2023 IEEE 24th Workshop on Control and Modeling for Power Electronics

UNIVERSITY OF MICHIGAN

JUNE 25-28, 2023 • UNIVERSITY OF MICHIGAN • ANN ARBOR, MI, USA

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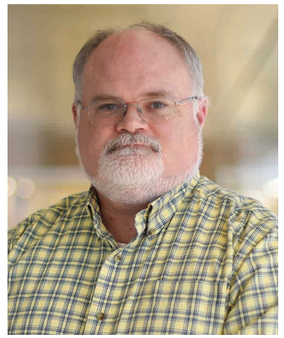
LOCAL ORGANIZING COMMITTEE

COMPEL 2023 is hosted by Electrical and Computer Engineering (ECE) at the University of Michigan in Ann Arbor.

Conference Chair:
Al-Thaddeus Avestruz,
University of Michigan



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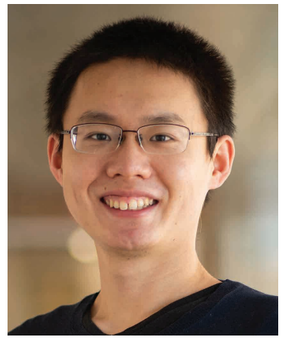


Publications Chair:
Xiaofan Cui,
Stanford University

Conference Planning:
Ann Stals,
University of Michigan

SCHEDULE

DAY 4
WEDNESDAY, JUNE 28, 2023

8:40 AM	T6: Systems Interactions
10:45 AM	Coffee break and divide for tours
11:00 AM	Lunch / technical tour
1:00 PM	Break / return from tours
1:30 PM	T7: Modulation
3:35 PM	Coffee Break
3:55 PM	T8: Other Topics
5:10 PM	End of technical sessions

DAY 3
TUESDAY, JUNE 27, 2023

7:30 AM	Women in Engineering Breakfast Vandenberg Room
8:40 AM	T4: Control I
10:20 AM	Coffee Break
10:40 AM	T5: Topologies II
12:20 PM	Lunch
1:30 PM	P1: Devices and Systems
3:05 PM	Coffee Break
3:25 PM	P2: Design and Control
5:00 PM	End of technical sessions
6:30 PM	Banquet University of Michigan Museum of Art
9:00 PM	End of day three

DAY 1
SUNDAY, JUNE 25, 2023

11:00 AM	On site registration opens
1:00 PM	Tutorial: Hybrid Switched Capacitor Converter Design and Modeling
3:00 PM	Coffee Break
	Tutorial continued
5:00 PM	Welcome Reception Circ Bar, Lounge & Roof Deck

DAY 2
MONDAY, JUNE 26, 2023

9:00 AM	Welcome from COMPEL General Chair
9:20 AM	Plenary
10:00 AM	Coffee Break
10:20 AM	T1: Topologies I
12:25 PM	Lunch
1:30 PM	T2: Components I
3:35 PM	Coffee Break
3:55 PM	T3: Grid Interactive
5:10 PM	End of technical sessions

GENERAL INFORMATION

Official Language
English

Registration Desk Hours
- **Sunday, June 25, Meeting venue (Michigan League): 11:00 AM - 4:00 PM**
- **Monday June 26, Meeting venue (Michigan League): 8:00 AM - 2:00 PM**
- **Tuesday June 27, Meeting venue (Michigan League): 8:00 AM - 2:00 PM**
- **Wednesday June 28, Meeting venue (Michigan League): 8:00 AM - 2:00 PM**

Internet/WIFI
WIFI is available for all attendees. Use MGuest and follow the prompt for an email address - no password is required.

Badges
Badges must be visibly worn at all times. You will not be allowed to enter the workshop sessions, the welcome cocktail and dinner locations without your badge.

Coffee Breaks and Lunches
Coffee breaks and lunches will be served to registered participants wearing their badges.

Certificate of Attendance
Certificates will be sent by email upon request to ece-compel2023@umich.edu after the workshop.

Persons with Special Needs
Every effort has been made to ensure that people with special needs are catered to. Should you require any specific assistance, please let us know.

Emergency Numbers
Emergency 911

Photo: Brad West

CONFERENCE SOCIAL EVENTS

The Circ Bar

UMMA

Welcome Reception

Sunday, June 25, 2023
The Circ Bar, 210 S 1st St, Ann Arbor, MI 48104
5:00 - 7:00 PM EDT

Light hors d'oeuvres will be offered, along with two drink tickets per guest. The bar will be open as a cash bar should guests want to purchase additional beverages.

Parking: metered street parking is available on surrounding side streets. A parking garage is located at 215 W. Washington St. and another lot is located at 415 W. Washington St.

Banquet

Tuesday, June 27, 2023
University of Michigan Museum of Art (UMMA), 525 S. State St
6:30 PM - cocktail hour
7:00 PM - dinner service begins
7:30 PM - awards and remarks
8:00 PM - dessert and gallery viewing

The event will take place in the Lizzie and Jonathan Tisch Apse. UMMA is within walking distance of the Michigan League.

Parking: metered parking is available on surrounding side streets. A public parking garage is located at 324 Maynard St., approximately three blocks from the museum. UMMA is within walking distance of the conference venue and North Quad dorm complex.

COMPEL 2023 PROGRAM

Sunday, June 25, 2023
1:00 - 4:00 PM
Michigan League Ballroom
Tutorial

A general approach for design optimization of high performance hybrid switched capacitor converters

Presenters:

- **Prof. Robert Pilawa-Podgurski**, Associate Professor, University of California-Berkeley
- **Nathan Brooks**, PhD Candidate, University of California-Berkeley
- **Samantha Coday**, PhD Candidate, University of California-Berkeley
- **Dr. Nathan Ellis**, Post-Doctoral Researcher, University of California-Berkeley
- **Rose Abramson**, PhD Student, University of California-Berkeley

Contact information:

[pilawa, nathanbrooks, scoday, nathanmilesellis, rose_abramson]@berkeley.edu

Abstract:

This tutorial will cover the design, optimization and implementation of hybrid switched capacitor (SC) converters. First, a motivation for why hybrid SC converters are suitable solutions for power dense and efficient power delivery will be covered. A general introduction to hybrid SC analysis will be reviewed, including charge flow analysis and general topology comparison. Next, a novel approach to the optimization of hybrid SC converters will be introduced, which allows designers to minimize the volume of their converter while operating both at-resonance and above-resonance. Motivation for operating above resonance will be discussed and experimental hardware results will be used to help motivate the described operations. Throughout the tutorial example designs will be utilized to showcase the utility of the presented methodology, for a wide range of applications including: space applications and data centers. These examples will also showcase some of the practical implementation challenges and proposed solutions for high-performance design. Finally, general figures of merit and key takeaways will be summarized for designers' consideration.

continued on page 8...

Detailed Tutorial Outline:

I. Introduction
- A. Benefits of hybrid SC converters
- B. Motivation of operation at and above resonance

II. Hybrid SC analysis at resonance
- A. Introduction to hybrid SC converter topologies
- B. Charge flow analysis
- C. Introduction to the Energy Method (at resonance)

III. Optimization of converters at resonance
- A. Volume optimization
- B. Mass optimization

IV. Example 1: Capacitively Isolated Dickson for Space Applications (20 min)

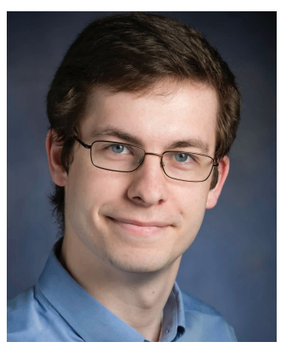
V. *Break (30 min)*

VI. Above Resonance Operation
- A. Motivation
- B. Above Resonance analysis
- C. Optimization above resonance

VII. Example 2: FCML converter above resonance (20 min)

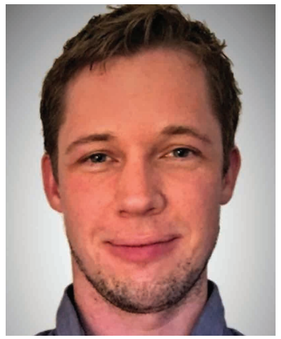
VIII. Topology Comparisons
- A. Introduction to switch stress metric
- B. Topology comparison using switch stress and minimized passive volume

Biographies:



• **Robert Pilawa-Podgurski** is currently an Associate Professor in the Electrical Engineering and Computer Sciences Department at the University of California, Berkeley. He received his BS, MEng, and PhD degrees from MIT. His research interests include renewable energy applications, electric vehicles, energy harvesting, CMOS power management, high density and high efficiency power converters, and advanced control of power converters. Dr. Pilawa-
Podgurski received the Google Faculty Research Award in 2013, and the 2014 Richard M. Bass Outstanding Young Power Electronics Engineer Award of the IEEE Power Electronics Society, given annually to one individual for outstanding contributions to the field of power electronics before the age of 35. In 2015, he received the AFOSR Young Investigator Award, the UIUC Dean's Award for Excellence in Research in 2016, and the UIUC ECE Ronald W. Pratt Faculty Outstanding Teaching Award in 2017. In 2018, he received the IEEE Education Society Mac E. Van Valkenburg Award, for outstanding contributions to teaching unusually early in his professional career. From 2014 to 2019, he served as Associate Editor for IEEE Transactions on Power Electronics, and for IEEE Journal of Emerging and Selected Topics in Power Electronics. He is co-author of thirteen IEEE prize papers.

• **Nathan Brooks** received his B.S. degree from Rose-Hulman Institute of Technology in 2016 and M.S. degree from University of Illinois at Urbana-Champaign in 2018 both in Electrical Engineering. He is currently pursuing his Ph.D. degree in Electrical Engineering at the University of California,



Berkeley. His research interests include high density single-phase multi-level power converters with emphasis on control and hardware optimization, modeling and simulation, and passive component characterization.

• **Samantha Coday** is a PhD candidate at University of California, Berkeley, advised by Dr. Robert Pilawa-Podgurski. Samantha received her Bachelor's degree in Electrical Engineering and Mathematics, in 2017, from Southern Methodist University. She then completed her Masters in 2019, at UC Berkeley. Her current research interests are in the design of light-weight multilevel switched capacitor power converters with applications in aerospace. Samantha has been selected as a 2021 EECS Rising Star, a Cadence Women in Technology Scholarship winner and an Outstanding Graduate Student Instructor.

• **Nathan M. Ellis** received the B.S. degree in Electrical and Electronic Engineering from the University College Cork, Ireland, in 2013, and the M.S. and Ph.D degrees in Electrical and Computer Engineering from the University of California, Davis in 2017 and 2020 respectively. During this time he was funded in part by both Texas Instruments and the U.S. Dept. of Education in recognition of research excellence in areas of national need. He is currently a Post-Doctoral Researcher at the University of California, Berkeley within the Department of Electrical Engineering and Computer Sciences. He is an author on over 30 journal and conference publications and holds four U.S. patents. His research interests include Mixed Signal Integrated Circuit Design, Energy Harvesting, Renewable Energy Integration, Biomedical Devices, and spans several topics in high performance power converter design, including; Hybridized Switched- Capacitor Power Converters, Multi-Level Converters, and Adiabatic Gate-Drives. Dr. Ellis was named Best Graduate Researcher by UC Davis' Industrial Affiliates in 2017, and he received the title of Analog Devices Outstanding Student Designer at the International Solid-State Circuits Conference (ISSCC) in 2020. He is an author on four IEEE prize papers.

• **Rose Abramson** received the B.S. and M.Eng degree in Electrical Engineering from Massachusetts Institute of Technology, Cambridge, MA in 2015 and 2016, respectively. After graduating, she worked at an EV startup developing power systems and drivetrains, and then at Lutron Electronics, Inc. developing offline LED drivers. She is currently pursuing her Ph.D. in Electrical Engineering at the University of California, Berkeley. Rose is a 2019 NDSEG Fellow and a recipient of the 2021 IEEE Joseph John Suozzi INTELEC Fellowship Award in Power Electronics. Her research focus includes hybrid and resonant switched-capacitor circuits and high-performance DC-DC conversion for data center applications.

PLENARY SPEAKER
MONDAY, JUNE 26, 2023, 9:20 - 10:00 AM

Anna Stefanopoulou
University of Michigan

Title:

Abstract:

Bio: Prof. Anna Stefanopoulou, the William Clay Ford Professor of Technology and Professor of Mechanical Engineering and Electrical Computer Engineering at the University of Michigan is a Fellow of the ASME (08), IEEE (09), and SAE (18) and has been recognized in her field with multiple awards. She was an elected member of the Executive Committee of the ASME Dynamics Systems and Control Division and the Board of Governors of the IEEE Control Systems Society, the Founding Chair of the ASME DSCD Energy Systems Technical Committee She was the Director of the UM Energy Institute (2018-2020) and the Director of the Automotive Research Center, a multi-university U.S. Army Center of Excellence in Modeling and Simulation of Ground Vehicles (2009-2018). Before Michigan, she was an assistant professor at the University of California, Santa Barbara, a visiting professor at ETH, Zurich, and a technical specialist at Ford.

Coffee Break 10:00 - 10:20 AM, Michigan League Concourse

T1: Topologies I

Chair: ????

Time	Nº	Paper	Title	Authors
10:20 AM	T1.1	97	48 V to 1 V Active-Clamp Stacked Direct Forward Converter	Shivangi Sinha, Branko Majmunovic and Dragan Maksimovic
10:45 AM	T1.2	98	A 48-V-to-1-V Switching Bus Converter for Ultra-High-Current Applications	Yicheng Zhu, Ting Ge, Nathan Ellis, Jiarui Zou and Robert Pilawa-Podgurski
11:10 AM	T1.3	48	High-Conversion Ratio Multi-Phase VRM Realized with Generic Modular Series-Capacitor-Boost Cells	Eli Hamo and Mor Peretz
11:35 AM	T1.4	66	Wide-Range Switched-Mode Power Amplifier Architecture	Xin Zan, Khandoker N Rafa Islam and David J. Perreault
12:00 PM	T1.5	83	Wideband Push-Pull Class E Amplifier for RF Power Delivery	Zikang Tong and Juan Rivas

Lunch 12:25 - 1:30 PM, Michigan League Ballroom

T2: Components I

Chair: ????

Time	Nº	Paper	Title	Authors
1:30 PM	T2.1	87	Merged Switched-Capacitor Piezoelectric-Resonator Based DC-DC Converter with Wide Voltage Conversion Ratio	Qijia Li, Yuetao Hou and Khurram Afridi
1:55 PM	T2.2	70	Flexible Lightweight Hybrid Switched-Capacitor-Transformer Power Converter for an Untethered Multi-Actuator Piezoelectric Soft Robot	Hsin Cheng, Zhiwu Zheng, Prakhar Kumar, Yenan Chen, Jaeil Baek, Ben Kim, Sigurd Wagner, Naveen Verma, James Sturm and Minjie Chen
2:20 PM	T2.3	51	Piezoelectric Transformer Component Design for DC-DC Power Conversion	Elaine Ng, Jessica D. Boles, Jeffrey H. Lang and David J. Perreault
2:45 PM	T2.4	32	STATE-SPACE CONTROL OF A MIMO H-BRIDGE-BASED SWITCHING DRIVER WITH ENERGY RECOVERY FOR MEMS ACTUATORS	Matteo Gianollo, Raffaele Enrico Furceri, Marco Zamprogno and Giacomo Langfelder
3:10 PM	T2.5	115	Class-E Power Amplifier using a Vertically Stacked Piezoelectric Transformer	Yuetao Hou, Meera Garud, Amit Lal and Khurram Afridi

Coffee Break 3:35 - 3:55 PM, Michigan League Concourse

T3: Grid Interactive

Chair: ????

Time	Nº	Paper	Title	Authors
3:55 PM	T3.1	69	A Grid Frequency and Voltage Agnostic Start-up Technique for Cascaded H-bridge Converters	Rahul Mallik and Brian Johnson
4:20 PM	T3.2	61	Frequency Synchronization of Grid-forming Inverters Under Fault Conditions and Overloading	Nathan Baeckeland and Gab-Su Seo
4:45 PM	T3.3	18	Multi-Frequency Power-Channel Power-Packet Networks	Wayne Weaver, Trever Hassell, David Wilson and Rush Robinette III

Photo: Mitch Hodiono

Women in Engineering Breakfast, 7:30 - 8:15 AM, Vandenberg room, Michigan League

T4: Control I

Chair: ????

Time	Nº	Paper	Title	Authors
8:40 AM	T4.1	74	A Combined Power Factor Correcting and Active Voltage Balancing Control Technique for Buck-Type AC/DC Grid-Tied Flying Capacitor Multi-Level Converters	Roderick Bayliss III, Nathan Brooks and Robert Pilawa-Podgurski
9:05 AM	T4.2	95	Improved Adaptive Feedback Control for a High-Power-Density Transformer-Less Online UPS	Maida Farooq and Khurram Afridi
9:30 AM	T4.3	80	Comparison of Voltage Balance and State Estimation Dynamics for Hybrid Switched-Capacitor Converter Topologies	Kishalay Datta and Jason Stauth
9:55: AM	T4.4	96	Closed-Loop Split-Phase Control Applied to the Symmetric Dual Inductor Hybrid (SDIH) Converter	Nathan Ellis, Haifah Sambo and Robert Pilawa-Podgurski

Coffee Break 10:20 - 10:40 AM, Michigan League Concourse

T5: Topologies II

Chair: ????

Time	Nº	Paper	Title	Authors
10:40 AM	T5.1	108	A Composite Converter Based Automotive LED Driver	Chandan Suthar, Inder Kumar Vedula, Vahid Yousefzadeh, Montu Doshi and Dragan Maksimovic
11:05 AM	T5.2	113	Novel Switched Capacitor DC-DC Converter Achieving Highest Rational Conversion Ratios Using Inter-stage Feedback	Nagesh Patle and Bibhudatta Sahoo
11:30 AM	T5.3	81	Averaged Switch Modeling of Multi-Inductor Hybrid Converters	Ratul Das and Hanh-Phuc Le
11:55 AM	T5.4	88	Adaptive Frequency Control of Bidirectional Class-E^2 Converter for Energy Storage Applications	Kamlesh Sawant and Jungwon Choi

Lunch 12:20- 1:30 PM, Michigan League Ballroom

P1: Devices and Systems

1:30 - 3:05 PM

Chair: ????

Nº	Paper	Title	Authors
P1.1	9	Scalable High-Power Battery Emulator for Power Hardware-in-the-Loop Applications	Bar Halivni, Daniel Beniaminson, Lee Maman, Adi Yankovich, Michael Evzelman and Mor Mordechai Peretz
P1.2	25	An Enhanced Discrete State Event Driven Simulation Framework for Railway WPT System	Shengyu Jia, Zhengming Zhao, Bochen Shi, Han Xu, Xuancen Wu, Zhujun Yu and Yikang Xiao
P.1.3	26	Design and Stability Analysis of Control System in Multiport Autonomous Reconfigurable Solar Power Plants (MARS)	Qianxue Xia, Suman Debnath, Phani Ratna Vanamali Marthi and Maryam Saeedifard
P1.4	28	Automation of High-Frequency Magnetic Core Loss Data Collection	Jacob Anderson and Mike Ranjram
P1.5	30	Multi-frequency Small-Signal Model of Single Phase Diode Rectifier	Han Mu and Dongsheng Yang
P1.6	33	Robust Double Grid Forming Controller of Multi-Modular Converters in a Hybrid AC/DC Grid	Eder Baron-Prada, Adolfo Anta, Florian Dörfler and Markus Makoschitz
P1.7	34	Wave Energy Converter Direct Drive Power-Take-Off Power Electronic Design to Maximize Power Production	Madelyn Veurink, Wayne Weaver and David Wilson
P1.8	37	Common Mode Current Resilient Solid State Transformer Architecture Design and Model Development	Timothy Donnelly and Lee Rashkin
P1.9	38	High-k Dielectric Assisted Trench Termination of the 4H-SiC Super Junction Device for Improved Avalanche Capability	Qiyue Zhu
P1.10	39	Voltage-power Relationship for DRU-HVDC Connected OWF System	Chengqi Zhang and Dongsheng Yang
P1.11	41	FPGA-based Modular DC Chopper Model for Real-time Simulation and HIL Tests	Zerui Dong and Wei Li
P.1.12	47	Fault-tolerant magnetic coupling topology for network parallel multilevel inverters	Rita Mattar and Marwan Ali
P1.13	55	A Method to Detect Man in the Middle Attack (MiTM) on a Grid Following PV System Powered by a Commercial Inverter	Faris Alotaibi, Hasan Ibrahim, Jaewon Kim and Prasad Enjeti
P1.14	56	A Robust Vector Control of Permanent Magnet AC Machines Resilient to Parameter	Ali Najmabadi, Kishan Srinivasan and Heath Hofmann
P1.15	57	Fidelity Analysis of Complex Large-Scale Simulation Models of PEs (MARS) in Future Power Grids	Phani R V Marthi, Suman Debnath and Qian Xue Xia
P1.16	58	Comparative Study of Online Loss Estimators Based on Electrical and Thermal Models for AC Permanent Magnet Machines	Yuanying Wang, Jake Chung, Ziyou Song, Fanny Pinto Delgado, Heath Hofmann, Jing Sun and Ali Najmabadi
P1.17	59	Robust Power Electronic Circuit Models with Accurate Loss Estimation	Kishan Srinivasan, Heath Hofmann and Jing Sun
P1.18	60	Interpolation Methods to Enable Fast and Accurate EMT Simulation of PV Inverters	Phani R V Marthi, Suman Debnath and Jongchan Choi
P1.19	67	Thermal evaluation of SiC/GaN Hybrid Active Neutral Point Clamp (ANPC) employing wide band gap devices for electric vehicle traction applications	Erick Pool-Mazun, Ankit Vivek Deshpande, Enrique Garza-Arias and Prasad Enjeti
P1.20	71	Assessment of FBG Sensor Installation Impact on IGBT Chip Electric Potential	Shiying Chen and Damian Vilchis-Rodriguez
P1.21	72	Cosimulation Approach for Transient Analysis and Inductor Design of DC-DC Buck Converters	Faraj Alyami, Pablo Gomez and Jean Cedric Gnamien
P1.22	75	Control of DC Microgrid based flexible cold-rolling steel mill Plant – an application of grid supporting rectifier	Naresh N Nandola, Biqi Wang, Xiaofan Wu and Rolando Burgos
P1.23	78	Design and Comparative Evaluation of a Capacitor Coupled DC/DC Converter for MV Solid-State Transformer Applications	Kamlesh Sawant and Jungwon Choi
P1.24	86	Direct In-situ Measurement of Inductor Core Loss under Rectangular Voltage Excitation in Power Electronic Circuits	Lifang Yi and Jinyeong Moon

P1: Devices and Systems | 1:30 - 3:05 PM

continued...

P1.25	99	SSR Stable Wind Speed Range Analysis for Hybrid Wind Farms Through Two-variable Admittance Modeling	Chengmao Du, Xiong Du, Xiaoming Zou, Junliang Liu and Ziming Qiu
P1.26	102	Active Current Limiting Control for Half-bridge MMC in HVDC Systems under Pole-to-Pole Fault Conditions	Pengxiang Huang and Shahil Shah
P1.27	107	Comparative Evaluation of DC-link Capacitor RMS current stress for conventional and Reduced Common Mode Voltage SVPWM based Inverters	Akbar Ali Khan, Nauman Ahmad Zaffar and Muhammad Jahangir Ikram
P1.28	120	Adaptive voltage control of grid-forming inverters	Jorge Rodrigo Massing, Márcio Stefanello, Hilton Abílio Gründling and Humberto Pinheiro

Coffee Break, 3:05 - 3:25 PM, Michigan League Concourse

P2: Design and Control

3:25 - 5:00 PM

Chair: ????

Nº	Paper	Title	Authors
P2.1	11	Analysis and Design of Finite Input Inductance Class-E Inverters with Variable Complex Loads	Yufei Wang, Min Sun, Dongsheng Cai, Jian Li, Qi Huang and Siming Pan
P2.2	22	The ΔV-Method: An Intuitive Method for Analyzing Soft-Charging Capabilities of Hybrid Switched-Capacitor DC-DC Converters	Markus Henriksen, Jens Otten, Adrian Gehl and Bernhard Wicht
P2.3	23	Interleaving Boost Extender Topology	Vikas Kumar Rathore, Michael Evzelman and Mor Mordechai Peretz
P2.4	24	Assessment of Cost Factors Impacting Planar Magnetic Windings	Emmanuel Havugimana, Sakib Ahmed and Mike K. Ranjram
P2.5	29	Piecewise Analytical Transient Model of SiC MOSFET and SiC Schottky Diode Pair	Yikang Xiao, Zhengming Zhao, Bochen Shi, Zhujun Yu, Shengyu Jia and Shiqi Ji
P2.6	31	Optimum Turn-to-turn Distance for Minimizing Parasitic Capacitance in Round-cable-based Inductors	Hongbo Zhao, Zhixing Yan, Shaokang Luan, Alireza Namadmalan, Ziwei Ouyang and Maeve Duffy
P2.7	42	Normalized Benchmarking of Hybrid Switched-Capacitor DC-DC Converters	Gael Pillonnet, Mahmoud Kamel and Patrick Mercier
P2.8	44	A DC-Bus Planar Rogowski Coil Based Current sensor for Half-Bridge Applications	Matthias Spieler, Che-Wei Chang, Muhammad Alvi, Ayman El-Refaie, Dong Dong and Rolando Burgos
P2.9	46	Modular Series Capacitor Buck Topology for Point of Load Applications with Duty Cycle Freer Circuit	Peng Fang and Zhichun Wang
P2.10	63	Highly-Scalable Differential Power Processing Architecture for On-Vehicle Photovoltaics	Michael Solomentsev and Alex Hanson
P2.11	64	A Simple, High-Speed Measurement Technique for Dynamic on-resistance of GaN Devices for Hard-Switched Pulsed Power Applications	Soham Roy, Chenmin Deng and Alex Hanson
P2.12	68	Design and Optimization of a High Gravimetric Power Density Receiver for Wireless Charging of Drones	Arka Basu, Kody Froehle and Daniel Costinett
P2.13	73	A 48-to-1 V LLC DC Transformer	Xufu Ren and Teng Long
P2.14	79	Autotuning of Resonant Switched-Capacitor Converters for Zero Voltage Switching Operation	Haifah Boureima H Sambo, Yicheng Zhu and Robert Carl Nikolai Pilawa-Podgurski
P2.15	84	Improving the Dynamic Performance of Bridgeless PFC Controllers with Zero Crossing Detector and Root-Mean-Square Calculation Blocks	Alberto Pigazo, Francisco J. Azcondo, Christian Brañas, Paula Lamo, Rosario Casanueva and F. Javier Diaz
P2.16	89	Flying Capacitor Four-Level Supply Modulator with Active Balancing for RF Power Amplifier Applications	Aarranon Bharathan, Audrey Cheshire and Dragan Maksimovic
P2.17	90	Unified Sliding-Mode Control of Non-Inverting Buck-Boost Converter	Shubham Narula, Luca Corradini and Dragan Maksimovic
P2.18	91	A Miniaturized Platform for a Modular High-Voltage Electrostatic Actuator Driver	Yanqiao Li, Bahlakoana Mabetha and Jason Stauth

P2: Design and Control | 3:25 - 5:00 PM

continued...

P2.19	93	Improvement of Magnetic Energy Harvesting via Desaturation	Min Gao, Lifang Yi and Jinyeong Moon
P2.20	101	Power Converter and Discrete Device Optimization Utilizing Discrete Time State-Space Modeling	Jared Baxter and Daniel Costinett
P2.21	103	A Selection Guide on High-AC/Low-DC Voltage Modular Multi-Cell Converters	Jayesh Kumar Motwani, Jian Liu, Dushan Boroyevich, Rolando Burgos and Dong Dong
P2.22	104	Improved Burst Mode Operation for DAB Converters to Achieve ZVS in Full-Load-Range by Considering Device Voltage Oscillation	Cheng Huang, Tomoyuki Mannen and Takanori Isobe
P2.23	109	Resonant Gate Drive for High Frequency Active-Bridge Power Converters	Udit Pratap Singh Tanwar, Chandan Suthar, Phyo Aung Kyaw, Inder Kumar Vedula and Dragan Maksimovic
P2.24	110	Steady-State Analysis of Series-Capacitor Buck Converters in Discontinuous Capacitor Voltage Mode	Nathan Biesterfeld, Yicheng Zhu, Rahul Iyer, Nathan Ellis and Robert Pilawa-Podgurski
P2.25	112	The Flying Capacitor LLC Converter: A Hybrid Switched Capacitor Converter with Galvanic Isolation for Large Step-Down Applications	Logan Horowitz, Nathan Brooks, Nathan Ellis and Robert Pilawa
P2.26	114	A Generalized Current Balancing Control for Series-Capacitor Buck Converter with Interleaved Phase Angle	Chung-Yi Li, Li Lin and Hung-Chi Chen
P2.27	116	Stacked Inverter Architecture for High-Frequency Capacitive Wireless Charging Systems	Dheeraj Etta, Sounak Maji, Yuetao Hou and Khurram Afridi
P2.28	117	High Performance Synchronous Resistance Compression Network-based Resonant DC-DC Converter Utilizing Matching Network	Firehiwot Gurara and Khurram Afridi

COMPEL Banquet, 6:30 - 9:00 PM, University of Michigan Museum of Art

T6: Systems Interactions

Chair: ????

Time	Nº	Paper	Title	Authors
8:40 AM	T6.1	49	Impedance-Based Modeling and Stability Analysis of the Input-Series Output-Parallel DAB3 Converter with Decentralized Control	Amandus Bach, Jan Mathé, Benedict J. Mortimer and Rik W. De Doncker
9:05 AM	T6.2	17	A Framework for Optimizing Multilevel AC Battery Energy Storage Systems	Alireza Ramyar, Jason B. Siegel, Anna G. Stefanopoulou and Al-Thaddeus Avestruz
9:30 AM	T6.3	3	Measurement of Unified Admittance Model for Three-Phase System by Two-Phase Excitations in the Sequence Domain	Toshiji Kato, Kaoru Inoue and Yoshiki Miwa
9:55 AM	T6.4	7	Stability Analysis of a Grid-Forming Inverter by Complex Vector Theory	Toshiji Kato, Kaoru Inoue, Ko Oue, Daiki Yamashita and Kosei Watanabe
10:20 AM	T6.5	94	A Nonlinear Decentralized Control strategy to ensure Power Sharing for IPOP DC-DC Converters	Pushkar Saraf and Alex Hanson

University of Michigan Technical Tour

10:45 AM - 1:15 PM

Grab a boxed lunch and get onto the bus at Michigan League

BUS ONE	BUS TWO	BUS THREE
MCity	**Ford Motor Company Robotics Building**	**Electrical Engineering and Computer Science Building**
Max capacity*: 45	Max capacity: 70	Max capacity: 60
Autonomous vehicle test facility	Robotics Labs; Wilson Center team workspace	Lurie Nanofabrication Facility; Power and Energy lab
*Pre-registration for MCity was required prior to the start of the conference		

UNIVERSITY OF MICHIGAN TECHNICAL TOUR
WEDNESDAY, JUNE 28, 2023

About the COMPEL 2023 Technical Tour Options:

MCity *(pre registration was required to attend due to capacity limitations)*

Mcity operates the world's first purpose-built proving ground for testing the performance and safety of connected and automated vehicles and technologies under controlled and realistic conditions.

Testing new technologies in a safe, controlled environment is essential before deploying automated vehicles on public streets, roads, and highways. The Mcity Test Facility sits on a 32-acre site on U-M's North Campus, with more than 16 acres of roads and traffic infrastructure. The full-scale outdoor laboratory simulates the broad range of complexities vehicles encounter in urban and suburban environments, and provides the connected infrastructure and operating system to serve as a smart city test bed.

Features include:
- State-of-the-art instrumentation and sensors throughout the facility include a control network to collect data about traffic activity using wireless, fiber optics, Ethernet, and a highly accurate real-time kinematic positioning system
- Patent-pending augmented reality testing technology allows physical test vehicles to interact with virtually connected vehicles in real time inside the facility
- Fully connected 5G network and vehicle-to-everything (V2X) communication throughout the facility
- Facility infrastructure and testing conditions can be controlled with our Mcity OS cloud-based software
- Multiple road surfaces, variety of road markings and crossing types (e.g. pedestrian, railroad)
- 1,000-foot straightaway, plus access ramps, curves, roundabout, traffic circle, and urban streets
- Traffic signals and traffic signs, plus building facades and simulated tree cover
- House and garage exterior with accessibility ramp for first-mile/last-mile testing, deliveries, and ride hailing
- Bridge deck, underpass, guardrails, barriers, and crash attenuators
- Onsite workstation and configurable open test areas
- Test vehicles and support available

Ford Motor Company Robotics Building; Wilson Center Team Workspace

FMCRB: Michigan Robotics aims to create a collaborative community of roboticists, where through mutual respect, integrity in action, and transparency in thought, we accelerate socially beneficial advances in robotics.

The Ford Motor Company Robotics Building is a new national centerpiece in robotics research, learning, and collaboration. Opened in 2021, the Ford Robotics building is the home of Michigan Robotics. The 134,000-square-foot, four-story complex houses classrooms, offices, a cafe, and a startup-style open collaboration area and tailored lab space for a variety of robotic technologies.

A few highlights include:
- Three-story fly zone for autonomous aerial vehicles
- An outdoor obstacle course for walking robots
- High-bay garage space for self-driving cars
- A rehabilitation lab with a Stewart platform, force plates, and dual-tread treadmill
- A robotics maker space with CNC, 3D printers, soldering irons, and other shop tools
- An outdoor Mars Yard with imitation martian rocks and soil for testing rovers
- Earned Gold LEED Certification for its construction and design

And in a unique agreement, Ford leases the fourth floor to perform robotics research and engineering in collaboration with U-M and other industry leaders.

Wilson Center Team Workspace:

The practice of engineering is and will continue to be characterized by groups of individuals working in diverse teams to find creative solutions to a variety of problems. One of the best ways for the College of Engineering students to gain critical hands-on design experience as well as important team, organizational, and management skills is through engineering design/build competitions. Student team projects provide practical design fabrication experience that complements classroom instruction in addition to real-life lessons in cooperation.

The Walter E. Wilson Student Team Project Center meets a critical need by providing students with dedicated space and facilities for teams to compete nationally and internationally.

This 20,000-square-foot center, located behind the François-Xavier Bagnoud Building and adjacent to Maya Lin's Wave Field, represents multiple renovation commitments on the part of the College of Engineering, the University of Michigan, and numerous sponsors and donors. A bequest from Walter E. Wilson to the College provided the financial foundation for the original space in 1999, while Vincent T. and Gloria M. Gorguze made it possible to double the size of the original Center in 2010.

The result is a $10-million facility for design, assembly, machining, electronics, and painting. A design room, a lecture room and a student lounge round out the Wilson Center, which is accessible to students 24 hours a day, 7 days a week.

Electrical Engineering and Computer Science

Lurie Nanofabrication Facility (LNF):

The Lurie Nanofabrication Facility serves technology educators and creators through broad access to advanced nanofabrication equipment and staff expertise in a safe, collaborative environment. We enable multi-disciplinary research, experiential learning, and co-operation with industry to advance cutting-edge technologies.

The LNF is available, on a fee basis, for use by research groups from government, industry and universities. Equipment and processes are available for research on silicon integrated circuits, MEMS, III-V compound devices, organic devices and nanoimprint technology. We also encourage researchers from non-traditional disciplines to make use of our processes, such as metal and dielectric coatings, vacuum processes, fabrication of micro and nano components and metrology tools.

Power and Energy Lab:

New opportunities in electrical energy and power systems are arising with advances in materials, communications, computation, and control. Students and faculty are investigating energy conversion systems where enhanced performance of electrical machines and power electronics is being exploited to develop a variety of novel applications, from automotive propulsion systems to wind generators. Power systems research is seeking new tools and techniques for improving grid efficiency and robustness. An important aspect of this work is the development of network control strategies for enhancing grid responsiveness, and enabling greater levels of renewable generation.

T7: Modulation

Chair: ????

Time	Nº	Paper	Title	Authors
1:30 PM	T7.1	4	Switching Frequency is Not the Limit: Multiphase Coupled Inductor FCML Converter Tracking Signals Above the Switching Frequency	Daniel Zhou and Minjie Chen
1:55 PM	T7.2	8	Digital Control and Phase Governing of Interleaved Multistage Hybrid Boost Capacitor Charger for Improved Efficiency and Power Density	Daniel Beniaminson, Bar Halivni, Michael Evzelman and Mor Mordechai Peretz
2:20 PM	T7.3	54	Partial Phase Overlap Control for Single-Stage 48 V Series Capacitor Buck Converter	Adhistira Naradhipa and Qiang Li
2:45 PM	T7.4	100	Modulation Improvements for Series-Capacitor Buck Converters under High Step-Down Conversion Ratios	Gianluca Roberts and Aleksandar Prodic
3:10 PM	T7.5	106	An Active Split-Phase Control Technique for Hybrid Switched-Capacitor Converters Using Capacitor Voltage Discontinuity Detection	Rose Abramson, Sahana Krishnan, Margaret Blackwell and Robert Pilawa-Podgurski

Coffee Break, 3:35 - 3:55 PM, Michigan League Concourse

T8: Other Topics

Chair: ????

Time	Nº	Paper	Title	Authors
3:55 PM	T8.1	10	Accurate Temperature Measurement of Active Area for Wide-Bandgap Power Semiconductors	Alireza Ramyar, Yukun Lou and Al-Thaddeus Avestruz
4:20 PM	T8.2	50	Failure Modes Assessment and Protection Design for a 7-Level 13.8 kV AC 22 kV DC Flying Capacitor Multicell Converter Based On 10 kV SiC MOSFET	Arthur Mendes, David Nam, Xiang Lin, Joshua Stewart, Dong Dong and Rolando Burgos
4:45 PM	T8.3	62	Novel S-Link Enabling Ultra-Compact and Ultra-Efficient Three-Phase and Single-Phase Operable On-Board EV Chargers	David Menzi, Weihe Sven, Jonas Huber, Jon Azurza Anderson, Matthias Joachim Kasper and Johann Kolar