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# TECHNICAL PAPERS

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**March 17, 2020**

8:30 - 12:00

## **T01: Hybrid DC-DC Converters**

ROOM Room 208-210

TRACK DC-DC Converters

SESSION CHAIRS

**Danny Clavette**, *Infineon Technologies AG*

**Hanh-Phuc Le**, *University of California-San Diego*

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TRACK Modeling and Simulation

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**Wisam Alhoor**, *Dialog Semiconductor*

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<sup>1</sup>University of Tennessee, United States, <sup>2</sup>EPC Power, United States, <sup>3</sup>Oak Ridge National Laboratory, United States

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ROOM Room 203-205

TRACK Motor Drives and Inverters

SESSION CHAIRS

**Rakibul Islam**, *Dura Automotive Systems LLC*

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ROOM Room 217-219

TRACK Control

SESSION CHAIR

**Yash Veer Singh, Eaton**

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<sup>1</sup>Virginia Polytechnic Institute and State University, United States, <sup>2</sup>ABB Corporate Research, United States

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<sup>1</sup>Minnesota State University, United States, <sup>2</sup>Eaton, United States

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Aalborg University, Denmark

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<sup>1</sup>University of Technology Sydney, Australia, <sup>2</sup>Miami University, United States, <sup>3</sup>The Ohio State University, United States, <sup>4</sup>Aalborg University, Denmark

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Indian Institute of Technology Kharagpur, India

## March 18, 2020

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### T09: DC-DC Converters for Data Centers

ROOM Room 208-210

TRACK DC-DC Converters

SESSION CHAIRS

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**Xin Zhang**, *IBM*

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*University of California-Berkeley, United States*

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<sup>1</sup>Princeton University, United States, <sup>2</sup>Google LLC, United States

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<sup>1</sup>Nanjing University of Aeronautics and Astronautics, China,<sup>2</sup>Tsinghua University, China

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Georgia Institute of Technology, United States

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<sup>1</sup>Clemson University, United States,<sup>2</sup>Savannah River National Laboratory, United States

8:30 - 11:50

## **T11: Microgrid Systems**

ROOM Room 225-227

TRACK Renewable Energy Systems

SESSION CHAIR

**Hou Rouyu**, GaN Systems

8:30

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<sup>1</sup>Zhejiang University, China,<sup>2</sup>Leadrive Technology (Shanghai) Co., Ltd., China,<sup>3</sup>Inner Mongolia Electric Power Research Institute, China

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Massachusetts Institute of Technology, United States

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<sup>1</sup>Harbin Institute of Technology, China,<sup>2</sup>Aswan University, Egypt,<sup>3</sup>Temple University, United States

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<sup>1</sup>Harbin Institute of Technology, China,<sup>2</sup>Aswan University, Egypt,<sup>3</sup>Temple University, United States

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North Carolina State University, United States

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|   | <b>Hengzhao Yang</b> , <i>New Mexico Institute of Mining and Technology</i>  |     |  |
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| SESSION CHAIRS                                     |              |  |     |
| <b>Ziaur Rahman</b> , <i>Department of Energy</i>  |              |  |     |
| <b>Mehdi Narimani</b> , <i>McMaster University</i> |              |  |     |
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|  |              | Zhe Zhang <sup>1</sup> , Ali M. Bazzi <sup>1,2</sup> , Afia Semin <sup>3</sup><br><sup>1</sup> <i>University of Connecticut, United States,</i> <sup>2</sup> <i>American University of Beirut, Lebanon,</i> <sup>3</sup> <i>Dartmouth College, United States</i> |     |
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<sup>1</sup>Florida International University, United States, <sup>2</sup>North China Electric Power University, China

11:00

- T13.7 Design and Analysis of Inverter-Fed High-Speed Induction Motors with Closed Rotor Slots Taking Enclosure Effect into Account** ..... 729  
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<sup>1</sup>North China Electric Power University, China, <sup>2</sup>Florida International University, United States

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The Ohio State University, United States

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Nico Angelo Macahig  
Power Integrations, Inc., Philippines

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## **T14: Control of DC-AC Inverters**

ROOM Room 217-219

TRACK Control

SESSION CHAIRS

**Jaber Abu Qahouq**, *The University of Alabama*

**Martin Ordenez**, *University of British Columbia*

8:30

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Javier Serrano<sup>1</sup>, Santiago Cobreces<sup>1</sup>, Emilio J. Bueno<sup>1</sup>, Mario Rizo<sup>2</sup>  
<sup>1</sup>Universidad de Alcalá, Spain, <sup>2</sup>Gamesa Electric, Spain

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<sup>1</sup>Collins Aerospace, United States, <sup>2</sup>University of Wisconsin-Madison, United States, <sup>3</sup>United Technologies Research Center, United States

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- T14.3 A PI based Simplified Closed Loop Controller for Dual Active Bridge DC-AC Converter for Standalone Applications** ..... 761  
Amit Bhattacharjee, Issa Batarseh  
University of Central Florida, United States

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M.S. Hassan<sup>1,2</sup>, Ahmed A. Zaki Diab<sup>1,2</sup>, Masahito Shoyama<sup>1</sup>, Gamal M. Dousoky<sup>1,2</sup>  
<sup>1</sup>Kyushu University, Japan, <sup>2</sup>Minia University, Egypt



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|-------|--------------|---|-----|
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| 11:20 | <b>T14.8</b> | <b>Self-Synchronizing Current Control of a Three-Phase Grid-Connected Inverter in the Presence of Unknown Grid Parameters</b> .....   | 793 |
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8:30 - 11:50

### **T15: Wireless Power Transfer: Design, Modeling, and Applications**

ROOM Room 220-222

TRACK Wireless Power Transfer

SESSION CHAIRS

**Franceso Carobolante**, *IoTissimo*

**Veda Galigekere**, *Oak Ridge National Laboratory*

8:30

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| <b>T15.3</b> | <b>A Series-Series-CL Resonant Converter for Wireless Power Transfer in Auxiliary Power Network</b> .....                           | 813 |
|              | Keyao Sun, Jun Wang, Rolando Burgos, Dushan Boroyevich<br><i>Virginia Polytechnic Institute and State University, United States</i> |     |

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| <b>T15.4</b> | <b>Design and Multi-Objective Optimization of Coil and Magnetic for Wireless Power Transfer in Auxiliary Power Network</b> .....    | 819 |
|              | Keyao Sun, Jun Wang, Rolando Burgos, Dushan Boroyevich<br><i>Virginia Polytechnic Institute and State University, United States</i> |     |

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| 9:50  | <b>T15.5</b> | <b>Characterisation of High Frequency Inductive Power Transfer Receivers using Pattern Recognition on the Transmit Side Waveforms</b> .....                                     | 825 |
|       |              | Juan M. Arteaga, Lingxin Lan, Christopher H. Kwan, David C. Yates, Paul D. Mitcheson<br><i>Imperial College London, United Kingdom</i>  |     |
| 10:40 | <b>T15.6</b> | <b>Robust Digital Algorithm for Rapid Phase Angle Tracking in Wireless Power Transfer</b> .....   | 832 |
|       |              | Aaron Troy, Francisco Paz, Martin Ordonez<br><i>University of British Columbia, Canada</i>  |     |
| 11:00 | <b>T15.7</b> | <b>A Hybrid Active/Passive Domino Architecture with MIMO Power Flow Control and Mixed Frequency Operation for Extended Range and Multi-Medium Wireless Power Transfer</b> ..... | 838 |
|       |              | Ming Liu, Yuqing Zhu, Zachary Wang, Minjie Chen<br><i>Princeton University, United States</i>   |     |
| 11:20 | <b>T15.8</b> | <b>An Induced Voltage Source Model for Capacitive Power Transfer</b> .....  | 846 |
|       |              | Shiyang Wang, Junrui Liang, Haoyu Wang, Minfan Fu<br><i>ShanghaiTech University, China</i>  |     |
| 11:40 | <b>T15.9</b> | <b>Bidirectional Capacitive Wireless Power Transfer for Energy Balancing in Modular Robots</b> .....  | 852 |
|       |              | Akshay Sarin, Duncan Abbot, Shai Revzen, Al-Thaddeus Avestruz<br><i>University of Michigan, United States</i>   |     |

8:30 - 11:50

## **T16: Transportation Power Electronics I**

ROOM Room 211-213

TRACK Transportation Power Electronics

SESSION CHAIRS

**Jason Neely**, *Sandia National Laboratories*

**Yingying Kuai**, *Caterpillar*

|      |              |   |     |
|------|--------------|---|-----|
| 8:30 | <b>T16.1</b> | <b>An Adjustable Turns Ratio Transformer based LLC Converter for Deeply-Depleted PEV Charging Applications</b> .....  | 860 |
|      |              | Dongdong Shu, Haoyu Wang<br><i>ShanghaiTech University, China</i>   |     |
| 8:50 | <b>T16.2</b> | <b>A New Two-Switch PFC DCM Boost Rectifier for Aviation Applications</b> .....   | 865 |
|      |              | Tomas Sadilek, Misha Kumar, Yungtaek Jang, Peter Barbosa<br><i>Delta Electronics Ltd., United States</i>  |     |
| 9:10 | <b>T16.3</b> | <b>Charge Management for an Inductively Charged On-Demand Battery-Electric Shuttle Service with High Penetration of Renewable Energy</b> .....  | 873 |
|      |              | Ahmed A.S. Mohamed, Dylan Day, Andrew Meintz, Jun Myungsoo<br><i>National Renewable Energy Laboratory, United States</i>  |     |
| 9:30 | <b>T16.4</b> | <b>Modeling and Design of Integrated Inductor and Transformer Considering Superposed Flux Density in On-Board-Charger</b> .....   | 879 |
|      |              | Jinxu Yang <sup>1</sup> , Xinke Wu <sup>1</sup> , Gang Liu <sup>2</sup> , Dinggang Ping <sup>2</sup> , Zhijiang Deng <sup>2</sup><br><i><sup>1</sup>Zhejiang University, China, <sup>2</sup>Hangzhou EV-Tech Co., Ltd., China</i> |     |

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| 9:50  | <b>T16.5</b> | <b>System-Level Conducted EMI Model for SiC Powertrain of Electric Vehicles</b> .....   | 885 |
|       |              | Xiaoyu Jia, Changsheng Hu, Bitao Dong, Fengchun He, Hui Wang, Dehong Xu<br><i>Zhejiang University, China</i>                                      |     |
| 10:40 | <b>T16.6</b> | <b>A 10-Level Flying Capacitor Multi-Level Dual-Interleaved Power Module for Scalable and Power-Dense Electric Drives</b> .....                   | 893 |
|       |              | Nathan Pallo, Samantha Coday, Joseph Schaad, Porya Assem, Robert C.N. Pilawa-Podgurski<br><i>University of California-Berkeley, United States</i> |     |
| 11:00 | <b>T16.7</b> | <b>Switched-Capacitor-Based Integrated Double-Input Single-Output DC-DC Converter for Electric Vehicle Applications</b> .....                     | 899 |
|       |              | Hadi Moradisizkoohi, Nour Elsayad, Osama A. Mohammed<br><i>Florida International University, United States</i>                                    |     |
| 11:20 | <b>T16.8</b> | <b>An SiC-Based AC/DC CCM Bridgeless Onboard EV Charger with Coupled Active Voltage Doubler Rectifiers for 800-V Battery Systems</b> .....        | 905 |
|       |              | Mehdi Abbasi, John Lam<br><i>York University, Canada</i>  |     |
| 11:40 | <b>T16.9</b> | <b>An Optimized Silicon Carbide based 2x250 kW Dual Inverter for Traction Applications</b> .....  | 911 |
|       |              | Yuheng Wu, Mohammad Hazzaz Mahmud, Eric Allee, Yue Zhao, Alan Mantooh<br><i>University of Arkansas, United States</i>                             |     |

14:30 - 17:40

## **T17: Resonant DC-DC Converters**

ROOM Room 208-210

TRACK DC-DC Converters

SESSION CHAIRS

**Luke Jenkins**, *IBM*

**Robert Pilawa-Podgurski**, *University of California-Berkeley*

|       |              |  |     |
|-------|--------------|--|-----|
| 14:30 | <b>T17.1</b> | <b>Control Design of a Dual-Input LLC Converter for PV-Battery Applications</b> .....  | 917 |
|       |              | S. Milad Tayebi <sup>1</sup> , Xi Chen <sup>2</sup> , Issa Batarseh <sup>1</sup><br><sup>1</sup> <i>University of Texas at Austin, United States</i> , <sup>2</sup> <i>University of Central Florida, United States</i>  |     |
| 14:50 | <b>T17.2</b> | <b>Optimal Phase Shift Control Strategy of Buck-Boost Integrated LLC Converter achieving Wide Input Voltage Range, MHz-Frequency and High Efficiency</b> .....   | 922 |
|       |              | Qinsong Qian <sup>1</sup> , Qi Liu <sup>1</sup> , Haisong Li <sup>2</sup> , Shen Xu <sup>1</sup> , Weifeng Sun <sup>1</sup><br><sup>1</sup> <i>Southeast University, China</i> , <sup>2</sup> <i>Wuxi Chipown Micro-electronics Limited, China</i>   |     |
| 15:10 | <b>T17.3</b> | <b>Output Plane Analyses of LLC Resonant Converter</b> .....   | 927 |
|       |              | Suyash Sushilkumar Shah, Sagar Kumar Rastogi, Subhashish Bhattacharya<br><i>North Carolina State University, United States</i>   |     |
| 15:30 | <b>T17.4</b> | <b>Resonant-Inductive-Boosting DC-DC Converter with Very High Voltage Gain</b> .....   | 935 |
|       |              | Kerui Li, Siew-Chong Tan, Ron Shu Yuen Hui<br><i>The University of Hong Kong, Hong Kong</i>  |     |
| 15:50 | <b>T17.5</b> | <b>Optimal Control of a Wide Range Resonant DC-DC Converter</b> .....  | 940 |
|       |              | Satyaki Mukherjee <sup>1</sup> , Alihossein Sepahvand <sup>2</sup> , Vahid Yousefzadeh <sup>2</sup> , Montu Doshi <sup>2</sup> , Dragan Maksimović <sup>1</sup><br><sup>1</sup> <i>University of Colorado-Boulder, United States</i> , <sup>2</sup> <i>Texas Instruments Inc., United States</i> |     |

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| 16:20 | <b>T17.6</b> | <b>Analysis of High-Efficiency Operating Modes for Piezoelectric Resonator-Based DC-DC Converters</b> .....  | 946 |
|       |              | Jessica D. Boles, Joshua J. Piel, David J. Perreault<br><i>Massachusetts Institute of Technology, United States</i>  |     |
| 16:40 | <b>T17.7</b> | <b>A Sensorless Synchronous Rectification Driving Scheme in 1-kV Input 1-MHz GaN LLC Converters with Matrix Transformers</b> .....   | 954 |
|       |              | Xinyi Zhu <sup>1</sup> , Zhiliang Zhang <sup>1</sup> , Zhibin Li <sup>1</sup> , Ke Xu <sup>1</sup> , Dongdong Ye <sup>2</sup> , Xiaoyong Ren <sup>1</sup> , Qianhong Chen <sup>1</sup><br><sup>1</sup> Nanjing University of Aeronautics and Astronautics, China, <sup>2</sup> Beijing Institute of Control Engineering, China |     |
| 17:00 | <b>T17.8</b> | <b>A Digital Sensor-Less Synchronous Rectification Algorithm for Symmetrical Bidirectional CLLC Resonant Converters</b> .....  | 962 |
|       |              | Xufu Ren, Long Pei, Shaojie Song, Jialei Zhang, Yunqing Pei, Laili Wang<br><i>Xi'an Jiaotong University, China</i>   |     |
| 17:20 | <b>T17.9</b> | <b>A Modified Dual-Input LLC Converter for Standalone PV/Battery Power System</b> .....  | 969 |
|       |              | Xi Chen <sup>1</sup> , Seyed Milad Tayebi <sup>2</sup> , Issa Batarseh <sup>1</sup><br><sup>1</sup> University of Central Florida, United States, <sup>2</sup> University of Texas at Austin, United States  |     |

14:30 - 17:40

## **T18: Controller and Filter Design for Utility Interface Converters**

ROOM Room 228-230

TRACK Power Electronics for Utility Interface

SESSION CHAIRS

**Malek Ramezani**, *South Dakota School of Mines and Technology*

**Yilmaz Sozer**, *University of Akron*

|       |              |   |      |
|-------|--------------|---|------|
| 14:30 | <b>T18.1</b> | <b>Design of Loop Gain for Load Converters in a Distributed System</b> .....  | 977  |
|       |              | Lei Wang, Mehran Mirjafari<br><i>Dell EMC, United States</i>  |      |
| 14:50 | <b>T18.2</b> | <b>High-Efficiency Model Predictive Control for Star-Connected Cascaded H-Bridge STATCOM under Unbalanced Conditions</b> .....  | 982  |
|       |              | Yufei Li <sup>1,2</sup> , Yue Zhao <sup>2</sup> , Fei Diao <sup>2</sup><br><sup>1</sup> Northwestern Polytechnical University, China, <sup>2</sup> University of Arkansas, United States  |      |
| 15:10 | <b>T18.3</b> | <b>A Supervisory Remote Management System for Parallel Operation of Modularized D-STATCOM</b> .....   | 989  |
|       |              | Radwa M. Abdalaal, Carl Ngai Man Ho<br><i>University of Manitoba, Canada</i>  |      |
| 15:30 | <b>T18.4</b> | <b>Improving Power Quality in Grid-Connected Wind Energy Conversion Systems using Supercapacitors</b> .....   | 995  |
|       |              | Ebrahim Mohammadi, Ramtin Rasoulinezhad, Gerry Moschopoulos<br><i>Western University, Canada</i>  |      |
| 15:50 | <b>T18.5</b> | <b>Asymmetrical Fault Current Calculation Method and Coupling Effect Analysis in N-Paralleled Droop-Controlled Inverters</b> .....  | 1001 |
|       |              | Huimin Zhao <sup>1</sup> , Zhikang Shuai <sup>1</sup> , Jun Ge <sup>1</sup> , Yu Feng <sup>1</sup> , John Shen <sup>2</sup><br><sup>1</sup> Hunan University, China, <sup>2</sup> Illinois Institute of Technology, United States |      |

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| 16:20  | <b>T18.6</b> | <b>An Arcless Step Voltage Regulator based on Paralleled Power Electronics Converter Configuration</b> .....  | 1006 |
|  |              | Yafeng Wang, Xiwen Xu, Tiefu Zhao<br><i>University of North Carolina at Charlotte, United States</i>  |      |
| 16:40  | <b>T18.7</b> | <b>Modeling and Practical Design Dual-Mode Sinewave and Common Mode Filter for PWM Motor Drives System using Tricore Laminations</b> .....  | 1012 |
|  |              | Tin Luu<br><i>MTE Corporation, United States</i>  |      |
| 17:00  | <b>T18.8</b> | <b>150-kW Three-Port Custom-Core Transformer Design Methodology</b> .....   | 1020 |
|  |              | Shamar Christian <sup>1</sup> , Roberto Armin Fantino <sup>1</sup> , Roderick Amir Gomez <sup>1</sup> , Juan Carlos Balda <sup>1</sup> , Yue Zhao <sup>1</sup> , Guangqi Zhu <sup>2</sup><br><i><sup>1</sup>University of Arkansas, United States, <sup>2</sup>Eaton, United States</i> |      |
| 17:20  | <b>T18.9</b> | <b>Analysis and Injection Control of Zero-Sequence Voltage and Circulating Current for MMC with Active Power Filter</b> .....   | 1025 |
|  |              | Guanlong Jia <sup>1</sup> , Song Tang <sup>1</sup> , Chenghao Zhang <sup>1</sup> , Min Chen <sup>1</sup> , Yi Lu <sup>2</sup> , Yong Yang <sup>2</sup><br><i><sup>1</sup>Zhejiang University, China, <sup>2</sup>State Grid Zhejiang Electric Power Co., Ltd., China</i>                |      |
| 14:30 - 17:40  |              |   |      |
| <b>T19: Bi-Directional Power Converters</b>                                      |              |   |      |
| ROOM Room 225-227  |              |   |      |
| TRACK Renewable Energy Systems   |              |   |      |
| SESSION CHAIRS   |              |   |      |
| <b>Junpeng Ji</b> , <i>Xi'an University of Technology</i>                        |              |   |      |
| <b>Saijun Mao</b> , <i>Shanghai Lingang Power Electronics Research Institute</i> |              |   |      |
| 14:30  | <b>T19.1</b> | <b>Soft Starting Strategy of Cascaded Dual Active Bridge Converter for High Power Isolated DC-DC Conversion</b> .....   | 1031 |
|  |              | Pengfei Yao <sup>1</sup> , Xiaohua Jiang <sup>1</sup> , Fei Wang <sup>2</sup><br><i><sup>1</sup>Tsinghua University, China, <sup>2</sup>University of Tennessee, United States</i>  |      |
| 14:50  | <b>T19.2</b> | <b>GaN FETs Enable High Frequency Dual Active Bridge Converters for Bi-Directional Battery Chargers</b> .....   | 1038 |
|  |              | Feng Qi, Zhan Wang, YiFeng Wu, Philip Zuk<br><i>Transphorm Inc., United States</i>  |      |
| 15:10  | <b>T19.3</b> | <b>Reverse Current Elimination for Capacitor Voltage Balanced Bidirectional Resonant Converter using a Bidirectional Switch</b> .....   | 1044 |
|  |              | Hwasoo Seok <sup>1</sup> , Jun-Seok Kim <sup>1</sup> , Owon Kwon <sup>1</sup> , Minsung Kim <sup>2</sup><br><i><sup>1</sup>Pohang University of Science and Technology, Korea, <sup>2</sup>Dongguk University, Korea</i>  |      |
| 15:30  | <b>T19.4</b> | <b>A Novel Reactive Power Control Mitigating a DC Link Ripple Voltage of Reactive Power Compensator for Distribution Line</b> .....   | 1051 |
|  |              | Woosik Sim <sup>1</sup> , Jongmin Jo <sup>1</sup> , Youngroc Kim <sup>2</sup> , Hanju Cha <sup>1</sup><br><i><sup>1</sup>Chungnam National University, Korea, <sup>2</sup>Hex Power System, Korea</i>   |      |

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| 15:50 | <b>T19.5</b> | <b>Family of Current-Fed Switched Capacitor –Based Modular DC Transformer Topologies for HVDC Interconnection Application</b> .....   | 1056 |
|       |              | Qianhao Sun <sup>1</sup> , Xiaohui Ye <sup>2</sup> , Jingwei Meng <sup>1</sup> , Xinyao Zhu <sup>3</sup><br><i><sup>1</sup>Tsinghua University, China, <sup>2</sup>China Electric Power Research Institute, China, <sup>3</sup>Jiangsu Electric Power Research Institute, China</i> |      |
| 16:20 | <b>T19.6</b> | <b>Transformer-Less Series-Input-Parallel-Output Dual Active Half-Bridge for MV-LV DC/DC Converter</b> .....  | 1061 |
|       |              | Jin-Su Hong, Jung-Ik Ha<br><i>Seoul National University, Korea</i>  |      |
| 16:40 | <b>T19.7</b> | <b>Modular Isolated Soft-Switching Medium Voltage String Inverter for Large-Scale PV Farm</b> .....   | 1067 |
|       |              | Zheng An, Xiangyu Han, Liran Zheng, Karthik Kandasamy, Rajendra Prasad Kandula, Deepak Divan<br><i>Georgia Institute of Technology, United States</i>   |      |
| 17:00 | <b>T19.8</b> | <b>A High Frequency CLLLC Bi-Directional Series Resonant Converter DAB using an Integrated PCB Winding Transformer</b> .....  | 1074 |
|       |              | Sheng-Yang Yu <sup>1</sup> , Chris Hsiao <sup>2</sup> , Jack Weng <sup>2</sup><br><i><sup>1</sup>Texas Instruments Inc., United States, <sup>2</sup>Cyntec, Taiwan</i>  |      |
| 17:20 | <b>T19.9</b> | <b>Bidirectional Isolated Ripple Cancel Dual Active Bridge Modular Multilevel DC-DC Converter</b> .....   | 1081 |
|       |              | Jugo Sugimoto, Pin-Yu Huang, Shota Okutani, Yuichi Kado<br><i>Kyoto Institute of Technology, Japan</i>  |      |

14:30 - 17:40

## **T20: SiC Devices and Components**

ROOM Room 206-207

TRACK Devices and Components

SESSION CHAIRS

**Ali Salih**, *ON Semiconductor*

**Rajib Datta**, *GE Research*

14:30

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| <b>T20.1</b> | <b>Impact of Submodule Voltage Sensor Noise in 10 kV SiC MOSFET Modular Multilevel Converters (MMCs) under High dv/dt Environment</b> .....  | 1089 |
|              | Shiqi Ji <sup>1</sup> , James Palmer <sup>1</sup> , Xingxuan Huang <sup>1</sup> , Dingrui Li <sup>1</sup> , Bill Giewont <sup>2</sup> , Leon M. Tolbert <sup>1,3</sup> , Fred Wang <sup>1,3</sup><br><i><sup>1</sup>University of Tennessee, United States, <sup>2</sup>EPC Power, United States, <sup>3</sup>Oak Ridge National Laboratory, United States</i> |      |

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| <b>T20.2</b> | <b>An Efficiency Improvement Method for Si/SiC Hybrid Switch based Inverter</b> .....    | 1094 |
|              | Zeng Liu, Zishun Peng, Ling Ou, Xiaogui Peng, Jun Wang<br><i>Hunan University, China</i> |      |

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| <b>T20.3</b> | <b>Utilizing Electroluminescence of SiC MOSFETs for Unified Junction-Temperature and Current Sensing</b> ..... | 1098 |
|              | Sven Kalker, Christoph H. van der Broeck, Rik W. De Doncker<br><i>RWTH Aachen University, Germany</i>          |      |

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| 15:30 | <b>T20.4</b> | <b>Investigation on Effects of Thermal Stress on SiC MOSFET Degradation through Power Cycling Tests</b> .....   | 1106 |
|       |              | Jianjun Chen, Xi Jiang, Zongjian Li, Hengyu Yu, Jun Wang, Z. John Shen<br><i>Hunan University, China</i>  |      |
| 15:50 | <b>T20.5</b> | <b>Comparative Evaluation of Surge Current Capability of the Body Diode of SiC JMOS, SiC DMOS, and SiC Schottky Barrier Diode</b> .....   | 1111 |
|       |              | Xi Jiang <sup>1</sup> , Jiajun Yu <sup>1</sup> , Jianjun Chen <sup>1</sup> , Hengyu Yu <sup>1</sup> , Zongjian Li <sup>1</sup> , Jun Wang <sup>1</sup> , Z. John Shen <sup>2</sup><br><sup>1</sup> <i>Hunan University, China</i> , <sup>2</sup> <i>Illinois Institute of Technology, United States</i> |      |
| 16:20 | <b>T20.6</b> | <b>Characterization of 1200V 300A SiC MOSFET Switching Performance Dependence on Load-Cable-Output Filter and Control Deadtime Optimization</b> .....   | 1116 |
|       |              | Yujia Cui, Willy Sedano, Peizhong Yi, Lixiang Wei<br><i>Rockwell Automation, Inc., United States</i>  |      |
| 16:40 | <b>T20.7</b> | <b>Measure the Thermal Parameters of SiC MOSFET through Case Temperature</b> .....  | 1122 |
|       |              | Shuai Zheng, Xiong Du, Yaoyi Yu, Quanming Luo, Pengju Sun<br><i>Chongqing University, China</i>   |      |
| 17:00 | <b>T20.8</b> | <b>A High-Density Single-Turn Inductor for a 6 kV SiC-Based Power Electronics Building Block</b> .....  | 1127 |
|       |              | He Song, Jun Wang, Yue Xu, Rolando Burgos, Dushan Boroyevich<br><i>Virginia Polytechnic Institute and State University, United States</i>   |      |
| 17:20 | <b>T20.9</b> | <b>Robustness Evaluation and Degradation Mechanisms of SiC MOSFETs Overstressed by Switched Stimuli</b> .....   | 1135 |
|       |              | Joseph P. Kozak, Ruizhe Zhang, Haoshen Yang, Khai D.T. Ngo, Yuhao Zhang<br><i>Virginia Polytechnic Institute and State University, United States</i>  |      |

14:30 - 17:40

## **T21: Motor Drives: Topology and control Strategies**

ROOM Room 203-205

TRACK Motor Drives and Inverters

SESSION CHAIRS

**Rashmi Prasad**, *General Motors*

**Mithat Kisacikoglu**, *The University of Alabama*

14:30

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| <b>T21.1</b> | <b>Advanced Modulation Scheme with Loss Balancing Effect under Low-Modulation Operation for FC-T<sup>2</sup>C Converter</b> .....  | 1141 |
|              | Runtian Chen <sup>1</sup> , Yifan Zhang <sup>1</sup> , Chushan Li <sup>1</sup> , Wuhua Li <sup>1</sup> , Xiangning He <sup>1</sup> , Jianguo Zhu <sup>2</sup> , Chenguang Li <sup>2</sup> , Xiaowei Gu <sup>3</sup><br><sup>1</sup> <i>Zhejiang University, China</i> , <sup>2</sup> <i>Shenzhen Winline Technology Co., China</i> , <sup>3</sup> <i>Zhejiang Sci-Tech University, China</i> |      |

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| <b>T21.2</b> | <b>A Novel Neutral-Point-Clamped Half-Bridge Eleven-Level Inverter with High DC Voltage Utilization Ratio and Fewer Switches</b> ..... | 1148 |
|              | Qicai Ren, Alian Chen, Jie Chen, Chenghui Zhang<br><i>Shandong University, China</i>   |      |

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| 15:10  | <b>T21.3</b> | <b>Three-Phase Inverter for Formula SAE Electric with Online Junction Temperature Estimation of all SiC MOSFETs</b> .....   | 1154 |
|  |              | Fausto Stella, Gianmario Pellegrino, Eric Armando<br><i>Politecnico di Torino, Italy</i>  |      |
| 15:30  | <b>T21.4</b> | <b>Isolated DC/AC Converter with ZVT based on Pulsating DC Link</b> .....   | 1162 |
|  |              | Carmine Abbate, Giovanni Busatto, Francesco Iannuzzo, Daniele Marciano, Davide Tedesco<br><i>Università degli Studi di Cassino e del Lazio Meridionale, Italy</i>                     |      |
| 15:50  | <b>T21.5</b> | <b>Multi-Level Power Converters using Coupled Inductors and Parallel Connected 2-Level Inverters</b> .....  | 1168 |
|  |              | Sukhjit Singh, Marius Takongmo, John Salmon<br><i>University of Alberta, Canada</i>   |      |
| 16:20  | <b>T21.6</b> | <b>Dual and Isomorphic Power Converters with the Topology Cycling Phenomenon</b> .....  | 1176 |
|  |              | Yuzhuo Li, Yun Wei Li<br><i>University of Alberta, Canada</i>   |      |
| 16:40  | <b>T21.7</b> | <b>Si-IGBT / SiC-MOSFET Hybrid Inverter Control Method for Reduced Loss and Switching Ripple</b> .....  | 1183 |
|  |              | Jonghun Choi <sup>1</sup> , Gyu Cheol Lim <sup>2</sup> , Jung-Ik Ha <sup>1</sup><br><sup>1</sup> Seoul National University, Korea, <sup>2</sup> Agency for Defense Development, Korea |      |
| 17:00  | <b>T21.8</b> | <b>Performance Improvement of Medium Voltage Modular Multilevel Converter based Motor Drive using SiC MOSFETs</b> .....   | 1189 |
|  |              | Karun Potty, Muneer Al Sabbagh, Jianyu Pan, Ziwei Ke, Julia Zhang, Longya Xu, Jin Wang<br><i>The Ohio State University, United States</i>   |      |
| 14:30 - 17:40  |              |   |      |
| <b>T22: Control Applications</b>                           |              |   |      |
| ROOM Room 217-219  |              |   |      |
| TRACK Control  |              |   |      |
| SESSION CHAIR  |              |   |      |
| <b>Shahab Mehraeen</b> , <i>Louisiana State University</i> |              |   |      |
| 14:30  | <b>T22.1</b> | <b>DC/DC Converter Output Capacitor Characterization using Identification Techniques and DTW</b> .....  | 1195 |
|  |              | M.A. Granda, C. Fernández, A. Barrado, P. Zumel<br><i>Universidad Carlos III de Madrid, Spain</i>   |      |
| 14:50  | <b>T22.2</b> | <b>Power Flow Decoupling Controller for Triple Active Bridge based on Fourier Decomposition of Transformer Currents</b> .....   | 1201 |
|  |              | Pavel Purgat, Soumya Bandyopadhyay, Zian Qin, Pavol Bauer<br><i>Delft University of Technology, The Netherlands</i>   |      |
| 15:10  | <b>T22.3</b> | <b>Performance Evaluation of Encoderless Control of Permanent Magnet Synchronous Machines using Predictive Current Observer Method</b> .....  | 1209 |
|  |              | Kevin Lee, Yaojin Mo<br><i>Eaton, United States</i>   |      |



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| 15:30 | <b>T22.4</b> | <b>Stability improving of an MMC Distributed System based on Instability Risk and Capacitor Voltage Balancing Capability Evaluation</b> .....   | 1216 |
|       |              | Shunfeng Yang, Shun Liu, Haiyu Wang, Hang Su, Jingchun Huang, Shuo Chen<br><i>Southwest Jiaotong University, China</i>  |      |
| 15:50 | <b>T22.5</b> | <b>Balancing Control of Paralleled Full-Bridge Converters in High-Current Gradient Amplifiers for MRI Applications</b> .....  | 1222 |
|       |              | Misha Kumar <sup>1</sup> , Laszlo Huber <sup>1</sup> , He Huang <sup>2</sup> , Zhiyu Shen <sup>1</sup> , Hongyuan Jin <sup>2</sup><br><sup>1</sup> <i>Delta Electronics Ltd., United States,</i> <sup>2</sup> <i>Delta Electronics Co., Ltd., China</i>                                   |      |
| 16:20 | <b>T22.6</b> | <b>A General Carrier-Based Modulation and Capacitor-Voltage Balancing Method for Multilevel Matrix Converters (AC-AC Stacked Multicell Converters)</b> .....  | 1230 |
|       |              | Boran Fan <sup>1</sup> , Vladimir Blasko <sup>2</sup> , Rolando Burgos <sup>1</sup> , Dushan Boroyevich <sup>1</sup><br><sup>1</sup> <i>Virginia Polytechnic Institute and State University, United States,</i><br><sup>2</sup> <i>United Technologies Research Center, United States</i> |      |
| 16:40 | <b>T22.7</b> | <b>Digital Lock-in Controller IC for Optimized Operation of Resonant SCC</b> .....  | 1236 |
|       |              | Tom Urkin, Guy Sovik, Erez Erzol Masandilov, Mor Mordechai Peretz<br><i>Ben-Gurion University of the Negev, Israel</i>  |      |

14:30 - 17:40

### **T23: Single-Phase AC-DC Converters**

ROOM Room 220-222

TRACK AC-DC Converters

SESSION CHAIR

**Alex Hanson**, *University of Texas*

|       |              |   |      |
|-------|--------------|---|------|
| 14:30 | <b>T23.1</b> | <b>A Soft-Switched Bridgeless AC/DC Converter for Electric Vehicles</b> .....   | 1244 |
|       |              | Rahil Samani <sup>1</sup> , Amir Hashemi <sup>2</sup> , Behzad Poorali <sup>1</sup> , Chris Botting <sup>3</sup> , Nick Dohmeier <sup>3</sup> , Majid Pahlevani <sup>2</sup><br><sup>1</sup> <i>University of Calgary, Canada,</i> <sup>2</sup> <i>Queen's University, Canada,</i> <sup>3</sup> <i>Delta-Q Technologies, Canada</i> |      |
| 14:50 | <b>T23.2</b> | <b>Single-Phase Bridgeless PFC Rectifier with Hybrid Switched-Capacitor Cell</b> .....  | 1250 |
|       |              | Julio Cesar Dias, Telles Brunelli Lazzarin<br><i>Federal University of Santa Catarina, Brazil</i>   |      |
| 15:10 | <b>T23.3</b> | <b>Analysis of a Magnetically Controlled Single Stage LLC Resonant Converter</b> .....  | 1257 |
|       |              | Yuqi Wei <sup>1</sup> , Quanming Luo <sup>2</sup> , Dereje Woldegiorgis <sup>1</sup> , Haider Mhiesan <sup>1</sup> , Alan Mantoosh <sup>1</sup><br><sup>1</sup> <i>University of Arkansas, United States,</i> <sup>2</sup> <i>Chongqing University, China</i>   |      |
| 15:30 | <b>T23.4</b> | <b>Valley Skipping Compensation for Low THD in Constant-on-Time Control for PFC Pre-Regulators: Implementation and Performance</b> .....  | 1264 |
|       |              | Alberto Bianco, Giuseppe Scappatura, Francesco Ciappa<br><i>STMicroelectronics, Italy</i>   |      |
| 15:50 | <b>T23.5</b> | <b>Improvement of Constant-on-Time Control for Transition Mode PFC Boost Pre-Regulators</b> .....   | 1268 |
|       |              | Giovanni Gritti<br><i>STMicroelectronics, Italy</i>   |      |

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| 16:20   | <b>T23.6</b> | <b>Means of Reducing Number of Sensors in Single-Phase Power Converters with an Active Power Buffer</b> .....  | 1273 |
|   |              | Huawei Yuan <sup>1</sup> , Sinan Li <sup>2</sup> , Siew-Chong Tan <sup>1</sup> , S.Y. Ron Hui <sup>1</sup><br><i><sup>1</sup>The University of Hong Kong, Hong Kong, <sup>2</sup>The University of Sydney, Australia</i>   |      |
| 16:40   | <b>T23.7</b> | <b>Design and Implementation of a High Power Density Bipolar Multi-Level Active Power Pulsation Buffer for Single-Phase Converters</b> .....   | 1279 |
|   |              | Zitao Liao, Robert C.N. Pilawa-Podgurski<br><i>University of California-Berkeley, United States</i>  |      |
| 17:00   | <b>T23.8</b> | <b>Single-Phase Active-Clamped Isolated SEPIC PFC Converter with Partial Power Processing Output Stage</b> .....   | 1285 |
|   |              | Deliang Wu, Raja Ayyanar<br><i>Arizona State University, United States</i>   |      |
| 17:20   | <b>T23.9</b> | <b>A Novel Bidirectional Transformer-Less Grid-Connected Inverter with Common-Mode Leakage Current Suppression</b> .....   | 1292 |
|   |              | Zhuoran Liu, Mei Liang, Kai Tian, Xiaobo Yang<br><i>ABB, China</i>   |      |
| 14:30 - 17:40   |              |  |      |
| <b>T24: DC-DC Converter Applications</b>              |              |  |      |
| ROOM Room 211-213                                     |              |  |      |
| TRACK DC-DC Converters                                |              |  |      |
| SESSION CHAIRS  |              |  |      |
| <b>Pradeep Shenoy</b> , <i>Texas Instruments Inc.</i> |              |  |      |
| <b>Cong Li</b> , <i>GE Research</i>                   |              |  |      |
| 14:30   | <b>T24.1</b> | <b>A Spur-Free, 150-mA Buck Regulator with 96.3% Peak-Efficiency and 77.2% Minimum Efficiency at 10-<math>\mu</math>A Load for Microcontrollers with Noise-Sensitive ADCs</b> .....  | 1298 |
|   |              | Muhammad Swilam Ahmed <sup>1,2</sup> , Wei Fu <sup>2</sup> , Russell Byrd <sup>2</sup> , Ayman Fayed <sup>1</sup><br><i><sup>1</sup>The Ohio State University, United States, <sup>2</sup>Texas Instruments Inc., United States</i>  |      |
| 14:50   | <b>T24.2</b> | <b>A Novel Multi-Input and Single-Output DC/DC Converter for Small Unmanned Aerial Vehicle</b> .....   | 1302 |
|   |              | Yeonho Jeong <sup>1</sup> , Jae-Do Park <sup>1</sup> , Ronald Rorrer <sup>1</sup> , Keon-Woo Kim <sup>2</sup> , Byoung-Hee Lee <sup>3</sup><br><i><sup>1</sup>University of Colorado-Denver, United States, <sup>2</sup>Korea Advanced Institute of Science and Technology, Korea, <sup>3</sup>Hanbat National University, Korea</i> |      |
| 15:10   | <b>T24.3</b> | <b>Design of a Two Input Buck Converter (TIBuck) for a Visible Light Communication LED Driver based on Splitting the Power</b> .....   | 1309 |
|   |              | Daniel G. Aller <sup>1</sup> , Diego G. Lamar <sup>1</sup> , Manuel Arias <sup>1</sup> , Juan Rodríguez <sup>2</sup> , Pablo F. Miaja <sup>1</sup> , Javier Sebastián <sup>1</sup><br><i><sup>1</sup>University of Oviedo, Spain, <sup>2</sup>Universidad Politécnica de Madrid, Spain</i>   |      |
| 15:30   | <b>T24.4</b> | <b>Kappa Switching DC-DC Converter with Continuous Input and Output Currents Achieving 86.7% Input Ripple Suppression and 16dB Peak EMI Reduction</b> .....  | 1315 |
|   |              | Xugang Ke, Zoe Hay, Shuilin Tian<br><i>Analog Devices, Inc., United States</i>   |      |

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| 15:50 | <b>T24.5</b> | <b>An Interleaved Boost and Dual Active Bridge based Three Port Microinverter</b> ..... 1320   |  |
|       |              | Amit Bhattacharjee, Issa Batarseh  |  |
|       |              | <i>University of Central Florida, United States</i>  |  |
| 16:20 | <b>T24.6</b> | <b>A Novel Mixed Planar Litz Transformer for High Frequency Active Clamp Flyback Converters</b> ..... 1327   |  |
|       |              | Mario Ursino <sup>1</sup> , Stefano Saggini <sup>1</sup> , Ruben Specogna <sup>1</sup> , Alberto Bianco <sup>2</sup> , Francesco Ciappa <sup>2</sup> , Giuseppe Scappatura <sup>2</sup>                                |  |
|       |              | <sup>1</sup> University of Udine, Italy, <sup>2</sup> STMicroelectronics, Italy  |  |
| 16:40 | <b>T24.7</b> | <b>High Frequency Online Battery Impedance Measurement Method using Voltage and Current Ripples Generated by DC-DC Converter</b> ..... 1333  |  |
|       |              | Zhiyong Xia, Jaber A. Abu Qahouq   |  |
|       |              | <i>The University of Alabama, United States</i>  |  |
| 17:00 | <b>T24.8</b> | <b>A High Efficiency High Power-Density LLC DC-DC Converter for Electric Vehicles (EVs) On-Board Low Voltage DC-DC Converter (LDC) Application</b> ..... 1339  |  |
|       |              | Xiang Zhou <sup>1</sup> , Bo Sheng <sup>1</sup> , Wenbo Liu <sup>1</sup> , Yang Chen <sup>1</sup> , Andrew Yurek <sup>1</sup> , Yan-Fei Liu <sup>1</sup> , P.C. Sen <sup>1</sup> , K. Lakshmi Varaha Iyer <sup>2</sup> |  |
|       |              | <sup>1</sup> Queen's University, Canada, <sup>2</sup> Magna International Inc., Canada   |  |
| 17:20 | <b>T24.9</b> | <b>Auxiliary Power Network Architecture for 10 kV SiC-Based Power Electronics Building Blocks</b> ..... 1347   |  |
|       |              | Keyao Sun, Ning Yan, Jun Wang, Dong Dong, Rolando Burgos, Dushan Boroyevich  |  |
|       |              | <i>Virginia Polytechnic Institute and State University, United States</i>  |  |

## March 19, 2020

8:30 - 11:15

### T25: Soft-Switching DC-DC Converters

ROOM Room 208-210

TRACK DC-DC Converters

SESSION CHAIR

**Shuai Jiang**, Google LLC

8:30

|              |   |  |
|--------------|---|--|
| <b>T25.1</b> | <b>Zero-Voltage and Zero-Current Switching (ZVZCS) Full-Bridge Three-Level DC/DC Converter</b> ..... 1353 |  |
|              | Dong Liu, Yanbo Wang, Zhe Chen  |  |
|              | <i>Aalborg University, Denmark</i>  |  |

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| <b>T25.2</b> | <b>Wide-Input-Voltage-Range 3 kW DC-DC Converter with Hybrid LLC &amp; Boundary / Discontinuous Mode Control</b> ..... 1359                               |  |
|              | G.C. Knabben <sup>1</sup> , J. Schäfer <sup>1</sup> , J.W. Kolar <sup>1</sup> , G. Zulauf <sup>2</sup> , M.J. Kasper <sup>3</sup> , G. Deboy <sup>3</sup> |  |
|              | <sup>1</sup> ETH Zürich, Switzerland, <sup>2</sup> Stanford University, United States, <sup>3</sup> Infineon Technologies Austria AG, Austria             |  |

9:10

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| <b>T25.3</b> | <b>Hardware Design and Demonstration of a 100kW, 99% Efficiency Dual Active Half Bridge Converter based on 1700V SiC Power MOSFET</b> ..... 1367 |  |
|              | Wei Xu, Zhicheng Guo, S. Milad Tayebi, Sanjay Rajendran, Ao Sun, Ruiyang Yu, Alex Q. Huang   |  |
|              | <i>University of Texas at Austin, United States</i>  |  |

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|-------|--------------|---|------|
| 9:30  | <b>T25.4</b> | <b>Enhanced Zero-Voltage-Switching Conditions of Dual Active Bridge Converter under Light Load Situations</b> .....   | 1374 |
|       |              | Bochen Liu, Pooya Davari, Frede Blaabjerg<br><i>Aalborg University, Denmark</i>   |      |
| 9:50  | <b>T25.5</b> | <b>The Optimal Design of a High-Temperature PCB-Embedded Transformer GaN-Based Gate-Drive Power Supply with a Wide-Input Range</b> .....  | 1382 |
|       |              | Jiewen Hu <sup>1</sup> , Bo Wen <sup>1</sup> , Rolando Burgos <sup>1</sup> , Dushan Boroyevich <sup>1</sup> , Yonghan Kang <sup>2</sup> , Hossein Dadkhah <sup>2</sup><br><sup>1</sup> <i>Virginia Polytechnic Institute and State University, United States</i> , <sup>2</sup> <i>LG Electronics Vehicle Components, United States</i> |      |
| 10:35 | <b>T25.6</b> | <b>Design Analysis for Current-Transformer based High-Frequency Auxiliary Power Supply for SiC-Based Medium Voltage Converter Systems</b> .....   | 1390 |
|       |              | Ning Yan, Jiewen Hu, Jun Wang, Dong Dong, Rolando Burgos<br><i>Virginia Polytechnic Institute and State University, United States</i>   |      |
| 10:55 | <b>T25.7</b> | <b>Design and Analysis of Tunable Piezoelectric Transformer based DC/DC Converter with AC Output Inductor</b> .....   | 1398 |
|       |              | Le Wang <sup>1</sup> , Rolando P. Burgos <sup>1</sup> , Alfredo Vazquez Carazo <sup>2</sup><br><sup>1</sup> <i>Virginia Polytechnic Institute and State University, United States</i> , <sup>2</sup> <i>Micromechatronics, Inc., United States</i>  |      |

8:30 - 11:15

## **T26: Modeling of Magnetic Components and Systems**

ROOM Room 228-230

TRACK Modeling and Simulation

SESSION CHAIRS

**Ali Safayet**, *Halla Mechatronics*

**Kasunaidu Vechalapu**, *Eaton*

8:30

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| <b>T26.1</b> | <b>Modelling and Experimental Evaluation of Ideal Transformer Algorithm Interface for Power Hardware in the Loop Architecture</b> ..... | 1404 |
|              | Mandip Pokharel, Carl Ngai Man Ho<br><i>University of Manitoba, Canada</i>  |      |

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| <b>T26.2</b> | <b>Analysis and Attenuation of Differential-Mode Resonances due to Winding Capacitances in High-Power Planar Transformers</b> ..... | 1411 |
|              | Yucheng Gao, Vivek Sankaranarayanan, Robert W. Erickson, Dragan Maksimović<br><i>University of Colorado-Boulder, United States</i>  |      |

9:10

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| <b>T26.3</b> | <b>Coreless Transformer based High Voltage Generator for Intense Magnetic Field Applications</b> .....  | 1418 |
|              | Saijun Mao <sup>1</sup> , Jan Braham Ferreira <sup>2</sup><br><sup>1</sup> <i>Fudan University, China</i> , <sup>2</sup> <i>University of Twente, The Netherlands</i> |      |

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| <b>T26.4</b> | <b>Comprehensive Analysis of Models and Operational Characteristics of Piezoelectric Transformers</b> ..... | 1422 |
|              | Le Wang, Rolando P. Burgos<br><i>Virginia Polytechnic Institute and State University, United States</i>     |      |

9:50  
**T26.5 Measurement-Based Modeling of Power Module Parasitics with Increased Accuracy** ..... 1430  
Blake Nelson<sup>1</sup>, Andrew Lemmon<sup>1</sup>, Brian DeBoi<sup>1</sup>, Marshal Olimmah<sup>1</sup>, Kraig Olejniczak<sup>2</sup>  
<sup>1</sup>The University of Alabama, United States, <sup>2</sup>Wolfspeed, A Cree Company, United States

10:35  
**T26.6 Modeling and Validation of Conducted Emissions Trends in Medium-Voltage Power Electronic Systems** ..... 1438  
Aaron D. Brovont<sup>1</sup>, Jin Zhao<sup>2</sup>, Andrew N. Lemmon<sup>2</sup>  
<sup>1</sup>PC Krause and Associates, United States, <sup>2</sup>The University of Alabama, United States

10:55  
**T26.7 A Simplified Approach to CM Modeling of a Vienna Rectifier for Electromagnetic Compliance** ..... 1445  
Harish Suryanarayana<sup>1</sup>, Sneha Narasimhan<sup>2</sup>, Maziar Mobarrez<sup>1</sup>, Arun Kadavelugu<sup>1</sup>  
<sup>1</sup>ABB, United States, <sup>2</sup>North Carolina State University, United States

8:30 - 11:15

## **T27: Energy Storage Systems**

ROOM Room 225-227

TRACK Renewable Energy Systems

SESSION CHAIRS

**Majid Pahlevani**, *Queen's University*

**Wei Xu**, *Huazhong University of Science and Technology*

8:30  
**T27.1 A String-to-Cell Battery Equalizer based on Fixed-Frequency LCC Resonant Converter** ..... 1450  
Zhengqi Wei, Faxiang Peng, Haoyu Wang  
*ShanghaiTech University, China*

8:50  
**T27.2 A Battery Equalizing Circuit based on Multi-Winding Transformer** ..... 1456  
Chunjian Cai, Junyang Ma, Jianglin Nie, Yupei Wan, Lan Ma, Zeliang Shu  
*Southwest Jiaotong University, China*

9:10  
**T27.3 Shared-Leg Fault Tolerant Operation of Multi-Channeled Power Converters Serving to Large Rated DFIM Unit** ..... 1461  
Raghu Selvaraj, Karthik Desingu, Thanga Raj Chelliah  
*Indian Institute of Technology Roorkee, India*

9:30  
**T27.4 Design and Implementation of Dual-Input Microinverter for PV-Battery Applications** ..... 1467  
Khalil Alluhaybi, Haibing Hu, Issa Batarseh  
*University of Central Florida, United States*

9:50  
**T27.5 A Multiway Bidirectional Multiport-AC-Coupled (MAC) Battery Balancer with Online Electrochemical Impedance Spectroscopy** ..... 1475  
Youssef Elasser, Yen-an Chen, Ming Liu, Minjie Chen  
*Princeton University, United States*

10:35  
**T27.6 Detection of Degraded/Aged Cell in a Li-Ion Battery Pack using Spread Spectrum Time Domain Reflectometry (SSTDR)** ..... 1483  
Sourov Roy, Faisal Khan  
*University of Missouri-Kansas City, United States*

10:55

- T27.7 A Transformer-Less Hybrid PV Inverter with Integrated Battery Energy Storage** ..... 1489  
Fahad Alhuwaisheh, Prasad Enjeti  
*Texas A&M University, United States*

8:30 - 11:15

**T28: Design Techniques for SiC-based Power Converters**

ROOM Room 206-207

TRACK Power Electronics Integration and Manufacturing

SESSION CHAIRS

**Yuzhi Zhang**, *ABB*

**Nathan Weise**, *Marquette University*

8:30

- T28.1 A Medium Power SiC Module with Integrated Active Snubber for Lowest Switching Losses** ..... 1496  
Michael Schlüter<sup>1</sup>, Andre Uhlemann<sup>1</sup>, Martin Pfof<sup>2</sup>  
<sup>1</sup>*Infineon Technologies AG, Germany*, <sup>2</sup>*Technische Universität Dortmund, Germany*

8:50

- T28.2 Advanced SiC Power Module Packaging Technology direct on DBA Substrate for High Temperature Applications** ..... 1501  
Chuantong Chen, Zheng Zhang, Dongjin Kim, Katsuaki Suganuma  
*Osaka University, Japan*

9:10

- T28.3 SiC Power Module Design for High Bandwidth Integrated Current Sensing using a Magnetoresistive Point Field Detector** ..... 1506  
Muhammad H. Alvi, Minhao Sheng, Robert D. Lorenz, Thomas M. Jahns  
*University of Wisconsin-Madison, United States*

9:30

- T28.4 A Crosstalk Suppression Technique for SiC MOSFETs in the Bridge-Leg Configuration** ..... 1513  
Boyi Zhang, Shuo Wang  
*University of Florida, United States*

9:50

- T28.5 Differential Mode EMI Filter Design for 100 kW SiC Filter-Less PV Inverter** ..... 1521  
Yu Zhang, Yanjun Shi, Hui Li  
*Florida State University, United States*

10:35

- T28.6 Online Junction Temperature Monitoring for SiC MOSFETs using Turn-on Delay Time** ..... 1526  
Liang Qiao<sup>1</sup>, Fred Wang<sup>1,2</sup>, Jacob Dyer<sup>1</sup>, Zheyu Zhang<sup>3</sup>  
<sup>1</sup>*University of Tennessee, United States*, <sup>2</sup>*Oak Ridge National Laboratory, United States*,  
<sup>3</sup>*Clemson University, United States*

10:55

- T28.7 A Robust Approach for Characterization of Junction Temperature of SiC Power Devices via Quasi-Threshold Voltage as Temperature Sensitive Electrical Parameter** ..... 1532  
Kanuj Sharma, Deepak Dayanand, Kevin Muñoz Barón, Johannes Ruthardt, Florian Münzenmayer, Jan Hüchelheim, Ingmar Kallfass  
*University of Stuttgart, Germany*

8:30 - 11:15

## T29: Gumbo Applications 10W LED to KW Converter

ROOM Room 203-205

TRACK Power Electronics Applications

SESSION CHAIRS

**Sombuddha Chakraborty**, *Texas Instruments Inc.*

**Pedro Alou**, *Universidad Politécnica de Madrid*

8:30

**T29.1 A New Electrolytic Capacitor-Less LED Driver with Coupled-Inductor** ..... 1537  
Lingling Cao<sup>1</sup>, Yichen Zhu<sup>1</sup>, Hao Wu<sup>2</sup>  
<sup>1</sup>Harbin Institute of Technology, China,<sup>2</sup>BYD Company Limited, China

8:50

**T29.2 A High Accuracy Scaleable LED Driver Topology for Multichannel Applications** ..... 1544  
Biju Antony, Ashwani Guleria  
OSRAM Americas, United States

9:10

**T29.3 A 5kV/15W Dual-Transformer Hybrid Converter with Extreme 2000X Conversion Ratios for Soft Mobile Robots** ..... 1548  
Tianshi Xie<sup>1,2</sup>, Miquel Ricart Oltra<sup>3</sup>, Hanh-Phuc Le<sup>1,2</sup>  
<sup>1</sup>University of Colorado-Boulder, United States,<sup>2</sup>University of California-San Diego, United States,<sup>3</sup>Polytechnic University of Catalonia, Spain

9:30

**T29.4 Multi-MHz Multi-kV Power Amplifier for Compact Particle Accelerators** ..... 1553  
Sreyam Sinha<sup>1</sup>, Di Ni<sup>1</sup>, Qing Ji<sup>2</sup>, Arun Persaud<sup>2</sup>, Peter Seidl<sup>2</sup>, Thomas Schenkel<sup>2</sup>, Amit Lal<sup>1</sup>, Khurram K. Afridi<sup>1</sup>  
<sup>1</sup>Cornell University, United States,<sup>2</sup>Lawrence Berkeley National Laboratory, United States

9:50

**T29.5 High-Performance Compact Electromagnetic Coilgun Propulsion System with Low-Voltage Modular Rapid Capacitor Charger** ..... 1559  
Doodi Dayan, Michael Evzelman, Mor Mordechai Peretz  
Ben-Gurion University of the Negev, Israel

10:35

**T29.6 The Fast Over-Voltage Protection Consideration and Design for SiC-Based Matrix Converters** ..... 1567  
Louelson A. Costa<sup>1</sup>, Boran Fan<sup>1</sup>, Rolando Burgos<sup>1</sup>, Dushan Boroyevich<sup>1</sup>, Warren Chen<sup>2</sup>, Vladimir Blasko<sup>2</sup>  
<sup>1</sup>Virginia Polytechnic Institute and State University, United States,<sup>2</sup>United Technologies Research Center, United States

10:55

**T29.7 7.2 kV Three-Port Single-Phase Single-Stage Modular Soft-Switching Solid-State Transformer with Active Power Decoupling and Reduced DC-Link** ..... 1575  
Liran Zheng, Xiangyu Han, Rajendra Prasad Kandula, Karthik Kandasamy, Maryam Saeedifard, Deepak Divan  
Georgia Institute of Technology, United States

8:30 - 11:15

### **T30: Gate Drive Circuits I**

ROOM Room 217-219

TRACK Control

SESSION CHAIR

**Bilal Akin**, *University of Texas at Dallas*

8:30

**T30.1** **Cyclically Adaptive Multilevel Gate Driving for Drain-Source Synchronous Rectifier Efficiency Improvement and Range Extension** ..... 1582  
Oscar Yu, Cheng-Wei Chen, Chih-Shen Yeh, Jih-Sheng Lai  
*Virginia Polytechnic Institute and State University, United States*

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**T30.2** **Load-Sensitive Gate Drive Scheme for PFC Boost Converters** ..... 1588  
Wolfgang Frank<sup>1</sup>, Franz Stückler<sup>2</sup>  
<sup>1</sup>*Infineon Technologies AG, Germany*, <sup>2</sup>*Infineon Technologies Austria AG, Austria*

9:10

**T30.3** **Gate Driver with Short Inherent Dead-Time for Wide-Bandgap High-Precision Inverters** ..... 1593  
Pelle Weiler, Bas Vermulst  
*Eindhoven University of Technology, The Netherlands*

9:30

**T30.4** **A Driving Loss and Speed Co-Optimized Series Resonant Gate Driver with Novel Time Segmented Methodology for High Frequency SiC MOSFETs** ..... 1599  
Hao Peng<sup>1</sup>, Han Peng<sup>1</sup>, Ziyue Dang<sup>1</sup>, Yong Kang<sup>1</sup>, Zhiqiang Wang<sup>1</sup>, Maojun He<sup>2</sup>, Xudan Liu<sup>2</sup>  
<sup>1</sup>*Huazhong University of Science and Technology, China*, <sup>2</sup>*Bosch China Research Center, China*

9:50

**T30.5** **Design and Test of a 6 kV Phase-Leg using Four Stacked 1.7 kV SiC MOSFET High-Current Modules** ..... 1604  
Emma Raszmann, Keyao Sun, Rolando Burgos, Igor Cvetkovic, Jun Wang, Dong Dong, Dushan Boroyevich  
*Virginia Polytechnic Institute and State University, United States*

10:35

**T30.6** **Active Voltage Balancing Embedded Digital Gate Driver for Series-Connected 10 kV SiC MOSFETs** ..... 1611  
Xiang Lin, Lakshmi Ravi, Slavko Mocevic, Dong Dong, Rolando Burgos  
*Virginia Polytechnic Institute and State University, United States*

8:30 - 11:15

### **T31: Wireless Power Transfer for Electric Transportation Applications**

ROOM Room 220-222

TRACK Wireless Power Transfer

SESSION CHAIRS

**Jason Pries**, *Oak Ridge National Laboratory*

**Raghav Khanna**, *University of Toledo*

8:30

**T31.1** **Design of Double-Layered Detection Coil for Metal Object Detection in Wireless Power Transfer Systems for Electric Vehicles** ..... 1617  
Jongeun Byun, Sangjoon Ann, Won-Jin Son, Jae Han Lee, Byoung Kuk Lee  
*Sungkyunkwan University, Korea*



|       |              |   |      |
|-------|--------------|---|------|
| 8:50  | <b>T31.2</b> | <b>Impedance Tuning Control and Synchronization Technique for Semi-Bridgeless Active Rectifier of IPT System in EV Applications</b> .....   | 1622 |
|       |              | Sangjoon Ann, Jongeun Byun, Won-Jin Son, Jae Han Lee, Byoung Kuk Lee<br><i>Sungkyunkwan University, Korea</i>   |      |
| 9:10  | <b>T31.3</b> | <b>An Active-Rectification based Communication Free Inductive Power Transfer for Battery Charging System with Soft-Switching Capability</b> .....   | 1627 |
|       |              | Yi Dou <sup>1</sup> , Yunfeng Liu <sup>1</sup> , Xiaosheng Huang <sup>1,2</sup> , Ziwei Ouyang <sup>1</sup> , Michael A.E. Andersen <sup>1</sup><br><sup>1</sup> <i>Technical University of Denmark, Denmark</i> , <sup>2</sup> <i>Fujian University of Technology, Denmark</i>   |      |
| 9:30  | <b>T31.4</b> | <b>A Modular Integration Design of LCL Circuit Featuring Field Enhancement and Misalignment Tolerance for Wireless EV Charging</b> .....  | 1634 |
|       |              | Pengcheng Zhang <sup>1</sup> , Maryam Saeedifard <sup>2</sup> , Omer C. Onar <sup>3</sup> , Qingxin Yang <sup>1,4</sup> , Changsong Cai <sup>5</sup><br><sup>1</sup> <i>Hebei University of Technology, China</i> , <sup>2</sup> <i>Georgia Institute of Technology, United States</i> , <sup>3</sup> <i>Oak Ridge National Laboratory, United States</i> , <sup>4</sup> <i>Tianjin University of Technology, China</i> , <sup>5</sup> <i>Wuhan University, China</i> |      |
| 9:50  | <b>T31.5</b> | <b>1-kW Wireless Charger for Power Wheelchairs</b> .....  | 1641 |
|       |              | Chakridhar Reddy Teeneti <sup>1</sup> , Ujjwal Pratik <sup>2</sup> , Ahmed Azad <sup>1</sup> , Reza Tavakoli <sup>1</sup> , Cathy Bodine <sup>3</sup> ,<br>Regan Zane <sup>1</sup> , Zeljko Pantic <sup>2</sup><br><sup>1</sup> <i>Utah State University, United States</i> , <sup>2</sup> <i>North Carolina State University, United States</i> ,<br><sup>3</sup> <i>University of Colorado-Denver, United States</i>  |      |
| 10:35 | <b>T31.6</b> | <b>Multi-Objective Optimization of Single-Transmitter Coupled Multi-Receiver IPT System for Maglev Trains</b> .....   | 1649 |
|       |              | Yuanqing Zhang <sup>1</sup> , Junjun Deng <sup>1</sup> , Shuo Wang <sup>1</sup> , Zhenpo Wang <sup>1</sup> , Yin Yang <sup>2</sup><br><sup>1</sup> <i>Beijing Institute of Technology, China</i> , <sup>2</sup> <i>China Railway Rolling Stock Corporation, China</i>   |      |
| 10:55 | <b>T31.7</b> | <b>100 MHz Wireless Power Transfer for Lightweight UAVs and Agile Robots</b> .....  | 1655 |
|       |              | Xin Zan, Al-Thaddeus Avestruz<br><i>University of Michigan, United States</i>   |      |

8:30 - 11:15

## **T32: Transportation Power Electronics II**

ROOM Room 211-213

TRACK Transportation Power Electronics

SESSION CHAIRS

**Suman Debnath**, *Oak Ridge National Laboratory*

**Karthik Jayaraman**, *Dialog Semiconductor*

8:30

|              |   |      |
|--------------|---|------|
| <b>T32.1</b> | <b>Real-Time Battery Cell Screening Algorithm to Estimate Available Maximum Charging/Discharging Current Considering Cell Deviation</b> ..... | 1662 |
|              | Jeonghyun Bae, Hae-Chan Han, Tae-Won Noh, Byoung Kuk Lee<br><i>Sungkyunkwan University, Korea</i>   |      |

8:50

|              |  |      |
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| <b>T32.2</b> | <b>Adaptive Cell Balancing of Series Connected Batteries using Hybrid Droop Controller</b> ..... | 1668 |
|              | Sifat Chowdhury, Yilmaz Sozer<br><i>University of Akron, United States</i>                       |      |

9:10

|              |   |      |
|--------------|---|------|
| <b>T32.3</b> | <b>Regulating Transformer Rectifier Unit (R-TRU) for More Electric Aircraft (MEA)</b> ..... | 1673 |
|              | Warren J. Wambsgans<br><i>Astronics AES, United States</i>                                  |      |

9:30

- T32.4 Analysis of High Frequency AC Link Isolated Three Port Resonant Converter for UAV Applications** ..... 1679  
Erdem Asa<sup>1</sup>, Kerim Colak<sup>2</sup>, Dariusz Czarkowski<sup>3</sup>, Burak Ozpineci<sup>1</sup>  
<sup>1</sup>Oak Ridge National Laboratory, United States,<sup>2</sup>HEVO Power Inc., United States,  
<sup>3</sup>New York University, United States

9:50

- T32.5 A Novel AC to AC Wireless Power Transfer System for EV Charging Applications** ..... 1685  
Erdem Asa, Jason Pries, Veda Galigekere, Subho Mukherjee, Omer C. Onar, Gui-Jia Su, Burak Ozpineci  
Oak Ridge National Laboratory, United States

10:35

- T32.6 An Active Rectifier Fed by a Variable-Speed Generator** ..... 1691  
Joseph Benzaquen, Behrooz Mirafzal  
Kansas State University, United States

10:55

- T32.7 Conducted EMI Performance of Active Neutral Point Clamped Phase Leg for Dual Active Bridge Converter based DC System** ..... 1697  
Saurabh Kumar, Ghanshyamsinh Gohil  
University of Texas at Dallas, United States

13:45 - 15:25

### **T33: Bi-Directional DC-DC Converters**

ROOM Room 208-210

TRACK DC-DC Converters

SESSION CHAIRS

**Xugang Ke**, *Analog Devices*

**Al-Thaddeus Avestruz**, *University of Michigan-Ann Arbor*

13:45

- T33.1 Efficiency Evaluation of a SiC-Based Bidirectional Boost Converter using TCM-ZVS with Different Voltage Conversion Ratios** ..... 1705  
Maria R. Rogina, Alberto Rodriguez, Aitor Vázquez, Manuel Arias, Diego G. Lamar  
University of Oviedo, Spain

14:05

- T33.2 A Synchronous Rectification Scheme based on Inductor Voltage Sensing for CLLC Bidirectional Resonant Converter** ..... 1713  
Ning Chen<sup>1</sup>, Bodong Li<sup>1</sup>, Xiaoqin Wang<sup>1</sup>, Xinnan Sun<sup>1</sup>, Jizhi Qi<sup>1</sup>, Min Chen<sup>1</sup>, Yongjiang Liu<sup>2</sup>  
<sup>1</sup>Zhejiang University, China,<sup>2</sup>Inner Mongolia Electric Power Research Institute, China

14:25

- T33.3 Generalized Bidirectional Multilevel DC-DC Converter** ..... 1720  
Hao Hu, Saikat Ghosh, Teng Long  
University of Cambridge, United Kingdom

14:45

- T33.4 An Isolated Multilevel Bi-Directional DC-DC Converter to Interface HV Battery and Traction Inverter in EVs** ..... 1727  
Vinay Rathore<sup>1</sup>, Kaushik Rajashekar<sup>1</sup>, Parthasarathy Nayak<sup>2</sup>  
<sup>1</sup>University of Houston, United States,<sup>2</sup>Emerson Commercial & Residential Solutions, United States

15:05

- T33.5 Soft-Switching Bi-Directional High Step-Up/Down Converter for Battery Charging Applications** ..... 1734  
L.H.P.N. Gunawardena, Dulika Nayanasingi, Yunwei Li  
University of Alberta, Canada

13:45 - 15:25

### T34: Fault Protection for Utility Interface Converters

ROOM Room 228-230

TRACK Power Electronics for Utility Interface

SESSION CHAIRS

**Mithat Kisacikoglu**, *The University of Alabama*

**Shahab Mehraeen**, *Louisiana State University*

13:45

- T34.1 An Ultra-Efficient DC Hybrid Circuit Breaker Architecture based on Transient Commutation Current Injection** ..... 1740  
Yuanfeng Zhou, Yanjun Feng, Nikolay Shatalov, Risha Na, Z. John Shen  
*Illinois Institute of Technology, United States*

14:05

- T34.2 A Coupled-Inductor DC Breaker with STFT-Based Arc Detection** ..... 1747  
Atif Maqsood<sup>1</sup>, Nick Rossi<sup>1</sup>, Yue Ma<sup>1</sup>, Keith Corzine<sup>1</sup>, Leila Parsa<sup>1</sup>, Damian Oslebo<sup>2</sup>  
<sup>1</sup>*University of California-Santa Cruz, United States*, <sup>2</sup>*Naval Postgraduate School, United States*

14:25

- T34.3 Detecting High-Impedance Fault with Z-Source Circuit Breakers in Smart Grids** ..... 1755  
Sagar Bhatta<sup>1</sup>, Yucheng Zhang<sup>1</sup>, Ruiyun Fu<sup>2</sup>  
<sup>1</sup>*Old Dominion University, United States*, <sup>2</sup>*Mercer University, United States*

14:45

- T34.4 Protection and Management of Internal Faults in Modular Smart Transformer** ..... 1762  
Thiago A. Pereira, Luis Camurca, Youngjong Ko, Rongwu Zhu, Marco Liserre  
*Christian-Albrechts-Universität zu Kiel, Germany*

15:05

- T34.5 A Multifunctional Active Grounding Method for Distribution Networks based on a Four-Leg Converter** ..... 1770  
Xingda Zhou, Shuai Lu  
*Chongqing University, China*

13:45 - 15:25

### T35: Grid-Tied Systems

ROOM Room 225-227

TRACK Renewable Energy Systems

SESSION CHAIRS

**Xiaonan Lu**, *Temple University*

**Pritam Das**, *Binghamton University*

13:45

- T35.1 Efficient Single-Stage Three-Phase Isolated Differential-Based Flyback Inverter with Selective Harmonic Compensation Strategy for Grid-Tied Applications** ..... 1778  
Ahmed I.M. Ali<sup>1,2</sup>, Mahmoud A. Sayed<sup>2</sup>, Ahmed Shawky<sup>1</sup>, Takaharu Takeshita<sup>1</sup>  
<sup>1</sup>*Nagoya Institute of Technology, Japan*, <sup>2</sup>*South Valley University, Egypt*

14:05

- T35.2 A Computational Efficient Space-Vector Modulation Scheme for a Hybrid Seven-Level Converter for Medium Voltage Grid-Tied Applications** ..... 1786  
Fei Diao, Yufei Li, Zhongjing Wang, Yuheng Wu, Yue Zhao  
*University of Arkansas, United States*

14:25

**T35.3 Small Signal Modeling and Stability Analysis of Novel Grid Connected Z-Source Virtual Synchronous Generator (ZVSG) ..... 1791**  
 Mohammad Khatibi, Yu-Fang Jin, Sara Ahmed  
*University of Texas at San Antonio, United States*

14:45

**T35.4 Analysis of the Impact of Delay on the Stability of Single-Loop Controlled Grid-Connected Inverters from the Perspective of Impedance ..... 1798**  
 Yiming Tu, Jinjun Liu, Zeng Liu, Danhong Xue  
*Xi'an Jiaotong University, China*

13:45 - 15:25

**T36: Gate Drive Circuits II**

ROOM Room 206-207

TRACK Devices and Components

SESSION CHAIRS

**Ahmed Elasser, GE**

**Mohammed Agamy, University at Albany**

13:45

**T36.1 A Level Shift Gate Driving Circuit of SiC MOSFET with Crosstalk Suppression Capability ..... 1806**  
 Guowen Li<sup>1</sup>, Anping Tong<sup>2</sup>, Lijun Hang<sup>1</sup>, Qingwei Zeng<sup>1</sup>, Xinming Zhan<sup>1</sup>, Guojie Li<sup>2</sup>, Yuanbin He<sup>1</sup>, Xiaogao Xie<sup>1</sup>, Lei Shen<sup>1</sup>, Yao Zhang<sup>1</sup>  
<sup>1</sup>Hangzhou Dianzi University, China,<sup>2</sup>Shanghai Jiao Tong University, China

14:05

**T36.2 A Robust 10 kV SiC MOSFET Gate Driver with Fast Overcurrent Protection Demonstrated in a MMC Submodule ..... 1813**  
 Xingxuan Huang<sup>1</sup>, Shiqi Ji<sup>1</sup>, James Palmer<sup>1</sup>, Li Zhang<sup>1</sup>, Dingrui Li<sup>1</sup>, Fred Wang<sup>1,2</sup>, Leon M. Tolbert<sup>1,2</sup>, William Giewont<sup>3</sup>  
<sup>1</sup>University of Tennessee, United States,<sup>2</sup>Oak Ridge National Laboratory, United States,<sup>3</sup>EPC Power, United States

14:25

**T36.3 Dual-Output Isolated Gate Driver Power Supply for Medium Voltage Converters using High Frequency Wireless Power Transfer ..... 1821**  
 Van Thuan Nguyen, Ghanshyamsinh Gohil  
*University of Texas at Dallas, United States*

14:45

**T36.4 Charge Pump Gate Drive to Improve Turn-on Switching Speed of SiC MOSFETs ..... 1829**  
 Handong Gui<sup>1</sup>, Jordan A. Jones<sup>2</sup>, Leon M. Tolbert<sup>1,3</sup>  
<sup>1</sup>University of Tennessee, United States,<sup>2</sup>Tuskegee University, United States,<sup>3</sup>Oak Ridge National Laboratory, United States

15:05

**T36.5 Condition Monitoring of SiC MOSFETs utilizing Gate Leakage Current ..... 1837**  
 Patrick Wang<sup>1</sup>, Joseph Zatarski<sup>1</sup>, Arijit Banerjee<sup>1</sup>, John Donnal<sup>2</sup>  
<sup>1</sup>University of Illinois at Urbana-Champaign, United States,<sup>2</sup>United States Naval Academy, United States

13:45 - 15:25

### T37: Telecom Applications

ROOM Room 203-205

TRACK Power Electronics Applications

SESSION CHAIRS

Justin Henspeter, *IBM*

Jeff Nilles, *Alpha & Omega*

13:45

- T37.1**     **A Hybrid Multitrack-Sigma Converter with Integrated Transformer for Wide Input Voltage Regulation** ..... 1844  
Mingxiao Li, Ziwei Ouyang, Michael A.E. Andersen  
*Technical University of Denmark, Denmark*

14:05

- T37.2**     **Design and Optimization of a High-Frequency GaN-Based ANPC Three-Level Converter as an Arbitrary PWL Voltage Generator** ..... 1851  
Vladan Ž. Lazarević, Miroslav Vasić, José A. Cobos  
*Universidad Politécnica de Madrid, Spain*

14:25

- T37.3**     **A Zero Inductor-Voltage 48V to 12V/70A Converter for Data Centers with 99.1% Peak Efficiency and 2.5kW/in<sup>3</sup> Power Density** ..... 1858  
Samuel Webb, Yan-Fei Liu  
*Queen's University, Canada*

14:45

- T37.4**     **High Efficiency Asymmetric Dual Active Clamp Forward Converter with Phase-Shift Control for Small Conduction Loss** ..... 1866  
Seunghwan Ko<sup>1</sup>, Yeonho Jeong<sup>2</sup>, Ronald A. L. Rorrer<sup>2</sup>, Jae-Do Park<sup>2</sup>  
*<sup>1</sup>Samsung Electronics, Korea, <sup>2</sup>University of Colorado-Denver, United States*

15:05

- T37.5**     **Multi-Phase Three-Level Buck Converter with Current Self-Balancing for High Bandwidth Envelope Tracking Power Supply** ..... 1872  
Srikanth Yerra, Harish Krishnamoorthy  
*University of Houston, United States*

13:45 - 15:25

### T38: Control of AC-DC and DC-AC

ROOM Room 217-219

TRACK Control

SESSION CHAIRS

Emanuel Serban, *University of British Columbia*

13:45

- T38.1**     **The Simple Power-Based Modulation Methods for DAB-Based AC-DC Converter with Unfolder Concept** ..... 1878  
Nie Hou, Yun Wei Li, Li Ding  
*University of Alberta, Canada*

14:05

- T38.2**     **Stability Analysis and Controller Design of MMC Considering Control Delay** ..... 1884  
Le Kong<sup>1</sup>, Shuyao Wang<sup>1</sup>, Nattapat Praisuwanna<sup>1</sup>, Fred Wang<sup>1,2</sup>, Leon M. Tolbert<sup>1,2</sup>  
*<sup>1</sup>University of Tennessee, United States, <sup>2</sup>Oak Ridge National Laboratory, United States*

|       |              |   |      |
|-------|--------------|---|------|
| 14:25 | <b>T38.3</b> | <b>Fast and Reliable Geometric-Based Controller for Three-Phase PWM Rectifiers</b> .....  | 1891 |
|       |              | Franco Degioanni, Ignacio Galiano Zurbriggen, Martin Ordonez<br><i>University of British Columbia, Canada</i>   |      |
| 14:45 | <b>T38.4</b> | <b>Adaptive Optimization of Current-Control Loop for Grid-Connected Inverters</b> .....   | 1897 |
|       |              | Roni Luhtala, Henrik Alenius, Tomi Roinila<br><i>Tampere University, Finland</i>  |      |
| 15:05 | <b>T38.5</b> | <b>Internal Model based Control to Tackle Non-Minimum Phase Behavior in Three-Phase Z-Source Inverters</b> .....  | 1904 |
|       |              | Sara Yazdani <sup>1</sup> , Mehdi Ferdowsi <sup>1</sup> , Masoud Davari <sup>2</sup> , Pourya Shamsi <sup>1</sup><br><sup>1</sup> Missouri University of Science and Technology, United States, <sup>2</sup> Georgia Southern University, United States |      |

13:45 - 15:25

### **T39: High-Power AC-DC Converters**

ROOM Room 220-222

TRACK AC-DC Converters

SESSION CHAIRS

**Eric Swenson**, *IBM*

**Jin Moon**, *Florida State University*

13:45

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|--------------|---|------|
| <b>T39.1</b> | <b>FoM based Optimal Frequency and Voltage Level Design for High Efficiency High Density Multilevel PFC with GaN Device</b> ..... | 1911 |
|              | Jiawen Wu, Xinke Wu<br><i>Zhejiang University, China</i>  |      |

14:05

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|--------------|---|------|
| <b>T39.2</b> | <b>An SiC &amp; Si Hybrid Five-Level Unidirectional Rectifier for Medium Voltage UPS Application</b> .....  | 1916 |
|              | Yifan Zhang <sup>1</sup> , Runtian Chen <sup>1</sup> , Chushan Li <sup>1</sup> , Wuhua Li <sup>1</sup> , Xiangning He <sup>1</sup> , Xiaowei Gu <sup>2</sup><br><sup>1</sup> Zhejiang University, China, <sup>2</sup> Zhejiang Sci-Tech University, China |      |

14:25

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| <b>T39.3</b> | <b>A New MPC-5LRSS High Power Factor Converter</b> .....   | 1923 |
|              | Naveen Yalla <sup>1</sup> , Narendra Babu A <sup>2</sup> , Pramod Agarwal <sup>3</sup><br><sup>1</sup> Pandit Deendayal Petroleum University, India, <sup>2</sup> Madanapalle Institute of Technology and Science, India, <sup>3</sup> Indian Institute of Technology Roorkee, India |      |

14:45

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| <b>T39.4</b> | <b>An Improved SVM Strategy to Reduce DC Current Ripple for AC-DC Matrix Converter</b> ..... | 1929 |
|              | Fanxiu Fang, Hao Tian, Yunwei Li<br><i>University of Alberta, Canada</i>                     |      |

15:05

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|--------------|--|------|
| <b>T39.5</b> | <b>A Single-Stage Rectifier with Interleaved Totem-Pole PFC and Dual Active Bridge (DAB) Converter for PHEV/BEV On-Board Charger</b> ..... | 1936 |
|              | Kenichi Itoh, Masanori Ishigaki, Naoto Kikuchi, Tomohisa Harada, Takahide Sugiyama<br><i>Toyota Central R&amp;D Labs., Inc., Japan</i>     |      |

13:45 - 15:25

## T40: Wide Bandgap Device and Circuit Modeling

ROOM Room 211-213

TRACK Modeling and Simulation

SESSION CHAIRS

**Jaume Roig Guitart**, *ON Semiconductor*

**Tirthajyoti Sarkar**, *ON Semiconductor*

13:45

**T40.1 Drain Current Characteristics of Enhancement Mode GaN HEMTs** ..... 1942  
Hitoshi Aoki<sup>1</sup>, Hiroyuki Sakairi<sup>2</sup>, Naotaka Kuroda<sup>2</sup>, Atsushi Yamaguchi<sup>2</sup>, Ken Nakahara<sup>2</sup>  
<sup>1</sup>Teikyo Heisei University, Japan, <sup>2</sup>ROHM Co., Ltd., Japan

14:05

**T40.2 Modelling GaN-HEMT Dynamic ON-State Resistance in High Frequency Power Converter** ..... 1949  
Ke Li<sup>1</sup>, Arnaud Videt<sup>2</sup>, Nadir Idir<sup>2</sup>, Paul Evans<sup>1</sup>, Mark Johnson<sup>1</sup>  
<sup>1</sup>University of Nottingham, United Kingdom, <sup>2</sup>University of Lille, France

14:25

**T40.3 Analytical Modeling of Switching Characteristics of the SiC MOSFET based on Finite State Machine** ..... 1956  
Yingzhe Wu<sup>1</sup>, Shan Yin<sup>2</sup>, Hui Li<sup>1</sup>  
<sup>1</sup>University of Electronic Science and Technology of China, China, <sup>2</sup>China Academy of Engineering Physics, China

14:45

**T40.4 Modeling and Validation of Medium Voltage SiC Power Modules** ..... 1964  
Brian DeBoi, Andrew Lemmon, Blake Nelson, Chris New, Dylan Hudson  
*The University of Alabama, United States*

15:05

**T40.5 Behavioral Modeling of Ground Current in Filter Inductors of Medium-Voltage SiC-MOSFET-Based Converters** ..... 1972  
Hongbo Zhao, Dipen Narendra Dalal, Jannick Kjær Jørgensen, Xiongfei Wang, Michael Møller Bech, Asger Bjørn Jørgensen, Szymon Bęczkowski, Christian Uhrenfeldt, Stig Munk-Nielsen  
*Aalborg University, Denmark*

11:15 - 13:45

## D01: AC-DC Converters

ROOM Poster Area

TRACK AC-DC Converters

SESSION CHAIRS

**JiangBiao He**, *University of Kentucky*

**Carl Ho**, *University of Manitoba*

**D01.1 Modulated Model Predictive Control for Grid-Connected Current Source Converter with LC Resonance Suppression** ..... 1979  
Cheng Xue, Li Ding, Yunwei Li  
*University of Alberta, Canada*

**D01.2 Investigation and Optimization for Planar Coupled Inductor Dual-Phase Interleaved GaN-Based Totem-Pole PFC** ..... 1984  
Yunfeng Liu, Mingxiao Li, Yi Dou, Ziwei Ouyang, Michael A.E. Andersen  
*Technical University of Denmark, Denmark*

|               |   |      |
|---------------|---|------|
| <b>D01.3</b>  | <b>A 480V to 45V GaN Bidirectional AC-DC Converter for Grid-Tied Battery Energy Storage System (BESS)</b> .....   | 1991 |
|               | Tianxiang Chen <sup>1</sup> , Ruiyang Yu <sup>1</sup> , Alex Q. Huang <sup>1</sup> , Stanley Atcitty <sup>2</sup><br><i><sup>1</sup>University of Texas at Austin, United States, <sup>2</sup>Sandia National Laboratories, United States</i>   |      |
| <b>D01.4</b>  | <b>High-Efficiency High-Power Bridgeless Integrated AC-DC Converter for On-Board Vehicle Battery Charger</b> .....  | 1997 |
|               | Minglong Wang <sup>1</sup> , Shangzhi Pan <sup>1</sup> , Jinwu Gong <sup>1</sup> , Wenqiang Lin <sup>1</sup> , Yumei Li <sup>2</sup> , Xiaoming Zha <sup>1</sup><br><i><sup>1</sup>Wuhan University, China, <sup>2</sup>Naval University of Engineering, China</i>  |      |
| <b>D01.5</b>  | <b>An Improved Modulation Scheme for "Si&amp;SiC" Hybrid 3L-Active NPC Rectifiers with Low Conduction Losses</b> .....  | 2004 |
|               | Xiutao Lou, Guang Chen, Li Zhang, Fengchen Zhao, Feng Wu<br><i>Hohai University, China</i>  |      |
| <b>D01.6</b>  | <b>High-Efficiency Bidirectional Isolated AC/DC Converter</b> .....   | 2010 |
|               | Mei Su, Sisheng Wu, Hanbing Dan, Yao Sun, Hui Wang, Yonglu Liu, Wenjing Xiong<br><i>Central South University, China</i>   |      |
| <b>D01.8</b>  | <b>Evaluation of Active Capacitor Bank for Floating H-Bridge Power Modules</b> .....  | 2014 |
|               | Tam K.T. Nguyen <sup>1</sup> , Bo Wen <sup>1</sup> , Rolando Burgos <sup>1</sup> , Dushan Boroyevich <sup>1</sup> , Jacob Verhulst <sup>2</sup> , David L. Vrtachnik <sup>2</sup> , Mohamed Belkhatat <sup>2</sup><br><i><sup>1</sup>Virginia Polytechnic Institute and State University, United States, <sup>2</sup>Newport News Shipbuilding, United States</i> |      |
| <b>D01.9</b>  | <b>A Control Scheme based on Lyapunov Function for Cascaded H-Bridge Multilevel Active Rectifiers</b> .....   | 2021 |
|               | Garry Jean-Pierre <sup>1</sup> , Necmi Altin <sup>2</sup> , Ahmad El Shafei <sup>1</sup> , Adel Nasiri <sup>1</sup><br><i><sup>1</sup>University of Wisconsin-Milwaukee, United States, <sup>2</sup>Gazi University, Turkey</i>   |      |
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|               | Bin Feng Zhang, Shaojun Xie, Jinming Xu, Zhouyang Li, Pengcheng Zhao<br><i>Nanjing University of Aeronautics and Astronautics, China</i>  |      |
| <b>D01.11</b> | <b>An Improved Digital Control System for LED Grow Lights used in Indoor Farming</b> .....  | 2032 |
|               | Milad Zareie <sup>1</sup> , Behzad Poorali <sup>1</sup> , Ed Nowicki <sup>1</sup> , Majid Pahlevani <sup>2</sup><br><i><sup>1</sup>University of Calgary, Canada, <sup>2</sup>Queen's University, Canada</i>  |      |
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|               | Kai Tian, Zhuoran Liu, Mei Liang, Xiaobo Yang<br><i>ABB, China</i>  |      |
| <b>D01.13</b> | <b>A 1MHz Class-E2 Single-Stage PFC Converter with Frequency Control</b> .....  | 2041 |
|               | Wenqi Zhu, Hiroo Sekiya<br><i>Chiba University, Japan</i>   |      |
| <b>D01.15</b> | <b>Analysis and Solution of the Unbalanced Device Voltage Issue for SiC MOSFET based Diode Neutral Point Clamped Converter</b> .....  | 2048 |
|               | Siyuan Chen, Md. Rashed Hassan Bipu, Dakai Wang, Wensong Yu<br><i>North Carolina State University, United States</i>  |      |



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## D02: DC-DC Converters I

ROOM Poster Area

TRACK DC-DC Converters

SESSION CHAIRS

**Cahit Gezgin**, *Infineon Technologies AG*

**Masoud Karimi-Ghartemani**, *Mississippi State University*

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| <b>D02.2</b>  | <b>New High Step-Up DC-DC Converter with Quasi-Z-Source Network and Switched-Capacitor Cell</b> .....  | 2062 |
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|               | Yu Yan <sup>1</sup> , Hua Bai <sup>1</sup> , Chuanchao Yang <sup>2</sup> , Wangbao Wang <sup>2</sup><br><sup>1</sup> <i>University of Tennessee, United States,</i> <sup>2</sup> <i>Jiangsu Wanbang Dehe New Energy Technology Co., Ltd., China</i>  |      |
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|               | Mingde Zhou, Haoyu Wang<br><i>ShanghaiTech University, China</i>   |      |
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|               | Tianhua Zhu, Fang Zhuo, Fangzhou Zhao, Kefan Yu, Feng Wang, Ruijie Song<br><i>Xi'an Jiaotong University, China</i>   |      |
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ROOM Poster Area  
TRACK DC-DC Converters

SESSION CHAIRS

**David Williams**, *Infineon Technologies*

**Robert Pilawa-Podgurski**, *University of California-Berkeley*

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#### **D04: Utility Interface I**

ROOM Poster Area

TRACK Power Electronics for Utility Interface

SESSION CHAIRS

**Jonathan Kimball**, *Missouri University of Science and Technology*

**Suman Debnath**, *Oak Ridge National Laboratory*

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## D05: Utility Interface II

ROOM Poster Area

TRACK Power Electronics for Utility Interface

SESSION CHAIRS

Ali Khajehoddin, *University of Alberta*

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<sup>1</sup>*Xi'an Jiaotong University, China*, <sup>2</sup>*Xi'an Auto Electric Power Plant Co., Ltd., China*
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<sup>1</sup>*Texas A&M University-Kingsville, United States*, <sup>2</sup>*Minnesota State University, United States*, <sup>3</sup>*National Renewable Energy Laboratory, United States*
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## **D06: Motor Drives II**

ROOM Poster Area

TRACK Motor Drives and Inverters

SESSION CHAIRS

**Mehdi Farasat**, *Louisiana State University*

**Ziaur Rahman**, *Department of Energy*

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## D07: Motor Drive and Inverters

ROOM Poster Area

TRACK Motor Drives and Inverters

SESSION CHAIRS

**Mehdi Narimani**, *McMaster University*

**Mithat Kisacikoglu**, *The University of Alabama*

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## D08: Devices and Components I

ROOM Poster Area

TRACK Devices and Components

SESSION CHAIRS

Charles Sullivan, Dartmouth College

Huai Wang, Aalborg University

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ROOM Poster Area

TRACK Devices and Components

SESSION CHAIRS

**Jason Neely**, *Sandia National Laboratories*

**Tomas Sadilek**, *Delta Electronics*

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## **D10: Power Converter Packaging, Integration, and EMI Considerations**

ROOM Poster Area

TRACK Power Electronics Integration and Manufacturing

SESSION CHAIRS

**Sandeep Bala**, ABB

**Luke Jenkins**, IBM

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## **D11: Modeling of Components and SiC Devices**

ROOM Poster Area

TRACK Modeling and Simulation

SESSION CHAIRS

**Bilal Akin**, University of Texas at Dallas

**Thomas Neyer**, ON Semiconductor

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TRACK Modeling and Simulation

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**Yue Cao**, *Oregon State University*

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### **D13: Control I**

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TRACK Control

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## **D15: Wireless Power Transfer**

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TRACK Wireless Power Transfer

SESSION CHAIR

**Sheldon Williamson**, *University of Ontario Institute of Technology*

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## D16: Renewable Energy Systems I

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TRACK Renewable Energy Systems

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**Yingying Kuai**, *Caterpillar*

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**D19: Applications uPower to Grid**

ROOM Poster Area

TRACK Power Electronics Applications

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**Juan Rivas**, *Stanford University*

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