Applied Power Electronics Conference

APEC 35TH ANNIVERSARY

APEC 2020

New Orleans

MARCH 15-19, 2020

Sponsored by:

IAS IEEE INDUSTRY APPLICATIONS SOCIETY Linking Research to Practice

pels IEEE POWER ELECTRONICS SOCIETY Powering a Sustainable Future

PSMA

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APEC MOBILE APP

Download the APEC 2020 mobile app to access the latest event updates and details, including session and speaker information. The app is accessible through Google Play (Android) and Apple Store (iOS devices) by searching **'APEC 2020'**.

WI-FI

apec@apec-conf.org

Network Name: APEC2020

Password: 35yearsAPEC *(case sensitive)*

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APEC: Applied Power Electronics Conference

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PROGRAM KEY

EDUCATIONAL PROGRAM

PROFESSIONAL EDUCATION SEMINARS

APEC strives to offer seminars with a practical mix of theory and application for the professional working in power electronics. APEC 2020 features 18 Professional Education Seminars with a broad range of topics. All attendees must be registered for the conference. To register or pick up conference materials, visit APEC Registration outside of Hall B.

PLENARY SESSION

The APEC 2020 Plenary Session is made up of several presentations from respected industry leaders. Each presentation is 30-minutes in length and allows for interactive Q&A at the end of each presentation.

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 **lecture 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 from 11:15 a.m. – 1:45 p.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

The Industry Session tracks 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. Presentations will be available through the APEC mobile app.

EXHIBITOR SEMINARS

APEC 2020 Exhibitor Seminars will highlight new products or initiatives that companies in the power electronics industry are developing, along with allowing the opportunity for attendees to interact with other companies in the industry.

RAP SESSIONS

The APEC 2020 RAP Sessions feature several exciting and contentious topics. RAP Sessions allow for exciting dialogue amongst attendees and presenters. Admission to all RAP Sessions is open to exhibits only and full conference registration.

FOREWORD

In 1986, the “applied” power electronics community gathered in New Orleans to envisage novel solutions to process electric energy more efficiently, more reliably, and cost-effectively. They were sharing their knowledge to progress faster. Now it is 2020 and we are back in New Orleans, celebrating the 35th anniversary of APEC.

Back in 1986, there were just 34 papers, 20 exhibitors, 6 technical sessions and 250 attendees. The conference has steadily grown, now attracting almost 6,000 attendees and offering an enormous breadth of educational and networking opportunities, and a sold-out Expo Hall with more than 250 exhibitors.

Over the decades, so many people have dedicated their time to make APEC possible, and on this anniversary, I want to explicitly mention John Kassakian, Dave Middlebrook, Alex Kusko, Tom Wilson, Lloyd Dixon, Rudy Severns, Jonathan Wood and Bill Hazen, among others, for their legacy. Having initiatives for the good of the community deserves recognition. Sustaining and growing those initiatives deserve our admiration and appreciation.

Today, the challenges to our industry go beyond cost, efficiency, power density or reliability, which are the traditional metrics of power electronics. Our goals for the future reach a level beyond and need to address energy efficiency, reduction of CO2 emissions, adoption of renewable energies, electro-mobility, big data, health, outer space … the list goes on. Energy is ubiquitous, and applied power electronics requires seamless interaction with all scientific and engineering disciplines to improve the global quality of life, and face the climate emergency. We are one of the key building blocks of a sustainable world and it is our responsibility to share knowledge and work together.

APEC is truly diverse and International, and we value that. While the conference might be local from a geographic perspective, it is truly global in cooperation. APEC is open to any person who wishes to get involved and enjoy the conference. The format facilitates interaction, whatever your background and interests and we are proud to present over 750 contributions in Technical and Industry Sessions, 3 Rap sessions, 50 Exhibitor Seminars, a huge Exposition (250+ companies), and 18 renowned Educational Professional Seminars. Social events have also been arranged with special care to have fun while we work, or, from a different perspective, to work while we have fun!

Be sure to use the detailed program contained here, and note the additional meetings organized by our three conference sponsors: Power Sources Manufacturers Association (PSMA), the IEEE Power Electronics Society (PELS) and Industry Applications Society (IAS).

Special thanks to all the people who have volunteered for this year’s gathering, including reviewers, Track Chairs and members of the Organizing and Steering Committees, and especially the staff from SmithBucklin, who were essential in facilitating this year’s conference.

Enjoy the conference and a very happy anniversary to APEC!

José A. Cobos
General Chair
2020 IEEE Applied Power Electronics Conference and Exposition

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Thank you to our 2020 Sponsors and Partners

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i-MicroNews Turn knowledge into value

PSD Information to Power Your Designs

POWER ELECTRONICS EUROPE

PowerPulse.Net Daily News for the Global Power Electronics Engineering Community

U.S. TECH The Global Electronics Publication

NOTES

CONFERENCE-AT-A-GLANCE

	Saturday March 14	Sunday March 15	Monday March 16	Tuesday March 17	Wednesday March 18	Thursday March 19
Plenary Session			✓			
RAP Session				✓		
Technical Lecture*				✓	✓	✓
Technical Dialogue*						✓
Industry Session*				✓	✓	✓
Professional Education Seminar*		✓	✓			
Exhibitor Seminars				✓	✓	
Expo Hall Open			✓	✓	✓	
Sponsor Meetings	✓	✓	✓	✓	✓	✓

**Paid Registration Required*

SCHEDULE-AT-A-GLANCE

Registration is open on Saturday, March 14 from 4:00 p.m. – 7:00 p.m. outside of Hall B.

SUNDAY, MARCH 15

8:00 a.m. – 5:00 p.m.	**Registration Open**	Outside Hall B
8:00 a.m. – 9:00 a.m.	**Speaker Breakfast**	Great Hall B
9:30 a.m. – 1:00 p.m.	**Professional Education Seminars**	see page 18 for specific locations
1:00 p.m. – 2:30 p.m.	**Afternoon Break**	
2:30 p.m. – 6:00 p.m.	**Professional Education Seminars**	see page 20 for specific locations

MONDAY, MARCH 16

7:00 a.m. – 6:00 p.m.	**Registration Open**	Outside Hall B
7:00 a.m. – 8:00 a.m.	**Speaker Breakfast**	Great Hall B
8:00 a.m. – 10:00 a.m.	**Spouse and Guest Breakfast**	Hilton New Orleans Riverside
8:30 a.m. – 12:00 p.m.	**Professional Education Seminars** (concurrent sessions)	see page 24 for specific locations
12:00 p.m. – 1:00 p.m.	**Lunch on Own**	
1:15 p.m. – 5:00 p.m.	**Plenary Session**	Great Hall A
3:00 p.m. – 3:30 p.m.	**Afternoon Break**	
5:00 p.m. – 8:00 p.m.	**Welcome Reception**	Expo Hall B/C
8:00 p.m. – 10:00 p.m.	**MicroMouse Contest**	Expo Hall B/C

TUESDAY, MARCH 17

8:00 a.m. – 5:00 p.m.	**Registration Open**	Outside Hall B
7:00 a.m. – 8:00 a.m.	**Speaker Breakfast**	Great Hall B
8:00 a.m. – 10:00 a.m.	**Spouse and Guest Breakfast**	Hilton New Orleans Riverside
8:30 a.m. – 10:10 a.m.	**Technical Sessions** (concurrent sessions)	see page 31 for specific locations
8:30 a.m. – 10:10 a.m.	**Industry Sessions** (concurrent sessions)	see page 28 for specific locations
9:00 a.m. – 5:00 p.m.	**Expo Hall Open**	Expo Hall B/C
10:10 a.m. – 10:40 a.m.	**Morning Break**	Expo Hall B/C
10:40 a.m. – 12:00 p.m.	**Technical Sessions** (concurrent sessions)	see page 31 for specific locations
10:40 a.m. – 11:55 a.m.	**Industry Sessions** (concurrent sessions)	see page 28 for specific locations
12:00 p.m. – 1:00 p.m.	**Lunch**	Expo Hall B/C
1:00 p.m. – 1:30 p.m.	**Exhibitor Seminars #1** (concurrent sessions)	Expo Hall B/C
1:45 p.m. – 2:15 p.m.	**Exhibitor Seminars #2** (concurrent sessions)	2nd Floor, Expo Hall B/C
2:30 p.m. – 3:00 p.m.	**Exhibitor Seminars #3** (concurrent sessions)	2nd Floor, Expo Hall B/C
3:15 p.m. – 3:45 p.m.	**Exhibitor Seminars #4** (concurrent sessions)	2nd Floor, Expo Hall B/C
4:00 p.m. – 4:30 p.m.	**Exhibitor Seminars #5** (concurrent sessions)	2nd Floor, Expo Hall B/C
5:00 p.m. – 6:30 p.m.	**RAP Sessions** (concurrent sessions)	see page 37 for specific locations

SCHEDULE-AT-A-GLANCE

WEDNESDAY, MARCH 18

8:00 a.m. – 2:00 p.m.	**Registration Open**	Outside Hall B
7:00 a.m. – 8:00 a.m.	**Speaker Breakfast**	Great Hall B
8:00 a.m. – 10:00 a.m.	**Spouse and Guest Breakfast**	Hilton New Orleans Riverside
8:30 a.m. – 10:10 a.m.	**Technical Sessions** (concurrent sessions)	see page 52 for specific locations
8:30 a.m. – 10:10 a.m.	**Industry Sessions** (concurrent sessions)	see page 47 for specific locations
10:00 a.m. – 2:30 p.m.	**Exhibit Hall Open**	Expo Hall B/C
10:10 a.m. – 10:30 a.m.	**Morning Break**	Expo Hall B/C
10:35 a.m. – 11:50 a.m.	**Technical Sessions** (concurrent sessions)	see page 52 for specific locations
11:45 a.m. – 1:00 p.m.	**Lunch**	Expo Hall B/C
12:15 p.m. – 12:45 p.m.	**Exhibitor Seminars #6** (concurrent sessions)	Expo Hall B/C
1:00 p.m. – 1:30 p.m.	**Exhibitor Seminars #7** (concurrent sessions)	2nd Floor, Expo Hall B/C
1:45 p.m. – 2:15 p.m.	**Exhibitor Seminars #8** (concurrent sessions)	2nd Floor, Expo Hall B/C
2:30 p.m. – 4:10 p.m.	**Technical Sessions** (concurrent sessions)	see page 57 for specific locations
2:30 p.m. – 4:10 p.m.	**Industry Sessions** (concurrent sessions)	see page 49 for specific locations
4:10 p.m. – 4:20 p.m.	**Afternoon Break**	Session Room Hallways
4:20 p.m. – 5:40 p.m.	**Technical Sessions** (concurrent sessions)	see page 57 for specific locations
4:20 p.m. – 5:35 p.m.	**Industry Sessions** (concurrent sessions)	see page 49 for specific locations
6:00 p.m. – 9:00 p.m.	**Social Event: Mardi Gras World**	Shuttle Pickup at Hall H

THURSDAY, MARCH 19

8:00 a.m. – 12:00 p.m.	**Registration Open**	Outside Hall B
7:00 a.m. – 8:00 a.m.	**Speaker Breakfast**	Great Hall B
8:00 a.m. – 10:00 a.m.	**Spouse and Guest Breakfast**	Hilton New Orleans Riverside
8:30 a.m. – 10:10 a.m.	**Technical Sessions** (concurrent sessions)	see page 73 for specific locations
8:30 a.m. – 10:10 a.m.	**Industry Sessions** (concurrent sessions)	see page 68 for specific locations
10:10 a.m. – 10:35 a.m.	**Morning Break**	Session Room Hallways
10:35 a.m. – 11:25 a.m.	**Technical Sessions** (concurrent sessions)	see page 73 for specific locations
10:35 a.m. – 11:25 a.m.	**Industry Sessions** (concurrent sessions)	see page 68 for specific locations
11:15 a.m. – 1:45 p.m.	**Dialogue Sessions and Lunch**	Great Hall A
1:45 p.m. – 3:25 p.m.	**Technical Sessions** (concurrent sessions)	see page 77 for specific locations
1:45 p.m. – 3:25 p.m.	**Industry Sessions** (concurrent sessions)	see page 70 for specific locations

GENERAL INFORMATION

CONFERENCE REGISTRATION

All attendees must be registered for the conference. To register or pick up conference materials, visit APEC Registration outside of Hall B.

	Full Registration	Technical Session Only Registration	Professional Education Seminars Only Registration	Exhibits Only Registration	Guest Registration
Plenary Session	✓	✓	✓	✓	
RAP Session	✓	✓	✓	✓	
Technical Lecture*	✓	✓			
Technical Dialogue*	✓	✓			
Industry Session*	✓	✓			
Professional Education Seminar*	✓		✓		
Exhibitor Seminars	✓	✓	✓	✓	✓

**Paid Registration Required*

Registration Hours

Saturday, March 14 . . . . . 4:00 p.m. – 7:00 p.m.
Sunday, March 15 . . . . . 8:00 a.m. – 5:00 p.m.
Monday, March 16. . . . . 7:00 a.m. – 6:00 p.m.
Tuesday, March 17 . . . . . 8:00 a.m. – 5:00 p.m.
Wednesday, March 18. . . . . 8:00 a.m. – 2:00 p.m.
Thursday, March 19. . . . . 8:00 a.m. – 12:00 p.m.

APEC EXPO HALL

The Expo Hall will open on Monday, March 16 when the Plenary Session concludes.

Expo Hall Hours

Monday, March 16. . . . . ..5:00 p.m. – 8:00 p.m.
Tuesday, March 17 . . . . . 9:00 a.m. – 5:00 p.m.
Wednesday, March 18. . . . . 10:00 a.m. – 2:30 p.m.

Expo Hall Admission

Entry is granted to persons 18 or older with any APEC badge, including the free Expo Hall badge which also grants admission to the exhibitor seminars, plenary session, MicroMouse contest and RAP sessions.

Lunch and Breaks

Lunch and coffee (when provided) in the Expo Hall is free of charge to all who have access to the Expo Hall. Lunch on Sunday and Monday will be on your own.

Tuesday Morning Break . . . . . 10:10 a.m. – 10:30 a.m.
Tuesday Lunch . . . . . 12:00 p.m. – 1:00 p.m.
Wednesday Morning Break . . 10:00 a.m. – 10:30 a.m.
Wednesday Lunch. . . . . 11:45 a.m. – 1:00 p.m.
Thursday Morning Break . . . . 10:10 a.m. – 10:35 a.m.
Thursday Lunch. . . . . 11:15 a.m. – 1:45 p.m.

Expo Hall Giveaway

During all three days of the Exposition we will be giving out prizes. At registration, everyone (registrants and exhibitors included) will be issued a raffle ticket that you will put in a drop box located in APEC HUB (Booth 1325). This will be good for all three days of raffles during the exposition.

Accessibility

MCCNO has ADA entrances currently at the Julia Street entrance, Lobby C in the Atrium, Lobby G and Lobby H/I. All crosswalks and entrances are wheelchair accessible and all of our elevators are clearly marked. MCCNO also has mobility scooters available for rental in our UPS Store in Lobby F.

MATERIALS PURCHASE

Purchase of Conference Proceedings and Seminar Workbooks

Copies of USB of the APEC Proceedings will only 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 and Seminars on USB Payment Policy

For payments at the conference, APEC can accept credit cards (Master Card, Visa or American Express), 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 an additional handling charge of $50. A limited number of copies of the Conference Proceedings and Seminar Workbooks may be available for sale at registration starting at March 18.

- **On-site Conference Proceedings (USB only):** $125
- **Seminar Workbook (USB only):** $125

Purchased publications 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

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IMPORTANT RULES, NOTICES, AND CONFERENCE POLICIES

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 and Photography

Attendee Recording/Photography: Video and audio recording may be conducted in the Expo Hall 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 by all attendees except for the professional APEC photographer. For more details, please see Show Management.

APEC Photography for Marketing Purposes: By registering for APEC 2020, you agree that any photos taken of you while at the conference by our professional photographer may be used by APEC in the future.

Showcasing/Suitcasing Policy

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 Expo Hall floor and at other events. Show Management must be informed of any hospitality suites, and expressed consent must be received prior to the event.

Recruitment Policy

IEEE Policy #10.1.24 prohibits recruiting at IEEE sponsored conferences. Consequently, recruiters and recruiting advertisements will not be permitted in the APEC 2020 hotel space, meeting facilities or Expo Hall.

Distribution of Commercial Material at APEC

Rules for Non-Exhibitors: Distribution of commercial material in the APEC 2020 hotel space (including directly to the hotel rooms of APEC participants), meeting space and Expo Hall 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.

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 2020 Exposition. In addition, APEC may use the information you provide to contact you with information about APEC 2020 or any future APEC events. 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 website, direct contact, digest submission, volunteering to review, or in any way other than registering for the conference, will not have their names and contact information distributed to anyone 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 exhibitors and media partners. Emails will only be provided to exhibitors through the Lead Retrieval systems used on the Expo Hall floor. Registering for APEC gives permission for your name and contact information to be provided to exhibitors and media partners and for 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.

INFORMATION FOR SPEAKERS

PROFESSIONAL EDUCATION SEMINAR SPEAKERS

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

> Sunday at 8:00 a.m.; Monday at 7:00 a.m. | Great Hall B

INDUSTRY SESSIONS AND LECTURE TECHNICAL SESSION SPEAKERS

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 confer with your session chairs and/or review your previously uploaded presentation in the speaker ready room.

> Tuesday-Thursday at 7:00 a.m. | Great Hall B

DIALOGUE TECHNICAL SESSION SPEAKERS

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 Great Hall prefunction area after the breakfast. Thumb tacks will be provided.

> Thursday at 7:00 a.m. | Great Hall B

SPEAKER READY ROOM

The Speaker Ready Room, located in Rivergate Room, will be available to all speakers should you need to review your presentation in advance of your session or make any edits .

> Sunday | 8:00 a.m. – 6:00 p.m.
> Monday | 7:00 a.m. – 1:00 p.m.
> Tuesday | 7:00 a.m. – 5:00 p.m.
> Wednesday | 7:00 a.m. – 5:30 p.m.
> Thursday | 7:00 a.m. – 3:30 p.m.

SPECIAL EVENTS

SPOUSE AND GUEST ACTIVITIES

APEC welcomes the spouses and guests of APEC registrants to participate in conference activities. Transportation to and from each activity will be provided from Hilton New Orleans Riverside Lobby following the Spouse and Guest Breakfast. This year's options include:

Creole Queen Paddlewheeler Lunch Cruise

Monday, March 16 | 9:30 a.m. – 1:00 p.m.

Focusing on 300 years of New Orleans history, this cruise is narrated by a local historian who takes guests on a journey through the story of the city as we sail downriver to the Jean Lafitte National Historical Park and the historic Chalmette Battlefield. Highlights of the tour include the founding of the city by the LeMoyne brothers, the expansion of the city into the "French Quarters" of the Treme and Marigny, the Louisiana Purchase, and the critical Battle of New Orleans. Lunch is provided and included in the tour.

> **$125 per person**

Historic New Orleans Garden District Tour & Lunch

Tuesday, March 17 | 9:15 a.m. – 1:00 p.m.

Explore one of the world's most dazzling residential neighborhoods with knowledgeable and entertaining guides. Experience the architectural splendor of the live oak-tree lined "American" sector of town and examine the antebellum era "Creole vs. American" conflict. Witness how history and culture are reflected in the use of architectural styles including Greek Revival, Italianate, Gothic, Georgian, Swiss Chalet, Queen Anne, and more. After completing your tour, dine at Lula's Restaurant Distillery for a traditional NOLA sponsored lunch.

> **$125 per person**

MICROMOUSE CONTEST

Monday, March 16 | 8:00 p.m. – 10:00 p.m. | Expo Hall

Enter the annual APEC MicroMouse contest or join us as a spectator for this exciting event. Participants design, build, and program robotic mice and compete to see who can navigate their way through the maze in the shortest time. The rules for the contest use a scoring system with a penalty for the time taken to map and run the maze, and a bonus for not touching the mouse. They are similar to those used at the IEEE World Final held in London in 1987 except that the touch penalty has been reduced from 10 seconds to 2 seconds . The time for each contestant has also been reduced from 15 to 7 minutes. Within this time limit, the MicroMouse may make up to five runs. Only one mouse per handler will be allowed this year.

Trophies and cash prizes will be awarded in the following categories based on score:

> **1st Place $500**
> **2nd Place. $250**
> **3rd Place $125**

Trophies and cash prizes will be awarded to students in the following categories:

> **Best Student (based on score) $500**
> **Fastest Run (based on run time). $150**

WEDNESDAY NIGHT SOCIAL

Mardi Gras World

Wednesday, March 18 | 6:00 p.m. - 9:00 p.m.

Mardi Gras World allows you to see firsthand what it takes to bring Mardi Gras to life year after year. Walk through the hard work and extensive planning that goes into this grand event when you tour Blaine Kern Studios, an operating workshop that has created breathtaking floats for Mardi Gras and other parades around the world since 1947. There will be tour guides available to lead you through the massive studio, where artists and architects build Mardi Gras floats from the ground up.

The event will also feature Mardi Gras themed entertainment, a jazz band, a Mini Mardi Gras Parade, and more!

All full conference attendees will have a ticket included with their registration. Conference attendees can purchase an additional social event ticket through registration for $100.

SPONSOR MEETINGS

PSMA MEETINGS

SATURDAY, MARCH 14

7:00 a.m. – 5:00 p.m.	**PSMA/PELS Workshop on High Frequency Magnetics**	R02-R07
7:00 a.m. – 5:00 p.m.	**PSMA/PELS Workshop on Capacitors**	R02-R07

SUNDAY, MARCH 15

12:00 p.m. – 2:30 p.m.	**PSMA Meeting with CPSS (Invite Only)**	TBA

MONDAY, MARCH 16

7:30 a.m. – 1:00 p.m.	**PSMA Annual Meeting – followed by March BoD Meeting**	Room 353-354

TUESDAY, MARCH 17

10:00 a.m. –	**PSMA Packaging Committee Meeting**	Room 231
10:00 a.m. –	**PSMA Safety & Compliance Committee Meeting**	Room 232
12:00 p.m. – 2:00 p.m.	**PSMA Energy Harvesting Committee Meeting**	Room 231
12:00 p.m. – 2:00 p.m.	**PSMA Power Technology Roadmap Committee Meeting**	Room 232
2:00 p.m. – 4:00 p.m.	**PSMA Energy Management Committee Meeting**	Room 231
2:00 p.m. – 4:00 p.m.	**PSMA Semiconductor Committee Meeting**	Room 232

WEDNESDAY, MARCH 18

8:30 a.m – 10:30 a.m.	**PSMA Magnetics Committee Meeting**	Room 231
8:30 a.m – 10:30 a.m.	**PSMA Transportation Committee Meeting**	Room 232
10:30 a.m. – 12:30 p.m.	**PSMA Capacitor Committee Meeting**	Room 231
10:30 a.m. –	**PSMA Reliability Committee Meeting**	Room 232
12:30 p.m. – 2:30 p.m.	**PSMA Industry-Education Committee Meeting**	Room 231
1:30 p.m. – 3:30 p.m.	**PSMA Marketing Committee Meeting**	Room 232

IEEE PELS MEETINGS

SUNDAY, MARCH 15

8:00 a.m. – 6:00 p.m.	**IEEE International Future Energy Challenge (IFEC) Workshop**	Room 352
12:00 p.m. – 1:30 p.m.	**PELS New AdCom Member Orientation**	Room 201-202
3:00 p.m. – 5:00 p.m.	**PELS Executive Team Pre-Strategy Meeting (Officers Only)**	Room 201-202

MONDAY, MARCH 16

8:00 a.m. – 12:00 p.m.	**Electronic Transformers Technical Committee (ETTC)**	Room 356-357
9:00 a.m. – 12:00 p.m.	**PELS Membership Meeting**	Room 224
10:00 a.m. – 11:00 a.m.	**PELS Cyber-Physical Security Committee**	Room 201-202
11:00 a.m. – 1:00 p.m.	**PELS Fellows Committee (Members Only)**	Room 201-202
11:30 a.m. – 1:00 p.m.	**PELS Chapter Chair Forum**	Room 224
11:30 a.m. – 1:00 p.m.	**PELS TC & Academic Chairs Lunch (Invite Only)**	Room 214
7:00 p.m. – 9:00 p.m.	**PELS Mentoring Round Tables**	ROOM TBD

TUESDAY, MARCH 17

8:15 a.m. – 10:15 a.m.	**PELS TC1 – Power and Control Core Technologies**	Room 224
9:00 a.m. – 10:00 a.m.	**PELS WIE Committee**	Room 201-202
9:00 a.m. – 10:30 a.m.	**PELS Long Range Planning Committee**	Room 356-357
9:00 a.m. – 12:00 p.m.	**Working Group P2004**	Room 352
10:00 a.m. – 12:00 p.m.	**PELS History/Milestone**	Room 201-202
10:00 a.m. – 12:00 p.m.	**IEEE Journal of Emerging and Selected Topics on Power Electronics Steering Committee & Editorial Board**	Room 224
10:30 a.m. – 12:00 p.m.	**PELS TC7- Communication Energy Systems**	Room 214
12:00 p.m. – 1:30 p.m.	**PELS OA-J**	Room 201-202
1:00 p.m. – 2:00 p.m.	**PELS Standards Meeting**	Room 214
1:00 p.m. – 2:00 p.m.	**CPSS Transactions on Power Electronics and Applications Editorial Board**	Room 356-357
1:00 p.m. – 2:30 p.m.	**PELS TC4- Vehicle and Transportation Systems**	Room 224
1:30 p.m. – 3:00 p.m.	**PELS Digital Media and Education Committee**	Room 201-202
2:00 p.m. – 3:00 p.m.	**PELS and CPSS Exec Team Meeting**	Room 356-357
2:30 p.m. – 4:00 p.m.	**PEDG Steering Committee Meeting**	Room 224

TUESDAY, MARCH 17 (continued)

2:30 p.m. – 4:30 p.m.	**PELS TC6 – High Performance and Emerging Technologies Meeting**	Room 214
3:30 p.m. – 5:00 p.m.	**Global Relations Committee Meeting**	Room 201-202
4:00 p.m. – 5:00 p.m.	**PELS Industry Advisory Board**	Room 356-357
4:00 p.m. – 5:30 p.m.	**PELS TC5 – Sustainable Energy Technical Committee**	Room 224
5:00 p.m. – 6:30 p.m.	**PELS Magazine Editorial Board**	Room 356-357
5:30 p.m. – 6:30 p.m.	**eGrid Steering Committee**	Room 224
5:30 p.m. – 7:00 p.m.	**PELS TC3 Motor Drives & Actuators**	Room 214
7:00 p.m. – 9:00 p.m.	**IEEE IAS/PELS Young Professional Reception**	Off Site

WEDNESDAY, MARCH 18

8:00 a.m. – 9:00 a.m.	**PELS Women in Engineering (WIE) Breakfast**	Room 215-216
9:00 a.m. – 11:00 a.m.	**PELS Products Committee**	Room 201-202
9:30 a.m. – 11:00 a.m.	**PELS TC2 – Power Conversion Systems and Components**	Room 224
10:00 a.m. – 11:00 a.m.	**PELS Day 2020 Meeting**	Room 215-216
10:00 a.m. – 12:00 p.m.	**ITRW 2.0**	Room 356-357
10:30 a.m. - 12:00 p.m.	**SPEC Steering Committee Meeting**	Room 224
11:00 a.m. – 12:00 p.m.	**PELS Mentorship Steering Committee**	Room 201-202
11:30 a.m. – 2:00 p.m.	**IEEE Transactions on Power Electronics Editorial Board (TPELS)**	Room 215-216
1:30 p.m. – 3:00 p.m.	**Energy Access Working Group**	Room 224
2:00 p.m. – 4:00 p.m.	**PELS Technical Operations Committee**	Room 201-202

THURSDAY, MARCH 19

7:30 a.m. – 8:30 a.m.	**PELS Conference Executive Committee Breakfast**	Room 215-216
8:30 a.m. – 11:30 a.m.	**PELS Conference Committee**	Room 215-216
12:00 p.m. – 6:30 p.m.	**PELS Administrative Committee**	Room 356-357

PROFESSIONAL EDUCATION SEMINARS

APEC strives to offer seminars with a practical mix of theory and application for the professional working in power electronics. APEC 2020 features 18 Professional Education Seminars with a broad range of topics.

SESSION 1

9:30 a.m. – 1:00 p.m.

S01: Fundamentals of Switch-Mode Power Conversion

ROOM 208-210

TRACK Topologies

Robert V. White
Embedded Power Labs, United States

Today's switch-mode power converters are extraordinary devices converting power with efficiencies approaching 100% and power conversion densities into the 100's of watts per cubic inch. Just how do they do that? This seminar is a look "under the hood" of switch mode power converter. Imagine looking under the hood of a car at the engine with a mechanic. The mechanic would describe all of the various parts, like pistons and fuel injectors, and how they work together to create the power to drive the car. This seminar is a "look under the hood" of switch mode power converters. The goal is to present the principles and concepts needed to understand how switch mode converters work without a deep technical dive into the details. The first half of the seminar will focus on the circuits ("topologies") used to convert power. The various building blocks, such a switching devices and inductors will be described. Then the key principle of switch mode power will be presented to show how an ideal switch mode converter can convert at 100% efficiency. This introduces the buck converter which is explored in some detail. The workings of other key topologies such as the boost, buck-boost, and flyback converter are shown to expand the understanding. In the second half, the basics of controlling a switch mode power converter are explained. A quick review of systems and feedback starts the discussion. Then roles and function of the error amplifier, compensator, and modulator described. The concepts of how one designs a stable control are also discussed. The seminar concludes with an overview of current mode control. This seminar is suited for those wishing to know how a switch mode power converter works without being drenched in technical details, such as those new to switch mode power conversion or those working in sales, marketing, or application support of switch power converters or components used in switch mode power converters.

9:30 a.m. – 1:00 p.m.

S02: High-Frequency Transformers for High-Power Converters – Materials, Modeling, Design and Applications

ROOM 206-207

TRACK Components & Design

Yue Zhao[1], Juan Carlos Balda[1], Paul R. Ohodnicki[2], Guangqi Zhu[3]
[1]University of Arkansas, United States, [2]University of Pittsburgh, United States, [3]Eaton, United States

Wide bandgap devices are creating new challenges and opportunities for passives, especially the magnetics and high frequency (HF) transformers. In this seminar, the researchers from university, national lab and industry will present advanced design and applications of high frequency (HF) transformers in high power medium voltage (MV) converters. The magnetics and HF transformers must be tested and characterized at relevant scales and voltage. Scaled down cores and voltages enable material characterization, but do not consider component level impacts (resonances, dielectric breakdown and losses, scaled manufacturing and etc.,). Therefore, this presentation starts with a comprehensive review of core materials and their characterization systems. Then a review of modeling approach for magnetics, especially considering the HF nonsinusoidal waveforms in the actual applications, will be presented, followed by the session of HF transformer design and optimization. In addition several case studies will be presented to illustrate the design methodology and validate the performance of these high power HF transformers.

9:30 a.m. – 1:00 p.m.

S03: Communication-Less Coordinative Control of Paralleled Inverters

ROOM 211-213

TRACK Control & Models

Jinjun Liu, Zeng Liu, PhD
Hunan University, China

One of the most effective solutions to integrate renewable energy into electrical power systems is the microgrid approach, where renewable sources as well as energy storages are usually interfaced with the ac bus of a microgrid through power electronics inverters. Meanwhile, in order to improve the power supply reliability, microgrids should be able to operate in islanded mode and switched off from utility grid when utility fails. Under this circumstance, the voltage quality of ac bus and the power sharing among these paralleled inverters are very crucial for the safe operation of system, which must and can only be handled by the coordinative control of the inverters. Communication-based coordinative control is widely used for paralleled inverters in conventional UPS systems. However, paralleled inverters in a microgrid are very often located at different sites, and communication-less coordinative control is much more attractive and competitive due to its higher reliability, less cost, and its plug-and-play nature for installation and maintenance. There are two types of communication-less coordinative control, i.e. master-slave control and droop control. The focus of this tutorial will be the droop control, which is more widely used because of its advantages over the master-slave control. The basic operation principles of droop control will be introduced with DC bus power grids as examples, through detailed illustrations based on the simplest system structure of 2 paralleled source converters and one common load. These principles will then be extended to AC bus power grids, where droop control is implemented in two channels: active power channel and reactive power channel. Several major technical issues that need to be dealt with in droop control will then be identified and some of them will be discussed extensively. An in-depth review of existing and recent work of droop control for paralleled inverters in islanded microgrids is then delivered. Topics that will be covered include power coupling introduced by distribution cables, reactive power sharing control, unbalanced and harmonics power sharing control, secondary control for frequency restoration, and comparison between droop control and Virtual Synchronous Generator (VSG) control. The targeting audience of the seminar would be engineers, graduate students and academia faculties who are interested in the topic. The level of the intended audience will be intermediate.

9:30 a.m. – 1:00 p.m.

S04: Full Technology Validation of 600V+ GaN Power Devices – From Device Structure, Performance and Reliability, to Application Economics, User Satisfaction and ppm Field Failure Rate

ROOM 217-219

TRACK Reliability, Thermal, and EMI

Yifeng Wu
Transphorm Inc., United States

After a decade-long development effort, GaN-on-Si power devices have turn a new leaf with 600/650V transistors in mass production for several years, accumulating >4 billion device hours in the field at a low ppm failure rate. This along with recent success in 650V automotive-grade devices and 900V devices will help expand the GaN power semiconductor market at 35% compounded growth to exceed $1 billion by 2027 as predicted by IHS Markit. This tutorial offers a comprehensive look at how the high-voltage GaN devices complete a full cycle of technology validation: from device design, manufacturability and reliability to system economics, user satisfaction and ppm field failure rate. Topics to cover include: 1) GaN's true worth as a power semiconductor, 2) device structural choices, properties and performance, 3) competitiveness over Si and SiC counterparts, 4) application design wins including titanium-grade PSUs for computing and compact USB-C fast chargers for laptops/smart phones, 5) reliability and quality requirements for low ppm-level failure rates. The intended audiences are engineers at or above intermediate level in power electronics but with no requirement for GaN device knowledge.

9:30 a.m. – 1:00 p.m.

S05: Soft Switching Technique for SiC MOSFET Three-Phase Power Conversion

ROOM 225-227

TRACK WBG Applications

Mark Dehong Xu[1], Ning He[2], Yenan Chen[3]
[1]Zhejiang University, China, [2]Delta Electronics, China, [3]Princeton University, United States

Increasing the switching frequency is critical to increase efficiency, power density and dynamic performance. Soft Switching Technology is an effective way to increase the switching frequency, which have been successfully applied in switching power supplies etc. However, applications of soft switching technique to IGBT-dominated three-phase converters/inverters are not common up to now. Wide-band-gap (WBG) device may help pushing the applications of soft-switching to three-phase systems. Firstly this tutorial will introduce impact of WBD device on the soft-switching

three-phase conversion technologies after explaining and the fundamental of soft-switching three-phase inverters/converters. A generic modulation method of Zero-Voltage-Switching (ZVS) three-phase power conversion are introduced, which is suitable to both 3-phase 3-wire and 4-wire power converters and inverters. Then analysis and design of ZVS three-phase inverters/converter is investigated with respect to resonant parameters, ZVS condition, stress of power devices etc. Afterwards the soft-switching concept are extended to other topologies such as Back to Back (BTB) converter, PV string inverter, battery systems etc. Finally Prototype of 20kW ZVS SiC inverter, and 10kW ZVS SiC BTB converter will be introduced. The intended audiences are researchers and engineers interested in either an entry-level of introduction or an in-depth understanding of progress of soft switching three-phase power conversion.

9:30 a.m. – 1:00 p.m.

S06: DC Microgrids for Transportation Electrification: Applications, Design & Control and Cyber-Security

ROOM 220-222

TRACK Transportation Electrification

Tomislav Dragičević[1], Subham Sahoo[1], Patrick Wheeler[2]

[1]Aalborg University, Denmark, [2]University of Nottingham

With the rapid development of power electronics technology to encompass reduced environmental impact, there is a clear tendency that high and low voltage have seen the proliferation of DC microgrids and its implementation for transmission and distribution in transportation systems, namely all/more electric aircrafts (A/MEAs) and shipboard systems. Moreover, DC architecture is considered as one of the most promising candidates for transportation electrification due to the potential advantages such as higher efficiency compared to AC, less weight of harness, absence of reactive power related issues and also reduced costs. However as compared to the traditional onboard power generation schemes, the recent trends in electrification also bring many design and control challenges. The aim of this tutorial is to identify these challenges and share with the audience (intermediate level) the instructors' industrial and academic experiences in the field. First of all, a detailed framework of industrial and transportation applications of DC microgrids in the real world will be provided. Further, the control and design challenges with electrification in the transportation sector will be addressed. Finally, a detailed study on investigating a primary concern, i.e., cyber security in DC microgrids will be carried out highlighting its critical vulnerabilities concerning system instability/shutdown.

SESSION 2

2:30 p.m. – 6:00 p.m.

S07: New Soft Switching Technologies for Very High Efficiency

ROOM 208-210

TRACK Topologies

Ionel Dan Jitaru

Rompower Energy Systems Inc., United States

The goal of this seminar is to present a new soft switching technology which can be applied to any of the classical hard switching topology and converting them to "true soft switching" topology. In true soft switching technology, the primary switching devices turn on at zero voltage and the secondary switching devices turn off at zero current. There is no ringing or, during operation, spikes across any of the switching devices in primary or secondary; this is done without the use of any snubbers. This new technology uses a self-adjusting current injection technology which ensure that all the switching elements in the secondary turn off at zero current and all the primary switchers turn on at zero voltage.

2:30 p.m. – 6:00 p.m.

S08: Isolated Gate Driver ICs in Power Electronics Systems – Insulation Specifications, IC Verification, Application Requirements and Design Optimization

ROOM 211-213

TRACK Components & Design

Wei Zhang

Texas Instruments Inc., United States

Isolated gate drivers are gaining more interest in high power density power supplies due to their superior dynamic performance and decreasing costs as more IC vendors drive innovation and enter the market. There are a few popular isolation technologies currently used in today's isolated gate drivers, and it is a challenge to compare them in key areas including: the insulation specifications, how the ICs are production tested, and how they are qualified and certified by independent agencies. Due to lengthy system-level isolation standards and multiple component-level standards, the designer may find it difficult to pick the optimal part with the right insulation level and package size with sufficient creepage/clearance distances to meet the requirements. Without fully comprehending the driver insulation specifications and the system-level isolation requirements, the designer often opts to choose an isolated driver that is "over-designed". This presentation will answer all these questions by summarizing the isolation technologies, studying the datasheet insulation table, and illustrating the

isolation testing methodologies within the context of end equipment standards. The final section will summarize the best practices to optimize system performance with the state-of-the-art isolated gate drivers.

2:30 p.m. – 6:00 p.m.

S09: Expanding PWM Converter Control Horizons

ROOM 217-219

TRACK Control & Models

Ray Ridley

Ridley Engineering, Inc., United States

The industry has historically focused on controlling basic power converters using either current-mode and voltage-mode control. Many analysis techniques have been proposed, and Dr. Ridley will provide a short review of these methods. The varying solutions have been inwardly focused on the components of the power supply. Trying to control components outside the confines of the basic converter cell is not usually considered. In this seminar, we will show how PWM modulation can be applied to the control of filters at the input and output of the converter power stage. Unique new control structures and magnetics small-signal models can be applied to produce a much more controllable power system without introducing lossy elements in the filter components. The power and utility of Bode plots for the design of complex high-order systems is presented in detail. This allows engineers to envisage solutions to difficult problems without difficult mathematical analyses.

2:30 p.m. – 6:00 p.m.

S10: Practical Thermal Knowledge for Electrical Engineers

ROOM 206-207

TRACK Reliability, Thermal, and EMI

Wenkang Huang

Infineon Technologies AG, United States

The seminar presents thermal knowledge from a completely different perspective than previous thermal management seminars at APEC and is for electrical engineers of entry and intermediate levels. The seminar starts with basic thermal resistance definitions and a few examples of misunderstanding of these thermal resistances by electrical engineers, and it then presents correct usage of thermal resistances based on simulation and test data. With size reduction of DC-DC converters, co-packaged power stages are developed and optimized to reduce temperature. The seminar demonstrate package improvement in discrete MOSFETs and power stages to optimize thermal performance. It compares two popular packages, DrMOS package versus single-clip package and then presents test results of exposed-top package versus molded package. The seminar offers tips in application of heatsink and temperature measurement by using thermal cameras and thermal couples. It also discusses chimney effect of airflow in system design and analyze thermal management in some computer designs. Additional topic includes temperature sensing for temperature reporting, over temperature protection, and current sensing compensation in DC-DC converters for servers and telecommunication systems, and the seminar will provide implementations of temperature compensation in inductor DCR and MOSFET Rds(on) current sensing.

2:30 p.m. – 6:00 p.m.

S11: Advanced 3-Φ Sic/GaN PWM Inverter Concepts for Future VSD Applications

ROOM 220-222

TRACK WBG Applications

J.W. Kolar, M. Guacci, M. Antivachis, D. Bortis, Mattia Guacci, Johann Kolar

ETH Zürich, Switzerland

This intermediate level seminar first introduces participants to state-of-the-art variable speed drive (VSD) systems and gives a short overview of the realization requirements and regulations detailed in corresponding product standards. Next, three-phase PWM inverter topologies with different types of explicit LC output filters, i.e. continuous sinusoidal output voltage, are discussed, which allow the full utilization of ultra-fast switching wide bandgap (WBG) SiC and GaN power semiconductors. The systems do not require shielded motor cables, ensure low motor losses and/or applicability of conventional low-cost motor technology and are preventing dv/dt-related motor insulation stresses, as well as bearing currents and reflections on long motor cables. Different filter structures and the filter design procedure are shown and examples of high switching frequency industrial drive systems with output filters are shown. Furthermore, advanced inverter bridge-leg topologies, including multilevel arrangements with series and/or parallel interleaving are evaluated concerning losses and output filter volume. In this context, a multi-level/cell GaN bridge-leg power module employing 650V GaN power semiconductors, operating at 4.8MHz effective switching frequency and integrating an ultra-compact output filter, is described. Subsequently, new three-phase voltage DC-link or current DC-link inverter concepts featuring buckboost functionality and inherently generating a continuous output voltage waveform are presented. The systems allow operation in a wide DC input voltage and/or AC output voltage/motor speed range and are therefore ideally suited for battery powered or distributed DC link VSD applications. The new converter topologies are derived starting from conventional inverter structures and are grouped into phase-modular

and phase-integrated concepts. Continuous and discontinuous modulation schemes are explained and evaluated for both converter groups and a synergetic coupling of the control of the input and output stages of the systems resulting in low overall switching losses is described. Furthermore, measurement results of high power density laboratory demonstrators of the systems employing latest SiC MOSFETs or monolithic bidirectional GaN e-FET technology are presented. Final considerations of the seminar are on the fast and accurate measurement of the switching and conduction losses of WBG power semiconductors, and of the low- and high-frequency losses of ceramic capacitors and magnetic core materials as basis for an inverter and/or output filter design. Furthermore, the advantages and challenges of a future embedding of the inverter into the motor are discussed and topics of latest research on next-generation VSD systems at the Power Electronic Systems Laboratory of ETH Zurich are presented.

2:30 p.m. – 6:00 p.m.

S12: Power Electronics Enabled Health-Conscious Battery Management and Fast Charging for E-Transportation

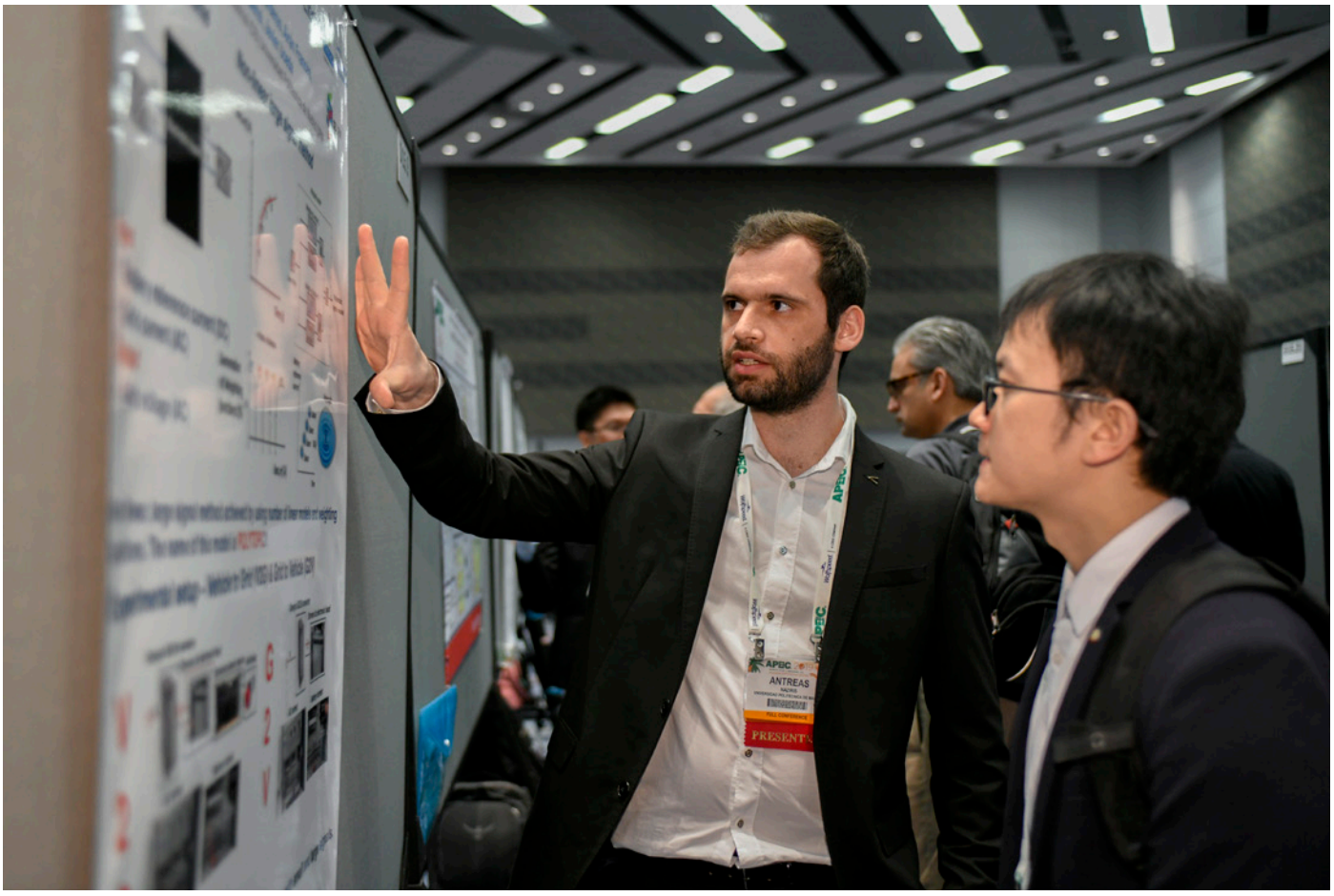
ROOM 225-227

TRACK Transportation Electrification

Vinicius Marcis, Sheldon S. Williamson

University of Ontario-Institute of Technology, Canada

Enhancing the life of Lithium-ion (Li-ion) battery packs has also been the topic of much interest in the e-transportation industry. In this framework, the role of on-board cell voltage balancing (with temperature rise considerations) of Li-ion batteries will be highlighted. This is a very important design aspect, which directly affects cost, calendar life, state-of-charge, and state-of-health. The design and implementation of a novel, reduced-parts DC/DC converter for battery cell-voltage-equalization will be discussed. For the first time ever, this talk will also introduce a closed-loop cell charge balancing technique that uses instantaneous cell voltage and/or temperature rise (ΔT) as a control parameter.



NOTES

SESSION 3

8:30 a.m. – 12:00 p.m.

S13: Circuit Techniques Towards 99% Efficiency, 99% Duty Ratio and Ultra-High Power Density

ROOM 220-222

TRACK Topologies

Don Tan

Northrop Grumman Aerospace Systems, United States

Emerging power circuits have obtained unprecedented performances in power efficiency and power density. Consequently they are entering mainstream power conversion. In this professional educational seminar, we will provide an overview of basic techniques from its past to present and to emerging trends. Challenges and opportunities will also be presented, together with potential breakthroughs.

8:30 a.m. – 12:00 p.m.

S14: LLC Calculator – Vector Method as an Application of the Design Oriented Analysis

ROOM 211-213

TRACK Components & Design

Mladen Ivanković, Jon Mark Hancock

Infineon Technologies AG, United States

The training provides practical approaches to developing a high performance LLC tank configuration in relation to your design targets, and selects the right components and optimizes their values, based on a power loss budgeting plan. These concepts will be demonstrated using existing free cost tools (Excel, LT spice) and Eval board designs. The training has three parts. LLC converter FHA model was used to develop circuit equations that are simple yet physically insightful. Boundary condition (point between inductive and capacitive mode of operation) investigation using vectors is the core of this novel method. Discovery of the orthogonality between inverse gain vector of the LLC and serial equivalent load vector leads to the very simple and close form equations for the LLC components. Having in mind limitations of FHA model, it was necessary to bring exact solution from time domain and compare them with FHA results. It was done by using simplified LT spice simulation. Comparison resulted with generation of the ROT (Rules of thumb) for LLC design. Application of this method was demonstrated on 600W LLC converter reference design. The topic will be treated in depth on intermediate level.

8:30 a.m. – 12:00 p.m.

S15: Designing Compensators for the Control of Switching Power Supplies

ROOM 217-219

TRACK Control & Models

Christophe Basso

ON Semiconductor, France

Switching power supplies are widely used in nowadays equipments, ranging from a few tens of watts in consumer applications to several hundred of watts and above in industrial applications. Despite the various architectures found in this field, they all share the need for a control circuit that maintains one or several delivered variables within a defined range. The compensator is the place where the designer shapes the loop frequency response for a particular performance and ensures stability over the entire operating range. Depending on the selected controller, the active element used to perform compensation can be an operational amplifier, a TL431 or a digital architecture. Targeting engineers and graduating students, this seminar describes how to efficiently compensate a power converter using an active analogue amplifier. Compensator types such as 1, 2 and 3 are covered in great details, with design examples used as a support. More complex implementations including anti-windup structures as well as a quick introduction to digital filters are also covered in this seminar. Using mathematical analysis and different tools such as SPICE, Mathcad® and SIMPLIS®, 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.

8:30 a.m. – 12:00 p.m.

S16: EMC Measurement, and Reduction Techniques for Switch-Mode Power Converters

ROOM 206-207

TRACK Reliability, Thermal, and EMI

Michael Schutten

General Electric Global Research, United States

This seminar is intended as a comprehensive introduction for engineers wanting a fundamental understanding of electromagnetic compatibility (EMC) issues associated with switch-mode power converters, and experienced engineers desiring a detailed understanding of electromagnetic interference (EMI) causes and fixes for power converters. The seminar begins with an introduction to noise coupling mechanisms and their properties. The concept of impedance mismatch

is presented as a basis for understanding filtering concepts. Differential-mode (DM) and common-mode (CM) separation and filtering approaches are derived, and measurement and separation techniques presented. DM & CM measurement and EMI reduction techniques are presented for an experimental flyback converter. Converter layout techniques and principles are derived, and experimentally verified. The seminar provides an emphasis on how DM and CM currents are created in power converters, and layout and construction techniques to minimize the need for costly filtering. Several practical EMI reduction techniques and construction methods are provided throughout the presentation. Frequency-domain and time-domain comparisons are presented for silicon carbide (SiC) and silicon (Si) power semiconductors.

8:30 a.m. – 12:00 p.m.

S17: High-Efficiency and High-Density Single-Phase PV Inverters with Advanced Topologies, Control and WBG Devices

ROOM 208-210

TRACK WBG Applications

Alex Q. Huang[1], Qingyun Huang[1], Patrick Chapman[2]

[1]University of Texas at Austin, United States,

[2]Enphase Energy, United States

This tutorial presents the high-efficiency and high-density single phase PV inverters with advanced topologies, control and WBG Devices. First, this tutorial comprehensively reviews the conventional topologies, control and performance limitations of the conventional single phase PV inverters including micro-inverters, string inverters, cascaded H-bridge inverters and medium voltage PV inverters. Based on the detailed review, this tutorial discusses the advanced topologies, modulations and control of single phase PV inverters. Microinverters are integrated with PV panels and get a great success. Dr. Patrick Chapman from Enphase Energy will present the history, the design requirements and approaches, and future challenges of high efficiency and high density microinverters. String inverters are the most popular single phase PV inverter products. Dr. Qingyun Huang from UT Austin will review the technologies and their limitations of the traditional string inverters first. Then two advanced string inverter topologies, the dual-Buck inverters and the flying capacitor multilevel inverters with GaN devices, will be presented with the control strategy and design methods. Dr. Qingyun Huang will also discuss the design, control and modulations of the panel based hybrid inverters, the cascaded H-bridge inverter and a new cascaded Buck-Boost inverter with high efficiency and low cost. Finally, Dr. Alex Huang from UT Austin will present the advanced high efficiency and high density modular medium voltage PV inverters including the applications, topologies, control and design methods.

8:30 a.m. – 12:00 p.m.

S18: Foreign Object Detection in Wireless Power Transfer Systems

ROOM 225-227

TRACK Transportation Electrification

Chris Mi, Jianghua Lu, Yiming Zhang, Bo Cheng, Chenwen Cheng

San Diego State University, United States

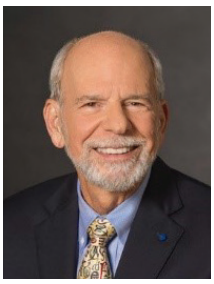
Wireless power transfer (WPT) technology has been developed for the wireless charging of electric vehicles, consumer electronics, and other applications. Inductive power transfer (IPT) uses the magnetic field for power transfer and it is currently the most popular and mature WPT technology. However, the strong magnetic field will heat up metal objects falling in the charging area due to eddy currents generated in the objects. It can also harm animals or toddlers staying in the charging area. To deal with these issues, foreign object detection (FOD), including metal object detection (MOD) and living object detection (LOD), should be developed for the safe operation of IPT systems. FOD can be divided into system parameter detection methods, wave-based detection methods, and field-based detection methods. System parameter detection methods are normally used in low-power systems for MOD. Wave-based detection methods are suitable for high-power applications, for both MOD and LOD. Field-based detection methods work for both high-power and low-power applications, for both MOD (in an inductive way) and LOD (in a capacitive way). This tutorial first reviews and summarizes the state-of-theart development of FOD technology in IPT systems. Then, a novel detection coil layout is proposed to not only cover the whole charging area but also decouple from the transmitter and receiver to minimize the impacts on power transfer. A mixed resonant circuit will be explained which will have better performance than the parallel resonant circuit. The impacts of the detection coil layer, turn number, trace width, and the capacitance ratio in the mixed resonant circuit will be discussed.

PLENARY SESSION

The APEC 2020 Plenary Session is made up of several presentations from respected industry leaders. Each presentation is 30-minutes in length and allows for interactive Q&A at the end of each presentation.

Presentation 1
Power Electronics: Where Have We Been? Where Are We Going?

1:30 p.m. – 2:00 p.m.



SPEAKER:

John Kassakian

Professor, Massachusetts Institute of Technology

Solid state power Electronics had its genesis in 1959 with the invention of the SCR at GE. The development of the 2N3055, one of the earliest and most ubiquitous Si power transistors followed shortly. Power electronics became an explicit focus of the IEEE in 1983 with the formation of the Power Electronics Council. The launching of APEC in 1986, and the creation of PELS in 1988 solidified its role in the Institute. Applications have grown rapidly, as have component and manufacturing technologies. Today we are challenged to meet requirements of evolving applications that demand multidisciplinary thinking, high levels of integration, very high efficiencies, high gravimetric and volumetric specific power, and significant cross-field collaboration. Industrial processes, electric vehicles, robotics, decreasing logic voltages, electric aircraft, attention to energy conservation and global warming, and even 5G, are providing power electronics with a fertile and exciting future.

Presentation 2
Power in Automotive: Performance in Several Dimensions

2:00 p.m. – 2:30 p.m.

SPEAKER:

David Dwelley

Vice President and Chief Technology Officer, Maxim Integrated

Power in automotive entails more than just power. Other important areas to consider are quality and diagnostics, safety, functionality, qualification and documentation. These important items, as well as traditional power performance, need to be designed in at the start. This session will discuss strategies to create power devices that meet the wide variety of automotive performance requirements.

Presentation 3
Emerging Technologies in Transportation Power Electronics

2:30 p.m. – 3:00 p.m.

SPEAKER:

Burak Ozpineci

Group Leader, Power Electronics and Electric Machinery Group, Program Manager, Electric Drive Technologies, Oak Ridge National Laboratory

Today's electric vehicles (EV) are not being designed like conventional gasoline vehicles where all the components are under the hood. Rather skateboard designs are being used where the skateboard holds the batteries and traction drive system. This require much higher power density, low profile designs for research in highly integrated power modules, high voltage inverters, non-heavy rare earth electric motors, and integrated electric drive systems. There is also a demand for faster charging times rivaling the refill times of gasoline vehicles which increases the interest in high power wired and wireless charging. This talk will focus on electric vehicle drive and charging challenges and approaches to achieving high power densities and fast charging. This talk will also cover the emerging technologies such as additive manufacturing, artificial intelligence/machine learning, cyber security issues, high-performance computing and their use in power electronics.

Presentation 4
Hybrid Switched-Capacitor Power Converters – Circuit Topologies and Control Techniques to Meet the Future Power Density Demands

3:30 p.m. – 4:00 p.m.

SPEAKER:

Robert Pilawa-Podgurski

Professor, University of California Berkeley

Recently, new circuit topologies and control techniques have been proposed to make use of the superior energy density of capacitors compared to inductors, to enable power converters with greatly increased power density and efficiency. In this talk, I will provide a review of the research develop-

ments over the last decade in the area of hybrid switched-capacitor (SC) converters, which have shown great promise to leverage the benefits of high density capacitors, while mitigating the detrimental characteristics of pure SC converters. Various methods for evaluating hybrid SC converter topologies along with figures of merit for different circuit topologies will be discussed, along with recent examples of high performance hardware prototypes in the area of data center power delivery. This talk will provide examples of how fundamental advancements in academic research have been rapidly picked up in industrial designs, and highlight key areas of research for further power density and efficiency improvements, along with considerations of reliability and cost.

Presentation 5
Power Electronics for Consumer Applications

4:00 p.m. – 4:30 p.m.

SPEAKER:

Balu Balakrishnan

CEO, Power Integrations

Power converters for consumer products have always been extremely cost sensitive. In recent times, innovations in circuit simplification and integration have worked well to drive costs down, in spite of regulatory pressure to reduce energy waste by improved efficiency and minimized no-load power use. Powerful market forces have emerged which are dramatically increasing the complexity of power supplies – variable output voltage USB-PD, for example – and also increasing the required power density. In fact, due to fast charging and bigger batteries demanded by today's large screen 5G cellphones, the power density needs of USB-PD adapters rival those of servers and other historically bleeding-edge application categories. In addition, the portability requirement and criticality of mobile devices in people's lives means that failure is not an option, even in regions with highly variable mains power, high surge and fast transient exposure. Efficiency, robustness, and compactness requirements have combined to drive the first high volume use of high voltage GaN transistors, implementation of thermal foldback, and load-driven real time voltage and current adjustments with tens of millivolt and milliamp accuracy, all while maintaining a weather eye on affordability. This presentation details the market forces driving product developments and the response to those demands by semiconductor manufacturers.

Presentation 6
SiC Power Technology: Answering Automotive Readiness

4:30 p.m. – 5:00 p.m.

SPEAKER:

John Palmour

CTO, Wolfspeed, A Cree Company

SiC semiconductor technology has entered a stage of rapid market adoption in the last few years. This rapid adoption has been due to continuous improvements in cost, quality, and availability. The costs are being driven down by higher volumes. Improved material defect densities are also lowering cost and improving quality and availability of higher current products. Further, system costs and range in Battery Electric Vehicles (BEVs) are both improved with SiC. A significant percentage of automotive OEMs are now targeting SiC power MOSFETs to power their drive trains, which will drive a very large increase in both volume, and ever-increasing expectations on quality.

The bulk of SiC power device manufacturing has now migrated to 150 mm substrates, and the industry is pushing to rapidly increase volume. In several years, it is expected that the volume demands will dwarf today's current demand. Efforts to meet this demand will be described. As the market grows further, the push to 200 mm substrates is inevitable, and these have been demonstrated in R&D already.

The rapid adoption of SiC is primarily driven by the on-board charger power density requirements and the efficiency advantages in the inverter for the drivetrain in BEVs. The advantages of SiC in these applications will be discussed. For example, SiC offers a 5-10% improvement in efficiency for the motor drive, which results in either extended range for the vehicle for a given battery charge, or a reduction in the battery pack required to go a certain distance. The large number of SiC die required per inverter will drive a requirement for very low failure rates, so the quality expectations for this will also be discussed.

INDUSTRY SESSIONS

The Industry Sessions 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. Presentations will be available through the APEC mobile app.

8:30 a.m. – 11:55 a.m.

IS01: Magnetic Design Applications

ROOM R04-R05

SESSION CHAIRS

Ed Herbert, *PSMA*

Stephen Carlsen, *Raytheon*

8:30 a.m.

IS01.1 **Optimized Inductor Designs for DC/DC Buck Converters from 150 kHz to 3 MHz using Distributed Gap Core Materials**
Christopher Oliver
Micrometals Inc., United States

8:55 a.m.

IS01.2 **Flyback Continuous Mode – Planar Transformer Design Tutorial**
Jim Marinos
Payton Planar, United States

9:20 a.m.

IS01.3 **Combined Inductor and Transformer Design for Resonant Converters**
Jennifer Pollock
Harley-Davidson Motor Company, United States

9:45 a.m.

IS01.4 **Design Space of Flyback Transformers**
George Slama
Würth Elektronik, United States

10:40 a.m.

IS01.5 **Transformer Design Consideration for Full Bridge Phase Shift**
José M. Molina
Frenetic, Spain

11:05 a.m.

IS01.6 **From Brute Force Grid Search to Artificial Intelligence: Which Algorithms for Magnetics Optimization?**
Thomas Guillod, J.W. Kolar
ETH Zürich, Switzerland

11:30 a.m.

IS01.7 **Magnetics Design Considerations for Wireless or Contactless Power Transfer for EV Charging and Data Center Servers Directly from MV DC Grid**
Subhashish Bhattacharya
North Carolina State University, United States

8:30 a.m. – 11:55 a.m.

IS02: Data Center Power Solution Ecosystem

ROOM R02-R03

SESSION CHAIRS

Shuai Jiang, *Google LLC*

Mobashar Yazdani, *Google LLC*

8:30 a.m.

IS02.1 **Driving 48V Technology Innovations Forward – Hybrid Converters and Trans-Inductor Voltage Regulator (TLVR)**
Shuai Jiang, Xin Li, Mobashar Yazdani, Chee Chung
Google LLC, United States

8:55 a.m.

IS02.2 **48V Sever Platform Power Architecture and Design Challenges**
Horthense Tamdem, Meng Wang, Behzad Vafakhah, Yinghua Ye, Fan Zhengguo
Intel Corporation, United States

9:20 a.m.

IS02.3 **Scalable 2-Stage 48V to POL Power Delivery for Data Centers**
Jinghai Zhou
Monolithic Power Systems, United States

9:45 a.m.

IS02.4 **Integrated STC with Autonomous ZCS and Monolithic Coupled L VRs for 48V-Core Datacenter Applications**
Andrea Pizzutelli, Thurein Paing
Maxim Integrated, United States

10:40 a.m.

IS02.5 **STacked Buck (STB): An Innovative, High Performance, Architecture for 48V Bus Regulated Power Delivery**
Osvaldo Zambetti, Raimondo Vai
STMicroelectronics, Italy

11:05 a.m.

IS02.6 **48V Data Center Power Solution Ecosystem: Technologies and Challenges**
Marcus O'Sullivan, Sal Afzal
Analog Devices, United States

11:30 a.m.

IS02.7 **Digital Power in the Datacenter**
Shea Petricek
Renesas Electronics, United States

8:30 a.m. – 11:55 a.m.

IS03: Vehicle Electrification I

ROOM R01

SESSION CHAIRS

Dennis Stephens, *Continental Automotive*

John Rice, *Maxim Integrated*

Pradeep Shenoy, *Texas Instruments, Inc.*

8:30 a.m.

IS03.1 **Changing the Input Rectification Paradigm: 600V Active Rectification for Power Mains Input Bridges**
Davide Giacomini
Infineon Technologies AG, Italy

8:55 a.m.

IS03.2 **Can Functionally-Safe Automotive Displays Ensure Driver and Passenger Safety?**
Szukang Hsien
Maxim Integrated, United States

9:20 a.m.

IS03.3 **Parallel Discrete Switch based High Efficiency High Power Inverters for EV Traction Systems**
Nayeem Arafat, Paul Carosa, George Woody
AC Propulsion, United States

9:45 a.m.

IS03.4 **Pyro-Fuses, Enablers for EV Performances?**
Pierric Gueguen
Mersen, France

10:40 a.m.

IS03.5 **Are Silicon Diodes Still Alive in Electric Vehicle Chargers? Considerations and Uses for the Lowest Pin Count Power Silicon Devices**
Claudio Mario Damilano[1], Alessio Gillone[1], Manuel Gomez Gomez[2]
[1]Vishay Semiconductor Italiana S.p.A., Application Laboratory for Power Systems (ALPS), Italy, [2]Politecnico di Torino, Italy

11:05 a.m.

IS03.6 **A Comparison of Fixed DC-Link and Variable DC-Link Schemes for Bi-Directional EV On-Board Charger**
Chen Wei, Jianwen Shao, Dongfeng Zhu, Haitao Xie
Wolfspeed, A Cree Company, United States

11:30 a.m.

IS03.7 **Efficiency Improvement of EV Fast Charger using SiC Schottky Diodes**
Leif Amber
Semikron Inc., United States

8:30 a.m. – 11:55 a.m.

IS04: Si and Wide Bandgap Switch Performance

ROOM R06

SESSION CHAIRS

Jaume Roig, *ON Semiconductor*

Stephanie Watts Butler, *Texas Instruments Inc.*

8:30 a.m.

IS04.1 **SiC MOSFET Corner and Statistical SPICE Model Generation**
James Victory, Canzhong He, Yunpeng Xiao, Herbert De Vleeschouwer, Elvis Zeng, Zhiping Hu
ON Semiconductor, United States

8:55 a.m.

IS04.2 **Power Conversion Switch Technology: The Who, When , Where and Why of using Si, SiC and GaN Transistors**
Peter Friedrichs
Infineon Technologies AG, Germany

9:20 a.m.

IS04.3 **The Path Forward for GaN Power**
Alex Lidow
Efficient Power Conversion Corporation, United States

9:45 a.m.

IS04.4 **200-mm GaN-On-Silicon Intelligent Power Solutions to Boost Performance of a New Generation of Power Converters**
Eric Moreau
ExaGaN, France

10:40 a.m.

IS04.5 **Advances Through Innovation: Transphorm Changes the Game with Gen-IV SuperGaN™ 650V GaN Platform**
Yifeng Wu
Transphorm, United States

11:05 a.m.

IS04.6 **Rugged, High-Performance 650 –1200V SiC MOSFETs with Flawless Gate Oxide Integrity**
Martin Domeij, Fredrik Allerstam, Thomas Neyer
ON Semiconductor, United States

11:30 a.m.

IS04.7 **Use of 3300V SiC MOSFETs and 1700 V SiC Diodes in Modern Applications**
Ranbir Singh, Sumit Jadav, Vamsi Mulpuri, Siddarth Sundaresan
GeneSiC Semiconductor Inc., United States

8:30 a.m. – 11:55 a.m.

IS05: Standing Up to the Mission Profiles of the Future: Capacitors Ready for eMobility & Broadband Applications

ROOM R07

SESSION CHAIRS

Fred Weber, *Future Technologies Worldwide*

Wilmer Companioni, *KEMET Electronics*

8:30 a.m.

IS05.2 **Satisfied with MLCC Downsizing and Availability? Let's Go Behind the Scenes of Technology, Their Physics & Alternatives**
Frank Puhane
Würth Elektronik, Germany

8:55 a.m.

IS05.3 **Innovative Power Capacitor Technologies for Wide Band-Gap Semiconductors**
Manuel Gómez
TDK, United States

9:20 a.m.

IS05.4 **A Ride-Along with Tantalum Polymer – A Solution for Ultra Extended Mission Profiles**
Wilmer Companioni
KEMET Electronics, United States

9:45 a.m.

IS05.5 **Hybrid Aluminum Electrolytic Capacitors High Energy Density and Low ESR for eMobility**
Manuel Gomez
TDK, United States

10:40 a.m.

IS05.6 **The Film Cap. Tech. for DC Link**
Anvy Chen
Xiamen Faratronic Co., Ltd., China

11:05 a.m.

IS05.7 **Supercapacitor based Long Time Constant Circuits: A Unique Design Opportunity for New Power Electronic Topologies**
Nihal Kularatna
The University of Waikato, New Zealand

8:30 a.m. – 11:55 a.m.

IS06: Market Research

ROOM R08

SESSION CHAIRS

Ada Cheng, *Adaclock*

Nigel Brooke, *pSemi*

8:30 a.m.

IS06.1 **High Voltage Power Management IC Platform - Market Trends and Semiconductor Solutions**
Erez Sarig
TowerJazz, Israel

8:55 a.m.

IS06.2 **A Review of the Power Device Ecosystem and IP Landscape for Gallium Nitride**
Sinjin Dixon-Warren
TechInsights Inc., Canada

9:20 a.m.

IS06.3 **The Power Electronics Industry is under Many Races: 300mm, SiC, GaN, Passives and More**
Claire Troadec, Ana Villamor, Milan Rosina
Yole Developpement, France

9:45 a.m.

IS06.4 **The Long Term Future of Wireless Charging**
Antoine Bonnabel, Claire Troadec
Yole Developpement, France

10:40 a.m.

IS06.5 **Isolation Electronics Trends in EVs**
John Wilson
Silicon Laboratories, United States

11:05 a.m.

IS06.6 **State of the Art of SiC Transistors and Modules: Technology & Cost Review**
Elena Barbarini
System Plus Consulting, France

11:30 a.m.

IS06.7 **5G Market Challenges for Power Electronics**
Francesco Carobolante
IoTissimo, United States

TECHNICAL LECTURES

APEC professionals participated in a rigorous peer review process and have carefully picked over 500 papers, which make up APEC's Technical Sessions. There are two categories of Technical Sessions. The Technical Lectures consist of papers of broad appeal scheduled for oral presentation. The various technical venues cover all areas of technical interest to the practicing power electronics professional.

8:30 a.m. – 12:00 p.m.

T01: Hybrid DC-DC Converters

ROOM 208-210

TRACK DC-DC Converters

SESSION CHAIRS

Danny Clavette, *Infineon Technologies AG*

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

8:30 a.m.

T01.1 **Cross-Coupled Series-Capacitor Quadruple Step-Down Buck Converter**
Michael Halamicek, Timothy McRae, Aleksandar Prodić
University of Toronto, Canada

8:50 a.m.

T01.2 **900-V SiC Based, Two-Phase Interleaved, Single Inductor, RSCC DC/DC Converter for use in 1500VDC PV Application**
Branislav Stevanović, Miroslav Vasić, Pedro Alou, José Antonio Cobos
Universidad Politécnica de Madrid, Spain

9:10 a.m.

T01.3 **A 47MHz Hybrid Resonant SC Converter with Digital Switch Conductance Regulation and Multi-Mode Control for Li-Ion Battery Applications**
Peter Renz[1], Michael Lueders[2], Bernhard Wicht[1]
[1]Leibniz Universität Hannover, Germany, [2]Texas Instruments Inc., Germany

9:30 a.m.

T01.4 **A Resonant 1:5 Cockcroft-Walton Converter utilizing GaN FET Switches with N-Phase and Split-Phase Clocking**
Nathan Ellis, Rajeevan Amirtharajah
University of California-Davis, United States

9:50 a.m.

T01.5 **Coupled-Inductor Configurations for a High-Gain, Interleaved, Hybrid Boost Converter**
Ankul Gupta, Raja Ayyanar
Arizona State University, United States

10:40 a.m.

T01.6 **Fast Transient Response of GaN-Based Hybrid Dickson Converter using Quasi-Fixed-Frequency Control for 48-V-to-1-V Direct Conversion in Automotive Applications**
Venkata Raghuram Namburi, Mojtaba Ashourloo, Olivier Trescases
University of Toronto, Canada

11:00 a.m.

T01.7 **Series-Capacitor Buck Converter with Soft Turn-On**
Cong Tu[1], Khai Ngo[1], Rengang Chen[2]
[1]Virginia Polytechnic Institute and State University, United States, [2]Texas Instruments Inc., United States

11:20 a.m.

T01.8 **LEGO-Boost: A Merged-Two-Stage Resonant-Switched-Capacitor Converter with High Voltage Conversion Ratio**
Yenan Chen, Jaeil Baek, Minjie Chen
Princeton University, United States

11:40 a.m.

T01.9 **A Bidirectional Resonant Two-Switch Boosting Switched-Capacitor Converter with Phase-Shift Modulation**
Shouxiang Li[1], Shengnan Liang[1], Zhenning Li[1], Wenhao Xie[2], Pengyu Jia[3], Jia Yao[4]
[1]Beijing Institute of Technology, China, [2]Harbin Institute of Technology, China, [3]North China University of Technology, China, [4]Nanjing University of Science and Technology, China

8:30 a.m. – 12:00 p.m.

T02: Converter Modeling & Analysis

ROOM 228-230

TRACK Modeling and Simulation

SESSION CHAIRS

Sideng Hu, *Zhejiang University*

Wisam Alhoor, *Dialog Semiconductor*

8:30 a.m.

T02.1 **Novel Methods for In-Situ Direct Magnetic Loss Measurement in a DC-DC Converter**
Lifang Yi, Jinyeong Moon
Florida State University, United States

8:50 a.m.

T02.2 **A Power Converter based Real-Time Air-Conditioner Motor Emulator**
Shuyao Wang[1], Haiguo Li[1], Jingxin Wang[1], Yiwei Ma[1], Fred Wang[1,2], Leon M. Tolbert[1,2]
[1]University of Tennessee, United States, [2]Oak Ridge National Laboratory, United States

9:10 a.m.

T02.3 **Small Signal Model of Triangular Current Mode (TCM) Operation for Bidirectional Source/Sink Buck and Boost Power Converters**
Aitor Vázquez, Kevin Martín, Manuel Arias, Diego G. Lamar, María R. Rogina, Javier Sebastián
University of Oviedo, Spain

9:30 a.m.

T02.4 **An Enhanced Generalized Average Modeling of Dual Active Bridge Converters**
Bochen Liu, Pooya Davari, Frede Blaabjerg
Aalborg University, Denmark

9:50 a.m.

T02.5 **Design-Oriented Equivalent Circuit Model for Resonant Converters**
Yi-Hsun Hsieh, Fred C. Lee
Virginia Polytechnic Institute and State University, United States

10:40 a.m.

T02.6 **Sample-Data Modeling for Active Clamp Flyback Converter in Critical Conduction Mode with PCM and ZVS Control at Variable Switching Frequency**
Shengyou Xu, Shen Xu, Qinsong Qian, Chong Wang, Shengli Lu, Weifeng Sun
Southeast University, China

11:00 a.m.

T02.7 **Pole-Zero Analysis of a Simple Gate Driver Circuit over the Medium Range of Frequency used in Power Electronics Devices**
Somnath Meikap, K. Ramachandra Sekhar
Indian Institute of Technology Ropar, India

11:20 a.m.

T02.8 **Improving Voltage Sensor Noise Immunity in a High Voltage and High dv/dt Environment**
James Palmer[1], Shiqi Ji[1], Xingxuan Huang[1], Li Zhang[1], William Giewont[2], Fred Wang[1,3], Leon M. Tolbert[1,3]
[1]University of Tennessee, United States, [2]EPC Power, United States, [3]Oak Ridge National Laboratory, United States

8:30 a.m. – 12:00 p.m.

T03: Renewable Energy Applications

ROOM 225-227

TRACK Renewable Energy Systems

SESSION CHAIRS

Rui Ma, *Northwestern Polytechnical University*

Praveen Jain, *Queen's University*

8:30 a.m.

T03.1 **Common-Mode Voltage Reduction of the Semi-Two-Stage Three-Phase Inverter Base on Modified Modulation Scheme**
Tianrui Ma, Tao Zhang, Li Zhang, Feng Wu
Hohai University, China

8:50 a.m.

T03.2 **No Communication Control Strategy in Photovoltaic Series-Connected Power Optimizer System**
Jizhi Qi[1], Yonghao Li[1], Yutai Fu[1], Fang Han[1], Min Chen[1], ShuYu Zhang[2], Zhang Wei[2]
[1]Zhejiang University, China, [2]Inner Mongolia Electric Power Research Institute, China

9:10 a.m.

T03.3 **Output Admittance Passivation for Grid-Side Current Controlled LCL-Type Inverters using Capacitor-Voltage Feedforward**
Chuan Xie[1], Kai Li[1], Jianxiao Zou[1], Dong Liu[2]
[1]University of Electronic Science and Technology of China, China, [2]Aalborg University, Denmark

9:30 a.m.

T03.4 **Analysis and Design of a Three-Phase Cuk-Derived PFC Converter**
S. Gangavarapu, A.K. Rathore
Concordia University, Canada

9:50 a.m.

T03.5 **Series LC Resonance-Pulse based Zero-Current-Switching Current-Fed Half-Bridge DC-DC Converter**
Swati Tandon, Akshay Kumar Rathore
Concordia University, Canada

10:40 a.m.

T03.6 **Acoustic Emission Analysis for Wind Turbine Blade Bearing Fault Detection using Sparse Augmented Lagrangian Algorithm**
Zepeng Liu, Long Zhang
University of Manchester, United Kingdom

11:00 a.m.

T03.7 **Wavelet Energy Transmissibility Analysis for Wind Turbine Blades Fault Detection**
Xuefei Wang, Long Zhang, William P. Heath
University of Manchester, United Kingdom

11:20 a.m.

T03.8 **A Phase-Shifting MPPT Method to Mitigate Interharmonics from Cascaded H-Bridge PV Inverters**
Yiwei Pan, Ariya Sangwongwanich, Yongheng Yang, Frede Blaabjerg
Aalborg University, Denmark

11:40 a.m.

T03.9 **Novel Current Sensor-Less MPPT Algorithm for Solar Applications**
Mahdi Tude Ranjbar, Suzan Eren
Queen's University, Canada

8:30 a.m. – 12:00 p.m.

T04: Magnetics and Passive Components

ROOM 206-207

TRACK Devices and Components

SESSION CHAIRS

Matt Wilkowski, *EnaChip Inc.*

Khurram Afridi, *Cornell University*

8:30 a.m.

T04.1 **Application Flexibility of a Low-Loss High-Frequency Inductor Structure**
Rachel S. Yang[1], Alex J. Hanson[2], Charles R. Sullivan[3], David J. Perreault[1]
[1]Massachusetts Institute of Technology, United States, [2]University of Texas at Austin, United States,[3]Dartmouth College, United States

8:50 a.m.

T04.2 **On-Chip Thin Film Inductor for High Frequency DC-DC Power Conversion Applications**
S. Lawrence Selvaraj[1], Martin Haug[2], Chor Shu Cheng[1], Dragan Dinulovic[2], Lulu Peng[1], Khaled El Shafey[2], Zishan Ali[1], Mahmoud Shousha[2], Yong Chau Ng[1], Nur Aziz Yosokumoro[1], Lothar Lehmann[1], Marcel Wieland[1]
[1]GlobalFoundries, Singapore,[2]Würth Elektronik eiSos GmbH & Co. KG, Germany

9:10 a.m.

T04.3 **20MHz, Two Phase Negative Coupled Inductor Design for Integrated Voltage Regulator in Smartphone Applications**
Feiyang Zhu, Qiang Li, Fred C. Lee
Virginia Polytechnic Institute and State University, United States

9:30 a.m.

T04.4 **High Accuracy Calorimetric Measurements and Modeling of Ceramic Capacitor Losses under Large Ripple Operation**
Samantha Coday, Robert C.N. Pilawa-Podgurski
University of California-Berkeley, United States

9:50 a.m.

T04.5 **Transient Calorimetric Measurement of Ferrite Core Losses**
Panteleimon Papamanolis, Thomas Guillod, Florian Krismer, Johann W. Kolar
ETH Zürich, Switzerland

10:40 a.m.

T04.6 **A Novel Three Dimensional (3D) Winding Structure for Planar Transformers**
Ruiyang Yu, Tianxiang Chen, Pengkun Liu, Alex Q. Huang
University of Texas at Austin, United States

11:00 a.m.

T04.7 **Analysis of Parasitic Capacitors' Impact on Voltage Sharing of Series-Connected SiC MOSFETs and Body-Diodes**
Xiang Lin, Lakshmi Ravi, Yuhao Zhang, Dong Dong, Rolando Burgos
Virginia Polytechnic Institute and State University, United States

11:20 a.m.

T04.8 **A Practical Method to Define High Frequency Electrical Properties of MnZn Ferrites**
Marcin Kącki[1], Marek S. Ryłko[1], John G. Hayes[2], Charles R. Sullivan[3]
[1]SMA Magnetics sp. z o.o., Poland,[2]University College Cork, Ireland,[3]Dartmouth College, United States

11:40 a.m.

T04.9 **Analytical Modelling of Current Sharing and Eddy Current Losses in PCB Windings of Stacked Transformers**
Jahangir Afsharian[1], Ning Zhu[2], Dewei Xu[3], Bing Gong[1], Zhihua Yang[1]
[1]Murata Power Solutions, Canada,[2]Sheridan College, Canada,[3]Ryerson University, Canada

8:30 a.m. – 12:00 p.m.

T05: Permanent Magnet Synchronous Motor Drives and Control Strategies

ROOM 203-205

TRACK Motor Drives and Inverters

SESSION CHAIRS

Rakibul Islam, *Dura Automotive Systems LLC*

Arijit Banerjee, *University of Illinois at Urbana-Champaign*

8:30 a.m.

T05.1 **A Decoupled Model Predictive Control Method for Twelve-Phase Permanent Magnet Synchronous Motors**
Biyang Chen, Xinjian Jiang, Jingliang Lv, Jianyun Chai, Xinzhen Zhang, Shuang Sheng
Tsinghua University, China

8:50 a.m.

T05.2 **Model Predictive Control of 5L-ANPC Converter-Fed PMSM Drives with Two-Stage Optimization**
Dehong Zhou, Li Ding, Zhongyi Quan, Yunwei Li
University of Alberta, Canada

9:10 a.m.

T05.3 **Research of Rotor Positioning on Solving the Pole Pairs Mismatch between PMSM and Rotating Transformer**
Chunjuan Zhang[1], Huizhen Wang[1], Weifeng Liu[1], Zirui Fu[2], Yongjie Wang[1], Yang Zhou[3]
[1]Nanjing University of Aeronautics and Astronautics, China,[2]Shanghai Institute of Mechanical and Electrical Engineering, China[3]Nantong University, China

9:30 a.m.

T05.4 **Intermittent Inductance Estimation for High-Speed PMSM Sensorless Control**
Bumun Jung[1], Pooreum Jang[1], Jimin Kim[2], Seungmoo Lim[2], Kwanghee Nam[1]
[1]Pohang University of Science and Technology, Korea,[2]Samsung Electronics, Korea

9:50 a.m.

T05.5 **A Novel Interior Permanent Magnet Synchronous Motor Drive Control Strategy based on Off-Line Calculation and Curve Fitting**
Yunpeng Si, Chunhui Liu, Zhengda Zhang, Yifu Liu, Mengzhi Wang, Qin Lei
Arizona State University, United States

10:40 a.m.

T05.6 **Torque Ripple and Current Distortion Reduction with Multiple Vector based Finite-Set Predictive Current Control for PMSM Drives**
Agoro Sodiq, Iqbal Husain
North Carolina State University, United States

11:00 a.m.

T05.7 **FCS Model Predictive Current Control Method for EV PMSMs at Low Control Frequency Considering Flux Mismatch**
Chao Gong[1], Mohammed Alkahtani[1], Wei Li[2], Tianhao Wu[1], Yihua Hu[1], Jinglin Liu[3]
[1]University of Liverpool, United Kingdom,[2]State Grid International Development Co. Ltd., Brazil,[3]Northwestern Polytechnical University, China

11:20 a.m.

T05.8 **Data-Driven Current Control of the PMSM with Dynamic Mode Decomposition and the Linear Quadratic Integrator**
Adam Stevens, Sodiq Agoro, Iqbal Husain
North Carolina State University, United States

11:40 a.m.

T05.9 **Low-Cost BLDC Claw-Pole Motor Design for Fan Applications with Reduced Cogging Torque and Balanced Axial Forces**
Stefan Leitner[1,2], Hannes Gruebler[1,2], Annette Muetze[1,2]
[1]Christian Doppler Laboratory for Brushless Drives for Pump and Fan Applications, Austria,[2]Graz University of Technology, Austria

8:30 a.m. – 12:00 p.m.

T06: Control of DC-DC Converters

ROOM 217-219

TRACK Control

SESSION CHAIRS

Yash Veer Singh, *Eaton*

Xinke Wu, *Zhejiang University*

8:30 a.m.

T06.1 **Online Efficiency Optimization of a Closed-Loop Controlled SiC-Based Boost Converter**
Vivek Sankaranarayanan, Yucheng Gao, Robert W. Erickson, Dragan Maksimović
University of Colorado-Boulder, United States

8:50 a.m.

T06.2 **Accurate Prediction of Vertical Crossings for Multi-Sampled Digital-Controlled Buck Converters**
Zhengyuan Zhou, Jike Wang, Zeng Liu, Jinjun Liu
Xi'an Jiaotong University, China

9:10 a.m.

T06.3 **Phase-Shift Control of Flying Capacitor Voltages in Multilevel Converters**
Samuel da Silva Carvalho, Nenad Vukadinović, Aleksandar Prodić
University of Toronto, Canada

9:30 a.m.

T06.4 **Absolute Minimum Deviation Controller for Multi-Level Flying Capacitor Direct Energy Transfer Converters**
Liangji Lu, Duo Li, Aleksandar Prodić
University of Toronto, Canada

9:50 a.m.

T06.5 **Stability Properties of Digital Predictive Current-Mode Controllers for Three-Level Flying Capacitor Converters**
Giovanni Bonanno, Luca Corradini
University of Padova, Italy

10:40 a.m.

T06.6 **An Improved Single-Mode Control Strategy based on Four-Switch Buck-Boost Converter**
Yuan Wang[1], Jianyu Lan[2], Xin Huang[1], Tianzhi Fang[1], Xinbo Ruan[1], Mengxue Dong[2]
[1]Nanjing University of Aeronautics and Astronautics, China,[2]Shanghai Institute of Space Power-Sources, China

11:00 a.m.

T06.7 **A Gm-Ramped Interleaving Technique with Adaptive-Extended TON Control (AETC) Scheme for Multi-Phase Buck Converter Achieving Fast Load Response**
Cheng-Yang Hong, Chieh-Ju Tsai, Ching-Jan Chen
National Taiwan University, Taiwan

11:20 a.m.

T06.8 **An Adaptive Control Method of DC Transformers Imitating AC Transformers for Flexible DC Distribution Application**
Feng An[1], Biao Zhao[1], Jing Wang[2], Bin Cui[1], Qiang Song[1], Tianlong Xiong[1]
[1]Tsinghua University, China,[2]Shenzhen Power Supply Bureau Co. Ltd., China

11:40 a.m.

T06.9 **Fractal Control with Anti-Windup Effect Applied on the Design of a 2000W Power Flyback Source**
Jesús Rodríguez Flores, Víctor Herrera Pérez
Escuela Superior Politecnica de Chimborazo, Ecuador

8:30 a.m. – 12:00 p.m.

T07: Reliability of Power Conversion Systems

ROOM 220-222

TRACK Power Electronics Integration and

SESSION CHAIRS

Zheyu Zhang, *Clemson University*

Qing Ye, *Toshiba International Corporation*

8:30 a.m.

T07.1 **Detection of Bond Wire Lift Off in IGBT Power Modules using Ultrasound Resonators**
Abu Hanif, A.N.M. Wasekul Azad, Faisal Khan
University of Missouri-Kansas City, United States

8:50 a.m.

T07.2 **An Improved Active Thermal Balancing Algorithm for Modular Multilevel Converter in HVDC Applications**
Di Wang, Jinjun Liu, Rui Cao, Yan Zhang, Shuguang Song, Xingxing Chen
Xi'an Jiaotong University, China

9:10 a.m.

T07.3 **Dynamic Safe Operating Area (SOA) of Power Semiconductor Devices**
Sourov Roy, Faisal Khan
University of Missouri-Kansas City, United States

9:30 a.m.

T07.4 **Duty Cycle based Condition Monitoring of MOSFETs in Digitally-Controlled DC-DC Converters**
Yingzhou Peng, Huai Wang
Aalborg University, Denmark

9:50 a.m.

T07.5 **PCB-Interposer-on-DBC Packaging of 650 V, 120 A GaN HEMTs**
Shengchang Lu[1], Tianyu Zhao[1], Rolando P. Burgos[1], Guoquan Lu[1], Sandeep Bala[2], Jing Xu[2]
[1]Virginia Polytechnic Institute and State University, United States,[2]ABB Corporate Research, United States

10:40 a.m.

T07.6 **Impedance-Balancing-Based Modulation Strategy for Common-Mode Noise Elimination of CHB Converter**
Yu Qi, Xinke Wu
Zhejiang University, China

11:00 a.m.

T07.7 **Common-Mode Current Reduction PWM Technique Optimized for Four-Wire Inverter-Fed Motors**
Zhao Zhao, Roberto Leidhold
Otto-von-Guericke-Universität Magdeburg, Germany

11:20 a.m.

T07.8 **Modeling and Reduction of Radiated EMI in Non-Isolated Power Converters in Automotive Applications**
Juntao Yao[1], Shuo Wang[1], Zheng Luo[2]
[1]University of Florida, United States,[2]Monolithic Power Systems, Inc., United States

11:40 a.m.

T07.9 **Simple Calorimetric Power Loss Measurement System using Single Chamber and Peltier Device with Ambient Temperature Tracking Control**
Kazuya Mitsugi, Yuichi Noge, Mingcong Deng
Tokyo University of Agriculture and Technology, Japan

8:30 a.m. – 12:00 p.m.

T08: Photovoltaic (PV) Inverters and Micro Inverters

ROOM 211-213

TRACK Renewable Energy Systems

SESSION CHAIRS

Yongheng Yang, *Aalborg University*

Li Zhang, *Hohai University*

8:30 a.m.

T08.1 **A Single-Stage Isolated Resonant SiC DC/AC Inverter for Efficient High-Power Applications**
S. Milad Tayebi, Wei Xu, Haoming Wang, Ruiyang Yu, Zhicheng Guo, Alex Q. Huang
University of Texas at Austin, United States

8:50 a.m.

T08.2 **A Four-Mode Three-State (FMTS) Swinging Bus Controller for PV Micro-Inverters to achieve Reactive Power Compensation and remove Electrolytic Capacitor**
Xinmin Zhang, Mahshid Amirabadi, Brad Lehman
Northeastern University, United States

9:10 a.m.

T08.3 **An Improved Quasi-Z-Source Three-Level T-Type Inverter and its Modulation Scheme**
Tao Wang[1], Xuehua Wang[1], Yuying He[1], Xu Chen[1], Xinbo Ruan[1], Zhiwei Zhang[2]
[1]Huazhong University of Science and Technology, China,[2]The Ohio State University, United States

9:30 a.m.

T08.4 **Event-Triggering Power Reserve Control for Grid-Connected PV Systems**
Qiao Peng[1], Zhongting Tang[2], Yongheng Yang[1], Frede Blaabjerg[1]
[1]Aalborg University, Denmark, [2]Central South University, China

9:50 a.m.

T08.5 **Two-Stage Power Decoupling for a Single-Phase Photovoltaic Inverter by Controlling the DC-Link Voltage Ripple in the DQ Frame**
Zhaoxia Yang[1], Jianwu Zeng[1], Dianzhi Yu[1], Qun Zhang[1], Zhe Zhang[2]
[1]Minnesota State University, United States, [2]Eaton, United States

10:40 a.m.

T08.6 **Lifetime Evaluation of Power Modules for Three-Level 1500-V Photovoltaic Inverters**
Jinkui He, Ariya Sangwongwanich, Yongheng Yang, Francesco Iannuzzo
Aalborg University, Denmark

11:00 a.m.

T08.7 **A Common Ground-Type Single-Phase Dual Mode Five-Level Switched-Capacitor Transformerless Inverter**
Md Noman Habib Khan[1], Yam P. Siwakoti[1], Mark J. Scott[2], Saad Ul Hasan[1], Benjamin Shaffer[3], Li Li[1], Shakil Ahamed Khan[1], Frede Blaabjerg[4]
[1]University of Technology Sydney, Australia,[2]Miami University, United States,[3]The Ohio State University, United States,[4]Aalborg University, Denmark

11:20 a.m.

T08.8 **A Novel Five-Level Switched Capacitor Type Inverter Topology for Grid-Tied Photovoltaic Application**
Shakil Ahamed Khan[1], Md Noman Habib Khan[1], Youguang Guo[1], Yam P. Siwakoti[1], Jianguo Zhu[2]
[1]University of Technology Sydney, Australia, [2]University of Sydney, Australia

11:40 a.m.

T08.9 **A Dual Active Bridge Converter with Multiphase Boost Interfaces for Single-Stage DC-AC Conversion**
Akhil Chambayil, Souvik Chattopadhyay
Indian Institute of Technology Kharagpur, India

RAP SESSIONS

The APEC 2020 RAP Sessions feature several exciting and contentious topics. RAP Sessions allow for exciting dialogue amongst attendees and presenters. Admission to all Rap Sessions is free with an Exhibits Only Registration.

5:00 p.m. – 6:30 p.m.

RAP SESSION #1:
Distributed vs. Centralized Control for Micro-Grid and Nano-Grid

ROOM 208-210

MODERATOR:
Alix Paultre, *Smartalix*

PANELISTS:

- **Madhav Manjrekar,** *University of North Carolina in Charlotte*
- **Ali Husain,** *ON Semiconductor*
- **Raghavan Nagarajan,** *Wind and Transmission & Distribution (T&D)*
- **John Lannan,** *Analog Devices*
- **Matt Baker,** *Microgrids and Critical Power, Typhoon HIL*

The ongoing migration towards more automated and self-sufficient facilities and campuses continues, there are issues of control and oversight that need to be addressed. One question is the developing debate between next-generation wireless in the Cloud and Edge Computing, for example. The related area of interest in the power space is the question of centralized or decentralized control in a micro- or nano-grid. Just as the IT world is trying to define the technologies and applications at the edge of the Cloud, so too must the power industry define its scope within the smart environment created.

In this session the panel will discuss and debate the merits of distributed vs. centralized power distribution in microgrids and smart facilities. On the one hand, although micro-grids themselves represent a form of decentralization in and of itself in regards to the local power grid, how that power is deployed within the micro-grid must also be determined. The panel is made up of two teams: one for centralized power, and one for distributed power. Both approaches have their merits, and our panel members will present their ideas and views on which is most appropriate. Please join us and debate this topic with our expert panelists.

5:00 p.m. – 6:30 p.m.

RAP SESSION #2:
Does High Level of Integration Make Power Converters More Reliable or Not?

ROOM 217-219

MODERATOR:
Indumini Ranmuthu, *Texas Instruments*

PANELISTS:

- **Madhu Chinthavali,** *Oakridge National Lab*
- **Robert Pillawa,** *University of Berkley*
- **Sandeep Bahl,** *Texas Instruments*
- **ChengChi Chen,** *Ford*
- **Huai Wang,** *Aalborg University*
- **Craig Popken,** *Artesyn*

There is significant trend in the industry towards higher power density and integration in power supplies. Progress made in wide bandgap devices and power packaging has accelerated this trend. Given this the reliability of wide band gap devices, new magnetics and advanced packaging now directly influences the system reliability. As power density goes up it tends to affect thermal signature as well. In cases where total power loss is reducing due to SiC, GaN the cooling systems can be simplified and made to be more reliable. Also integration has allowed enhanced protection and reliability features to be implemented. From a practical stand point reliability can have a tradeoff with cost as well. As we all know industry wants reliable and cost effective products. In this session, the panel will discuss, debate the merits and challenges of high level of integration in power systems. Please join us and debate this topic with our expert panelists and find out the state of the art.

5:00 p.m. – 6:30 p.m.

RAP SESSION #3:
Where Does the Expertise for the Next Generation of Magnetics Come From? The Magnetics Companies, or the Engineer Designing the Power Supply.

ROOM 220-222

MODERATOR:

Kevin Parmenter, *Taiwan Semiconductor*

PANELISTS:

- **Paul Greenland,** *Analog Devices*
- **Paul Yeaman,** *Vicor*
- **Dan Jitaru,** *Rompower*
- **Brooks Leman,** *Maxim Integrated*
- **Jim Marinos,** *Payton Magnetics*
- **Ray Ridley,** *Ridley Engineering*
- **Kevin Enser,** *Renco Electronics*

The next great frontier in power supply design is magnetics. Decades of investment in semiconductor technology has given us a wide array of almost-perfect switches, but to take full advantage of this, we are going to need new technology for the inductors and transformers.

Who is going to do this work? Will it be the magnetics manufacturers or the power supply designers? Manufacturers have a deep knowledge of materials and processes needed to assemble components. However, the circuit designer has an intimate knowledge of all the topologies available, the waveforms and harmonic content. Perhaps the semiconductor companies doing the reference designs have this knowledge or could it be something else? Who is most qualified to assess the performance of new designs? In this lively rap session, we will look at the paths available for future progress. Highly qualified panel members from all sides of the issue will provide an entertaining and informative evening that is not to be missed.

EXHIBITOR SEMINARS *as of February 21, 2020*

APEC 2020 Exhibitor Seminars will highlight new products or initiatives that companies in the power electronics industry are developing, along with allowing the opportunity for attendees to interact with other companies in the industry.

1:00 p.m. – 1:30 p.m.

Exhibitor Seminars – Session 1

Ridley Engineering, Inc.

EXHIBIT THEATER 2

Frequency Response Measurements for Power Systems

PRESENTED BY: **Dr. Ray Ridley**

The AP310 Test & Measurement System, powered by RidleyWorks®Design Software, is the most powerful full-featured analyzer in the industry. Developed by AP Instruments in the 1990s, this instrument has led the test and measurement market with new features and applications every year since its inception. Typical users include aerospace, defense, university research, and high-performance commercial applications.

The RidleyBox®, also powered by RidleyWorks® Design Software, is our new compact and portable Design & Test Center — including a 4-channel Oscilloscope, Frequency Response Analyzer, Injection Isolator, and Computer — in a small package at an affordable price. Typical users include applications engineers, university teaching, consultants and mid-range commercial applications.

TDK Corporation

EXHIBIT THEATER 3

High Frequency Film Capacitors for Advanced Semiconductors

PRESENTED BY: **Manuel Gomez**

New modular DC-Link film capacitor technologies have been developed by TDK. These technologies assist in controlling electromagnetic effects and improve the efficiency and power density of power converters.

High frequency performance of film capacitors will be analyzed, including a description of the electromagnetic root causes and how to control them. The analysis will be based on both experimental results and electromagnetic simulations based on PEEC (Partial Equivalent Electrical Circuits). Main root causes analyzed will be: skin effect, internal resonances, inhomogeneous internal impedances, electromagnetic interactions and metallization profiles.

Texas Instruments

EXHIBIT THEATER 4

Solving High-Power Density and EMIi Challenges With High-Voltage Isolated and High-Current Non-Isolated Converters & Modules

PRESENTED BY: **Rich Nowakowski**

Board space is limited, and unwanted EMI noise presents itself when least expected. Designers of telecommunication units, industrial test and measurement equipment, rack servers, and automotive sub-assemblies are trying to fit more features and functions into a confined space, and do it quietly. Texas Instruments released new gate drivers, DC/DC converters, and non-isolated power modules with packaging, process, and circuit design improvements to help designers save space and reduce noise, which allows them to differentiate their own products in the marketplace. This presentation will highlight products demonstrated at the show and describe how advance technology improves power density and noise performance.

Infineon Technologies Americas Corp

EXHIBIT THEATER 1

The New 650V Silicon Carbide MOSFET from Infineon

PRESENTED BY: **Sam Abdel-Rahman**

The 650V SiC MOSFET is the new addition to the Infineon silicon carbide portfolio. Build on the CoolSiC™ technology, the novel 650V SiC MOSFET is capable of bringing assessable benefits to applications ranging from SMPS, power converters, UPS, PV inverters, energy storage system and electrical vehicles. How will the new MOSFET coexist with the 600/650V CoolMOS™ superjunction MOSFETs and CoolGaN™ HEMTs? Which are the distinctive features of the 650V CoolSiC™ MOSFET technology? What is Infineon's vision for the SiC and wide band gap future?

1:45 p.m. – 2:15 p.m.

Exhibitor Seminars – Session 2

Powersim, Inc
ROOM 211-213

DSIM – A Quantum Leap in Simulation Speed

PRESENTED BY: **Albert Dunford**

The DSIM engine revolutionizes offline power electronics simulation. DSIM is 100s to 10,000s of times faster than existing simulation tools. This incredible performance boost will disrupt the way power converters are conceived and designed.

DSIM allows for a non-ideal switch to be simulated with minor impact to overall simulation speed. DSIM enables more to be done with simulation, which will change the design cycle as fewer prototypes need to be built. Simulate different scenarios or converters, microgrids and other systems with thousands of switches.

With DSIM the power electronics design cycle will be reimagined.

Mitsubishi Electric US, Inc
EXHIBIT THEATER 4

Mitsubishi Next Generation SiC

PRESENTED BY: **Eric Motto**

This presentation will show Mitsubishi Electric's latest developments in high power SiC modules for industrial, commercial and transportation applications. Newly developed devices with blocking voltage ratings ranging from 600V to 3.3KV and current ratings from 25A to 1200A will be presented. The presentation will include an overview of device structure and electrical characteristics as well as an update on the latest chip technology and future development roadmap.

Transphorm
ROOM 225-227

No Digital Control Experience Needed: Bridgeless Totem Pole PFC GaN Designs Made Simple with Transphorm and Microchip

PRESENTED BY: **Jenny Cortez,** *North American FAE, Transphorm Inc.*

High voltage GaN FETs are optimized within the bridgeless totem pole PFC topology. However, use of this topology within power systems is still fairly new. As is the requirement to digitally control such systems when building AC to DC converters. These realities may limit access to the high efficiency (> 99%), high performance GaN power electronics. Committed to closing that knowledge gap between traditional Silicon power designs and advanced GaN power designs, Transphorm—along with partner Microchip Technology—tackles these challenges head on. Join the companies as they demonstrate the first DSP-integrated bridgeless totem pole PFC reference design for 4 kW AC to DC applications using Transphorm's latest Gen IV technology and Microchip's dsPIC. Further, learn how a globally supported, production-ready reference design that provides a digital code development environment will help you quickly bring to market reliable, optimized GaN-based products.

ON Semiconductor
ROOM 203-205

New Innovative TM-PIM solving Reliability and Robustness issues in Industrial Drives

PRESENTED BY: **Jinchang Zhou**

Industrial Drives are used in a variety of environments that expose the semiconductors used in the drives to harsh gases in addition to needing to last extended lifetimes. Currently, the most commonly used semiconductor power modules are gel-filled that experience reliability and robustness issues in these harsh environments. ON Semiconductor's new Transfer-Molded Power Integrated Modules (TM-PIM) use traditional transfer-molded packaging addresses these concerns with improved reliability and robustness characteristics. A comparison will be made between these two types of modules demonstrating the benefits that the TM-PIM offers to Industrial Drives.

Mersen
EXHIBIT THEATER 3

Improving Safety & Reliability for Power Electronics

PRESENTED BY: **Kian Sanjari, P.Eng.**

Session presents Mersen's commitment to develop industry leading technologies to improve efficiency and reliability of power electronics equipment. Key topics include an Overview of High Speed Protection Fuses and innovative hybrid DC overcurrent protection devices for EV/EES applications. We will explain how Air and Liquid Cooling solutions provide thermal protection for semiconductor components and that efficient cooling is key to long term reliability and performance of fast switching semiconductor components. We will also present how Laminated bus bars provide the most efficient connection between various components, thus limiting parasitic inductance, improving ease of assembly and integration while minimizing wiring errors and costs.

Chroma Systems Solutions, Inc.
EXHIBIT THEATER 1

Total EV Testing Solution, From Car to Component Testing

PRESENTED BY: **Luis Veliz**

Chroma understands the automotive trends and obstacles that our customers face during design verification, functional and mass production testing and we have been actively developing solutions to improve EV testing performance by developing instruments, functional test systems, battery test and simulation systems. Chroma understands the whole scope of work and, besides reliability and performance as customers are usually accustomed to focus on, we also extend our expertise to electrical safety who is often forgotten as we enter the all-electric car world with a myriad of electrical safety analyzers for multiple uses.

Chroma is a technological leader for nearly 30 years in the Power Conversion Testing world and Electric Vehicles hit our sweet spot under our expertise, this presentation will cover the major components starting from the outside world with the commonly known as EV Charger (or technically known as AC or DC EVSE and all its available standards and modes like wired and wireless), then moving to the next to component in-line as we make our way through the car which is the OBC (or On-Board Charger) followed by the DC-DC Converters routing power to other components and finally to the core, which is the battery. Then exploring each testing and simulating each brand to have a Total EV Testing Solution, from car to component testing!

OPAL-RT Technologies
ROOM 206-207

Accelerate Product Development Using Power Hardware-in-the-Loop

PRESENTED BY: **Pierre Boissoneault**

Real time simulation and hardware-in-the-loop (HIL) allows engineers to combine the design, development and validation steps of products reducing their time to market. Power HIL (PHIL) allows the development engineers to go a step further and validate the product operation with actual power exchange with the device under test, while emulating rest of the system with a combination of a real time simulator and a power amplifier.

Setting up a PHIL testbed requires thorough understanding of its components and implications that arise when integrating them to constitute a testbed. The seminar will introduce the steps involved and the components required in setting up a PHIL testbed for various applications. The services and products that Opal-RT provides in setting up a testbed will also be presented.

CogniPower
EXHIBIT THEATER 2

New Technique for Achieving Ultra-Low Standby Current

PRESENTED BY: **Tom Lawson**

Denser and more efficient power supplies with lower vampire power are in ever-increasing demand. New technologies push back earlier limits while lowering cost. Demand Pulse Regulation (DPR), an emerging topology, offers both simplicity and efficiency. DPR can also provide an order of magnitude lower vampire current when combined with new triggered pulse generation circuitry.

That simple trigger circuit has other applications for IoT power and standby supplies, as well as for battery powered devices. The triggered pulse generation circuit will also be shown serving as an ultra-efficient power switch driver for a buck converter that runs on vanishingly low vampire power.

2:30 p.m. – 3:00 p.m.

Exhibitor Seminars – Session 3

Siemens Digital Industries Software
ROOM 203-205

Developing Optimum Motor Configurations with Multi-Physics Simulation and Design Exploration

PRESENTED BY: **Adrian Perregaux**

Delivering on-time, innovative electric motor designs and evaluating system performance is typically a time consuming simulation and analysis task. To enable more efficient development, Siemens Digital Industries provides several accurate simulation tools (available on the PC) which allow you to do coupled multi-physics (magnetic & thermal), coupled multi-domain (1D, 2D & 3D) analysis and an ability to combine these with extensive design exploration capabilities to assess a large numbers of design variations and operating scenarios to optimize your design faster. This presentation introduces this new approach to motor design with simulation, system analysis and an efficient workflow.

Simcenter Motorsolve, for motor electromagnetics performance, coupled with Simcenter FLOEFD, a fully CAD embedded CFD tool, provide you with the robust ability to replicate your laboratory experiments with “virtual prototypes” that reflect local heat distributions and material property dependencies. Simcenter HEEDS, a design exploration tool, is demonstrated controlling the various geometry parameters for the rotor and stator components and how to explore design alternatives required to maximize shaft torque and motor efficiency while minimizing

magnet mass and torque ripple. Finally, assessing the system performance of the motor alongside other components is assessed for in-service use using Simcenter Amesim, the 1D system simulation software, by incorporating behavior models from prior motor design analysis for expected operating ranges into a system model.

Simplis Technologies
ROOM 206-207

Using the SIMPLIS Magnetic Design Module and the SIMPLIS C-code DLL Digital Control Feature in an LLC Converter Application

PRESENTED BY: **Andrija Stupar, John Wilson**

The SIMPLIS Magnetics Design Module is used to analyze the performance of both the transformer and the resonant inductor in an LLC converter. Magnetic device loss predictions – including core losses, skin and proximity effect losses in the windings – are compared to measured and FEM simulation results.

Digital control of this LLC converter is implemented with the SIMPLIS C-code DLL feature of SIMetrix/SIMPLIS Pro or Elite Version 8.4. User-defined C or C++ code describes the digital behavior of the LLC controller using three functions: housekeeping setup, assignment of initial conditions of the output pins, and the digital device's behavior during simulation.

United Silicon Carbide
ROOM 211-213

UnitedSiC Debuts "Next Generation" (Gen 4) SiC FET Technology, Delivers New Levels of Efficiency, Losses and Cost Effectiveness

PRESENTED BY: **Dr. Anup Bhalla,** *VP of Technology, UnitedSiC*

UnitedSiC will discuss the characteristics of a new generation of SiC FET technology, which sets new benchmarks for RdsA, Rds*Eoss etc. Device characteristics relevant to hard and soft switched applications will be presented, along with thermal resistance, avalanche and short circuit behavior. The end product impact on key applications such as EV inverters, chargers, and server/telecom power supplies will also be described. Finally, power designers will be shown a direct path for easy upgrading of existing Si superjunction FETs to higher-performance, cost-effective SiC FETs.

Wurth Electronics
ROOM 225-227

USB Type-C Power Delivery, A New Power Paradigm

PRESENTED BY: **George Slama**

As consumers upgrade their electronic devices, USB Type-C® is taking over the ports on just about everything. Not only is it becoming the defacto port, it's becoming the only port type on many devices. Leaving laptops are the multitude of video ports (VGA, HMDI, Mini HDMI, DisplayPort, Thunderbolt, etc.) – never the right one you need – but also charging, audio and any other interface. The USB Type-C® is an extremely versatile connector system. It is also unique from a power point of view. Not only can it source or sink power, it can provide different voltages at different power levels. No longer are we restricted to 5 V at a few watts. Now devices can negotiate their power requirements up to 100 W (20 V @ 5 A) if available. This session gives an overview of the USB Type-C Power Delivery subsystem from source to sink including the type of power converters that can be used as well as protection and filtering devices required for a successful implementation.

Mouser Electronics, Inc.
EXHIBIT THEATER 2

Enabling and Expanding Broader Power Markets with Silicon Carbide

PRESENTED BY: **Guy Moxey**

Using leading edge technology development to achieve both performance and cost, Wolfspeed is expanding the reach of Silicon Carbide power devices into broader applications where silicon fails to deliver. From 600V to 10kV, watts to mega watts, silicon carbide is now way past an interesting concept and is being widely adopted in all major market segments and end user systems. Wolfspeed is leading this charge with the industries commanding position both in established product offering and new technology.

Dean Technology, Inc.
EXHIBIT THEATER 1

Thermally Protected Power Line SPDs from Dean Technology

PRESENTED BY: **Jawanza Hall**

The HE series from Dean Technology are UL approved Type 1 and Type 2 power line surge protection devices covering system voltages from 120 to 600 volts and 25 to 300 kA per phase, in four different package sizes with a variety of features.

Panasonic
EXHIBIT THEATER 4

X-GaN Power Transistor in Practical Use

PRESENTED BY: **Kazuhiro Murata**

After Panasonic launched high reliability GaN power transistor, that practical use have been expected in the market.

Nowadays, the challenges which prevent from the practical use of GaN transistor have been solved by the world wide engineers' effort including us.

On this seminar, we will present 1) the superior ability in reliability of Panasonic X-GaN, 2) the feature of Gate and its driving method and 3) the effective application to maximize GaN benefit.

NH Research, Inc.
EXHIBIT THEATER 3

Battery Emulation Test Solutions: Technology Trends & Opportunities

PRESENTED BY: **Martin Weiss**

Using batteries as power sources for testing is an extremely time-consuming and costly challenge across the transportation electrification industry including EV, aerospace, and e-mobility markets. The transition from traditional to modern electrification architectures, require flexible and scalable testing methodologies.

Testing with batteries can delay projects, increase safety risks and hinder engineering productivity. As electrification is evolving to higher power demands, the ability to emulate a battery or energy storage systems with speed and precision is critical. Battery emulation can substantially reduce test time, energy consumption and operating costs.

Learn what battery emulation capabilities are the right approaches for faster, scalable and more repeatable testing. We'll share next generation techniques for testing propulsion systems in planes, trains and automobiles. This talk will also cover industry uses cases for testing DC Fast Chargers, batteries and other EV applications from R&D to production.

3:15 p.m. – 3:45 p.m.

Exhibitor Seminars – Session 4

Focused Test, Inc.
EXHIBIT THEATER 2

An Innovative Technique for Calibrating Sub-NanoCoulomb Gate Charge of Power Discrete Devices

PRESENTED BY: **Gordon Leak**

Focused Test, Inc manufactures the FTI 1000 test system for DC and AC characterization and production test of power discrete devices. FTI 1000 performs AC tests such as Gate Charge (Qg) test using an AC channel board as part of our 'Tester-per-Board' system architecture. The Gate Charge test method uses an on-board Pulse Generator to supply a constant current Gate ramp and an on-board Digitizer to capture the Gate voltage. A software algorithm detects the Qgs and Qgd inflection points and datalogs the Gate Charge values.

We have developed a proprietary calibration method to eliminate the parasitic parameters of the test fixture and device package to enable accurate Qgs and Qgd measurements on devices with sub-1nC Gate Charge. To illustrate this, consider a high voltage discrete device with 1pF Gate to Drain capacitance. At 500V operation this results in a Qgd of 500pC. Our Qg calibration method ensures that the total parasitic capacitance is reduced to less than 1pF to enable accurate Qgd measurement.

Pulse Electronics
ROOM 225-227

High Voltage Isolation Transformers for Industrial and Automotive Battery Applications

PRESENTED BY: **John Gallagher, David Wiest**

The demand for low-power, high-voltage isolation transformers has increased dramatically in the last few years as a result of the growth in high power electric mobility systems, energy storage systems, charging stations and industrial automation. Although not part of the main power train, these small, high-density transformers, are crucial in isolating user accessible ports from dangerous high voltage systems and ensuring overall compliance with various global safety standards. Typically, these transformers are converting < 5W of power but are connected to 400V/800V/1.2kV systems requiring isolation in excess of 5kVrms. This seminar will explain and detail several design approaches for maintaining the required agency safety distances (creepage and clearances), review some common pitfalls when dealing with triple insulated Teflon wire (TIW) and fully insulated magnet wire (FIW) as well as explain some of the ramifications of the new IEC61558-1 safety standard as it supersedes the traditional UL60950-1.

Pulse Electronics will introduce multiple new high voltage isolation transformer platforms for use with push-pull, flyback and h-bridge topologies, review the relevant specifications and applications including industrial control boards, solar systems, UPS and electric vehicles.

DEWESoft LLC

EXHIBIT THEATER 1

DEWESoft Power Analyzer

PRESENTED BY: **John Miller**

DEWESoft will present their one-of-a-kind power analyzer. DEWESoft's power analyzer is unique in the market with the capability of continuous (or triggered) storing of all raw data along with any computed data, making it one of the most versatile platforms on the market.

The instrument allows the user to easily synchronize the power analyzer to any other inputs including analog (temperature, pressure, force, etc.), digital (encoders, Tachometers, etc.), Video, GPS, CAN, Ethernet, or many other inputs. This flexible hardware with powerful software combines the functionalities of a Power Analyzer, Scope, FFT Analyzer, Data Logger, Transient Recorder and Power Quality Analyzer in a single instrument. This product is truly the first of its generation and great for any power electronics applications ranging from evaluating converts, motor inverter analysis, renewable energy or charging testing, etc.

Nichicon (America) Corp

ROOM 211-213

Nichicon's New Li-Ion Battery: Disrupting and Revolutionizing Energy Storage!

PRESENTED BY: **Mark Gebbia**

Nichicon is introducing our newest small lithium-ion rechargeable battery. This new technology is the best of two worlds; EDLC's and Li-Ion batteries.

In this presentation we will discuss the technical details of the SLB series as well as possible applications.

ITG Electronics, Inc.

EXHIBIT THEATER 4

Selecting The Right Inductor for Buck Converter Application

PRESENTED BY: **Rickey Cheang**

Inductor is a very important electrical component for energy storage, transfer, amplify and releasing in a power converting circuit. A good inductor is able to provide a high-efficiency and stable power supply which is extremely important to the electronics equipment and device. How to choose the right power inductor for the application to meet the high efficiency requirement becomes the first consideration. In this presentation, we will review the power converters, focusing on DC-DC and Buck converter to select the right inductor based on consideration of inductance, core material comparison, and power loss.

Heraeus Electronics

EXHIBIT THEATER 3

High Reliable Packaging Solutions for High Power Density Modules in Electronic Vehicles and Other Applications

PRESENTED BY: **Ryan Persons**

Problematic for thermal cycling during die-attach and during mission profile in power electronics is the mismatch of coefficients of thermal expansion (CTE) of copper and semiconductor (17ppm/K for Cu, around 3-5ppm/K for Si, SiC, GaN) that leads to mechanical stress possibly destroying the brittle semiconductor.

Metal ceramic substrates (MCS) mitigate this problem. They typically consist of a stack of bottom and top copper sheets separated by a ceramic sheet. This ceramic sheet has three basic functions: 1) confining the high CTE of the copper, 2) electrically insulating the top copper sheet carrying electric power from the grounded bottom sheet, while 3) providing thermal conductivity for the excess heat to be dissipated.

An outstanding level of reliability can be achieved using silicon nitride ceramics (Si3N4), offering a high thermal conductivity combined with an excellent mechanical robustness (high bending strength and high fracture toughness) compared to standard MCS, which are alumina based and direct copper bonded (DCB) substrates. To attach copper sheets to a silicon nitride sheet, an active metal brazing (AMB) process must be applied, forming a 10-30µm thick very strong brazing zone. It is so strong that copper sheets of up to 1mm thickness can be applied to the ceramic, having typical thicknesses of 0.32mm and 0.25mm. The outstanding thermal dissipation performance and mechanical robustness of Condura®.prime enables power modules with highest power densities.

Combined with customized mAgic silver sinter paste for die-attach and top side connection materials like aluminum thick bonding wires and ribbons, copper and coated copper bonding wires (CuCorAl®) and most importantly the Die Top System (DTS®), HET enables its customers using the full potential of wide-bandgap semiconductors (SiC, GaN).

KEMET Electronics Corporation
ROOM 203-205

K-LEM: KEMET Life Expectancy Model

PRESENTED BY: **Walter Bruno, Vincenzo Emanuele Caridà, Hector Nieves**

Temperature, Relative Humidity and Voltage Stress combinations on Metallized Films trigger different aging mechanisms and impact the performance of Film Capacitors during application.

K-LEM (KEMET Life Expectancy Model) is a powerful tool able to predict Metallized Film Capacitor service life for series designed to withstand temperature, humidity & voltage (THB).

K-LEM is the first of its kind tool able to take into consideration the Temperature, Relative Humidity and Voltage effect based on a model developed at KEMET from experimental measurements on capacitors.

The Life Expectancies calculated by the Model are a useful tool for designers to model typical behavior of a Film Capacitor based on the mission profile of the appliance or electronic device.

We are developing a K-LEM Web application tool where customers can input the Voltage, ambient temperature, Irms current, frequency & relative humidity for all the conditions related to the mission profile.

The KEMET tool allows a designer to select the part number that bests fit with customer needs and its life expectancy.

Littelfuse, Inc.
ROOM 206-207

IXYS Gate Drivers

PRESENTED BY: **Xuning Zhang**

An essential building block of any converter design, the gate driving circuitry is sometimes overshadowed by the power semiconductors of the system. As a manufacturer of both power semiconductors and gate driver ICs, Littelfuse has extensive knowledge about how these components should best be implemented to maximize system performance.

4:00 p.m. – 4:30 p.m.

Exhibitor Seminars – Session 5

Murata
ROOM 203-205

New High-Power, High-Frequency Transformer Improves Efficiency and Size in Fast-Charging Applications

PRESENTED BY: **Andrea Polti**

With advances in semiconductor technology, magnetic components are becoming a barrier to better efficiency in high-power, high-frequency converters, such as electrical vehicle (EV) DC fast chargers.

Thanks to Murata's patented pdqb winding technology, designs no longer need to be constrained by lossy conventional transformers. This technology opens up a world of opportunities for energy, cost and size savings, with consequent user benefits.

Dexter Magnetic Technologies
EXHIBIT THEATER 1

Providing Value to Core Materials

PRESENTED BY: **Charles Wild**

In this presentation, Dexter Magnetic Technologies will present the value experience can provide in the choice of materials for applications, based on frequency, temperature or other operating conditions. The presentation will then look at various manufacturing techniques for providing gapping for standard cores as well as an in-depth analysis of "complete custom" cores and the various machining techniques used to perform these operations, including surface grinding, ID/OD grind, milling, slicing, centerless grind and CNC.

Henkel Corporation
EXHIBIT THEATER 2

Thermal Interface Solutions for Packaging Power Electronics

PRESENTED BY: **Danny Leong**

Continued miniaturization, automotive electrification, 5G and Industry 4.0 demand ever increasing use of thermal solutions for performance, reliability and safety of power electronics. Power electronics based on silicon devices must operate below 125 C and IGBTs under 150 C - WBG devices could extend this to 200 C. Thermal management of power electronics requires interfacing the package to a heat sink using a thermal interface material (TIM).

Traditionally used thermal greases provide good end of line performance but they can degrade. TIMs come in a wide variety of properties, physical formats and automation readiness to suit the wide variety of applications. Additionally, TIMs may be tasked with insulation reliability, adhesion and encapsulation. Hence, the selection depends on the thermal and electrical insulation needs to meet the respective application requirements. Moreover, the solution has to have manufacturability and automation in selecting the right solution TIM.

SanRex Corporation

ROOM 206-207

High Reliability Packaging Technologies for SiC MOSFET

PRESENTED BY: **Harry Hiraoka**

SanRex's low Rds(on) Silicon Carbide MOSFET is in TECHNO BLOCK package, and is bringing out the best performance out from DioMOS dies. TECHNO BLOCK uses the latest transfer molding technologies, and has stretched its Power Cycle 3-5 times over the conventional packages. The new package also significantly reduced its size, and is ready to take on the challenges from the power conversion industries, demanding higher power density. SanRex is a Japanese manufacturer of Power Semiconductor with its own die foundry, packaging facilities, and design R&D.

SST Vacuum Reflow Systems

ROOM 211-213

Extremely Low-Void, Lead-Free Solder Solutions for Power Module Applications

PRESENTED BY: **Matt Vorona**

Power Semiconductors have enjoyed steady growth for at least the last 15 years, with only the occasional down turn. These devices are expected to be more efficient and to operate under more stressful conditions, such as higher temperatures, more power cycles, etc. This is particularly true for the automotive industry, as it transitions from the fossil fuel-powered engine to the electric vehicle.

SST Vacuum Reflow Systems is addressing these issues to provide extremely low-void, lead-free solder solutions for power module applications. They will present an overview of their automated solutions and test results.

IWATSU Electric Co.,Ltd.

EXHIBIT THEATER 4

Evaluation of Power Loss using High Voltage Probe and 100MHz Rogowski Coil Current Probe for GaN/SiC, Magnetics Material Device and Actual Measurement Example of EHV

PRESENTED BY: **Ryu Nagahama**

We will help to solve low distortion power loss measurement to using 100MHz rogowski coil current probe and high bandwidth differential probe . And we show many example for measuring EV's inverter.

VisIC Technologies

ROOM 225-227

D3GaN for EV Motor Inverter Applications

PRESENTED BY: **Tamara Baksht**

In this session, you will be able to learn about how VisIC's D3GaN solution supports the high demanding automotive requirements for motor inverter applications and the benefits of using it. We will present the eMobility application package which consists of inverter and charger sections. Test results of GaN-based inverter above 45 kW, paralleling capability of D3GaN platform up to 600A with related thermal measurements and short circuit protection will be presented. The high-frequency operation that leads to disruptive power density will be presented in battery chargers. Reliability data and automotive readiness of D3GaN platform will be presented and openly discussed.

Indium Corporation®

EXHIBIT THEATER 3

High Reliability Solders & Technology for Power Electronics

PRESENTED BY: **Tim Jensen**

The solder joints for die attach and substrate attach are critical layers in the stack-up of a power module. In this session, two methods for improving the reliability of these interfaces will be discussed. One method is to design an alternative alloy to change the solder joint microstructure. The second approach is to reinforce the solder with a metal matrix. It is also possible to combine both approaches for even further improvement.

8:30 a.m. – 9:55 a.m.

IS07: Data Center

ROOM R04-R05

SESSION CHAIRS

Wisam Moussa, *Infineon Technologies*

Misha Kumar, *Delta*

Davide Giacomini, *Infineon Technologies AG*

8:30 a.m.

IS07.1 **An Active Inrush Current Limiter based on a SCRs Control for a 3.6kW Bridgeless PFC Totem Pole**
Ghafour Benabdelaziz
STMicroelectronics, France

8:55 a.m.

IS07.2 **Analysis of the Body Diode Roles in Resonant Topologies and Failures Evaluation**
Domenico Nardo, Alfio Scuto, Simone Buonomo
STMicroelectronics, Italy

9:20 a.m.

IS07.3 **An Ultra-Thin 48 V-20 V, 250 W DC-DC Converter using GaN FETs and Digital Control**
Jianjing Wang, Yuanzhe Zhang, Michael de Rooij
Efficient Power Conversion Corporation, United States

8:30 a.m. – 10:10 a.m.

IS08: Production Use Cases of Wide Bandgap Semiconductors

ROOM R02-R03

SESSION CHAIRS

Tirthajyoti Sarkar, *ON Semiconductor*

Tim McDonald, *Infineon Technologies*

8:30 a.m.

IS08.1 **Cost Effective ToF Lidar using GaN Devices**
John Glaser, Alex Lidow
Efficient Power Conversion Corporation, United States

8:55 a.m.

IS08.2 **Portable Power for the People: Inergy Realizes its Vision with Transphorm GaN**
Philip Zuk[1], Sean Luangrath[2]
[1]Transphorm, United States, [2]Inergy, United States

9:20 a.m.

IS08.3 **High-Density 65W USB-PD GaN Chargers: Market Demand, Technical Solutions and Pricing**
Stephen Oliver
Navitas Semiconductor, United States

8:30 a.m. – 10:10 a.m.

IS09: WBG Going Mainstream: Commercial and Industrial Applications

ROOM R01

SESSION CHAIRS

Victor Veliadis, *PowerAmerica*

James LeMunyon, *PowerAmerica*

8:30 a.m.

IS09.1 **Challenges in Testing SiC Devices**
Stephen Bayne[1], Jonathan Forbes[2], Joshua Macfie[2], Jim Tsoi[2], Mark Harral[2]
[1]Texas Tech University, United States, [2]Group NIRE, United States

8:55 a.m.

IS09.2 **Solid-State Circuit Breakers**
Ryan Kennedy
Atom Power, Inc., United States

9:20 a.m.

IS09.3 **Enabling 1.4 kV Multi-kW Grid Converters with TI-GaN**
Tong Yao, Paul Brohlin, Johan Strydom, Masoud Beheshti
Texas Instruments Inc., United States

9:45 a.m.

IS09.4 **Wide-Band-Gap Power Semiconductor Devices for Automotive Applications - Opportunities & Challenges**
Chingchi Chen
Ford Research and Advanced Engineering, United States

8:30 a.m. – 10:10 a.m.

IS10: Applications I

ROOM R06

SESSION CHAIRS

David Levett, *Infineon Technologies AG*

Davide Giacomini, *Infineon Technologies AG*

Greg Evans, *Welcomm, Inc.*

8:30 a.m.

IS10.1 **Is Stable really Stable? How Load Input Impedance can influence Transient Response and Stability**
Peter James Miller
Texas Instruments Inc., United States

8:55 a.m.

IS10.2 **Modeling the Performance of Embedded Heat Pipes in Heatsinks with Dependable Results for Power Electronic Applications**
Cliff Weasner, Neda Mansouri, Ahmed Zaghlol
Mersen, Canada

9:20 a.m.

IS10.3 **10 kV Thyristor Over-Voltage Protection for AC/DC Conversion**
Ghafour Benabdelaziz
STMicroelectronics, France

9:45 a.m.

IS10.4 **Charging with USB Type-C™ and Power Delivery**
Deric Waters, Indumini Ranmuthu
Texas Instruments Inc., United States

8:30 a.m. – 10:10 a.m.

IS11: Energy Harvesting Enables the IoT and 5G

ROOM R07

SESSION CHAIRS

Brian Zahnstecher, *PowerRox LLC*

Mike Hayes, *Tyndall National Institute*

8:30 a.m.

IS11.1 **3D Silicon Capacitive Interposer for RF Energy Harvesting Device: Higher Efficiency, Higher Integration and Simplified Topology**
Mohamed Mehdi Jatlaoui
Murata, France

8:55 a.m.

IS11.2 **Optimizing Piezoelectric Synchronized-Discharge Harvesters**
Siyu Yang
Georgia Institute of Technology, United States

9:20 a.m.

IS11.3 **EnABLES – Growing the Power IoT Ecosystem**
Mike Hayes
Tyndall National Institute, Ireland

9:45 a.m.

IS11.4 **Energy Harvesting**
Mike Hayes[1], Lorandt Foelkel[2], Brian Zahnstecher[3], Dan Stieler[4]
[1]Tyndall National Institute, Ireland, [2]Würth Elektronik, United States, [3]PSMA, United States, [4]PowerFilm, United States

8:30 a.m. – 10:10 a.m.

IS12: EMI I

ROOM R08

SESSION CHAIRS

Carl Walker, *Artesyn*

Tom Neville, *Rohde & Schwarz USA, Inc.*

Ed Herbert, *PSMA*

8:30 a.m.

IS12.1 **Overview of Automotive EMI Reduction Techniques**
Josh Mandelcorn, Pradeep Shenoy
Texas Instruments Inc., United States

8:55 a.m.

IS12.2 **Practical DC/DC PCB Layout Techniques and Inductor EMI Analysis**
Hebberly Ahatlan[1], Quentin Laidebeur[2]
[1]Analog Devices, Inc., United States, [2]Würth Elektronik, United States

9:20 a.m.

IS12.3 **Mitigating EMI Problems & Filter Selection**
Dylan Nourse
ITG Electronics, Inc., United States

9:45 a.m.

IS12.4 **Simplify your Design using a Half-Watt, Reinforced Isolated Power Module with an Integrated Magnetic Core Transformer**
Zhemin Zhang
Texas Instruments Inc., United States

2:30 p.m. – 5:35 p.m.

IS13: Power Electronics for High Performance Computing

ROOM R04-05

SESSION CHAIRS

Minjie Chen, *Princeton University*

Xin Zhang, *IBM*

2:30 p.m.

IS13.1 **Advanced Low-Voltage & Medium-Voltage AC/DC Grid Interfaces for High Performance Computing**
Johann W. Kolar
ETH Zürich, Switzerland

2:55 p.m.

IS13.2 **54V Power Delivery Architecture for VRMs**
Sombuddha Chakraborty
Texas Instruments Inc., United States

3:20 p.m.

IS13.3 **Hybrid and Resonant Switched-Capacitor Converters: Achieving Ultra Efficient and Compact High Step-Down DC-DC Power Conversion for Datacenter Application**
Robert Pilawa-Podgurski
University of California-Berkeley, United States

3:45 p.m.

IS13.4 **Microprocessor Power Delivery Challenges**
Jonathan Douglas, Kaladhar Radhakrishnan
Intel Corporation, United States

4:20 p.m.

IS13.5 **Power Conversion and Power Integrity Co-Design**
Shuai Jiang, Houle Gan, Gregory Sizikov, Xin Li
Google LLC, United States

4:45 p.m.

IS13.6 **Overcoming Magnetics Limitations for Data Center Power**
Charles R. Sullivan
Dartmouth College, United States

2:30 p.m. – 5:35 p.m.

IS14: Magnetics II

ROOM R02-R03

SESSION CHAIRS

Chris Jones, *Artesyn*

George Slama, *Würth Elektronik*

Cahit Gezgin, *Infineon Technologies*

2:30 p.m.

IS14.1 **Investigating Loss Mechanisms in High Frequency Inductors used in Single and Multiphase Core Voltage and Point of Load Regulators**
John Gallagher, David Wiest
Pulse Electronics, Inc., United States

2:55 p.m.

IS14.2 **Performance Study of Magnetic Epoxies used in Ferrite Power Inductors**
John Gallagher, David Wiest
Pulse Electronics, Inc., United States

3:20 p.m.

IS14.3 **Graphene based Power Magnetics: A New Material for Improved Performance**
Claudio Cabeza, Antonio Rojas Cuevas, Raquel Rodríguez Munín
PREMO, Spain

3:45 p.m.

IS14.4 **Common Mode Filter Characterization**
Hebberly Ahatlan
Würth Elektronik, United States

4:20 p.m.

IS14.5 **Coupled Inductor Confusion**
George Slama
Würth Elektronik, United States

4:45 p.m.

IS14.6 **Inductor AC Losses with DC Bias and Temperature**
George Slama[1], Ranjith Bramanpaili[2]
[1]Würth Elektronik, United States,
[2]Würth Elektronik, Germany

5:10 p.m.

IS14.7 **Optimizing Efficiency in a Ferrite Inductor Design for a 3.6KW Conventional Boost PFC**
Steven Aherne, Cathal Sheehan
Bourns, Ireland

2:30 p.m. – 5:35 p.m.

IS15: Packaging Circuits to Make Small and Reliable Products

ROOM R01

SESSION CHAIRS

Brian Narveson, *Narveson Innovative Consulting*

2:30 p.m.

IS15.1 **Thermal Packaging Challenges for Next-Generation Power Electronics**
Ercan M. Dede
Toyota Research Institute of North America, United States

2:55 p.m.

IS15.2 **Full 3D Advanced Packaging Concepts for Wide Bandgap Power Electronics**
JL. Schanen, Y. Avenas, PO. Jeannin
Université Grenoble Alpes, France

3:20 p.m.

IS15.3 **Ultra-High Density Double-Sided Half-Bridge Packaging with Organic Laminates**
Douglas C. Hopkins, Tuz-Hsuan Cheng
North Carolina State University, United States

3:45 p.m.

IS15.4 **5G is Broken and the Heatsink is to Blame**
Doug Kirkpatrick[1], Brian Zahnstecher[2]
[1]Eridan Communications, United States, [2]PowerRox, United States

4:20 p.m.

IS15.5 **System-Level Design Considerations for Performance Enhancing SiC Power Modules**
Ty McNutt
Wolfspeed, A Cree Company, United States

4:45 p.m.

IS15.6 **Reliability of Thermally Integrated 3D Power Packaging**
F. Patrick McCluskey
University of Maryland, United States

5:10 p.m.

IS15.7 **Using Advanced Manufacturing Techniques for Thermal Management of High-Reliability Power Components**
Jens Eltze
APEX Microtechnology, United States

2:30 p.m. – 5:35 p.m.

IS16: Vehicle Electrification II

ROOM R06

SESSION CHAIRS

Weimin Zhang, *SERES, Inc.*

David Divins, *Infineon Technologies*

Francesco Carobolante, *IoTissimo*

2:30 p.m.

IS16.1 **A New AC to DC Converter Technology for Electric Aircraft Propulsion**
Travis Sitton
Crane Aerospace, United States

2:55 p.m.

IS16.2 **Improved Thermal Management of DC-Link Capacitors in 48V Hybrid Passenger Vehicles**
Toshihiko Furukawa[1], Yuya Tamai[2], Toshiki Wakabayashi[2], Yuhei Kobayashi[2]
[1]United Chemi-Con, United States, [2]Nippon Chemi-Con, Japan

3:20 p.m.

IS16.3 **Leveraging Efficiency in Automotive On-Board Chargers**
Severin Kampl
Infineon Technologies AG, Austria

3:45 p.m.

IS16.4 **High Frequency Three-Phase PFC Solutions for High Power Charging Stations**
F. Gennaro, G. Aiello
STMicroelectronics, Italy

4:20 p.m.

IS16.5 **100kW GaN HEMT based BLDC Motor Inverter**
Sam Ben-Yaakov[1], David Shapiro[2], Paul Price[3]
[1]Ben-Gurion University of the Negev, Israel, [2]VisIC Technologies, Israel, [3]IRP, Israel

4:45 p.m.

IS16.6 **The Case for Vertical Gallium Nitride Devices in Electric Vehicle Drives**
Jason Neely, Greg Pickrell, Jack Flicker, Lee Rashkin, Robert Kaplar
Sandia National Laboratories, United States

2:30 p.m. – 5:35 p.m.

IS17: Electrification Everywhere: Trains, Aircraft & Vehicles

ROOM R07

SESSION CHAIRS

Ralph Taylor, *Independent*

Fred Weber, *Future Technologies Worldwide*

2:30 p.m.

IS17.1 **Modernization of Electric Railways – Part 1: Ground Facilities Energy Management System for Urban Network, Energy-Efficient Power Supply for High Speed Train, Super Speed Maglev System**
Eisuke Masada, Tetsuo Uzuka
Railway Technical Research Institute, Japan

2:55 p.m.

IS17.2 **Modernization of Electric Railways – Part 2: Energy-Efficient and Alternative Fuel Vehicle Drive Systems for Urban, Regional and High Speed Train**
Eisuke Masada, Tetsuo Uzuka
Railway Technical Research Institute, Japan

3:20 p.m.

IS17.3 **On the Sustainability of Battery Electric Vehicles from View Point of "Well to Wheel Model"**
Hazime Shimizu
NPERC-J, Japan

3:45 p.m.

IS17.4 **Overview of Energy Storage with a Focus on Extreme Fast Charging and Behind the Meter Storage**
Matthew Keyser
NREL, United States

4:20 p.m.

IS17.5 **Electrifying the High School Student Pipeline**
Marc E. Herniter[1], Thomas P. Foulkes[2]
[1]Rose-Hulman Institute of Technology, United States, [2]University of Illinois, United States

4:45 p.m.

IS17.6 **Functional Safety Standards and Implications for Vehicle Power Electronics Design**
Andrew Ellenson
John Deere Electronic Solutions, United States

5:10 p.m.

IS17.7 **Aircraft Power Electronics: Trends, Obstacles, and Opportunities**
Tim O'Connell
PC Krause & Associates, United States

2:30 p.m. – 5:35 p.m.

IS18: Gate Drives

ROOM R08

SESSION CHAIRS

Jim Spangler, *Independent*

Kevin Parmenter, *Taiwan Semiconductor*

2:30 p.m.

IS18.1 **Optocouplers – Robust and Reliable Performance for Galvanic Isolation**
Chwan Jye Foo
Broadcom, United States

2:55 p.m.

IS18.2 **Gate Driver Common Mode Transient Immunity Testing**
Eric Benedict
Analog Devices, United States

3:20 p.m.

IS18.3 **Dual Gate-Drive Technique for Temperature and Load Optimization at Turn-Off**
Wolfgang Frank
Infineon Technologies AG, Germany

3:45 p.m.

IS18.4 **Optimizing Isolated Gate Drivers for SiC-MOSFET**
Long Nguyen
Silicon Laboratories, United States

4:20 p.m.

IS18.5 **New Automotive Qualified High Current Isolated Gate Driver**
Mitch Van Ochten
ROHM Semiconductor U.S.A.,LLC, United States

4:45 p.m.

IS18.6 **Investigating the Effects of Catastrophic Failure on Gate Driver Safety Isolation**
Sudhakar Chakkirala
Power Integrations, United States

5:10 p.m.

IS18.7 **Multi-Watt Galvanically Isolated Power from Optical Converter**
Jan-Gustav Werthen
Broadcom, United States

8:30 a.m. – 11:50 a.m.

T09: DC-DC Converters for Data Centers

ROOM 208-210

TRACK DC-DC Converters

SESSION CHAIRS

Olivier Trescases, *University of Toronto*

Xin Zhang, *IBM*

8:30 a.m.

T09.1 **Optimal Self-Tuning Control for Data-Centers' 48V-12V ZCS-STC**
Guy Sovik, Tom Urkin, Erez Erzol Masandilov, Mor Mordechai Peretz
Ben-Gurion University of the Negev, Israel

8:50 a.m.

T09.2 **A High Power Density 48V-12V DCX with 3-D PCB Winding Transformer**
Guangcan Li, Xinke Wu
Zhejiang University, China

9:10 a.m.

T09.3 **A 97% Peak Efficiency and 308 A/in3 Current Density 48-to-4 V Two-Stage Resonant Switched-Capacitor Converter for Data Center Applications**
Wen Chuen Liu, Zichao Ye, Robert C.N. Pilawa-Podgurski
University of California-Berkeley, United States

9:30 a.m.

T09.4 **A 48-to-6 V Multi-Resonant-Doubler Switched-Capacitor Converter for Data Center Applications**
Zichao Ye, Rose A. Abramson, Robert C.N. Pilawa-Podgurski
University of California-Berkeley, United States

9:50 a.m.

T09.5 **Interleaved SCC-LCLC Converter with TO-220 GaN HEMTs and Accurate Current Sharing for Wide Operating Range in Data Center Application**
Mojtaba Forouzesh, Bo Sheng, Yan-Fei Liu
Queen's University, Canada

10:40 a.m.

T09.6 **LEGO-PoL: A 48V-1.5V 300A Merged-Two-Stage Hybrid Converter for Ultra-High-Current Microprocessors**
Jaeil Baek[1], Ping Wang[1], Youssef Elasser[1], Yenan Chen[1], Shuai Jiang[2], Minjie Chen[1]
[1]Princeton University, United States, [2]Google LLC, United States

11:00 a.m.

T09.7 **High Density 48V-to-PoL VRM with Hybrid Pre-Regulator and Fixed-Ratio Buck**
Mario Ursino[1], Stefano Saggini[1], Shuai Jiang[2], Chenhao Nan[2]
[1]University of Udine, Italy,[2]Google LLC, United States

11:20 a.m.

T09.8 **A Novel Coupled Inductor to Improve Performance of Voltage Regulators in Computing System**
Xiaoguo Liang, Meng Wang, Horthense Tamdem, Nishi Ahuja
Intel Asia-Pacific Research & Development Ltd., China

11:40 a.m.

T09.9 **Three-Phase Interleaved LLC Resonant Converter with Integrated Planar Magnetics for Telecom and Server Application**
Rimon Gadelrab, Fred C. Lee, Qiang Li
Virginia Polytechnic Institute and State University, United States

8:30 a.m. – 11:50 a.m.

T10: Topologies for Utility Interface Converters

ROOM 228-230

TRACK Power Electronics for Utility Interface

SESSION CHAIRS

Andy Lemmon, *The University of Alabama*

Agasthya Ayachit, *Mercedes-Benz Research and Development North America, Inc.*

8:30 a.m.

T10.1 **A Multiport DC-DC Modular Multilevel Converter for HVDC Interconnection**
Futian Qin, Tianqu Hao, Feng Gao, Tao Xu, Decun Niu, Zhan Ma
Shandong University, China

8:50 a.m.

T10.2 **Improved DC Transformer Submodule with High Input Voltage**
Liangcai Shu, Wu Chen, Dajun Ma, MA
Southeast University, China

9:10 a.m.

T10.3 **Cascaded Packed U-Cell STATCOM with Low Capacitance and its Third Harmonic Control**
Decun Niu[1], Tianqu Hao[1], Feng Gao[1], Tao Xu[1], Xiangjian Meng[1], Futian Qin[1], Zhan Ma[1], Xuefeng Ge[2]
[1]Shandong University, China,[2]State Grid Jiangsu Electric Power Co., Ltd. Research Institute, China

9:30 a.m.

T10.4 **A Low Conduction Loss Modular Multilevel Converter Sub-Module Topology with DC Fault Blocking Capability**
Cheng Peng, Rui Li
Shanghai Jiao Tong University, China

9:50 a.m.

T10.5 **Topology Analysis and Validation of Novel Modular DC-DC Auto-Transformer**
Yang Chen[1], Miao Zhu[2], Jianjun Ma[2], Xu Cai[2]
[1]Queen's University, [2]Shanghai Jiao Tong University, China

10:30 a.m.

T10.6 **High Frequency Integrated Solid State Transformer (SST) for Utility Interface of Solar PV / Battery Energy Storage Systems**
Salwan Sabry, Prasad Enjeti
Texas A&M University, United States

10:50 a.m.

T10.7 **Comparative Research on Compensation Controls for a Novel Three-Port Dynamic Voltage Restorer**
Chenxing Sha[1], Jiangfeng Wang[2], Baolin Chen[1], Yan Xing[1], Hongfei Wu[1], Haibing Hu[1]
[1]Nanjing University of Aeronautics and Astronautics, China,[2]Tsinghua University, China

11:10 a.m.

T10.8 **New Single-Stage Soft-Switching Solid-State Transformer with Reduced Conduction Loss and Minimal Auxiliary Switch**
Liran Zheng, Rajendra Prasad Kandula, Deepak Divan
Georgia Institute of Technology, United States

11:30 a.m.

T10.9 **Transformerless Converter-Based GMD Protection for Utility Transformers**
Moazzam Nazir[1], Klaehn Burkes[2], Mohammad Babakmehr[1], Farnaz Harirchi[1], Johan H. Enslin[1]
[1]Clemson University, United States,[2]Savannah River National Laboratory, United States

8:30 a.m. – 11:50 a.m.

T11: Microgrid Systems

ROOM 225-227

TRACK Renewable Energy Systems

SESSION CHAIRS

Haoyu Wang, *ShanghaiTech University*

Zeng Liu, *Xi'an Jiaotong University*

8:30 a.m.

T11.1 **Islanding Detection Methods based on Self-Oscillation of Particular Frequency in DC Distribution Systems**
Qinghui Huang[1], Chushan Li[1], Heya Yang[1], Yufei Dong[2], Wuhua Li[1], Xiangning He[1], Wei Zhang[3], Junfei Han[3]
[1]Zhejiang University, China,[2]Leadrive Technology (Shanghai) Co., Ltd., China,[3]Inner Mongolia Electric Power Research Institute, China

8:50 a.m.

T11.2 **A Workflow for Non-Linear Load Parameter Estimation using a Power-Hardware-in-the-Loop Experimental Testbed**
Matthew Overlin, Christopher Smith, Marija Ilic, James L. Kirtley Jr.
Massachusetts Institute of Technology, United States

9:10 a.m.

T11.3 **Virtual Impedance Shaping for Low Voltage Microgrids**
Sourav Patel[1], Soham Chakraborty[1], Subhrajit Roychowdhury[2], Murti V. Salapaka[1]
[1]University of Minnesota, United States, [2]GE Research, United States

9:30 a.m.

T11.4 **Fully Distributed Controller for Economic Load Sharing of DC Microgrid Clusters**
Mohamed Zaery[1,2], Panbao Wang[1], Xiaonan Lu[3], Wei Wang[1], Dianguo Xu[1]
[1]Harbin Institute of Technology, China,[2]Aswan University, Egypt,[3]Temple University, United States

9:50 a.m.

T11.5 **Fully Distributed Fixed-Time Optimal Dispatch for Islanded DC Microgrids**
Mohamed Zaery[1,2], Panbao Wang[1], Xiaonan Lu[3], Rui Huang[1], Wei Wang[1], Dianguo Xu[1]
[1]Harbin Institute of Technology, China,[2]Aswan University, Egypt,[3]Temple University, United States

10:30 a.m.

T11.6 **A Virtual Impedance Scheme for Voltage Harmonics Suppression in Virtual Oscillator Controlled Islanded Microgrids**
Hui Yu, M.A. Awal, Hao Tu, Yuhua Du, Srdjan Lukic, Iqbal Husain
North Carolina State University, United States

10:50 a.m.

T11.7 **Controller Development of an Asynchronous Microgrid Power Conditioning System (PCS) Converter Considering Grid Requirements**
Dingrui Li[1], Shiqi Ji[1], Xingxuan Huang[1], James Palmer[1], Fred Wang[1,2], Leon M. Tolbert[1,2]
[1]University of Tennessee, United States,[2]Oak Ridge National Laboratory, United States

11:10 a.m.

T11.8 **Correction of Line-Voltage Unbalance by the Decentralized Inverters in an Islanded Microgrid**
Subhrasankha Ghosh, Souvik Chattopadhyay
Indian Institute of Technology Kharagpur, India

11:30 a.m.

T11.9 **Resonant Flyback PV Microinverter with Low Component Count**
Seung-Won Jo[1], Hwasoo Seok[2], Jun-Sik Kim[1], Minsung Kim[1]
[1]Dongguk University, Korea,[2]Pohang University of Science and Technology, Korea

8:30 a.m. – 11:50 a.m.

T12: GaN/Si Devices and Components

ROOM 206-207

TRACK Devices and Components

SESSION CHAIRS

Hengzhao Yang, *New Mexico Institute of Mining and Technology*

Ahmed Elasser, *GE*

8:30 a.m.

T12.1 **A Massive Adoption Ready 200mm 40V-650V E-Mode GaN-on-Si Power HEMTs Technology**
David C. Zhou, Han C. Chiu, Jeff Zhang, Roy K.-Y. Wong, Thomas Zhao, Frank Zhang, Martin Zhang, Yanbo Zou, Larry Chen
Innoscience Technology, China

8:50 a.m.

T12.2 **Current and Temperature Measurement via Spectral Decomposition of Light Emission from a GaN Power Diode**
Matthew A. Porter[1], Johnathan Williams[1], Maeve Broeg[1], Keith Corzine[2], Todd Weatherford[1]
[1]Naval Postgraduate School, United States, [2]University of California-Santa Cruz, United States

9:10 a.m.

T12.3 **A New Method of Switching Loss Evaluation for GaN HEMTs in Half-Bridge Configuration**
Hao Wen, Yajing Zhang, Dong Jiao, Jih-Sheng Lai
Virginia Polytechnic Institute and State University, United States

9:30 a.m.

T12.4 **100 A Solid State Circuit Breaker using Monolithic GaN Bidirectional Switch with Two-Step Gate-Discharging Technique**
Yusuke Kinoshita, Takashi Ichiryu, Asamira Suzuki, Hidetoshi Ishida
Panasonic Corporation, Japan

9:50 a.m.

T12.5 **Design Optimization for a GaN FET-Based Three-Level Synchronous Buck Converter**
Yuanzhe Zhang, Jianjing Wang, Michael de Rooij
Efficient Power Conversion Corporation, United States

10:30 a.m.

T12.6 **Analysis and Reduction of Radiated EMI in High-Frequency GaN IC-Based Active Clamp Flyback Converters**
Juntao Yao[1], Yiming Li[1], Shuo Wang[1], Xiucheng Huang[2], Xiaofeng Lyu[2]
[1]University of Florida, United States, [2]Navitas Semiconductor, Inc., United States

10:50 a.m.

T12.7 **Linear SR Mode of Power MOSFETs and its Application in an EMI-Suppressing Rectifier Bridge**
Ke-Wei Wang, Kun Zhang, Chung-Pui Tung, Shu-Hung Chung
City University of Hong Kong, Hong Kong

11:10 a.m.

T12.8 **User-Programmable Short-Circuit Capability Enhancement for 1.2 kV Si IGBTs using a 40 V Si Enhancement-Mode MOSFET Connected in Series with the Emitter**
Ajit Kanale, B.J. Baliga
North Carolina State University, United States

11:30 a.m.

T12.9 **High dV/dt Controllability of 1.2kV Si-TCIGBT for High Flexibility Design with Ultra-Low Loss Operation**
Peng Luo[1], Sankara Narayanan Ekkanath Madathil[1], Shin-Ichi Nishizawa[2], Wataru Saito[2]
[1]University of Sheffield, United Kingdom, [2]Kyushu University, Japan

8:30 a.m. – 11:50 a.m.

T13: Motor Drives I

ROOM 203-205

TRACK Motor Drives and Inverters

SESSION CHAIRS

Ziaur Rahman, *Department of Energy*

Mehdi Narimani, *McMaster University*

8:30 a.m.

T13.1 **Design and Implementation of Trans-Z-Source Inverter-Fed Induction Motor Drive with Fault-Tolerant Capability**
Vivek Sharma, M.J. Hossain, S.M.N. Ali, Muhammad Kashif, Edstan Fernandez
Macquarie University, Australia

8:50 a.m.

T13.2 **Modular Multiphase Drives for Variable-Pole Induction Machines in Electric Vehicles**
Elie Libbos, Ruomu Hao, Bonhyun Ku, Arijit Banerjee, Philip T. Krein
University of Illinois at Urbana-Champaign, United States

9:10 a.m.

T13.3 **Model Predictive Current Control of Mutually Coupled Switched Reluctance Machines using a Three-Phase Voltage Source Converter**
Kun Hu, Lulu Guo, Jin Ye
University of Georgia, United States

9:30 a.m.

T13.4 **An Active Zero-State Switch (AZS) for Common-Mode Voltage Reduction in Voltage Source Inverter (VSI) Drives**
Zhe Zhang[1], Ali M. Bazzi[1,2], Afia Semin[3]
[1]University of Connecticut, United States,
[2]American University of Beirut, Lebanon,
[3]Dartmouth College, United States

9:50 a.m.

T13.5 **Discontinuous Bi-Tri Logic SPWM for Current Source Converter with Optimized Zero-State Replacement**
Li Ding[1], Yun Wei Li[1], Kai Sun[2]
[1]University of Alberta, Canada,
[2]Tsinghua University, China

10:30 a.m.

T13.6 **Power Losses and Magnetic Flux Analysis of Vector Controlled Induction Motor with Stator Turn-to-Turn Fault**
Hassan H. Eldeeb[1], Haisen Zhao[1,2], Osama A. Mohammed[1]
[1]Florida International University, United States,
[2]North China Electric Power University, China

10:50 a.m.

T13.7 **Design and Analysis of Inverter-Fed High-Speed Induction Motors with Closed Rotor Slots Taking Enclosure Effect into Account**
Haisen Zhao[1], Xinglan Guo[1], Hassan H. Eldeeb[2], Guorui Xu[1], Yang Zhan[1], Osama A. Mohammed[2]
[1]North China Electric Power University, China,
[2]Florida International University, United States

11:10 a.m.

T13.8 **Impact of the Leakage Inductance on the Reflected Wave Phenomenon in MMC based Motor Drives**
Xiao Li, Jianyu Pan, Ziwei Ke, Rui Liu, Niu Jia, Yue Zhang, Boxue Hu, Risha Na, Longya Xu, Jin Wang
The Ohio State University, United States

11:30 a.m.

T13.9 **A 6-Wire 3-Phase Inverter Topology for Improved BLDC Performance and Harmonics**
Nico Angelo Macahig
Power Integrations, Inc., Philippines

8:30 a.m. – 11:50 a.m.

T14: Control of DC-AC Inverters

ROOM 217-219

TRACK Control

SESSION CHAIRS

Jaber Abu Qahouq, *The University of Alabama*

Martin Ordonez, *University of British Columbia*

8:30 a.m.

T14.1 **Passivity-Based Robust Current Control of Grid-Connected VSCs**
Javier Serrano[1], Santiago Cobreces[1], Emilio J. Bueno[1], Mario Rizo[2]
[1]Universidad de Alcalá, Spain,[2]Gamesa Electric, Spain

8:50 a.m.

T14.2 **Resilient Synchronization of Grid Converters at Low Sampling Frequencies**
Vlatko Miskovic[1,2], Vladimir Blasko[3], Thomas M. Jahns[2], Michael C. Harke[1]
[1]Collins Aerospace, United States,
[2]University of Wisconsin-Madison, United States,
[3]United Technologies Research Center, United States

9:10 a.m.

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

9:30 a.m.

T14.4 **Interleaved PWM Strategy for Common-Mode Leakage Current and EMI Noise Reduction of Paralleled Single-Stage DC-AC Converters**
M.S. Hassan[1,2], Ahmed A. Zaki Diab[1,2], Masahito Shoyama[1], Gamal M. Dousoky[1,2]
[1]Kyushu University, Japan,[2]Minia University, Egypt

9:50 a.m.

T14.5 **Modified Control Laws for Accommodating Magnetizing and Demagnetizing Inductances in 100 kHz LC Single-Phase Converter with D-Σ Processes to Improve Current Tracking Performance**
Tsai-Fu Wu, Sakavov Temir, Yun-Tsung Liu, Yen-Hsiang Huang
National Tsing Hua University, Taiwan

10:30 a.m.

T14.6 **Analysis and Control of Modular Multilevel Converters using Discontinuous Modulation**
Deepak Ronanki, Sheldon S. Williamson
University of Ontario Institute of Technology, Canada

10:50 a.m.

T14.7 **Selective-Harmonic Spatial Repetitive Control for PWM Converter Operation over a Wide Fundamental Frequency Range**
Hao Zeng[1], Bulent Sarlioglu[1], Thomas M. Jahns[1], Christoph H. van der Broeck[2], Rik W. De Doncker[2]
[1]University of Wisconsin-Madison, United States, [2]RWTH Aachen University, Germany

11:10 a.m.

T14.8 **Self-Synchronizing Current Control of a Three-Phase Grid-Connected Inverter in the Presence of Unknown Grid Parameters**
Joseph Latham[1], Moath Alqatamin[1], Zachary T. Smith[2], Brandon M. Grainger[2], Michael McIntyre[1]
[1]University of Louisville, United States, [2]University of Pittsburgh, United States

8:30 a.m. – 11:50 a.m.

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

ROOM 220-222

TRACK Wireless Power Transfer

SESSION CHAIRS

Franceso Carobolante, *IoTissimo*
Veda Galigekere, *Oak Ridge National Laboratory*

8:30 a.m.

T15.1 **Wireless Power Transformation for Data Centers and Medium Voltage Applications**
Guangqi Zhu[1], Birger Pahl[1], Zelin Xu[2], Suvendu Samanta[3], Isaac Wong[3], Subhashish Bhattacharya[3], Richard Beddingfield[4], Paul R. Ohodnicki[4]
[1]Eaton, United States,[2]IEECAS, United States, [3]North Carolina State University, United States, [4]National Energy Technology Laboratory, United States

8:50 a.m.

T15.2 **Adaptive Self-Tuned Mixed-Signal Controller IC for Resonant Wireless Power Transfer**
Eli Abramov, Mor Mordechai Peretz
Ben-Gurion University of the Negev, Israel

9:10 a.m.

T15.3 **A Series-Series-CL Resonant Converter for Wireless Power Transfer in Auxiliary Power Network**
Keyao Sun, Jun Wang, Rolando Burgos, Dushan Boroyevich
Virginia Polytechnic Institute and State University, United States

9:30 a.m.

T15.4 **Design and Multi-Objective Optimization of Coil and Magnetic for Wireless Power Transfer in Auxiliary Power Network**
Keyao Sun, Jun Wang, Rolando Burgos, Dushan Boroyevich
Virginia Polytechnic Institute and State University, United States

9:50 a.m.

T15.5 **Characterisation of High Frequency Inductive Power Transfer Receivers using Pattern Recognition on the Transmit Side Waveforms**
Juan M. Arteaga, Lingxin Lan, Christopher H. Kwan, David C. Yates, Paul D. Mitcheson
Imperial College London, United Kingdom

10:30 a.m.

T15.6 **Robust Digital Algorithm for Rapid Phase Angle Tracking in Wireless Power Transfer**
Aaron Troy, Francisco Paz, Martin Ordonez
University of British Columbia, Canada

10:50 a.m.

T15.7 **A Hybrid Active/Passive Domino Architecture with MIMO Power Flow Control and Mixed Frequency Operation for Extended Range and Multi-Medium Wireless Power Transfer**
Ming Liu, Yuqing Zhu, Zachary Wang, Minjie Chen
Princeton University, United States

11:10 a.m.

T15.8 **An Induced Voltage Source Model for Capacitive Power Transfer**
Shiying Wang, Junrui Liang, Haoyu Wang, Minfan Fu
ShanghaiTech University, China

11:30 a.m.

T15.9 **Bidirectional Capacitive Wireless Power Transfer for Energy Balancing in Modular Robots**
Akshay Sarin, Duncan Abbot, Shai Revzen, Al-Thaddeus Avestruz
University of Michigan, United States

8:30 a.m. – 11:50 a.m.

T16: Transportation Power Electronics I

ROOM 211-213

TRACK Transportation Power Electronics

SESSION CHAIRS

Jason Neely, *Sandia National Laboratories*
Yingying Kuai, *Caterpillar*

8:30 a.m.

T16.1 **An Adjustable Turns Ratio Transformer based LLC Converter for Deeply-Depleted PEV Charging Applications**
Dongdong Shu, Haoyu Wang
ShanghaiTech University, China

8:50 a.m.

T16.2 **A New Two-Switch PFC DCM Boost Rectifier for Aviation Applications**
Tomas Sadilek, Misha Kumar, Yungtaek Jang, Peter Barbosa
Delta Electronics Ltd., United States

9:10 a.m.

T16.3 **Charge Management for an Inductively Charged On-Demand Battery-Electric Shuttle Service with High Penetration of Renewable Energy**
Ahmed A.S. Mohamed, Dylan Day, Andrew Meintz, Jun Myungsoo
National Renewable Energy Laboratory, United States

9:30 a.m.

T16.4 **Modeling and Design of Integrated Inductor and Transformer Considering Superposed Flux Density in On-Board-Charger**
Jinxu Yang[1], Xinke Wu[1], Gang Liu[2], Dinggang Ping[2], Zhijiang Deng[2]
[1]Zhejiang University, China,[2]Hangzhou EV-Tech Co., Ltd., China

9:50 a.m.

T16.5 **System-Level Conducted EMI Model for SiC Powertrain of Electric Vehicles**
Xiaoyu Jia, Changsheng Hu, Bitao Dong, Fengchun He, Hui Wang, Dehong Xu
Zhejiang University, China

10:30 a.m.

T16.6 **A 10-Level Flying Capacitor Multi-Level Dual-Interleaved Power Module for Scalable and Power-Dense Electric Drives**
Nathan Pallo, Samantha Coday, Joseph Schaadt, Pourya Assem, Robert C.N. Pilawa-Podgurski
University of California-Berkeley, United States

10:50 a.m.

T16.7 **Switched-Capacitor-Based Integrated Double-Input Single-Output DC-DC Converter for Electric Vehicle Applications**
Hadi Moradisizkoohi, Nour Elsayad, Osama A. Mohammed
Florida International University, United States

11:10 a.m.

T16.8 **An SiC-Based AC/DC CCM Bridgeless Onboard EV Charger with Coupled Active Voltage Doubler Rectifiers for 800-V Battery Systems**
Mehdi Abbasi, John Lam
York University, Canada

11:30 a.m.

T16.9 **An Optimized Silicon Carbide based 2×250 kW Dual Inverter for Traction Applications**
Yuheng Wu, Mohammad Hazzaz Mahmud, Eric Allee, Yue Zhao, Alan Mantooth
University of Arkansas, United States

2:30 p.m. –5:40 p.m.

T17: Resonant DC-DC Converters

ROOM 208-210

TRACK DC-DC Converters

SESSION CHAIRS

Luke Jenkins, *IBM*

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

2:30 p.m.

T17.1 **Control Design of a Dual-Input LLC Converter for PV-Battery Applications**
S. Milad Tayebi[1], Xi Chen[2], Issa Batarseh[1]
[1]University of Texas at Austin, United States, [2]University of Central Florida, United States

2:50 p.m.

T17.2 **Optimal Phase Shift Control Strategy of Buck-Boost Integrated LLC Converter achieving Wide Input Voltage Range, MHz-Frequency and High Efficiency**
Qinsong Qian[1], Qi Liu[1], Haisong Li[2], Shen Xu[1], Weifeng Sun[1]
[1]Southeast University, China,[2]Wuxi Chipown Micro-electronics Limited, China

3:10 p.m.

T17.3 **Output Plane Analyses of LLC Resonant Converter**
Suyash Sushilkumar Shah, Sagar Kumar Rastogi, Subhashish Bhattacharya
North Carolina State University, United States

3:30 p.m.

T17.4 **Resonant-Inductive-Boosting DC-DC Converter with Very High Voltage Gain**
Kerui Li, Siew-Chong Tan, Ron Shu Yuen Hui
The University of Hong Kong, Hong Kong

3:50 p.m.

T17.5 **Optimal Control of a Wide Range Resonant DC-DC Converter**
Satyaki Mukherjee[1], Alihossein Sepahvand[2], Vahid Yousefzadeh[2], Montu Doshi[2], Dragan Maksimović[1]
[1]University of Colorado-Boulder, United States, [2]Texas Instruments Inc., United States

4:20 p.m.

T17.6 **Analysis of High-Efficiency Operating Modes for Piezoelectric Resonator-Based DC-DC Converters**
Jessica D. Boles, Joshua J. Piel, David J. Perreault
Massachusetts Institute of Technology, United States

4:40 p.m.

T17.7 **A Sensorless Synchronous Rectification Driving Scheme in 1-kV Input 1-MHz GaN LLC Converters with Matrix Transformers**
Xinyi Zhu[1], Zhiliang Zhang[1], Zhibin Li[1], Ke Xu[1], Dongdong Ye[2], Xiaoyong Ren[1], Qianhong Chen[1]
[1]Nanjing University of Aeronautics and Astronautics, China,[2]Beijing Institute of Control Engineering, China

5:00 p.m.

T17.8 **A Digital Sensor-Less Synchronous Rectification Algorithm for Symmetrical Bidirectional CLLC Resonant Converters**
Xufu Ren, Long Pei, Shaojie Song, Jialei Zhang, Yunqing Pei, Laili Wang
Xi'an Jiaotong University, China

5:20 p.m.

T17.9 **A Modified Dual-Input LLC Converter for Standalone PV/Battery Power System**
Xi Chen[1], Seyed Milad Tayebi[2], Issa Batarseh[1]
[1]University of Central Florida, United States, [2]University of Texas at Austin, United States

2:30 p.m. –5:40 p.m.

T18: Controller and Filter Design for Utility Interface Converters

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*

2:30 p.m.

T18.1 **Design of Loop Gain for Load Converters in a Distributed System**
Lei Wang, Mehran Mirjafari
Dell EMC, United States

2:50 p.m.

T18.2 **High-Efficiency Model Predictive Control for Star-Connected Cascaded H-Bridge STATCOM under Unbalanced Conditions**
Yufei Li[1,2], Yue Zhao[2], Fei Diao[2]
[1]Northwestern Polytechnical University, China,[2]University of Arkansas, United States

3:10 p.m.

T18.3 **A Supervisory Remote Management System for Parallel Operation of Modularized D-STATCOM**
Radwa M. Abdalaal, Carl Ngai Man Ho
University of Manitoba, Canada

3:30 p.m.

T18.4 **Improving Power Quality in Grid-Connected Wind Energy Conversion Systems using Supercapacitors**
Ebrahim Mohammadi, Ramtin Rasoulinezhad, Gerry Moschopoulos
Western University, Canada

3:50 p.m.

T18.5 **Asymmetrical Fault Current Calculation Method and Coupling Effect Analysis in N-Paralleled Droop-Controlled Inverters**
Huimin Zhao[1], Zhikang Shuai[1], Jun Ge[1], Yu Feng[1], John Shen[2]
[1]Hunan University, China,[2]Illinois Institute of Technology, United States

4:20 p.m.

T18.6 **An Arcless Step Voltage Regulator based on Paralleled Power Electronics Converter Configuration**
Yafeng Wang, Xiwen Xu, Tiefu Zhao
University of North Carolina at Charlotte, United States

4:40 p.m.

T18.7 **Modeling and Practical Design Dual-Mode Sinewave and Common Mode Filter for PWM Motor Drives System using Tricore Laminations**
Tin Luu
MTE Corporation, United States

5:00 p.m.

T18.8 **150-kW Three-Port Custom-Core Transformer Design Methodology**
Shamar Christian[1], Roberto Armin Fantino[1], Roderick Amir Gomez[1], Juan Carlos Balda[1], Yue Zhao[1], Guangqi Zhu[2]
[1]University of Arkansas, United States, [2]Eaton, United States

5:20 p.m.

T18.9 **Analysis and Injection Control of Zero-Sequence Voltage and Circulating Current for MMC with Active Power Filter**
Guanlong Jia[1], Song Tang[1], Chenghao Zhang[1], Min Chen[1], Yi Lu[2], Yong Yang[2]
[1]Zhejiang University, China,[2]State Grid Zhejiang Electric Power Co., Ltd., China

2:30 p.m. –5:40 p.m.

T19: Bi-Directional Power Converters

ROOM 225-227

TRACK Renewable Energy Systems

SESSION CHAIRS

Junpeng Ji, *Xi'an University of Technology*

Saijun Mao, *Shanghai Lingang Power Electronics Research Institute*

2:30 p.m.

T19.1 **Soft Starting Strategy of Cascaded Dual Active Bridge Converter for High Power Isolated DC-DC Conversion**
Pengfei Yao[1], Xiaohua Jiang[1], Fei Wang[2]
[1]Tsinghua University, China,[2]University of Tennessee, United States

2:50 p.m.

T19.2 **GaN FETs Enable High Frequency Dual Active Bridge Converters for Bi-Directional Battery Chargers**
Feng Qi, Zhan Wang, YiFeng Wu, Philip Zuk
Transphorm Inc., United States

3:10 p.m.

T19.3 **Reverse Current Elimination for Capacitor Voltage Balanced Bidirectional Resonant Converter using a Bidirectional Switch**
Hwasoo Seok[1], Jun-Seok Kim[1], Owon Kwon[1], Minsung Kim[2]
[1]Pohang University of Science and Technology, Korea,[2]Dongguk University, Korea

3:30 p.m.

T19.4 **A Novel Reactive Power Control Mitigating a DC Link Ripple Voltage of Reactive Power Compensator for Distribution Line**
Woosik Sim[1], Jongmin Jo[1], Youngroc Kim[2], Hanju Cha[1]
[1]Chungnam National University, Korea, [2]Hex Power System, Korea

3:50 p.m.

T19.5 **Family of Current-Fed Switched Capacitor – Based Modular DC Transformer Topologies for HVDC Interconnection Application**
Qianhao Sun[1], Xiaohui Ye[2], Jingwei Meng[1], Xinyao Zhu[3]
[1]Tsinghua University, China,[2]China Electric Power Research Institute, China,[3]Jiangsu Electric Power Research Institute, China

4:20 p.m.

T19.6 **Transformer-Less Series-Input-Parallel-Output Dual Active Half-Bridge for MV-LV DC/DC Converter**
Jin-Su Hong, Jung-Ik Ha
Seoul National University, Korea

4:40 p.m.

T19.7 **Modular Isolated Soft-Switching Medium Voltage String Inverter for Large-Scale PV Farm**
Zheng An, Xiangyu Han, Liran Zheng, Karthik Kandasamy, Rajendra Prasad Kandula, Deepak Divan
Georgia Institute of Technology, United States

5:00 p.m.

T19.8 **A High Frequency CLLLC Bi-Directional Series Resonant Converter DAB using an Integrated PCB Winding Transformer**
Sheng-Yang Yu[1], Chris Hsiao[2], Jack Weng[2]
[1]Texas Instruments Inc., United States,[2]Cyntec, Taiwan

5:20 p.m.

T19.9 **Bidirectional Isolated Ripple Cancel Dual Active Bridge Modular Multilevel DC-DC Converter**
Jugo Sugimoto, Pin-Yu Huang, Shota Okutani, Yuichi Kado
Kyoto Institute of Technology, Japan

2:30 p.m. –5:40 p.m.

T20: SiC Devices and Components

ROOM 206-207

TRACK Devices and Components

SESSION CHAIRS

Ali Salih, *ON Semiconductor*

Rajib Datta, *GE Research*

2:30 p.m.

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

2:50 p.m.

T20.2 **An Efficiency Improvement Method for Si/SiC Hybrid Switch based Inverter**
Zeng Liu, Zishun Peng, Ling Ou, Xiaogui Peng, Jun Wang
Hunan University, China

3:10 p.m.

T20.3 **Utilizing Electroluminescence of SiC MOSFETs for Unified Junction-Temperature and Current Sensing**
Sven Kalker, Christoph H. van der Broeck, Rik W. De Doncker
RWTH Aachen University, Germany

3:30 p.m.

T20.4 **Investigation on Effects of Thermal Stress on SiC MOSFET Degradation through Power Cycling Tests**
Jianjun Chen, Xi Jiang, Zongjian Li, Hengyu Yu, Jun Wang, Z. John Shen
Hunan University, China

3:50 p.m.

T20.5 **Comparative Evaluation of Surge Current Capability of the Body Diode of SiC JMOS, SiC DMOS, and SiC Schottky Barrier Diode**
Xi Jiang[1], Jiajun Yu[1], Jianjun Chen[1], Hengyu Yu[1], Zongjian Li[1], Jun Wang[1], Z. John Shen[2]
[1]Hunan University, China,[2]Illinois Institute of Technology, United States

4:20 p.m.

T20.6 **Characterization of 1200V 300A SiC MOSFET Switching Performance Dependence on Load-Cable-Output Filter and Control Deadtime Optimization**
Yujia Cui, Willy Sedano, Peizhong Yi, Lixiang Wei
Rockwell Automation, Inc., United States

4:40 p.m.

T20.7 **Measure the Thermal Parameters of SiC MOSFET through Case Temperature**
Shuai Zheng, Xiong Du, Yaoyi Yu, Quanming Luo, Pengju Sun
Chongqing University, China

5:00 p.m.

T20.8 **A High-Density Single-Turn Inductor for a 6 kV SiC-Based Power Electronics Building Block**
He Song, Jun Wang, Yue Xu, Rolando Burgos, Dushan Boroyevich
Virginia Polytechnic Institute and State University, United States

5:20 p.m.

T20.9 **Robustness Evaluation and Degradation Mechanisms of SiC MOSFETs Overstressed by Switched Stimuli**
Joseph P. Kozak, Ruizhe Zhang, Haoshen Yang, Khai D.T. Ngo, Yuhao Zhang
Virginia Polytechnic Institute and State University, United States

2:30 p.m. –5:40 p.m.

T21: Motor Drives: Topology and Control Strategies

ROOM 203-205

TRACK Motor Drives and Inverters

SESSION CHAIRS

Rashmi Prasad, *General Motors*

Mithat Kisacikoglu, *The University of Alabama*

2:30 p.m.

T21.1 **Advanced Modulation Scheme with Loss Balancing Effect under Low-Modulation Operation for FC-T2C Converter**
Runtian Chen[1], Yifan Zhang[1], Chushan Li[1], Wuhua Li[1], Xiangning He[1], Jianguo Zhu[2], Chenguang Li[2], Xiaowei Gu[3]
[1]Zhejiang University, China,[2]Shenzhen Winline Technology Co., China,[3]Zhejiang Sci-Tech University, China

2:50 p.m.

T21.2 **A Novel Neutral-Point-Clamped Half-Bridge Eleven-Level Inverter with High DC Voltage Utilization Ratio and Fewer Switches**
Qicai Ren, Alian Chen, Jie Chen, Chenghui Zhang
Shandong University, China

3:10 p.m.

T21.3 **Three-Phase Inverter for Formula SAE Electric with Online Junction Temperature Estimation of all SiC MOSFETs**
Fausto Stella, Gianmario Pellegrino, Eric Armando
Politecnico di Torino, Italy

3:30 p.m.

T21.4 **Isolated DC/AC Converter with ZVT based on Pulsating DC Link**
Carmine Abbate, Giovanni Busatto, Francesco Iannuzzo, Daniele Marciano, Davide Tedesco
Università degli Studi di Cassino e del Lazio Meridionale, Italy

3:50 p.m.

T21.5 **Multi-Level Power Converters using Coupled Inductors and Parallel Connected 2-Level Inverters**
Sukhjit Singh, Marius Takongmo, John Salmon
University of Alberta, Canada

4:20 p.m.

T21.6 **Dual and Isomorphic Power Converters with the Topology Cycling Phenomenon**
Yuzhuo Li, Yun Wei Li
University of Alberta, Canada

4:40 p.m.

T21.7 **Si-IGBT / SiC-MOSFET Hybrid Inverter Control Method for Reduced Loss and Switching Ripple**
Jonghun Choi[1], Gyu Cheol Lim[2], Jung-Ik Ha[1]
[1]Seoul National University, Korea,[2]Agency for Defense Development, Korea

5:00 p.m.

T21.8 **Performance Improvement of Medium Voltage Modular Multilevel Converter based Motor Drive using SiC MOSFETs**
Karun Potty, Muneer Al Sabbagh, Jianyu Pan, Ziwei Ke, Julia Zhang, Longya Xu, Jin Wang
The Ohio State University, United States

2:30 p.m. –5:40 p.m.

T22: Control Applications

ROOM 217-219

TRACK Control

SESSION CHAIRS

Seungdeog Choi, *Mississippi State University*

Shahab Mehraeen, *Louisiana State University*

2:30 p.m.

T22.1 **DC/DC Converter Output Capacitor Characterization using Identification Techniques and DTW**
M.A. Granda, C. Fernández, A. Barrado, P. Zumel
Universidad Carlos III de Madrid, Spain

2:50 p.m.

T22.2 **Power Flow Decoupling Controller for Triple Active Bridge based on Fourier Decomposition of Transformer Currents**
Pavel Purgat, Soumya Bandyopadhyay, Zian Qin, Pavol Bauer
Delft University of Technology, The Netherlands

3:10 p.m.

T22.3 **Performance Evaluation of Encoderless Control of Permanent Magnet Synchronous Machines using Predictive Current Observer Method**
Kevin Lee, Yaojin Mo
Eaton, United States

3:30 p.m.

T22.4 **Stability improving of an MMC Distributed System based on Instability Risk and Capacitor Voltage Balancing Capability Evaluation**
Shunfeng Yang, Shun Liu, Haiyu Wang, Hang Su, Jingchun Huang, Shuochen Chen
Southwest Jiaotong University, China

3:50 p.m.

T22.5 **Balancing Control of Paralleled Full-Bridge Converters in High-Current Gradient Amplifiers for MRI Applications**
Misha Kumar[1], Laszlo Huber[1], He Huang[2], Zhiyu Shen[1], Hongyuan Jin[2]
[1]Delta Electronics Ltd., United States, [2]Delta Electronics Co., Ltd., China

4:20 p.m.

T22.6 **A General Carrier-Based Modulation and Capacitor-Voltage Balancing Method for Multilevel Matrix Converters (AC-AC Stacked Multicell Converters)**
Boran Fan[1], Vladimir Blasko[2], Rolando Burgos[1], Dushan Boroyevich[1]
[1]Virginia Polytechnic Institute and State University, United States,[2]United Technologies Research Center, United States

4:40 p.m.

T22.7 **Digital Lock-in Controller IC for Optimized Operation of Resonant SCC**
Tom Urkin, Guy Sovik, Erez Erzol Masandilov, Mor Mordechai Peretz
Ben-Gurion University of the Negev, Israel

2:30 p.m. –5:40 p.m.

T23: Single-Phase AC-DC Converters

ROOM 220-222

TRACK AC-DC Converters

SESSION CHAIRS

John Lam, *York University*

Alex Hanson, *University of Texas*

2:30 p.m.

T23.1 **A Soft-Switched Bridgeless AC/DC Converter for Electric Vehicles**
Rahil Samani[1], Amir Hashemi[2], Behzad Poorali[1], Chris Botting[3], Nick Dohmeier[3], Majid Pahlevani[2]
[1]University of Calgary, Canada,[2]Queen's University, Canada,[3]Delta-Q Technologies, Canada

2:50 p.m.

T23.2 **Single-Phase Bridgeless PFC Rectifier with Hybrid Switched-Capacitor Cell**
Julio Cesar Dias, Telles Brunelli Lazzarin
Federal University of Santa Catarina, Brazil

3:10 p.m.

T23.3 **Analysis of a Magnetically Controlled Single Stage LLC Resonant Converter**
Yuqi Wei[1], Quanming Luo[2], Dereje Woldegiorgis[1], Haider Mhiesan[1], Alan Mantooth[1]
[1]University of Arkansas, United States, [2]Chongqing University, China

3:30 p.m.

T23.4 **Valley Skipping Compensation for Low THD in Constant-on-Time Control for PFC Pre-Regulators: Implementation and Performance**
Alberto Bianco, Giuseppe Scappatura, Francesco Ciappa
STMicroelectronics, Italy

3:50 p.m.

T23.5 **Improvement of Constant-on-Time Control for Transition Mode PFC Boost Pre-Regulators**
Giovanni Gritti
STMicroelectronics, Italy

4:20 p.m.

T23.6 **Means of Reducing Number of Sensors in Single-Phase Power Converters with an Active Power Buffer**
Huawei Yuan[1], Sinan Li[2], Siew-Chong Tan[1], S.Y. Ron Hui[1]
[1]The University of Hong Kong, Hong Kong, [2]The University of Sydney, Australia

4:40 p.m.

T23.7 **Design and Implementation of a High Power Density Bipolar Multi-Level Active Power Pulsation Buffer for Single-Phase Converters**
Zitao Liao, Robert C.N. Pilawa-Podgurski
University of California-Berkeley, United States

5:00 p.m.

T23.8 **Single-Phase Active-Clamped Isolated SEPIC PFC Converter with Partial Power Processing Output Stage**
Deliang Wu, Raja Ayyanar
Arizona State University, United States

5:20 p.m.

T23.9 **A Novel Bidirectional Transformer-Less Grid-Connected Inverter with Common-Mode Leakage Current Suppression**
Zhuoran Liu, Mei Liang, Kai Tian, Xiaobo Yang
ABB, China

2:30 p.m. –5:40 p.m.

T24: DC-DC Converter Applications

ROOM 211-213

TRACK DC-DC Converters

SESSION CHAIRS

Pradeep Shenoy, *Texas Instruments Inc.*
Cong Li, *GE Research*

2:30 p.m.

T24.1 **A Spur-Free, 150-mA Buck Regulator with 96.3% Peak-Efficiency and 77.2% Minimum Efficiency at 10-µA Load for Microcontrollers with Noise-Sensitive ADCs**
Muhammad Swilam Ahmed[1,2], Wei Fu[2], Russell Byrd[2], Ayman Fayed[1]
[1]The Ohio State University, United States, [2]Texas Instruments Inc., United States

2:50 p.m.

T24.2 **A Novel Multi-Input and Single-Output DC/DC Converter for Small Unmanned Aerial Vehicle**
Yeonho Jeong[1], Jae-Do Park[1], Ronald Rorrer[1], Keon-Woo Kim[2], Byoung-Hee Lee[3]
[1]University of Colorado-Denver, United States, [2]Korea Advanced Institute of Science and Technology, Korea, [3]Hanbat National University, Korea

3:10 p.m.

T24.3 **Design of a Two Input Buck Converter (TIBuck) for a Visible Light Communication LED Driver based on Splitting the Power**
Daniel G. Aller[1], Diego G. Lamar[1], Manuel Arias[1], Juan Rodríguez[2], Pablo F. Miaja[1], Javier Sebastián[1]
[1]University of Oviedo, Spain, [2]Universidad Politécnica de Madrid, Spain

3:30 p.m.

T24.4 **Kappa Switching DC-DC Converter with Continuous Input and Output Currents Achieving 86.7% Input Ripple Suppression and 16dB Peak EMI Reduction**
Xugang Ke, Zoe Hay, Shuilin Tian
Analog Devices, Inc., United States

3:50 p.m.

T24.5 **An Interleaved Boost and Dual Active Bridge based Three Port Microinverter**
Amit Bhattacharjee, Issa Batarseh
University of Central Florida, United States

4:20 p.m.

T24.6 **A Novel Mixed Planar Litz Transformer for High Frequency Active Clamp Flyback Converters**
Mario Ursino[1], Stefano Saggini[1], Ruben Specogna[1], Alberto Bianco[2], Francesco Ciappa[2], Giuseppe Scappatura[2]
[1]University of Udine, Italy, [2]STMicroelectronics, Italy

4:40 p.m.

T24.7 **High Frequency Online Battery Impedance Measurement Method using Voltage and Current Ripples Generated by DC-DC Converter**
Zhiyong Xia, Jaber A. Abu Qahouq
The University of Alabama, United States

5:00 p.m.

T24.8 **A High Efficiency High Power-Density LLC DC-DC Converter for Electric Vehicles (EVs) On-Board Low Voltage DC-DC Converter (LDC) Application**
Xiang Zhou[1], Bo Sheng[1], Wenbo Liu[1], Yang Chen[1], Andrew Yurek[1], Yan-Fei Liu[1], P.C. Sen[1], K. Lakshmi Varaha Iyer[2]
[1]Queen's University, Canada, [2]Magna International Inc., Canada

5:20 p.m.

T24.9 **Auxiliary Power Network Architecture for 10 kV SiC-Based Power Electronics Building Blocks**
Keyao Sun, Ning Yan, Jun Wang, Dong Dong, Rolando Burgos, Dushan Boroyevich
Virginia Polytechnic Institute and State University, United States

as of February 21, 2020

12:15 p.m. – 12:45 p.m.

Exhibitor Seminars – Session 6

Synopsys, Inc.
EXHIBIT THEATER 4

Optimize Your Power Electronic Systems with the Saber Simulator

PRESENTED BY: **Alan Courtay**

The periodic AC analysis in Saber™ now supports a multi-tone mode that significantly accelerates the generation of Bode plots to assess the stability of power supplies. In this session, we will review this new feature and demonstrate how the Saber simulation platform can be used to model the power electronics of an electric vehicle powertrain at different levels of abstraction, starting from the detailed switching of inverter IGBTs and MOSFETs. This presentation will also cover how the Saber built-in optimizer can be used to improve designs toward specific goals (like extending the range of an electric vehicle).

NexGen Power Systems
EXHIBIT THEATER 2

NexGen Vertical GaN® Power Transistors

PRESENTED BY: **Dinesh Ramanathan**

NexGen is founder of Vertical GaN™ technology, designs and produces high voltage vertical GaN power devices.

Process and device technology enabling high performance-for-GaN-on-GaN devices for application voltages ranging from 100V to 4000V, and switching frequencies as high as 2MHz (or higher)

Coilcraft, Inc.
EXHIBIT THEATER 1

Power Magnetics for Today and Tomorrow

PRESENTED BY: **Len Crane**

New Coilcraft power inductors set the bar for high performance, small size, and reliability. Our expanded XGL family and others reach new standards for high efficiency, enabling converter designs to be smaller, run cooler, emit less EMI, and last longer. These inductors give designers the freedom to re-envision converter design – achieving greater power densities and higher performance figures. This presentation introduces exciting new inductors, discusses their key features, and provides guidance on how to best apply them to optimize your converter designs.

Omicron Lab
EXHIBIT THEATER 3

Accurately Measure Inductance with DC BIAS to 125Amps

PRESENTED BY: **Steven Sandler**

Inductors are plentiful in power electronics. They're used for input EMI filters, output EMI filters, and switching inductors for various switching regulator topologies. Recently, it has become even more necessary to measure inductors with bias, due to an increase in counterfeit magnetic cores. Measuring these inductors with DC bias has been difficult, particularly as DC/DC converters and step-down regulators exceed 90 Amps. The bias sources are expensive, large, and heavy.

In this session we'll show two accurate, low cost, highly portable methods of measuring frequency dependent inductance, with DC Bias effects included.

One method uses a Frequency Response Analyzer to measure inductors biased up to 20 Amp. The other method uses the 2-port shunt through VNA setup to measure inductors up to 125 Amps. Both of these methods are highly portable and utilize power supplies that you likely already have.

1:00 p.m. – 1:30 p.m.

Exhibitor Seminars – Session 7

Efficient Power Conversion Corporation (EPC)
EXHIBIT THEATER 1

Silicon is Dying in Computing Applications

PRESENTED BY: **Alex Lidow**

For over 10 years gallium nitride power devices have been in volume production and have established an enviable reliability track record. As advancements in computing have pushed power densities higher every year, the aging silicon MOSFET is now past its expiration date. Soon, automotive electronics will follow the same path. In this talk we will show how the changing architecture of advanced computing and automobiles favors the capabilities and cost structure of GaN transistors and ICs more and more over the silicon MOSFET.

Maxim Integrated
EXHIBIT THEATER 2

Getting the Most from SIMPLIS DC-DC Converter Simulation

PRESENTED BY: **Brooks Leman,** *Senior Principal Member of Technical Staff at Maxim Integrated*

Use the online EE-Sim® DC-DC tool to quickly create and verify Maxim DC-DC converter designs with preconfigured

SIMPLIS simulations. For advanced analysis, download the schematic and use the free OASIS simulator to explore and optimize specific modes of operation.

The EE-Sim DC-DC tool takes from the user a simple set of design requirements (including Vin range, Vout, Iout, Switching Frequency, and other features), checks against the design guidelines for the selected Maxim part, synthesizes a complete design, draws the schematic, offers several different basic simulations to run (including Load step transient response, Bode plots, Startup), selects component part numbers, provides a complete bill of material, and automatically generates a complete report.

Maxim's new OASIS (Offline Analog Simulator Including SIMPLIS) tool performs more advanced analysis such as Bode sub-plots, output impedance, and multi-variable simulations. All Maxim parts with EE-Sim models have a SIMPLIS schematic in the free OASIS simulator. EE-Sim schematics can also be easily run in a fully licensed SIMPLIS version.

United Chemi-Con
ROOM 211-213

Newly Developed Advanced High Ripple Current AL E-CAP for High Frequency Power Converter with SiC and/or GaN

PRESENTED BY: **Derrick Fitzpatrick,** *United Chemi-Con;* **Atsushi Yoshida,** *Nippon Chemi-Con*

The presentation will focus on AL E-Cap suitable solution for high frequency power converters with advanced SiC and/or GaN power devices.

Power Integrations
ROOM 203-205

The Power of GaN Integration

PRESENTED BY: **Doug Bailey,** *Vice President of Marketing*

The transformative effect of highly-efficient GaN switch technology means that heat dissipation is no longer the key factor in limiting the size of many adapter, consumer and industrial power supplies. The reduction in waste heat allows the elimination of heatsinks and increases in power density, so for the first time we are able to make power adapters that are small, lightweight and attractive. Discrete and passive component counts have now become a key limiting factor in small cost-effective power supply design. We will show that solving these problems through smart integration and the adoption of highly innovative circuit-communication and control techniques leads to simpler, more reliable and more manufacturable offline power supplies.

PPST Solutions
ROOM 206-207

The Application of Regenerative AC and DC Test Equipment for Electric Vehicle technology and Micro-grid Research and Development

PRESENTED BY: **Herman vanEijkelenburg**

This industry session will prove an overview of available programmable power test equipment capable of simulating micro-grids for alternative energy research and development as well as EV Charging systems testing. It will also cover regenerative DC power test systems for development and testing of EV and Energy Storage Solutions applications.

This session will also touch on testing of bidirectional AC and DC products for compliance to international test standards for international markets.

West Coast Magnetics
ROOM 225-227

The Use of Foil and Litz Wire in High Frequency SMPS Transformers

PRESENTED BY: **Jacob Campbell**

Higher frequency in SMPS power conversion is often limited by magnetic elements in the circuit. While planar transformers provide high power density, limitations include high capacitive coupling between windings, and in providing a high level of isolation between the windings isolation. Wire windings provide a solution but are limited by winding losses. Copper foil and litz wire have lower AC winding loss at SMPS frequencies and inherently low capacitive coupling. The suitability of litz wire and copper foil however depend on a number of variables including voltage and frequency. In this presentation we will explore tradeoffs and present a roadmap for when a litz wire winding is preferred, or copper foil is a better choice.

Pacific Sowa Corporation; C/O Epson Atmix
EXHIBIT THEATER 3

High Reliability Soft Magnetic Powder for Automotive Inductors

PRESENTED BY: **Masahito Yoshizawa**

EPSON ATMIX Corporation is the world leading magnetic powder provider in Japan. Our amorphous powder "KUAMET" is widely used for inductors in ICT and automotive industries. Super fine powder ATFINE® contributes to reduction of core loss and increase of fillability. Our unique insulation technology enhances reliability of your applications.

Plexim
EXHIBIT THEATER 4

Code Generation for Embedded Processors in 30 Minutes or Less Using the PLECS Toolchain

PRESENTED BY: **Vitalik Ablaev**

Automatic code generation accelerates the design, programming, and validation of embedded control systems, making microcontrollers more accessible to power electronics engineers in a range of applications. Starting from a blank canvas, in this seminar we will show step-by-step how to create a closed-loop controller running on an MCU from scratch. We will demonstrate how to generate control code for a TI C2000 microprocessor from PLECS and then verify the controller performance using the PLECS RT Box as a hardware-in-the-loop (HIL) test platform. We will benchmark offline and real-time simulations, demonstrating how embedded controls can quickly be developed and tested in real-time using the PLECS toolchain.

1:45 p.m. – 2:15 p.m.

Exhibitor Seminars – Session 8

Premo
ROOM 211-213

Key Fatal Failures & Solutions in EV Power Magnetics

PRESENTED BY: **Nantonio Rojas**

Fatal failure in Power Electronics often ends up in the car stopped and rowed to service (best case), and expensive replacement of the full functional block and in some very mediatic times, seeing the car into flames with a very serious reputational damage for the Car Makers and a serious situation for the car owner (worst case).

DCDC/ACDC converters in EV-Cars today and int the next future will handling high power in the smallest possible space, with dramatic and potential decrease of reliability if heat management is not driving in a proper way, not only from the Power semiconductor point of view but also from Power Magnetic Design (higher integration with significant increase of power density).

Most of the issues that affects Lithium batteries in EV (pressure, Heating, short circuits, flame risks are common with Power Electronics circuits and thus the same solutions apply).

LTEC Corporation
ROOM 206-207

Supporting System Design/Development by Physical Analysis

PRESENTED BY: **Dr. Adan Alberto**

Physical analysis of the latest competing products and technologies is a powerful tool of learning. Focused on wide bandgap semiconductors, LTEC Corporation will reveal through numerous examples how often yet undisclosed knowledge gained through deep physical analysis is directly applicable to new product development. Attendees will see physical analysis data and simulation results generated by LTEC as an unbiased, independent third party, thus empowering designers to make well informed decisions about product selection, and methods to enhance system-level reliability. The presenter will reveal SiC semiconductor technology trends derived from physical analysis-based data. Contents of the latest technical analysis reports will also be introduced.

LTEC Corporation, Japan's dominant intellectual property analysis company (Exhibit Booth 739), provides deep analysis services for new product research and development engineering teams and industrial legal communities worldwide.

Exagan
EXHIBIT THEATER 3

Accelerating the New Generation of Power Electronics with Competitive GaN Solutions

PRESENTED BY: **Eric Moreau**

GaN-on-Silicon power devices are recognized as a key technology to sustain future power converter systems roadmaps in the field of IT electronics, renewable solar and emission free automotive applications. Exagan implemented proprietary 200-mm's GaN-on-Silicon technologies into high volume production to enable higher integration and improved efficiency.

G-FET™ & G-Drive™ Exagan product portfolio provides GaN-on-Silicon solutions that enable a new generation of power electronics.

This paper will present the latest products and tools to be released to leverage on cost effective G-Stack™ 200-mm's GaN-on-Silicon proprietary technology.

ON Semiconductor
EXHIBIT THEATER 2

Reducing Size & Increasing Efficiency with Disruptive Tech of SiC/GaN MOSFET's

PRESENTED BY: **Brandon Becker**

Silicon Carbide MOSFETs proliferation into Power Designs are solving a multitude of limitations posed by Silicon switches. This presentation is target at sharing ON Semiconductors latest product portfolio offering as well as take a deep dive into two applications where SiC is reducing size and increasing efficiency; (1) SiC Motor drive, UPS, PV inverter and Elevator Emergency System, whose DC link voltage are up to 300VDC to 1000VDC (2) SiC Bridgeless Totempole PFC Solution targeted for 80 Plus Titanium and 80 Plus Platinum solutions.

IMEC
ROOM 203-205

Monolithically integrated GaN – MPW

PRESENTED BY: **Phillip Christie**

Special attention has been dedicated to enable full GaN power integrated circuits (IC), where all the components (e.g. half bridge, drivers, comparators, dead-time control etc...) are integrated into a single GaN chip. This technology is a game changer for GaN.

With imec's GaN-IC technology, designers can finally unlock the full potential of GaN technology and can realize unprecedented complex and compact power systems on a chip.

In this talk, imec's GaN-IC technology will be explained, examples of what is possible to realize with such a technology are shown, and of course, how to access it through imec's services.

Tyndall National Institute
ROOM 225-227

Tyndall National Institute – Your partner in Deep Tech Research and Innovation

PRESENTED BY: **Prof. Cian O'Mathuna; Michael Hayes**

Tyndall is a leading European research centre of over 600 researchers, work with industry (200 companies) and academia to transform research into products in their core market areas of electronics, communications, energy, power, health, agri-food and the environment.

This presentation will introduce the Tyndall National Institute with particular focus on research activities in the power and energy areas:

- Integrated Magnetics devices on silicon for power conversion applications
- Integrated Power Management Systems Research - PMICs and PwrSiPs
- Microelectronics circuit design space with an emphasis on mixed-signal, analogue and RF circuits (Microelectronics Circuits Centre Ireland – MCCI).
- Industry-led collaborative research center in the field of integrated sustainable energy systems. (International Energy Research Centre - IERC)
- Energy Harvesting, storage & power management solutions to extend battery life of IoT edge devices

Infineon Technologies Americas Corp

EXHIBIT THEATER 1

Silicon-on-Insulator (SOI) Technology for 100- to 1200-V High-Voltage Gate Drivers

PRESENTED BY: **Tom Kapucija**

Latest generation of level-shift gate drivers using Silicon-on-Insulator (SOI) technology enable migration to higher switching frequencies and new applications while providing system level advantages to existing motor control and inverter applications. Reduced level shift losses enable higher frequency operation with reduced power dissipation for increased system reliability and reduced system Bill of Material cost and smaller system footprint.

SOI based gate drivers break through the 100kHz switching frequency ceiling to enable lower cost and smaller footprint solutions for 100V to 1200V applications.

EGSTON Power Electronics Gmbh

EXHIBIT THEATER 4

Power HIL: Enabling Flexible and Repeatable Testing of Power Electronics Systems in Close-to-reality Environment

PRESENTED BY: **Srdjan Srdic, PhD**

The growing market need for flexible and repeatable testing of power electronics systems in grid, automotive, aerospace and defense applications, has made power hardware-in-the loop (P-HIL) a very attractive test approach. With P-HIL, test voltages and currents are generated in user-configurable real-time models, enabling emulation of different operating environments for the physical system that is being tested. A single software-configurable P-HIL test platform can be used to test multiple systems in different test scenarios and operating environments. This is extremely beneficial because it provides high testing flexibility, reduces system cost and accelerates product time-to-market. Enabling repeatable automated tests of power electronics systems significantly de-risks product development by reducing time needed for design iteration.

EGSTON Power Electronics is the leading manufacturer of high-performance P-HIL test and emulation platforms, ranging from 100 kVA to 1.2 MVA power. The COMPISO System from EGSTON Power Electronics is the most versatile P-HIL test and emulation platform currently on the market. With four-quadrant operation, 5 kHz large-signal bandwidth, several predefined operation modes and software applications for easier system use in different test scenarios, the COMPISO System is successfully serving the market since 2016.

This seminar will include the company introduction followed by a brief overview of P-HIL concepts and advantages of P-HIL approach in system testing. The COMPISO System emulation and test platform will be introduced and its many advantages explained using several use cases as examples.

8:30 a.m. – 11:25 a.m.

IS19: GaN Applications and Integration

ROOM R04-R05

SESSION CHAIRS

Peter Di Maso, *GaN Systems*

Dilip Risbud, *Dialog Semi*

Tony O'Brien, *Cisco Systems, Inc.*

8:30 a.m.

IS19.1 **High Efficiency AC/DC Power Supply using Integrated GaN Power Devices**
Thierry Bouchet, Dominique Bergogne
Wise Integration, France

8:55 a.m.

IS19.2 **A Monolithic GaN Half-Bridge IC for High-Frequency Power Converters**
Jianjing Wang, Brandon Perez, Michael de Rooij
Efficient Power Conversion Corporation, United States

9:20 a.m.

IS19.3 **Navigating the Optimal USB-PD Fast-Charger Topology Maze from 27W to 100W+**
Xiucheng Huang, Tom Ribarich, Stephen Oliver
Navitas Semiconductor, United States

9:45 a.m.

IS19.4 **GaN Power ICs Enable Design of High Density USB PD Power Adapters**
Jimmy Chen
Power Integrations, United States

10:35 a.m.

IS19.5 **The Effect of Dynamic On-State Resistance to System Losses in GaN-Based Hard-Switching Applications**
Ruoyu Hou, Juncheng Lu
GaN Systems Inc., Canada

8:30 a.m. – 11:25 a.m.

IS20: PwrSoC Driving Leading Edge Components

ROOM R02-R03

SESSION CHAIRS

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

8:30 a.m.

IS20.1 **Power Supply on Chip as a Key Enabler for High-Performance Applications**
Francesco Carobolante
IoTissimo, United States

8:55 a.m.

IS20.2 **Integrated Capacitors: Trends and Challenges for the Future**
Medhi Jatlaoui
Murata, France

9:20 a.m.

IS20.3 **A History and Prospective View in Integrated Inductors**
Mark Allen
University of Pennsylvania, United States

9:45 a.m.

IS20.4 **The Path to a Power Conversion System on a Chip - One GaN Stage at a Time**
Alex Lidow, David Tam, Ravi Ananth
Efficient Power Conversion Corporation, United States

10:35 a.m.

IS20.5 **A Perspective of Magnetics Integration: On-Chip Vs PCB**
Baoxing Chen
Analog Devices, United States

11:00 a.m.

IS20.6 **Voltage Regulators with Integrated Inductors- on-Chip Vs in-Package**
Santosh Kulkarni
Dialog Semiconductor, United Kingdom

8:30 a.m. – 11:25 a.m.

IS21: Components

ROOM R01

SESSION CHAIRS

Harry Soin, *Artesyn*

Rick Fishbune, *IBM*

Ada Cheng, *Adaclock*

8:30 a.m.

IS21.1 **Not all GaN Power Transistors are made Equal – The Benefits of Vertical GaN-on-GaN**
Dinesh Ramanathan
NexGen Power Systems, United States

8:55 a.m.

IS21.2 **AC Ratings and Thermal Properties of Multilayer Ceramic Capacitors (MLCCs) in Resonant Applications**
Allen Templeton, Hunter Hayes, Nathan Reed, John Bultitude, Jonathan Paulsen, Mark Laps
KEMET Electronics, United States

9:20 a.m.

IS21.3 **Capacitors for Power Converters based on Novel Thin Film Vacuum Technology**
Kevin A. O'Connor
Caporus Technologies, LLC, United States

9:45 a.m.

IS21.4 **High Performance Pulse Load Surface Mount Resistors**
Breno Albuquerque
Vishay Intertechnology, Inc., United States

10:35 a.m.

IS21.5 **Energy Storage Capacitor Technology Comparison and Selection**
Daniel West, Ron Demcko, Joe Hock, Bob Knopsnyder, Vincent Mao, Ashley Stanziola
AVX Corporation, United States

11:00 a.m.

IS21.6 **Practical Current Sensing with Resistors**
Tom Morris
TT Electronics, United States

8:30 a.m. – 11:25 a.m.

IS22: Modules

ROOM R06

SESSION CHAIRS

Eric Persson, *Infineon Technologies*

8:30 a.m.

IS22.1 **How to Preserve Power Module Integrity without compromising Switching Performance**
Vittorio Giuffrida, Alessandra Manzitto, Gaetano Bazzano, Simone Buonomo, Mario Pulvirenti
STMicroelectronics, Italy

8:55 a.m.

IS22.2 **Next Generation High Power SiC MOSFET Modules**
Mark Steiner, Eric Motto, Michael Rogers
Mitsubishi Electric US, United States

9:20 a.m.

IS22.3 **Key Challenges in Achieving Short-Circuit Protection on SiC Power Modules using Isolated Gate Drivers**
Deepak Gunasekaran
Analog Devices, United States

9:45 a.m.

IS22.4 **Increasing Power Density with Direct-Cooled SiC Power Modules in 3-Phase Inverters**
Matthew Feurtado
Wolfspeed, A Cree Company, United States

10:35 a.m.

IS22.5 **Thermal Stability Evaluation of the Electro-Casting Copper (ECC) AlN Ceramic Substrate**
Jay Yu[1], Jason Huang[2]
[1]*ICP Technology Co., LTD, Taiwan,*
[2]*Sentec E&E Co., LTD, Taiwan*

8:30 a.m. – 11:25 a.m.

IS23: The Modernization of Quality & Reliability: Testing Methods & Benchmarks for GaN and SiC Semiconductors

ROOM R07

SESSION CHAIRS

Jeff Casady, *Wolfspeed, A Cree Company*
Primit Parikh, *Transphorm*

8:30 a.m.

IS23.1 **Extreme Reliability and Test to Fail Methodology for GaN Devices**
Alex Lidow, Robert Strittmatter
Efficient Power Conversion Corporation, United States

8:55 a.m.

IS23.2 **Best Practices using Voltage Acceleration for Reliability Testing of High Voltage GaN**
Ronald Barr, Yifeng Wu
Transphorm, United States

9:20 a.m.

IS23.3 **Selected Topics on Power GaN and SiC Reliability**
Sameh Khalil
Infineon Technologies, United States

9:45 a.m.

IS23.4 **JEDEC JC-70 Datasheet, Qualification, and Test Standards for Wide Bandgap: Progress and Impact**
Stephanie Watts Butler[1], Peter Friedrichs[2]
[1]*Texas Instruments Inc., United States,*
[2]*Infineon Technologies AG, Germany*

10:35 a.m.

IS23.5 **SiC MOSFET Reliability for EV Drivetrain**
Don Gajewski, Brett Hull
Wolfspeed, A Cree Company, United States

11:00 a.m.

IS23.6 **GaN Systems Demonstrates Reliability based on Qualification and Lifetime Data**
Maryam Abouie
GaN Systems, Canada

8:30 a.m. – 11:25 a.m.

IS24: Addressing EMI Challenges with Wide Band Gap Devices

ROOM R08

SESSION CHAIR

Randy White, *Rohde & Schwarz USA, Inc.*

8:30 a.m.

IS24.1 **Redesign with SiC – An EMI Compliance Rapid Proto-Typing Approach**
Cam Pham
Cree Europe GmbH, United States

8:55 a.m.

IS24.2 **Best Practices for EMI Debug and Pre-Compliance**
Markus Herdin
Rohde and Schwarz, Germany

9:20 a.m.

IS24.3 **Addressing EMI Challenges with System Design and Troubleshooting**
Benjamin Dannan
Diversey, United States

9:45 a.m.

IS24.4 **EMI Mitigation Techniques for Wide-Bandgap Devices (WBDs)**
Jared Quenzer
Würth Elektronik, United States

10:35 a.m.

IS24.5 **Simulating Conducted Emissions from Electric Vehicle Powertrains**
Jing Zhou
Dassault Systèmes, United States

11:00 a.m.

IS24.6 **Ultra-High Bandwidth GaN-Based Class-D Power Amplifier for Testing of Three-Phase Mains Interfaces for Renewable Energy Systems**
P.S. Niklaus, J. Azurza Anderson, D. Bortis, J.W. Kolar
ETH Zürich, Switzerland

1:45 p.m. – 3:25 p.m.

IS25: SiC Applications

ROOM R04-R05

SESSION CHAIRS

Victor Veliadis, *PowerAmerica*

Peter Friedrichs, *Infineon Technologies AG*

Nagarajan Sridhar, *Texas Instruments, Inc.*

1:45 p.m.

IS25.1 **Status, Evaluation and Modeling of SiC MOSFETs Short-Circuit Robustness**
Alberto O. Adan, Yusuke Takagi, Seiji Takeuchi, Louis Burgyan, Yuji Kakizaki
LTEC Corp., Japan

2:10 p.m.

IS25.2 **SiC MOSFETs Applications and Technology Robustness Evaluation under Avalanche Conditions**
Mario Pulvirenti, Angelo G. Sciacca, Luciano Salvo, Gionatan Montoro, Massimo Nania
STMicroelectronics, Italy

2:35 p.m.

IS25.3 **High-Frequency High-Power-Density Power Converters with SiC MOSFETs**
Yuequan Hu, Jianwen Shao, Teik Siang Ong
Wolfspeed, A Cree Company, United States

3:00 p.m.

IS25.4 **ROHM's Next-Generation SiC MOSFETs**
Kenji Yamamoto[1], Seigo Mori[1], Sawa Haruyama[1], Takui Sakaguchi[1], Yuki Nakano[1], Noriaki Kawamoto[1], Motohiro Ando[1], Ming Su[2]
[1]ROHM Co., Ltd., Japan, [2]ROHM Semiconductor LLC, United States

1:45 p.m. – 3:25 p.m.

IS26: Applications II

ROOM R02-R03

SESSION CHAIRS

Davide Giacomini, *Infineon Technologies AG*

Greg Evans, *Welcomm, Inc.*

1:45 p.m.

IS26.1 **FAST Constant On-Time Control for Point-of-Load Applications**
John Bang Sup Lee, Min Chen, Yong Zhou, Bhanu Baddipadiga, Danny Clavette
Infineon Technologies, United States

2:10 p.m.

IS26.2 **GaN FETs for Lidar Cameras and other Low Voltage, Very High Frequency, Ultrafast Pulse Power Applications**
John Glaser
Efficient Power Conversion, United States

2:35 p.m.

IS26.3 **Benefits of Secondary-Side Control**
Thomas Quigley[1], Swaroop Vaidyanath[2]
[1]Microchip Technology Inc., United States, [2]Würth Elektronik, United States

1:45 p.m. – 2:35 p.m.

IS27: Test

ROOM R01

SESSION CHAIRS

Bill Peterson, *E&M Power*

Edward Jones, *Infineon Technologies AT*

Davide Giacomini, *Infineon Technologies AG*

1:45 p.m.

IS27.1 **How to make accurate Dynamic Characterization on WBG Power Devices while keeping the flexibility of a Test System**
Ryo Takeda, Bernhard Holzinger
Keysight Technologies, United States

2:10 p.m.

IS27.2 **Power Source Testing: It's More than Just Efficiency**
Chad Clark
Vitrek, LLC, United States

2:35 p.m.

IS27.3 **Using Battery/Fuel Cell Emulation for Testing DC Fast Chargers & Powertrains**
Martin Weiss
NH Research, United States

3:00 p.m.

IS27.4 **Silicon Carbide (SiC) Power Semiconductor Thermal Characterization with Thermal Transient Testing Techniques**
Andras Vass-Varnai, Gabor Farkas, Young Joon Cho, Weikun-Jimmy He, Joe Proulx, Peter Doughty
Siemens, United States

1:45 p.m. – 3:25 p.m.

IS28: Power Supplies: Where Hardware and Software Meet

ROOM R06

SESSION CHAIRS

Brian Zahnstecher, *PowerRox LLC*

Tony O'Brien, *Cisco Systems, Inc.*

1:45 p.m.

IS28.1 **Test vs. Analysis: What's the Right Ratio?**
Charles Hymowitz
AEi Systems, United States

2:10 p.m.

IS28.2 **System Reliability for Small Cells Enable 5G**
Doug Kirkpatrick
Eridan Communications, United States

2:35 p.m.

IS28.3 **Actions to Improve Software Quality in Digital Power Electronics using PSMA's SW Reliability Report**
Hamish Laird
ELMG Ltd., New Zealand

3:00 p.m.

IS28.4 **Challenges on Reliability of Passive Components with Future Mobility Concepts**
Lorandt Foelkel
Würth Elektronik, Germany

1:45 p.m. – 3:25 p.m.

IS29: Not Knowing the Rules Can Ruin Your Power Converter Design

ROOM R07

SESSION CHAIRS

Ed Herbert, *PSMA*

1:45 p.m.

IS29.1 **If your Efficiency is too Low, Your Sales will be too Low**
Ada Cheng[1], Arnold Alderman[2]
[1]Ada'Clock, United States, [2]Anagenesis, United States

2:10 p.m.

IS29.2 **If your Standby Power is too High, Your Power Converter will not Sell**
David Chen
Power Integrations, United States

2:35 p.m.

IS29.3 **If Your Power Converter is Not Safe, You May Have an Expensive Recall**
Mark Batulan
Power Integrations, United States

3:00 p.m.

IS29.4 **EMI: If you don't Comply, It will interfere with your Sales!**
Kevin Parmenter[1], Jim Spangler[2]
[1]Taiwan Semiconductor US, United States, [2]Spangler Prototype, United States

1:45 p.m. – 3:00 p.m.

IS30: Challenges of Semiconductor System Integration for Power Electronics

ROOM R08

SESSION CHAIRS

Aung Tu, *Infineon Technologies AG*

Reenu Garg, *Microchip*

1:45 p.m.

IS30.1 **An 800V 0.25um HVIC Technology for High Speed, Cost Efficient GaN Drivers**
Arash Elhami Khorasani, Mark Griswold
ON Semiconductor, United States

2:10 p.m.

IS30.2 **The Case for GaN Integrated-Circuits**
Edward Lee, Mike Chapman, Ravi Ananth
Efficient Power Conversion Corporation, United States

2:35 p.m.

IS30.3 **Gate Driver Solution for GaN based Low Power Motor Control Applications**
Eric Persson
Infineon Technologies, United States

8:30 a.m. – 11:15 a.m.

T25: Soft-Switching DC-DC Converters

ROOM 208-210

TRACK DC-DC Converters

SESSION CHAIRS

Shuai Jiang, *Google LLC*

Shangzhi Pan, *Wuhan University*

8:30 a.m.

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

8:50 a.m.

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

9:10 a.m.

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

9:30 a.m.

T25.4 **Enhanced Zero-Voltage-Switching Conditions of Dual Active Bridge Converter under Light Load Situations**
Bochen Liu, Pooya Davari, Frede Blaabjerg
Aalborg University, Denmark

9:50 a.m.

T25.5 **The Optimal Design of a High-Temperature PCB-Embedded Transformer GaN-Based Gate-Drive Power Supply with a Wide-Input Range**
Jiewen Hu[1], Bo Wen[1], Rolando Burgos[1], Dushan Boroyevich[1], Yonghan Kang[2], Hossein Dadkhah[2]
[1]Virginia Polytechnic Institute and State University, United States,[2]LG Electronics Vehicle Components, United States

10:35

T25.6 **Design Analysis for Current-Transformer based High-Frequency Auxiliary Power Supply for SiC-Based Medium Voltage Converter Systems**
Ning Yan, Jiewen Hu, Jun Wang, Dong Dong, Rolando Burgos
Virginia Polytechnic Institute and State University, United States

10:55

T25.7 **Design and Analysis of Tunable Piezoelectric Transformer based DC/DC Converter with AC Output Inductor**
Le Wang[1], Rolando P. Burgos[1], Alfredo Vazquez Carazo[2]
[1]Virginia Polytechnic Institute and State University, United States,[2]Micromechatronics, Inc., United States

8:30 a.m. – 11:15 a.m.

T26: Modeling of Magnetic Components and Systems

ROOM 228-230

TRACK Modeling and Simulation

SESSION CHAIRS

Ali Safayet, *Halla Mechatronics*

Kasunaidu Vechalapu, *Eaton*

8:30 a.m.

T26.1 **Modelling and Experimental Evaluation of Ideal Transformer Algorithm Interface for Power Hardware in the Loop Architecture**
Mandip Pokharel, Carl Ngai Man Ho
University of Manitoba, Canada

8:50 a.m.

T26.2 **Analysis and Attenuation of Differential-Mode Resonances due to Winding Capacitances in High-Power Planar Transformers**
Yucheng Gao, Vivek Sankaranarayanan, Robert W. Erickson, Dragan Maksimović
University of Colorado-Boulder, United States

9:10 a.m.

T26.3 **Coreless Transformer based High Voltage Generator for Intense Magnetic Field Applications**
Saijun Mao[1], Jan Braham Ferreira[2]
[1]Fudan University, China,[2]University of Twente, The Netherlands

9:30 a.m.

T26.4 **Comprehensive Analysis of Models and Operational Characteristics of Piezoelectric Transformers**
Le Wang, Rolando P. Burgos
Virginia Polytechnic Institute and State University, United States

9:50 a.m.

T26.5 **Measurement-Based Modeling of Power Module Parasitics with Increased Accuracy**
Blake Nelson[1], Andrew Lemmon[1], Brian DeBoi[1], Marshal Olimmah[1], Kraig Olejniczak[2]
[1]The University of Alabama, United States, [2]Wolfspeed, A Cree Company, United States

10:35 a.m.

T26.6 **Modeling and Validation of Conducted Emissions Trends in Medium-Voltage Power Electronic Systems**
Aaron D. Brovont[1], Jin Zhao[2], Andrew N. Lemmon[2]
[1]PC Krause and Associates, United States, [2]The University of Alabama, United States

10:55 a.m.

T26.7 **A Simplified Approach to CM Modeling of a Vienna Rectifier for Electromagnetic Compliance**
Harish Suryanarayana[1], Sneha Narasimhan[2], Maziar Mobarrez[1], Arun Kadavelugu[1]
[1]ABB, United States,[2]North Carolina State University, United States

8:30 a.m. – 11:15 a.m.

T27: Energy Storage Systems

ROOM 225-227

TRACK Renewable Energy Systems

SESSION CHAIRS

Majid Pahlevani, *Queen's University*

Wei Xu, *Huazhong University of Science and Technology*

8:30 a.m.

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

8:50 a.m.

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

9:10 a.m.

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

9:30 a.m.

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

9:50 a.m.

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

10:35 a.m.

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

10:55 a.m.

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

8:30 a.m. – 11:15 a.m.

T28: Design Techniques for SiC-Based Power Converters

ROOM 206-207

TRACK Power Electronics Integration and

SESSION CHAIRS

Yuzhi Zhang, *ABB*

Nathan Weise, *Marquette University*

8:30 a.m.

T28.1 **A Medium Power SiC Module with Integrated Active Snubber for Lowest Switching Losses**
Michael Schlüter[1], Andre Uhlemann[1], Martin Pfost[2]
[1]Infineon Technologies AG, Germany,[2]Technische Universität Dortmund, Germany

8:50 a.m.

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

9:10 a.m.

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

9:30 a.m.

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

9:50 a.m.

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

10:35 a.m.

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

10:55 a.m.

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

8:30 a.m. – 11:15 a.m.

T29: Gumbo Applications 10W LED to KW Converter

ROOM 203-205

TRACK Power Electronics Applications

SESSION CHAIRS

Sombuddha Chakraborty, *Texas Instruments Inc.*

Pedro Alou, *Universidad Politécnica de Madrid*

8:30 a.m.

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

8:50 a.m.

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

9:10 a.m.

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

9:30 a.m.

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

9:50 a.m.

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

10:35 a.m.

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

10:55 a.m.

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**
Liran Zheng, Xiangyu Han, Rajendra Prasad Kandula, Karthik Kandasamy, Maryam Saeedifard, Deepak Divan
Georgia Institute of Technology, United States

8:30 a.m. – 11:15 a.m.

T30: Gate Drive Circuits I

ROOM 217-219

TRACK Control

SESSION CHAIRS

Bilal Akin, *University of Texas at Dallas*

Chushan Li, *Zhejiang University*

8:30 a.m.

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

8:50 a.m.

T30.2 **Load-Sensitive Gate Drive Scheme for PFC Boost Converters**
Wolfgang Frank[1], Franz Stückler[2]
[1]Infineon Technologies AG, Germany,[2]Infineon Technologies Austria AG, Austria

9:10 a.m.

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

9:30 a.m.

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

9:50 a.m.

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

10:35 a.m.

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

8:30 a.m. – 11:15 a.m.

T31: Wireless Power Transfer for Electric Transportation Applications

ROOM 220-222

TRACK Wireless Power Transfer

SESSION CHAIRS

Jason Pries, *Oak Ridge National Laboratory*
Raghav Khanna, *University of Toledo*

8:30 a.m.

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

8:50 a.m.

T31.2 **Impedance Tuning Control and Synchronization Technique for Semi-Bridgeless Active Rectifier of IPT System in EV Applications**
Sangjoon Ann, Jongeun Byun, Won-Jin Son, Jae Han Lee, Byoung Kuk Lee
Sungkyunkwan University, Korea

9:10 a.m.

T31.3 **An Active-Rectification based Communication Free Inductive Power Transfer for Battery Charging System with Soft-Switching Capability**
Yi Dou[1], Yunfeng Liu[1], Xiaosheng Huang[1,2], Ziwei Ouyang[1], Michael A.E. Andersen[1]
[1]Technical University of Denmark, Denmark,[2]Fujian University of Technology, Denmark

9:30 a.m.

T31.4 **A Modular Integration Design of LCL Circuit Featuring Field Enhancement and Misalignment Tolerance for Wireless EV Charging**
Pengcheng Zhang[1], Maryam Saeedifard[2], Omer C. Onar[3], Qingxin Yang[1,4], Changsong Cai[5]
[1]Hebei University of Technology, China,[2]Georgia Institute of Technology, United States,[3]Oak Ridge National Laboratory, United States,[4]Tianjin University of Technology, China,[5]Wuhan University, China

9:50 a.m.

T31.5 **1-kW Wireless Charger for Power Wheelchairs**
Chakridhar Reddy Teeneti[1], Ujjwal Pratik[2], Ahmed Azad[1], Reza Tavakoli[1], Cathy Bodine[3], Regan Zane[1], Zeljko Pantic[2]
[1]Utah State University, United States,[2]North Carolina State University, United States,[3]University of Colorado-Denver, United States

10:35 a.m.

T31.6 **Multi-Objective Optimization of Single-Transmitter Coupled Multi-Receiver IPT System for Maglev Trains**
Yuanqing Zhang[1], Junjun Deng[1], Shuo Wang[1], Zhenpo Wang[1], Yin Yang[2]
[1]Beijing Institute of Technology, China,[2]China Railway Rolling Stock Corporation, China

10:55 a.m.

T31.7 **100 MHz Wireless Power Transfer for Lightweight UAVs and Agile Robots**
Xin Zan, Al-Thaddeus Avestruz
University of Michigan, United States

8:30 a.m. – 11:15 a.m.

T32: Transportation Power Electronics II

ROOM 211-213

TRACK Transportation Power Electronics

SESSION CHAIRS

Suman Debnath, *Oak Ridge National Laboratory*
Karthik Jayaraman, *Dialog Semiconductor*

8:30 a.m.

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

8:50 a.m.

T32.2 **Adaptive Cell Balancing of Series Connected Batteries using Hybrid Droop Controller**
Sifat Chowdhury, Yilmaz Sozer
University of Akron, United States

9:10 a.m.

T32.3 **Regulating Transformer Rectifier Unit (R-TRU) for More Electric Aircraft (MEA)**
Warren J. Wambsganss
Astronics AES, United States

9:30 a.m.

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

9:50 a.m.

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

10:35 a.m.

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

10:55 a.m.

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

1:45 p.m. – 3:25 p.m.

T33: Bi-Directional DC-DC Converters

ROOM 208-210

TRACK DC-DC Converters

SESSION CHAIRS

Xugang Ke, *Analog Devices*

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

1:45 p.m.

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

2:05 p.m.

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

2:25 p.m.

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

2:45 p.m.

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

3:05 p.m.

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

1:45 p.m. – 3:25 p.m.

T34: Fault Protection for Utility Interface Converters

ROOM 228-230

TRACK Power Electronics for Utility Interface

SESSION CHAIRS

Mithat Kisacikoglu, *The University of Alabama*

Shahab Mehraeen, *Louisiana State University*

1:45 p.m.

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

2:05 p.m.

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

2:25 p.m.

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

2:45 p.m.

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

3:05 p.m.

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

1:45 p.m. – 3:25 p.m.

T35: Grid-Tied Systems

ROOM 225-227

TRACK Renewable Energy Systems

SESSION CHAIRS

Xiaonan Lu, *Temple University*

Pritam Das, *Binghampton University*

1:45 p.m.

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

2:05 p.m.

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

2:25 p.m.

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

2:45 p.m.

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

1:45 p.m. – 3:25 p.m.

T36: Gate Drive Circuits II

ROOM 206-207

TRACK Devices and Components

SESSION CHAIRS

Ahmed Elasser, *GE*

Mohammed Agamy, *University at Albany*

1:45 p.m.

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

2:05 p.m.

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

2:25 p.m.

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

2:45 p.m.

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

3:05 p.m.

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

1:45 p.m. – 3:25 p.m.

T37: Telecom Applications

ROOM 203-205

TRACK Power Electronics Applications

SESSION CHAIRS

Justin Henspeter, *IBM*

Jeff Nilles, *Alpha & Omega*

1:45 p.m.

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

2:05 p.m.

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

2:25 p.m.

T37.3 **A Zero Inductor-Voltage 48V to 12V/70A Converter for Data Centers with 99.1% Peak Efficiency and 2.5kW/in3 Power Density**
Samuel Webb, Yan-Fei Liu
Queen's University, Canada

2:45 p.m.

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

3:05 p.m.

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

1:45 p.m. – 3:25 p.m.

T38: Control of AC-DC and DC-AC

ROOM 217-219

TRACK Control

SESSION CHAIRS

Emanuel Serban, *University of British Columbia*

1:45 p.m.

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

2:05 p.m.

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

2:25 p.m.

T38.3 **Fast and Reliable Geometric-Based Controller for Three-Phase PWM Rectifiers**
Franco Degioanni, Ignacio Galiano Zurbriggen, Martin Ordonez
University of British Columbia, Canada

2:45 p.m.

T38.4 **Adaptive Optimization of Current-Control Loop for Grid-Connected Inverters**
Roni Luhtala, Henrik Alenius, Tomi Roinila
Tampere University, Finland

3:05 p.m.

T38.5 **Internal Model based Control to Tackle Non-Minimum Phase Behavior in Three-Phase Z-Source Inverters**
Sara Yazdani[1], Mehdi Ferdowsi[1], Masoud Davari[2], Pourya Shamsi[1]
[1]Missouri University of Science and Technology, United States,[2]Georgia Southern University, United States

1:45 p.m. – 3:25 p.m.

T39: High-Power AC-DC Converters

ROOM 220-222

TRACK AC-DC Converters

SESSION CHAIRS

Eric Swenson, *IBM*

Jin Moon, *Florida State University*

1:45 p.m.

T39.1 **FoM based Optimal Frequency and Voltage Level Design for High Efficiency High Density Multilevel PFC with GaN Device**
Jiawen Wu, Xinke Wu
Zhejiang University, China

2:05 p.m.

T39.2 **An SiC & Si Hybrid Five-Level Unidirectional Rectifier for Medium Voltage UPS Application**
Yifan Zhang[1], Runtian Chen[1], Chushan Li[1], Wuhua Li[1], Xiangning He[1], Xiaowei Gu[2]
[1]Zhejiang University, China,[2]Zhejiang Sci-Tech University, China

2:25 p.m.

T39.3 **A New MPC-5LRSS High Power Factor Converter**
Naveen Yalla[1], Narendra Babu A[2], Pramod Agarwal[3]
[1]Pandit Deendayal Petroleum University, India,[2]Madanapalle Institute of Technology and Science, India,[3]Indian Institute of Technology Roorkee, India

2:45 p.m.

T39.4 **An Improved SVM Strategy to Reduce DC Current Ripple for AC-DC Matrix Converter**
Fanxiu Fang, Hao Tian, Yunwei Li
University of Alberta, Canada

3:05 p.m.

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

1:45 p.m. – 3:25 p.m.

T40: Wide Bandgap Device and Circuit Modeling

ROOM 211-213

TRACK Modeling and Simulation

SESSION CHAIRS

Jaume Roig Guitart, *ON Semiconductor*

Tirthajyoti Sarkar, *ON Semiconductor*

1:45 p.m.

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

2:05 p.m.

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

2:25 p.m.

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

2:45 p.m.

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

3:05 p.m.

T40.5 **Behavioral Modeling of Ground Current in Filter Inductors of Medium-Voltage SiC-MOSFET-Based Converters**
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

TECHNICAL DIALOGUE SESSIONS

APEC professionals participated in a rigorous peer review process and have carefully picked over 500 papers, which make up APEC's Technical Sessions. There are two categories of Technical Sessions. The Technical Dialogue Sessions feature papers with a more specialized focus and provide opportunities for discussion with authors.

11:15 a.m. – 1:45 p.m.

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
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
Yunfeng Liu, Mingxiao Li, Yi Dou, Ziwei Ouyang, Michael A.E. Andersen
Technical University of Denmark, Denmark

D01.3 A 480V to 45V GaN Bidirectional AC-DC Converter for Grid-Tied Battery Energy Storage System (BESS)
Tianxiang Chen[1], Ruiyang Yu[1], Alex Q. Huang[1], Stanley Atcitty[2]
[1]University of Texas at Austin, United States, [2]Sandia National Laboratories, United States

D01.4 High-Efficiency High-Power Bridgeless Integrated AC-DC Converter for On-Board Vehicle Battery Charger
Minglong Wang[1], Shangzhi Pan[1], Jinwu Gong[1], Wenqiang Lin[1], Yumei Li[2], Xiaoming Zha[1]
[1]Wuhan University, China,[2]Naval University of Engineering, China

D01.5 An Improved Modulation Scheme for "Si&SiC" Hybrid 3L-Active NPC Rectifiers with Low Conduction Losses
Xiutao Lou, Guang Chen, Li Zhang, Fengchen Zhao, Feng Wu
Hohai University, China

D01.6 High-Efficiency Bidirectional Isolated AC/DC Converter
Mei Su, Sisheng Wu, Hanbing Dan, Yao Sun, Hui Wang, Yonglu Liu, Wenjing Xiong
Central South University, China

D01.8 Evaluation of Active Capacitor Bank for Floating H-Bridge Power Modules
Tam K.T. Nguyen[1], Bo Wen[1], Rolando Burgos[1], Dushan Boroyevich[1], Jacob Verhulst[2], David L. Vrtachnik[2], Mohamed Belkhayat[2]
[1]Virginia Polytechnic Institute and State University, United States,[2]Newport News Shipbuilding, United States

D01.9 A Control Scheme based on Lyapunov Function for Cascaded H-Bridge Multilevel Active Rectifiers
Garry Jean-Pierre[1], Necmi Altin[2], Ahmad El Shafei[1], Adel Nasiri[1]
[1]University of Wisconsin-Milwaukee, United States, [2]Gazi University, Turkey

D01.10 An Optimized Isolated Swiss-Forward Three-Phase Rectifier
Binfeng Zhang, Shaojun Xie, Jinming Xu, Zhouyang Li, Pengcheng Zhao
Nanjing University of Aeronautics and Astronautics, China

D01.11 An Improved Digital Control System for LED Grow Lights used in Indoor Farming
Milad Zareie[1], Behzad Poorali[1], Ed Nowicki[1], Majid Pahlevani[2]
[1]University of Calgary, Canada,[2]Queen's University, Canada

D01.12 An Interleaved AC-DC Converter with Common-Mode and Differential-Mode Coupled Inductors for Better EMI Performance
Kai Tian, Zhuoran Liu, Mei Liang, Xiaobo Yang
ABB, China

D01.13 A 1MHz Class-E2 Single-Stage PFC Converter with Frequency Control
Wenqi Zhu, Hiroo Sekiya
Chiba University, Japan

D01.15 Analysis and Solution of the Unbalanced Device Voltage Issue for SiC MOSFET based Diode Neutral Point Clamped Converter
Siyuan Chen, Md. Rashed Hassan Bipu, Dakai Wang, Wensong Yu
North Carolina State University, United States

11:15 a.m. – 1:45 p.m.

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*

D02.1 LLC-MMC Resonant DC-DC Converter: Modulation Method and Capacitor Voltage Balance Control Strategy
Zhongzhiguang Lu, Lei Lin, Xuehua Wang, Chen Xu
Huazhong University of Science and Technology, China

D02.2 New High Step-Up DC-DC Converter with Quasi-Z-Source Network and Switched-Capacitor Cell
Jessika Melo de Andrade, Roberto Francisco Coelho, Telles Brunelli Lazzarin
Federal University of Santa Catarina, Brazil

D02.3 Securing Full-Load-Range Zero Voltage Switching for a Dual Active Bridge based Electric Vehicle Charger
Yu Yan[1], Hua Bai[1], Chuanchao Yang[2], Wangbao Wang[2]
[1]University of Tennessee, United States,[2]Jiangsu Wanbang Dehe New Energy Technology Co., Ltd., China

D02.5 Optimal Design of H5 Bridge based LLC Converter with Ultra-Wide Input Voltage Range and Synchronous Rectification
Mingde Zhou, Haoyu Wang
ShanghaiTech University, China

D02.6 A Novel APWM Control Scheme for GaN based Full-Bridge CLLC Resonant Converter with Improved Light-Load Efficiency
Tianhua Zhu, Fang Zhuo, Fangzhou Zhao, Kefan Yu, Feng Wang, Ruijie Song
Xi'an Jiaotong University, China

D02.7 Resonant Parameter Design for the LLC-Type Dual Active Bridge Converter with Considerations of Voltage Conversion Gain and Stability in the Cascaded System
Fanfan Lin, Xin Zhang, Jingjing Huang
Nanyang Technological University, Singapore

D02.8 Interleaved Bidirectional Chopper with Auxiliary Converters for Battery Energy Storage Systems
Hamzeh J. Ahmad, Makoto Hagiwara
Tokyo Institute of Technology, Japan

D02.9 Design and Development of High Step-Up DC-DC Converter to Realize High Efficiency and Reduced Voltage Stress
Waqas Hassan, Rasedul Hasan, Dylan Dah-Chuan Lu, Weidong Xiao
The University of Sydney, Australia

D02.10 A New Modulation Strategy for Four-Switch Buck-Boost Converter with Reduced Freewheeling Current
Qi Liu[1], Qinsong Qian[1], Bowen Ren[1], Shen Xu[1], Weifeng Sun[1], Haisong Li[2]
[1]Southeast University, China,[2]Wuxi Chipown Micro-electronics Limited, China

D02.11 A Bidirectional Switch based Half-Bridge Series-Resonant Converter Operating in DCM and CCM
Changkyu Bai[1], Byeongcheol Han[2], Minsung Kim[3]
[1]Pohang University of Science and Technology, Korea,[2]Virginia Polytechnic Institute and State University, United States,[3]Dongguk University, Korea

D02.12 A Multi-Resonant-Core-Based Series-Parallel Resonant Switched-Capacitor Converter with Wide Voltage Gain Range
Shouxiang Li[1], Zhenning Li[1], Guoqiang Zhao[1], Wenhao Xie[2], Pengyu Jia[3], Jia Yao[4]
[1]Beijing Institute of Technology, China,[2]Harbin Institute of Technology, China,[3]North China University of Technology, China,[4]Nanjing University of Science and Technology, China

D02.13 Analysis and Design of a ZVS Clamp-Switch SEPIC DC/DC Converter
Burkhard Ulrich
Baden-Wuerttemberg Cooperative State University Stuttgart, Germany

D02.14 New Synchronous Rectifier Control Scheme for High Efficiency and Density Interleaved Boost Converter with Passive Soft-Switching Cell
Won-Sang Jeong[1], Chung-Yuen Won[1], Jintae Kim[2]
[1]Sungkyunkwan University, Korea,
[2]ON Semiconductor, Korea

D02.15 Passive Soft-Switching Circuit for High Power Density SiC-Based DC-DC Boost Converter
Ngoc Dat Dao, Dong-Choon Lee
Yeungnam University, Korea

D02.16 Multiwinding based Semi-Dual Active Bridge Converter
Felix Hoffmann[1], Jan-Ludwig Lafrenz[1], Marco Liserre[1], Nimrod Vazquez[2]
[1]Christian-Albrechts-Universität zu Kiel, Germany,[2]Tecnologico Nacional de Mexico, Mexico

D02.17 Computational Burden Reduction in Real-Time System Identification of Multi-Rail Power Converter by Re-Using Covariance Matrix Approximation
Jin Xu[1], Matthew Armstrong[1], Maher Al-Greer[2]
[1]Newcastle University, United Kingdom,
[2]Teesside University, United Kingdom

D02.20 Hybrid PWM Control of Bidirectional DC/DC Resonant Converter for Low-Current-Ripple and Wide-Voltage-Gain Application
Ling Gu, Pengfei Li
Nanjing University of Science and Technology, China

D02.21 DC-Link Capacitor Voltage Balancing Control for Series Half Bridge LLC Resonant Converter
Chi Zhang, Yang Jiao, Zhiyu Shen, Peter Barbosa
Delta Electronics Ltd., United States

11:15 a.m. – 1:45 p.m.

D03: DC-DC Converters II

ROOM POSTER AREA

TRACK DC-DC Converters

SESSION CHAIRS

David Williams, *Infineon Technologies*

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

D03.1 Design Optimization and Performance Evaluation of Class Φ2 VHF DC/DC Converter
Yuri Panov, Laszlo Huber, Milan M. Jovanović
Delta Electronics Ltd., United States

D03.3 Accurate Light Load Loss Analysis of Hybrid Modulation Strategy for ZVS Operation of Low-Q LLC Resonant Converter for Wide Input Voltage Range Applications
Abhishek Awasthi, Snehal Bagawade, Praveen Jain
Queen's University, Canada

D03.4 Investigation of Adaptive Synchronous Rectifier (SR) Driving Scheme for LLC/CLLC Resonant Converter in EV On-Board Chargers
Zhengda Zhang, Chunhui Liu, Yunpeng Si, Yifu Liu, Qin Lei
Arizona State University, United States

D03.5 Applying Coupled Inductor to Voltage and Current Balanced between Paralleled SiC MOSFETs for a Resonant Pulsed Power Converter
Qunfang Wu, Mengqi Wang, Weiyang Zhou, Guanliang Liu, Xiaoming Wang
University of Michigan-Dearborn, United States

D03.6 Configurable Dual Output Non-Isolated Resonant Converter for 48 V Applications
Mario Ursino[1], Stefano Saggini[1], Osvaldo Zambetti[2]
[1]University of Udine, Italy,[2]STMicroelectronics, Italy

D03.7 Digital Controller for High-Performance Multiphase VRM with Current Balancing and Near-Ideal Transient Response
Bar Halivni, Mor Mordechai Peretz
Ben-Gurion University of the Negev, Israel

D03.9 Analysis on the Effect of Secondary Side Devices for the Operation of GaN based LLC Resonant Converter
Hao Wen, Yong Liu, Jih-Sheng Lai
Virginia Polytechnic Institute and State University, United States

D03.10 GaN Devices based Integrated Two-Stage DC-DC Converter with Voltage Regulation
Zhiwei Wang[1], Zongheng Wu[1], Cai Chen[1], Yong Kang[1], Zhao Yuan[2], Fang Luo[2]
[1]Huazhong University of Science and Technology, China,[2]University of Arkansas, United States

D03.11 A Voltage-Competing Flyback-Based Balancer Combined with Auxiliary Power Supplier
Pengzhao Wen, Shaojun Xie, Haichun Liu, Qiang Qian, Hanlin Feng, Binfeng Zhang
Nanjing University of Aeronautics and Astronautics, China

D03.12 Enhancing Efficiency in Bidirectional Resonant DC-DC Converter
Eun-Soo Kim, Jae-Sung Oh, Min-Ji Kim, Jun-Hwan Lee, Jung-Won Woo, Yong-Seog Jeon
Jeonju University, Korea

D03.13 Stability Enhancement Method for DC Microgrids with Constant Power Loads using Variable Inductor
Bhanu Babaiahgari, Yeonho Jeong, Jae-Do Park
University of Colorado-Denver, United States

D03.14 Optimal Design of Planar Transformer for GaN based Phase-Shifted Full Bridge Converter
Thiago A. Pereira[1], Felix Hoffmann[1], Pramod K. Prasobhu[1], Marco Liserre[1], Victor Golev[2], Jasper Schnack[2], Ulf Schümann[2]
[1]Christian-Albrechts-Universität zu Kiel, Germany, [2]Kiel University of Applied Sciences, Germany

D03.15 High Isolation Auxiliary Power Supply for Medium-Voltage Power Electronics Building Block
Soumik Sen, Liqi Zhang, Xianyong Feng, Alex Q. Huang
University of Texas at Austin, United States

D03.16 A "Predictive" Synchronous Rectifier Control for High-Frequency Series Resonant Converters
Sheng-Yang Yu[1], Manish Bhardwaj[1], Hung-Chi Chen[2]
[1]Texas Instruments Inc., United States,[2]National Chiao Tung University, Taiwan

D03.17 A New High Step-Up DC-DC Topology with Zero DC Magnetizing Inductance Current and Continuous Input Current
Mohsen Mahmoudi[1], Ali Ajami[1], Ebrahim Babaei[2], Nima Abdolmaleki[3], Caisheng Wang[3]
[1]Azarbaijan Shahid Madani University, Iran,[2]University of Tabriz, Iran,[3]Wayne State University, United States

D03.18 SiC-Enabled Medium Voltage Isolated DC-DC Converter based Power Optimizer for Large Photovoltaic Parks
Sai Kiran Voruganti, Ghanshyamsinh Gohil
University of Texas at Dallas, United States

D03.19 Inductorless Soft Switching DC-DC Converter with an Optimized Piezoelectric Resonator
Weston D. Braun, Zikang Tong, Juan Rivas-Davila
Stanford University, United States

D03.20 48V-to-12V Dual-Path Hybrid DC-DC Converter
Katsuhiro Hata, Yoshitaka Yamauchi, Toru Sai, Takayasu Sakurai, Makoto Takamiya
The University of Tokyo, Japan

11:15 a.m. – 1:45 p.m.

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*

D04.1 A Multiport Three-Stage Power Electronic Transformer
Dajun Ma, Wu Chen, Liangcai Shu
Southeast University, China

D04.2 Simplified Model Predictive Control with Preselection Technique for Reduction of Calculation Burden in 3-Level 4-Leg NPC Inverter
Roh Chan[1], Kyung-Hwan Kim[1], Ji-Young Park[1], Sang-Shin Kwak[2]
[1]Korea Research Institute of Ships and Ocean Engineering, Korea,[2]Chung-Ang University, Korea

D04.4 Performance of the 6.6-kV 200-kVA Transformerless SDBC-Based STATCOM using 3.3-kV SiC-MOSFET Modules for Reactive-Power Compensation
Toshihisa Tajyuta, Laxman Maharjan, Koji Maruyama, Akio Toba, Akio Suzuki, Hiroshi Shinohara, Tomomi Kaneko
Fuji Electric Co., Ltd., Japan

D04.5 A Novel Deep Convolution Neural Network and Spectrogram based Microgrid Power Quality Disturbances Classification Method
Haihua Xue, Alian Chen, Deqiang Zhang, Chenghui Zhang
Shandong University, China

D04.6 Comparison of Transient Angle Stability between Virtual Synchronous Generator and Droop-Controlled Inverter
Feng Zhao[1], Zhikang Shuai[1], Chao Shen[1], Huijie Cheng[1], Yang Shen[1], Yelun Peng[2]
[1]Hunan University, China,[2]Nanyang Technological University, China

D04.7 Interleaving Technique applied in an Active Filter based on the Full-Bridge Cascaded Converter
Samuel S. Queiroz, Demercil S. Oliveira, Paulo P. Praça, Luiz Henrique S.C. Barreto
Federal University of Ceará, Brazil

D04.9 Inrush Current Testing
Erik K. Saathoff[1], Zachary J. Pitcher[1], Steven R. Shaw[2], Steven B. Leeb[1]
[1]Massachusetts Institute of Technology, United States,[2]Montana State University, United States

D04.10 A Frequency Control Method for Islanded Microgrids using Energy Storage Systems
Mohsen S. Pilehvar, Behrooz Mirafzal
Kansas State University, United States

D04.11 Multi-Port Coordinated Control Strategy of SOP in Distribution Network
Min Yang, Xuejun Pei, Yuze Li
Huazhong University of Science and Technology, China

D04.12 SiC based Interleaved Voltage Source Converter for Active Power Filter Applications
M.A. Awal, Yukun Luo, Dhrubo Rahman, Li Yang, Wensong Yu, Iqbal Husain
North Carolina State University, United States

11:15 a.m. – 1:45 p.m.

D05: Utility Interface II

ROOM POSTER AREA

TRACK Power Electronics for Utility Interface

SESSION CHAIRS

Ali Khajehoddin, *University of Alberta*

Blake Nelson, *The University of Alabama*

D05.1 Improved Transient Power Sharing of Droop Controlled Islanded Microgrids
Salman Harasis, Yilmaz Sozer
University of Akron, United States

D05.2 Design and Implementation of a Medium Voltage, High Power, High Frequency Four-Port Transformer
Ahmad El Shafei[1], Saban Ozdemir[2], Necmi Altin[2], Garry Jean-Pierre[1], Adel Nasiri[1]
[1]University of Wisconsin-Milwaukee, United States, [2]Gazi University, Turkey

D05.4 Coordinated Control Strategy with Inertia of Grid-Forming Two-Stage Energy Storage Converters
Yonghui Liu[1], Shulin Cai[2], Yang Peng[1], Pengkun Li[1], Pengfei Han[2], Yongbin Jiang[1], Mingxuan Li[1], Yue Wang[1]
[1]Xi'an Jiaotong University, China,[2]Xi'an Auto Electric Power Plant Co., Ltd., China

D05.5 A Modular Multilevel Converter with Integrated Self-Balancing Series IGBTs
Lu Yue, Xiu Yao
State University of New York at Buffalo, United States

D05.6 Secure and Cost-Effective Micro Phasor Measurement Unit (PMU)-Like Metering for Behind-the-Meter (BTM) Solar Systems using Blockchain-Assisted Smart Inverters
Abdullah A. Hadi[1], Gomanth Bere[1], Taesic Kim[1], Justin J. Ochoa[1], Jianwu Zeng[2], Gab-Su Seo[3]
[1]Texas A&M University-Kingsville, United States, [2]Minnesota State University, United States, [3]National Renewable Energy Laboratory, United States

D05.7 Realtime Degradation-Aware Adaptive Control of Solid State Transformer
Moinul Shahidul Haque, Seungdeog Choi
Mississippi State University, United States

D05.8 Single Stage EMI Filter for Server Power Supply
Shuo Wang, Yuchen Yang, Fred C. Lee, Qiang Li
Virginia Polytechnic Institute and State University, United States

D05.9 **Three-Phase Three-Level Shunt APF Control System based on Multi-Task Parallel MCU**
Kefan Yu, Zebin Yang, Yuguo Li, Hao Yi, Feng Wang, Fang Zhuo
Xi'an Jiaotong University, China

D05.10 **Optimal Design of Nested Current and Voltage Loops in Grid-Connected Inverters**
Nima Amouzegar Ashtiani[1], S. Ali Khajehoddin[1], Masoud Karimi-Ghartemani[2]
[1]University of Alberta, Canada,[2]Mississippi State University, United States

D05.11 **Self Synchronizing Controller for a Multifunctional Single Phase AC-DC-AC Converter**
Krishan Kant, Matthew Overlin, Lukasz Huchel, Mohammad Qasim, James L. Kirtley Jr.
Massachusetts Institute of Technology, United States

D05.12 **A Modified DQ Impedance Model of Three-Phase Grid-Connected Inverter-Grid System Considering Coupling between Inverter and Grid**
Weihua Zhou[1], Yanbo Wang[1], Raymundo E. Torres-Olguin[2], Dong Liu[1], Zhe Chen[1]
[1]Aalborg University, Denmark,[2]SINTEF Energy Research Institute, Norway

D05.13 **Modular Multilevel Converter with Minimum Arm Inductance and Automatic Sub-Module Voltage Balance – Y-Matrix Modulation and its Theoretical Proof of the Automatic Voltage Balance**
Qichen Yang, Hamed Pourgharibshahi, Robson Bauwelz Gonzatti, Sandro Martin, Hui Li, Fang Peng
Florida State University, United States

11:15 a.m. – 1:45 p.m.

D06: Motor Drives II

ROOM POSTER AREA

TRACK Motor Drives and Inverters

SESSION CHAIRS

Mehdi Farasat, *Louisiana State University*

Ziaur Rahman, *Department of Energy*

D06.1 **Robust Speed Control of Switched Reluctance Motor Drive based on Full Order Terminal Sliding Mode Control**
M. Divandari[1], B. Rezaie[2], E. Amiri[3]
[1]Azad University, Iran,[2]Babol University of Technology, Iran,[3]University of New Orleans, United States

D06.2 **Maximum Torque per Ampere (MTPA) Control for Scalar v/f Controlled SPMSM Drives**
Kibok Lee[1], Yongsu Han[2]
[1]Incheon National University, Korea,[2]Seoul National University, Korea

D06.3 **A Control Method for Smooth Transition from Motoring to Generating Modes in Switched Reluctance Machines**
Okan Boler, Omer Gundogmus, Yilmaz Sozer
University of Akron, United States

D06.4 **Regenerative Active Front End based Motor-Drive Systems with Enhanced Dynamic Performance**
Ahmed Sayed-Ahmed, Robert Miklosovic
Rockwell Automation, Inc., United States

D06.5 **Cascadable Dual-Buck Multilevel Inverter Modules with Autonomous DC Capacitor Voltage Balance**
Zi-Xiang Dai[1], Woei-Luen Chen[1], Chia-Ting Lin[2], Ming-Sheng Xu[2], Kun-Feng Chen[2]
[1]University of Taipei, Taiwan,[2]National Chung-Shan Institute of Science and Technology, Taiwan

D06.6 **A Hybrid Three-Phase Seven-Level CHB Inverter with a Novel Modulation Scheme**
Zhansen Akhmetov[1], Li Chushan[2], Wuhua Li[2], Alexander Ruderman[1]
[1]Nazarbayev University, Kazakhstan, [2]Zhejiang University, China

D06.7 **Design of a 6.8-kW Two-Phase Converter for 48V Automotive Applications**
Tianyu Chen, Carlos Caicedo-Narvaez, Pengyuan Chen, Amir Parsapour, Babak Fahimi
University of Texas at Dallas, United States

D06.8 **A New Model Predictive Control Formulation for CHB Inverters**
Zhituo Ni, Mehdi Narimani
McMaster University, Canada

D06.9 **Impact of Mixed Switching Frequency Scheme on Different Topologies of Multilevel Converters for Efficiency Improvement**
Abdullah Al Hadi[1], Xingang Fu[1], Rajab Challoo[1], Shuhui Li[2], Mehrdad Ehsani[3]
[1]Texas A&M University-Kingsville, United States, [2]The University of Alabama, United States, [3]Texas A&M University-College Station, United States

D06.10 **Capacitor Voltage Ripple Reduction of Hybrid Balanced Two-Leg Five-Level Neutral Point Clamped Inverter**
Eshet T. Wodajo[1], Malik Elbuluk[1], Seungdeog Choi[2], Haitham Abu-Rub[3]
[1]University of Akron, United States,[2]Mississippi State University, United States,[3]Texas A&M University, Qatar

11:15 a.m. – 1:45 p.m.

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*

D07.1 **Fault Detection Technique based on Clustering Approach of Artificial Intelligence in Electric Vehicle Converters**
A. Sharma[1], Y. Elhaj[1], Mohamed Z. Youssef[1], Jing Ren[1], Mohamed Orabi[2]
[1]University of Ontario Institute of Technology, Canada,[2]Aswan University, Egypt

D07.2 **Online Harmonic Elimination Pulse Width Modulation Method for Modular Multilevel Converter**
Abdul Moeed Amjad[1], Kamyar Mehran[1], Shady Gadoue[2]
[1]Queen Mary University of London, United Kingdom,[2]Aston University, United Kingdom

D07.3 **Power Cycling of Three-Level Inverters for Low Speed Operation**
Marzieh Karami[1], Ranga Tallam[1], Rober Cuzner[2]
[1]Rockwell Automation, Inc., United States, [2]University of Wisconsin-Milwaukee, United States

D07.4 **SVPWM Techinque with Reduced Common Mode Voltage for Three-Phase Voltage Source Inverter**
Alexandre G.F. da Silva, Isaac S. de Freitas, Gilielson F. da Paz, Lucas J. Oliveira, Vinicius C. Ferreira, Simplicio A. da Silva, Victor F.M.B. Melo
Federal University of Paraíba, Brazil

D07.5 **Improved Modulation Strategy with Reduced Switching Loss for Single-Phase Three-Level T-Type Inverter**
Zhizhen Wang, Xiaoyan Li, Xiangyang Xing, Chenghui Zhang
Shandong University, China

D07.6 **A Current Limiting Method with Distortion Suppression for Stand-Alone Three-Phase Inverter**
Peng Zhou, Xuejun Pei, Yuze Li
Huazhong University of Science and Technology, China

D07.7 **An H7 Current-Source Inverter using Wide Bandgap Bidirectional Switches to Achieve High Efficiency and Low Conducted Common-Mode EMI**
Hang Dai, Renato A. Torres, Jerome Gossmann, Woongkul Lee, Thomas M. Jahns, Bulent Sarlioglu
University of Wisconsin-Madison, United States

D07.8 **A Cascade PI-SMC Method for Brushless Doubly-Fed Induction Machine with Matrix Converter**
Xun Zhao[1], Hui Wang[1], Hanbing Dan[1], Zhengzhang Di[1], Yao Sun[1], Mei Su[1], Marco Rivera[2], Patrick Wheeler[3]
[1]Central South University, China,[2]Universidad de Talca, Chile,[3]University of Nottingham, United Kingdom

D07.9 **Decoupled Modeling of Three-Phase TCM Inverters utilizing Three Different Conduction-Modes for ZVS Operation**
Sungjae Ohn, Rolando Burgos, Dushan Boroyevich
Virginia Polytechnic Institute and State University, United States

D07.10 **Cuk-Derived Five-Level T-Type Inverter (CD-5LT2I)**
Masih Khodabandeh, Mahshid Amirabadi
Northeastern University, United States

D07.11 **Model Predictive Control of a New Five-Level Voltage Source Converter**
Apparao Dekka[1,2], Ahoora Bahrami[1], Mehdi Narimani[1]
[1]McMaster University, Canada,[2]Lakehead University, Canada

11:15 a.m. – 1:45 p.m.

D08: Devices and Components I

ROOM POSTER AREA

TRACK Devices and Components

SESSION CHAIRS

Charles Sullivan, *Dartmouth College*

Huai Wang, *Aalborg University*

D08.1 **Enhancement of Surge-Suppression Performance of a Solid-State Snubber by a SiC Avalanche-Diode**
Kunio Koseki, Masayuki Yamamoto, Yasunori Tanaka
National Institute of Advanced Industrial Science and Technology, Japan

D08.2 **Condition Monitoring of IGBT Module and Forced Air Cooling System using Time Constants of Heat Sink Temperature Cooling Curve**
Jun Zhang[1], Xiong Du[2], Shuai Zheng[2]
[1]Hohai University, China,[2]Chongqing University, China

D08.3 **An Active Voltage Balancing Control based on adjusting Driving Signals Time Delay for Series-Connected IGBTs**
Tao Wang, Hua Lin, Shengsheng Liu
Huazhong University of Science and Technology, China

D08.4 **Study on the CM EMI Characteristics of Si/SiC Hybrid Switch based Converter**
Xiaogui Peng[1], Jun Wang[1], Zishun Peng[1], Zeng Liu[1], Minying Li[2], Yuxing Dai[1,3]
[1]Hunan University, China,[2]Guangdong Zhicheng Champion Group Co., Ltd., China,[3]Wenzhou University, China

D08.5 **Analysis of GaN Converter Circuit Stability Influenced by Current Collapse Effect**
Arnaud Videt[1], Ke Li[2], Nadir Idir[1], Paul Evans[2], Mark Johnson[2]
[1]University of Lille, France,[2]University of Nottingham, United Kingdom

D08.6 **Diagnosing for Cross-Conduction in GaN Half-Bridge**
Yajie Qiu, Jinseng Vanderkloot, Ruoyu Hou, Juncheng Lu
GaN Systems Inc., Canada

D08.7 **Surge-Robust Flyback Power Supplies with GaN**
Kamal Varadarajan, Sudhakar Singamaneni, Santhosh Kappala
Power Integrations, Inc., United States

D08.8 **A Coupled Inductor based Circuit for Voltage Balancing among Series Connected SiC MOSFETs**
Saizhen Chen, Chengmin Li, Zhebie Lu, Haoze Luo, Wuhua Li, Xiangning He
Zhejiang University, China

D08.9 **PowerBox: A Modern Power Electronics Education Toolbox using Si and SiC Devices**
Trenton Kilgore[1], Alastair Thurlbeck[1], Yue Cao[1], Ted Brekken[1], Chushan Li[2], Philip T. Krein[2]
[1]Oregon State University, United States,[2]Zhejiang University-University of Illinois at Urbana-Champaign Institute, China

D08.10 **Experimental Investigation of the Single Pulse Avalanche Ruggedness of SiC Power MOSFETs**
Zijian Gao, Lei Cao, Qing Guo, Kuang Sheng
Zhejiang University, China

D08.11 **A Novel Real-Time Junction Temperature Monitoring Circuit for SiC MOSFET**
Hengyu Yu, Xi Jiang, Jianjun Chen, Jun Wang, Z. John Shen
Hunan University, China

D08.12 **Design the High-Frequency DC-DC Converter with Integrated Coupled Inductor and Current-Balancing-Transformer**
Yi Dou, Ziwei Ouyang, Michael A.E. Andersen
Technical University of Denmark, Denmark

D08.13 **Design Approach of Inductive Components in Medium Voltage Modular Multilevel Converter Considering DC Side Fault Protection Conditions**
Luis Camurca, Marius Langwasser, Marco Liserre
Christian-Albrechts-Universität zu Kiel, Germany

D08.14 **A Novel Passive Integrated Unit for a Single-Stage LED Driver**
Cheng Deng[1,2], Yun Yu[1], Yuzhi Zhang[3], Andrés Escobar-Mejía[4]
[1]Xiangtan University, China,[2]Hunan Province Cooperative Innovation Center for Wind Power Equipment and Energy Conversion, [3]ABB, United States,[4]Universidad Tecnológica de Pereira, Colombia

D08.15 **An Evaluation of the failures in Resonant Topologies due to the Body Diode and the role of Fast Diode MOSFET**
Domenico Nardo, Alfio Scuto, Simone Buonomo
STMicroelectronics, Italy

D08.16 **A New Method for Current Distribution Study in the 6-in IGCT**
Wenpeng Zhou, Jiapeng Liu, Chunpin Ren, Zhengyu Chen, Rong Zeng
Tsinghua University, China

11:15 a.m. – 1:45 p.m.

D09: Devices and Components II

ROOM POSTER AREA

TRACK Devices and Components

SESSION CHAIRS

Jason Neely, *Sandia National Laboratories*

Tomas Sadilek, *Delta Electronics*

D09.1 **Intelligent Automotive Isolated Gate Driver with Adaptive Fault Management and Built-in Switched Mode Power Supply**
Yunfeng Liang
Broadcom Inc., Singapore

D09.2 **Novel Integrated BEOL Compatible Inductances for Power Converter Applications**
Malte Päsler, Thomas Lisec, Holger Kapels
Fraunhofer Institute for Silicon Technology ISIT, Germany

D09.3 **Analysis and Experimental Verification of Reducing Intra-Winding Capacitance in a Copper Foil Transformer**
Rakesh Ramachandran, Morten Nymand, Jesper Nielsen
University of Southern Denmark, Denmark

D09.5 **Design of Coupled Inductor for Two-Phase Synchronous Boost Converters in Automotive Applications**
Georg Tobias Götz, Alexander Stippich, Arne Hendrik Wienhausen, Rik W. De Doncker
RWTH Aachen University, Germany

D09.6 **Loss Evaluation of Aluminum Electrolytic Capacitor under Power Electronics Converter Excitation**
Hiroaki Matsumori[1], Takashi Kosaka[1], Nobuyuki Matsui[1], Kenichi Onda[2], Masashi Ozawa[2], Kaho Toda[2]
[1]Nagoya Institute of Technology, Japan,[2]Nippon Chemi-Con Corporation, Japan

D09.7 **Advanced Gate Drive Unit for Junction Temperature Monitoring and Dynamic Current Balancing of GaN Transistors Operating in Parallel**
Ashot Melkonyan, Martin Schulz
Siemens AG, Germany

D09.8 **Design and Evaluation of Nano-Composite Core Inductors for Efficiency Improvement in High-Frequency Power Converters**
Eric Langlois[1], John Watt[2], Dale Huber[1], Matthew McDonough[1], Todd Monson[1], Jason Neely[1]
[1]Sandia National Laboratories, United States, [2]Los Alamos National Laboratory, United States

D09.9 **Impedance-Based Common-Mode Inductor Design Approach Considering Frequency-Dependent and Imaginary Permeability**
Ren Ren[1], Zhou Dong[1], Bo Liu[3], Fred Wang[1,2]
[1]University of Tennessee, United States,
[2]Oak Ridge National Laboratory, United States,
[3]United Technologies Research Center, United States

D09.10 **Degradation Analysis of Planar Magnetics**
Zhan Shen, Qian Wang, Huai Wang
Aalborg University, Denmark

D09.11 **Design and Verification of a Medium-Frequency Transformer in a Three-Phase Dual-Active Bridge DC-DC Converter for Medium-Voltage Grid Connection of Offshore Wind Farms**
Murat Kaymak[1], Rik W. De Doncker[1], Takushi Jimichi[2]
[1]RWTH Aachen University, Germany,
[2]Mitsubishi Electric Corporation, Japan

D09.12 **Programmable Gate Driving Platform for Easy Device Driving and Performance Tuning**
Wen Zhang[1], Fred Wang[1,2], Bernhard Holzinger[3]
[1]University of Tennessee, United States,
[2]Oak Ridge National Laboratory, United States,
[3]Keysight Technologies, Germany

D09.13 **Transformer and Frequency Optimization in a GaN-Based Active-Clamp Flyback Converter**
Andrew B. Nadler, Aaron L.F. Stein, Charles R. Sullivan
Dartmouth College, United States

D09.14 **Diode Clamped Solid-State Circuit Breaker: A Novel Solid-State Circuit Breaker without Dynamic Voltage Unbalancing Issues**
Tiancan Pang, Muhammad Foyazur Rahman, Ehab Shoubaki, Madhav Manjrekar
University of North Carolina at Charlotte, United States

D09.15 **Thermal Design Consideration of Medium Voltage High Frequency Transformers**
Haoming Wang[1,2], Zhichen Guo[1], S. Milad Tayebi[1], Xin Zhao[1], Qingyun Huang[1], Ruiyang Yu[1], Qingxin Yang[2], Yongjian Li[2], Alex Q. Huang[1]
[1]University of Texas at Austin, United States,
[2]Hebei University of Technology, China

D09.16 **Core Losses of Nanocrystalline Materials under DC Bias Conditions**
Mickael J. Mauger, Xiwei Zheng, Prasad Kandula, Deepak Divan
Georgia Institute of Technology, United States

11:15 a.m. – 1:45 p.m.

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*

D10.2 **Empirical Radiation Noise Identification and Reduction by Optimized IGBT without Increasing Power Loss**
Toshiya Tadakuma[1], Shogo Shibata[1], Michael Rogers[2], Koichi Nishi[1]
[1]Mitsubishi Electric Corporation, Japan,
[2]Mitsubishi Electric US, Inc., United States

D10.3 **Near-Field Radiation EMS Research for Driver PCB in MMC-HVDC System: A Novel Copper Layer based EMI Coupling Model**
Yidong Tian, Wenjie Chen, Angyang Zhou, Xu Yang
Xi'an Jiaotong University, China

D10.4 **Analysis and Evaluation of Thermally Annealed Pyrolytic Graphite Heat Spreader for Power Modules**
Emre Gurpinar[1], Burak Ozpineci[1], John Preston Spires[2], Wei Fan[3]
[1]Oak Ridge National Laboratory, United States,
[2]University of Tennessee, United States,
[3]Momentive Performance Materials Inc., United States

D10.5 **A System Power Device Technology Vertically Integrating Magnetic Substrate**
Jerry Zhai, Fei Feng
GrenoSoC Integrated, Inc., China

D10.6 **Demonstration of a 10 kV SiC MOSFET based Medium Voltage Power Stack**
Dipen Narendra Dalal, Hongbo Zhao, Jannick Kjær Jørgensen, Nicklas Christensen, Asger Bjørn Jørgensen, Szymon Bęczkowski, Christian Uhrenfeldt, Stig Munk-Nielsen
Aalborg University, Denmark

D10.7 **Feasibility on High Frequency Resonant Networks for Induction Heating Superheated Steam Generators for Wafer Cleaning Systems**
Eunsu Jang, Sang Min Park, Byoung Kuk Lee
Sungkyunkwan University, Korea

D10.8 **A Novel DCR Current Sensing Scheme for Accurate Current Readback in Power uModule Applications**
Shuilin Tian, Wesley Ballar, Xuebing Chen, Yingyi Yan, Zhengyang Liu, Richard Ying, Eddie Beville
Analog Devices, Inc., United States

D10.9 **System-Level Thermal Modeling of a Modular Multilevel Converter**
Yi Zhang, Huai Wang, Zhongxu Wang, Frede Blaabjerg
Aalborg University, Denmark

D10.11 **A Double-Sided Cooling 650V/30A GaN Power Module with Low Parasitic Inductance**
Kangping Wang, Bingyang Li, Hongkeng Zhu, Zheyuan Yu, Laili Wang, Xu Yang
Xi'an Jiaotong University, China

D10.12 **A 900A High Power Density and Low Inductive Full SiC Power Module for High Temperature Applications based on 900V SiC MOSFETs**
Chi Zhang[1], Zhizhao Huang[1], Cai Chen[1], Xinmin Liu[1], Fang Luo[2], Yong Kang[1]
[1]Huazhong University of Science and Technology, China,[2]University of Arkansas, China

D10.13 **Design of a Lightweight Low Inductance Power Module with Ceramic Baseplates**
Xintong Lyu, Xingyue Tian, He Li, Haoyang You, Jin Wang
The Ohio State University, United States

D10.14 **Detection of Power Switch Failures using Discrete Fourier Transform for DC-DC Flying Capacitor Multilevel Converters**
Ruqiang Zheng, Xin Yin, Sai Tang, Chao Zhang, Daming Wang, Jun Wang, Z. John Shen
Hunan University, China

11:15 a.m. – 1:45 p.m.

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*

D11.1 **Modelling Flexible a-Si PV for Increased Energy Capture and Improved Reliability**
Pallavi Bharadwaj[1], Bradley Lehman[2]
[1]Indian Institute of Science, India, [2]Northeastern University, United States

D11.2 **Accurate Conducted EMI Simulation of a Buck Converter with a Compact Model for an SiC-MOSFET**
Yuki Ishii[1], Shinobu Nagasawa[1], Takeshi Horiguchi[1], Yasushige Mukunoki[1], Takushi Jimichi[1], Masaki Kuzumoto[2], Makoto Hagiwara[2]
[1]Mitsubishi Electric Corporation, Japan, [2]Tokyo Institute of Technology, Japan

D11.3 **Semi-Theoretical Prediction of Turn-Off Surge Voltage in a SiC MOSFET Power Module with an Embedded DC-Link Decoupling Capacitor**
Tatsuya Miyazaki, Yuta Okawauchi, Hirotaka Otake, Ken Nakahara
ROHM Co., Ltd., Japan

D11.4 **Turn-On Gate Resistor Optimization for Paralleled SiC MOSFETs**
Pengkun Liu[1], Ruiyang Yu[1], Alex Q. Huang[1], Johan Strydom[2]
[1]University of Texas at Austin, United States, [2]Texas Instruments Inc., United States

D11.5 **Voltage Dependence and Characterization of Ceramic Capacitors under Electrical Stress**
Michael Fuchs, Markus Sievers, Bernd Deutschmann
Graz University of Technology, Austria

D11.6 **Leakage Inductance Estimation of Toroidal Common-Mode Choke from Perspective of Analogy between Reluctances and Capacitances**
Ren Ren[1], Zhou Dong[1], Bo Liu[3], Fred Wang[1,2]
[1]University of Tennessee, United States, [2]Oak Ridge National Laboratory, United States, [3]United Technologies Research Center, United States

D11.7 **An Analytical SiC MOSFET Switching Behavior Model Considering Parasitic Inductance and Temperature Effect**
Yiyang Yan[1], Zhiwei Wang[1], Cai Chen[1], Yong Kang[1], Zhao Yuan[2], Fang Luo[2]
[1]Huazhong University of Science and Technology, China,[2]University of Arkansas, United States

D11.8 **Analysis of Low Noise Switching Waveform Considering Both Laminated Bus Bar and Terminal Geometry for AC Resistance**
Koji Mitsui, Keiji Wada
Tokyo Metropolitan University, Japan

11:15 a.m. – 1:45 p.m.

D12: Modeling and Simulation of Converters and Systems

ROOM POSTER AREA

TRACK Modeling and Simulation

SESSION CHAIRS

Yue Cao, *Oregon State University*

Ernest Wittenbreder, *Technical Witts*

D12.1 **A Voltage Interpolation Method in Inverter Modeling for Fast Electromagnetic Transient Simulations**
Shuntaro Horiuchi[1], Kenichiro Sano[1], Taku Noda[2]
[1]Tokyo Institute of Technology, Japan,[2]Central Research Institute of Electric Power Industry, Japan

D12.2 **Analysis for Capacitor Voltage Deterioration based on Harmonic Interaction in MMC Distributed Control System with Sub-Module Asynchrony**
Shunfeng Yang, Haiyu Wang, Shun Liu, Hang Su, Shuochen Chen
Southwest Jiaotong University, China

D12.3 **Electro-Thermal Average Modeling of a Boost Converter Considering Device Self-Heating**
Tian Cheng, Dylan Dah-Chuan Lu, Yam P. Siwakoti
University of Technology Sydney, Australia

D12.4 **A Time-Domain based APP Designer for Resonant Converters with GUI Features**
Amit Kumar, Abhishek Awasthi, Omid Salari, Arpan Laha, Aiswarya Mathew, Praveen Jain
Queen's University, Canada

D12.5 **Reduced-Order Model of Power Converters to Optimize Power Hardware-in-the-Loop Technology in DC-Distributed Systems**
M. Sanz, D. Santamargarita, F. Huerta, D. Ochoa, A. Lázaro, A. Barrado
Universidad Carlos III de Madrid, Spain

D12.6 **Design Optimization of Flyback Power Converters by Interval Branch and Bound**
Michael Levashov
Power Integrations, Inc., United States

D12.7 **A Power Hardware-in-the-Loop Testbench for Aerospace Applications**
John Noon[1], He Song[1], Bo Wen[1], Rolando Burgos[1], Igor Cvetkovic[1], Dushan Boroyevich[1], Srdjan Srdic[2], Gernot Pammer[2]
[1]Virginia Polytechnic Institute and State University, United States,[2]EGSTON Power Electronics GmbH, Austria

D12.8 **Design Automation of Power Electronic Converters a Grid Elitist Multiobjective Genetic Algorithm**
Timothé Delaforge, Sebastien Mariethoz
Bern University of Applied Sciences, Switzerland

D12.9 **Limit Cycle Phenomenon in Boost Converter**
Wencheng Li[1], Wentao Wang[2], Xuehua Wang[1], Yuying He[1], Xinbo Ruan[1], Fuxin Liu[3]
[1]Huazhong University of Science and Technology, China,[2]Wuhan Second Ship Design and Research Institute, China,[3]Nanjing University of Aeronautics and Astronautics, China

D12.10 **Modeling and Analysis of Zero Common-Mode Voltage Modulation with Dead-Time for Three-Level Inverter**
Ruirui Chen[1], Fred Wang[1,2], Leon M. Tolbert[1,2], Daniel J. Costinett[1,2], Benjamin B. Choi[3]
[1]University of Tennessee, United States,[2]Oak Ridge National Laboratory, United States,[3]NASA Glenn Research Center, United States

D12.11 **Design and Characterization of a Neutral-Point-Clamped Inverter using Medium-Voltage Silicon Carbide Power Modules**
Christopher D. New[1], Andrew N. Lemmon[1], Brian T. DeBoi[1], Blake W. Nelson[1], Jin Zhao[1], Aaron D. Brovont[2]
[1]The University of Alabama, United States,[2]PC. Krause and Associates, United States

D12.12 **Modified Direct Torque and Flux Control of Switched Reluctance Motor Drive with Reduced Source Current Ripple for Vehicular Applications**
Apparao Dekka[1], Deepak Ronanki[2], Krishna Reddy Pittam[3], Parthiban Perumal[3], Abdul R. Beig[4]
[1]Lakehead University, Canada,[2]University of Ontario Institute of Technology, Canada,[3]National Institute of Technology Karnataka, India,[4]Khalifa University, U.A.E.

11:15 a.m. – 1:45 p.m.

D13: Control I

ROOM POSTER AREA

TRACK Control

SESSION CHAIRS

Xiaonan Lu, *Temple University*

Taesic Kim, *Texas A&M University-Kingsville*

D13.1 **Synchronous Rectification using Resonant Capacitor Voltage for Secondary Side Resonant Active Clamp Flyback Converter**
Shengyou Xu, Qinsong Qian, Tao Tao, Limin Yu, Shengli Lu, Weifeng Sun
Southeast University, China

D13.2 **A Novel Digital PCM-V2 Control Method for Active Clamp Flyback Converter to Realize Fast Output Dynamic Response**
Tingying Wang, Liangchuang Liao, Shengyou Xu, Cheng Gu, Qinsong Qian, Weifeng Sun
Southeast University, China

D13.3 **Space Vector Modulation Scheme for Dual-Output Four-Leg Inverter**
Mahdi Azizi[1], Sima Aznavi[2], Poria Fajri[2], Arash Khoshkbar-Sadigh[3]
[1]Eindhoven University of Technology, The Netherlands,[2]University of Nevada-Reno, United States,[3]Pennsylvania State University, United States

D13.5 **Voltage Balancing Control Method using Variable Capacitors with Simple Turn-on Adjusting Function for Multi-Stage FET Bidirectional Converter**
Yuki Ishikura[1,2], Tatsuya Hosotani[1,2], Mostafa Noah[2], Jun Imaoka[2], Masayoshi Yamamoto[2]
[1]Murata Manufacturing Co., Ltd., Japan, [2]Nagoya University, Japan

D13.6 **Comparison of Two Power Electronic Topologies for Power Hardware in the Loop Machine Emulator**
Manuel Fischer, Dennis Erthle, Philipp Ziegler, Johannes Ruthardt, Jörg Roth-Stielow
University of Stuttgart, Germany

D13.7 **Closed Loop Junction Temperature Control of Power Transistors for Lifetime Extension**
Johannes Ruthardt, Lukas Schnabel, Philipp Ziegler, Philipp Marx, Kanuj Sharma, Manuel Fischer, Maximilian Nitzsche, Jörg Roth-Stielow
University of Stuttgart, Germany

D13.9 **Simplified Space Vector Modulation Strategy for Three-Level Inverters**
Dereje Woldegiorgis, Estefano Soria, Yuqi Wei, Haider Mhiesan, Alan Mantooth
University of Arkansas, United States

D13.10 **A Hybrid Resonant Three-Level ZCS Converter Suitable for Medium Voltage DC Distribution Network**
Syed Waqar Azeem, Wu Chen, Yao Jinjie, Irfan Tariq
Southeast University, China

D13.11 A THD Optimization Control for High Frequency Full-SiC PWM Rectifier based on Multi-Resolution Algorithm
Yan Ming, Rui Zhao, Chuanhao Ji, Yuhang Zou, Yan Xing, Chenxing Sha, Baolin Chen
Nanjing University of Aeronautics and Astronautics, China

D13.12 1phi SOGI Phase Locked Loop with Secondary Control Path in Grid-Connected Power Converters
Paula Lamo, Francisco J. Azcondo, Alberto Pigazo
University of Cantabria, Spain

D13.13 Closed-Loop Admittance Shaping using Impedance-Based Stability Criteria in QFT Robust Control Technique
J. Manuel Del Toro[1], Carlos de la Viesca[1], Santiago Cobreces[2]
[1]Ingenieria Viesca S.L., Spain,[2]Universidad de Alcalá, Spain

D13.14 Flyback Converter Control by Inner Supply Voltage Feedback using Sigma-Delta Converter
Geon-Hong Min, Jung-Ik Ha
Seoul National University, Korea

D13.15 Three-Level Boost Converter with CRM Operation
Moonhyun Lee, Jong-Woo Kim, Jih-Sheng Lai
Virginia Polytechnic Institute and State University, United States

D13.16 Suppression of Circulating Currents for Paralleled Three-Level T-Type Inverters under Unbalanced Operating Conditions
Xi Liu, Tong Liu, Alian Chen, Xiangyang Xing, Chenghui Zhang
Shandong University, China

D13.17 Analysis and Extension of the Canonical Model Applied to DC-DC Converters with Input Filter and Output Post-Filter
Diego Ochoa[1], Antonio Lázaro[1], Marina Sanz[1], Andrés Barrado[1], Jorge Rodriguez[2]
[1]Universidad Carlos III de Madrid, Spain, [2]Power Smart Control SL, Spain

11:15 a.m. – 1:45 p.m.

D14: Control II

ROOM POSTER AREA

TRACK Control

SESSION CHAIRS

Guangqi Zhu, *Eaton*

Emanuel Serban, *University of British Columbia*

D14.1 A Dynamic Voltage Balancing Control Method for Series-Connected SiC MOSFETs in High Voltage Applications
Chengzi Yang[1], Mengyu Zhu[1], Yunfei Xu[2], Longyang Yu[1], Huaqing Li[1], Laili Wang[1]
[1]Xi'an Jiaotong University, China,[2]Global Energy Interconnection Research Institute, China

D14.2 A Sensorless Current Balance Control Method for Interleaved Boost Converter
Guanliang Liu[1], Weiyang Zhou[1], Qunfang Wu[1], Yongsheng Fu[2], Mengqi Wang[1]
[1]University of Michigan-Dearborn, United States, [2]Xi'an Technological University, China

D14.3 Sensorless Control of Doubly-Fed Reluctance Machines for Wind Energy Conversion Systems
Milutin Jovanović[1], Sul Ademi[2]
[1]Northumbria University Newcastle, United Kingdom,[2]University of Warwick, United Kingdom

D14.4 Improved V² Constant On-Time Control with State-Trajectory Control
Virginia Li, Qiang Li, Fred C. Lee
Virginia Polytechnic Institute and State University, United States

D14.5 Initial Rotor Polarity Detection of Single-Phase PMSM based on Nonlinear Permeability of Permanent Magnet
Sung-Woo Seo[1], Seon-Hwan Hwang[1], Jong-Won Park[2], Chan-Nyeong Heo[2]
[1]Kyungnam University, Korea,[2]GMB Korea, Korea

D14.6 Design of DPWM with High Resolution under 80 ps using Low-Cost Xilinx FPGA
M. Fernandez-Gomez[1], C. Fernández[1], P. Zumel[1], A. Sanchez[2], A. de Castro[2]
[1]Universidad Carlos III de Madrid, Spain,[2]Universidad Autónoma de Madrid, Spain

D14.7 Operation and Control of a Matrix Converter in Current Control Mode with Voltage Boost Capability
Vladimir Blasko[1], Boran Fan[2], Mahmoud El Chamie[1], Warren Chen[1], Rolando Burgos[2]
[1]United Technologies Research Center, United States, [2]Virginia Polytechnic Institute and State University, United States

D14.8 Adaptive Hysteresis Comparison Control of Load Sharing for Three-Phase Interleaved SCC-LLC Converter
Bo Sheng, Xiang Zhou, Wenbo Liu, Andrew Yurek, Yang Chen, Yan-Fei Liu, P.C. Sen
Queen's University, Canada

D14.9 Generalized Average Modeling of a Single-Stage Resonant-Based Inverter
S. Milad Tayebi, Sanjay Rajendran, Ao Sun, Alex Q. Huang
University of Texas at Austin, United States

D14.10 Current Jump Mechanism and Suppression in Paralleled Three-Level Inverters with Space Vector Modulation
Ruirui Chen[1], Fred Wang[1,2], Leon M. Tolbert[1,2], Daniel J. Costinett[1,2], Benjamin B. Choi[3]
[1]University of Tennessee, United States, [2]Oak Ridge National Laboratory, United States, [3]NASA Glenn Research Center, United States

D14.11 State-of-Charge Control with Series Output Connected DC-DC Modules in Active Battery Management Systems
Mohamed Kamel[1], Vivek Sankaranarayanan[2], Regan Zane[1], Dragan Maksimović[2]
[1]Utah State University, United States,[2]University of Colorado-Boulder, United States

D14.12 Robust Sliding Mode Control of a Three-Phase Grid-Forming Inverter in Non-Ideal Grid Conditions and Isolated Mode of Operation
Sara Yazdani[1], Mehdi Ferdowsi[1], Masoud Davari[2], Pourya Shamsi[1]
[1]Missouri University of Science and Technology, United States,[2]Georgia Southern University, United States

D14.13 Improvement of Transient Response of a Grid-Connected Inverter Applying Estimated Disturbance Rejection
Horyeong Jeong, Sungmin Choi, Jae Suk Lee
Jeonbuk National University, Korea

D14.14 Stop-and-Go Gate Drive Minimizing Test Cost to Find Optimum Gate Driving Vectors in Digital Gate Drivers
Toru Sai[1], Koutaro Miyazaki[1], Hidemine Obara[2], Tomoyuki Mannen[3], Keiji Wada[3], Ichiro Omura[4], Takayasu Sakurai[1], Makoto Takamiya[1]
[1]The University of Tokyo, Japan,[2]Yokohama National University, Japan,[3]Tokyo Metropolitan University, Japan,[4]Kyusyu Institute of Technology, Japan

D14.15 Medium Voltage Bidirectional DC-DC Isolator using Series Connected 10kV SiC MOSFETs
Sanket Parashar, Ashish Kumar, Nithin Kolli, Raj Kumar Kokkonda, Subhashish Bhattacharya
North Carolina State University, United States

D14.16 Proportional Capacitor Current Feedback based Active Damping Control for LCL-Filter Converters with Considerable Control Delay
Zhijun Ma, Linyuan Zhou, Jinjun Liu
Xi'an Jiaotong University, China

11:15 a.m. – 1:45 p.m.

D15: Wireless Power Transfer

ROOM POSTER AREA

TRACK Wireless Power Transfer

SESSION CHAIRS

Sheldon Williamson, *University of Ontario Institute of Technology*

Raghav Khanna, *University of Toledo*

D15.1 High-Frequency Differential Resonant Rectifier with DC Output Voltage Regulation
Kerui Li, Siew-Chong Tan, Ron Shu Yuen Hui
The University of Hong Kong, Hong Kong

D15.2 Small-Signal Modeling for Adaptive Closed-Loop Control in Two-Coil Wireless Power System
Kang Tang[1], Huawei Yang[2], Huaiqi Xie[3], Yuan Cao[4]
[1]Nanjing Normal University, China,[2]Florida State University, United States,[3]Missouri University of Science and Technology, United States,[4]The University of Alabama, United States

D15.3 Decoupling Control of Modular WPT Systems
Chen Zhu, Wenxing Zhong, Dehong Xu
Zhejiang University, China

D15.4 A Novel Method to Calculate the Efficiency of a Wireless Power Transfer System using Modified Ferreira's/Dowell's Method
Bazil Nawaz, Cem Som, Christopher Schaffelhofer
Würth Elektronik eiSos GmbH & Co. KG, Germany

D15.5 WPC Qi Mobile Device Rx Coil Design and Optimization
Qi Tian, Liang Jia
Google LLC, United States

D15.6 Efficiency Evaluation of Laser based Wireless Power Transmission System
Weiyang Zhou[1], Ke Jin[2], Mengqi Wang[1], Qunfang Wu[1]
[1]University of Michigan-Dearborn, United States, [2]Nanjing University of Aeronautics and Astronautics, China

D15.7 Soft-Switching in Capacitive-Coupled Wireless Power Transfer with LCLC Compensation Networks
Eli Abramov[1], Mor Mordechai Peretz[1], Ilya Zeltser[2]
[1]Ben-Gurion University of the Negev, Israel,[2]Rafael Advanced Defense Systems Ltd., Israel

D15.8 A Method of Simultaneous Transmission of Power and Information based on Laser Power Transfer System
Tianyi Yang, Ke Jin
Nanjing University of Aeronautics and Astronautics, China

D15.9 Efficiency Optimization of Multiple-Tap-Coil-Based IPT System for Reefer Container
Yefei Xu, Huanyu Yang, Yundong Gu, Ruikun Mai
Southwest Jiaotong University, China

D15.10 Design and Implementation of Estimating Algorithm for Foreign Object Location in Wireless Charging EV Systems
Hassan Jafari, Temitayo O. Olowu, Maryam Mahmoudi, Arif Sarwat
Florida International University, United States

D15.11 A Control Scheme to Mitigate the Dead-Time Effects in a Wireless Power Transfer System
Utkarsh D. Kavimandan[1], Veda P. Galigekere[2], Omer Onar[2], Burak Ozpineci[2], Satish M. Mahajan[1]
[1]Tennessee Technological University, United States, [2]Oak Ridge National Laboratory, United States

D15.12 Three-Phase Integrated PFC AC-AC Half-Bridge Boost Rectifier and Class D Resonant Inverter with Weak Coupled Coils for IH Application
Ruan C.M. Gomes, Montiê A. Vitorino, Mauricio B.R. Corrêa
Federal University of Campina Grande, Brazil

D15.13 An LC-CLC Compensated CPT System to Achieve the Maximum Power Transfer for High Power Applications
Bo Luo[1], Lingli Xu[2], Tao Long[1], Yefei Xu[1], Ruikun Mai[1], Zhengyou He[1]
[1]Southwest Jiaotong University, China,[2]Beijing Urban Construction Design & Development Group Co., Ltd., China

D15.14 Light Weight and Efficient Litz-Wire based Ferrite-Less Shielding for Wireless Power Transfer
Alireza Dayerizadeh, Sofia Taylor, Hao Feng, Srdjan Lukic
North Carolina State University, United States

D15.15 Direct Envelope Modeling of Load-Resonant Inverter for Wireless Power Transfer Applications
Veda P. Galigekere, Rong Zeng, Jason Pries, Omer Onar, Gui-Jia Su
Oak Ridge National Laboratory, United States

D15.16 Sensitivity Analysis and Controller Design of High Power LCC-LCC Compensated Wireless Battery Charging for Electric Ship Applications
Moinul Shahidul Haque[1], Mostak Mohammad[2], Seungdeog Choi[1]
[1]Mississippi State University, United States, [2]Oak Ridge National Laboratory, United States

D15.17 20-kW Bi-Directional Wireless Power Transfer System with Energy Storage System Connectivity
Omer C. Onar, Gui-Jia Su, Erdem Asa, Jason Pries, Veda Galigekere, Larry Seiber, Cliff White, Randy Wiles, Jonathan Wilkins
Oak Ridge National Laboratory, United States

11:15 a.m. – 1:45 p.m.

D16: Renewable Energy Systems I

ROOM POSTER AREA

TRACK Renewable Energy Systems

SESSION CHAIRS

Suzan Eren, *Queen's University*

Justin Henspeter, *IBM*

D16.2 A Single-Phase Five-Level Transformerless Photovoltaic Inverter
Xiaonan Zhu, Xinyue Chen, Renjie Sun, Zhenzhen Li, Xiumei Yue, Hongliang Wang
Hunan University, China

D16.3 A Decentralized Control of Series-Connected PV-ES Inverters with MPPT and Virtual Inertia Functionality
Huanyue Liao[1], Xin Zhang[1], Xiaochao Hou[2]
[1]Nanyang Technological University, Singapore, [2]Central South University, China

D16.4 Synchronous Combined Cuk-SEPIC Converter for Single Phase Transformerless Solar Inverter
Saikat Ghosh[1], Daniel Gaona[1], Yam Siwakoti[2], Teng Long[1]
[1]University of Cambridge, United Kingdom,[2]University of Technology Sydney, Australia

D16.5 Critical Conduction Mode based High Frequency Single-Phase Transformerless PV Inverter
Gibong Son, Zhengrong Huang, Qiang Li, Fred C. Lee
Virginia Polytechnic Institute and State University, United States

D16.6 Model Predictive Control of Seven-Level Single-Phase Boost Inverter without Weighting Factor for Grid-Tied Photovoltaic Applications
Md Noman Habib Khan[1], Yam P. Siwakoti[1], Li Li[1], Shakil Ahamed Khan[1], Frede Blaabjerg[2]
[1]University of Technology Sydney, Australia, [2]Aalborg University, Denmark

D16.7 A Hybrid Modulation Method for Two-Stage Grid-Tied PV Inverter with Leakage Current Suppression and Efficiency Improvement
Gengzhe Zheng[1], Yu Chen[1], Zhuoran Liu[2], Kai Tian[2]
[1]Huazhong University of Science and Technology, China,[2]ABB, China

D16.8 Efficiency Optimized Design Procedure of Low-Q LLC Resonant Converter for Wide Input Voltage and Load Range Application
Abhishek Awasthi, Snehal Bagawade, Amit Kumar, Praveen Jain
Queen's University, Canada

D16.9 Hybrid 2/3L Inverter with Unequal PV Array Voltages
Narendrababu A[1], Naveen Yalla[2], Pramod Agarwal[3]
[1]Madanapalle Institute of Technology and Science, India,[2]Pandit Deendayal Petroleum University, India,[3]Indian Institute of Technology Roorkee, India

D16.10 Eliminating Frequency Coupling of DFIG System using a Complex Vector PLL
Chao Wu[1], Bin Hu[2], Peng Cheng[3], Heng Nian[2], Frede Blaabjerg[1]
[1]Aalborg University, Denmark,[2]Zhejiang University, China,[3]North China Electric Power University, China

D16.11 A Novel Stator Frequency Control Method of DFIG-DC System based on Regulating Air Gap Flux Vector
Chao Wu[1], Yingzong Jiao[2], Peng Cheng[3], Heng Nian[2], Frede Blaabjerg[1]
[1]Aalborg University, Denmark,[2]Zhejiang University, China,[3]North China Electric Power University, China

D16.12 Harmonic Current Depression for Medium Voltage Three-Level Wind Power Converter with Active Damping Control
Zhijun Ma, Linyuan Zhou, Jinjun Liu
Xi'an Jiaotong University, China

D16.13 Aerodynamic Frequency Domain Model for Evaluating Small Wind Turbines
David R. López-Flores, José L. Durán-Gómez, Javier Vega-Pineda
Tecnológico Nacional de México / Instituto Tecnológico de Chihuahua, Mexico

D16.16 A Novel DROGI Algorithm for Non-Linear Unbalanced Load Compensation using Four-Leg Converter
Shilei Jiao, Krishna Raj R., Kaushik Rajashekara
University of Houston, United States

D16.17 An Adaptive Proportional Feedforward Scheme for LCL-Type Grid-Connected Inverter
Kuang Qin[1], Wentao Wang[2], Xuehua Wang[1], Yuying He[1], Xinbo Ruan[1], Fuxin Liu[3]
[1]Huazhong University of Science and Technology, China,[2]Wuhan Second Ship Design and Research Institute, China,[3]Nanjing University of Aeronautics and Astronautics, China

D16.18 Modified Proportional Resonant Current Controller with MPPT for Three Phase Single Stage Grid Integrated PV System
Manash Kumar Mishra, Vivek Nandan Lal
Indian Institute of Technology (BHU) Varanasi, India

D16.19 Five-Level Grid-Tied Inverter Employing Switched-Capacitor Cell with Common-Grounded Feature
Reza Barzegarkhoo[1], Yam P. Siwakoti[1], Teng Long[2], Frede Blaabjerg[3]
[1]University of Technology Sydney, Australia, [2]University of Cambridge, United Kingdom, [3]Aalborg University, Denmark

D16.20 Seamless Transition Mode Control for SiC Energy-Recycling DC Electronic Loads
Jiahua Xu, Zhiliang Zhang, Mingxie He, Jing Zhu, Xiang Li, Qi Yang, Xiaozhong Wei, Xiaoyong Ren, Qianhong Chen
Nanjing University of Aeronautics and Astronautics, China

D16.21 Lyapunov based Neural Network Estimator Designed for Grid-Tied Nine-Level Packed E-Cell Inverter
Mohammad Babaie[1], Mohammad Sharifzadeh[1], Majid Mehrasa[2], Kamal Al-Haddad[1]
[1]École de Technologie Supérieure, Canada, [2]Babol Noshirvani University, Iran

D16.22 A Seven-Level Boost Inverter for Medium Power PV Applications
Omar Abdel-Rahim[1,2], Haoyu Wang[1]
[1]ShanghaiTech University, China, [2]Aswan University, Egypt

D16.23 GaN-Based MHz Single Phase Inverter with a High Efficiency Hybrid TCM Control Method
Teng Liu[1], Ke Xu[1], Yi Zhang[1], Cai Chen[1], Yong Kang[1], Fang Luo[2]
[1]Huazhong University of Science and Technology, China,[2]University of Arkansas, United States

D16.24 An Improved Control Strategy for a Single-Phase Non-Isolated Photovoltaic Grid-Tied Inverter
Jianbo Jiang[1], Shangzhi Pan[1], Long Xie[2], Weiwen Zeng[2], Jinwu Gong[1], Xiaoming Zha[1]
[1]Wuhan University, China,[2]Central Southern China Electric Power Design Institute Co., Ltd., China

11:15 a.m. – 1:45 p.m.

D17: Renewable Energy Systems II

ROOM POSTER AREA

TRACK Renewable Energy Systems

SESSION CHAIRS

Ed Nowicki, *University of Calgary*

Pritam Das, *Binghampton University*

D17.1 Switched-Mode Control of Battery Backup Unit in Data Center for Online Impedance Detection
Yuan Cao, Huawei Yang, Tianyi Gao, Shuai Shao, Binghua Zhang
Baidu USA, United States

D17.2 A High-Speed GMPPT Method under Gaussian Laser Beam Conditions
Ran Zhang, Ke Jin, Tianyi Yang
Nanjing University of Aeronautics and Astronautics, China

D17.3 A Novel Single-Stage Buck-Boost Transformerless Inverter for 1-Φ Grid-Connected Solar PV Systems
Phani Kumar Chamarthi, Mohamed Shawky El Moursi, Vinod Khadkikar, Khalifa Hassan Al Hosani
Khalifa University, U.A.E.

D17.4 Lithium-Ion Battery Life Cycle Prediction with Deep Learning Regression Model
Huawei Yang, Yuan Cao, Huaiqi Xie, Shuai Shao, Jie Zhao, Tianyi Gao, Jiajun Zhang, Binghua Zhang
Baidu USA, United States

D17.5 A Novel High Step-Up Three-Port Bidirectional DC/DC Converter for PV-Battery Integrated System
Mohammad Al-Soeidat[1,2], Habes Khawaldeh[1], Dylan D.-C. Lu[1], Jianguo Zhu[1]
[1]University of Technology Sydney, Australia, [2]Al-Hussein Bin Talal University, Jordan

D17.6 High Reliable Power Conversion System with Active Battery Balancing Capability
Gwangyol Noh[1,2], Jung-Ik Ha[1]
[1]Seoul National University, Korea, [2]Samsung Electronics, Korea

D17.7 A Control Method of Dual Active Bridge DC-DC Converters Maintaining Soft-Switching at Different Voltage Ratio
Takeshi Uchida[1], Yoichi Ishizuka[1], Daisuke Yamashita[1], Toshiro Hirose[2], Kazuto Ura[1]
[1]Nagasaki University, Japan,[2]Nishimu Electronics Industries Co., Ltd., Japan

D17.8 Online Bus Impedance Estimation and Stabilization of DC Power Distribution Systems: A Method based on Source Converter Loop-Gain Measurement
Hessamaldin Abdollahi[1], Aram Khodamoradi[2], Enrico Santi[1], Paolo Mattavelli[2]
[1]University of South Carolina, United States, [2]University of Padova, Italy

D17.9 **Fuzzy Logic based Module-Level Power Electronics for Mitigation of Rapid Cloud Shading in Photovoltaic Systems**
Rachel Belcher, Javad Fattahi, Karin Hinzer, Henry Schriemer
University of Ottawa, Canada

D17.10 **A Module-Based Hierarchical Microgrid with a Bottom-Up Building Architecture for Rural Electrification**
Dong Li, Carl Ngai Man Ho, Ken Kingman Siu, Mandip Pokharel
University of Manitoba, Canada

D17.11 **Modeling and Control of a Four-Port DC-DC Converter for a DC Microgrid with Renewable Energy Sources**
Xia Du[1], Jianwu Zeng[1], Jiahong Ning[1], Taesic Kim[2], Vincent Winstead[1]
[1]Minnesota State University, United States, [2]Texas A&M University-Kingsville, United States

D17.12 **Feasibility Study of Compact High-Efficiency Bidirectional 3-Level Bridgeless Totem-Pole PFC/Inverter at Low Cost**
Trong Tue Vu[1], Rytis Beinarys[2]
[1]ICERGi Ltd., Ireland,[2]Maynooth University, Ireland

D17.13 **The True Unit Power Factor Converter with Flexible Arrangement for Battery Energy Systems: Series and Separate DC Bus Connection**
Thiago M. Parreiras[1], Marcos H. da S. Alves[1], Camila E. Almeida[2], Sidelmo M. Silva[1], Braz de J.C. Filho[1]
[1]Universidade Federal de Minas Gerais, Brazil,[2]Halliburton Brazil Technology Center, Brazil

D17.14 **An SVM Strategy with Two-Step Commutation for Isolated AC-DC Matrix Converter**
Fanxiu Fang, Hao Tian, Yunwei Li
University of Alberta, Canada

D17.16 **An Integrated Design of the Solid-State Circuit Breaker and the DC-DC Converter**
Xiaoguang Diao, Wenkun Zhu, Yuan Song, Fei Liu, Mengyue Xu, Jianjun Sun
Wuhan University, China

D17.17 **Lithium-Ion Battery State of Health Estimation using Empirical Mode Decomposition Sample Entropy and Support Vector Machine**
Xin Sui, Shan He, Daniel-Ioan Stroe, Remus Teodorescu
Aalborg University, Denmark

D17.18 **Implementation and Experimental Evaluation of an Efficiency-Improved Modulation Technique for IBCI DC-DC Converters**
Francesco Toniolo, Simone Pistollato, Tommaso Caldognetto, Simone Buso, Giorgio Spiazzi, Paolo Mattavelli
University of Padova, Italy

D17.19 **Decentralized Solution based on Small-AC-Signal Injection for Accurate Power Sharing in Islanded Microgrids with Complex Line Impedances**
Ronghui An, Zeng Liu, Jinjun Liu, Baojin Liu
Xi'an Jiaotong University, China

D17.20 **Electrochemical Impedance Spectroscopy based Power-Mix Control Strategy for Improved Lifetime Performance in Second-Life Battery Systems**
C. Lamoureux, Z. Gong, M. Nasr, S.A. Assadi, K. Gupta, D. Galatro, O. Tayyara, C. da Silva, C. Amon, O. Trescases
University of Toronto, Canada

D17.21 **Design and Control of AC Current Injector for Battery EIS Measurement**
Abdulraouf Benshatti[1], S.M. Rakiul Islam[1], Thomas Link[1], Sung-Yeul Park[1], Sungmin Park[2]
[1]University of Connecticut, United States, [2]Hongik University, Korea

D17.22 **A Soft-Switching Single-Stage Zeta-/SEPIC-Based Inverter/Rectifier**
Masih Khodabandeh, Mahshid Amirabadi
Northeastern University, United States

D17.23 **Soft Switching over the entire Line Cycle for a Quadruple Active Bridge DCX in a DC to Three-Phase AC Module**
Branko Majmunović[1], Satyaki Mukherjee[1], Rahul Mallik[2], Soham Dutta[2], Gab-Su Seo[3], Brian Johnson[2], Dragan Maksimović[1]
[1]University of Colorado-Boulder, United States, [2]University of Washington, United States, [3]National Renewable Energy Laboratory, United States

D17.24 **Analytical Approach to Calculate Inductor Current Ripple Cancellation in Two-Phase Interleaved Single-Phase Inverter**
Saleh Farzamkia[1], Arash Khoshkbar-Sadigh[1], Juan R. Nunez Forestieri[2], Mehdi Farasat[2], Vahid Dargahi[3]
[1]Pennsylvania State University, United States, [2]Louisiana State University, United States, [3]University of Washington, United States

11:15 a.m. – 1:45 p.m.

D18: Transportation Power Electronics III

ROOM POSTER AREA

TRACK Transportation Power Electronics

SESSION CHAIRS

Yingying Kuai, *Caterpillar*

Suman Debnath, *Oak Ridge National Laboratory*

D18.2 **Capacitor-Clamped LLC Resonant Converter for Constant Power EV Charging with Fixed Operation Frequency**
Jiayang Wu[1], Sinan Li[2], Siew-Chong Tan[1], S. Y. (Ron) Hui[1]
[1]The University of Hong Kong, Hong Kong, [2]The University of Sydney, Australia

D18.3 **Bidirectional DC-DC Converter utilizing New Loss Reduction Techniques for HV/PHV**
Ken Toshiyuki, Hyoungjun Na, Kazunobu Eritate, Naoyoshi Takamatsu, Masaki Okamura, Masato Taki
Toyota Motor Corporation, Japan

D18.4 **Fast Switching SiC Cascode JFETs for EV Traction Inverters**
Ruizhu Wu, Jose Ortiz Gonzalez, Zarina Davletzhanova, Philip Mawby, Olayiwola Alatise
University of Warwick, United Kingdom

D18.5 **A Hybrid Modular Multilevel Converter with Multiple Common-Mode Voltages Injection Control for Electric Vehicle Applications**
Di Wang[1,2], Luigi Piegari[2], Jinjun Liu[1], Davide De Simone[2], Shuguang Song[1], Xingxing Chen[1]
[1]Xi'an Jiaotong University, China, [2]Politecnico di Milano, Italy

D18.6 **A 20 kW High Power Density Isolated DC-DC Converter for an On-Board Battery Charger utilizing Very-Low Inductive SiC Power Modules**
Rakesh Ramachandran[1], Jesper Nielsen[1], Morten Nymand[1], Nils Nageler[2], Ronald Eisele[2]
[1]University of Southern Denmark, Denmark, [2]Kiel University of Applied Sciences, Germany

D18.7 **A New System of Combined Propulsion and Levitation for Maglev Transportation**
Vladimir Kuptsov[1], Poria Fajri[1], Salvador Magdaleno-Adame[2], Konstantin Hadziristic[3]
[1]University of Nevada-Reno, United States, [2]Magnetic Instrumentation, United States, [3]Sympatico, Canada

D18.8 **Modeling and Analysis of Low-Frequency Oscillation in PETT-Based Train-Network System**
Yi Hong[1], Zhikang Shuai[1], Xiongfei Wang[2], Jingyan Xie[1]
[1]Hunan University, China, [2]Aalborg University, Denmark

D18.10 **Fast DC-Link Capacitor Design for Voltage Source Inverters based on Weighted Total Harmonic Distortion**
Cornelius Rettner, Maximilian Schiedermeier, Andreas Apelsmeier, Martin März
Friedrich-Alexander University Erlangen-Nürnberg, Germany

D18.11 **V2X Operation of Integrated Single-Phase Bidirectional Electric Vehicle Charger**
Sepehr Semsar, Peter W. Lehn
University of Toronto, Canada

D18.12 **Lithium-Ion Battery Charging Control using a Coupled Electro-Thermal Model and Model Predictive Control**
Aloisio Kawakita de Souza, Gregory Plett, M. Scott Trimboli
University of Colorado-Colorado Springs, United States

D18.14 **DC Link Capacitor Reduction with Feedforward Control in Series-Series Compensated Wireless Power Transfer Systems**
Subhajyoti Mukherjee, Veda P. Galigekere, Omer Onar, Burak Ozpineci
Oak Ridge National Laboratory, United States

D18.15 **Performance Evaluation of 10kV SiC-Based Extreme Fast Charger for Electric Vehicles with Direct MV AC Grid Interconnection**
G. Veera Bharath, Sai Kiran Voruganti, Van Thuan Nguyen, Vaibhav Uttam Pawaskar, Ghanshyamsinh Gohil
University of Texas at Dallas, United States

11:15 a.m. – 1:45 p.m.

D19: Applications uPower to Grid

ROOM POSTER AREA

TRACK Power Electronics Applications

SESSION CHAIRS

Jungwon Choi, *University of Minnesota*

Juan Rivas, *Stanford University*

D19.2 **An Observer based Algorithm for Input Current Quality Optimization in AC/DC Boost Converters**
Zain Bin Tariq[1], Andrea Morici[2]
[1]Technical University of Munich, Germany, [2]Infineon Technologies AG, Germany

D19.3 **Impedance-Based Interaction Analysis for AC/DC and DC/DC Converters in Telecom Power System**
Xiaolong Yue
Ericsson AB, Sweden

D19.6 **Self-Sustaining High-Power RF Signal Generation using LDMOS based Power Amplifier and Nonlinear Transmission Line**
A.N.M. Wasekul Azad, Faisal Khan, Anthony Caruso
University of Missouri-Kansas City, United States

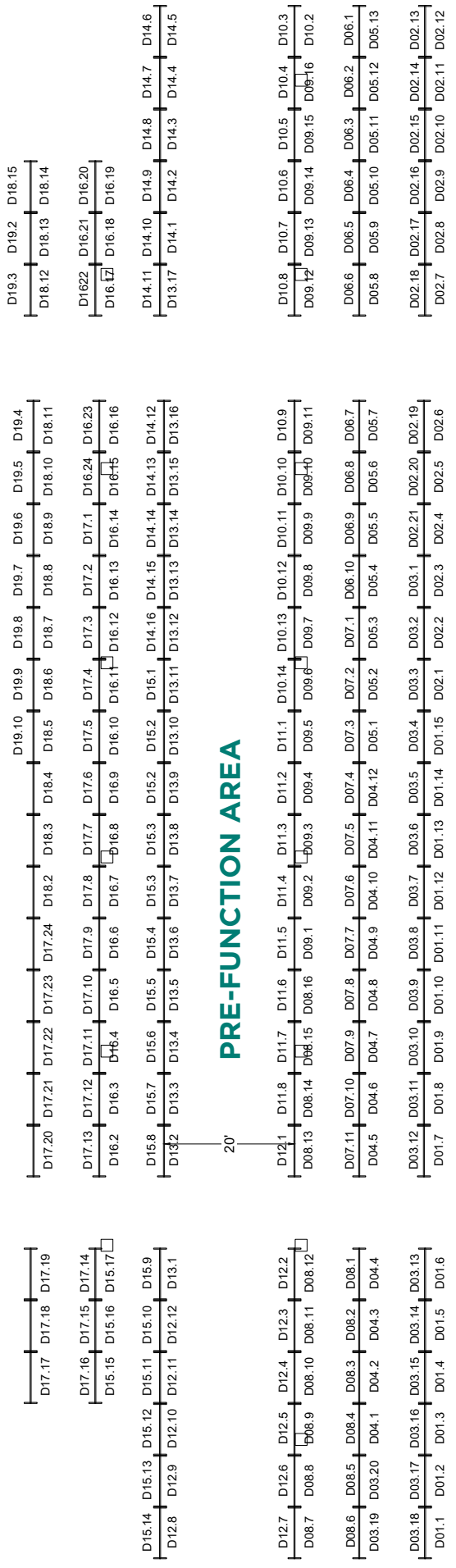
D19.7 **An L∞ Feedback Control Strategy for Grid-Connected Three-Phase Voltage Source Inverters**
Daniel Fernandez, Sara Ahmed, Ahmad F. Taha
University of Texas at San Antonio, United States

D19.8 **An Interleaved Active Neutral-Point Clamped Nine-Level Converter**
Yu Cao, Rui Li
Shanghai Jiao Tong University, China

D19.9 **Wireless Power Transfer using EF2 Inverter with Fixed Coil Capacitor and Air Core Inductor**
Soumya Ranjan Meher, Deepak Gautam, Rajeev Singh
Indian Institute of Technology (BHU) Varanasi, India

D19.10 **A Fully PCB Integrated Self-Powered Micro Generator for Vibration Electromagnetic Harvesting**
Jiahua Chen, Han Peng, Zhijie Feng, Yu Chen, Chenhang Zeng, Yong Kang
Huazhong University of Science and Technology, China

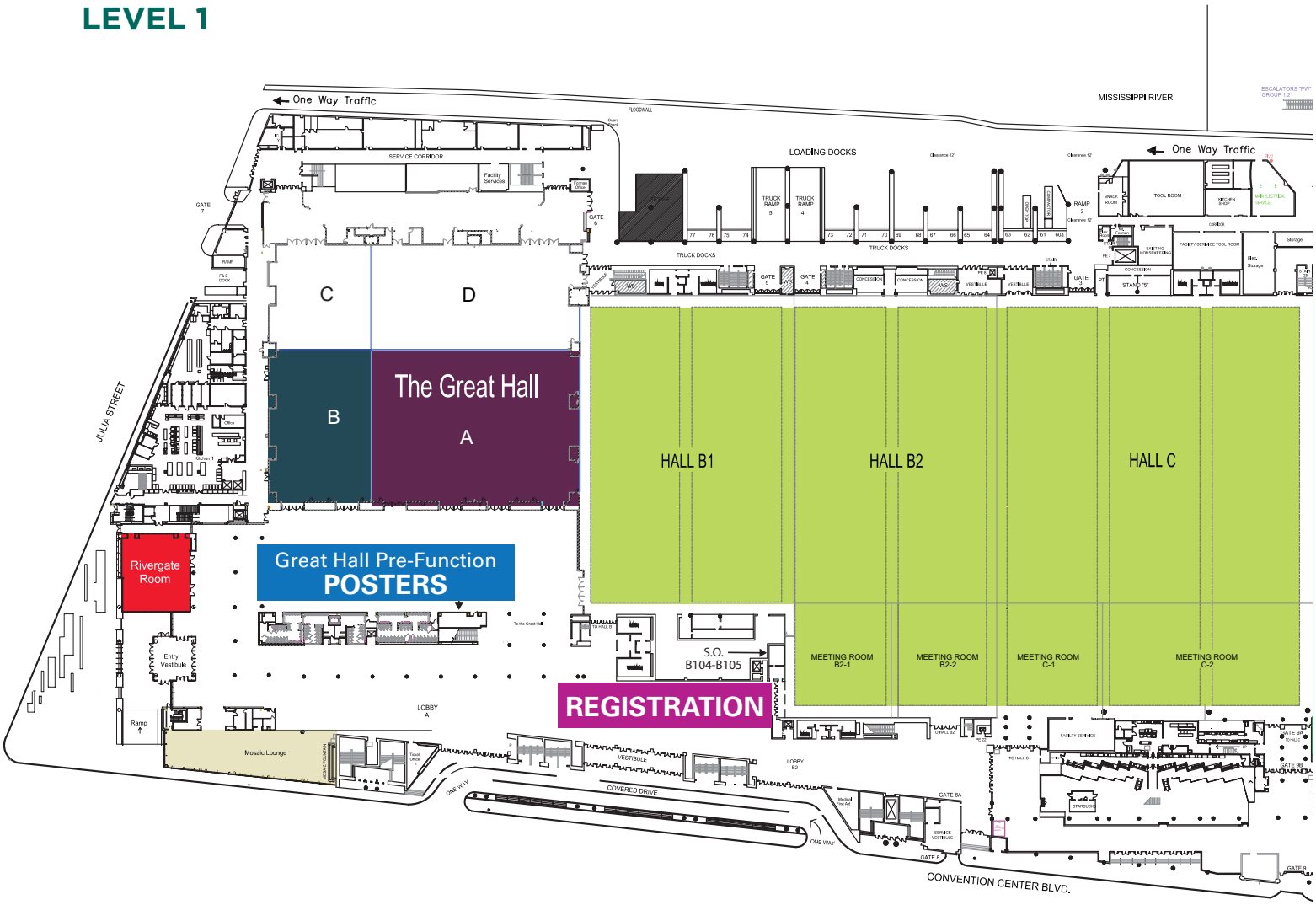
DIALOGUE SESSIONS FLOOR PLAN



150 POSTER BOARDS
300 POSTER SIDES

CONVENTION CENTER FLOOR PLAN

LEVEL 1



Speaker Breakfast

Plenary

Speaker Ready Room

Exhibit Hall: Halls B-C

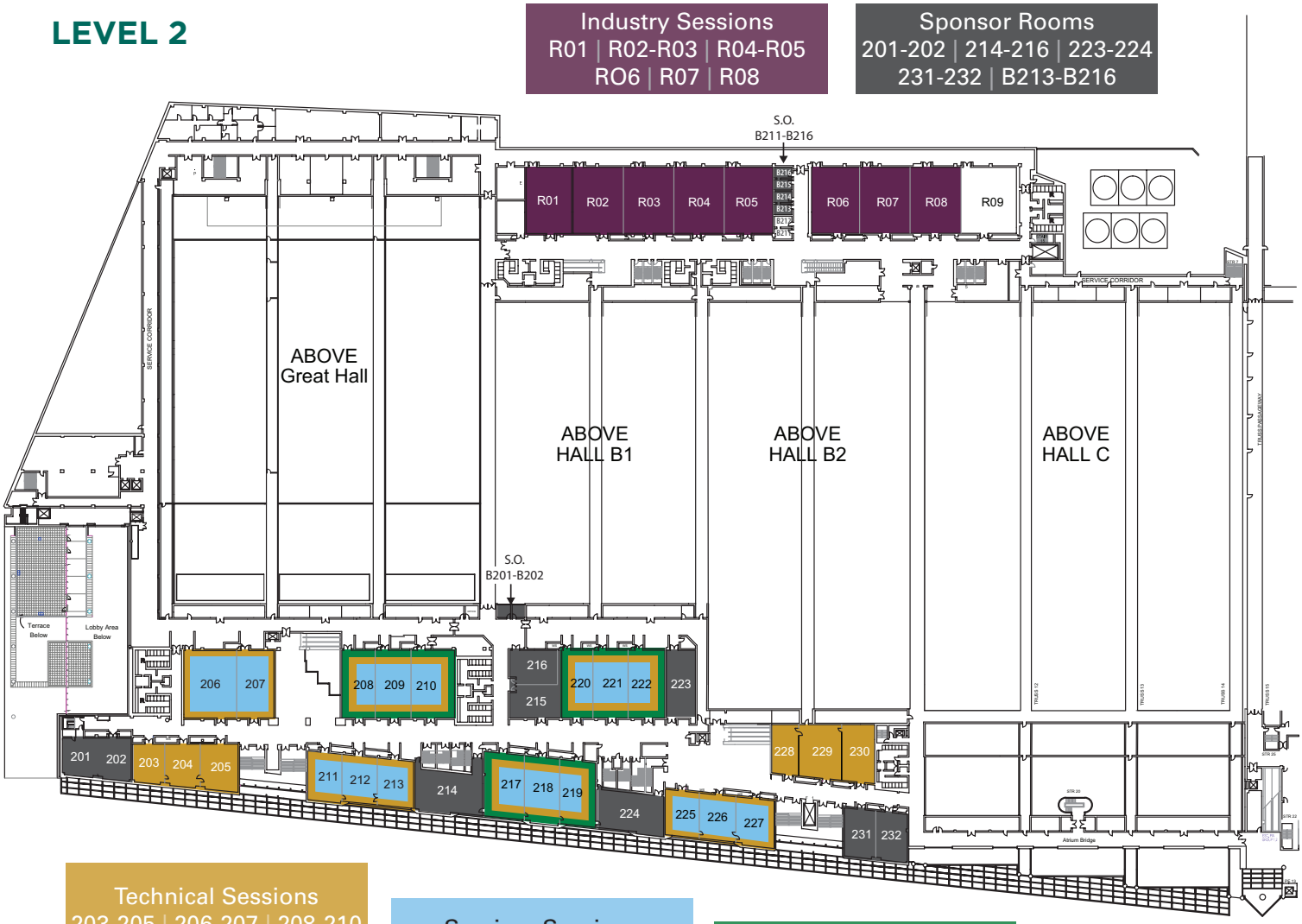
Build Out: Press Room
Mosaic Longe

CONVENTION CENTER FLOOR PLAN

LEVEL 2

Industry Sessions
R01 | R02-R03 | R04-R05
RO6 | R07 | R08

Sponsor Rooms
201-202 | 214-216 | 223-224
231-232 | B213-B216



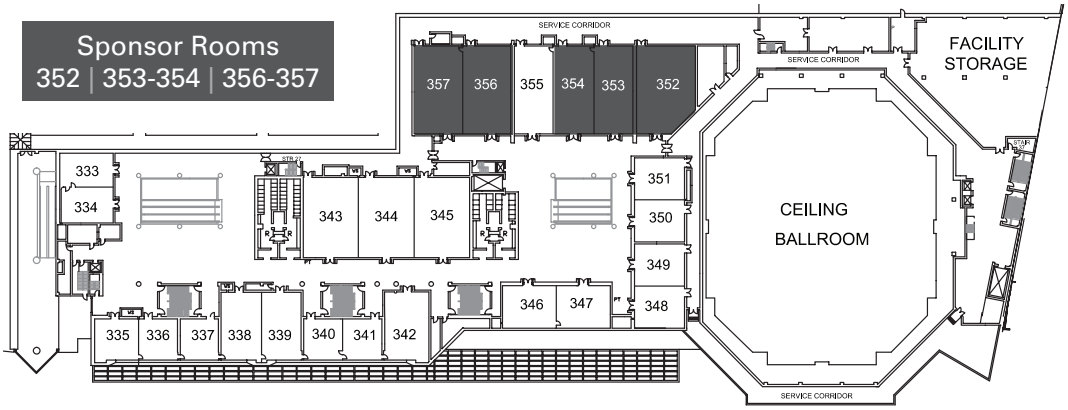
Technical Sessions
203-205 | 206-207 | 208-210
211-213 | 217-219 | 220-222
225-227 | 228-230

Seminar Sessions
206-207 | 208-210 | 211-213
217-219 | 220-222 | 225-227

Rap Sessions (Tuesday)
208-210 | 217-219
220-222

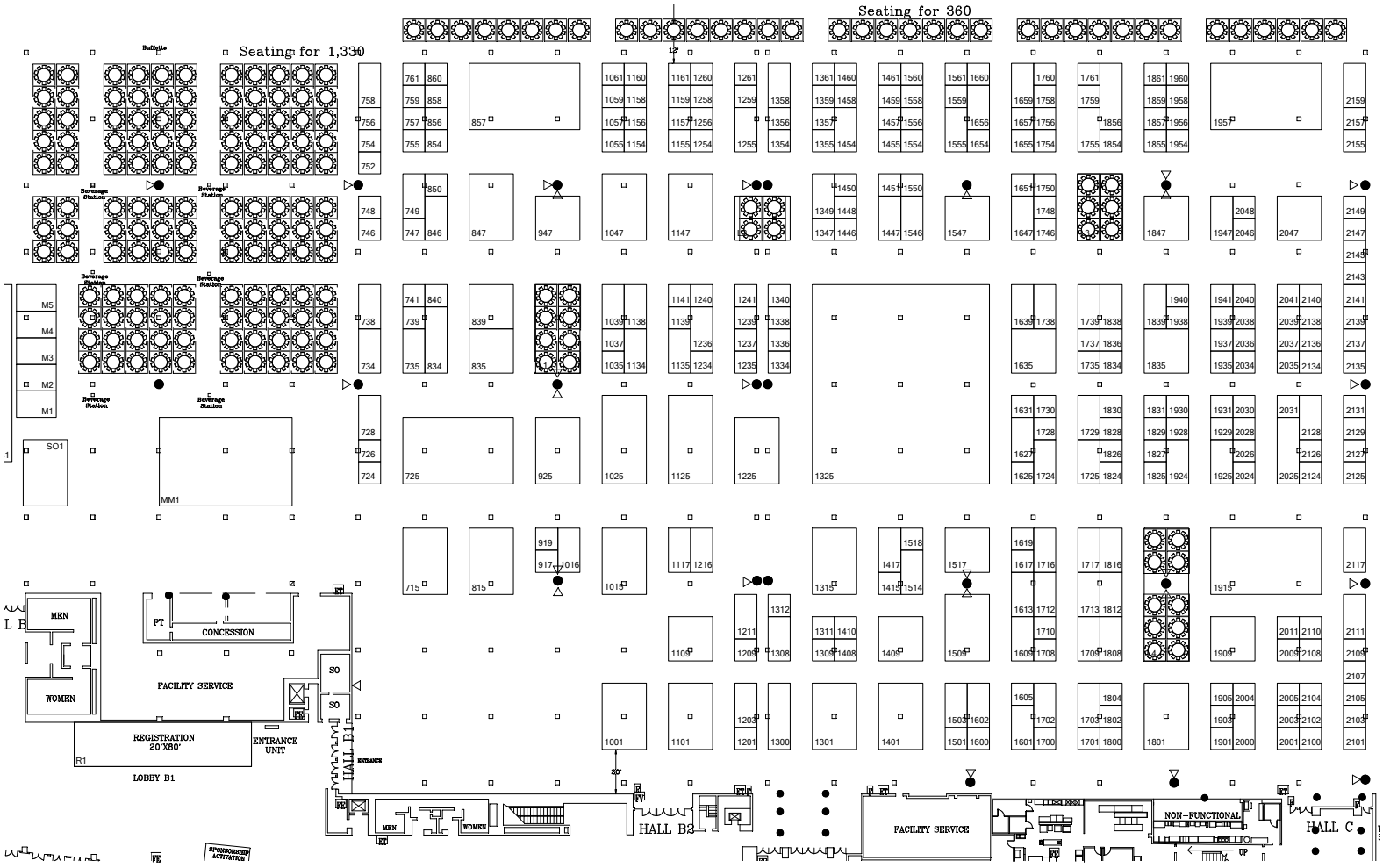
LEVEL 3

Sponsor Rooms
352 | 353-354 | 356-357



EXPOSITION FLOOR PLAN

ERNEST N. MORIAL CONVENTION CENTER
NEW ORLEANS, LA
FIRST FLOOR/EXHIBIT HALLS B/C



EXHIBITOR LISTING

as of February 17, 2020

EXHIBITOR	BOOTH #
5S Components	1839
AC POWER CORP. (Preen)	1601
Acopian Power Supplies	1627
Advanced Conversion	1804
Advanced Test Equipment Rentals	1759
AEM	1457
AE Techron	1657
AgileSwitch, LLC	1703
AIR-VAC Automation	1901
Aishi Capacitors	2117
All Flex Flexible Circuits and Heaters	2036
Alpha & Omega Semiconductor	1039
Altair	1631
AmePower Manufacturing Support & Service	1546
AMETEK Programmable Power	2159
AMETHERM, INC	1340
Amogreentech Co., Ltd.	1309
Amphenol Corporation	1808
AMX Automatrix SRL	1956
Analog Devices	947
ANSYS, Inc.	1035
AOS Thermal Compounds	1237
APEC Hub	1325
Apex Microtechnology	2041
APM Technologies (Dongguan) Co. Ltd	1558
ASC Capacitors-Shizuki Electric Company	2110
AVX	1716
B&K Precision	2124
Baknor Thermal	746
BH Electronics	1937
BMI	1748
Bomatec International Corp	2139
Boschman-Advanced Packaging Technology	1461
Bourns, Inc.	2128
Broadcom Inc.	850
Brownsburg Electronik	1854
CAEN Technologies Inc.	2138
CalRamic Technologies, LLC	2040
Captor Corporation	1710
Central Semiconductor Corp.	1935
Centrotherm International AG	860
Cergen	1259
Chroma Systems Solutions, Inc.	1547
CISSOID	1760
Classic Coil Company	2048
CogniPower	1338
Coil Winding Specialist, Inc.	1651
Coilcraft, Inc.	1211
Coilmaster USA Inc	758
Cornell Dubilier Electronics	1619
CPS Technologies	1708
Cramer Magnetics	1336
Cypress	2109
Danfoss Silicon Power GmbH	1647
Dartmouth PMIC	2143
Datatronics	1446
Dean Technology, Inc.	724
DEWESoft LLC	2011
Dexter Magnetic Technologies	1940
Digi-Key Electronics	1835
Dino-Lite Scopes	1355
DMEGC Magnetics Co., LTD	1209
Dongguan Mentech Optical & Magnetic Co., Ltd.	839
dSPACE Inc.	2108
Ducati Energia Power Capacitors	747
EA Elektro-Automatik	1358
Eaton	1939
EBG Resistors	726
ECI	1312
EFC/Wesco	1139
Efficient Power Conversion Corporation (EPC)	1847
EGSTON Power Electronics Gmbh	1518
Electrocube, Inc.	1826
Electronic Concepts, Inc.	1203
Electronicon Kondensatoren GmbH	2111
Elna Magnetics	1730

EXHIBITOR LISTING

EXHIBITOR	BOOTH #
EMWORKS	2026
Enapros India	2105
Epoxies, Etc.	1359
Exagan	1059
Fair-Rite Products	1746
Faratronic Co. Ltd.	1156
Ferrite International Co.	858
Ferro Corporation	1561
Ferroxcube, Inc.	1417
Focused Test, Inc.	2009
Fuji Electric Corp. of America	835
Fujipoly America Corp	1958
GAN Systems	1147
GaNPower International Inc.	1158
GeneSiC Semiconductor	2149
GES High Voltage, Inc	1356
GLOBALFOUNDRIES	1550
GMW Associates	2125
Good-Ark Semiconductor	1154
Gowanda Components Group	1938
GW Instek	1559
Harwin Inc.	1754
Henkel Corporation	2126
Heraeus Electronics	1712
Hesse Mechatronics	1724
Hioki USA Corp.	734
Hitachi America, Ltd.	1816
Hitachi Metals America, LTD.	1713
Hoi Luen Electrical Manufacturer Co., Ltd.	1750
Holy Stone International	1827
Hotland International Corp	1157
HVM Technology	1258
HVR Advanced Power Components	1415
IAS (IEEE Industry Applications Society)	1325
ICE Components, Inc.	1141
ICEL s.r.l.	2035
Ikonix USA	2155
Illinois Capacitor	1617

EXHIBITOR	BOOTH #
IMEC	2103
Indium Corporation	1905
Infineon Technologies Americas Corp	1015
Inter Outstanding Electronics Inc (IOE)	1829
ITELCOND SRL	1929
ITG Electronics, Inc.	854
IWATSU ELECTRIC CO.,LTD.	1450
JFE Steel Corporation	1755
Jianghai America Inc	1830
Johanson Dielectrics, Inc	1930
Jovil Universal LLC	1354
Kaschke Components GMBH	1235
KEMET Electronics Corporation	1047
Kendeil srl	1836
KEPCO, Inc.	1155
Keysight Technologies	1301
Kikusui America, Inc.	1954
LEM USA, Inc.	1812
Li Tone Electronics Co, LTD	2140
LinkCom Manufacturing Co., Ltd	1857
Littelfuse, Inc.	2047
Lodestone Pacific	1347
LTEC Corporation	739
Mag. Layers USA	748
Magna-Power Electronics	1609
Magnetic Metals Corporation	2024
Magnetics	1625
Malico Inc.	2107
Maxim Integrated	1409
MaxLinear Corporation	1236
MaxPower Semiconductor, Inc.	1057
Mersen	1109
Methode Electronics	1117
Microchip Technology, Inc.	1225
Micrometals, Inc.	1334
Mitsubishi Electric US, Inc	925
MK Magnetics Inc	1824
Molex, LLC	1659

EXHIBITOR LISTING

EXHIBITOR LISTING

EXHIBITOR	BOOTH #
Stellar Industries Corp.	1055
STMicroelectronics	715
Storm Power Components	1701
StratEdge Corporation	2157
Sumida America Components Inc.	846
Synopsys, Inc.	2030
Taiwan Chinsan Electronic Ind. Co., Ltd.	2101
Taiyo Kogyo Co., Ltd.	1260
Taiyo Yuden USA Inc.	1254
Tamura Corp. of America,Tamura Japan	735
TDK Corporation	1101
TechInsights	919
Tektronix Inc.	2025
Teledyne LeCroy	1947
Tesec, Inc.	1261
Texas Instruments	1001
Thermik Corporation	1201
Torotel Products, Inc.	1454
TowerJazz	1738
Transcat, Inc	2129
Transphorm	1514
Tran-Tec	756
Trigon Components, Inc.	1554
TSC America Inc.	1737
TT Electronics	1503
Tyndall National Institute	917
Typhoon HIL, Inc.	1455

EXHIBITOR	BOOTH #
UNC Charlotte-EPIC	2137
United Chemi-Con	1216
United Silicon Carbide	1138
uPI Semiconductor/Sentec	1255
VAC Magnetics, LLC	1241
Verivolt	2031
Versatile Power	1828
Viking Tech America Corporation	1037
Vincotech GmbH	1838
Vishay Intertechnology	1509
VisIC Technologies	1361
Vitrek-High Voltage Test & Measurement	2145
Voltage Multipliers, Inc.	1941
Wacker Chemical Corporation	2136
Wakefield-Vette	1729
Well Ascent Electronic (Ganzhou) Co., Ltd.	856
WEMS ELECTRONICS	2038
West Coast Magnetics	1654
WIMA Capacitors GmbH & Co.KG	1458
Wolfspeed, A Cree Company	1315
Wurth Electronics	1025
X-FAB	840
Yokogawa Corporation of America	2131
Yole Developpement	2141
ZES ZIMMER Inc.	1834
Zhuhai Weihan Wire Co., Ltd	1160
Zurich Instruments AG	761

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