or the surroundings to ensure high quality data signal places a large focus Ethernet’s primary magnetic component, the LAN transformer. The importance of understanding and selection of magnetic component in high speed Ethernet communication is critical while design in the application. We’ll discuss these situations in the PoE Magnetics course.

**Transphorm, Inc.**

**How to Design with GaN in an Hour or Less**

**Presented by:**

Philip Zuk, Sr. Director, Technical Marketing, Transphorm
Gaetan Campeau, President, Telcodium Inc.

Welcome to the GaN Revolution! Gallium Nitride (GaN) is the recognized solution to the industry’s power density challenge, delivering over 99 percent efficiency and reducing energy loss by more than 40 percent, but is not without its challenges. GaN leader Transphorm, along with power supply manufacturer Telcodium, will address critical power design requirements and complexities. Further, they will introduce innovative techniques and tools built on Transphorm’s JEDEC-qualified GaN FETs that dramatically reduce design time, giving designers the unprecedented ability to develop any switch mode power supply across a range of power levels—in an hour or less. Join the revolution!

**SP Control Technologies**

**The innovation in SP Control Technologies**

**Presented by:** Jose Maria Molina

The challenge for the Power Electronic designers is developing power systems with higher power densities in each generation, as well as robustness, safety and, the most difficult requirement, within the shortest time. SPC Control Technologies proposes a software to design and implement your controls in a very fast way and without changing your hardware. This software is the SpTool and will allow you to test all your ideas very efficiently. Great innovations always start with small changes and here you have one opportunity.

**Exhibitor Seminars – Session #6**

**Semikron**

**ROOM 1/2**

**Power Converter Development: Reducing Time to Market**

**Presented by:** Paul Drexhage, SEMIKRON Inc.

For Project and Engineering Managers, the task of overseeing the development of a power electronics converter in an aggressive time frame can be daunting. Fortunately, new standardized building blocks are bringing us closer to “plug and play” systems that not only reduce development time but are also aimed at cost-effective volume production. Come see a power semiconductor manufacturer’s view on development costs, processes, and a universal control solution from National Instruments catering to systems from 50kW to 10MW+.

**IWATSU ELECTRIC**

**ROOM 11**

**Power Loss Measurement for High Phase Angle Magnetics Core**

**Presented by:** Ryu Nagahama

High-frequency transformers used in switching power supplies and DC-DC converters suffer current leakage, which increases as the handled frequency increases. The causes of the leakage include hysteresis loss and eddy-current loss. The heat generated by lost current causes the temperature of the equipment to rise, making it difficult to reduce the size of equipment. Measuring core loss of soft magnetic parts provides the best solution to minimizing loss and enabling further reductions in equipment size. For the development of magnetic material, IWATSU measurement, has a solution of BH analyzer.

**Efficient Power Conversion Corporation**

**ROOM 13**

**GaN Transistors for Efficient Power Conversion**

**Presented by:** Alex Lidow, Ph.D.

In a post-silicon world, GaN is taking power conversion to the next level. Gallium nitride transistors are rapidly being designed into many power conversion applications. This seminar will provide an update on the state-of-the art in GaN transistor technology, highlighting the latest generation of EPC enhancement-mode GaN products and end-use applications including high power density DC-DC converters, high frequency envelope tracking, LiDAR, and wireless power transfer.
SBE, Inc.
ROOM 14
Advancements in DC Link Design for the Next Gen Inverters
Presented by: Michael Brubaker
Inverter power density is limited by the size of the DC link capacitor required. The SBE Power Ring Film CapacitorTM offers a novel annular form factor with a much higher ampere per micro-Farad rating than conventional film “cans”. When integrated with an optimized bus structure as a “surface mount” capacitor, very low inductance can be achieved to allow faster switching. This topology approach provides more power per dollar spent on solid state switches and is an enabling technology for utilizing next generation silicon carbide devices. An overview of the SBE technology advantage will be presented along with various product examples.

Zipalog, Inc
ROOM 20
System and Fault Scenario Analysis for Power Management IC’s
Presented by: Felicia James
Designing integrated circuits for today’s complex power electronics systems poses numerous challenges to successfully address system requirements. Much of the focus during design is addressing the chip performance during normal operation. However, designing circuitry that meets requirements for expected behavior during fault scenarios requires significant design expertise and can easily compromise normal parametric performance. Power systems with complex loads and sources pose interesting challenges for the design engineer and the simulators that help analyze the design. This session will examine approaches to evaluate common fault scenarios such as system opens and shorts and harness faults during analog integrated circuit design.

Powersim Inc.
ROOM 21
Integrating PSIM & SPICE for System Level to Device Level Simulation
Presented by: Albert Dunford
This session will introduce key features in the new PSIM release, especially the new SPICE engine. The new release allows designers to use the same schematic and environment for both device and system level simulations. With the robust PSIM engine, one can carry out studies and proof of concept quickly in terms of topology, energy storage, and control needs. With the SPICE engine, one can utilize industry SPICE models and study switching transients, gate drive requirements, parasitic interactions, and other device level phenomena. Other features, such as InstaSPIN support for sensorless motor control, will also be presented.

Synopsys, Inc.
ROOM 22
Saber Periodic AC (PAC) analysis and Power MOSFET Tool
Presented by: Alan Courtay
Saber, a leading circuit simulator, addresses the engineering needs of the power electronic community with two new features:

1. PAC is a simulation analysis producing Bode plots for nonlinear switching circuits that allows the stability of SMPS regulation loops to be analyzed without the need for averaged models.

2. The new power MOSFET tool quickly generates accurate models from datasheets and is applicable to Silicon Carbide. Static and dynamic behaviors are accurately matched over a range of temperatures, including gate charge characteristic, body diode reverse recovery, switching characteristics and thermal impedance.

Altair
ROOM 23
Multiphysics Modeling – Optimizing current input to cancel torque ripple
Presented by: Philippe Wendling
Torque ripples and cogging torques lead to vibrations in machines. Noise generated by these vibrations, especially in the automotive industry, need to be addressed and limited if not eliminated. Through a multi parameters and multi constraints optimization in a multidisciplinary environment, topology and signal are optimized to cancel torque ripple. The workflow of such optimization is presented in this session.
Microchip Technology, Inc.
ROOM 11

Using Core Independent Peripherals (CIPs) to Build a Custom Control

PRESENTED BY: Keith Curtis

Microcontrollers have revolutionized switch mode power in recent years and now Core Independent Peripherals (CIPs) are set to revolutionize microcontrollers used in switching power supplies. CIPs will accomplish this by making it possible to design custom autonomous switching power supply controllers on-chip. This presentation will discuss the various CIPs and how they can be combined to produce a variety of custom controls. Also included are several examples of optional extras such as trouble shooting options, current limit, continuous/discontinuous switching, Soft-start, and Constant on time configurations. Finally, the presentation will include a discussion of the Microchip Code Configurator tool and how it simplifies the design and implementation of CIP designs.
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USA
www.electrocube.com

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Exxelia is a leading designer and manufacturer of high-reliability passive components. Exxelia’s products are commonly used for power electronics, power generation, energy storage, and signal filtering functions in demanding domains: Defense, Aviation, Space, Energy, Transportation, Medical, Telecom and Industrial applications.

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USA
www.fair-rite.com

Fair-Rite is a leader in the ferrite industry committed to quality. We will DESIGN your custom components utilizing our machine shop, DEVELOP a robust process, and DELIVER a cost-effective solution. For all of your needs, Fair-Rite is Your Signal Solution.
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Fastron is a leading global manufacturer of high performance power and RF inductors for the automotive, medical, and lighting industries. Our manufacturing facilities are ISO 14001, 9001, and ISO/TS 16949 certified. Stop by and see our new high voltage inductors.

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Leader in soft ferrite technology. FERROXCUBE provides customers the highest level of support in the development of your new innovative designs. Our competencies cover soft ferrite cores, materials, and accessories. They are developed to meet today’s demanding high-frequency, low-loss requirements.

Focused Test, Inc. ........................... Booth 437
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Suite 106
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USA
www.focusedtest.com

FTCAP GmbH ................................. Booth 1233
Carl-Benz-Strasse 1
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Germany
https://www.ftcap.de/

FTCAP has more than 65 years of experience in the development and production of capacitors used in diverse industries. The product spectrum includes both film and aluminium electrolytic capacitors.

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Fuji Electric delivers high-performance power semiconductors for energy, automotive, information technology, and industrial applications. Our extensive product line includes MOSFETs, IGBT (Modules and Discretes), IPM (Intelligent Power Modules), PIM (Power Integrated Modules), Diodes: Fast Recovery, High Speed, and Schottky.

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#501
Ottawa, ON K2K 3G8
Canada
www.gansystems.com

GaN Systems’ unique Island Technology addresses today’s challenges of cost, performance, and manufacturability resulting in devices that are smaller and more efficient than other GaN design approaches. A fabless power semiconductor company, GaN Systems is headquartered in Ottawa, Canada.

Gaotune Technologies Co., Ltd ............ Booth 1837
801 # Changhong Building High-tech Park
Shenzhen, GD 518000
China
www.gaotune.com

Gaotune Technologies is a leading manufactory of the Amorphous cores and Nanocrystalline cores located in China. Most of our customers come from Europe and North America, including Siemens, ABB, Coilcrafter etc.

Main products: Amorphous&NanocrystallineC-core, E-core and Block core. Nanocrystalline Ring Core and Rectangular Cores (Plastic case or Epoxy coating)

Global Power Technologies Group ......... Booth 1823
20692 Prism Place
Lake Forest, CA 92630
USA
www.gptechgroup.com

Global Power Technologies Group is a manufacture of following SiC Products.

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GLOBALFOUNDRIES is the world’s first full-service semiconductor foundry with a truly global footprint. With operations in Singapore, Germany and the United States, GLOBALFOUNDRIES is the only foundry that offers the flexibility and security of manufacturing centers spanning three continents.

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www.goodarksemi.com

Good-Ark Semiconductor is a leading global discrete semiconductor manufacturer that offers a wide variety of surface mount, through-hole and wafer devices with superior quality and reliability at competitive costs.

**Gowanda Electronics**
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Gowanda, NY 14070
USA
www.gowanda.com

Gowanda Electronics is a US-based manufacturer of power & RF inductors, transformers and application-specific magnetics. Capabilities: custom-molding/winding/prototyping, Class 100,000 cleanrooms, environmental test lab, ISO13485/AS9100/ISO9001 standards.

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China
www.bm-cap.com

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Hesse Mechatronics is a global leader in wire bonding technology and ultrasonic interconnection for power electronics. Hesse has application labs in Clinton, MA, Raleigh, NC (at NC State), Tempe, AZ and Irvine, CA (at University California-Irvine).

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www.himag.co.uk

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Hitachi Metals manufactures and markets a diverse portfolio of high-grade metal products and materials, magnetic materials and applications, high-grade functional components and equipment, wires, cables and related products.

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AmePower, Official Authorized Distributor of Hitachi Semiconductors, is a DBE, SBE, WBE and MBE Certified Engineering Company with more than 20 years of experience in Power Electronics Solutions; offering from High Power Thyristors, Diodes, GTOs, IGBTs, IGCT

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Hoi Luen group is the premier supplier for FIW, triple insulated wire, magnet wire, tinned copper wire, power cord and cable assembly.

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Holy Stone Enterprise Company, Ltd. (HolyStone International) is a Taiwan based manufacturer of high technology Multi-layer Ceramic Capacitors. Although Holy Stone produces a full line of MLCC’s we are best known for High Voltage, Safety Certified, High Cap/Voltage and other specialty ceramic capacitors.

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ias.ieee.org

The scope of the Industry Applications Society, as a trans-national organization, is the advancement of the theory and practice of electrical and electronic engineering in the development, design, manufacture and application of electrical systems, apparatus, devices and controls to the processes and equipment of industry and commerce; the promotion of safe, reliable and economic installations; industry leadership in energy conservation and environmental, health, and safety issues; the creation of voluntary engineering standards and recommended practices; and the professional development of its membership.

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ICE is a leading provider of components for the power industry. Our programmable current sensors feature low cost, easy assembly and high creepage. We also provide custom and standard magnetic components and power assemblies for a wide range of markets.

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Infolytica Corporation is the developer of MagNet 2D/3D, the leading electromagnetic field simulation software, and ElecNet 2D/3D for electric fields. Some typical design applications include transformers, motors, DC-DC converters, sensors/NDT and muchmore. Our tools support VHDL-AMS for use in multi-domain system simulations and Hardware in the loop (HIL).

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www.inteproate.com

Intepro supplies Automated Test systems to manufacturers all over the world to test power electronics used in a wide range of applications. Our knowledge and expertise in moving and measuring power makes our systems unparalleled for characterization of power components, environmental stress screening, production test and repair across all industries.

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Taiwan
www.ioeinc.com.tw

Inter Outstanding Electronics Inc (IOE) was founded in Taiwan in 1982 and we offer expertise in marketing, design and manufacturing of power and audio transformer, toroid transformer, ferrite transformer, ignition coils, and many other coil windings. The company now employs over 400 employees both in China and Taiwan. Quality is always been our core value and we commit to this legendary to exceed customer's needs.
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USA
www.itape.com

Intertape Polymer Group is a North American based manufacturer offering electrical insulating tapes, electronic tapes, industrial tapes, carton sealing tapes, and coated fabrics to end user manufacturers and repair facilities.

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Italy
www.itelcond.it

Our society, from over 40 years it produces electrolytic aluminium capacitors. With an elevated qualitative level. We turn us to different societies that build electronic equipments as UPS, Inverter, Welders, Control Motor, Medical Equipment. We have the UL certification for the electrolytic capacitors.

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We manufacture a wide range of electronic testing equipment such as semiconductor curve tracers, B-H analyzers, highvoltage isolated measurement system to cover various types of demands from industries and research for energy-efficient power managements.

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Germany
www.kaschke.de
Kaschke Components is one of the leading designer and manufacturer of soft magnetic materials and inductive components, located in Germany. Kaschke offers customised inductive solutions with a focus on renewable energies, smart grids and energy efficiency.

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www.kemet.com
KEMET Electronics is a leading global supplier of electronic components. We offer our customers the broadest selection of capacitor technologies in the industry, along with an expanding range of electromechanical devices, electromagnetic compatibility solutions and supercapacitors. Our vision is to be the preferred supplier of electronic component solutions for customers demanding the highest standards of quality, delivery and service.

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Keysight Technologies is the world’s leading electronic measurement company, transforming today’s measurement experience through innovations in wireless, automotive and energy, and software solutions. Keysight’s focus on measurement helps scientists, researchers, and engineers address their toughest challenges with precision and confidence.

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Santa Clara, CA 95051
USA
www.kikusuiamerica.com

KIKUSUI AMERICA, INC., a subsidiary of Kikusui Electronics Corporation was founded October 1, 2004. Kikusui provides a wide variety of High-Quality and Reliable Electronic Measuring Instruments, DC and AC Power Supplies, Electronic Loads, and Safety Test Equipment. Made in Japan since 1951.

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USA
www.knowlescapacitors.com/

At Knowles Capacitors we make Multilayer, High Reliability, Single-Layer and Precision Variable Capacitors, EMI Filters and Thin Film Devices. The markets we serve include medical implantable and equipment, military, aerospace/avionics, EMI filtering, oil, instrumentation, industrial control, optical networks, telecom and automotive.

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Kulicke & Soffa (K&S) is a leading provider of semiconductor packaging and electronic assembly solutions supporting the global automotive, consumer, communications, computing and industrial segments.

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USA
www.lenco-elect.com

Inductor and Transformer manufacturer, Lenco Electronics can custom design or build to your exact specifications. Lenco manufactures Inductors and Transformers using a variety of magnetic core materials such as ferrites, iron powder, laminations and amorphous alloy. Common conductor materials used in our manufacturing process include magnet wire, Litz wire, aluminum and copper foil.
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Milpitas, CA 95035  
USA  
www.linear.com

Linear Technology Corporation has been designing, manufacturing and marketing a broad line of high performance analog integrated circuits for major companies worldwide for three decades. The Company’s products provide an essential bridge between our analog world and the digital electronics in communications, networking, industrial, automotive, computer, medical, instrumentation, consumer, and military and aerospace systems. Linear Technology produces power management, data conversion.

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USA  
www.lodestonepacific.com

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Seoul, 135-738  
Korea  
www.magnachip.com/

MagnaChip is a Korea-based designer and manufacturer of analog and mixed-signal semiconductor products for high-volume consumer, communication, industrial and computing applications. MagnaChip owns a portfolio of more than 3,500 registered and pending patents, and has extensive engineering, design and manufacturing process expertise resulting from its 30-year operating history.

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USA  
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USA  
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Magnetic Metals offers tape wound toroidal and cut cores, value added contract manufacturing winding and assembly services including a range of GFCI, ALCI and AFCI components. Established in 1942, Magnetic Metals AS9100C and ISO 9001 certified to service industrial, commercial and defense clients worldwide.

**Magnetics** ................................. Booth 1023
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Magnetics is a leading manufacturer and supplier of soft magnetic components, including powder cores, ferrite cores, and tape wound cores, for the international electronics industry.
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PCIM Europe is the international leading exhibition and conference for power electronics and its applications. From the latest developments of power semiconductors, passive components, products for thermal management, new materials, sensors as well as servo-technology and the wide area of power quality and energy-management – PCIM Europe offers a comprehensive, focused and compact presentation of products all under one roof!

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Rolling Meadows, IL 60008
USA
www.methode.com/power.html#.WlzITBsrJhE

As a global power distribution and thermal management solutions provider, Methode Power Solutions designs and manufactures innovative products that meet the requirements of a variety of high-demand applications. Visit booth #810 to learn more about Methode’s Power!

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www.mhw-intl.com

MH&W is a distributor of magnetic core materials including soft ferrites for transformers, CMC and inductors, powder cores for inductors, Cool Blue cores for control of EMI/RFI in VFD/motor systems and thermal interphase films and pads.

Microchip Technology, Inc .................. Booth 403
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Chandler, AZ 85224
USA
www.microchip.com

Microchip Technology Inc. is a leading provider of microcontroller, mixed-signal, analog and Flash-IP solutions, providing low-risk product development, lower total system cost and faster time to market for thousands applications worldwide.
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Anaheim, CA 92807
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Leading manufacturer of magnetic cores made with various tape ribbon including: amorphous (Metglas), nanocrystalline, silicon-steel, nickel and cobalt alloys, Cut C-cores, E-cores and toroids. Applications: inverters, filter chokes, transformers, etc.

Monolith Semiconductor Inc. .... Booth 536
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Monolith Semiconductor is a fabless supplier of high-voltage Silicon Carbide diodes and MOSFETs manufactured in an automotive qualified 150mm silicon CMOS foundry. Monolith is partnered with Littelfuse and committed to providing industry leading SiC products and customer support.

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Mornsun America LLC, a leading manufacturer of DC-DC, AC-DC converter, isolation amplifier and RS232/CAN/485 transceivers, as well as EMC components.

Mornsun’s products are widely used in industrial, automation, instrumentation, power systems, IGBT/ SiC gate driver, PV/Renewable energy, Smart Grid & Energy Storage, IoT, medical and automotive devices and other commercial applications.

Mouser Electronics, Inc. .......... Booth 1822
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Mansfield, TX 76063
USA
www.mouser.com

Mouser Electronics is the global authorized distributor with the newest semiconductors and electronic components, including the latest power electronics components. With over 500 manufacturers on its linecard, Mouser caters to design engineers and buyers.

MPS Industries, Inc. ............... Booth 627
19210 S Vermont Ave
Bldg. D Suite 405
Gardena, CA 90248
USA
www.mpsind.com

MPS Industries is a leading manufacturer of magnetic components with a broad product line of standard and custom transformers, inductors, common mode chokes, and current sensors. Our U.S. based engineering team is highly experienced in a wide variety.

MS Power GmbH ..................... Booth 1732
Mergenthalerallee 23A
65760 Eschborn, Deutschland
www.mspowergroup.com

MS Power GmbH, headquartered in Eschborn, Germany, is recognized for manufacturing high quality products. Current products portfolio mainly covers the range of Bi-Polar semiconductor chips and discrete in forms of Stud Screw Fit Diodes/Thyristors, Capsule Devices and Modules.
MTL Distribution

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USA
www.mtldistribution.com

With 28 years of experience, MTL is an authorized distributor of magnetic cores and associated hardware for Magnetics Inc and powder iron toroid cores for Micrometals. We also provide value-added custom machining services for clients with special requests or short lead time requirements. Our friendly staff is dedicated to providing the highest quality service with flexible pricing and delivery options to help meet our customer’s needs.

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Integrated Digital Platform for Power Electronics Model Based Design ‘All-in-One package for Advanced R&D’

NAC Semi

1790 Commerce Ave
St. Petersburg, FL 33716
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www.nacsemi.com

NAC Semi is a global electronic component design services & distribution company. Our linecard supports the needs of customers in the high-power market by representing companies such as Fuji Electric, Dynex, AgileSwitch, Mornsun, SanRex, Jianghai Capacitor, and others.

National Magnetics
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1210 Win Dr
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USA
www.cmi-ferrite.com

Ceramic Magnetics (CMI) offers a wide variety of MnZn and NiZn ferrites, specializing in custom machined cores as well as standard shapes. Our engineering and manufacturing capabilities enable CMI to develop proof of concept prototypes and then seamless

NEC TOKIN America Inc.

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www.nec-tokin.com/english

NEC TOKIN Corporation was established in 1938 through a partnership with Tohoku University in Japan. Since its inception, NEC TOKIN offers innovative capacitor and magnetic products to meet the technological needs of today and the future.

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3115-P N Willke Rd
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USA
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Power Analyzers, Swept Frequency Response (Gain/Phase) Analyzers, Vector Voltmeters, Phase-meters, LCR meters, True RMS Voltmeters, Harmonic Analyzers, Selective Level Meters, Wideband Current Shunts, Wideband Amplifiers, designed and manufactured using innovative techniques and state-of-the art technology to offer precision performance/accuracy and ease of use at highly competitive prices.
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www.nhresearch.com

NH Research is the technology leader supplying power testing instrumentation AC Grid-Simulators, AC & DC Power Sources, Electronics Loads and Power Meters as well as complete functional-test systems for battery (EV/HEV/ESS), on-grid solar, LED, medical, military and power conversion applications.

Nichicon (America) Corporation .......... Booth 1330
927 E State Parkway
Schaumburg, IL 60173
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www.nichicon-us.com

A dominant manufacturer in the capacitor industry, Nichicon is sought after time and time again for its superior capacitor selection and performance. Manufacturers of Aluminum Electrolytic Capacitors, Film Capacitors, Conductive Polymer Capacitors, and Electric Double Layer Capacitors. #nichicon-power2017

NORWE Inc. ............................... Booth 1131
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USA
www.norwe.com

NORWE is a leading manufacturer of standard and custom designed thermoplastic bobbins for ferrite cores & laminations, SMD components and accessories. All products comply with the RoHS & REACH. NORWE is certified according to DIN EN ISO 9001:2008, to DINEN ISO 14001:2009 and to UL 746D.

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USA
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A leading manufacturer of AC and DC film capacitors for industrial and military applications. With 92,000 sq feet of U.S. production capacity, we provide both standard and engineered solutions, including water-cooled, air-cooled, oil-filled and dry-type capacitors.

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Ohmite MFG. ................................ Booth 1610
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Ohmite has been the leading provider of resistive products for over 90 years. Ohmite offers a full complement of resistors and heatsinks for high current, high voltage, and high energy applications.

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USA
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ON Semiconductor drives energy efficient innovations, empowering customers to reduce energy use. The company is a leading supplier of semiconductor-based solutions, offering a comprehensive portfolio of energy efficient power management, analog, sensors, logic, timing, connectivity, discrete, SoC and custom devices.

OPAL-RT TECHNOLOGIES .............. Booth 1326
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Suite 2525
Montreal, QC H3K 1G6
Canada
www.opal-rt.com

OPAL-RT TECHNOLOGIES is a leading developer of open, real-time digital simulators and Hardware-In-the-Loop testing equipment for electrical, electro-mechanical and power electronics systems. Our validation and test benches are used by engineers and research.

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Paktron Capacitors, Division of Pancon Corp. ......................... Booth 713
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USA
www.panconcorp.com

Paktron designs and manufactures in the USA, a Multi-layer Polymer (MLP) Film Capacitor that provides improved stability, both electrically and mechanically compared to multi-layer ceramic capacitors. Paktron capacitors feature non shorting operation and does not crack like large ceramic chip capacitors. Paktron also manufactures the Quencar RC network.

Panasonic ........................................ Booth 201
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Japan

Panasonic provides ENELEAD, the “Total solution of power devices”, which supports from power system design to purchasing of components, allowing you to select a suitable small, high-efficiency power device, to easily perform a design and evaluation of power.

Parker Overseas .................................... Booth 638
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Distt. Ghaziabad, Utta Paredsh
Ghaziabad, 110092
India
www.parkeroverseas.com

Parker Overseas (an ISO 9001:2008 & ISO 14001:2004 certified company) a 100% Export Oriented Unit engaged in the Design, Manufacture & Supply of RoHS and REACH compliant in Thru-Hole (TH) & Surface Mount Type (SMT) Wound Magnetic Components like Transformers, Inductors, Chokes, Coils, Line Filters, Power Transformers, Current Transformers, Power Toroidal Transformers, Switching and SMPS Transformers, Modules for ISM/ISDN/ADSL/XDSL for Electronics and Telecommunication Applications. The products are UL.

Payton America Inc. .................................. Booth 423
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USA
www.paytongroup.com

Payton is the world leader in Planar magnetics technology and manufacturing. Designs in 24 hours and custom samples in few weeks. Few watts to over 100kWatts from 50kHz to few MHz. Design and manufacturing facilities around the world.

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www.pearsonelectronics.com

Pearson Electronics is the original and leading manufacturer of the Wide Band Current Transformers used for accurate AC current measurements. Pearson Current Transformers can measure transients, harmonics, pulse, sine-wave and other complex current wave shapes. A typical model has 1% accuracy and a 3 dB bandwidth from 1 Hz to 20 MHz. We meet both OEM and custom requirements.

PELS (IEEE Power Electronics Society) .................. Booth 214
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Piscataway, NJ 08854
USA
www.ieee-pels.org

The Power Electronics Society is one of the fastest growing technical societies of the Institute of Electrical and Electronics Engineers (IEEE). For over 20 years, PELS has facilitated and guided the development and innovation in power electronics technology.

Pin Shine Industrial Co., Ltd ............................ Booth 1433
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Taiwan
www.pinshine.com

Pin Shine is a total solution manufacturer of electronic-mechanical components by using high-precision mold manufacturing, plastic injection insert molding, overmolding, metal stamping, plating, die-casting, and automatic production for applications for industries such as consumer electronics, industrial, automotive, and medical devices.
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www.pink.de/en

PINK GmbH Thermosysteme is the leading manufacturer of Vacuum Soldering and Sintering systems. The VADU systems have the ability to process both preforms and solder paste within the same system. Whether performing R&D or high volume production, PINK’s VADU systems can meet your requirements.

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Plexim provides solutions for the design and test of power electronic systems and their associated controls. Our portfolio consists of the trusted simulation software PLECS, the RT Box for controller hardware-in-the-loop and rapid control prototyping, and processor-in-the-loop and web-based simulation tools.

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Richardson, TX 75080 1141
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The Power Management Bus (PMBus) is an open standard power-management protocol pioneered by leading power supply and semiconductor companies. Redefining power management, the communications protocol is maintained and promoted by the PMBus Implementers Forum (PMBus-IF) comprised of over 40 companies.

PMK Mess – und Kommunikationstechnik GmbH .................. Booth 1723
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Bad Soden, Hess 65812
Germany
www.pmk.de

PMK Mess- und Kommunikationstechnik GmbH is one of the leading independent manufacturers for electronic test and measurement equipment. Customers are industrial companies as well as developers.

Power Electronic Measurements Ltd. ............................ Booth 925
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Power Integrations is a leading innovator in high-voltage power conversion. Our ICs are key to the clean-power ecosystem; enabling renewable energy and providing efficient power consumption in applications ranging from milliwatts to megawatts.

Power Solutions Inc. ........................................ Booth 935
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Duluth, GA 30097
USA
www.psl-powersolutions.com

PSL-Power Solutions Inc. are experts in Power Conversion Assemblies and Thermal Solutions. Producing in-house machined parts, water cooled chill-plates, heat-pipe solutions and bonded fin heat sinks. A subsidiary of PSL Assemblies located in the UK.

PowerAmerica .............................................. Booth 737
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Suite 200
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USA
https://www.poweramericainstitute.org/

PowerAmerica aims to save energy and create manufacturing jobs by accelerating the adoption of wide bandgap semiconductor devices in power electronic systems. Through participation in PowerAmerica, companies grow business by expedited product introduction, and universities engage in collaborative projects with industry.
**PowerbyProxi** ........................... Booth 1839
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Freemans Bay
Auckland, NA 1011
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www.powerbyproxi.com

PowerbyProxi designs & develops safe, high efficiency & high density wireless power technology. We solve mission-critical problems in demanding, hostile industrial environments where the delivery of consistent power is imperative. Our wireless power designs & IP are used in numerous commercial applications around the world by some of the world’s largest companies.

**PowerELab Ltd.** ........................ Booth 831
RM521-522, BLK 9, Enterprise Place
5 Science Park West Ave, HK Science Park, Shatin
Hong Kong
www.powerelab.com

PowerELab provides design services for many high efficiency, high power density and special application power electronics products, e.g. AC-DC power supply, 80+ server, 80+ ATX, LED driver, electronic ballast, 99+% Eff. Totem Pole PFC, EV charger, DC-AC inverter, battery charger, medical power supply, DC-DC converter, etc. patent licensing, consultancy and training. We also developed a LLC +SR digital controller and a free on-line power supply design tool PowerEsim.

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USA
www.pwrx.com

Powerex offers power semiconductor solutions including discrete diodes, SCRs, and power modules serving a broad range of applications including automotive, traction, industrial, medical, renewable energy, and white goods. A Industry standard and custom packages are available along with Silicon Carbide solutions.

**Powersim, Inc** ............................ Booth 615
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Rockville, MD 20850
USA
https://powersimtech.com/

Our main product PSIM is a power electronics simulation tool that empowers engineers to accelerate their pace of innovation with the fastest, most reliable and easy-to-use solution. PSIM is now available with an integrated SPICE engine.

**Precision Inc.** ............................ Booth 715
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Minneapolis, MN 55430
USA
www.precision-inc.com

Precision, Inc. is a manufacturer of Inductors, Transformers, Coils and other Power Magnetics Products. Precision Provides Engineering Assistance, Custom Designs and Prototypes. Clean Room Production with ISO 9001 and ISO 13485. Recent Designs Include GaN

**PSMA (Power Sources Manufacturers Association)** ............................ Booth 212
P.O. Box 418
Mendham, NJ 07945
USA
www.psma.com

The Power Sources Manufacturers Association is an industry organization of power supply manufacturers, users, power component suppliers, academics and consultants. Incorporated in 1985, as a non-profit, democratic, participative organization, PSMA’s main

**Qualtek** ................................. Booth 730
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Mentor, OH 44060
USA
www.qualtekusa.com

Qualtek Electronics has established itself as the global leader of high quality low cost products while providing the latest technology. Showcased are our full line of power supplies, AC and DC fans, and a full range of fan accessories.

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Chino, CA 91710
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A Taiwanese discrete semiconductor manufacturer since 1975, offers Diodes, Rectifiers, Transistors, SiC Schottky, TVS, ESD arrays, Zeners, and MOSFET products. All Rectron factories are wholly owned and have achieved TS16949 quality standards.
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Leading Manufacture of Coils, Transformers and Inductors. Renco is an Engineering driven company based in Florida with worldwide manufacturing and distribution. Design, build to print or work in conjunction with your Engineering Team. Custom made prototypes as fast as 1 week.

Renesas Electronics ................................. Booth 926
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Santa Clara, CA 95050
USA
www.am.renesas.com

Renesas Electronics America, Inc., headquartered in Santa Clara, California, is a wholly owned subsidiary of Renesas Electronics Corporation, the world's number one supplier of microcontrollers and a premier supplier of advanced semiconductor solutions including microcontrollers, SoC solutions, and a broad range of analog and power devices. More information about the products offered by Renesas Electronics America can be found at renesas.com.

Richardson RFPD ........................................ Booth 930
1950 S Batavia Ave
Suite 100
Geneva, IL 60134
USA
www.richardsonrfpd.com

Richardson RFPD is a global leader in the RF and wireless communications, power conversion and renewable energy markets. It brings relationships with many of the industry's top RF and power component suppliers whether it's designing components or engineering complete solutions.

Ridley Engineering, Inc. ................................. Booth 303
601 E Daily Dr
Suite 112
Camarillo, CA 93010
USA
www.RIDLEYENGINEERING.com

Ridley Engineering is a global leader best known for its laboratory design workshops, POWER 4-5-6 design software and AP300 frequency response analyzer. A new Design Center facility opened in Camarillo, California in 2016 for training courses, research and consulting.

Rogers Corporation ................................. Booth 1125
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Rogers, CT 06263
USA
www.rogerscorp.com

Rogers is a global technology leader in specialty materials & components that enable high performance and reliability of power electronics, mass transit, automotive & sustainable energy. RO-LINX’ laminated busbars and curamik’ Ceramic Substrates & Micro-Channel Coolers on display.

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Manufacturer of ROHS and REACH compliant and ISO/TS 16949 certified capacitors and modules, inductors and cores for all electric devices and modules. Value-creating corporation for mankind and environment.

SanRex Corporation ......................... Booth 1325
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www.sanrex.com

SanRex power module and discrete product lines: pioneer of diodes, thyristors, and triacs for electrical power switching, and conversion. We continue to achieve success developing power semiconductor technology. And, now we can include a range of SiC MOSFET products.

SBE, Inc. .................................. Booth 1434
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USA
www.sbeelectronics.com
SBE Inc is a leading developer and manufacturer of integrated AC and DC film capacitor solutions for transportation, alternative energy, medical, HVDC and STATCOM systems and Data-center network power. The company has locations in Vermont, Colorado, and China.

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USA
www.trencos.com

Schaffner is a market leader in the design and manufacture of power conditioning, filtering and distribution equipment. Product scope includes EMC filters thru large power magnetic devices along with custom engineered solutions. Schaffner serves many North American and Global markets.

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www.aluminium-graphite.com

Schunk Hoffmann Carbon Technology offers parts made of Aluminium Graphite, such as base plates or heat sinks for high reliability applications. Additionally, we will premier our self-encapsulating carbon phase change material as a novel approach for latent heat storage units.

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STI tests a wide array of devices including GaN, SiC, wafer level, and packaged devices. STI equipment can interface with any prober or handler and it can be utilized as a curve tracer or for simple go/no go testing.
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Semtech Corporation .......................... Booth 1525
200 Flynn Rd
Camarillo, CA 93012
USA
www.semtech.com
Semtech Corporation is a leading supplier of analog and mixed-signal semiconductors for high-end consumer, computing, communications and industrial equipment. Power management products include the LinkCharge wireless charging platform, Neo-Iso™ switches for IoT applications, and more. For more information, visit www.semtech.com.

Shenzhen Zeasset Electronic Technology Co., Ltd. .......................... Booth 323
B1 Building Anle Industrial Pak
Hangcheng Road, Banan District
Shenzhen
China
www.zeasset.com
Shenzhen Zeasset Electronic Technology Co., Ltd. specializes in R&D, production and marketing of aluminum electrolytic capacitors & EDLC, which products have characteristic of high voltage, high temperature, high reliability, long life, high ripple current, rapid charge and discharge, etc.

Silicon Frontline Technology, Inc. ................................. Booth 331
4030 Moorpark Ave
Suite 249
San Jose, CA 95117
USA
www.siliconfrontline.com
SFT provides electro-thermal analysis of power devices. R3D analyzes designs for Rdson, current density and sensitivity analysis. R3D Gate provides transient analysis of the distributed model of the device. Ethan delivers transient electro-thermal simulation of the design including packaging.

Simplis Technologies ................................. Booth 1223
P.O. Box 40084
Portland, OR 97240-0084
USA
www.simplistechnologies.com
SIMPLIS Technologies is the creator of SIMPLIS, the leading simulation engine for switched mode power supply design. In partnership with SIMetrix Technologies Ltd we develop and market the SIMetrix/SIMPLIS software products which provides unmatched capabilities.

Sonoscan, Inc ................................. Booth 1710
2149 E Pratt Blvd
Elk Grove Village, IL 60007
USA
www.sonoscan.com
Sonoscan is a leader and innovator in Acoustic Micro Imaging (AMI) technology. Sonoscan manufactures acoustic microscope systems and provides laboratory services to nondestructively inspect and analyze products. Our C-SAM microscopes provide unmatched accuracy for the inspection of products for hidden internal defects in SMT devices, ceramic capacitors and resistors, hybrids, MEMs, etc.

SP Control Technologies ................................. Booth 1639
Calle Rios Rosas 47
Madrid, 28003
Spain
www.thespcard.com
SP Control Technologies is a startup company focused on developing state of the art electronics technology, like the SpCard, and innovative programs to help companies like Virtual Engineer.

Standex-Meder Electronics ................................. Booth 1137
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USA
www.standexelectronics.com
Standex-Meder Electronics is a worldwide market leader in the design, development, and manufacture of standard reed switch-based solutions & custom magnetics and power conversion components and assemblies.
Stapla Ultrasonics .......................... Booth 1536
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Stellar Industries Corp. ..................... Booth 211
50 Howe Ave
Millbury, MA 01527
USA
www.stellarind.com
Stellar Industries is an approved and preferred supplier to the Telecom, Biomedical, Microwave, and Defense Industries for custom metallized ceramic components and services.

STMicroelectronics .......................... Booth 803
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USA
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Storm Power Components .................. Booth 1435
240 Industrial Park Ln
Decatur, TN 37322
USA
www.stormpowercomponents.com
Storm’s vertically integrated US facility is your one-stop source for simple to complex solutions for all power electronics & distribution needs. Laminated busbars, aluminum or copper, in-house electroplating & film or epoxy powder coat insulation systems, plus value added assemblies!

Sumida America Components Inc. ...... Booth 1711
1251 N Plum Grove Rd
Suite 150
Schaumburg, IL 60173
USA
www.sumida.com
Sumida is one of the largest manufacturers of coils and wire wound electronic products globally with over 75,000 active parts. Whether Consumer, Industrial or Automotive applications, Sumida has over 60 years of experience finding the best solution for its customers.

Synopsys, Inc. .............................. Booth 637
690 E Middlefield Rd
Mountain View, CA 94043
USA
www.synopsys.com
Synopsys is the Silicon to Software™ partner for companies developing electronic products, efficient power electronics and software applications. Synopsys has the solutions needed to deliver innovative, high-quality, secure products.

Taiwan Chinsan Ind. Co., LTD. .......... Booth 1930
No. 1, Alley 11, Lane 68, Sec. 1 Kwang Fu Rd
San Chung Dist.
New Taipei City, 24158
Taiwan
www.chinsan.com
Taiwan Chinsan Electronic was established in 1970 and is a publicly listed company on the Taiwan Stock Exchange (code: 8042). For 46 years Chinsan has manufactured the ELITE brand aluminum electrolytic capacitor ranging from radial, snap-in, lug, and screw type capacitors and more recently the conductive solid aluminium polymer capacitors.

Taiwan Semiconductor Inc. ............ Booth 633
3040 Saturn St
Suite 200
Brea, CA 92821
USA
www.taiwansemi.com
Taiwan Semiconductor is a global supplier of power discrete semiconductor products. TSC provides high quality power control solutions for electronic applications such as power conversion, lighting, motor control, auto, industrial, and commercial.

Taiyo Kogyo Co., LTD ..................... Booth 1237
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Japan
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Taiyo Kogyo manufactures Heavy Copper/High Current PCB (HCPCB) used in low impedance power conversion, eliminating wires, dissipating heat efficiently. HCPCB combines signal with power on the same layer, and embeds busbars such as with IGBT or MOSFET signal.
**Tamura Corporation of America**  
Booth 436  
1040 So. Andreasen Dr  
Suite 100  
Escondido, CA 92029  
USA  
www.tamuracorp.com; www.tamura-ss.co.jp

Tamura is a broad line magnetics manufacturer producing Standard and custom Transformers, Inductors, Reactors from 2VA to 1MVA. Also have Hall Effect Current Sensors, Power Modules and Gate Drivers. We will have reps from US, Japan and China available.

**TDK Corporation**  
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