

TABLE OF CONTENTS

Please follow the "Important Instruction for Electronic Proceedings" to change the preference in Adobe Reader so that a new window will be opened after you click the **Blue** paper title to read that paper. After viewing the paper, you can go back to the Table of Content window to continue reading.

Monday, September 30

Session 1: Wind Systems

Chair(s): Qiang Wei, Hengzhao Yang

Remote Monitoring and Diagnostics of Pitch Bearing Defects in a MW-Scale Wind Turbine using Pitch Symmetrical-component Analysis	1
Lijun He ¹ , Liwei Hao ¹ , Wei Qiao ²	
¹ GE Research, United States; ² University of Nebraska-Lincoln, United States	
LVRT Control of Back-to-Back Power Converter PMSG Wind Turbine Systems: An FPGA based Hardware-in-the-Loop Solution	7
Zhenkun Zhang ¹ , Zhenbin Zhang ¹ , Xiaodong Liu ¹ , Quanrui Hao ¹ , Zhiwei Zhang ²	
¹ Shandong University, China; ² The Ohio State University, United States	
Maximum Power Point Tracking for Wind Turbine using Integrated Generator-Rectifier Systems	13
Phuc Huynh, Samira Tungare, Arijit Banerjee	
University of Illinois Urbana-Champaign, United States	
Simple Empiric Root-Mean-Square Electric-Drivetrain Model for Wind Turbines with Full-Size Converter	21
Daniel von den Hoff, Denise Cappel, Abdul Baseer, Rik W. De Doncker, Ralf Schelenz	
RWTH Aachen University, Germany	
Session 2: Grid-Forming Converters	
Chair(s): Xiongfei Wang, Yanan Chen	
Small-Signal Modeling, Stability Analysis, and Controller Design of Grid-Friendly Power Converters with Virtual Inertia and Grid-Forming Capability	27
Deng Han ¹ , Jingyang Fang ¹ , Jiale Yu ¹ , Yi Tang ¹ , Vincent Debusschere ²	
¹ Nanyang Technological University, Singapore; ² Grenoble Institute of Technology, France	
Transient Stability Analysis of Droop-Controlled Grid-Connected Converters with Inertia Emulating Low-Pass Filters	34
Donghua Pan ¹ , Xiongfei Wang ¹ , Fangcheng Liu ² , Rongliang Shi ²	
¹ Aalborg University, Denmark; ² Huawei Technologies Co., Ltd., China	
Active Power Reserve Control for Grid-Forming PV Sources in Microgrids using Model-based Maximum Power Point Estimation	41
Zhe Chen, Robert H. Lasseter, Thomas M. Jahns	
University of Wisconsin-Madison, United States	

An Optimized Virtual Synchronous Generator Control Strategy for Power Decoupling in Grid Connected Inverters	49
Yuzhi Zhang, Utkarsh Raheja	
<i>ABB Inc., United States</i>	

Session 3: Converters for HVDC

Chair(s): Hans-Peter Nee, Balanthi Abdul Beig

Hybrid Phase Converter with Enhanced Efficiency and dc Fault Tolerant Capability for HVDC Application	55
Siba Kumar Patro, Anshuman Shukla	
<i>Indian Institute of Technology Bombay, India</i>	

Level-Shift Modulation and Control of a Dual H-bridge Current Flow Controller in Meshed HVDC Systems	62
Wei Liu, Jun Liang, C.E. Ugalde-Loo, Chuanyue Li, Gen Li, Peng Yang	
<i>Cardiff University, United Kingdom</i>	

HVDC Breaker Test Bench based on a Power Converter using Cascaded H-bridge Cells	67
Nikola Krneta, Makoto Hagiwara	
<i>Tokyo Institute of Technology, Japan</i>	

Operation of a Novel Hybrid Modular Multilevel Energy Storage Converter under Fault Condition	75
Wu Zeng, Rui Li	
<i>Shanghai Jiao Tong University, China</i>	

Session 4: Datacenter and Computer Power Supplies

Chair(s): Taesic Kim, Gab-Su Seo

3kW Four-Level Flying Capacitor Totem-Pole Bridgeless PFC Rectifier with 200V GaN Devices	81
Qingyun Huang ¹ , Qingxuan Ma ¹ , Pengkun Liu ¹ , Alex Huang ¹ , Michael de Rooij ²	
¹ University of Texas-Austin, United States; ² Efficient Power Conversion, United States	

A Comparison of Multilevel “Zero Inductor-Voltage” Converters for Data Center Applications	89
Samuel Webb, Tianshu Liu, Yan-Fei Liu	
<i>Queen's University, Canada</i>	

Low-Frequency Input Impedance Modeling of Single-Phase PFC Converters for Data Center Power System Stability Studies	97
Jian Sun ¹ , Mingchun Xu ² , Mauricio Cespedes ² , Mike Kauffman ²	
¹ Rensselaer Polytechnic Institute, United States; ² Facebook, Inc., United States	

Modeling and Analysis of Data Center Power System Stability by Impedance Methods	107
Jian Sun ¹ , Mingchun Xu ² , Mauricio Cespedes ² , David Wong ² , Mike Kauffman ²	
¹ Rensselaer Polytechnic Institute, United States; ² Facebook, Inc., United States	

Session 5: Inductive Power Transfer

Chair(s): Burak Ozpineci, Yue Cao

Time-weighted Average Efficiency Optimization for Reconfigurable IPT System with CC and CV Outputs	117
Ruimin Dai, Ruikun Mai, Zhehui Zhu, Zhengyou He	
<i>Southwest Jiaotong University, China</i>	

Power Factor Correction in EV Charger with Bridgeless Zeta-SEPIC Converter	121
Radha Kushwaha, Bhim Singh <i>Indian Institute of Technology Delhi, India</i>	
Study on Parasitic Capacitance Effect in High Power Inductive Power Transfer System	129
Ying Mei ¹ , Jiande Wu ¹ , Xiangning He ¹ , Hua Zhang ² , Fei Lu ² ¹ Zhejiang University, China; ² Drexel University, United States	
Design of Isolated Gate Driver Power Supply in Medium Voltage Converters using High Frequency and Compact Wireless Power Transfer	135
Van Thuan Nguyen, Bharath G. Veera, Ghanshyamsinh Gohil <i>The University of Texas-Dallas, United States</i>	
Session 6: DC-DC Non-Isolated Converter 1	
Chair(s): Santanu Mishra, Christina DiMarino	
MSP-LEGO: Modular Series-Parallel (MSP) Architecture and LEGO Building Blocks for Non-isolated High Voltage Conversion Ratio Hybrid Dc-Dc Converters	143
Yueshi Guan ^{1,2} , Ping Wang ¹ , Ming Liu ¹ , Dianguo Xu ² , Minjie Chen ¹ ¹ Princeton University, United States; ² Harbin Institute of Technology, China	
Ladder Transformerless Stacked Active Bridge Converters	151
Jianglin Zhu ¹ , Roman Scheuss ² , Dragan Maksimovic ¹ ¹ University of Colorado-Boulder, United States; ² University of Applied Sciences Buchs NTB, Switzerland	
Equilateral Triangle Modular Multilevel Step-Up DC/DC Converter for Offshore Wind Energy Systems	157
Esmail Gandomkar, Hamid Naseem, Jul-Ki Seok <i>Yeungnam University, Republic of Korea</i>	
A Novel High-Gain DC-DC Topology based on Coupled Inductors and Decreased Voltage Stresses on Output Elements	164
Nima Abdolmaleki ¹ , R.A. McCann ¹ , Mohsen Mahmoudi ² , Ali Ajami ² ¹ University of Arkansas, United States; ² Azərbaycan Şahid Mədani University, Iran	
Session 7: AC-DC – Single-Phase	
Chair(s): Brian Cheng, Pritam Das	
A kW Power Factor Corrector using Low-voltage Current Device for Input Current Shaping	171
Chung-Pui Tung ¹ , John Wing-To Fan ¹ , Jeff Po-Wa Chow ¹ , Akhil Relekar ¹ , Wan-Tim Chan ² , Ka-Wai Ho ² , Ke-Wei Wang ¹ , Henry Shu-hung Chung ¹ ¹ City University of Hong Kong, China; ² Mosway Semiconductor Limited, China	
A High-performance 65 W Universal ac-dc Converter using a Variable-Inverter-Rectifier-Transformer with Improved Step-down Capability	179
Intae Moon ¹ , Mike K. Ranjram ¹ , Sombuddha Chakraborty ² , David J. Perreault ¹ ¹ Massachusetts Institute of Technology, United States; ² Texas Instruments, United States	
5-Level Flying Capacitor Bridgeless PFC Converter using Cost-Effective Low-Voltage GaN Transistors	187
Kun Xiong ¹ , Xin Yin ¹ , Sai Tang ¹ , Chao Zhang ¹ , Daming Wang ¹ , Jun Wang ¹ , Zhikang Shuai ¹ , Z. John Shen ² ¹ Hunan University, China; ² Illinois Institute of Technology, United States	

Analyzing and Reducing Current Harmonics of AC and DC sides of Cascaded H-Bridge Converters for Electric Vehicle Charging Stations	193
Amirhossein Moeini, Shuo Wang University of Florida, United States	

Session 8: Multilevel Converter Control

Chair(s): Vito Giuseppe Monopoli, Qing-Chang Zhong

Circulating Current Suppression Control of Modular Multilevel Converters under Optimized Phase Disposition (PD) Modulation	201
Y. Sun ¹ , D. Lyu ¹ , C.A. Teixeira ² , B.P. McGrath ² , D.G. Holmes ² , Q. Wang ¹ ¹ Nanjing Normal University, China; ² RMIT University, Australia	

Strategies for Decoupling Internal and External Dynamics Resulting from Inter-Arm Passive Component Tolerances in HVDC-MMC	209
Shuren Wang ¹ , Grain Adam ¹ , Ahmed Massoud ² , Derrick Holliday ¹ , Barry Williams ¹ ¹ University of Strathclyde, United Kingdom; ² Qatar University, Qatar	

A Generalized Voltage Balancing Algorithm for Modular Multilevel Cascaded Converters	214
Ezequiel Rodriguez ¹ , Glen G. Farivar ¹ , Josep Pou ¹ , Hossein Dehghani Tafti ¹ , Christopher D. Townsend ² , Sergio Vazquez ³ ¹ Nanyang Technological University, Singapore; ² University of Western Australia, Australia; ³ Universidad de Sevilla, Singapore	

Computationally-efficient Hierarchical Optimal Controller for Grid-tied Cascaded Multilevel Inverters	219
Mitchell Easley ¹ , Mohsen Hosseinzadehtaher ¹ , Amin Y. Fard ¹ , Mohammad B. Shadmand ¹ , Haitham Abu-Rub ² ¹ Kansas State University, United States; ² Texas A&M University-Qatar, Qatar	

Session 9: Modulation 1

Chair(s): John Shen, Marcello Pucci

Model Predictive Control with Secondary Objective Functions for Power Module Loss Reduction	225
Luo Cheng Wang ¹ , Tao Han ¹ , Tiefu Zhao ¹ , Jiangbiao He ² ¹ University of North Carolina-Charlotte, United States; ² University of Kentucky, United States	

Fast Detection of Open Circuit Device Faults and Fault-Tolerant Operation of Single-Phase H-Bridge Flying Capacitor Multilevel Converters	232
Parham Hekmati, Z. John Shen, Ian P. Brown Illinois Institute of Technology, United States	

Self-healing Model Predictive Controlled Cascaded Multilevel Inverter	239
Mitchell Easley ¹ , Matthew Baker ¹ , Ahmad Khan ¹ , Mohammad B. Shadmand ¹ , Haitham Abu-Rub ² ¹ Kansas State University, United States; ² Texas A&M University-Qatar, Qatar	

iTHD Improvement for Interleaved Totem-pole CRM PFC	245
Teng Xu, Jinfeng Song, Yuefei Wu, Yajuan Jiang, Zhuang Lin LG Electronic, China	

Session 10: Prof. Bob Lorenz Memorial Session 1

Chair(s): Thomas M. Jahns, Bulent Sarliglu

Analysis of Novel Hybrid-Magnet-Circuit Variable Flux Memory Machines with Different Magnet Arrangements 251

Hui Yang¹, Hao Zheng¹, Heyun Lin¹, Z.Q. Zhu², Jiaying Lei¹, Wei Liu¹, Shukang Lyu¹

¹Southeast University, China; ²The University of Sheffield, United Kingdom

A Methodology of Permanent Magnet Material Selection for Active Magnetization Change 259

Ryoko Imamura, Robert D. Lorenz

University of Wisconsin-Madison, United States

Self-Sensing and Power Conversion Comparison for Flux Weakening Surface Mounted Permanent Magnet Servo Motors Designed using Symmetric and Asymmetric Rotors 267

Huthaifa Mohammad Flieh, Timothy Slininger, Robert D. Lorenz, Shao-Chuan Chien², Li-Hsing Ku²

¹University of Wisconsin-Madison, United States; ²Delta Electronics, Inc., Taiwan

Session 11: Doubly-Fed Electric Machines

Chair(s): Tausif Husain, Renato Lyra

Radial Forces in Brushless Doubly-Fed Machines 275

Peng Han¹, Ming Cheng²

¹University of Kentucky, United States; ²Southeast University, China

Synthesis of Airgap Magnetic Field Modulation Phenomena in Electric Machines 283

Peng Han¹, Ming Cheng²

¹University of Kentucky, United States; ²Southeast University, China

Analysis of Operation Modes and Grid-Connected Control for the Dual-Stator Brushless Doubly Fed Induction Generator 291

Yu Zeng, Ming Cheng, Xinchu Wei

Southeast University, China

An Approach to Maximize Torque Density in a Brushless Doubly-fed Reluctance Machine 298

Shivang Agrawal, Alexander Province, Arijit Banerjee

University of Illinois Urbana-Champaign, United States

Session 12: High-Speed Electric Drives

Chair(s): Shih-Chin Yang, Roberto Petrella

A Real-Time Real-Power DSCC-Based Emulator Capable of Reproducing Both Bending and Torsional Vibrations of a Motor and Load 306

Kenichiro Saito, Hirofumi Akagi

Tokyo Institute of Technology, Japan

Pseudo Six-Step Modulation with Optimal Flux Tracking for Control of High-Speed Permanent Magnet Synchronous Machines (PMSMs) 313

Shangjian Dai¹, Jiabin Wang¹, Zhigang Sun²

¹The University of Sheffield, United Kingdom; ²Rolls-Royce plc, United Kingdom

Comparison of High Speed Permanent Magnet Machine Sensorless Drive using Trapezoidal BLDC and Sinusoidal FOC under Insufficient PWM Frequency	321
Ching-Lon Huang ¹ , Guan-Ren Chen ¹ , Shih-Chin Yang ¹ , Yu-Liang Hsu ²	
¹ National Taiwan University, Taiwan; ² Feng Chia University, Taiwan	

Optimized Flux-Weakening Control with Virtue Voltage Buffer for Saturated High-Speed Induction Motor Drives	326
Zhen Dong ¹ , Zhengtao Ding ¹ , Dianguo Xu ²	
¹ The University of Manchester, United Kingdom; ² Harbin Institute of Technology, China	

Session 13: Diagnostics and Fault Tolerance in Electric Drives

Chair(s): Pinjia Zhang, Antonio J. Marques Cardoso

Reuse of a Damaged Permanent Magnet Synchronous Motor for Torque Ripple and Acoustic Noise Elimination using a Novel Repetitive Observer	334
Mi Tang, Shafiq Odhano, Andrea Formentini, Pericle Zanchetta	
University of Nottingham, United Kingdom	

Wavelet Transformation-Based Diagnosis of Turn-to-Turn Faults in Vector Control Drive system ...	339
Hassan H. Eldeeb ¹ , Haisen Zhao ^{1,2} , Osama Mohammed ¹	
¹ Florida International University, United States; ² North China Electric Power University, China	

Modular 2n-phase Inverter (M2I) Topology with Novel Phase Current Injection Scheme for Fault-tolerant Multiphase Electric Machine Drives	345
Woongkul Lee, Seun Guy Min, Bulent Sarlioglu	
University of Wisconsin-Madison, United States	

Hardware-in-the-loop Simulations of Inverter Faults in an Electric Drive System	353
K.S. Amitkumar, Pragasen Pillay, Jean Bélanger	
¹ Concordia University, Canada; ² OPAL-RT TECHNOLOGIES, Inc. , Canada	

Session 14: SiC Device and Application

Chair(s): Ruxi Wang, Jin Wang

Output Sine-Wave Filter Design and Characterization for a 10 kW SiC Inverter	359
Jan-Kaspar Müller ¹ , Tobias Manthey ¹ , Di Han ² , Bulent Sarlioglu ² , Jens Friebe ¹ , Axel Mertens ¹	
¹ Leibniz Universität Hannover, Germany; ² University of Wisconsin-Madison, United States	

Analysing the Crosstalk Effect of SiC MOSFETs in Half-Bridge Arrangements	367
Ian Laird, Xibo Yuan	
University of Bristol, United Kingdom	

Design of 6.78 MHz SiC MOSFET Class-E Inverter with a Class-Φ High-Speed Driver	375
Haruma Yogi ¹ , Xiuqin Wei ¹ , Hiroo Sekiya ² , Takashi Hikiyama ³	
¹ Chiba Institute of Technology, Japan; ² Chiba University, Japan; ³ Kyoto University, Japan	

An Analog Active Gate Drive Circuit Architecture for Wide Band Gap Devices	380
Ramanujam Ramabhadran ¹ , Maja Harfman Todorovic ¹ , Cong Li ¹ , Erdem Asa ² , Kum-Kang Huh ¹	
¹ GE Global Research, United States; ² Oak Ridge National Lab, United States	

Session 15: Power Device Characterization and Measurement

Chair(s): Mark J Scott, Jun Wang

Characterization of the Delay and Transfer Function of Measurement Equipment for SiC - Power Semiconductors 387

David Reiff¹, Jianghua Feng², Jing Shang², Volker Staudt¹
¹Ruhr University Bochum, Germany; ²CRRC Zhuzhou Institute, China

Impedance Matching Scheme of Electrical Variable Capacitors using SiC MOSFET for 13.56Mhz RF Plasma Systems 392

Beomseok Chae¹, Juhwa Min¹, Yongsug Suh¹, Jinho Kim², Hyunbae Kim²
¹Chonbuk National University, Republic of Korea; ²Samsung Electronics, Republic of Korea

Analysis of PiN Diode Reverse Recovery based on the Field-circuit Couple Modeling 399

Mingyang Wang, Zipeng Liang, Mufeng Xiong, Shaoxing Qu, Sideng Hu, Xiangning He
Zhejiang University, China

Teaching how to Characterize and Implement High Speed Power Devices for Tomorrow's Engineers 404

Jean-Luc Schanen, Yvan Avenas, Benoit Sarrazin, Caio Freitas, Wendpanga Biking, A. Derbey, S. Flury, F. Dumas, P. Lefranc, R. Hanna, H. Chazal
University Grenoble Alpes, France

Session 16: Wind Systems

Chair(s): Jonathan Bird, Akanksha Singh

Impedance-Based Small-Signal Modeling and Stability Analysis of Type-3 Wind Turbines in Weak Grid 412

Donghai Zhu¹, Xudong Zou¹, Wen Dong², Xiang Guo¹, Yihang Yang¹, Xinchun Lin¹, Yong Kang¹
¹Huazhong University of Science and Technology, China; ²State Grid Jiangsu Electric Power Co., Ltd., China

SWT and BES Optimisation for Grid-connected Households in South Australia 418

Rahmat Khezri¹, Amin Mahmoudi¹, Mohammed H. Haque²
¹Flinders University, Australia; ²University of South Australia, Australia

Transformerless Series Active Compensator operating with Floating Capacitors for DFIG based Wind Energy Conversion System 426

Ítalo A. Cavalcanti de Oliveira¹, Cursino Brandão Jacobina¹, Nady Rocha², Emerson de Lacerda Soares¹, Nayara Brandão de Freitas¹
¹Federal University of Campina Grande, Brazil; ²Federal University of Paraíba, Brazil

Parametrically Robust Mutual Inductance Estimation based Adaptive Control Architecture for Doubly Fed Induction Generator (DFIG) 434

Anuprabha Ravindran Nair, Rojan Bhattarai, Sukumar Kamalasan
University of North Carolina-Charlotte, United States

Design and Analysis of an Axial Flux Doubly Fed Induction Generator for Wind Turbine Applications 442

Shuvajit Das, Yilmaz Sozer
University of Akron, United States

Session 17: Stability in Smart Grid Applications

Chair(s): Robert S. Balog, Adel Nasiri

Stability Boundary Acquisition of Weak Grid-Tied Single-Stage Inverter 448

Yiming Tu, Jinjun Liu, Zeng Liu, Danhong Xue, Xiangpeng Cheng
Xi'an Jiaotong University, China

Optimal Digital Controller Design for Passive Stabilization of a Grid-Connected Three-Phase Inverter with LCL filter 455

Toshiji Kato, Kaoru Inoue, Yuki Yamamoto
Doshisha University, Japan

An Active Voltage Stabilizer for a Generic DC Microgrid 462

Vishnu Mahadeva Iyer¹, Srinivas Gulur¹, Subhashish Bhattacharya¹, Jun Kikuchi², Srikanthan Sridharan²,
Ke Zou², Chingchi Chen²
¹North Carolina State University, United States; ²Ford Motor Company, United States

Passivity-Oriented Discrete-Time Voltage Controller Design for Grid-Forming Inverters 469

Hui Yu, M.A. Awal, Hao Tu, Yuhua Du, Srdjan Lukic, Iqbal Husain
North Carolina State University, United States

Stability Analysis of the PV Generator based on Describing Function Method 476

Yue Li, Yanghong Xia, Yonggang Peng
Zhejiang University, China

Session 18: Smart Buildings and Appliances

Chair(s): Xiaonan Lu, Michael McIntyre

Model-Predictive Control of Electrical Energy Storage Systems for Microgrids-Integrated Smart Buildings 483

Enrico Mion, Tommaso Caldognetto, Francesco Simmini, Mattia Bruschetta, Ruggero Carli
University of Padova, Italy

An Improved Temperature Prediction Technique for HVAC Units using Intelligent Algorithms 490

Keming Yan, Chris Diduch, Mary E. Kaye
University of New Brunswick, Canada

A Generic Load Forecasting Method for Aggregated Thermostatically Controlled Loads based on Convolutional Neural Networks 495

Xun Gong, Eduardo Castillo Guerra, J.L. Cardenas Barrera, Bo Cao, Liuchen Chang, Saleh Saleh
University of New Brunswick, Canada

On the Optimal Energy Controls for Large Scale Residential Communities including Smart Homes 503

Huangjie Gong¹, Vandana Rallabandi¹, Michael L. McIntyre², Dan M. Ione¹
¹University of Kentucky, United States; ²University of Louisville, United States

Peer-to-Peer Energy Arbitrage in Prosumer-based Smart Residential Distribution System 508

Md Habib Ullah, Jae-Do Park
University of Colorado-Denver, United States

Session 19: Datacenter, UPS and Battery Management

Chair(s): Katherine Kim, Josiah McClurg

High-Power-Density GaN-Based Single-Phase Online Uninterruptible Power Supply 515

Danish Shahzad¹, Nauman Zaffar², Khurram K. Afridi¹

¹Cornell University, United States; ²Lahore University of Management Sciences, Pakistan

Design Optimization of Unregulated LLC Converter with Integrated Magnetics for Two-Stage 48V VRM 521

Mohamed H. Ahmed¹, Fred C. Lee¹, Qiang Li¹, Michael De Rooij²

¹Virginia Polytechnic Institute and State University, United States; ²Efficient Power Conversion, United States

Experimental validation of an Ultra-Fast Medium Voltage UPS Utility Disconnect Switch 529

Pietro Cairoli¹, Rodrigues Rostan¹, Utkarsh Raheja¹, Simon Walton², Nick Elliott²

¹ABB Inc., United States; ²ABB Ltd., New Zealand

A 13.56 MHz Multiport-Wireless-Coupled (MWC) Battery Balancer with High Frequency Online Electrochemical Impedance Spectroscopy 537

Ming Liu, Ping Wang, Yueshi Guan, Minjie Chen

Princeton University, United States

A Denoising SVR-MLP Method for Remaining useful Life Prediction of Lithium-ion Battery 545

Weirong Liu^{1,2}, Lisen Yan^{1,2}, Xiaoyong Zhang^{1,2}, Dianzhu Gao^{1,2}, Bin Chen^{1,2}, Yingze Yang^{1,2}, Fu Jiang^{1,2}, Zhiwu Huang^{1,2}, Jun Peng^{1,2}

¹Central South University, China; ²Hunan Engineering Laboratory of Rail Vehicles Braking Technology, China

Session 20: Other Charging Techniques

Chair(s): Mithat Kisacikoglu, Yingjie Li

Embedded compensation for DDQ/Bipolar-Q IPT Charging Pads 551

Daniel E. Gaona, Saikat Ghosh, Teng Long

University of Cambridge, United Kingdom

Bidirectional Grid-Side Power Management in DWPT Systems for EV Charging Applications 557

Ahmed Azad, Zeljko Pantic

Utah State University, United States

Zero Torque Three Phase Integrated On-board Charger by Multi-Elements Motor Torque Cancellation 563

Jialou Gao, Dong Jiang, Wei Sun, Yuanzhi Zhang

Huazhong University of Science and Technology, China

Fast and Ultra-Fast Charging for Battery Electric Vehicles – A Review 569

Camilo Suarez, Wilmar Martinez

KU Leuven, Belgium

Analysis and Design of Double-sided LCLC Compensation Parameters with Coupling-insensitive ZVS Operation for Capacitive Power Transfer 576

Feng Gao, Zhenpo Wang, Lantian Li, Shuo Wang, Junjun Deng

Beijing Institute of Technology, China

Session 21: DC-AC – Multi-Phase

Chair(s): Pedro Rodriguez, Alireza Safae

High Power Density Medium-Voltage Megawatt- Scale Power Converter for Aviation Hybrid-Electric Propulsion Applications 582

Di Zhang, Jiangbiao He, Di Pan, Michael Schutten, Mark Dame
GE Research, United States

Three Phase Quasi Z Source Inverters with Multiple AC Outputs 589

Shri Prakash Sonkar, V.N. Lal, R.K. Singh
Indian Institute of Technology Varanasi, India

A Soft-switched isolated Single Stage Bidirectional Three phase AC-DC Converter 596

Dibakar Das, Kaushik Basu
Indian Institute of Science, India

A Modified PBC Controller using Dynamic Damping Injection for LCL-Filtered Grid-Tied Inverter with Zero Steady-State Error 602

Jinping Zhao¹, Weimin Wu¹, Huang Min¹, Huai Wang², Frede Blaabjerg², Henry Chung³
¹Shanghai Maritime University, China; ²Aalborg University, Denmark; ³City University of Hong Kong, China

Stabilization of Inverter-Based Distributed Generation System via Virtual Impedance Regulator 609

Huanyue Liao, Xin Zhang
Nanyang Technological University, Singapore

Session 22: DC-AC – Modulation Techniques

Chair(s): John Lam, Regan Zane

Constant Common-Mode Voltage Transformerless Inverter for Grid-Tied Photovoltaic Application 616

Md N.H. Khan¹, Yam P. Siwakoti¹, L. Li¹, F.T.K. Suan²
¹University of Technology Sydney, Australia; ²Asia Pacific University of Technology and Innovation, Malaysia

Improved Three-Phase Critical-Mode-Based Soft-Switching Modulation Technique with Low Leakage Current for PV Inverter Applications 622

Zhengrong Huang, Qiang Li, Fred C. Lee
Virginia Polytechnic Institute and State University, United States

Five-phase Series-end Winding Motor Controller: Converter Topology and Modulation Method 629

An Li, Dong Jiang, Liu Zicheng, Wubin Kong
Huazhong University of Science and Technology, China

An Asymmetrical Space Vector PWM Scheme for a Three Phase Single-stage DC-AC Converter 635

Parthasarathy Nayak, Kaushik Rajashekara
University of Houston, United States

Mixed Series-Parallel Connected Current Source Converters with Interleaved SPWM 640

Li Ding, Yun Wei Li
University of Alberta, Canada

Session 23: Small and Large Signal Modeling

Chair(s): Jian Sun, Braham Ferreira

- DC Impedance Model of MMC Considering Capacitor Voltage and Circulating Current Dynamics** 646
Le Kong¹, Shuyao Wang¹, Nattapat Praisuwan¹, Shuoting Zhang¹, Liang Qiao¹,
Fred Wang^{1,2}, Leon M. Tolbert^{1,2}
¹University of Tennessee-Knoxville, United States; ²Oak Ridge National Lab, United States
- An Enhanced Multi-frequency Small-Signal Model for a High-Bandwidth PCM Buck Converter** 654
Xiangpeng Cheng, Jinjun Liu, Zeng Liu, Li Cheng, Yiming Tu
Xi'an Jiaotong University, China
- Accurate Small-signal Model for LLC Resonant Converters** 660
Yi-Hsun Hsieh, Fred C. Lee
Virginia Polytechnic Institute and State University, United States
- Machine Learning based Modeling of Power Electronic Converters** 666
Harish S. Krishnamoorthy, Tulasi Narayanan Aayer
University of Houston, United States
- An Exact Time-Domain based Novel Simulation-Design Tool for Study and Optimal Design of LLC and CLL Resonant Converters** 673
Amit Kumar, Abhishek Awasthi, Omid Salari, Arpan Laha, Praveen Jain
Queen's University, Canada

Session 24: DC-DC Converter Control

Chair(s): Santanu Kapat, Chi Kong Tse

- Current Sharing Method of Charge Controlled Interleaved Buck Converter** 681
Minrui Leng, Guohua Zhou, Qingxin Tian, Lunbo Deng, Songrong Wu
Southwest Jiaotong University, China
- Second Harmonic Current Reduction for Cascaded Inverter with Pre-regulator+LLC Converter as Front-End DC-DC Converter** 686
Fei Liu, Xinbo Ruan, Xinze Huang, Yang Qiu
Nanjing University of Aeronautics and Astronautics, China
- Self-Correction and Dead-Beat Current Control Strategy for Digital Programmed Boost Converter** 691
Bingqing Shi, Zhengming Zhao, Shusheng Wei, Chunpeng Zhang
Tsinghua University, China
- An Extended Describing Function Model for a Hybrid Frequency/Phase-shift Controlled SiC-Based High-Gain DC-DC Resonant Converter Module** 695
Mehdi Abbasi¹, Reza Emamalipour¹, Muhammad Ali Masood Cheema², John Lam¹
¹York University, Canada; ²Northern Transformer, Canada
- Cycle-by-Cycle Digital Control of a Multi-Megahertz Variable-Frequency Boost Converter for Automatic Power Control of LiDAR** 702
Xiaofan Cui, Christopher Keller, Al-Thaddeus Avestruz
University of Michigan-Ann Arbor, United States

Session 25: Electric Machines: Direct Drive and Magnetic Gearing

Chair(s): Jonathan Bird, Greg Heins

Comparative Study on a Novel Consequent-Pole Modular Linear Vernier Machine with PMs on both Mover and Stator Iron Cores 712

Chaojie Shi, Ronghai Qu, Dawei Li, Yuting Gao, Rui Li
Huazhong University of Science and Technology, China

Acoustic Noise Analysis of a Magnetically Geared Permanent Magnet Generator 717

Steffen Korsgaard¹, Anders Byrdal Kjaer¹, Simon Staal Nielsen¹, Loránd Demsa², Peter Omand Rasmussen¹
¹Aalborg University, Denmark; ²Vestas Wind Systems A/S, Denmark

Design Optimisation and Comparison of Fractional-Slot Overlap and Non-Overlap Winding Direct-Drive PM Wind Generators for DC-Connected Applications 724

C.J.J. Labuschagne, M.J. Kamper
Stellenbosch University, South Africa

Electromagnetic Design and Assembly Analysis of a Halbach Rotor Magnetic Gear for a Marine Hydrokinetic Application 732

Hossein Baninajar¹, Jonathan Z. Bird¹, Sina Modaresahmadi², Wesley Williams²
¹Portland State University, United States; ²University of North Carolina-Charlotte, United States

Rotor Slots Design based on Skin Effect to Reduce Losses in Line-Start Vernier Motor 740

Vincent Fedida, Dawei Li, Ronghai Qu
Huazhong University of Science and Technology, China

Session 26: Electric Machines: Additive Manufacturing

Chair(s): Nick Simpson, Rafal Wrobel

Characterization of Magnetic Anisotropy for Binder Jet Printed Fe_{93.25}Si_{6.75} 745

Thang Q. Pham, Hawke Suen, Patrick Kwon, Shanelle N. Foster
Michigan State University, United States

Design and Experimental Characterisation of an Additively Manufactured Heat Exchanger for the Electric Propulsion Unit of a High-Altitude Solar Aircraft 753

Rafal Wrobel¹, Ben Scholes¹, Ahmad Mustaffar¹, Sana Ullah¹, David Reay¹, Barrie Mecrow¹, Ahmed Hussein²
¹Newcastle University, United Kingdom; ²HiETA Technologies Ltd., United Kingdom

Design of High Performance Shaped Profile Windings for Additive Manufacture 761

Nick Simpson¹, Chris Tighe², Phil Mellor¹
¹University of Bristol, United Kingdom; ²Electrical Cooling Solutions Ltd., United Kingdom

Ceramic 3D Printed Direct Winding Heat Exchangers for Improving Electric Machine Thermal Management 769

William Sixel, Mingda Liu, Gregory Nellis, Bulent Sarlioglu
University of Wisconsin-Madison, United States

Investigation of an Additively-Manufactured Modular Permanent Magnet Machine for High Specific Power Design 777

Fan Wu, Ayman M. EL-Refai
Marquette University, United States

Session 27: Sensorless Control of Electric Drives

Chair(s): Hinkkanen Marko, Radu Bojoi

Analysis of Position Control Stability affected by Non-ideal Characteristics of IPMSM in Signal-Injection Sensorless Control 785

Joohyun Lee¹, Yong-Cheol Kwon², Seung-Ki Sul¹

¹Seoul National University, Republic of Korea; ²PLECKO Co., Ltd., Republic of Korea

A Linear Active Disturbance Rejection Controller-Based Sensorless Control Scheme for PMSM Drives 792

Lizhi Qu, Liyan Qu, Wei Qiao

University of Nebraska-Lincoln, United States

Discrete-time SMO based Sensorless Control of CSC-fed PMSM Drives with Low Switching Frequency 798

Li Ding¹, Yun Wei Li¹, Navid R. Zargari², Richard Paes²

¹University of Alberta, Canada; ²Rockwell Automation, Canada

High Frequency Injection based Rotor Position Self-Sensing for Synchronous Electrostatic Machines 804

Aditya N. Ghule, Peter Killeen, Daniel C. Ludois

University of Wisconsin-Madison, United States

Sensorless Self-Commissioning of Synchronous Reluctance Machine with Rotor Self-Locking Mechanism 812

Anantaram Varatharajan, Paolo Pescetto, Gianmario Pellegrino

Politecnico di Torino, Italy

Session 28: GaN Device and Application

Chair(s): Han Peng, Feng Qi

An Ultrafast Discrete Protection Circuit utilizing Multi-Functional Dual-Gate Pads of GaN HEMTs 818

Ruoyu Hou, Juncheng Lu

GaN Systems Inc., Canada

Impact of Substrate Termination on Dynamic On-State Characteristics of a Normally-off Monolithically Integrated Bidirectional GaN HEMT 824

Carsten Kuring¹, Nick Wiczorek¹, Oliver Hilt², Mihaela Wolf², Jan Böcker¹,

Joachim Würfl², Sibylle Dieckerhoff¹

¹Technische Universität Berlin, Germany; ²Ferdinand-Braun-Institut, Germany

Three-Dimensional Integrated GaN-based DC-DC Converter with an Inductor Substrate 832

Zhiyuan Qi, Laili Wang, Yunqing Pei, Cheng Zhao, Fengtao Yang, Zijie Zheng

Xi'an Jiaotong University, China

Finite Element Modeling of IGBT Modules to Explore the Correlation between Electric Parameters and Damage in Bond Wires 839

Maogong Jiang¹, Guicui Fu¹, Lorenzo Ceccarelli², He Du², Martin Bendix Fogsgaard², Amir Sajjad Bahman², Yongheng Yang², Francesco Iannuzzo²

¹Beihang University, China; ²Aalborg University, Denmark

Design of GaN based Ultra-High Efficiency, High Power Density Resonant Dickson Converter for High Voltage Step-Down Ratio 845
Deepak Gunasekaran¹, Fang Z. Peng²
¹Michigan State University, United States; ²Florida State University, United States

Session 29: LED Drivers and Intelligent Illumination

Chair(s): Omer Gundogmus, Eflen Flores-Garcia

Fault-Tolerant LED Lighting Systems featuring Minimal Loss of Luminous Flux 853
Fernando Bento, Antonio J. Marques Cardoso
University of Beira Interior, Portugal

Closed-Loop Control of LCL-T Resonant DC-DC Converter Operating as Automotive LED Driver 860
Mausamjeet Khatua¹, Satyaki Mukherjee², Alihossein Sepahvand³, Vahid Yousefzadeh³, Montu Doshi³,
Khurram K. Afridi¹, Dragan Maksimović²
¹Cornell University, United States; ²University of Colorado-Boulder, United States; ³Texas Instruments, United States

Resonant Switched-Capacitor Auxiliary Circuit for Active Power Decoupling in Electrolytic Capacitor-less AC/DC LED Drivers 866
Zhenyu Shan¹, Xiaomei Chen¹, Shengwen Fan¹, Guofeng Yuan¹, Chi K. Tse²
¹North China University of Technology, China; ²Hong Kong Polytechnic University, China

Adapting the Outphasing Technique for VLC based on Summing the Light 872
Daniel G. Aller, Diego G. Lamar, Juan Rodríguez, Pablo F. Miaja, Javier Sebastián
University of Oviedo, Spain

An Energy Efficient Li-Fi Transmitter with Single Inductor Multiple Output LED Driver 877
Kumar Modepalli¹, Soumya Chakraborty¹, Leila Parsa²
¹Rensselaer Polytechnic Institute, United States; ²University of California-Santa Cruz, United States

Session 30: Emerging Design and Applications of Energy Conversion 1

Chair(s): Eduard Muljadi, Aparna Saha

Low-Loss Switched Capacitor Voltage Balancing Circuit and its Design Considerations 882
Zach Pan¹, Liming Liu¹, Yu Du¹, Yuxiang Shi¹, Yang Xiaobo²
¹ABB Inc., United States; ²ABB, China

Design and Implementation of Switch-mode Solar Photovoltaic Emulator using Power-Hardware-in-the-loop Simulations for Grid Integration Studies 889
Isuru Jayawardana, Carl Ngai Man Ho, Mandip Pokharel
University of Manitoba, Canada

Discrete State Event-Driven Framework for Simulation of Switching Transients in Power Electronic Systems 895
Yicheng Zhu, Zhengming Zhao, Bochen Shi, Jiahe Ju, Zhujun Yu, Liqiang Yuan, Kainan Chen
Tsinghua University, China

Considerations of the Magnetic Field Uniformity for 2-D Rotational Core Loss Measurement 901
Shuaichao Yue¹, Yongjian Li¹, Changgeng Zhang¹, Qingxin Yang²
¹Hebei University of Technology, China; ²Tianjin University of Technology, China

Application of Linear Permanent Magnet Flux-Switching Motors to Needle-free Jet Injection	908
Nick N.L. Do, Andrew J. Taberner, Bryan P. Ruddy <i>The University of Auckland, New Zealand</i>	
Session 31: Alternative Energy Systems and Grid Connection	
Chair(s): Ke Ma, Akshay Rathore	
Feed-forward Controlled Single-Switch Three-Phase Wind Power Converter with Harmonic Injection Mechanism	916
Ray-Lee Lin, Lung-Shing Lin <i>National Cheng Kung University, Taiwan</i>	
On the Efficiency of Series-Connected Offshore DC Wind Farm Configurations	921
Marten Pape, Mehrdad Kazerani <i>University of Waterloo, Canada</i>	
An Improved Modulation Strategy for Single-Phase Quasi-Single-Stage AC-DC Converter	927
Xiaoguang Li, Fengjiang Wu, Jianyong Su <i>Harbin Institute of Technology, China</i>	
Multi-Frequency Signal Synthesis for Accurate Fuel Cell Impedance Estimation	934
Fabusuyi A. Aroge, Paul S. Barendse, Jessica Chamier <i>University of Cape Town, South Africa</i>	
A Novel Control Scheme for High Efficiency Fuel Cell Power Systems in Parallel Structure	940
Yeonho Jeong ¹ , Ronald A.L. Rorrer ¹ , Byoung-Hee Lee ² , Jae-Do Park ¹ ¹ University of Colorado-Denver, United States; ² Hanbat National University, Republic of Korea	
Experimental Studies on a Current-source Converter-based Wind Power Plant Composed of Series-connected Wind Turbine Generators and Synchronous-compensator-commutated Thyristor Inverter	947
Ken-ichiro Yamashita ¹ , Fujio Tatsuta ² , Shoji Nishikata ² ¹ Salesian Polytechnic, Japan; ² Tokyo Denki University, Japan	
Frequency Support Enhancement of a Permanent Magnet-Based Adjustable-Speed Pumped Hydropower Plant	955
Jinho Kim ¹ , Eduard Muljadi ¹ , Erol Kevin Chartan ² , Henry Oberneyer ³ , Lindsay George ⁴ ¹ Auburn University, United States; ² National Renewable Energy Laboratory, United States; ³ Obermeyer Hydro, Inc., United States; ⁴ Small Hydro Consulting, LLC, United States	
Power Quality Improvement in PMSG based Hydro-BES System Operating in Isolated Remote Areas using CF-FLL Control	960
Vineet P. Chandran, Shadab Murshid, Bhim Singh <i>Indian Institute of Technology Delhi, India</i>	
Active Power Limit for DFIG-Based Wind Turbine under Weak Grid	968
Xiang Guo, Xudong Zou, Congcong Jiang, Donghai Zhu, Yihang Yan, Li Peng, Xinchun Lin <i>Huazhong University of Science and Technology, China</i>	
Energy Harvesting from Moving Vehicles on Highways	974
Fubing Han, Abdul W. Bandarkar, Yilmaz Sozer <i>University of Akron, United States</i>	

An Approach in Torque Control of Hydraulic Wind Turbine Powertrains	979
Rasoul Akbari, Afshin Izadian, Robert Weissbach <i>Indiana University-Purdue University Indianapolis, United States</i>	
A Five Level Gird-Connected ANPC Inverter with a Novel Energy Transfer Strategy for Battery Energy Storage Systems	983
Hamid R. Teymour ¹ , Reza Sabzehgar ² , Mohammad Rasouli ³ , Danny Sutanto ⁴ , Kashem M. Muttaqi ⁴ ¹ Jabil Circuit, United States; ² San Diego State University, United States; ³ The Pennsylvania State University-Behrend, United States; ⁴ University of Wollongong, Australia	
Session 32: Grid Applications of Power Electronics	
Chair(s): Zhe Zhang, Srdjan Lukic	
Online Stabilization of DC Power Distribution Systems applying MIMO-Identification Method and Resonance-Enhanced Voltage Controller	990
Hessamaldin Abdollahi ¹ , Tomi Roinila ² , Silvia Arrua ¹ , Enrico Santi ¹ ¹ University of South Carolina, United States; ² Tampere University of Technology, Finland	
A Proposed Capacitor Voltage-Balancing Strategy for Double-Y STATCOM Operated under Unbalanced Conditions	998
Ehsan Behrouzian ¹ , Massimo Bongiorno ¹ , Jan R. Svensson ² , Aravind Mohanaveeramani ² ¹ Chalmers University of Technology, Sweden; ² ABB Corporate Research, Sweden	
Controller Design of Parallel Buck Voltage Balancers for Bipolar DC Microgrids	1006
Luis Herrera ¹ , Dane DiMaria ¹ , Chad Miller ² , Bang-Hung Tsao ³ ¹ University at Buffalo, United States; ² Air Force Research Laboratories, United States; ³ University of Dayton Research Institute, United States	
Robust Control for Islanded and Seamless Mode Switching of Wind-PV-Grid Tied Generation System	1012
Seema Kewat, Bhim Singh <i>Indian Institute of Technology Delhi, India</i>	
A Hybrid Method for Islanding Detection of Inverter Interfaced Distributed Generators utilizing Superimposed Component of d-axis Voltage	1020
Diptak Pal, Bijaya Ketan Panigrahi, Seema Kewat <i>Indian Institute of Technology Delhi, India</i>	
A Reliable Suppression Method of High Frequency Circulating Current in Parallel Grid Connected Inverters	1026
Sungjoon Cho ¹ , Yun Jang ² , Sejong Jeon ¹ , Kyo-Beum Lee ¹ ¹ Ajou University, Republic of Korea; ² LG Chem, Republic of Korea	
Back-to-Back 31 Level Modular Multilevel Converter with EtherCAT Communication	1032
Chagn-Hwan Park ¹ , Belete Belayneh Negesse ¹ , Jang-Mok Kim ¹ , Chan-Ki Kim ² ¹ Pusan National University, Republic of Korea; ² KEPCO Research Institute, Republic of Korea	
Operation of MMC based HVDC under SM Failure at Sending End Converter	1040
Richa Kumar ¹ , Abdul R. Beig ² , Khaled Al-Jaafari ² , R. Jayashree ¹ ¹ B.S. Abdur Rahman Crescent Institute of Science and Technology, India; ² Khalifa University, United Arab Emirates	

A DC Circuit Breaker with Artificial Zero Current Interruption	1047
Shrishti Singh, Subhashish Bhattacharya, Leonard W. White <i>North Carolina State University, United States</i>	
The Impact of Multi-Terminal DC Grids on AC Line Overload Alleviation: A Model Predictive Approach	1052
Mahmoud Mehrabankhomartash, Maryam Saeedifard <i>Georgia Institute of Technology, United States</i>	
Flexible Intelligent Real-time dc-ac grid Emulator (FIRE): Power Electronic Hardware-in-the-Loop (PE-HIL) Amplifier	1060
Suman Debnath, Sheng Zheng, Nathaniel Watson, Steven Campbell, Rong Zeng, Madhu Chinthavali <i>Oak Ridge National Lab, United States</i>	
Systematic Characterization of Power Hardware-in-the-Loop Evaluation Platform Stability	1068
Jing Wang, Blake Lundstrom, Ismael Mendoza, Annabelle Pratt <i>National Renewable Energy Laboratory, United States</i>	
Identification of Grid Impedance during Severe Faults	1076
Robert Eric Betz ¹ , Mads Graungaard Taul ² ¹ <i>University of Newcastle, Australia;</i> ² <i>Aalborg University, Denmark</i>	
A Bidirectional Single-Stage Isolated AC-DC Converter for Electric Vehicle Chargers	1083
Leonardo Adriano Ramos ¹ , Rafael Felipe Van Kan ¹ , Marcello Mezaroba ¹ , Alessandro Luiz Batschauer ¹ , Cassiano Rech ² ¹ <i>Santa Catarina State University, Brazil;</i> ² <i>Federal University of Santa Maria, Brazil</i>	
Development of Submodule Test Equipment for MMC-Based VSC-HVDC System	1088
Chang-Yeol Oh, Ki Ryong Kim, Ho Sung Kim, Jong-Pil Lee, Tae-Jin Kim <i>Korea Electrotechnology Research Institute, Republic of Korea</i>	
Switching Device Number Reduction for Three-Phase Cascade-Modular Solid-State Transformer System with Employment of Three-Phase T-Type Converter	1093
Nam Hoai Le, Satoshi Nagai, Keisuke Kusaka, Jun-ichi Itoh <i>Nagaoka University of Technology, Japan</i>	
Short Circuit Protection for AC Solid-State Power Controller based on GaN	1101
Zixuan Zhao, Li Wang <i>Nanjing University of Aeronautics and Astronautics, China</i>	
A Reconfigurable Test Bed for Experimental Studies on Islanded Hybrid AC/DC Microgrids	1106
Mahmoud A. Allam, Marten Pape, Mehrdad Kazerani <i>University of Waterloo, Canada</i>	
A 2kV Intelligent DC Solid State Circuit Breaker using Series Connected SiC JFETs	1114
Dong He ¹ , Zhikang Shuai ¹ , Wei Wang ¹ , Ying Cheng ¹ , Lei Yu ² , Z. John Shen ³ ¹ <i>Hunan University, China;</i> ² <i>Electric Power Research Institute, China Southern Power Grid, China;</i> ³ <i>Illinois Institute of Technology, United States</i>	

High Efficiency Isolated Resonant PFC Converter for Two-stage AC-DC Converter with Enhanced Performance	1120
Sung-Ho Lee, Min-Jae Kim	
¹ Korea Atomic Energy Research Institute, Republic of Korea; ² Pohang Accelerator Laboratory, Republic of Korea	

Session 33: Power Converters for Datacenters and LED Drivers

Chair(s): Ray-Lee Lin, Yu-Chen Liu

Efficient Power Transfer to Data Center Racks using Medium Voltage Inductive Coupling	1125
Suvendu Samanta ¹ , Richard Beddingfield ² , Isaac Wong ¹ , Subhashish Bhattacharya ¹	
¹ North Carolina State University, United States; ² National Energy Technology Laboratory, United States	

A Current Sensorless Coulomb-Counting Method for Enhanced Battery State-of-Charge Estimation Accuracy	1131
Zakariya Dalala ¹ , Osama Saadeh ¹ , Ala A. Hussein ^{2,3}	
¹ German Jordanian University, Jordan; ² Yarmouk University, Jordan; ³ University of Central Florida, United States	

Predicting Lithium-ion Battery Resistance Degradation in a Log-Linear Model	1136
Søren B. Vilsen, Søren Knudsen Kaer, Daniel-Ioan Stroe	
Aalborg University, Denmark	

An Ideal Current-Source Gate Driver for Buck VRMs	1144
Iman Abdali Mashhadi, Seyedali Ali Seif Kashani, Behzad Poorali, Majid Pahlevani	
Queen's University, Canada	

A Multiplexing Off-Line LED Driver Achieves High Power Factor and Flicker-Free Operation	1148
Peng Fang ¹ , Yan-Fei Liu ² , Paresh C. Sen ²	
¹ University of Minnesota-Duluth, United States; ² Queen's University, Canada	

Session 34: Inductive Power Transfer & Charging Techniques

Chair(s): Omer Onar, Jason Pries

Challenges in the Z-Class Compatible Inductive Power Transfer System Considering the Wide Varying Range of the Coupling Coefficient	1155
Hua Zhang ¹ , Ying Mei ² , Chong Zhu ³ , Yao Wang ¹ , Sheng Zheng ⁴ , Fei Lu ¹	
¹ Drexel University, United States; ² Zhejiang University, China; ³ Shanghai Jiao Tong University, China; ⁴ Oak Ridge National Lab, United States	

An Universal On-board Battery Charger with Wide Output Voltage Range for Electric Transportation	1159
A.V.J.S. Praneeth, Deepa Vincent, Sheldon S. Williamson	
University of Ontario Institute of Technology, Canada	

Enhanced Rotary Transformer-Based Field Excitation System for Wound Rotor Synchronous Motor	1166
Josiah Haruna ¹ , Tsarafidy Raminosoa ² , Jonathan Wilkins ²	
¹ Tennessee Tech University, United States; ² Oak Ridge National Lab, United States	

Coupled-Inductor Bidirectional DC-DC Converter for EV Charging Applications with Wide Voltage Conversion Ratio and Low Parts Count	1174
Agasthya Ayachit ¹ , Saad Ul Hasan ² , Yam P. Siwakoti ² , Mohamad Abdul-Hak ¹ , Marian K. Kazimierczuk ³ , Frede Blaabjerg ⁴	
¹ Mercedes-Benz Research and Development North America, Inc., United States; ² University of Technology Sydney, Australia; ³ Wright State University, United States; ⁴ Aalborg University, Denmark	
Transformer-less Medium Voltage EV Chargers	1180
Muhammad H. Alvi, Giri Venkataramanan University of Wisconsin-Madison, United States	
Design Considerations of a Bipolar Track for Dynamic Electric Vehicle Charging	1188
Weitong Chen, Feiyang Lin, Grant A. Covic, John T. Boys The University of Auckland, New Zealand	
Leakage Current Mitigation of Non-Isolated Integrated Chargers for Electric Vehicle	1195
Yue Zhang ¹ , William Perdikakis ¹ , Yizhou Cong ¹ , Xiao Li ¹ , Mohamed Elshaer ¹ , Yousef Abdullah ¹ , Jin Wang ¹ , Ke Zou ² , Zhuxian Xu ² , Chingchi Chen ²	
¹ The Ohio State University, United States; ² Ford Motor Company, United States	
Passive Reflection Winding for Ferrite-less Double D Topology for Roadway IPT Applications	1202
Matthew G.S. Pearce, Grant A. Covic, John T. Boys The University of Auckland, New Zealand	
Empirical Closed-Form Analysis for Inductance and Coupling Coefficient Calculation for Ferrite-Based Matched Inductive Charging Systems	1210
Benny J. Varghese, Abhilash Kamineni, Regan A. Zane Utah State University, United States	
A Novel Maximum Efficiency Point Tracking Technique for Modular Paralleled Electric Vehicle Charging System	1215
Zhuang Lin, Xuexiao Luo, Yajuan Jiang, Lingli Fan, Yuefei Wu, Yingqi Zhang LG Electronics China R&D Center, China	
Natural Convection Cooled SiC-based LLC Resonant Converters in Wide Voltage Range Battery Charger Application	1223
Rui Zhou, Qianqian Jiao, Yincan Mao EnerSys, United States	
High Performance Active Battery Management System with Multi-Winding Transformer	1231
Umberto Abronzini ¹ , Mauro Di Monaco ¹ , Francesco Porpora ¹ , Giuseppe Tomasso ¹ , Matilde D'Arpino ² , Ciro Attaianesi ³	
¹ University of Cassino and Southern Lazio, Italy; ² The Ohio State University, United States; ³ University of Naples Federico II, Italy	
Medium Voltage Dual Active Bridge using 3.3 kV SiC MOSFETs for EV Charging Application	1237
Lee Gill, Takayuki Ikari, Toshihiro Kai, Bo Li, Khai Ngo, Dong Dong Virginia Polytechnic Institute and State University, United States	
A Parallel Topology for Modularized IPT Systems	1245
Hongsheng Hu ¹ , Tao Cai ¹ , Shanxu Duan ¹ , Xiaoming Zhang ¹ , Jintao Niu ¹ , Hao Feng ²	
¹ Huazhong University of Science and Technology, China; ² North Carolina State University, United States	

Session 35: DC-DC Converters

Chair(s): Arijit Banerjee, Vito Giuseppe Monopoli

- Analysis and Implementation of a New Non-isolated High-Voltage Gain Boost Converter** 1251
Anh Dung Nguyen¹, Jih-Sheng Lai¹, Huang-Jen Chiu²
¹Virginia Polytechnic Institute and State University, United States;
²National Taiwan University of Science and Technology, Taiwan
- A Novel Circuit Topology and its Design for Class-E² DC-DC Converter** 1256
Yusuke Ogi¹, Fumiya Ebihara¹, Xiuqin Wei¹, Hiroo Sekiya²
¹Chiba Institute of Technology, Japan; ²Chiba University, Japan
- In-situ Direct Magnetic Loss Measurement in a DC-DC Converter** 1261
Jinyeong Moon
Florida State University, United States
- 400 V to 12 V Step-down DC-DC Power Converter based on the Differential Concept** 1269
Neilor Colombo Dal Pont¹, Jessika Melo Andrade¹, Matheus Schramm Dall'Asta¹,
Telles Brunelli Lazzarin¹, Brad Lehman²
¹Federal University of Santa Catarina, Brazil; ²Northeastern University, United States
- Multi-resonant Non-Inverting Buck-Boost Converter** 1275
D.R. Nayanasingi¹, Yunwei Li¹, L.H.P.N. Gunawardena²
¹University of Alberta, Canada; ²University of Moratuwa, Sri Lanka
- An IPOS LLC Converter with Current Sharing Capability** 1283
Yucen Li¹, Shuai Shao¹, Hui Chen², Junming Zhang¹, Kuang Sheng¹
¹Zhejiang University, China; ²Zhejiang University City College, China
- A Comprehensive Analysis of Gate Drive Delay in CLLC Converters and its Compensation Method** 1288
Huan Chen¹, Kai Sun¹, Hongsheng Chong¹, Zheyuan Yi¹, Shujun Mu², Yang Mei³
¹Tsinghua University, China; ²Nation Institute of Clean and Low Carbon Energy, China;
³North China University of Technology, China
- Improvement on Transient Performance of Cooperative Triple-Phase-Shift Control for Dual Active Bridge DC-DC Converter** 1296
Jianyong Su, Suhua Luo, Fengjiang Wu
Harbin Institute of Technology, China
- An Improved Power Processing Unit for Multi-Mode Monopropellant Electro-spray Thrusters for Satellite Propulsion Systems** 1302
Kartikeya Jayadurga Prasad Veeramraju, Jonathan W. Kimball
Missouri S&T, United States
- A Soft-switching Current-fed Isolated Bidirectional DC-DC Converter with Low Circulating Power and Easy-implemented Control Strategy** 1310
Zhao Zhang, Zhiying Wu, Shaojun Xie, Xiaoyu Ma, Jinming Xu, Miao Liu
Nanjing University of Aeronautics and Astronautics, China

A Two-Stage Isolated Converter without Intermediate Capacitor for Wide Voltage Range Applications	1315
Pengyu Jia ¹ , Zehui Huang ¹ , Yaozong Hao ¹ , Qian Chen ² , Shengwen Fan ¹	
¹ North China University of Technology, China; ² Electric Power Research Institute of State Grid Zhejiang Electric Power Corporation, China	
Analytical Solution for Minimum RMS Current and Reactive Power Modulation of a Soft Switched Dual Active Bridge Converter	1321
Amit Bhattacharjee, Xi Chen, Issa Batarseh	
University of Central Florida, United States	
Multi-Phase Input-Parallel Output-Parallel DualActive Bridge with Inherent Current sharing and Optimized Integrated Transformer	1328
Wucheng Ying ¹ , Hui Zhao ¹ , Yanfeng Shen ¹ , Zhaokai Li ² , Hao Hu ¹ , Teng Long ¹	
¹ University of Cambridge, United Kingdom; ² Zhejiang University, China	
Time-Domain Analysis of APWM-Frequency Modulated Low-Q LLC Resonant Converter for Wide Input and Load Range Applications	1334
Abhishek Awasthi, Snehal Bagawade, Amit Kumar, Praveen Jain	
Queen's University, Canada	
Four-Port Bidirectional Dual Active Bridge Converter for EVs Fast Charging	1341
M. La Mendola ¹ , M. di Benedetto ¹ , A. Lidozzi ¹ , L. Solero ¹ , S. Bifaretti ²	
¹ Roma Tre University, Italy; ² University of Roma Tor Vergata, Italy	
Digitally-assisted Hysteresis Voltage Prediction Control for Series-Form Switch-Linear Hybrid Envelope-Tracking Power Supply	1348
Ying Li, Xinbo Ruan, Yazhou Wang, Chengxiang Zhang	
Nanjing University of Aeronautics and Astronautics, China	
Current Balancing Technique in Symmetrical Configuration of Quad-Active-Bridge Converter using Integrated Magnetic Current Balancing Cells	1353
Nabeel Naseem ¹ , Honnyong Cha ¹ , Jong-Soo Kim ²	
¹ Kyungpook National University, Republic of Korea; ² Daejin University, Republic of Korea	
Fault-Tolerant Bidirectional Series Resonant DC-DC Converter with Minimum Number of Components	1359
Dmitri Vinnikov ¹ , Andrii Chub ¹ , Oleksandr Korkh ¹ , Mariusz Malinowski ²	
¹ Tallinn University of Technology, Estonia; ² Warsaw University of Technology, Poland	
Development of a High Power Density GaN-based Transistor Low-Voltage High-Current Phase-Shift Full-Bridge Current Doubler Converter for Electric Vehicles	1364
Sangjin Kim, Adhistira M. Naradhipa, Sewan Choi	
Seoul National University of Science and Technology, Republic of Korea	
A Small Signal Model of Dual Bridge Series Resonant DC/DC Converter for Power Electronic Traction Transformer	1370
Bo Yang ^{1,2} , Qiongquan Ge ¹ , Lu Zhao ¹ , Zhou Zhida ^{1,2} , Yaohua Li ¹	
¹ Chinese Academy of Sciences, China; ² University of Chinese Academy of Sciences, China	

Analysis and Design of SR Driver Circuit for LLC DC-DC Converter under High Load Current Application 1375
Xiang Zhou, Bo Sheng, Wenbo Liu, Yang Chen, Andrew Yurek, Yan-Fei Liu, P.C. Sen
Queen's University, Canada

Simultaneous Model based Control of a Non-Inverting Buck-Boost Converter for PFC Applications at a Reduced Current Stress 1382
Franklin Velasquez, Akarsh Murthy, Mohamed Badawy
San Jose State University, United States

Class E Resonant Low dv/dt Rectifier using Common Grounded Switch Controlled Capacitor 1389
Yuki Hirama, Hirotaka Koizumi
Tokyo University of Science, Japan

Exact Steady-State Analysis of Phase-Shifted Dual-Input LLC Converter 1394
Abdullah Alhatlani¹, Sumana Ghosh¹, Issa Batarseh¹, Nasser Kutkut²
¹*University of Central Florida, United States*; ²*Advanced Charging Technologies, United States*

Stacked DC-DC Converter with Wide Voltage Range 1401
Liming Liu¹, Sandeep Bala¹, Francisco Canales²
¹*ABB Inc., United States*; ²*ABB, Switzerland*

Session 36: Power Converter Control

Chair(s): John Lam, Han Peng

Novel Switching Control Method for Synchronous Rectifier of Phase-Shifted Full-Bridge Converter in Light-Load Conditions 1408
Sunho Lee, Junhyuk Lee, Usman Ali Khan, Jung-Wook Park
Yonsei University, Republic of Korea

Zero Sequence Circulating Current Reduction of Paralleled Converters with Interleaved Discontinuous PWM 1414
Hanwei Xu, Lie Xu, Kui Wang, Zedong Zheng, Yongdong Li
Tsinghua University, China

Design and Control of a Modular 48/400V Power Converter for the Grid Integration of Energy Storage Systems 1421
Miguel Crespo, Pablo García, Ramy Georgious, Geber Villa, Jorge García
University of Oviedo, Spain

LMI-based Control Design to Enhance Robustness of Synchronous Power Controller 1429
Ngoc Bao Lai¹, Andrés Tarrasó², Pedro Rodriguez¹
¹*Universidad Loyola Andalucía, Spain*; ²*Universitat Politècnica de Catalunya, Spain*

All-Fixed Switching Frequency Control of CRM Boost PFC Converter based on Variable Inductor in a Wide Input Voltage Range 1434
Zhen Zhang, Kai Yao, Chunwei Ma, Jienan Chen, Lingge Li, Chanbo Guan, Chengjian Wu
Nanjing University of Science and Technology, China

Optimized Carrier Disposition based Discontinuous Pulse-width Modulation Method for Three-Level NPC Converters	1442
Meiqi Wang ¹ , Lie Xu ² , Bo Yang ³ , Jing Li ¹ , Chunyang Gu ¹ , He Zhang ¹ , Chris Gerada ⁴ , Yongdong Li ²	
¹ University of Nottingham Ningbo China, China; ² Tsinghua University, China; ³ Xi'an University of Technology, China; ⁴ University of Nottingham, United Kingdom	
FS-MPC Algorithm for Optimized Operation of a Hybrid Active Neutral Point Clamped Converter	1447
Mateja Novak ¹ , Victor N. Ferreira ² , Markus Andresen ² , Tomislav Dragicevic ¹ , Frede Blaabjerg ¹ , Marco Liserre ²	
¹ Aalborg University, Denmark; ² Christian-Albrechts-Universität zu Kiel, Germany	
Virtual DC Generator Control Strategy based on Differential Compensation	1454
Na Zhi ¹ , Youguo Ding ¹ , Liang Du ²	
¹ Xi'an University of Technology, China; ² Temple University, United States	
Optimal Dual Constant Switching Frequency Control for CRM Buck-Buck/Boost PFC Converter	1459
Chunwei Ma, Kai Yao, Chengjian Wu, Jienan Chen, Lingge Li, Chanbo Guan, Zhen Zhang	
Nanjing University of Science and Technology, China	
An Enhanced Power Decoupling Control for Grid-connected Capacitive-Coupling Inverters	1466
Wenyang Deng ¹ , Ning Yi Dai ¹ , Keng-Weng Lao ¹ , Josep M. Guerrero ²	
¹ University of Macao, China; ² Aalborg University, Denmark	
Carrier-Based MPC for Interleaved 2L-VSIs with Reduced Low-order Zero-Sequence Circulating Current	1474
Changpeng Jiang, Zhongyi Quan, Dehong Zhou, Yunwei Li	
University of Alberta, Canada	
Improved Voltage Control Scheme for Single-Phase UPS Inverter with Repetitive Current Controller	1482
Seunghoon Baek ¹ , Younghoon Cho ¹ , Sijun Yeo ²	
¹ Konkuk University, Republic of Korea; ² Sungshin Electric Co., Ltd., Republic of Korea	
A Simplified Voltage Balancing Control of a Modular Medium-Frequency Transformer-Based Current Source Converter	1488
Qiang Wei ¹ , David Xu ² , Bin Wu ² , Navid R. Zargari ³	
¹ Lakehead University, Canada; ² Ryerson University, Canada; ³ Rockwell Automation, Canada	
State-Space Control for LCL Filters: Comparison between the Converter and Grid Current Measurements	1491
F. M. Mahafugur Rahman ¹ , Jarno Kukkola ¹ , Ville Pirsto ¹ , Mikko Routimo ^{1,2} , Marko Hinkkanen ¹	
¹ Aalto University, Finland; ² ABB Drives, Finland	
Low-Frequency Oscillation Suppression in Series Resonant Dual-Active-Bridge Converters under Fault Tolerant Operation	1499
Yiwei Pan ¹ , Yongheng Yang ¹ , Jinwei He ² , Ariya Sangwongwanich ¹ , Frede Blaabjerg ¹	
¹ Aalborg University, Denmark; ² Tianjin University, China	
Grid Impedance Identification using the VSC Switching Ripple	1506
Diego Pérez-Estévez, Jesús Doval-Gandoy	
University of Vigo, Spain	

An FPGA-based Switch-mode Power Amplifier using Boundary Control to achieve High System Bandwidth	1514
Zhuang Zhang ¹ , Carl Ngai Man Ho ¹ , Wenxun Xiao ²	
¹ University of Manitoba, Canada; ² South China University of Technology, China	
Segmented Constant-On-Time Control Method for CRM Buck-Buck/Boost PFC Converter	1520
Jienan Chen, Kai Yao, Bin Fang, Lingge Li, Chanbo Guan, Chengjian Wu, Zhen Zhang, Chunwei Ma, Huili Zhang	
Nanjing University of Science and Technology, China	
A Nested-loop Control Strategy for a Bidirectional Ćuk Inverter	1528
Linda Shelembe, Paul Barendse	
University of Cape Town, South Africa	
Optimal Frequency and Critical Soft Switching Control of DC/DC Converter	1536
Liwei Zhou, Matthias Preindl	
Columbia University, United States	
Spatial Repetitive Controller based Harmonic Mitigation Methodology for Wide Varying Base Frequency Range	1542
Hao Zeng ¹ , Robert D. Lorenz, Christoph H. van der Broeck ² , Rik W. De Doncker ²	
¹ University of Wisconsin-Madison, United States; ² RWTH Aachen University, Germany	
A Novel Model Predictive Current Control Strategy for Non-Isolated Single-Phase Grid-Connected Inverter	1550
Qi Liu ¹ , Jian Yang ¹ , Dongran Song ¹ , Guoxun Xiao ²	
¹ Central South University, China; ² Changsha Best Electrical Technology Co., Ltd., China	
A Novel Dual Phase Shift Modulation for Dual-Active-Bridge Converter	1556
Song Chi, Peng Liu, Xue Li, Mocheng Xu, Shanhu Li	
Hebei University of Technology, China	
Cable Overcurrent Control Strategy of Stand-Alone Brushless Doubly-Fed Power Generation System	1562
Debin Zhang, Yu Chen, Jingyuan Su, Yong Kang	
Huazhong University of Science and Technology, China	
Switching Losses Reduction of Grid-tied Inverters with Variable Switching Frequency Discontinuous PWM	1567
Hanwei Xu, Lie Xu, Kui Wang, Zedong Zheng, Yongdong Li	
Tsinghua University, China	
Predictive Switching Sequence-based Control for Constant Power Load	1574
Debanjan Chatterjee, Sudip K. Mazumder	
University of Illinois-Chicago, United States	
Thermal Stress Reduction for DC-link Capacitors of Three-phase VSI with Multiple PWM Switching Patterns	1584
Koroku Nishizawa ¹ , Jun-ichi Itoh ¹ , Satoru Fujita ² , Akihiro Odaka ² , Akio Toba ² , Hidetoshi Umida ²	
¹ Nagaoka University of Technology, Japan; ² Fuji Electric Co., Ltd., Japan	

An Optimized SM Fault-Tolerant Control Method for MMC-based HVDC Applications	1592
Mohammed Alharbi, Semih Isik, Subhashish Bhattacharya North Carolina State University, United States	
Wear-Out Failure of a Power Electronic Converter under Inversion and Rectification Modes	1598
Saeed Peyghami ¹ , Pooya Davari ¹ , Dao Zhou ¹ , Mahmud Fotuhi-Firuzabad ² , Frede Blaabjerg ¹ ¹ Aalborg University, Denmark; ² Sharif University of Technology, Iran	
Control Scheme for LLC Resonant Converter with Improved Performance under Light Loads and Wide Input-Output Voltage Variation	1605
Jaspreet Narli, Hossein Dehghani Tafti, Glen G. Farivar, Josep Pou, Bac Xuan Nguyen, Koh Leong Hai Nanyang Technological University, Singapore	
Session 37: Induction and Synchronous Machines	
Chair(s): Ramakrishnan Rajavenkitasubramony, Alireza Fatemi	
48V Starter-Generator Induction Machine with Pole Changing Windings	1609
Srinivas Mallampalli ¹ , Z.Q. Zhu ¹ , Jean-Claude Mipo ² , Sophie Personnaz ² ¹ The University of Sheffield, United Kingdom; ² Valeo, France	
A Fault Tolerant Induction Motor Drive	1616
Fangbo Liu ¹ , Barrie Mecrow ¹ , Alexander C. Smith ¹ , B. Alvarenga ² , Xu Deng ¹ ¹ Newcastle University, United Kingdom; ² Federal University of Goias, Brazil	
Rotor Fault Detection of Squirrel Cage Induction Motor using Spectrum Analysis of Dynamic Simulation and Experimental Validation	1623
Ariunbolor Purvee ¹ , Enkhbat Tsend-Ayush ² , Natsagdorj Erdenetsogt ³ , Robert Morelos-Zaragoza ⁴ ¹ German Mongolian Institute for Resources & Technology, Mongolia; ² Mongolian University of Science and Technology, Mongolia; ³ Mongolian National Defense University, Mongolia; ⁴ San Jose State University, United States	
Online Estimation of Rotor Temperature in Induction Motors based on Parameter Identification	1629
Haisen Zhao ^{1,2,3} , Hassan H. Eldeeb ³ , Jinyu Wang ^{1,2} , Yang Zhan ^{1,2} , Guorui Xu ^{1,2} , Osama A. Mohammed ³ ¹ North China Electric Power University, China; ² Yangzhong Intelligent Electrical Institute, China; ³ Florida International University, United States	
A Study on Efficiency of Magnetic Levitation Trains using Linear Induction Motor by Slip Pattern	1635
Hyunuk Seo ¹ , Jaewon Lim ¹ , Sang Uk Park ² , Hyung-Soo Mok ² ¹ Korea Institute of Machinery & Materials, Republic of Korea; ² Konkuk University, Republic of Korea	
Real-time Loss Minimizing Control of Induction Machines for Dynamic Load Profiles under Deadbeat-Direct Torque and Flux Control	1641
Yuying Shi, Bulent Sarlioglu, Robert D. Lorenz University of Wisconsin-Madison, United States	
On Shortening the Numerical Transient in Time-Stepping Finite Element Analysis of Induction Motor under Broken Rotor Bar Faults	1649
Hossein Nejadi Koti, Hao Chen, Yue Sun, Nabeel A. O. Demerdash Marquette University, United States	

Induction Machine Efficiency at Variable Frequencies	1655
Emmanuel Agamloh ¹ , Andrea Cavagnino ² , Silvio Vaschetto ²	
¹ Baylor University, United States; ² Politecnico di Torino, Italy	
Design of a PM-Assisted Synchronous Reluctance Motor utilizing Additive Manufacturing of Magnetic Materials	1663
Maged Ibrahim, Fabrice Bernier, Jean-Michel Lamarre	
National Research Council of Canada, Canada	
Comparison of two Analytical Methods for Calculating the Maximum Mechanical Stress in the Rotor of High Speed Assisted Synchronous Reluctance Machines	1669
Iman Kleilat ¹ , Khadija El Kadri Benkara ¹ , Guy Friedrich ¹ , Stephane Vivier ¹ , Nazih Moubayed ² , Rabih Dib ²	
¹ University of Technology of Compiègne, France; ² Lebanese University, Lebanon	
Stochastic Analysis for Influence of Manufacturing Tolerance of Permanent Magnet on Performance of IPMSM	1675
Deok-Jae Kwon ¹ , Jun-Hyuk Im ¹ , Seung-Tae Lee ² , Jin Hur ¹	
¹ Incheon National University, Republic of Korea; ² Wiseworks Co. Ltd., Republic of Korea	
Online Diagnosis and Severity Estimation of Partial and Uniform Irreversible Demagnetization Fault in Interior Permanent Magnet Synchronous Motor	1682
Zia Ullah ¹ , Seung-Tae Lee ² , Mudassir Raza Siddiqi ¹ , Jin Hur ¹	
¹ Incheon University, Korea, Republic of Korea; ² Wiseworks Co. Ltd., Republic of Korea	
FEA based Separation of Torque Components in Interior Permanent Magnet Machines	1687
Mohamed Zubair M. Jaffar, Iqbal Husain	
North Carolina State University, United States	
Modeling of Electromagnetic Torque in Synchronous Reluctance Machines using Inductance Harmonics	1695
Mazharul Chowdhury ¹ , Mohammad Islam ¹ , Iqbal Husain ²	
¹ Halla Mechatronics, United States; ² North Carolina State University, United States	
Scalability of Synchronous Reluctance Machines Considering Thermal Performance	1701
Yawei Wang ¹ , Michele Bonfante ¹ , Nicola Bianchi ¹ , Roberto Petrella ²	
¹ University of Padova, Italy; ² University of Udine, Italy	
Synchronous Reluctance Rotor Design Considerations based on Winding Configuration	1708
Dheeraj Bobba ¹ , Gerd Bramerdorfer ² , Hao Ding ¹ , Siegfried Silber ³ , Bulent Sarlioglu ¹	
¹ University of Wisconsin-Madison, United States; ² Johannes Kepler University Linz, Austria;	
³ Linz Center of Mechatronics GmbH, Austria	
Influence of Rotor Pole Number on Performance of Novel Slot Permanent Magnet Machines with Complementary Rotors	1716
Qingsong Wang ¹ , Martin Ordonez ¹ , Junnian Wang ² , Mohammad Ali Saket ¹ , Rouhollah Shafaei ¹	
¹ University of British Columbia, Canada; ² Jilin University, China	
A Novel Dual-Sided PM Machine with Stator Spoke-Type PM Structure	1721
Ya Li, Hui Yang, Heyun Lin, Wei Liu, Shukang Lyu	
Southeast University, China	

Damping Torque Coefficient affected by different Rotor Damping Structures of Turbo-generator during Large Disturbance	1729
Guorui Xu ¹ , Jingdi Zhou ¹ , Zhiqiang Li ² , Haisen Zhao ¹ , Zhiwei Cao ³ , Jihao Wang ³	
¹ North China Electric Power University, China; ² China Electric Power Research Institute, China;	
³ Electric Power Research Institute of Shandong Power Supply Company of State Grid, China	
Evaluation of Slotless Permanent Synchronous Motor with Toroidal Winding	1735
Ho-Young Lee, Eui-Chun Lee, Gi-Ju Lee, Soon-O Kwon	
Korea Institute of Industrial Technology, Republic of Korea	
Wound Field Synchronous Machine with Segmented Rotor Laminations and Die Compressed Field Winding	1739
Mohamad Salameh ¹ , Thomas Spillman ¹ , Mahesh Krishnamurthy ¹ , Ian P. Brown ¹ , Daniel C. Ludois ²	
¹ Illinois Institute of Technology, United States; ² University of Wisconsin-Madison, United States	
Investigation of Rotor Designs of Variable-Flux Interior Permanent Magnet Synchronous Machines for Traction Applications	1747
Cong Ma, Tausif Husain	
BorgWarner Inc., United States	
Electromagnetic Forces on Coils and Bars inside the Slot of Hydro-Generator	1754
Barvir Sanosian ¹ , Philippe Wendling ² , Tan Pham ³ , Willian Akaishi ¹	
¹ Stantec, United States; ² Altair, United States; ³ Solar Turbines, United States	
Analytical Model and Sensitivity Analysis of Tooth-Coil-Winding Permanent Magnet Synchronous Machine with Modular U-Shape Stator	1761
Carlos Madariaga ¹ , Werner Jara ¹ , Juan Tapia ² , Javier Riedemann ¹ , Gerd Bramerdorfer ³ , Pablo Castro ⁴ , Bulent Sarlioglu ⁴	
¹ Pontificia Universidad Católica de Valparaíso, Chile; ² University of Concepcion, Chile;	
³ Johannes Kepler University Linz, Austria; ⁴ University of Wisconsin-Madison, United States	
Extended Field Weakening Range in Slotless/Coreless Permanent Magnet Machines	1769
Md Sariful Islam ¹ , Rajib Mikail ² , Iqbal Husain ¹	
¹ North Carolina State University, United States; ² ABB Inc., United States	
Sliding Mode Current Control of Mutually Coupled Switched Reluctance Machines using a Three-phase Voltage Source Converter	1776
Kun Hu, Jin Ye, Javad Mohammadpour Velni	
University of Georgia, United States	
A Modest Attempt on the Electromagnetic Design and Performance Prediction of Turbo Wound-Field Flux Switching Synchronous Condensers	1782
Udochukwu B. Akuru, Maarten J. Kamper	
Stellenbosch University, South Africa	
Session 38: Control of Electric Drives	
Chair(s): Luca Zarri, Milijana Odavic	
Current Ripple Reduction for Dual-Segment Three-phase PMSM with ZCMV PWM Scheme through Neutral Point Separation	1790
Zewei Shen, Dong Jiang, Zicheng Liu, Dawei Li	
Huazhong University of Science and Technology, China	

An Advanced Harmonic Compensation Strategy for Dual Three Phase Permanent Magnet Synchronous Machines Considering Different Angle Displacements	1797
Jin Xu, Milijana Odavic, Ziqiang Zhu <i>The University of Sheffield, United Kingdom</i>	
A Nonlinear Control of Synchronous Reluctance Motors (SynRM) based on Feedback Linearization Considering the Self and Cross-Saturation Effects	1804
Angelo Accetta ¹ , Maurizio Cirrincione ² , Marcello Pucci ¹ , Antonino Sferlazza ³ ¹ <i>Institute for Marine Engineering, Italy;</i> ² <i>University of the South Pacific, Fiji;</i> ³ <i>University of Palermo, Italy</i>	
Torque Ripple Minimization of Four-Phase Switched Reluctance Motor using Direct Torque Control with an Innovative Switching Sequence Scheme	1810
Krishna Reddy Pittam ¹ , Deepak Ronanki ² , Parthiban Perumal ¹ , Abdul R. Beig ³ , Sheldon S. Williamson ² ¹ <i>National Institute of Technology Karnataka, India;</i> ² <i>University of Ontario Institute of Technology, Canada;</i> ³ <i>Khalifa University, United Arab Emirates</i>	
On the Concept of Four Nearest Space Vector PWM for Multi Source Inverters	1816
O. Salari, K. Hashttrudi Zaad, A. Kumar, A. Bakhshai, P. Jain <i>Queen's University, Canada</i>	
Power Decoupling Technique for Reducing DC-Link Capacitor of Switched Reluctance Machine Drives	1822
Md Ehsanul Haque, Anik Chowdhury, Yilmaz Sozer <i>University of Akron, United States</i>	
Analytic MTPA Solution for Synchronous Reluctance Machine	1827
Wonhee Lee ¹ , Kwanghee Nam ¹ , Jaehong Kim ² ¹ <i>Pohang University of Science and Technology, Republic of Korea;</i> ² <i>Chosun University, Republic of Korea</i>	
A Simpler Gopinath-Style Flux Observer without a Constant Speed Assumption for Low and High Sampling-to-Fundamental Frequency Ratios for Induction Machines	1832
Austin E.N. Gaspar, Yang Xu, Robert D. Lorenz <i>University of Wisconsin-Madison, United States</i>	
Improved Finite Control Set Model Predictive Control for Permanent Magnet Synchronous Motor Drives with Current Ripple Minimization	1840
Guanghan Zhao, Shamsuddeen Nalakath, Ali Emadi <i>McMaster University, Canada</i>	
Rotor Position Estimation Error Analysis of Indirect High Frequency Signal Injection Method for Sensorless Starting Control of Aircraft Starter-Generator	1846
Heng Lu, Jiadan Wei, Hua Xue, Zhuoran Zhang, Xianghao Kong <i>Nanjing University of Aeronautics and Astronautics, China</i>	
A Novel Virtual Space Vector Modulation Scheme for Three-Level NPC Power Converter with Neutral-Point Voltage Balancing and Common-Mode Voltage Reduction for Electric Starter/Generator System in More-Electric-Aircraft	1852
Feng Guo, Tao Yang, Serhiy Bozhko, Patrick Wheeler <i>University of Nottingham, United Kingdom</i>	

Grid-Connected Induction Motor using a Floating DC-Link Converter under Unbalanced Voltage Sag	1859
Maxsuel F. Cunha, Cursino B. Jacobina, Nayara B. de Freitas <i>Federal University of Campina Grande, Brazil</i>	
Robust Signal Offset Identification for Sensorless Control of Induction Machines at Rated Load using One-Active Modulating Pulse Excitation	1867
Eduardo Rodriguez Montero ¹ , Markus Vogelsberger ² , Felix Baumgartner ¹ , Thomas Wolbank ¹ ¹ <i>Technische Universität Wien, Austria; </i> ² <i>Bombardier Transportation Austria GmbH, Austria</i>	
Dual Converter for Connection of a Doubly-Fed Induction Generator to a DC-Microgrid	1873
Emerson L. Soares ¹ , Cursino B. Jacobina ¹ , Victor Felipe M.B. Melo ² , Nady Rocha ² , Edison Roberto C. da Silva ² ¹ <i>Federal University of Campina Grande, Brazil; </i> ² <i>Federal University of Paraíba, Brazil</i>	
Quantitative Characterization Comparison between Six Step and Field Oriented Control Methods for Permanent Magnet Brushless DC Motors	1881
Feilang Li ¹ , Wenxi Yao ¹ , Kevin Lee ² ¹ <i>Zhejiang University, China; </i> ² <i>Eaton Corporation, United States</i>	
A Full-Speed Range Hybrid PWM Strategy for High-Speed Permanent Magnet Synchronous Machine Considering Mitigation of Current Harmonics	1886
Yang Liang ¹ , Deliang Liang ¹ , Shaofeng Jia ¹ , Shuaijun Chu ¹ , Jiangbiao He ² ¹ <i>Xi'an Jiaotong University, China; </i> ² <i>University of Kentucky, United States</i>	
Comparative Study on Decoupling Synchronous Current Proportional-Plus-Integral Regulator Design in High Speed PMSM Drives	1891
Xiaolong Zhang, Yuyao Wang, Kiruba S. Haran, Philip T. Krein <i>University of Illinois Urbana-Champaign, United States</i>	
Session 39: SiC Devices and Applications	
Chair(s): Bilal Akin, David Feng	
A 400V/300A Ultra-Fast Intelligent DC Solid State Circuit Breaker using Parallel Connected SiC JFETs	1899
Wei Wang ¹ , Zhikang Shuai ¹ , Ying Cheng ¹ , Dong He ¹ , Xue Yang ¹ , Jinyong Lei ² , Z. John Shen ¹ ¹ <i>Hunan University, China; </i> ² <i>Electric Power Research Institute, China</i>	
Analysis of Antiparallel Diode Connection for Hybrid Si/SiC based ANPC for PV Applications	1905
Satish Belkhode, Anshuman Shukla, Suryanarayana Doolla <i>Indian Institute of Technology Bombay, India</i>	
Analytical Switching Model of the 1200V SiC MOSFET in a High-voltage High-frequency Pulsed Power Converter for Plasma Generation	1911
Qunfang Wu, Mengqi Wang, Weiyang Zhou, Guanliang Liu, Xiaoming Wang, Changqi You <i>University of Michigan-Dearborn, United States</i>	
Performance Comparison of Traditional and JBS Integrated SiC MOSFETs in Si/SiC Hybrid Switch	1918
Jiajun Yu, Zongjian Li, Zhizhi He, Xi Jiang, Chao Zhang, Jun Wang <i>Hunan University, China</i>	

Current-dependent Variable Switching Strategy for Si/SiC Hybrid Switch-based Single-phase Inverter	1922
Zeng Liu, Zishun Peng, Xiaogui Peng, Jun Wang Hunan University, China	
Design and Testing of a Modular Multilevel Converter Submodule based on 10 kV SiC MOSFETs	1926
Xingxuan Huang ¹ , James Palmer ¹ , Shiqi Ji ¹ , Li Zhang ¹ , Fred Wang ^{1,2} , Leon M. Tolbert ^{1,2} , William Giewont ³ ¹ University of Tennessee-Knoxville, United States; ² Oak Ridge National Lab, United States; ³ EPC Power, United States	
Evaluation and Characterization of Parallel Connected Ultra-Low Inductance 400A SiC MOSFET Modules	1934
Eddy Aeloiza ¹ , Arun Kadavelugu ¹ , Rostan Rodrigues ¹ , Mika Niemi ² , Markus Oinonen ² , Veli-Matti Leppanen ² ¹ ABB Inc., United States; ² ABB Motion, Finland	
Experimental Investigation and Verification of Traps affecting the performance of 3C-SiC-on-Si Schottky Barrier Diodes	1941
A. Arvanitopoulos ¹ , F. Li ² , M.R. Jennings ³ , S. Perkins ¹ , K.N. Gyftakis ⁴ , M. Antoniou ² , Phil Mawby ² , N. Lophitis ¹ ¹ Coventry University, United Kingdom; ² University of Warwick, United Kingdom; ³ Swansea University, United Kingdom; ⁴ The University of Edinburgh, United Kingdom	
Measurement of Important Circuit Parasitics for Switching Transient Analysis of SiC MOSFET and Schottky Diode Pair	1948
Shamibrota Kishore Roy, Kaushik Basu Indian Institute of Science Bangalore, India	
Medium Voltage (13.8 kV) Transformer-less Grid-Connected DC/AC Converter Design and Demonstration using 10 kV SiC MOSFET with High Frequency	1953
Shiqi Ji ¹ , Xingxuan Huang ¹ , Li Zhang ¹ , James Palmer ¹ , William Giewont ² , Fred Wang ^{1,3} , Leon M. Tolbert ^{1,3} ¹ University of Tennessee-Knoxville, United States; ² EPC Power, United States; ³ Oak Ridge National Lab, United States	
Characterization and Modeling of SiC MOSFETs Turn On in a Half Bridge Converter	1960
Mario Pulvirenti ¹ , Luciano Salvo ¹ , Giacomo Scelba ² , Angelo Giuseppe Sciacca ¹ , Massimo Nania ¹ , Giuseppe Scarcella ² , Mario Cacciato ² ¹ STMicroelectronics, Italy; ² University of Catania, Italy	
Multiple-Step Commutation Scheme for Avoiding High dv/dt in Modular Multilevel Converter with 10 kV SiC MOSFETs	1968
Li Zhang ¹ , Shiqi Ji ¹ , Xingxuan Huang ¹ , James Palmer 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 Lab, United States	
Optimal DC-Link RC Snubber Design for SiC MOSFET Applications	1974
Zheng Chen, Julius Rice, Jianwen Shao, Yuequan Hu Wolfspeed, A Cree Company, United States	
Performance Comparison of the Auxiliary Resonant Commutated Pole Inverter (ARCP) using SiC MOSFETs or Si IGBTs	1981
Wenzhi Zhou, Xibo Yuan, Ian Laird University of Bristol, United Kingdom	

Performance Improvement of Dual Active Bridge DC-DC Converter using Cost-Effectiveness Si/SiC Hybrid Switch 1988
Zongjian Li, ZhiZhi He, Jiajun Yu, Xi Jiang, Jun Wang
Hunan University, China

SiC-hybrid based Railway Inverter for Metro Application with 3.3kV Low Inductance Power Modules 1992
Alejandro Rujas¹, Victor M. Lopez¹, Irma Villar¹, Txomin Nieva², Ivan Larzabal²
¹IKERLAN Technology Research Centre, Spain; ²CAF Power & Automation, Spain

Switching Behavior Method to Estimate the Intrinsic Gate Resistance of a Transistor by using the Gate Plateau Voltage 1998
Tatsuya Yanagi, Ken Nakahar
Rohm Co., Ltd., Japan

Testing and Validation of 10 kV SiC MOSFET based 35 kVA MMC Phase-leg for Medium Voltage (13.8 kV) Grid 2001
James Palmer¹, Shiqi Ji¹, Xingxuan Huang¹, Li Zhang¹, William Giewont², Fred Wang^{1,3}, Leon M. Tolbert^{1,3}
¹University of Tennessee-Knoxville, United States; ²EPC Power, United States;
³Oak Ridge National Lab, United States

Session 40: Emerging Design and Applications of Energy Conversion **Chair(s): Fei Lu, Salman Harasis**

Miniature High-Voltage DC-DC Power Converters for Space and Micro-Robotic Applications 2007
Sanghyeon Park, Aaron Goldin, Juan Rivas-Davila
Stanford University, United States

Consensus Control for CC-CV Charging of Supercapacitors 2015
Xiaoyong Zhang^{1,2}, Yexin Liao^{1,2}, Heng Li^{1,2}, Yongjie Liu^{1,2}, Rui Zhang^{1,2}, Zhiqiang Meng^{1,2}, Jun Peng^{1,2}, Zhiwu Huang^{1,2}
¹Central South University, China; ²Hunan Engineering Laboratory of Rail Vehicles Braking Technology, China

Aging Condition Assessment for Live XLPE-Type Cables through Precise High Frequency Impedance Phase Detection 2021
Okan Boler¹, Yilmaz Sozer¹, Alex De Abreu Garcia¹, John Lauletta²
¹University of Akron, United States; ²Exacter Inc., United States

A Cost-effective, Compact, Automatic Testing System for Dynamic Characterization of Power Semiconductor Devices 2026
Avishek Ghosh, Carl Ngai Man Ho, Jared Prendergast
University of Manitoba, Canada

Tuesday, October 1

Session 41: PV Systems 1 **Chair(s): Mohammad B Shadmand, Hengzhao Yang**

Comprehensive Approach of Estimating Power-Peaks of Partially Shaded PV Strings with Overlapping Bypass Diodes 2033
Zaid Alqaisi, Yousef Mahmoud
Worcester Polytechnic Institute, United States

A GaN-Based Active Power Decoupling Approach for Enhancing the Efficiency and Reliability of Residential PV Microinverters 2039

Malek Ramezani¹, Fariborz Musavi¹, Saeed Golestan², Siavash Beheshtaein³,
Josep M. Guerrero², Robert Cuzner³

¹Washington State University, United States; ²Aalborg University, Denmark;

³University of Wisconsin-Milwaukee, United States

One Year Submillisecond Fast Solar Database: Collection, Investigation, and Application 2047

Yue Cao¹, John A. Magerko III², Rodrigo Serna³, Shibin Qin⁴, Robert C.N. Pilawa-Podgurski⁵, Philip T. Krein⁶

¹Oregon State University, United States; ²EPRI, United States; ³Citadel LLC, United States; ⁴Apple Inc., United States; ⁵University of California-Berkeley, United States; ⁶University of Illinois-Urbana-Champaign, United States

A Novel Approximate Model based Fault Diagnosis Technique for a Photovoltaic DC/AC Grid Tied Inverter 2054

Laurice Ann L. Smith, Satya Naidu, Mohamed O. Badawy

San Jose State University, United States

Session 42: DC Microgrid Control

Chair(s): Yaow-Ming Chen, Anshuman Shukla

Finite-time Stabilization of Constant Power Loads in DC Microgrids 2059

Qianwen Xu^{1,2}, Frede Blaabjerg¹, Chuanlin Zhang³

¹Nanyang Technological University, Singapore; ²Aalborg University, Denmark;

³Shanghai University of Electric Power, China

Optimal Droop Coefficient Computation by Multi-Objective Optimization for Distributed Generators in DC Microgrids 2065

Anushka M. Dissanayake, Nishantha C. Ekneligoda

Oklahoma State University, United States

Time Optimal Control of Constant Power Loads in DC Microgrids 2072

Anushka M. Dissanayake, Nishantha C. Ekneligoda

Oklahoma State University, United States

Hysteresis Droop Controller with One Sample Delay for DC-DC Converters in DC Microgrids 2078

Guangyuan Liu, Paolo Mattavelli

University of Padova, Italy

Session 43: Virtual Synchronous Generators

Chair(s): Qing-Chang Zhong, Pedro Rodriguez

Improved VSG Control for Type-IV Wind Turbine Generator Considering Operation Limitations 2085

Chu Sun¹, Syed Qaseem Ali², Geza Joos¹, Francois Bouffard¹

¹McGill University, Canada; ²OPAL-RT TECHNOLOGIES Inc., Canada

Stability Analysis Considering Dual Physical Constraints of Parallel-connected Virtual Synchronous Generators forming Microgrids 2092

Peilin Xie¹, Chang Yuan², Yajuan Guan¹, Sen Tan¹, Mingshen Li¹, Juan C. Vasquez¹, Josep M. Guerrero¹

¹Aalborg University, Denmark; ²North China Electric Power University, China

Transient Stability Analysis of Virtual Synchronous Generator Connected to an Infinite Bus	2099
Pengkun Li, Yue Wang, Yonghui Liu, Hui Zhou, Guoqing Gao, Wanjun Lei <i>Xi'an Jiaotong University, China</i>	
Multi-parameter Adaptive Power Allocation Strategy for Microgrid with Parallel PV/Battery-VSGs	2105
Meiqin Mao, Jian Hu, Yong Ding, Liuchen Chang <i>Hefei University of Technology, China</i>	
Session 44: Inductive Power Transfer 2	
Chair(s): Mehdi Farasat, Jin Ye	
A Reactive Compensation Method using Switch Controlled Capacitor for Wireless Power Transfer	2112
Jin Zhao ¹ , Jianzhong Zhang ¹ , Yaqian Zhang ¹ , Zakiud Din ¹ , Juri Jatskevich ² ¹ <i>Southeast University, China</i> ; ² <i>University of British Columbia, Canada</i>	
Variable Duty Control of Three-Phase Voltage Source Inverter for Wireless Power Transfer Systems	2118
Gui-Jia Su, Omer C. Onar, Jason Pries, Veda Prakash Galigekere <i>Oak Ridge National Lab, United States</i>	
A Self-oscillating Controller based on Pulse Density Modulator in Wireless Power Transfer	2125
Dong Wu, Ruikun Mai, Shiqiao Zhao, Zhengyou He, Fan Peng <i>Southwest Jiaotong University, China</i>	
A Soft-switched Active Clamped Half-bridge Current Source Inverter for Wireless Inductive Power Transfer	2129
Phuoc Sang Huynh, Sheldon S. Williamson <i>University of Ontario Institute of Technology, Canada</i>	
Session 45: AC-DC – Multi-Phase	
Chair(s): Srdjan Lukic, Mohamed Youssef	
Improved Modulation for Dual Active Bridge based Three-Phase Single-Stage AC-DC Converter	2135
Fengjiang Wu, Xiaoguang Li <i>Harbin Institute of Technology, China</i>	
A Single-Stage High Frequency-link Modular Three-Phase Soft-Switching AC-DC Converter for EV Battery Charger	2141
Tomokazu Mishima, Shoya Mitsui <i>Kobe University, Japan</i>	
Integration of Minimum-Voltage Active-Clamping to Three-Phase Four-Wire Rectifiers with a Balancing Leg	2148
An Zhao, Yangtao Huang, Keyan Shi, Jinyi Deng, Changsheng Hu, Dehong Xu <i>Zhejiang University, China</i>	
AC-DC Power Conversion Systems for Open-End Winding PMSM based on Vienna Rectifiers	2156
Amanda P. Monteiro, Cursino B. Jacobina, Filipe A.C. Bahia, Reuben P.R. Sousa <i>Federal University of Campina Grande, Brazil</i>	

Session 46: DC-DC Non-Isolated Converter 2

Chair(s): Parag Kshirsagar, Dong Cao

Voltage-Controlled Tunable Capacitor based Resonant Power Converter 2164

Ben Guo¹, Suman Dwari¹, Shashank Priya²

¹United Technologies Research Center, United States; ²Pennsylvania State University, United States

An Inductor-less DC to DC Converter Suitable for use in 1500V Solar Power Applications 2170

Mahesh Swamy

Yaskawa America, Inc., United States

Resonant Network Design Methodology based on Two-port Network Analysis Considering Load Impedance Variation 2178

Euihoon Chung, Jung-Ik Ha

Seoul National University, Republic of Korea

A Novel Switched-Capacitor Converter with Phase Shift Modulation 2184

Hongyang Xie, Rui Li

Shanghai Jiao Tong University, China

Session 47: Design for Reliability

Chair(s): Ke Ma, Alan Mantooth

DC Pulsed Transient Waveform Characterization under Wavelet Transformation 2192

Damian Oslebo¹, Keith Corzine², Todd Weatherford¹, Roberto Cristi¹, Atif Maqsood²

¹Naval Postgraduate School, United States; ²University of California-Santa Cruz, United States

Application of Digital Twin Concept in Condition Monitoring for DC-DC Converters 2199

Yingzhou Peng, Huai Wang

Aalborg University, Denmark

A Quasi-Online Monitoring Method of Output Capacitor and Boost Inductor for DCM Boost Converter 2205

Lingge Li, Kai Yao, Chanbo Guan, Chengjian Wu, Bin Fang, Zhen Zhang, Chunwei Ma, Jienan Chen, Junfang Zhang

Nanjing University of Science and Technology, China

PCB Layout based Short-Circuit Protection Scheme for GaN HEMTs 2212

Ozturk Sahin Alemdar¹, Furkan Karakaya², Ozan Keysan²

¹Aselsan Inc., Turkey; ²Middle East Technical University, Turkey

Session 48: Large Signal Stability and Control

Chair(s): Minjie Chen, Yunwei Li

An Asymmetrical Fault Current Iterative Algorithm of Droop-Controlled Inverter 2219

Huimin Zhao¹, Jun Ge¹, Zhikang Shuai¹, Ying Cheng¹, Jinyong Lei², John Shen³

¹Hunan University, China; ²China Southern Power Grid, China; ³Illinois Institute of Technology, United States

Suppression of Quantization-Induced Limit Cycles in Digitally Controlled DC-DC Converters by Dyadic Digital Pulse Width Modulation 2224

Maksudjon Usmonov, Paolo S. Crovetto, Francesco Gregoretti, Francesco Musolino

Politecnico di Torino, Italy

Conceptual Systematic Stability Analysis of Power Electronics based Power Systems	2232
Qianwen Xu, Xiongfei Wang, Mads Graungaard Taul, Frede Blaabjerg <i>Aalborg University, Denmark</i>	
A Stabilizer for Inverters Operating in Grid-Feeding, Grid-Supporting and Grid-Forming Modes	2239
Aswad Adib, Fariba Fateh, Behrooz Mirafzal <i>Kansas State University, United States</i>	
Session 49: Modeling and Simulation Tools	
Chair(s): Han Peng, Dragan Maksimovic	
A Numerical Method for Calculating the Output Spectrum of an H-Bridge Inverter with Dead-time based on Switching Mode Analysis	2245
Qihao Yu, Erik Lemmen, Bas Vermulst <i>Eindhoven University of Technology, Netherlands</i>	
Three-Phase Test Bench for Multiple Submodules in Modular Multilevel Converter System	2252
Shan Jiang, Ke Ma, Ye Zhu <i>Shanghai Jiao Tong University, China</i>	
Hierarchical Layout Synthesis and Design Automation for 2.5D Heterogeneous Multi-Chip Power Modules	2257
Imam Al Razi, Quang Le, H. Alan Mantooth, Yarui Peng <i>University of Arkansas, United States</i>	
Estimation of Lumped Equivalent Circuit Elements of a SiC Power Module	2264
David Reiff ¹ , Axel Rothstein ¹ , Jianghua Feng ² , Jing Shang ² , Volker Staudt ¹ ¹ Ruhr University Bochum, Germany; ² CRRC Zhuzhou Institute, China	
Session 50: Inverter Control	
Chair(s): Carl Ho, Marcello Pucci	
Optimized based Algorithm First Order Sliding Mode Control for Grid-Connected Packed E-Cell (PEC) Inverter	2269
Mohammad Babaie ¹ , Mohammad Sharifzadeh ¹ , Majid Mehrasa ² , Kamal Al-Haddad ¹ ¹ École de Technologie Supérieure, Canada; ² Babol Noshirvani University of Technology, Iran	
A Novel Decentralized Control Strategy for Input-Series Output-Parallel Inverter System	2274
Ke Zhang, Wu Chen, Liangcai Shu, Chenyang Xue, Han Ye, Syed Waqar Azeem <i>Southeast University, China</i>	
Power Decoupling Control for Boost-Type Single-Phase Inverter with Active Power Buffer	2280
Shenquan Liu ¹ , Yufei He ² , Gang Wang ¹ , Minghao Wang ² ¹ South China University of Technology, China; ² The Hong Kong Polytechnic University, China	
Harmonic Analysis of Common-mode Reduction Modulation for Three-level Inverter	2286
Ruirui Chen ¹ , Jiahao Niu ¹ , Handong Gui ¹ , Zheyu Zhang ⁴ , Fred Wang ^{1,2} , Leon M. Tolbert ^{1,2} , Benjamin J. Blalock ¹ , Daniel J. Costinett ^{1,2} , Benjamin B. Choi ³ ¹ University of Tennessee, United States; ² Oak Ridge National Lab, United States; ³ NASA Glenn Research Center, United States; ⁴ Clemson University, United States	

Session 51: Electric Machines: Loss analysis 1

Chair(s): Gerd Bramerdorfer, Franco Leonardi

A new Zig-Zag Variable Load Test Approach for Enhanced Stray-Load Loss Measurements 2294

Silvio Vaschetto¹, Andrea Cavagnino¹, Emmanuel Agamloh², Alberto Tenconi³

¹Politecnico di Torino, Italy; ²Baylor University, United States

Effect of Inverter Output dv/dt with Respect to Gate Resistance and Loss Comparison with dv/dt Filters for SiC MOSFET based High Speed Machine Drive Applications 2301

Heonyoung Kim, Sayan Acharya, Anup Anurag, Byeong-Heon Kim, Subhashish Bhattacharya

North Carolina State University, United States

Investigation and Prediction of PWM-induced Iron Loss in Lamination Steels using High-Frequency Inverters with Wide-Bandgap Switches 2307

Le Chang¹, Woongkul Lee¹, Thomas M. Jahns¹, Khwaja Rahman²

¹University of Wisconsin-Madison, United States; ²General Motors Global Propulsion Systems, United States

Iron Loss Calculation under PWM Inverter Switching for SiFe Steel Materials 2315

Hiroaki Matsumori¹, Toshihisa Shimizu², Takashi Kosaka¹, Nobuyuki Matsui¹

¹Nagoya Institute of Technology, Japan; ²Tokyo Metropolitan University, Japan

Session 52: Induction Machines

Chair(s): Cong Ma, Silvio Vaschetto

Induction Motor Mapping using Rotor Field-Oriented Analysis Technique 2321

Matteo Carbonieri, Nicola Bianchi, Luigi Alberti

University of Padova, Italy

Prediction of Drive-Fed Induction Machine Efficiency using Sine Wave Efficiency Results 2329

Mahmud Ghasemi Bijan, Pragasen Pillay

Concordia University, Canada

Hybrid Method for Measuring Rotor Bar-Lamination Contact Resistances 2335

Andrea Cavagnino¹, Silvio Vaschetto¹, Zbigniew Gmyrek²

¹Politecnico di Torino, Italy; ²Lodz University of Technology, Poland

A Method to Estimate Torque and Stray Load Loss of Induction Motor without Torque Detector 2341

Shu Yamamoto, Hideaki Hirahara, Balapuwaduge Amith Shantha Gunasekara

Polytechnic University, Japan

Session 53: Energy Efficiency Issues in Electric Drives

Chair(s): Lijun He, Arijit Banerjee

Novel Winding Changeover Method for a High Efficiency AC Motor Drive 2347

Seong-Hwan Im¹, Gwangmin Park², Bon-Gwan Gu¹

¹Kyungpook National University, Republic of Korea; ²Korea Automotive Technology Institute, Republic of Korea

Operation and Analysis of Current-Source Inverters using Dual-Gate Four-Quadrant Wide-Bandgap Power Switches 2353

Renato A. Torres, Hang Dai, Thomas M. Jahns, Bulent Sarlioglu

University of Wisconsin-Madison, United States

An H8 Current-Source Inverter using Wide Bandgap Bidirectional Switches 2361
Hang Dai, Renato A. Torres, Thomas M. Jahns, Bulent Sarlioglu
University of Wisconsin-Madison, United States

Implementation of the Master-Slave Windings Scheme for the Low Pulse Ratio Operation in Motor Drivers 2369
Mufeng Xiong, Zipeng Liang, Sideng Hu, Wenxi Yao, Xiangning He
Zhejiang University, China

Session 54: Prof. Bob Lorenz Memorial Session 2
Chair(s): Thomas M. Jahns, Bulent Sarlioglu

Design of Current Regulator for Induction Machines at Low Sampling-to-Fundamental Frequency Ratios with Improved Current Observer 2374
Yang Xu¹, Chikara Morito², Robert D. Lorenz¹
¹University of Wisconsin-Madison, United States; ²Toshiba Mitsubishi-Electric Industrial Systems Corporation, Japan

Spatial Deadbeat Torque Control for Six-Step Operation 2380
Marc S. Petit¹, Bulent Sarlioglu¹, Robert D. Lorenz¹, Brent S. Gagas², Caleb W. Secrest²
¹University of Wisconsin-Madison, United States; ²General Motors, United States

SPMSMs Sensorless Torque Estimation using High Frequency Signal Injection 2388
David Reigosa¹, Ye Gu Kang², María Martínez¹, Daniel Fernández¹, J.M. Guerrero¹, Fernando Briz¹
¹University of Oviedo, Spain; ²University of Wisconsin-Madison, United States

Session 55: Gate Drive for Wide Band Gap Device 1
Chair(s): Tanya Gachovska, He Li

An Intelligent Model-Based Multi-Level Active Gate Driver for Power Semiconductor Devices 2394
Shuang Zhao, Xingchen Zhao, Haider Mehsan, Chris Farnell, Alan Mantooth
University of Arkansas, United States

Economical Methods for SiC JFET's Short-circuit Protection using Commercial Gate Drivers 2401
Rostan Rodrigues, Xiaoqing Song
ABB Inc., United States

Design and Implementation of Digital Active Gate Control with Variable 63-level Drivability Controlled by Serial 4-bit Signals 2408
Hidemine Obara¹, Tomoyuki Mannen², Keiji Wada², Koutaro Miyazaki³, Toru Sai³, Makoto Takamiya³, Takayasu Sakurai³
¹Yokohama National University, Japan; ²Tokyo Metropolitan University, Japan; ³The University of Tokyo, Japan

Current Sharing and Overvoltage Issues of Paralleled SiC MOSFET Modules 2413
Krishna Mainali¹, Ruxi Wang², Juan Sabate², Steven Klopman²
¹Renesas Electronics America Inc., United States; ²GE Global Research, United States

Session 56: Emerging Design and Applications of Energy Conversion 2
Chair(s): Kaveh Ashenayi, Ahmet Yeksan

Electronically Assisted Circuit Breaker (EACB) for DC Power Systems 2419
Yanjun Feng¹, Yuanfeng Zhou¹, Z. John Shen¹, Xin Zhou², Slobodan Krstic²
¹Illinois Institute of Technology, United States; ²Eaton Corporation, United States

High-Frequency Resonant Inverter for Power Transfer between Distributed Modules of a Biomedical Implant 2426
Usama Anwar¹, Khurram K. Afridi², Dejan Markovic¹
¹University of California-Los Angeles, United States; ²Cornell University, United States

Development of a Power Electronics Teaching Lab incorporating WBG Semiconductors with Plug and Play Modular Hardware and Advanced Curriculum 2432
Chondon Roy, Namwon Kim, Robert Cox, Babak Parkhideh
University of North Carolina-Charlotte, United States

A New Adaptive Virtual Impedance based Fault Current Limiter for Converters 2439
Siavash Beheshtaein¹, Saeed Golestan², Robert Cuzner¹, Josep M. Guerrero²
¹University of Wisconsin-Milwaukee, United States; ²Aalborg University, Denmark

Session 57: Energy Storage Systems

Chair(s): Adel Nasiri, Ke Ma

Residential (Secondary-Use) Energy Storage System with Modular Software and Hardware Power Electronic Interfaces 2445
M. Starke¹, M. Chinthavali¹, S. Zheng¹, S.S. Campbell¹, R. Zeng¹, M. Smith¹, B. Dean²
¹Oak Ridge National Lab, United States; ²University of Tennessee, United States

Energy Storage Systems based on Sodium Metal Halides Batteries 2452
Mauro Boi, Daniele Battaglia, Andrea Salimbeni, Alfonso Damian
Universita degli Studi di Cagliari, Italy

Measuring Individual Battery Dimensional Changes for State-of-Charge Estimation using Strain Gauge Sensors 2460
Ryan Hickey, Thomas M. Jahns
University of Wisconsin-Madison, United States

Direct Comparison of State-of-Charge and State-of-Energy Metrics for Li-Ion Battery Energy Storage 2466
Ryan Hickey, Thomas M. Jahns
University of Wisconsin-Madison, United States

High-Efficiency Silicon Carbide (SiC) Converter using Paralleled Discrete Devices in Energy Storage Systems 2471
Zheyu Zhang¹, Hao Tu^{1,2}, Xu She¹, Tomas Sadilek¹, Ramanujam Ramabhadran¹, Huan Hu¹, William Earls¹
¹GE Global Research, United States; ²North Carolina State University, United States

Battery Loss Modelling using Equivalent Circuits 2478
Siwei Liu, Andrew Forsyth, Rebecca Todd
The University of Manchester, United Kingdom

Nonlinear Control Design for Bidirectional Synchronous Buck-Boost Converters used in Residential Battery Storage Systems 2485
Andres Salazar¹, Alberto Berzoy¹, Javad Mohammadpour Velni²
¹Sonnen Inc., United States; ²University of Georgia, United States

Li-ion Batteries Parameter Estimation using Converter Excitation and Fusion Methods 2491
Irene Peláez, Pablo García, Geber Villa, Sarah Saeed
University of Oviedo, Spain

Measurement and Estimation of the Equivalent Circuit Parameters for Multi-MW Battery Systems	2499
Oluwaseun M. Akeyo ¹ , Vandana Rallabandi ¹ , Nicholas Jewell ² , Dan M. Ionel ¹	
¹ University of Kentucky, United States; ² Louisville Gas and Electric and Kentucky Utilities, United States	
Power Allocation for Energy Stored Quasi-Z-Source Inverter based on the Power Loss Modelling	2505
Yangyang Meng, Yujie Wang, Mufeng Xiong, Sideng Hu, Xiangning He	
Zhejiang University, China	
Polynomial Regression method-based Remaining Useful Life Prediction and Comparative Analysis of Two Lithium Nickel Cobalt Manganese Oxide Batteries	2510
Soon-Jong Kwon ¹ , Jinhyeong Park ¹ , Jin Hyeok Choi ² , Ji-Hun Lim ² , Sung-Eun Lee ² , Jonghoon Kim ¹	
¹ Chungnam National University, Republic of Korea; ² Korea Electric Power Corporation Research Institute, Republic of Korea	
Battery Internal Resistance Estimation using a Battery Balancing System based on Switched Capacitors	2516
Cristina González Moral ¹ , Diego Fernández Laborda ² , Lidia Sánchez Alonso ² , Juan Manuel Guerrero ² , Daniel Fernández ² , Carlos Rivas ¹ , David Diaz Reigosa ²	
¹ ELINSA, Spain; ² University of Oviedo, Spain	
Impact of Energy Storage System Response Speed on Enhanced Frequency Response Services	2523
Qingwei Zhu, Alberto Bolzoni, Andrew Forsyth, Rebecca Todd	
The University of Manchester, United Kingdom	
Evaluation of BESS Management Strategies for Grid Primary and Enhanced Frequency Response	2530
Yiheng Hu ¹ , Xihai Cao ² , Nigel Schofield ¹ , Nan Zhao ²	
¹ University of Huddersfield, United Kingdom; ² University College Dublin, Ireland	
Session 58: Renewable Generation and Energy Storage	
Chair(s): Mahshid Amirabadi, Katherine Kim	
Grid Interfaced PV System using a Generalized Mixed p-Norm Adaptive Filtering Algorithm	2538
Shalvi Tyagi, Shailendra Kumar, Bhim Singh, Subarni Pradhan	
Indian Institute of Technology Delhi, India	
Enhancing Power System Transient Stability by Virtual Synchronous Generator Control using Wide-Area Measurements	2546
Yiwei Ma ¹ , Lin Zhu ¹ , Fred Wang ^{1,2} , Leon M. Tolbert ^{1,2}	
¹ University of Tennessee, United States; ² Oak Ridge National Lab, United States	
Neural Network based Control Algorithm for Solar PV Interfaced System	2552
Pavitra Shukl, Bhim Singh	
Indian Institute of Technology Delhi, India	
Improvement of Grid Current Quality for Droop-Controlled Grid-Connected Inverters under Distorted Grid Conditions	2560
Baojin Liu, Jinjun Liu, Zeng Liu	
Xi'an Jiaotong University, China	

Synchronization and Current Sharing for Nonlinear-oscillator-based Inverters in Islanded Three-phase Microgrid	2566
Mingshen Li, Baoze Wei, Peilin Xie, Sen Tan, Josep M. Guerrero, Juan C. Vasquez <i>Aalborg University, Denmark</i>	
Instantaneous Zero Sequence Voltage for Grid Energy Balancing under Unbalanced Power Generation	2572
Ricardo P. Aguilera ¹ , Pablo Acuna ² , Christian A. Rojas ³ , Georgios Konstantinou ⁴ , Josep Pou ⁵ ¹ University of Technology Sydney, Australia; ² University of Talca, Chile; ³ Universidad Técnica Federico Santa María, Chile; ⁴ University of New South Wales Sydney, Australia; ⁵ Nanyang Technological University, Singapore	
LCL-Filter Design to Suppress Transient Overshoots of Grid-Connected Inverters under Grid Voltage Fluctuations or Faults	2578
Jinming Xu, Zhao Zhang, Shenyiyang Bian, Miao Liu, Shaojun Xie <i>Nanjing University of Aeronautics and Astronautics, China</i>	
Analysis of the Parallel Operation between Synchronverters and PLL-Based Converters	2583
Roberto Rosso ¹ , Soenke Engelken ¹ , Marco Liserre ² ¹ WRD GmbH, Germany; ² Christian-Albrechts-Universität zu Kiel, Germany	
Analysis and Mitigation of Voltage Measurement Errors for Three-Phase Parallel Voltage Source Inverters	2591
Yang Qi ¹ , Jiazhe Liu ¹ , Yi Tang ¹ , Kaushik Rajashekara ² ¹ Nanyang Technological University, Singapore; ² University of Houston, United States	
Selective Harmonic Elimination and Balancing of Capacitor Voltage in Hybrid Cascaded Multilevel Inverter using Model Predictive Control	2597
Abhinandan Routray, R.K. Singh, R. Mahanty <i>Indian Institute of Technology Varanasi, India</i>	
Leakage Current Mitigation in Transformerless Z-Source/Quasi Z-Source PV Inverters: An Overview	2603
Jing Yuan, Yongheng Yang, Frede Blaabjerg <i>Aalborg University, Denmark</i>	
Impedance Characterization of Utility-Scale Renewable Energy and Storage Systems	2609
Shahil Shah, Przemyslaw Koralewicz, Robb Wallen, Vahan Gevorgian <i>National Renewable Energy Laboratory, United States</i>	
A DC Component Suppression Technique based on Virtual Capacitors	2617
Bo Long ¹ , Wenting Fang ¹ , Udaya K. Madawala ² ¹ University of Electronic Science and Technology, China; ² University of Auckland, New Zealand	
Influence of the ICF Decoupling Technique on the Stability of the Current Control Loop of a Grid-Tied VSC	2622
Leonardo Marin ¹ , Andres Tarrasó ¹ , Ignacion Candela ¹ , Rebecca Rye ² , Pedro Rodriguez ³ ¹ Universitat Politècnica de Catalunya, Spain; ² Virginia Polytechnic Institute and State University, United States; ³ Universidad Loyola Andalucía, Spain	
Active Compensator for Multi-Paralleled Grid-Tied Inverters under variable Grid Conditions	2629
Yuqi Peng, Yuanbin He, Lijun Hang <i>Hangzhou Dianzi University, China</i>	

- Reactive Power Injection and SOGI based Active Anti-Islanding Protection Method** 2637
 Yunpeng Si, Yifu Liu, Chunhui Liu, Zhengda Zhang, Qin Lei
Arizona State University, United States
- A Grid-compatible Virtual Oscillator Controller: Analysis and Design** 2643
 Minghui Lu¹, Soham Dutta¹, Victor Purba², Sairaj Dhople², Brian Johnson¹
¹University of Washington, United States; ²University of Minnesota, United States
- Design of Bipolar Interface Converter for Purely DC Microgrid with Minimally Processed Maximum Power Point Operation of Photovoltaics** 2650
 Sanchit Mishra, Visweshwar Chandrasekaran, Sreekanth T., Ned Mohan
University of Minnesota, United States
- Multi-mode Control for Three-phase Bidirectional AC/DC Converter in Hybrid Microgrid under Unbalanced AC Voltage Conditions** 2658
 Chunguang Ren, Longfeng Liu, Xiaoqing Han, Baifu Zhang, Lei Wang, Peng Wang
Tauyuan University of Technology, China
- Session 59: Batteries Management & Infrastructures**
Chair(s): Veda Prakash Galigekere, Sifat Chowdhury
- State of Charge and Equivalent Internal Resistance Estimation for a Multi-cell Application based on Cell-Difference-Model** 2664
 Woo-Yong Kim¹, Pyeong-Yeon Lee², Jonghoon Kim², Kyung-Soo Kim¹
¹Korea Advanced Institute of Science & Technology, Republic of Korea;
²Chungnam National University, Republic of Korea
- Thermal Modeling of a Lithium-Ion Battery Pack in a Plug-in Electric Vehicle** 2669
 Xiaohui Li¹, Meng Yao¹, Linpei Zhu², Xiayi Yuan², Jin Shang¹, Bozhi Yang¹
¹GAC R&D Center Silicon Valley, United States; ²Guangzhou Automobile Engineering Institute, China
- A Selection Switch based Cell-to-cell Battery Voltage Equalizer with Reduced Switch Count** 2674
 Shimul K. Dam, Vinod John
Indian Institute of Science, India
- A Three-Level DC-DC Converter for Battery Impedance Spectroscopy** 2682
 Omolola M. Faloye, Paul Barendse
University Of Capetown, South Africa
- Modelling and Simulation of Fuel Cell/Supercapacitor Passive Hybrid Vehicle System** 2690
 Qian Xun, Yujing Liu, Jian Zhao, Emma Arfa Grunditz
Chalmers University of Technology, Sweden
- Online Adaptive SOC Estimation via Information on Linear Regression Model based SOH for Electric Powered Application** 2697
 Pyeong-Yeon Lee¹, Seong-Yun Park¹, Seoungjun Lee², Woonki Na³, Cheolwoo Lim⁴, Jonghoon Kim¹
¹Chungnam National University, Republic of Korea; ²Chosun University, Republic of Korea; ³California State University-Fresno, United States; ⁴Korea Institute of Science and Technology, Republic of Korea

Session 60: Rectifiers & Inverters

Chair(s): Arijit Banerjee, Vito Giuseppe Monopoli

- WBG Partial Power Processing: A New PFC Design with Interleaved MHz-Frequency GaN and Low-Frequency Si Phases** 2702
Chao Zhang¹, Xin Yin¹, Sai Tang¹, Daming Wang¹, Xifei Liu¹, Jun Wang¹, Z. John Shen²
¹Hunan University, China; ²Illinois Institute of Technology, United States
- Reconfigurable Universal Buck-Boost PFC with Ultra Wide Input Voltage Range** 2707
Mohammad Mahdavi, Hamed Valipour, Martin Ordonez
The University of British Columbia, Canada
- A New AC/DC Half-Bridge/String-Inverter Hybrid-Structured Isolated Bi-directional Converter** 2713
Reza Emamalipour, John Lam
York University, Canada
- Low Frequency Finite Set Model Predictive Control for Seven-Level Modified Packed U-Cell Rectifier** 2719
Mohammad Babaie¹, Majid Mehrasa², Mohammad Sharifzadeh¹, Kamal Al-Haddad¹
¹École de Technologie Supérieure, Canada; ²Babol Noshirvani University of Technology, Iran
- A Two-phase Three-dimension Common Capacitor LLC Resonant Converter** 2725
Wenhui Mo, Xiumei Yue, Kui Li, Xinyue Chen, Hongliang Wang
Hunan University, China
- A Multimode Bridge-less SiC-Based AC/DC Step-up Converter with a Dual Active Auxiliary Circuit for Wind Energy Conversion Systems with MVDC Grid** 2731
Mehdi Abbasi, John Lam
York University, Canada
- 3-Level Asymmetric Full-Bridge Soft-Switched PWM Converter for 3-Phase Unfolding based Battery Charger Topology** 2737
Dorai Babu Yelaverthi, Rees Hatch, Mahmoud Mansour, Hongjie Wang, Regan Zane
Utah State University, United States
- Experimental Validation of Single-Stage Three-Phase Non-Isolated Cuk Rectifier** 2744
Nikhil Kumar, Moien Mohamadi, Sudip Mazumder
University of Illinois-Chicago, United States
- Design Methodology of a ZVS Class-E Inverter with Fixed Gain** 2752
Lujie Zhang, Khai Ngo
Virginia Polytechnic Institute and State University
- A Novel Auxiliary Resonant Snubber Inverter using Wide Bandgap Devices** 2759
Yu Wei¹, Ming-Cheng Chen², Chih-Shen Yeh³, Jih-Sheng Lai³
¹Cummins Inc., United States; ²National Taiwan University of Science and Technology, Taiwan;
³Virginia Polytechnic Institute and State University, United States
- Design and Implementation of Dual-Frequency Single-Phase Grid-connected Inverter** 2766
Liyong Yang¹, Aoyu Chang¹, Shuo Liu¹, Zhigang Chen², Guofeng Yuan¹
¹North China University of Technology, China; ²University of Science & Technology Beijing, China

An Improved Time-Delay Compensation Scheme for Enhancing Control Performance of Digitally Controlled Grid-Connected Inverter	2772
Yinglin Jin ¹ , Tianzhi Fang ¹ , Kai Yao ²	
¹ Nanjing University of Aeronautics and Astronautics, China; ² Nanjing University of Science and Technology, China	
A High Power Density Three Phase Inverter for Microcars based on 100V/600A Six-pack MOSFET Module	2777
Dongmyoung Joo, Yong-Su No, Byoung Jo Hyon, Joon Sung Park, Jin-Hong Kim, Jun-Hyuk Choi	
Intelligent Mechatronics Research Center, Republic of Korea	
Single-Phase Cascaded-Transformer Converter with Two DC Links	2782
Nayara B. de Freitas, Cursino B. Jacobina, Maxsuel F. Cunha	
Federal University of Campina Grande, Brazil	
A Modified Lyapunov-based Control Strategy for a Single-Phase VSI with a Load Estimator	2789
Chan Chok You ¹ , Xiaochao Hou ² , Jinsong He ¹ , Xin Zhang ¹	
¹ Nanyang Technological University, Singapore; ² Central South University, China	
Gain Enhancement of Switched Boost Inverter using a Novel PWM Scheme	2794
Anil Gambhir, Santanu Mishra	
Indian Institute of Technology Kanpur, India	
Implementation and Comparison of Active and Reactive Power Flow Control Methods in a Single Phase Grid-Connected Microgrid	2800
Dimitrios Kanavaros ¹ , Giovanna Oriti ¹ , Alexander Julian ²	
¹ Naval Postgraduate School, United States; ² Consultant, United States	
A Single-Stage Three-Phase Split-Y-Source Inverter	2808
Manxin Chen, Changqing Yin, Lei Ming, Poh Chiang Loh	
The Chinese University of Hong Kong, China	
A Variable Switching Frequency Virtual Space Vector Pulse-Width Modulation based on the Current Ripple Prediction	2814
Xingchen Zhao, Shuang Zhao, Zhe Zhao, Fei Diao, Yue Zhao, Chris Farnell, Alan Mantooth	
University of Arkansas, United States	
Zero-sequence Component Injection ZVS-PWM for Three-phase Grid Inverter with Arbitrary Power Factor Angle	2821
Yuying Wu, Ning He, Dehong Xu	
Zhejiang University, China	
Reduction of DC-link Ripples for SiC-based Three-phase Four-wire Inverters with Unbalanced Loads	2829
Peng Yang, Wenlong Ming, Jun Liang, Jianzhong Wu, Wei Liu	
Cardiff University, United Kingdom	
A Novel Three-Phase H7 Current-Source Inverter with Improved Reliability	2836
Fazal Akbar, Honnyong Cha	
Kyungpook National University, Republic of Korea	

Control of a Three-Phase Grid-Tied Inverter Designed for Discontinuous Current Mode Operation 2842
Minami Terada, Hiroaki Toyoda, Ryuji Iijima, Takanori Isobe, Hiroshi Tadano
University of Tsukuba, Japan

A Single-Stage Isolated Three-Phase Bidirectional AC/DC Converter for High-Power Applications 2850
Ling Gu, Kai Peng
Nanjing University of Science and Technology, China

Session 61: Converter Modeling, Control and Design 1
Chair(s): Sheng Zheng, Fei Lu

Quantitative Analysis of Incomplete Shielding Layer in Flyback Converter for Common-Mode Noise Suppression 2855
Yan Liu, Fanghua Zhang, Guangdong Dong
Nanjing University of Aeronautics and Astronautic, China

High-Frequency Noise Suppression in a Buck-Converter System based on SiC Devices 2859
Shotaro Takahashi¹, Satoshi Ogasawara¹, Masatsugu Takemoto¹, Koji Orikawa¹, Michio Tamate²
¹Hokkaido University, Japan; ²Fuji Electric Co., Ltd., Japan

Pulse Width Modulation-Based Common-Mode Noise Source Characterization of Three-Phase Two-Level Split-Source Inverter 2867
M.S. Hassan^{1,2}, Masahito Shoyama¹
¹Kyushu University, Japan; ²Minia University, Egypt

Current-bias Dependent Permeability of Powder and Amorphous Core Induced Unbalanced DM Impedance and Mixed-mode Noise 2873
Ren Ren¹, Bo Liu³, Zhou Dong¹, Fred Wang^{1,2}
¹University of Tennessee-Knoxville, United States; ²Oak Ridge National Lab, United States;
³United Technologies Research Center, United States

On the Stability of Virtual Inertia Control Implemented by Grid-Connected Power Converters with Delay Effects 2881
Haoxin Yang¹, Jingyang Fang¹, Yi Tang¹, Ching-Ming Lai², Han Deng¹
¹Nanyang Technological University, Singapore; ²National Chung Hsing University, Taiwan

Transient Angle Stability Comparison of Paralleled VSGs System and Hybrid System Comprised by VSG and Diesel Generator 2889
Huijie Cheng¹, Ying Cheng¹, Zhikang Shuai¹, Chao Shen¹, Zhiyong Yuan², Ke Zhou³, John Shen⁴
¹Hunan University, China; ²China Southern Power Grid, China; ³Guangxi Power Grid Co., Ltd., China;
⁴Illinois Institute of Technology, United States

Re-synchronization Capability Analysis of Virtual Synchronous Generators in Microgrids 2896
Chao Shen¹, Ying Cheng¹, Zhikang Shuai¹, Huijie Cheng¹, Jinyong Lei², Ke Zhou², Z. John Shen³
¹Hunan University, China; ²China Electric Power Research Institute, China;
³Illinois Institute of Technology, United States

Universal Active Power Filter based on Three Three-Leg Converters and a Single DC-link 2902
Phelipe L.S. Rodrigues, Cursino B. Jacobina, Andre E.L. Costa, Italo A. Cavalcanti de Oliveira
Federal University of Campina Grande, Brazil

Cascaded Dual Output Multilevel Converter to Enhance Power Delivery and Quality	2910
Vijesh Jayan, Amer Ghias Nanyang Technological University, Singapore	
A Single-Objective FCS-MPC Method for Three-Level APF	2916
Bo Peng, Guorong Zhang Hefei University of Technology, China	
A New Fault-Tolerant Control Method for Cascaded H-Bridge Multilevel Inverter to Increase Maximum Output Voltage	2922
Saeed Ouni ¹ , Mehdi Narimani ¹ , Navid Zargari ² , Zhongyuan Cheng ² ¹ McMaster University, Canada; ² Rockwell Automation, Canada	
Detecting Method for an Open-Switch Fault of SiC MOSFET and Si IGBT in Hybrid ANPC Inverter System	2928
Bong-Hyun Kwon, Kyu-Chul Bae, Seok-Min Kim, Kyo-Beum Lee Ajou University, Republic of Korea	
Model based Parametric Fault Detection in Power Electronic Circuits	2933
Kang Yue ¹ , Yu Liu ^{1,2} , Rong He ¹ , Minfan Fu ¹ , Haoyu Wang ¹ ¹ ShanghaiTech University, China; ² Ministry of Education, China	
Arc Fault Detection in DC Distribution using Semi-Supervised Ensemble Machine Learning	2939
Yu Le ¹ , Xiu Yao ¹ , Chad Miller ² , Tsao-Bang Hung ² ¹ University at Buffalo, United States; ² Air Force Research Laboratory, United States	
A Data-driven RUL Prediction Method Enhanced by Identified Degradation Model for Lithium-ion Battery of EVs	2946
Jun Peng ^{1,2} , Mingjian Wu ^{1,2} , Dianzhu Gao ^{1,2} , Xiaoyong Zhang ^{1,2} , Yijun Cheng ^{1,2} , Zhiyong Zheng ^{1,2} , Bin Chen ^{1,2} , Fu Jiang ^{1,2} , Zhiwu Huang ^{1,2} ¹ Central South University, China; ² Hunan Engineering Laboratory of Rail Vehicles Braking Technology, China	
Online Monitoring Method for a DC-Link Capacitor in an AC/DC/AC Converter	2953
Weiyang Zhou ¹ , Mengqi Wang ¹ , Qunfang Wu ¹ , Xi Lu ² , Kewei Xiao ² , Chingchi Chen ² ¹ University of Michigan-Dearborn, United States; ² Ford Motor Company, United States	
Junction Temperature Model and Degradation Effect in IGBT Multichip Power Modules	2957
Fernando Gonzalez-Hernando ¹ , Jon San-Sebastian ¹ , Asier Garcia-Bediaga ¹ , Manuel Arias ² , Alejandro Rujas ¹ ¹ IKERLAN Technology Research Centre, Spain; ² Oviedo University, Spain	
A Nonintrusive IGBT Open-Circuit Fault and Current Sensor Fault Diagnosis Method for Grid-Tied Three-phase Three-wire Inverter with Two Current Sensors	2963
Zhan Li ^{1,2} , Pat Wheeler ³ , Alan Watson ³ , Alessandro Costabeber ³ , Zhihong Bai ¹ , Xin Zhang ² , Bohui Zhao ² , Hao Ma ¹ ¹ Zhejiang University, China; ² Nanyang Technological University, Singapore; ³ University of Nottingham, United Kingdom	
Fault Detection of Switch Mode Power Converters based on Radiated EMI Analysis	2968
Mohammad Arifur Rahman ¹ , Elham Pazouki ² , Yilmaz Sozer ¹ , J. Alexis De Abreu-Garcia ¹ ¹ University of Akron, United States; ² Rockwell Automation, United States	

MOSFET Junction Temperature Measurements using Conducted Electromagnetic Emissions and Support Vector Machines 2973
Justin Demus, Viktoriia Sysoeva, Qianyi Cheng, Matt Boubin, Ahmed Siraj, Mark Scott
Miami University, United States

Grid Voltage Estimation and Feedback Linearization based Control of a Three phase Grid Connected Inverter under Unbalanced Grid Conditions with LCL Filter 2979
Vikram Roy Chowdhury, Jonathan W. Kimball
Missouri University of Science and Technology, United States

A New Fault-Tolerant Method for 5-Level Active Neutral Point Clamped Inverter using Sinusoidal PWM 2985
Peter Azer, Saeed Ouni, Mehdi Narimani
McMaster University, Canada

Session 62: Machine Modelling and Non-Conventional Machines
Chair(s): Wen Ouyang, Shafiq Ahmed Odhano

High Torque Density Fractional-Slot Concentrated-Winding Axial-Flux Permanent-Magnet Machine with Modular SMC Stator 2991
Weiwei Geng¹, Zhuoran Zhang², Qiang Li¹
¹*Nanjing University of Science and Technology, China;* ²*Nanjing University of Aeronautics and Astronautics, China*

2-D Modeling and Experimental Testing of Single Rotor and Dual Stator Axial-Flux Permanent Magnet Machine 2996
Calvin Corey^{1,2}, Ju Hyung Kim¹, Bulent Sarlioglu¹
¹*DRS Naval Power Systems, United States;* ²*University of Wisconsin, Madison, United States*

Design of a Novel Axial Flux Permanent Magnet Assisted Synchronous Reluctance Motor 3004
Md Tawhid Bin Tarek, Yilmaz Sozer
University of Akron, United States

Basic Design of an Ultra-lightweight Machine based on Magnetic Resonance Coupling and Influence of AC Losses due to High Frequency 3010
Kazuto Sakai, Kenta Takishima
Toyo University, Japan

Comparison of Different Capacitor Tuning Criteria in Air-Cored Resonant Induction Machines 3017
Zhao Jin¹, Matteo F. Iacchetti¹, Alexander C. Smith¹, Rajesh P. Deodhar², Keisuike Mishima³
¹*The University of Manchester, United Kingdom;* ²*IMRA Europe SAS, United Kingdom;* ³*Aisin Seiki Co., Ltd., Japan*

Synthesis of an Equivalent π -model of Two-winding Transformer and Resonance Frequency Estimation using Lumped Circuit Parameters 3025
Annoy Kumar Das, Baylon G. Fernandes
Indian Institute of Technology Bombay, India

A Novel Modular Transverse Flux Linear Permanent Magnet Vernier Machine with Halbach Arrays and Consequent Poles 3033
Rui Li, Ronghai Qu, Dawei Li, Yuting Gao, Chaojie Shi
Huazhong University of Science and Technology, China

Analytic Magnetic Field Modelling approach for Iron-less Tubular Permanent Magnet Linear Synchronous Motors	3038
Matthew Forbes ¹ , William S.P. Robertson ¹ , Anthony C. Zander ¹ , Johannes J.H. Paulides ² <i>¹University of Adelaide, Australia; ²Advanced Electromagnetics Group, The Netherlands</i>	
Converter-fed Induction Motor Efficiency Measurement under Variable Frequency/Load Points: An Extension of the IEC/TS 60034-2-3	3046
Muhammad Aminu, John Mushenya, Paul S. Barendse, Mohammed Azeem Khan <i>University of Cape Town, South Africa</i>	
Electromagnetic and Thermal Behavior of a Triple Redundant 9-phase PMASynRM with Insulation Deterioration Fault	3053
Yanwen Shi, Jiabin Wang, Rongguang Hu, Bo Wang <i>University of Sheffield, United Kingdom</i>	
Minimization of AC Losses in Permanent Magnet Machines by Transposed Coil Connection	3061
Jingyi Liu, Xinggong Fan, Dawei Li, Ronghai Qu, Haiyang Fang <i>Huazhong University of Science and Technology, China</i>	
Spatial MMF Harmonic Mitigation in Aluminum-Cage Induction Motors	3067
Andrea Cavagnino ¹ , Silvio Vaschetto ¹ , Luca Ferraris ¹ , Zbigniew Gmyrek ² , Emmanuel Agamloh ³ , Gerd Bramerdorfer ⁴ <i>¹Politecnico di Torino, Italy; ²Lodz University of Technology, Poland; ³Baylor University, United States; ⁴Johannes Kepler University Linz, Austria</i>	
On the Accuracy and Improvement of FE-Based Electric Machine Evaluation Concerning Soft Magnetic Material Modeling	3074
Gerd Bramerdorfer, Gereon Goldbeck, Martin Kitzberger <i>Johannes Kepler University Linz, Austria</i>	
Impact of Local Degradation in Soft Magnetic Materials on Performance of Permanent Magnet Synchronous Machines	3081
Gereon Goldbeck, Gerd Bramerdorfer, Wolfgang Amrhein <i>Johannes Kepler University Linz, Austria</i>	
On Shortening the Numerical Transient in Time-Stepping Finite Element Analysis of Induction Motors under Static and Dynamic Eccentricity Faults	3088
Hossein Nejadi Koti, Hao Chen, Yue Sun, Nabeel A. O. Demerdash <i>Marquette University, United States</i>	
An Upper Bound of the Torque Production for Round Rotor Wound Field Synchronous Machines and its Electromagnetic Scalability	3096
Baoyun Ge <i>Independent Researcher, United States</i>	
Conjugate Heat Transfer and CFD Modeling of Self-ventilated Traction Motors	3103
Luca Boscaglia ¹ , Fabio Bonsanto ² , Aldo Boglietti ¹ , Shafigh Nategh ³ , Claudio Scema ¹ <i>¹Politecnico di Torino, Italy; ²Ansys Inc., Italy; ³ABB AB, Sweden</i>	

Design of High Bandwidth Motor System Considering Electrical and Mechanical Time Constants	3110
Soo-Hwan Park ^{1,3} , Jin-Cheol Park ¹ , Ji-Min Kim ² , Ho-Young Lee ^{1,3} , Soon-O Kwon ³ , Myung-Seop Lim ⁴	
¹ Hanyang University, Republic of Korea; ² Samsung Electronics, Republic of Korea; ³ Korea Institute of Industrial Technology, Republic of Korea; ⁴ Yeungnam University, Republic of Korea	
Automated HF Modelling of Induction Machines Considering the Effects of Aging	3117
Riccardo Leuzzi ¹ , Vito Giuseppe Monopoli ¹ , Francesco Cupertino ¹ , Pericle Zanchetta ²	
¹ Politecnico di Bari, Italy; ² University of Nottingham, United Kingdom	
Axial-field Vernier-type Flux Modulation Machines for Low-speed Direct-drive Applications	3123
Vandana Rallabandi, Peng Han, Murat Gurhan Kesgin, Narges Taran, Dan M. Ionel	
University of Kentucky, United States	
Performance Impacts of Practical Fabrication Tradeoffs for a Radial Flux Coaxial Magnetic Gear with Halbach Arrays and Air Cores	3129
Matthew C. Gardner ¹ , Matthew Johnson ² , Hamid A. Toliyat ¹	
¹ Texas A&M University, United States; ² US Army Research Laboratory, United States	
Study on AC Resistance of Winding According to Configuration of Strands	3137
Jun-Woo Chin ¹ , Kyoung-Soo Cha ¹ , Jin-Cheol Park ¹ , Jung-Pyo Hong ¹ , Myung-Seop Lim ²	
¹ Hanyang University, Republic of Korea; ² Yeungnam University, Republic of Korea	
Winding Material Effect on High Speed Brushless Permanent Magnet Machines	3144
Giuseppe Volpe ¹ , Mircea Popescu ¹ , Ian Foley ² , James Goss ¹	
¹ Motor Design Ltd., United Kingdom; ² Equipmake Ltd., United Kingdom	
Session 63: Integrated Electric Drives, Diagnostics and Prognostics	
Chair(s): Alberto Bellini, Rangarajan Tallam	
A Novel Label-Free Supervision Learning Method for Lithium-ion Battery RUL Prediction	3150
Zhiwu Huang ^{1,2} , Xu Zhou ^{1,2} , Dianzhu Gao ^{1,2} , Xiaoyong Zhang ^{1,2} , Fu Jiang ^{1,2} , Bin Chen ^{1,2} , Yingze Yang ^{1,2} , Mingjian Wu ^{1,2} , Jun Peng ^{1,2}	
¹ Central South University, China; ² Hunan Engineering Laboratory of Rail Vehicles Braking Technology, China	
Reliability Evaluation of DC-link Capacitors in Multi-drive Systems	3157
Shili Huang ¹ , Haoran Wang ² , Dinesh Kumar ³ , Guorong Zhu ¹ , Huai Wang ²	
¹ Wuhan University of Technology, China; ² Aalborg University, Denmark; ³ Danfoss Drives A/S, Denmark	
Real-time Bond Wire Lift-off Monitoring via Module Integrated Current Sensors	3163
Minhao Sheng, Muhammad H. Alvi, Robert D. Lorenz	
University of Wisconsin-Madison, United States	
3-D Point Magnetic Field Detection for Compact Current Sensing in Three-Phase Busbars and Cables	3170
Muhammad H. Alvi, Minhao Sheng, Robert D. Lorenz, Thomas M. Jahns	
University of Wisconsin-Madison, United States	
Fault-Tolerant Control of Dual Three-phase PMSM Drives Fed by T-type Three-level Inverters	3178
Xueqing Wang, Zheng Wang, Zhixian Xu, Ming Cheng	
Southeast University, China	

Analytical Method for Extraction of Stray Capacitance in Single-Layer CM Chokes	3185
Guangdong Dong, Fanghua Zhang, Yan Liu, Wuji Meng, Ce Xu <i>Nanjing University of Aeronautics and Astronautics, China</i>	
DC Bus Utilization Analysis with Bootstrap based Power Supply	3192
Willy Sedano, Peizhong Yi, Lixiang Wei, Brian Brown <i>Rockwell Automation, United States</i>	
Magnetic Model Identification for Synchronous Reluctance Motors Including Transients	3196
L. Ortombina, D. Pasqualotto, F. Tinazzi, M. Zigliotto <i>University of Padova, Italy</i>	
Back-to-back Starting of Large-capacity Condenser with Virtual Synchronous Generator	3203
Liang Tao ¹ , Jianjun Sun ¹ , Qian Tao ² , Yibo Cui ² , Xiaoming Zha ¹ ¹ Wuhan University, China; ² Hubei Electric Power Research Institute, State Grid, China	
DC-link Capacitor Reduction in Low Voltage and High Power Integrated Modular Motor Drives	3208
Andrew Hopkins ¹ , Bernhard Hopfensperger ² , Phil Mellor ¹ ¹ University of Bristol, United Kingdom; ² Ostbayerische Technische Hochschule Regensburg, Germany	
Power Routing to Enhance the Lifetime of Multiphase Drives	3215
Victor N. Ferreira ¹ , Rodrigo R. Bastos ² , Tamires S. de Souza ² , Marco Liserre ¹ , Braz J. Cardoso Filho ² ¹ Christian-Albrechts-Universität zu Kiel, Germany; ² Federal University of Minas Gerais, Brazil	
Comparative Analysis of Static Eccentricity Faults of Double Stator Single Rotor Axial Flux Permanent Magnet Motors	3223
Md Tawhid Bin Tarek, Shuvajit Das, Yilmaz Sozer <i>University of Akron, United States</i>	
Session 64: Advanced Power Devices, Modules and Gate Drives	
Chair(s): Jun Wang, Ahmed Elasser	
Turn-off Period Improved Switching Model of SiC Devices with Stray Capacitances and Inductances	3229
Yue Xie, Yiyang Yan, Shaokang Luan, Cai Chen, Yong Kang <i>Huazhong University of Science and Technology, China</i>	
Voltage Balancing Control with Active Gate Driver for Series Connected SiC MOSFETs	3235
Inhwan Lee, Lu Yue, Xiu Yao <i>University at Buffalo, United States</i>	
A High Power Density Two-Stage GaN-Based Isolated Bi-Directional DC-DC Converter	3240
Shaokang Luan, Zongheng Wu, Zhiwei Wang, Xinmin Liu, Cai Chen, Yong Kang <i>Huazhong University of Science and Technology, China</i>	
Paralleling GaN Switches for Low Voltage High Current Half-bridges	3245
J. Burkard, J. Biela <i>ETH Zurich, Switzerland</i>	
Si and GaN Devices in Quasi Resonant Flyback Converters for Wall Charger Applications	3253
Giuseppe Mauromicale ¹ , Angelo Raciti ¹ , Santi Agatino Rizzo ¹ , Giovanni Susinni ¹ , Filadelfo Fusillo ² , Agatino Palermo ² , Filippo Scrimizzi ² , Rosario Scollo ² ¹ University of Catania, Italy; ² STMicroelectronics, Italy	

Review and Bandwidth Measurement of Coaxial Shunt Resistors for Wide-Bandgap Devices Dynamic Characterization	3259
Wen Zhang ¹ , Zheyu Zhang ² , Fred Wang ^{1,3}	
¹ University of Tennessee, United States; ² Clemson University, United States; ³ Oak Ridge National Lab, United States	
Condition Monitoring the Forced Air Cooling System using the Natural Frequency of Thermal Network	3265
Jun Zhang, Xiong Du, Rui Du, Pengju Sun	
Chongqing University, China	
Investigation of Performance Degradation in Power MOSFET under OFF-State Avalanche Breakdown Test	3269
Chi Xu ¹ , Fei Yang ¹ , Bilal Akin ¹ , Yogesh Ramadass ²	
¹ The University of Texas-Dallas, United States; ² Texas Instruments, United States	
Active Switching with SiC MOSFETs	3275
Patrick Palmer ¹ , Jin Zhang ² , Edward Shelton ²	
¹ Simon Fraser University, Canada; ² University of Cambridge, United Kingdom	
Design of Drive Parameters considering Crosstalk Suppression in SiC MOSFETs Application	3281
Shengsheng Liu ¹ , Hua Lin ¹ , Tao Wang ¹ , Chunhui Liu ²	
¹ Huazhong University of Science and Technology, China; ² Arizona State University, United States	
High-isolation Low-coupling-capacitance Standalone Gate Drive Power Supply for SiC-based Medium-Voltage Power Electronic Systems	3287
Srdjan Srdic, Fei Teng, Srdjan Lukic	
North Carolina State University, United States	
Load Current and Temperature Dependent Optimization of Active Gate Driving Vectors	3292
Toru Sai ¹ , Koutaro Miyazaki ¹ , Hidemine Obara ² , Tomoyuki Mannen ³ , Keiji Wada ³ , Ichiro Omura ⁴ , Makoto Takamiya ¹ , Takayasu Sakurai ¹	
¹ The University of Tokyo, Japan; ² Yokohama National University, Japan; ³ Tokyo Metropolitan University, Japan; ⁴ Kyushu Institute Technology, Japan	
A Circuit for Testing Common-mode Transient Immunity (dv/dt) of Isolated Current Sense Amplifiers and Drivers	3298
Tanya K. Gachovska ¹ , Gabriel Scarlatescu ¹ , Jerry L. Hudgins ²	
¹ Solantra Semiconductors Corp, Canada; ² University of Nebraska-Lincoln, United States	
Closed Loop dv/dt Control for Equal Voltage Sharing between Series Connected SiC MOSFETs	3303
Vaibhav Uttam Pawaskar, Ghanshyamsinh Gohil	
The University of Texas-Dallas, United States	
A Method to Contain the Temperature Rise of a Press-Pack Thyristor during a Short Circuit Protection Operation	3311
Erfan Bashar ¹ , Ruizhu Wu ¹ , Li Ran ¹ , Jose Ortiz Gonzalez ¹ , Arne Benjamin Renz ¹ , Guy Baker ¹ , Mike Jennings ² , Philip Mawby ¹ , Tim C. Green ³ , Dan Rogers ⁴	
¹ University of Warwick, United Kingdom; ² Swansea University, United Kingdom;	
³ Imperial College London, United Kingdom; ⁴ University of Oxford, United Kingdom	
A Method to Minimize Junction Temperature Difference of Dies in Multichip Power Modules	3318
Cheng Zhao ¹ , Laili Wang ¹ , Yunfei Xu ² , Fengtao Yang ¹ , Jianpeng Wang ¹ , Zhiyuan Qi ¹	
¹ Xi'an Jiaotong University, China; ² State Key Laboratory of Advanced Power Transmission Technology, China	

Designing Power Modules for Degradation Sensing 3325

Timothy A. Polom¹, Robert D. Lorenz¹, Christoph H. van der Broeck, Rik W. De Doncker

¹University of Wisconsin-Madison, United States; ²RWTH Aachen University, Germany

Session 65: Wireless Power Transfer 1

Chair(s): Mohamed Badawy, Shuvajit Das

Multi-layer Non-uniform Series Self-resonant Coil for Wireless Power Transfer 3333

Ruiyang Qin, Daniel Costinett

The University of Tennessee, United States

A 22 kW-85 kHz Three-phase Wireless Power Transfer System with 12 coils 3340

Keisuke Kusaka¹, Rintaro Kusui¹, Jun-ichi Itoh¹, Daisuke Sato², Shuichi Obayashi³, Masaaki Ishida³

¹Nagaoka University of Technology, Japan; ²Nagaoka Motor Development Co., Ltd., Japan;

³Toshiba Corporation, Japan

An Optimal Driving Strategy for Maximum Electro-optical Conversion Efficiency of Laser Diode in Laser Power Transmission System 3348

Siyu Feng, Ke Jin, Qi Hui, Li Wang

Nanjing University of Science and Technology, China

Analyzing Resonant Points of SLLD Circuit to Achieve MPPT for Capacitive-Coupling Wireless Power Transfer 3353

Yashwanth Bezawada¹, Ruiyun Fu², Yucheng Zhang¹

¹Old Dominion University, United States; ²Mercer University, United States

Efficiency Optimization of Series/Series-Parallel IPT System with Load-Independent Output Voltage and Zero Input Phase Angle 3358

Zhicong Huang¹, Zhijian Fang², Chi-Seng Lam¹, Pui-In Mak¹, Rui P. Martins¹

¹University of Macau, Macau; ²China University of Geosciences, China

A New Bi-directional Wireless EV Charging Controller Tolerant to Large Pad Misalignments 3363

Yeran Liu¹, Udaya K. Madawala², Ruikun Mai¹, Zhengyou He¹

¹Southwest Jiaotong University, China; ²University of Auckland, New Zealand

Double-side Phase Shift Control for Impedance Matching in Wireless High Power Transfer 3368

Yongbin Jiang, Min Wu, Zexian Zeng, Jing Sun, Yonghui Liu, Laili Wang, Yue Wang

Xi'an Jiaotong University, China

General Analysis of LC Resonance Principles for Inductive Power Transfer Systems 3374

Yang Chen, Naijian Yang, Qiao Li, Ruimin Dai, Zhengyou He, Ruikun Mai

Southwest Jiaotong University, China

Session 66: Solar Energy Systems

Chair(s): Ahmed Elasser, Yongheng Yang

A Novel Solar Harvesting Wireless Sensor Node with Energy Management System: Design & Implementation 3381

J. Henry, D. Qendri, R. Lang, M. Youssef

University of Ontario Institute of Technology, Canada

A Study of Partially-Shaded PV Modules with Overlapping Diodes	3388
Zaid Alqaisi, Yousef Mahmoud Worcester Polytechnic Institute, United States	
A CMOS-Based Energy Harvesting Approach for Laterally-Arrayed Multi-Bandgap Concentrated Photovoltaic Systems	3394
Haoquan Zhang ¹ , Konstantin Martynov ² , Duanhui Li ¹ , David J. Perreault ² ¹ Massachusetts Institute of Technology, United States; ² Analog Devices Inc., United States	
Direct Frequency Control based MPPT Algorithm of LLC Resonant Converter for Photovoltaic System	3402
Yizhan Zhuang, Fei Liu, Xiangjing Zhang, Xiaoguang Diao, Jianbo Jiang, Jianjun Sun Wuhan University, China	
Distributed Maximum Power Point Tracking Control under Sudden Partial Shade using an Isolated Modular Boost Converter for Automotive Application	3407
Yusuke Zushi, Yoshiyuki Nagai, Tsutomu Tanimoto, Yosuke Tomita Nissan Motor Co., Ltd., Japan	
Updated Electrochemical Model of Micro Photosynthetic Power Cells	3413
Tamanwè Payarou, Pragasen Pillay, Muthukumaran Packirisamy Concordia University, Canada	
Grid Integration of a Three Phase Multifunctional SECS using Lorentzian Adaptive Filter based Control with Impulsive Disturbance Rejection Capability	3419
Syed Bilal Qaiser Naqvi, Shailendra Kumar, Bhim Singh, Yashi Singh Indian Institute of Technology Delhi, India	
Analysis of Solar Panel's Lumped Equivalent Circuit Parameters using LASSO	3427
Martin Garaj ¹ , Henry Shu-hung Chung ¹ , Alan Wai-lun Lo ² , Huai Wang ³ ¹ City University of Hong Kong, China; ² Chu Hai College of Higher Education, China; ³ Aalborg University, Denmark	
An Integrated PV-Battery Soft-switched Power Converter with MPPT and Voltage Regulation	3433
Sanjida Moury, John Lam York University, Canada	
Dimension and Mechanical Structure Design of Low-Cost Heliostats in Concentrated Solar Power Plants	3441
Shen Zhang, Abdulaziz M. Qwbaiban, Jeongmin Huh, Thomas G. Habetler Georgia Institute of Technology, United States	
Differential Power Processing Architecture with Virtual Port in Series and MPPT in Submodule Level	3448
Lyuyi Lin, Junming Zhang, Yan Deng Zhejiang University, China	
Session 67: Power and Energy Management for Smart Grids	
Chair(s): Christina DiMarino, Jin Ye	
Event-Triggered based Distributed Secondary Control for Islanded AC Microgrids Considering Unreliable Communications	3456
Xiaoxiao Meng, Niancheng Zhou, Qianggang Wang, Jianquan Liao Chongqing University, China	

Multi-Agent System-based Distributed Energy Management in Smart Grid under Uncertainty	3462
Md Habib Ullah, Anas Alseyat, Jae-Do Park <i>University of Colorado-Denver, United States</i>	
Distributed Event-Driven Power Sharing Control for CCVSI-Based Distributed Generators in AC Isolated Microgrids	3469
Jingang Lai ¹ , Xiaoqing Lu ² , Antonello Monti ¹ , Rik W. De Doncker ¹ ¹ <i>RWTH Aachen University, Germany</i> ; ² <i>Wuhan University, China</i>	
Optimal WT, PV and BES based Energy Systems for Standalone Households in South Australia	3475
Rahmat Khezri ¹ , Amin Mahmoudi ¹ , Mohammed H. Haque ² ¹ <i>Flinders University, Australia</i> ; ² <i>University of South Australia, Australia</i>	
Optimal Capacity of PV and BES for Grid-connected Households in South Australia	3483
Rahmat Khezri ¹ , Amin Mahmoudi ¹ , Mohammed H. Haque ² ¹ <i>Flinders University, Australia</i> ; ² <i>University of South Australia, Australia</i>	
An Advanced Framework for Electric Vehicles Interaction with Distribution Grids based on Q-Learning	3491
Qiyun Dang, Di Wu, Benoit Boulet <i>McGill University, Canada</i>	
Networked Control and Optimization for Widescale Integration of Power Electronic Devices in Residential Homes	3496
M. Starke ¹ , M. Chinthavali ¹ , C. Winstead ¹ , Z. Sheng ¹ , S. Campbell ¹ , R. Zeng ¹ , T. Kuruganti ¹ , Y. Xue ¹ , C. Thomas ² ¹ <i>Oak Ridge National Lab, United States</i> ; ² <i>Electric Power Research Institute, United States</i>	
Generalized Energy Storage Configuration Method based on Bi-level Optimization for Distribution Power System with High Penetration of Renewable Energy	3502
Meiqin Mao, Xun Jiang, Yunhui Liu, Liuchen Chang, Yangyang Wang <i>Hefei University of Technology, China</i>	
Secondary Control for DC Microgrids with Optimal Sparse Feedback	3510
Jianzhe Liu ¹ , Xiaonan Lu ² , Chen Chen ¹ ¹ <i>Argonne National Laboratory, United States</i> ; ² <i>Temple University, United States</i>	
High-Performance Adaptive Control for Inverter-Based Residential Microgrids	3516
Cheng Wang ¹ , Liqun He ² ¹ <i>Nanjing University of Science and Technology, China</i> ; ² <i>Soochow University, China</i>	
Session 68: Electric Propulsion & Other E-transportation Applications	
Chair(s): Tausif Husain, Mohammad Islam	
A Stabilization Method of the Current Controller in the Over-Modulation Region for NEV Traction Motor	3524
Sang Min Kim <i>Hyundai Mobis, Republic of Korea</i>	
Performance of a Hybrid Powertrain Employing a Magnetic Power Split Device	3529
Khoa D. Hoang ¹ , Kais Atallah ¹ , Milijana Odavic ¹ , Jeff Birchall ² , Stuart Calverley ² ¹ <i>The University of Sheffield, United Kingdom</i> ; ² <i>Magnomatics Limited, United Kingdom</i>	

Design of Multi-layer IPMSM using Ferrite PM Considering Mechanical and Electrical Characteristics 3534
Young-Hoon Jung, Ki-O Kim, Jung-Pyo Hong
Hanyang University, Republic of Korea

A Temperature-Suppression Power Allocation Strategy for Hybrid Energy Management of EVs 3542
Zhiwu Huang^{1,3}, Yinhui Le^{1,3}, Hongtao Liao^{1,3}, Yanhui Zhou^{1,3}, Yue Wu^{1,3}, Heng Li^{1,3}, Shuo Li^{2,3},
Xianqi Lu^{1,3}, Jun Peng^{1,3}
¹Central South University, China; ²Changsha University of Science & Technology, China;
³Hunan Engineering Laboratory of Rail Vehicles Braking Technology, China

Suppressing Gate Voltage Oscillation in Paralleled SiC MOSFETs for HEV/EV Traction Inverter Application 3548
Fan Xu, Lihua Chen
Ford Motor Company, United States

Session 69: AC-AC and Multilevel Power Converters
Chair(s): Lixiang Wei, Stefano Bifaretti

A Novel Space Vector Overmodulation Strategy based on Input Current Vector for Indirect Matrix Converter 3554
Zhaoyang Jin¹, Shanhu Li¹, Wensheng Wang¹, Xu Liu¹, Yiping Liu², Bingnan Ji³
¹Hebei University of Technology, China; ²Tianjin Power Street Light Management Department, China;
³Zhengzhou Yutong Bus. CO.,Ltd., China

A Predictive-Control-Based Over-Modulation Method for Third-Harmonic Injection Two-Stage Matrix Converter 3559
Xida Chen, Hui Wang, Yao Sun, Mei Su, Wenjing Xiong
Central South University, China

A Single-Phase Hybrid Six-Leg AC-DC-AC Multilevel Converter 3563
André Elias Lucena da Costa¹, Cursino Brandão Jacobina¹, Nady Rocha²
¹Federal University of Campina Grande, Brazil; ²Federal University of Paraíba, Brazil

A Single-Phase AC-DC-AC Five-leg Multilevel Converter 3571
André Elias Lucena da Costa¹, Cursino Brandão Jacobina¹, Nady Rocha², Phelipe Leal Serafim Rodrigues¹
¹Federal University of Campina Grande, Brazil; ²Federal University of Paraíba, Brazil

Three-Phase Hybrid AC-DC-AC Voltage/Current Source Converter for Wind Energy Conversion Systems 3579
Nayara I.L. Santos, Louelson A.L. de A.C. Costa, Maurício B.R. Corrêa, Montie A. Vitorino
Federal University of Campina Grande, Brazil

Expand Output Voltage Range of AC/AC Converter using Reversible Indirect Matrix Converter (R-IMC) 3587
Kodai Okuzono, Sho Tomita, Hitoshi Haga
Nagaoka University of Technology, Japan

Three-Phase Four-Wire AC-DC-AC Converter with Shared Legs 3593
Alan S. Felinto¹, Cursino B. Jacobina¹, Edgard L.L. Fabricio², Rodrigo P. de Lacerda¹
¹Federal University of Campina Grande, Brazil; ²Federal Institute of Paraíba, Brazil

New Two-to-Three-Phase AC-AC Indirect Matrix Converter with Open-end Rectifier Stage	3601
André Wild S. Ramalho, Montié A. Vitorino, Maurício B.R. Correa, Edgar R. Braga-Filho <i>Federal University of Campina Grande, Brazil</i>	
A Dual Mode 5-Level Inverter with Wide Input Voltage Range	3609
Yam P. Siwakoti ¹ , Teng Long ² , Reza Barzegarkhoo ¹ , Frede Blaabjerg ³ ¹ University of Technology Sydney, Australia; ² University of Cambridge, United Kingdom; ³ Aalborg University, Denmark	
Cascaded Multilevel Rectifiers with Reduced Number of Controlled Switches for Open-End Winding PMSM	3616
Amanda P. Monteiro, Cursino B. Jacobina, Filipe A.C. Bahia, Reuben P.R. Sousa <i>Federal University of Campina Grande, Brazil</i>	
A Novel Three-Phase Multilevel Inverter Topology with Reduced Device Count for Open-end Winding Motor Drives	3624
S. Foti ¹ , A. Testa ¹ , S. De Caro ¹ , T. Scimone ¹ , L.D. Tornello ² , G. Scarcella ² , G. Scelba ² ¹ University of Messina, Italy; ² University of Catania, Italy	
Novel Active Nested Neutral-Point Piloted Nine-level Converter	3631
Ahmed S. Hussein, Amer Ghias <i>Nanyang Technological University, Singapore</i>	
Comparison of PIR and MPC Control Schemes to Reduce Circulating Currents in a Modular Multilevel Converter Terminal	3637
A.J. Marin-Hurtado ¹ , W.J. Gil-Gonzalez ¹ , A. Escobar-Mejía ¹ , Cheng Deng ² ¹ Universidad Tecnológica de Pereira, Colombia; ² Xiangtan University, China	
A New DC Fault Blocking Capability Technique for Modular Multilevel Converters	3643
Iman Aghabali, Mehdi Narimani <i>McMaster University, Canada</i>	
A New 7-Level Voltage Source Converter for Medium-Voltage Application	3649
Niloufar Keshmiri, Mehdi Narimani <i>McMaster University, Canada</i>	
Session 70: Converter Modeling, Control and Design 2	
Chair(s): Meiqin Mao, Raja Ayyanar	
Multifrequency Impedance Model for Parallel Single-phase Grid-connected Parallel Inverters for Analysis on Circulating Resonant Current	3655
Miao Liu, Qi Wei, Shaojun Xie, Qiang Qian, Zhao Zhang, Jinming Xu <i>Nanjing University of Aeronautics and Astronautics, China</i>	
Common Mode Voltage Reduction of Single-Phase Quasi-Z-Source Inverter based Photovoltaic System	3659
Yushan Liu ¹ , Yaosuo Xue ² , Hexu Sun ³ ¹ Beihang University, China; ² Oak Ridge National Lab, United States; ³ Hebei University of Technology, China	
Quasi-Two-Level Flying-Capacitor-Converter for Medium Voltage Grid Applications	3666
Stefan Mersche, Daniel Bernet, Marc Hiller <i>Karlsruher Institut fuer Technologie, Germany</i>	

Parameter Optimization based on the Minimum Peak Current Curve for LCC Resonant Converters Operating in DCM	3674
Zhigang Chen ^{1,2} , Jun Liu ² , Shengwen Fan ^{1,2} , Chaonan Tong ¹ , Shuo Liu ²	
¹ University of Science and Technology-Beijing, China; ² North China University of Technology, China	
Digital Interleaving Control for Two-Phase TCM GaN Totem-Pole PFC to Reduce Current Distortion	3682
Qingxuan Ma, Qingyun Huang, Ruiyang Yu, Tianxiang Chen, Alex Q. Huang	
University of Texas-Austin, United States	
Average Modeling of Active Neutral Point Clamped Inverter	3689
Jagath Vallabhai Missula, Ravindranath Adda, Praveen Tripathy	
Indian Institute of Technology Guwahati, India	
A Lifetime-Aware Control Strategy for Parallel Charging Systems of Energy Storage Light Rail	3697
Yongjie Liu ^{1,2} , Zhiwu Huang ^{1,2} , Hongtao Liao ^{1,2} , Heng Li ^{1,2} , Yue Wu ^{1,2} , Yanhui Zhou ^{1,2} , Fu Jiang ^{1,2} , Jun Peng ^{1,2}	
¹ Central South University, China; ² Hunan Engineering Laboratory of Rail Vehicles Braking Technology, China	
Auto-tuned Model Parameters in Predictive Control of Power Electronics Converters	3703
Mitchell Easley ¹ , Amin Y. Fard ¹ , Fariba Fateh ¹ , Mohammad B. Shadmand ¹ , Haitham Abu-Rub ²	
¹ Kansas State University, United States; ² Texas A&M University-Qatar, Qatar	
Switching Transient Analysis of SiC MOSFET based MMC Motor Drive Systems	3710
Xiao Li, Yue Zhang, Ziwei Ke, Jianyu Pan, Niu Jia, Risha Na, Longya Xu, Jin Wang	
The Ohio State University, United States	
Control Strategies for Parallel Connected IGBT Modules	3717
Patrick Palmer ¹ , Tianqi Zhang ² , Xueqiang Zhang ² , Edward Shelton ² , Teng Long ²	
¹ Simon Fraser University, Canada; ² University of Cambridge, United Kingdom	
Reachability Analysis of Dual Active Bridge DC-DC Converters	3723
Heqiang Wang, Zefan Tang, Yan Li, Peng Zhang	
University of Connecticut, United States	
Real-time Identification Method for LCL Filters Used with Grid Converters	3729
Ville Pirsto, Jarno Kukkola, F. M. Mahafugur Rahman, Marko Hinkkanen	
Aalto University, Finland	
Impacts of Switched-Diode Capacitor Stages on the Flying Capacitor Multilevel Flyback Converter	3737
Santino F. Graziani, Brandon M. Grainger	
University of Pittsburgh, United States	
Interactions of Capacitor Voltage Ripple with the Circulating Current and Output Current Controllers in Low-Capacitance Modular Multilevel Converters	3742
Sumeet Singh Thakur, Milijana Odavic, Z.Q. Zhu	
University of Sheffield, United Kingdom	
Modelling of Bidirectional CLLC Resonant Converter Operating under Frequency Modulation	3750
Lais Farias Martins, David Stone, Martin Foster	
University of Sheffield, England	

A Model Predictive Control Scheme Formulation for Active Rectifiers with LCL Filter	3758
Joseph Benzaquen, Aswad Adib, Fariba Fateh, Behrooz Mirafzal Kansas State University, United States	
An Approach to Increase the Bandwidth of Current Controllers for Grid-tied Converters with LCL Filter	3764
Marcos Paulo F. de Assunção ¹ , Luiz A. de S. Ribeiro ¹ , José G. de Matos ¹ , Francisco D. Freijedo ² ¹ Federal University of Maranhão, Brazil; ² École Polytechnique Fédérale de Lausanne, Switzerland	
Deep Learning Neural Networks for Heat-Flux Health Condition Monitoring Method of Multi-Device Power Electronics System	3769
Borong Hu ^{1,2} , Zedong Hu ² , Li Ran ^{1,2} , Phil Mawby ² , Chunjiang Jia ³ , Chong Ng ³ , Paul McKeever ³ ¹ Chongqing University, China; ² University of Warwick, United Kingdom; ³ Offshore Renewable Energy Catapult, United Kingdom	
Leakage Current Mitigation in Current-Source Inverter based Transformerless Photovoltaic System using Active Zero-State Space Vector Modulation	3775
Hang Gao ¹ , Shuai Wang ¹ , Dewei Xu ¹ , Bin Wu ¹ , Navid R. Zargari ² ¹ Ryerson University, Canada; ² Rockwell Automation, Canada	
Dealing with Suboptimality in Multistep Model Predictive Control for Transient Operations	3780
Roky Baidya ¹ , Ricardo P. Aguilera ² , Petros Karamanakos ³ , Pablo Acuna ⁴ , Chirstian Rojas ⁵ , Tobias Geyer ⁶ , Dylan D.-C. Lu ² ¹ Chittagong University of Engineering and Technology, Bangladesh; ² University of Technology Sydney, Australia; ³ Tampere University of Technology, Finland; ⁴ University of Talca, Chile; ⁵ Universidad Técnica Federico Santa María, Chile; ⁶ ABB Corporate Research, Switzerland	
Session 71: Transportation, Application, NVH and Diagnosis of Electrical Machines	
Chair(s): Pinjia Zhang, Grant Pitel	
Asymmetrical Design in Electrical Machines	3786
Xikai Sun ¹ , Gennadi Sizov ² , Mike Melfi ² ¹ Rockwell Automation, China; ² Rockwell Automation, United States	
Visualization of Multi-Objective Switched Reluctance Machine Optimization at Multiple Operating Conditions with t-SNE	3793
Shen Zhang ¹ , Shibo Zhang ² , Sufei Li ³ , Liang Du ⁴ , Thomas G. Habetler ¹ ¹ Georgia Institute of Technology, United States; ² Northwestern University, United States; ³ Ansys Inc., United States; ⁴ Temple University, United States	
Partitioned Stator- Flux Switching Machine utilizing Different Magnet Grades	3799
Ali Al-Qarni, Ayman EL-Refai Marquette University, United States	
MTPA Control Strategy for Six-phase DC-biased Hybrid Excitation Vernier Reluctance Machines	3807
Zhiyue Yu, Huida Gao, Liang Chang, Wubin Kong, Chun Gan, Ronghai Qu Huazhong University of Science and Technology, China	
Design and Evaluation of Single-Layer Dual-Stator 6/4 FSPM Machine with Toroidal Winding	3813
Mingda Liu ¹ , William Sixel ¹ , Yingjie Li ¹ , Jagadeesh Tangudu ² , Vladimir Blasko ² , Bulent Sarlioglu ¹ ¹ University of Wisconsin-Madison, United States; ² United Technology Research Center, United States	

CFD based Design of an Impeller for a Novel Integrated Motor-Compressor System	3820
Abdul W. Bandarkar, Yilmaz Sozer, J. A. De Abreu-Garcia <i>University of Akron, United States</i>	
Carrier Electromagnetic Vibration of DC Voltage Fluctuation in Permanent-Magnet Synchronous Motor with Distributed Winding	3825
Takafumi Hara ¹ , Toshiyuki Ajima ¹ , Katsuhiko Hoshino ² , Akihiro Ashida ² ¹ <i>Hitachi, Ltd., Japan</i> ; ² <i>Hitachi Automotive Systems Ltd., Japan</i>	
Lifetime of Machines undergoing Thermal Cycling Stress	3831
Antonio Griffo ¹ , Igor Tsyokhla ² , Jiabin Wang ¹ ¹ <i>The University of Sheffield, United Kingdom</i> ; ² <i>Sphere Fluidics, United Kingdom</i>	
Comparative Study of Electromagnetic Force Characteristics of Flux Reversal PM Machines with Asymmetrical and Symmetrical Stators	3837
Wei Liu, Hui Yang, Heyun Lin, Shukang Lyu, Ya Li <i>Southeast University, China</i>	
A Comprehensive Analysis of the Acoustic Noise in an Interior Permanent Magnet Traction Motor	3845
Jianbin Liang, Yihui Li, Christopher Mak, Berker Bilgin, Dhafar Al-Ani, Ali Emadi <i>McMaster University, Canada</i>	
The Influence of Flux-Barriers Distribution on Vibrations in Synchronous Reluctance Machine	3852
Emanuel Castagnaro, Nicola Bianchi <i>University of Padova, Italy</i>	
A Novel Monitoring Technique using Commonmode Voltages for the Transformer energized by VSCs	3860
Geye Lu, Pinjia Zhang <i>Tsinghua University, China</i>	
Misalignment and Rotor Fault Severity Indicators based on the Transient DWT Analysis of Stray Flux Signals	3867
Pedro A. Pastor-Osorio, Jose Antonino-Daviu, Alfredo Quijano-Lopez <i>Universitat Politecnica de Valencia, Spain</i>	
Vibration Analysis of Internal Permanent Magnet Synchronous Machines under Asymmetric Three-Phase Current Condition	3872
Jiaxiong Guo, Haiyang Fang, Dawei Li, Ronghai Qu, Yunsong Xu, Tonghai Pei, Yu Zhao <i>Huazhong University of Science and Technology, China</i>	
Rotor UMP & Mechanical Response in HSPMSM in Typical Running Conditions	3878
Yu-Ling He ¹ , Gaurang Vakil ² , Xiao-Chen Zhang ² , Peng Gao ³ , David Gerada ² , Chris Gerada ² ¹ <i>North China Electric Power University, China</i> ; ² <i>University of Nottingham, United Kingdom</i> ; ³ <i>Tianjin University, China</i>	
Bearing Fault Detection using Low-Frequency Total Components in Phase Current	3884
Jun-Hyuk Im ¹ , Jun-Kyu Park ² , Jin Hur ¹ ¹ <i>Incheon National University, Republic of Korea</i> ; ² <i>University of Padova, Italy</i>	

Flexibility of Remediation Methods for Winding Open Circuit Faults in a Multiphase PM Machine Considering Iron Losses Minimization	3889
Fan Wu, Ayman M. EL-Refaiie Marquette University, United States	
Robust Inter-turn Short-circuit Detection in PMSMs with Respect to Current Controller Bandwidth	3897
Shaopo Huang ¹ , Elias G. Strangas ² , Anmol Aggarwal ² , Kui Li ¹ , Feng Niu ¹ ¹ Hebei University of Technology, China; ² Michigan State of University, United States	
A Multi-sensor Fusion Scheme for Broken Rotor Bar and Air-gap Eccentricity Detection of Induction Machines	3905
Genyi Luo ¹ , Thomas G. Habetler ¹ , Jed Hurwitz ² ¹ Georgia Institute of Technology, United States; ² Analog Devices, United Kingdom	
Fault Diagnosis and Isolation of an Electro-Pump using Neural Data Fusion	3912
Saeid Jorkesh ¹ , Javad Poshtan ¹ , Majid Poshtan ² ¹ Iran University of Science and Technology, Iran; ² California Polytechnic State University, United States	
Design and Experimental Validation of a Delta Connected 36-Slot 28-Pole Permanent Magnet Machine for Hybrid Traction Applications	3917
Boris Dotz ¹ , Dieter Gerling ² ¹ Valeo Siemens eAutomotive Germany GmbH, Germany; ² Universitaet der Bundeswehr Muenchen, Germany	
A Copper Rotor Induction Motor Solution for Electrical Vehicles Traction System	3924
Mircea Popescu ¹ , Nicolas Riviere ¹ , Giuseppe Volpe ¹ , Marco Villani ² , Giuseppe Fabri ² , Lino Di Leonardo ² ¹ Motor Design Ltd., United Kingdom; ² University of L'Aquila, Italy	
Comparison of Bar-Wound Windings Permanent Magnet Machine with Different Cross-Sectional Shape for Hybrid Electric Vehicle	3931
Yu Zhao, Dawei Li, Tonghao Pei, Jiaxiong Guo, Ronghai Qu Huazhong University of Science and Technology, China	
Improvement of Field-Weakening Performance of IPM Machines with Salient Pole Shoe Rotors	3937
Nan Zhao ¹ , Nigel Schofield ² ¹ University College Dublin, Ireland; ² University of Huddersfield, United Kingdom	
Electro-Mechanical Challenges in the Design of a High-Speed-High-Power-PMSM Rotor for an Aerospace Application	3944
Nicola Chiodetto, Barrie Mecrow, Rafal Wrobel, Timothy Lisle Newcastle University, United Kingdom	
Performance Comparison of Rare earth and Non-Rare Earth based SPM Machines with High Silicon Steel	3952
Zhentao Stephen Du, Jagadeesh Tangudu United Technologies Research Center, United States	
Modeling, Design and Control of Wound-Field Synchronous Motor for High Energy Efficiency of Electric Vehicle	3960
Min-Ro Park ¹ , Dong-Min Kim ¹ , Young-Hoon Jung ¹ , Myung-Seop Lim ² , Jung-Pyo Hong ¹ ¹ Hanyang University, Republic of Korea; ² Yeungnam University, Republic of Korea	

Non-Dominated Sorting Genetic Algorithm based Investigation of Optimal Odd Slot Numbers for Stator Shifted Fractional-Slot Wound PMSMs 3968
Shruthi Mukundan, Himavarsha Dhulipati, Eshaan Ghosh, Guodong Feng, Jimi Tjong, Narayan C. Kar
University of Windsor, Canada

Rotor Configuration Comparison for the Design of a PM Conical Machine 3976
Sara Roggia¹, Gaetano Roggia², Francesco Cupertino³, Michael Galea⁴
¹Safran, France; ²IDIADA, Spain; ³Politecnico di Bari, Italy; ⁴University of Nottingham, United Kingdom

Design of a Highly Integrated Electric-Hydraulic Machine for Electrifying Off-Highway Vehicles 3983
F.N.U. Nishanth¹, Garrett Bohach², James Van de Ven², Eric L. Severson¹
¹University of Wisconsin-Madison, United States; ²University of Minnesota, United States

Finite Element Simulation based method for Design and Optimization of Flux Switching Motor for EV/HEV Traction Application 3991
Krishan Kant¹, Lakshmi Varaha Iyer², James L. Kirtley¹, Gerd Schlager²
¹Massachusetts Institute of Technology, United States; ²Magna International Inc., United States

Motor Trends: Effects of Era, Age, and Maintenance on Failure Rates 3998
Andrew D. Stringer, Christopher C. Thompson, Carolina I. Barriga
U.S. Army Corps of Engineers, United States

Session 72: Integrated Electric Drives and Control

Chair(s): Fernando Briz, Mahesh Swamy

Silicon Carbide JFET Super-Cascodes for Normally-On Current Source Inverter Switches in Medium Voltage Variable Speed Electrostatic Drives 4004
Peter Killeen, Aditya N. Ghule, Daniel C. Ludois
University of Wisconsin-Madison, United States

High Temperature Design of a GaN based Modular Integrated Drive with Natural Cooling using Metal Clad PCBs 4012
Yousef Abdullah¹, Xiao Li¹, Ke Wang¹, Jin Wang¹, Liming Liu², Sandeep Bala²
¹The Ohio State University, United States; ²ABB, United States

The Optimal Direct Torque Control Strategy for Open-Winding Permanent Magnet Synchronous Motor in Variable DC Voltage Conditions 4018
Wenjie Tao, Jiadan We, Jianhao Ji, Zhuoran Zhang, Xianghao Kong
Nanjing University of Aeronautics and Astronautics, China

Analytical Formulation of a Maximum Torque per Ampere (MTPA) Technique for SynRMs Considering the Magnetic Saturation 4024
Angelo Accetta¹, Maurizio Cirrincione², Maria Carmela Di Piazza¹, Giuseppe La Tona¹,
Massimiliano Luna¹, Marcello Pucci¹
¹INM-CNR, Italy; ²University of the South Pacific, Fiji

A Generalized Self-Sensing Method for Induction Machines based on Vector Tracking using Deadbeat-Direct Torque and Flux Control 4030
Yang Xu¹, Chikara Morito², Robert D. Lorenz¹
¹University of Wisconsin-Madison, United States; ²Toshiba Mitsubishi-Electric Industrial Sys Corp, Japan

Sliding Mode Speed Estimators for the Induction Motor – A Performance Comparison at Low Speed	4037
Mihai Comanescu <i>Pennsylvania State University-Altoona, United States</i>	
A Real-time Sinusoidal Voltage-Adjustment Power Supply based on Wide-Band-Gap Devices for Linear Power Amplifier	4043
Xiaofeng Ding, Jiawei Cheng <i>Beihang University, China</i>	
Comprehensive Analysis of Extended Electro Motive Force Observers for Position Estimation in Interior Permanent Magnet Synchronous Machines	4050
Abdelrahman Elsmam, Fabio Giulii Capponi, Federico Caricchi <i>University of Roma "La Sapienza", Italy</i>	
SiC Inverter for Electric Vehicles with Improved Trade-off between Reduced Switching Losses and Increased Radiation Noise	4058
Kenta Emori, Jumpei Niida, Akinori Okubo, Keiichiro Numakura, Tetsuya Hayashi, Takuya Hara <i>Nissan Motor Co., Ltd., Japan</i>	
Design of a SiC-based Five-Level Stacked Multicell Converter for High-Speed Motor Drives	4063
Jianghui Yu ¹ , Rolando Burgos ¹ , Qiong Wang ¹ , Ismail Agirman ² ¹ Virginia Polytechnic Institute and State University, United States; ² United Technologies Corporation, United States	
Adaptive H_∞-Based Variable Structure Control for Permanent-Magnet Synchronous Motor-Driven Uncertain Linear Stage via Self-Learning Recurrent Fuzzy-Wavelet-Neural-Network	4069
Fayez F.M. EL-Sousy ¹ , Mahmoud Amin ² , Osama A. Mohammed ³ ¹ Prince Sattam bin Abdulaziz University, Saudi Arabia; ² Manhattan College, United States; ³ Florida International University, United States	
Improved Self-Sensing Estimation Accuracy and System Bandwidth via Negative Sequence Image Tracking	4077
Timothy S. Slininger ¹ , Huthaifa Flieh ¹ , Robert D. Lorenz ¹ , Shao-Chuan Chien ² , Li-Hsing Ku ² ¹ University of Wisconsin-Madison, United States; ² Delta Electronics, Inc., Taiwan	
Model Predictive Speed Control with Dynamic Reference for Electric Drive of Permanent Magnet Synchronous Machine	4085
Luocheng Wang, Tao Han, Tiefu Zhao <i>University of North Carolina-Charlotte, United States</i>	
Phase Delay Analysis of Current Sampling in Inverter-Fed Induction Machines	4091
Lei Jin ¹ , Haihui Lu ¹ , Zhendong Zhang ² , Timothy Rowan ² ¹ Rockwell Automation, Inc., China; ² Rockwell Automation, Inc., United States	

Session 73: Material, Passive Devices and Packaging

Chair(s): Fang Luo, Cai Chen

Industrial 650V 4-Pack Super-Junction MOSFET Module using Transfer Molding Process	4097
Jangmuk Lim ¹ , Jihwan Seong ¹ , Sang Won Yoon ¹ , You Suk Kim ² , Hun-chang Im ² , Won Sik Hong ³ ¹ Hanyang University, Republic of Korea; ² iA Powertron Co., Ltd., Republic of Korea; ³ Korea Electronics Technology Institute, Republic of Korea	

Loss Prediction of Medium Voltage Power Modules: Trade-offs between Accuracy and Complexity	4102
Jannick Kjaer Jorgensen, Nicklas Christensen, Dipen Narendra Dalal, Asger Bjorn Jorgensen, Hongbo Zhao, Stig Munk-Nielsen, Christian Uhrenfeldt <i>Aalborg University, Denmark</i>	
GaN Module Design Recommendations based on the Analysis of a Commercial 3-Phase GaN Module	4109
John Alex Brothers, Troy Beechner <i>Mainstream Engineering Corporation, United States</i>	
Accurate Characterization and Emulation of Active Bridge Magnetic Efficiencies with Novel Excitation Circuit	4117
Richard B. Beddingfield ¹ , Subhashish Bhattacharya ² , Paul Ohodnicki Jr. ¹ ¹ <i>National Energy Technology Lab, United States; </i> ² <i>North Carolina State University, United States</i>	
Comparative Analysis of Magnetic Core Loss Measurement Methods with Arbitrary Excitations	4125
Zhedong Ma, Juntao Yao, Yiming Li, Shuo Wang <i>University of Florida, United States</i>	
Filter Design for AFE Rectifier using SiC MOSFET	4131
Xikai Sun ¹ , Lixiang Wei ² ¹ <i>Rockwell Automation, China; </i> ² <i>Rockwell Automation, United States</i>	
Investigation of Design Methodology of Planar Transformers for EV On Board Chargers	4139
Zhengda Zhang ¹ , Chunhui Liu ¹ , Yunpeng Si ¹ , Yifu Liu ¹ , Qin Lei ¹ , Sheng Ai ² ¹ <i>Arizona State University, United States; </i> ² <i>Huanzhong University of Science and Technology, China</i>	
Novel PCB Integrated Magnetic Component Design for Reduced AC Power Losses	4146
G.Y. Sizov, Z. Vrankovic, G.L. Skibinski <i>Rockwell Automation, United States</i>	
Shielding of Leakage Flux Induced Losses in High Power, Medium Frequency Transformers	4154
Richard B. Beddingfield ¹ , Subhashish Bhattacharya ² , Paul Ohodnicki Jr. ¹ ¹ <i>National Energy Technology Lab, United States; </i> ² <i>North Carolina State University, United States</i>	
Electrical Insulation Packaging for a 20 kV High Density Wide Bandgap Power Module	4162
Maryam Mesgarpour Tousi, Mona Ghassemi <i>Virginia Polytechnic Institute and State University, United States</i>	
50kW Nano-Crystalline Core based Three Port Transformer for Triple Active Bridge Converter	4167
Ritwik Chattopadhyay ¹ , Srinivas Gulur ¹ , Viju Nair ¹ , Subhashish Bhattacharya ¹ , Paul R. Ohodnicki ² ¹ <i>North Carolina State University, United States; </i> ² <i>National Energy Technology Laboratory, United States</i>	
Lifetime Estimation of DC-Link Electrolytic Capacitor for Smart Transformer LV Side Inverter	4174
Rongwu Zhu, Marco Liserre <i>Christian-Albrechts-Universität zu Kiel, Germany</i>	
A High Power Density Thermal Management Approach using Multi-PCB Distributed Cooling (MPDC) Structure	4181
Wenbo Liu, Andrew Yurek, Yang Chen, Bo Sheng, Xiang Zhou, Yan-Fei Liu <i>Queen's University, Canada</i>	

A Novel Digital Active Gate Driver for High-Power IGBT to Reduce Switching Losses and Stresses	4189
Yatao Ling, Zhengming Zhao, Yicheng Zhu Tsinghua University, China	

Session 74: Wireless Power Transfer 2

Chair(s): Choi Uimin, Okan Boler

Design of a Downscaled Dynamic Wireless EV Charging System for Traffic Intersection Application	4195
Qingwei Zhu ¹ , Yanjie Guo ² , Lifang Wang ² , Chenglin Liao ² ¹ The University of Manchester, United Kingdom; ² Chinese Academy of Sciences, China	

Induction Application to Aircraft Ice Protection System	4201
Irma Villar ¹ , Ugaitz Iruretagoyena ¹ , Ana Cardenas ² , Francisco Redondo ² ¹ IKERLAN Technological Research Centre, Spain; ² Airbus S.A.S., Spain	

A Novel Self-adaptive Wireless Power Transfer System to Cancel the Reactance of the Series Resonant Tank and Deliver More Power	4207
Lixin Shi, Pedro Alou, Jesus A. Oliver, Jose A. Cobos Universidad Politecnica de Madrid, Spain	

Impacts of the Detuning of Compensation Inductances to the Performance of a Double-Sided LC-Compensated CPT System	4212
Hua Zhang ¹ , Chong Zhu ² , Fei Lu ¹ ¹ Drexel University, United States; ² Shanghai Jiao Tong University, China	

Load Estimation of a Series-Series Tuned Wireless Power Transfer System	4216
Sangmin Lee, Jaehong Lee, Eunchong Noh, Taelk Gil, Seung-Hwan Lee University of Seoul, Republic of Korea	

The High Order Harmonic Distortion Phenomenon in the Strongly Coupled IPT System and its Reduction Method	4223
Hua Zhang ¹ , Yao Wang ¹ , Chong Zhu ² , Ying Mei ^{3,4} , Teng Xu ⁴ , Fei Lu ¹ ¹ Drexel University, United States; ² Shanghai Jiao Tong University, China; ³ Zhejiang University, China; ⁴ LG Electronics, China	

Wednesday, October 2

Session 75: PV Systems 2

Chair(s): Rangarajan Tallam, Mehdi Narimani

Single-Stage Common-Ground Boost Inverter (S²CGBI) for Solar Photovoltaic Systems	4229
Sze Sing Lee ¹ , Chee Shen Lim ² , Yam P. Siwakoti ³ , Kyo-Beum Lee ⁴ ¹ Newcastle University in Singapore, Singapore; ² University of Southampton Malaysia, Malaysia; ³ University of Technology Sydney, Australia; ⁴ Ajou University, Republic of Korea	

Dual-Input Single-Stage Inverter for Photovoltaic-Battery Applications	4234
Khalil Alluhaybi, Haibing Hu, Issa Batarseh University of Central Florida, United States	

Operating Mode and Coordinated Power Control for Photovoltaic Battery Hybrid System using Cascaded Multilevel Inverter 4241
Junmou Feng¹, Zhao Liu¹, Jianshou Kong¹, Yue Zhang¹, Shanshan Zhao¹, Liang Dong¹, Qian Ma¹, Jian Ma²
¹Nanjing University of Science and Technology, China; ²Nanjing Rail Transit Systems Co., Ltd., China

A High-Gain, Soft-switched PV Micro-Converter using a Single Switch with a Low Switch-Voltage-to-Output-Bus-Voltage Ratio 4249
Kajanan Kanathipan, John Lam
York University, Canada

Session 76: Converters for DC Microgrids

Chair(s): Marco Liserre, Giovanna Oriti

Hybrid Modulated Bidirectional Resonant DC/DC Converter for High-Voltage Bus-Based Energy Storage Systems 4256
Junyun Deng, Haoyu Wang
ShanghaiTech University, China

Adaptive Current Sharing of Distributed Battery Systems in DC Microgrids using Adaptive Virtual Resistance-Based Droop Control 4262
Yajie Jiang¹, Yun Yang¹, Siew-Chong Tan¹, Shu-Yuen Ron Hui^{1,2}
¹The University of Hong Kong, China; ²Imperial College London, United Kingdom

Virtual Transformer Control for DC-DC Interlinking Converters in DC Microgrids 4268
Haixu Shi¹, Kai Sun¹, Yunwei Li², Hongfei Wu³
¹Tsinghua University, China; ²University of Alberta, Canada;
³Nanjing University of Aeronautics and Astronautics, China

Efficiency Evaluation for DAB Converter with Reactive Power Minimization Strategy and Full ZVS Operation 4274
Yan Hu¹, Yu Zhang¹, Qing Chen², Tianhui Zhang¹, Qingxin Guan¹, Yang Liu³, Yongyong Jia³, Jiexin Yu¹
¹Huazhong University of Science and Technology, China; ²State Grid Jiangsu Electric Power Co., Ltd., China;
³State Grid Jiangsu Electric Power Co., Ltd. Research Institute, China

Session 77: Power Quality in Power Systems

Chair(s): Norma Anglani, Ali Bazzi

Comparative Analysis on Performance of Power Quality Improvement of Grid-Connected Inverters 4281
Wooyoung Choi, Bulent Sarlioglu
University of Wisconsin-Madison, United States

A Hybrid Front-end for Multi-Generator Power System Harmonic Elimination 4287
Jongwan Kim, Jih-Sheng Lai
Virginia Polytechnic Institute and State University, United States

A Double Reduced Order Generalized Integrator based Algorithm for Control of Four-leg Converter to Enhance Power Quality 4293
S. Jiao¹, K. Rajashekara¹, R.K. Potti¹, L. Ben-Brahim², A. Gastli²
¹University of Houston, United States; ²Qatar University, Qatar

Power Quality Enhancement by SiC Active Power Filters in Oil and Gas Platforms 4299

Laís A. Vitoi¹, Danilo I. Brandao¹, Elisabetta Tedeschi²

¹Federal University of Minas Gerais, Brazil; ²Norwegian University of Science and Technology, Norway

Session 78: Grid-Converter Interactions

Chair(s): Grant Pitel, Qin Lei

Synchronous Frequency Support of Photovoltaic Power Plants with Inertia Emulation 4305

Cristian Verdugo¹, Andres Tarraso¹, Jose I. Candela¹, Joan Rocabert¹, Pedro Rodriguez²

¹Polytechnic University of Catalonia, Spain; ²Universidad Loyola Andalucía, Spain

Transient Stability Impact of Reactive Power Control on Grid-Connected Converters 4311

Donghua Pan¹, Xiongfei Wang¹, Fangcheng Liu², Rongliang Shi²

¹Aalborg University, Denmark; ²Huawei Technologies Co., Ltd., China

Grid-Tied Inverter with Simplified Virtual Synchronous Compensator for Grid Services and Grid Support 4317

Fabio Mandrile, Enrico Carpaneto, Radu Bojoi

Politecnico di Torino, Italy

Improved Transient Frequency Stabilization of Grid Feeding Distributed Generation Systems using Active Damping Control 4324

Salman Harasis, Yilmaz Sozer

University of Akron, United States

Session 79: DC-AC – Single-Phase

Chair(s): Daniel Costinett, Zhiliang Zhang

A Single-Phase PV Inverter with Swinging Bus Controller to Eliminate Electrolytic Capacitor and achieve Reactive Power Generation Capability 4331

Xinmin Zhang, Mahshid Amirabadi, Brad Lehman

Northeastern University, United States

An Isolated Single-Stage Single-Phase Micro-Inverter Topology with Integrated Magnetic Components 4339

Hafis Kolapo Umar-Lawal, Carl Ngai Man Ho, Ken King Man Siu

University of Manitoba, Canada

Improvements on Harmonic Current Distortion for MHz-Operated Discontinuous Current Mode Single Phase Grid-Tied Inverter with GaN-HEMT Device 4345

Jiantao Zhang, Takanori Isobe, Hiroshi Tadano

University of Tsukuba, Japan

A Family of Enhanced Voltage Gain Switched-Boost Impedance-Source Inverter Topologies for Renewable Energy Resources 4353

Anish Ahmad, Rajeev Kumar Singh, Vivek Nandan Lal

Indian Institute of Technology Varanasi, India

Session 80: DC-DC Non-Isolated Converter 3

Chair(s): Jen-Hung (Peter) Huang, Li Zhang

Analysis of Hybrid SiC IGBT based Resonant Switched Capacitor Converter with Circuit Parasitics Consideration 4359

Piao Wen¹, Xiaofeng Yang¹, Chengzhang Yan¹, Trillion Q. Zheng¹, Seiki Igarashi²
¹Beijing Jiaotong University, China; ²Fuji Electric Co., Ltd., Japan

A 3L Capacitor Clamping Converter with Low Current Ripple and High Voltage Gain 4366

Hong Li, Wencai Wang, Yangbin Zeng, Yangyang Zhao, Yanfeng Jiang
Beijing Jiaotong University, China

Fault Tolerance Analysis of Non-isolated High Gain Boost Converter 4372

Ankul Gupta¹, Raja Ayyanar¹, Sombuddha Chakraborty²
¹Arizona State University, United States; ²Texas Instruments, United States

A Resonant Cockcroft-Walton Switched-Capacitor Converter Achieving Full ZCS and > 10kW/inch³ Power Density 4378

Nathan Ellis, Rajeevan Amirtharajah
University of California Davis, United States

Session 81: PWM and Harmonic Reduction 1

Chair(s): Sewan Choi, Toshihisa Shimizu

Power Quality Optimization of Post-Fault Reconfigured Multi-Level Inverter 4385

Weiqiang Chen, Ali M. Bazzi
University of Connecticut, United States

Optimized Digital Implementation of Carrier-based Randomized Discontinuous PWM Technique for Active Front End (AFE) Drives 4390

Zhe Zhang¹, Lixiang Wei², Peizhong Yi², Puneeth Srikanta Murthy², Yujia Cui²
¹University of Connecticut, United States; ²Rockwell Automation, Inc., United States

An Asymmetric Selective Harmonic Current and Voltage Modulation-PWM Technique for Electric Vehicle Charging Stations with Cascaded H-Bridge Converters to meet Power Quality Standards 4395

Amirhossein Moeini, Shuo Wang
University of Florida, United States

Discontinuous Modulation of Interleaved Parallel NPC Inverters with Reduced Circulating Current 4403

Anatolii Tcai, Sante Pugliese, Marco Liserre
Christian-Albrechts-Universität zu Kiel, Germany

Session 82: Steady State Modeling

Chair(s): Huai Wang, Dong Jiang

Resolving Loss Discrepancy between Calculation and Measurement in a 4.5 kW GaN-based Inverter 4409

Zhe Yang¹, Paige Williford¹, Edward A. Jones¹, Jianliang Chen¹, Fred Wang^{1,2}, Sandeep Bala³, Jing Xu³
¹University of Tennessee-Knoxville, United States; ²Oak Ridge National Lab, United States;
³ABB Corporate Research, United States

The Principle and Calculation of AC-side Ground Resistance of Three-phase Converter through DC Insulation Monitoring 4415
Jifei Du, Trillion Q. Zheng, Hong Li, Yangbin Zeng, Hongyan Zhao
Beijing Jiaotong University, China

Analysis of a GaN-Based CRM Totem-Pole PFC Converter considering Current Sensing Delay 4421
Jingjing Sun, Nathan N. Strain, Daniel J. Costinett, Leon M. Tolbert
University of Tennessee, United States

Comparison between Different Analysis Methodologies for LLC Resonant Converter 4429
Yuqi Wei¹, Quanming Luo², Zhiqing Wang², Alan Mantooth¹, Xingchen Zhao¹
¹The University of Arkansas, United States; ²Chongqing University, China

Session 83: Grid Synchronization

Chair(s): Xinke Wu, Vito Giuseppe Monopoli

Re-synchronization of Universal Droop Control Distributed Generation Inverter to the Grid 4435
Mohammad Amin¹, Qing-Chang Zhong²
¹Norwegian University of Science and Technology, Norway; ²Illinois Institute of Technology, United States

Adaptive Synchronization Technique for Single-phase Inverters in AC Microgrid 4441
Animesh Sahoo¹, Khizir Mahmud¹, Mihai Ciobotaru², Jayashri Ravishankar¹
¹University of New South Wales, Australia; ²Macquarie University, Australia

Series Harmonic Voltage Canceller for Mitigating Effect of Grid Impedance on the Stability of Microgrids 4447
Chun-Tak Lai¹, Henry Shu-hung Chung¹, Weimin Wu²
¹City University of Hong Kong, China; ²Shanghai Maritime University, China

Observer based Admittance Shaping for Resonance Damping in Voltage Source Converters with LCL Filter 4455
M.A. Awal¹, Hui Yu¹, Leandro Della Flora², Wensong Yu¹, Srdjan Lukic¹, Iqbal Husain¹
¹North Carolina State University, United States; ²Danfoss Drives, United States

Session 84: Electric Machines for Transportation 1

Chair(s): Takashi Kato, Ayman El-Refaie

Synchronous Reluctance Motors with Asymmetric Rotor Shapes and Epoxy Resin for Electric Vehicles 4463
Andrea Credo¹, Marco Villani¹, Mircea Popescu², Nicolas Riviere²
¹University of L'Aquila, Italy; ²Motor Design Ltd., United Kingdom

Addressing the Challenges of Lightweight Aircraft Electric Propulsion through Electrical Machines with Air-gap Windings 4470
Philip H. Mellor¹, Callum Heath², Suzanne Collins¹, Nick Simpson¹, Ian Bond¹
¹University of Bristol, United Kingdom; ²National Composites Centre, United Kingdom

Systematic Comparison of Two Axial Flux PM Machine Topologies: Yokeless and Segmented Armature versus Single Sided 4477
Narges Taran¹, Greg Heins², Vandana Rallabandi¹, Dean Patterson², Dan M. Ionel¹
¹University of Kentucky, United States; ²Regal Beloit Corporation, Australia

Analytical Design of an Easily Manufacturable, Air-Cooled, Toroidally Wound Permanent Magnet Ring Motor with Integrated Propeller for Electric Rotorcraft 4483
Max Liben, Daniel C. Ludois
University of Wisconsin-Madison, United States

Session 85: Electric Machines: Diagnostics, Noise and Vibration 1
Chair(s): Rakib Islam, Shanelle Foster

Detection and Classification of Damper Bar and Field Winding Faults in Salient Pole Synchronous Motors 4491
Y. Park¹, S.B. Lee¹, J. Yun², M. Sasic³, G.C. Stone³
¹Korea University, Republic of Korea; ²Hyundai Electric, Republic of Korea;
³Quaitrol - Iris Power Engineering, Canada

Comparison of Fault Characteristics for Dual Three-Phase Synchronous Reluctance Motor 4499
Jun-Kyu Park¹, Cristian Babetto¹, Grazia Berardi¹, Jin Hur², Nicola Bianchi¹
¹University of Padova, Italy; ²Incheon National University, Republic of Korea

Analysis of Unbalanced Magnetic Pull in PMSM due to Static Eccentricity 4507
Anmol Aggarwal¹, Elias G. Strangas¹, John Agapiou²
¹Michigan State University, United States; ²General Motors, United States

Radial Force Reduction in SRMs using Partial Teeth Insertion on Stator and Rotor Poles 4515
Lavanya Vadamodala, Omer Gundogmus, Abdul Wahab Bandarkar, Yilmaz Sozer
University of Akron, United States

Session 86: Prof. Manfred Depenbrock Memorial Session
Chair(s): Mario Pacas, Volker Staudt

In Memoriam Manfred Depenbrock 4520
Volker Staudt¹, Andreas Steimel¹, Mario Pacas²
¹Ruhr-University Bochum, Germany; ²University of Siegen, Germany

Zero Voltage Vector Selection in a Saturation Controller-Based Direct Torque Control for Permanent-Magnet Synchronous Motors 4528
Lizhi Qu¹, Liyan Qu¹, Wei Qiao¹, Zhe Zhang²
¹University of Nebraska-Lincoln, United States; ²Eaton Corporation, United States

A Very Simple and Practical Deadbeat Direct Torque and Flux Control for IPMSM 4534
Xiaogang Lin, Wenxin Huang, Yong Zhao, Wen Jiang, Ning Su, Shanfeng Zhu
Nanjing University of Aeronautics and Astronautics, China

A High Frequency Signal Injection based Optimum Reference Flux Searching for Direct Torque Control of a Three-Level Traction Drive 4540
Mohammad Hazzaz Mahmud, Yuheng Wu, Waleed Alhosaini, Fei Diao, Yue Zhao
University of Arkansas, United States

Session 87: High Power Switching Devices and Application
Chair(s): Ramanujam Ramabhadran, Xiu Yao

A 20 kV, 125 kHz Photonically Driven Power MOSFET-like Device 4546
Kristin Sampayan, Stephen Sampayan
Opcondys, Inc., United States

Integrator Design of the Rogowski Current Sensor for Detecting Fast Switch Current of SiC Devices 4551
Lei Ming, Zhen Xin, Changqing Yin, Manxin Chen, Poh Chiang Loh
The Chinese University of Hong Kong, China

Multi-Objective Optimization Control Strategy for SiC/Si Hybrid Switches 4558
Zhizhi He, Zongjian Li, Jiajun Yu, Xi Jiang, Jun Wang
Hunan University, China

SiC MOSFETs Modeling Considering Characteristics Variation for Module Parallel Applications 4562
David Hongfei Lu, Hiromu Takubo, Motohito Hori, Akio Toba
Fuji Electric Co., Ltd., Japan

Session 88: Wireless Power Transfer 1

Chair(s): Fuxin Liu, Daniel Ludois

Design of Loosely Coupled Transformer of Wireless Power Transfer for Higher Misalignment Tolerance of System Efficiency 4569
Haisen Zhao¹, Yufei Wang^{2,3}, Hassan H. Eldeeb^{2,3}, Yang Zhan^{2,3}, Guorui Xu^{2,3}, Osama A. Mohammed^{2,3}
¹Florida International University, United States; ²North China Electric Power University, China;
³Yangzhong Intelligent Electrical Institute, China

Magnetic Stray Field Attenuation in High-Power WPT Systems based on a Modular Concept 4575
Abubakar Uba Ibrahim, Wenxing Zhong, Hongzhi Cui, Hao Li, Dehong Xu
Zhejiang University, Hangzhou, China

Interoperability Evaluation of Wireless Electric Vehicle Charging Systems based on Impedance 4580
Kai Song¹, Guang Yang¹, Ruizhi Wei¹, Xiaohua Huang², Qian Zhang³, Chunbo Zhu¹
¹Harbin Institute of Technology, China; ²China Electric Power Research Institute, China;
³State Grid Beijing Power Research Institute, China

Automatic Active Compensation Method of Cross-Coupling in Multiple-receiver Resonant Inductive Coupling Wireless Power Transfer Systems 4584
Masataka Ishihara, Keita Fujiki, Kazuhiro Umetani, Eiji Hiraki
Okayama University, Japan

Session 89: Multi Level PV Systems

Chair(s): Elisabetta Tedeschi, Mohammad B. Shadmand

Three-Phase Transformer-less Hybrid-Bypass Inverter 4592
Liwei Zhou, Matthias Preindl
Columbia University, United States

Multilevel-Boost-Converter-Neutral-Point-Clamped-Inverter Photovoltaic System with MPPT based on Fibonacci Search 4597
Ronnan de B. Cardoso, Edison Roberto C. da Silva, Darlan A. Fernandes
Federal University of Paraíba, Brazil

Design Optimization of a 1500 V GaN-Based Solar Inverter using Flying Capacitor Multi-Level Converter Stages 4605
Andrew Stillwell¹, Robert C.N. Pilawa-Podgurski²
¹University of Illinois Urbana-Champaign, United States; ²University of California-Berkeley, United States

Switched-Capacitor-Inductor-based Differential Power Converter for Solar PV Modules 4613
Kamran Ali Khan Niazi¹, Yongheng Yang¹, Jinkui He¹, Akif Zia Khan², Dezso Sera¹
¹Aalborg University, Denmark; ²The Hong Kong Polytechnic University, China

Session 90: Solid State Transformers 1

Chair(s): Subhadeep Bhattacharya, Ghanshyamsinh Gohil

Implementation of Flexible Large Power Transformers using Modular Solid State Transformer Topologies Enabled by SiC Devices 4619
Venkat N. Jakka, Harshit Nath, Sayan Acharya, Arun Kadavelugu, S. Madhusoodhanan, A. Tripathi, D. Patel, K. Mainali, Subhashish Bhattacharya
North Carolina State University, United States

Discrete State Event-Driven Approach for High-Power Converter Simulations 4627
Bochen Shi, Zhengming Zhao, Yicheng Zhu, Zhujun Yu, Jiahe Ju, Liqiang Yuan, Kainan Chen
Tsinghua University, China

Modified Feedforward Control to Suppress DC Voltage Disturbances for Three-Stage MMC-PET 4632
Yaqian Zhang, Jianzhong Zhang, Jin Zhao, Fujin Deng
Southeast University, China

Intelligent Transformer Unit Topology using Additional Small Power Converter based on Conventional Distribution Transformer 4639
Hyun-Jun Lee, Young-Doo Yoon
Hanyang University, Republic of Korea

Session 91: Synchronization of Grid Converters

Chair(s): Dong Dong, Brian Johnson

Self-Synchronising Stationary Frame Current Regulation for Grid-Connected LCL Converters under Unbalanced Grid Voltage Conditions 4646
A.A. Nazib, D.G. Holmes, B.P. McGrath
RMIT University, Australia

Wind Power System Control based on the Self-Synchronized Universal Droop Controller 4654
Yang Ruan, Qing-Chang Zhong
Illinois Institute of Technology, United States

Synchronous Power Controller for Distributed Generation Units 4660
Andrés Tarrasó¹, Cristian Verdugo¹, Ngoc Bao Lai², Jose Ignacio Candela¹, Pedro Rodriguez²
¹Universitat Politècnica de Catalunya, Spain; ²Universidad Loyola Andalucía, Spain

A Single-phase Synchronization Technique for Grid-connected RESS under Distorted Grid Conditions 4665
Komal Saleem, Zunaib Ali, Kamyar Mehran
Queen Mary University of London, United Kingdom

Session 92: Prof. Milan M. Jovanovic Memorial Session

Chair(s): Dushan Borojevic, Fred Lee

Review of Milan M. Jovanovic's Work and Impact on the Power Electronics Industry 4673

Laszlo Huber, Yungtaek Jang, Yuri Panov
Delta Electronics (Americas) Ltd., United States

A Two-stage Universal Input Charger with Wide Output Voltage Range 4685

Mike K. Ranjram, Cheng Zhang, David J. Perreault
Massachusetts Institute of Technology, United States

A "Reverse-Feeding" Hold-up Time Strategy for Two-Stage Grid-Interface PFC with a Rectifier-Coupled Boost Inductor 4693

Jaeil Baek¹, Gun-Woo Moon², Minjie Chen¹
¹*Princeton University, United States;* ²*Korea Advanced Institute of Science and Technology, Republic of Korea*

Wide Voltage Range High-Efficiency Sigma Converter 48V VRM with Integrated Magnetics 4701

Mohamed H. Ahmed, Fred C. Lee, Qiang Li
Virginia Polytechnic Institute and State University, United States

Session 93: Multilevel Converters Voltage Balancing

Chair(s): Thomas Podlesak, Brendan McGrath

Capacitor Voltage Balancing Control Strategy for Single Phase Five-Level ANPC Photovoltaic Inverter 4708

Haihua Xue, Deqiang Zhang, Xi Liu, Alian Chen, Chenghui Zhang
Shandong University, China

Hybrid DC Link Voltage Balancing for a Two-Leg Five-Level Neutral Point Clamped Inverter 4714

Eshet T. Wodajo¹, Malik Elbuluk¹, Seungdeog Choi², Haitham Abu-Rub³
¹*University of Akron, United States;* ²*Mississippi State University, United States;* ³*Texas A&M University - Qatar, Qatar*

Balancing Average Capacitor Voltages in Neutral-Point-Clamped Converters using Band-Limited Three-Level Modulation 4721

Neha Beniwal¹, Christopher D. Townsend², Glen Farivar¹, Josep Pou¹, Salvador Ceballos³
¹*Nanyang Technological University, Singapore;* ²*University of Western Australia, Australia;* ³*Tecnalia Research and Innovation, Spain*

New Active Capacitor Voltage Balancing Method for Seven-Level Full-Bridge Flying-Capacitor-Multicell (FCM) Inverters 4727

Arash Khoshkbar-Sadigh¹, Vahid Dargahi², Keith Corzine²
¹*Pennsylvania State University, United States;* ²*University of California-Santa Cruz, United States*

Session 94: DC-DC Non-Isolated Converter 4

Chair(s): Pradeep Shenoy, Michael Gonzalez

Light-Load Switching-Loss Elimination utilizing Pulse Density Modulation for Switched-Capacitor-Based Resonant Converters 4734

Hadi Setiadi, Hideaki Fujita
Tokyo Institute of Technology, Japan

Synthesizing a Family of Converters for a Specified Conversion Ratio using Flux Balance Principle 4741
Ramanuja Panigrahi, Santanu K. Mishra, Avinash Joshi
Indian Institute of Technology Kanpur, India

A Modular DC-DC Converter Topology based on a Three-Level DC-DC Converter for Distributed Fuel Cell Architecture 4747
Mohammad Afkar¹, Roghayeh Gavagsaz-Ghoachani¹, Matheepot Phattanasak², Apinya Siangsanoh³, Jean-Philippe Martin³, Serge Pierfederici³
¹*Shahid Beheshti University, Iran*; ²*King Mongkut's University of Technology North Bangkok, Thailand*; ³*Université de Lorraine, France*

Non-isolated High Gain Boost Converter Operating in Critical Conduction Mode 4754
Ankul Gupta¹, Raja Ayyanar¹, Sombuddha Chakraborty²
¹*Arizona State University, United States*; ²*Texas Instruments, United States*

Session 95: PWM and Harmonic Reduction 2
Chair(s): Sewan Choi, Toshihisa Shimizu

Interharmonics Reduction in Photovoltaic Systems with Random Sampling MPPT Technique 4760
Ariya Sangwongwanich, Frede Blaabjerg
Aalborg University, Denmark

A Phase-Shifted-Among-Legs PWM Scheme for the Hybrid Cascaded Converter based STATCOM 4766
Yu-chen Su, Jing-syuan Wang, Po-tai Cheng
National Tsing Hua University, Taiwan

Multifunctional Grid-Tied PV System using Modified KLMS Control 4774
Abhishek Kumar¹, Seema Kewat², Bhim Singh², Rashmi Jain³, Anjeet Verma²
¹*Indian Institute of Technology Madras, India*; ²*Indian Institute of Technology Delhi, India*; ³*J.C. Bose University of Science and Technology, YMCA, India*

Design Considerations of DSP-based SiC-MOSFET SAPF with 100kHz Sampling and Switching Frequency 4781
Yuxiao Zhang¹, Ke Dai¹, Hongwei Xu¹, Haitao Lin¹, Debin Zhang¹, Qin Lei²
¹*Huazhong University of Science and Technology, China*; ²*Arizona State University, United States*

Session 96: Control of MMC
Chair(s): Xiaonan Lu, Hanchao Liu

Control and Design of Mission Profile Emulator for Sub-modules in Modular Multilevel Converter 4789
Yunxiao Yang, Ke Ma, Yubo Song, Weiyao Wang
Shanghai Jiao Tong University, China

Accurate Neutral Current Control for Neutral Point Voltage Balancing in Three-Level Inverters Considering Digital Control and PWM Delay 4795
Hyun-Jun Lee, Sungmin Kim, Young-Doo Yoon
Hanyang University, Republic of Korea

- Comparison of Phase-Shifted Carrier PWM Schemes for Modular Multilevel Converter** 4801
 Qian Cheng, Chenchen Wang
Beijing Jiaotong University, China
- Thermal Loading and Analysis of Modular Multilevel Converters using Injection Control of Circulating Current and Common-mode Voltage** 4808
 Deepak Ronanki, Sheldon S. Williamson
University of Ontario Institute of Technology, Canada
- Session 97: AC-DC Converter Control**
Chair(s): Sheng Zheng, John Lam
- DCM Buck-Buck/Boost PFC Converter with Segmented Fixed Duty-Cycle Control** 4816
 Chengjian Wu, Kai Yao, Zhen Zhang, Chunwei Ma, Jienan Chen, Lingge Li, Chanbo Guan
Nanjing University of Science and Technology, China
- A SVPWM Method with Reduced Switching Frequency suitable for High Power Three-level NPC Rectifiers** 4824
 Zhan Gao^{1,2}, QiongXuan Ge¹, YaoHua Li¹, Lu Zhao¹, Bo Zhang¹
¹Chinese Academy of Sciences, China; ²University of Chinese Academy of Sciences, China
- Single DC-Link Three-phase AC-DC-AC Converter with Shared Legs** 4832
 Alan S. Felinto¹, Cursino B. Jacobina¹, Edgard L.L. Fabricio², Rodrigo P. de Lacerda¹
¹Federal University of Campina Grande, Brazil; ²Federal Institute of Paraíba, Brazil
- Grid Impedance Identification and Structured-h2 Optimization based Controller Design of Active Front-end in Embedded AC Networks** 4840
 Kang Li, David Dewar, Andrea Formentini, Pericle Zanchetta, Pat Wheeler
University of Nottingham, United Kingdom
- Session 98: Electric Machines: Loss Analysis 2**
Chair(s): Franco Leonardi, Julia Zhang
- Efficiency Maps Computation and Comparison including Thermal Limits** 4846
 Giacomo Bacco, Cristian Babetto, Michele Bonfante, Matteo Carbonieri, Nicola Bianchi
University of Padova, Italy
- Electrical Machine Loss Distribution and Thermal Parameter Identification through Experimentally Informed Virtual Prototyping** 4853
 Dominic North, Suzanne Collins, Nick Simpson, Phil Mellor
University of Bristol, United Kingdom
- Efficient Multidisciplinary Modeling and Simulation of a Washing Machine Motor Duty Cycle** 4860
 Martin Ortega¹, Anqi Sun², Manoj Kandukuri², Tan Pham³, Philippe Wendling²
¹Mabe, Mexico; ²Altair Engineering, Inc., United States; ³Solar Turbines, United States
- A Hybrid Analytical and FE-based Method for Calculating AC Eddy Current Winding Losses taking 3D Effects into Account** 4867
 Narges Taran, Dan M. Ionel
University of Kentucky, United States

Session 99: IPMSM and Synchronous Reluctance Machines

Chair(s): Tsarafidy Raminosa, Julia Zhang

Reduction of Cross Magnetization in Interior Permanent Magnet Synchronous Motors with V-Shape Magnet Configurations by Optimizing Rotor Slits 4873

Katsumi Yamazaki, Ryota Kondo
Chiba Institute of Technology, Japan

Optimal Design and Experimental Validation of a Synchronous Reluctance Machine for Fault-Tolerant Applications 4880

Cristian Babetto¹, Nicola Bianchi¹, Ambra Torreggiani², Claudio Bianchini², Matteo Davoli³, Alberto Bellini⁴
¹University of Padova, Italy; ²University of Modena and Reggio Emilia, Italy; ³Raw Power S.r.l., Italy;
⁴University of Bologna, Italy

Standstill Determination of PM Flux Linkage based on Minimum Saliency Tracking for PM-SyR Machines 4888

Paolo Pescetto, Gianmario Pellegrino
Politecnico di Torino, Italy

Torque Ripple Minimization of PM-assisted Synchronous Reluctance Machines via Asymmetric Rotor Poles 4895

Simone Ferrari, Eric Armando, Gianmario Pellegrino
Politecnico di Torino, Italy

Session 100: Control of Electric Drives

Chair(s): Wei Xu, Michael Harke

Decoupled Torque Control of Multiple Three-Phase Induction Motor Drives 4903

Sandro Rubino, Radu Bojoi, Davide Cittanti, Luca Zarri
¹Politecnico di Torino, Italy; ²University of Bologna, Italy

Modulated Model Predictive Control for Induction Motor Drives with Sequential Cost Function Evaluation 4911

Valerio Vodola¹, Shafiq Odhano², Cristian Garcia³, Margarita Norambuena⁴, Silvio Vaschetto¹, Pericle Zanchetta², Jose Rodriguez⁵, Radu Bojoi¹
¹Politecnico di Torino, Italy; ²University of Nottingham, United Kingdom; ³Universidad de Talca, Chile;
⁴Universidad Tecnica Federico Santa Maria, Chile; ⁵Universidad Andres Bello, Chile

Predictive Current Control of Mutually Coupled Switched Reluctance Motors using Net Flux Method 4918

Siddharth Mehta¹, Iqbal Husain¹, Prerit Pramod²
¹North Carolina State University, United States; ²Nexteer Automotive, United States

Levitation Control for a Double-Sided Bearingless Linear Motor based on Feedback Linearization 4923

Seppo E. Saarakkala, Maksim Sokolov, Reza Hosseinzadeh, Marko Hinkkanen
Aalto University, Finland

Session 101: Thermal Management

Chair(s): Francesco Iannuzzo, Lauren Boteler

Two-Dimensional Thermal Modeling and Parametric Optimization of Printed Circuit

Board Vias 4931

Yanfeng Shen¹, Hui Zhao¹, Teng Long¹, Huai Wang², Frede Blaabjerg²

¹University of Cambridge, United Kingdom; ²Aalborg University, Denmark

Thermal Buffering Effect of Phase Change Material on Press-pack IGBT during Power Pulse 4937

Hai Ren¹, Gaofeng Hao¹, Weihua Shao¹, Li Ran¹, Lin Zhou¹, Philip Mawby², Huaping Jiang¹

¹Chongqing University, China; ²The University of Warwick, United Kingdom

Thermal Characterization of SiC Modules for Variable Frequency Drives 4944

Marzieh Karami, Rangarajan Tallam

Rockwell Automation, United States

A High-Accuracy, Low-Order Thermal Model of SiC MOSFET Power Modules Extracted from Finite

Element Analysis via Model Order Reduction 4950

Cameron Entzminger, Wei Qiao, Liyan Qu, Jerry L. Hudgins

University of Nebraska-Lincoln, United States

Session 102: Wireless Power Transfer 2

Chair(s): David Dorrell, Omer Onar

Communication-Free Control Scheme for Qi-Compliant Wireless Power Transfer Systems 4955

Yun Yang¹, Siew-Chong Tan¹, Shu Yuen Ron Hui^{1,2}

¹The University of Hong Kong, China; ²Imperial College London, United Kingdom

A Square-Shaped Omnidirectional Wireless Charging Bowl with a Double Layer Electromagnetic

Shield for Portable Device Applications 4961

Junjie Feng, Qiang Li, Fred C. Lee

Virginia Polytechnic Institute and State University, United States

Inductive Wireless Power Transfer at 100 MHz with Wide Load Range and Constant

Output Current 4967

Xin Zan¹, Zizhen Guo², Al-Thaddeus Avestruz¹

¹University of Michigan-Ann Arbor, United States; ²Tsinghua University, China

A Wireless Power Transfer System with Multiple Constant Current and Constant

Voltage Outputs 4976

Zhe Zhou¹, Zhanfeng Deng¹, Chenwen Cheng², Weiguo Li¹, Fangyi Li¹, Chris Mi²

¹Global Energy Interconnection Research Institute, China; ²San Diego State University, United States

Session 103: Wave and Ocean Energy Systems

Chair(s): Mehdi Narimani, Yongheng Yang

An Experimental Investigation into the Wave Power Extraction of a Small-Scale Fixed Multi-Chamber

OWC Device 4982

Mohammad Shalby¹, David Dorrell², Paul Walker¹, Ahmed Elhanafi³

¹University of Technology Sydney, Australia; ²University of KwaZulu-Natal, South Africa;

³University of Tasmania, Australia

Damping Selection Strategy for Maximum Energy on Wave Energy Power Converters 4988

Chien-An Chen, Lei Zuo

Virginia Polytechnic Institute and State University, United States

Adaptive Control of a Hybrid Energy Storage System for Wave Energy Conversion Application 4994

Apoorv Agarwal, Vishnu Mahadeva Iyer, Anup Anurag, Subhashish Bhattacharya

North Carolina State University, United States

Investigating the Performance of a Variable Stiffness Magnetic Spring for Resonant Ocean Power Generation 5002

Md Emrad Hossain, Jonathan Z. Bird

Portland State University, United States

Session 104: Solid State Transformers 2

Chair(s): John Shen, Enrico Santi

A Decoupled Control Scheme of Four-Port Solid State Transformer 5009

Saban Ozdemir^{1,2}, Necmi Altin^{1,2}, Ahmad El Shafei¹, Mo Rashidi³, Adel Nasiri¹

¹University of Wisconsin-Milwaukee, United States; ²Gazi University, Turkey; ³Eaton Corporation, United States

Hybrid Multiple-Active Bridge for Unequal Power Flow in Smart Transformers 5016

Victor N. Ferreira¹, Nimrod Vazquez², Braz Cardoso³, Marco Liserre¹

¹Christian-Albrechts-Universität zu Kiel, Germany; ²Instituto Tecnológico de Celaya, Mexico;

³Federal University of Minas Gerais, Brazil

Estimation of Eddy Current Winding Losses in Soft-Switching Solid-State Transformer 5022

Xiwei Zheng, Xiangyu Han, Mickael Mauger, Prasad Kandula, Karthik Kandasamy, Deepak Divan

Georgia Institute of Technology, United States

AC-DC Converter with Hybrid Three-Level and Two-Level Legs using Space Vector Modulation for Medium-Voltage SST Applications 5029

Dakai Wang, Wensong Yu, Siyuan Chen, David Philpott

North Carolina State University, United States

Session 105: Inverter Control

Chair(s): Brendan McGrath, Leon M. Tolbert

Evaluation of Voltage Regulators for Dual-Loop Control of Voltage-Controlled VSCs 5036

Yicheng Liao, Xiongfei Wang

Aalborg University, Denmark

A Modified Lyapunov-function based Control Scheme for Three-phase UPS with a Load Estimator in Synchronous Rotating Frame 5043

Jinsong He¹, Fanfan Lin¹, Qingsong Ran², Xin Zhang¹

¹Nanyang Technological University, Singapore; ²Powerchina Resources Ltd., China

Grid Tied Wind Energy Generating System incorporating an Observer based Nonlinear Control Exhibiting Robustness 5048

Subarni Pradhan, Shadab Murshid, Bhim Singh, Bijaya Ketan Panigrahi

Indian Institute of Technology Delhi, India

Inverter Output Current Overshoot Suppression during Fault Ride-through Operation for Three-phase Grid-tied Inverter with Minimized Inductor 5056
Satoshi Nagai, Hiroki Watanabe, Jun-ichi Itoh
Nagaoka University of Technology, Japan

Session 106: Batteries and Battery Management 1

Chair(s): Mohammed Alam, Arash Nassiri Bavili

Simplified Control Strategy for an Inhomogeneous Series-connected Battery String 5064
Rishab Anand, B.G. Fernandes
Indian Institute of Technology Bombay, India

High-dimensional Data Abnormity Detection based on Improved Variance-of-Angle (VOA) Algorithm for Electric Vehicles Battery 5072
Peng Liu¹, Jin Wang¹, Zhenpo Wang¹, Zhaosheng Zhang¹, Shuo Wang¹, David G. Dorrell²
¹Beijing Institute of Technology, China; ²University of Kwa-Zulu-Natal, South Africa

A Single-Capacitor Equalizer using Optimal Pairing Algorithm for Series-Connected Battery Cells 5078
Phuong-Ha La, Hong-Hee Lee, Sung-Jin Choi
University of Ulsan, Republic of Korea

Optimized Design of an Onboard Resonant Self-Heater for Automotive Lithium-Ion Batteries at Cold Climates 5084
Chong Zhu¹, Yunlong Shang², Fei Lu³, Hua Zhang³
¹Shanghai Jiao Tong University, China; ²Shandong University, China; ³Drexel University, United States

Session 107: Multilevel Converters Modulation

Chair(s): Roberto Petrella, Lee Empringham

Unfolder Operation and Modulation Strategy of Paralleled Current-source Converters 5089
Yuzhuo Li, Nie Hou, Li Ding, Yunwei Li
University of Alberta, Canada

Three-phase Multilevel Asymmetric Current Source Converter 5096
Nayara I.L. Lisboa, Louelson A.L. de A.C. Costa, Montiê A. Vitorino, Maurício B.R. Corrêa
Federal University of Campina Grande, Brazil

An Optimized Phase Shifted PWM for Flying Capacitor Multilevel Converter 5104
Waqar A. Khan, Sina Vahid, Md Rakib-Ur Rahman, Ramin Katebi, Ayman EL-Refaie, Nathan Weise
Marquette University, United States

Model Predictive Control for Three Level Neutral Point Clamped Inverter with Reduced Numbers of Switching State Combinations 5109
Ritwik Ghosh, Narsa Reddy Tummuru, Bharat Singh Rajpurohit
Indian Institute of Technology Mandi, India

Session 108: DC-DC Non-Isolated Converter 5

Chair(s): Sombuddha Chakraborty, Junichi Itoh

A Bidirectional LLC Converter enabled by Common-Mode and Differential-Mode Operation 5116
Jessica D. Boles, Seungbum Lim, Juan A. Santiago-González, David M. Otten, David J. Perreault
Massachusetts Institute of Technology, United States

A 99.7% Efficient 300 W Hard Disk Drive Storage Server with Multiport Ac-Coupled Differential Power Processing (MAC-DPP) Architecture 5124
Ping Wang, Yanan Chen, Parker Kushima, Youssef Elasser, Ming Liu, Minjie Chen
Princeton University, United States

Multi-objective Design of LC Filter for High-efficiency, High-power-density and High-performance Buck Converter 5132
Xinze Li¹, Fanfan Lin¹, Xin Zhang¹, Meng Huang², Huai Wang³
¹Nanyang Technological University, Singapore; ²Wuhan University, China; ³Aalborg University, Denmark

Generalized Multilevel Converter in DC/DC Application 5137
Hao Hu¹, Saikat Ghosh¹, Yam Siwakoti², Teng Long¹
¹University of Cambridge, United Kingdom; ²University of Technology Sydney, Australia

Session 109: DC-DC Isolated Converter 1
Chair(s): Jianwu Zeng, Burgos Rolando

Real-Time Modeling and HIL Simulation of Stacked Low-Inertia Converters with Soft-Switching and Fast Dynamic Control 5144
Xiangyu Han, Liran Zheng, Rajendra Prasad Kandula, Karthik Kandasamy,
Maryam Saeedifard, Deepak Divan
Georgia Institute of Technology, United States

A Novel Modulation Method of LLC Resonant Converter with Linear Model and High Efficiency 5152
Zhijian Fang^{1,2}, Zhicong Huang³, Hang Jing⁴, Guozhen Hu⁵, Junhua Wang⁴, Liang Tao⁴
¹China University of Geosciences, China; ²Hubei Key Laboratory of Advanced Control and Intelligent Automation for Complex Systems, China; ³University of Macau, Macau; ⁴Wuhan University, China; ⁵Hubei Polytechnic University, China

LEGO-MIMO Architecture: A Universal Multi-Input Multi-Output (MIMO) Power Converter with Linear Extendable Group Operated (LEGO) Power Bricks 5156
Yenan Chen, Ping Wang, Youssef Elasser, Minjie Chen
Princeton University, United States

High Efficiency High Power Density Bidirectional DC-DC Converter for Photovoltaic Energy Storage System Utilization 5164
Fangyuan Shi, Rui Li
Shanghai Jiao Tong University, China

Session 110: Converter Stability Analysis
Chair(s): Harish Krishnamoorthy, Chi Kong Tse

Stability Analysis of Grid-Connected VSCs based on S-parameters and Reflection Coefficient 5171
Shih-Feng Chou, Xiongfei Wang, Frede Blaabjerg
Aalborg University, Denmark

Stability Analysis of MMC under Grid Voltage Phase Change 5179
Yushuang Liu¹, Meng Huang¹, Xiaoming Zha¹, Chi K. Tse², Zhihong Yan¹
¹Wuhan University, China; ²Hong Kong Polytechnic University, China

Stability Analysis of Grid-Connected Inverters during the Transient of Grid Voltage Fluctuations in Weak Grid Cases 5185
Jinming Xu, Shenyiyang Bian, Miao Liu, Zhao Zhang, Shaojun Xie
Nanjing University of Aeronautics and Astronautics, China

Systematic Approach for Transient Stability Evaluation of Grid-Tied Converters during Power System Faults 5191
Mads Graungaard Taul, Xiongfei Wang, Pooya Davari, Frede Blaabjerg
Aalborg University, Denmark

Session 111: DAB Converter Control

Chair(s): Hui Li, Leila Parsa

An Analog-based, Duty Cycle Modulation Method to remove the DC Bias in the Transformer for a Dual Active Bridge Converter 5199
Bocheng Zhang, Shuai Shao, Naipeng Yu, Xinke Wu, Junming Zhang
Zhejiang University, China

An Uncertainty and Disturbance Estimator based Voltage Control for Dual-Active-Bridge Converters 5204
Yuheng Wu¹, Mohammad Hazzaz Mahmud¹, Waleed Alhosaini¹, Yue Zhao¹, Alan Mantooth¹, Yuzhi Zhang²
¹University of Arkansas, United States; ²ABB, Inc., United States

Instantaneous Start-Up and Shutdown Method for Three-Phase Dual-Active Bridge DC-DC Converters 5210
Daniel von den Hoff, Rik W. De Doncker
¹RWTH Aachen University, Germany

Dual Switching Frequency Operation of Dual Active Bridge Converter 5217
Changjiang Sun¹, Xin Zhang¹, Xu Cai²
¹Nanyang Technological University, Singapore; ²Shanghai Jiao Tong University, China

Session 112: Switched Reluctance and Flux Switching Machines 1

Chair(s): Rajesh Deodhar, Akira Chiba

Analysis of Novel Consequent Pole Flux Reversal Permanent Magnet Machine 5223
H. Qu, Z.Q. Zhu, H.Y. Li
The University of Sheffield, United Kingdom

Improved Current Profile for Noise Reduction of Switched Reluctance Motor at Middle Speed 5231
Candra Adi Wiguna, Jihad Furqani, Akira Chiba
Tokyo Institute of Technology, Japan

Design Considerations and Performance Analysis of a Super High-Speed Switched Reluctance Motor for Electric Supercharger 5238
Grace Firsta Lukman, Kwang-Il Jeong, Jin-Woo Ahn, Do-Kwan Hong
¹Kyungsung University, Republic of Korea; ²Korea Electrotechnology Research Institute, Republic of Korea

A Phase Current Peak Prediction Technique to Increase the Output Power of Switched Reluctance Generators for Wind Turbines 5244
Prashant Carl Buck, Babak Fahimi, Poras T. Balsara
The University of Texas-Dallas, United States

Session 113: High Speed and Bearingless Machines 1

Chair(s): Iqbal Husain, Eric Severson

Very-High-Speed Miniaturized Permanent Magnet Motors: Modeling and Experimental Validation 5251

Guillaume Burnand, Yves Perriard
École Polytechnique Fédérale de Lausanne, Switzerland

Very-High-Speed Miniaturized Permanent Magnet Motors: Design and Optimization 5258

Guillaume Burnand, Yves Perriard
École Polytechnique Fédérale de Lausanne, Switzerland

Optimal Design of the Bearingless Induction Motor for Industrial Applications 5265

Jiahao Chen, Eric L. Severson
University of Wisconsin-Madison, United States

Design of a Miniaturized Single-Drive Bearingless Motor 5273

Guilherme Cavalcante Rubio, Hiroya Sugimoto, Akira Chiba
Tokyo Institute of Technology, Japan

Session 114: Induction Motor Drives 1

Chair(s): Alireza Fetemi, Xuechao Wang

Fault-Tolerant DTC Technique for Five-phase Three-level NPC Inverter fed Induction Motor Drive with an Open-phase Fault 5281

Bheemaiah Chikondra, Utkal Ranjan Muduli, Ranjan Kumar Behera
Indian Institute of Technology Patna, India

Rotor Resistance Estimation for Sensorless Induction Motor Drives with a Torque Ripple Reduction Method 5288

Cheng Luo, Bo Wang, Yong Yu, Tianqing Wang, Zhixin Huo, Dianguo Xu
Harbin Institute of Technology, China

A General Coordinate Transformation based on Fourier Matrices for Modelling Space Harmonics in Induction Machines 5293

Julien Cordier, Stefan Klass, Ralph Kennel
Technische Universität München, Germany

Active and Reactive Power Control of the Rotor Loads in a Five-Phase Wound Rotor Induction Motor Drive 5301

Gabriele Rizzoli, Michele Mengoni, Luca Vancini, Giacomo Sala, Luca Zarri, Angelo Tani
University of Bologna, Italy

Session 115: High Power SiC Packaging

Chair(s): Christina DiMarino, Ariunbolor Purvee

Novel SiC Power Module for Traction Power Inverters with Low Parasitic Inductances 5307

Marko Jaksic, Ajay Patwardhan, John Czubay, Constantin Stancu, Terence Ward, Dawud Abu-Zama, Sung Chung, Ioan Suciuc, Mehrdad Teimorzadeh, Brian Peaslee
General Motors, United States

Enhanced Over-current Capability and Extended SOA of Power Modules utilizing Phase Change Material 5315
 Weihua Shao¹, Ruizhu Wu², Li Ran¹, Huaping Jiang¹, Tom Combs², Kieran Yardley², Philip Mawby², Debaprasad Kastha³, Prabodh Bajpai³
¹Chongqing University, China; ²University of Warwick, United Kingdom; ³Indian Institute of Technology Kharagpur, India

Current Sharing Behavior and Characterization of a 1200 V, 6.5 mΩ SiC Half-Bridge Power Module with Flexible PCB Gate Loop Connection 5321
 Grace Watt¹, Slavko Mocevic¹, Rolando Burgos, Amy Romero², Marko Jaksic³, Mehrdad Teimor³
¹Virginia Polytechnic Institute and State University, United States; ²Wolfspeed, A Cree Company, United States; ³General Motors, United States

A Highly-Integrated SiC Power Module for Fast Switching DC-DC Converters 5329
 Alexander Stippich, Tobias Kamp, Alexander Sewergin, Lukas Fraeger, Arne Hendrik Wienhausen, David Bündgen, Rik W. De Doncker
 RWTH Aachen University, Germany

Session 116: Wireless Power Transfer 3
Chair(s): Xin Dai, Jason Pries

Precise General Modeling of Windings for Wireless Power Transfer 5337
 Xinhe Liu, Wenxing Zhong, Hongzhi Cui, Ping Lin, Dehong Xu
 Zhejiang University, China

A Novel Soft-Switching Dual-Side Phase Shift Circuit for Wireless Power Transfer 5344
 Chu Wang¹, Min Chen¹, Hongzhi Cui¹, Xinhe Liu¹, Wenxing Zhong¹, Fangyuan Shi²
¹Zhejiang University, China; ²Shanghai Jiao Tong University, China

A Novel Hinge-Joint Structure for Wireless Power Transfer System 5352
 Mohamad Abou Houran¹, Xiaoteng Li², Xu Yang¹, Wenjie Chen¹
¹Xi'an Jiaotong University, China; ²State Grid Shaanxi Electric Power Company, China

Low-Cost, Printed Circuit Board Construction, Capacitively Coupled Excitation System for Wound Field Synchronous Machines 5358
 Skyler Hagen¹, Jiejian Dai¹, Ian P. Brown², Daniel C. Ludois²
¹University of Wisconsin-Madison, United States; ²Illinois Institute of Technology, United States

Session 117: Energy Storage Systems
Chair(s): Wasi Uddin, Alex De Abreu-Garcia

Improved Modular Multilevel Converter with Symmetrical Integrated Super Capacitor Energy Storage System for Electrical Energy Router Application 5365
 Zejie Li¹, Xiaofeng Yang¹, Haibo Tao¹, Trillion Q. Zheng¹, Xiaojie You¹, Pavel Kobrle²
¹Beijing Jiaotong University, China; ²Czech Technical University, Czech Republic

Current Controlled Operation of Cascaded H-Bridge Converter for Fast SoC Balancing in Grid Energy Storage 5373
 Amir Hussain¹, Krishna Raj¹, Kaushik Rajashekara¹, Harish Krishnamoorthy¹, Stanley Atcitty²
¹University of Houston, United States; ²Sandia National Laboratories, United States

SoH-Aware Charging of Supercapacitor with Lifetime Maximization 5380
Fu Jiang^{1,2}, Cheng Jin^{1,2}, Yongjie Liu^{1,2}, Heng Li^{1,2}, Xiaoyong Zhang^{1,2}, Yingze Yang^{1,2}, Jun Peng^{1,2},
Zhiwu Huang^{1,2}
¹Central South University, China; ²Hunan Engineering Laboratory of Rail Vehicles Braking Technology, China

Architecture for Utility-Scale Multi-Chemistry Battery Energy Storage 5386
Mitchell T. Smith^{1,2}, Michael R. Starke¹, Madhu Chinthavali¹, Leon M. Tolbert^{1,2}
¹Oak Ridge National Lab, United States; ²University of Tennessee-Knoxville, United States

Session 118: AC Microgrids

Chair(s): Johan HR Enslin, Rob Cuzner

Decentralized Reactive Power Sharing among Parallel Inverters through Inherent Dead-time Effect 5393
Yang Qi, Yi Tang
Nanyang Technological University, Singapore

On the Effect of Line Dynamics in Multi-inverter Systems with Generalized Droop Control 5400
Gurupraanesh Raman¹, Jimmy Chih-Hsien Peng¹, Sidhaarth Venkatachari²
¹National University of Singapore, Singapore; ²National Institute of Technology Tiruchirappalli, India

A Common Second Frequency Control of Island Cascaded-type Microgrid 5407
Guangze Shi¹, Hua Han¹, Yao Liu², Mei Su¹, Zhangjie Liu¹, Yao Sun¹
¹Central South University, China; ²South China University of Technology, China

Leader Selection in Robust Pinning-based Distributed Control for Islanded Microgrids 5411
Jianzhe Liu¹, Xiaonan Lu², Chen Chen¹, Bo Chen¹
¹Argonne National Laboratory, United States; ²Temple University, United States

Session 119: Dynamics of Inverter-Based Resources

Chair(s): Yunwei Li, Robert S. Balog

Model Predictive Current Control of Active Distribution Transformer with Consideration of its Stability Analysis based on AC-AC Matrix Converter 5417
Yougui Guo¹, Bowen Yang¹, Chuyun Li¹, Wenlang Deng¹, Frede Blaabjerg²
¹Xiangtan University, China; ²Aalborg University, Denmark

Passivity Analysis and Enhancement of Voltage Control for Voltage-Source Converters 5424
Yicheng Liao, Xiongfei Wang
Aalborg University, Denmark

Interactions between Phase-locked Loop Synchronized Grid Converters with Different Bandwidths and Power Ratings 5430
Zhi-Xiang Zou, Behnam Daftary Besheli, Roberto Rosso, Marco Liserre
Christian-Albrechts-Universität zu Kiel, Germany

A Reduced-order Model of PMSG for the Low Frequency Oscillation Analysis of Power Systems 5438
Xianzhe Li, Shuhan Liao, Xiaoming Zha
Wuhan University, China

Session 120: Battery and Charging Infrastructure

Chair(s): Rashmi Prasad, Babak Nahid-Mobarakeh

Control and Implementation of Renewable Energy based Smart Charging Station Beneficial for EVs, Home and Grid 5443

Anjeet Verma, Bhim Singh
Indian Institute of Technology Delhi, India

High Voltage Resonance Auxiliary Power Converter for Online Battery Impedance Measurement 5450

Shimul K. Dam, Vinod John
Indian Institute of Science Bangalore, India

Multi-port, Bi-directional Contactless Connector for the Interface of Modular Portable Battery System 5458

Masanori Ishigaki, Keisuke Ishikawa, Makoto Kusakabe, Kosuke Tahara
Toyota Central R&D Labs, Japan

A Novel Systematic Approach to Construct and Assess Power Electronic Conversion Architectures using Graph Theory and its Application in Battery Systems 5465

Wenping Zhang^{1,2}, Liuchen Chang¹, Riming Shao¹
¹*University of New Brunswick, Canada;* ²*Siemens Ltd., China*

Session 121: AC-AC Converters

Chair(s): Mahshid Amirabadi, Maurizio Cirrincione

Three-Phase to Single-Phase Multi-Resonant Direct AC-AC Converter for Metal Hardening High-Frequency Induction Heater 5472

Tomokazu Mishima, Ryosuke Kawashima, Chiaki Ide
Kobe University, Japan

Single-Phase Five-Leg AC-DC-AC Multilevel Converter to Enhance Power Quality 5479

Rodrigo P. de Lacerda¹, Cursino B. Jacobina¹, Edgard L.L. Fabricio²
¹*Federal University of Campina Grande, Brazil;* ²*Federal Institute of Paraíba, Brazil*

A Hybrid 4-quadrant Switch for AC Power Conversion 5487

Giri Venkataramanan, Namrata Kogalur
University of Wisconsin-Madison, United States

Modular Capacitive-Link-Based Three-Phase AC-AC Power Converter 5494

Ehsan Afshari, Mahshid Amirabadi
Northeastern University, United States

Session 122: Multilevel Converters Applications 1

Chair(s): Yongsug Suh, Madhav Manjrekar

An Open-Circuit Fault Diagnosis Method for T-type Three-Level Rectifiers 5502

Jie Chen, Chenghui Zhang, Xiangyang Xing, Alian Chen, Chunshui Du
Shandong University, China

A Novel Hybrid N-Level T-Type Inverter Topology 5507

S. Foti¹, A. Testa¹, T. Scimone¹, S. De Caro¹, L.D. Tornello², G. Scarcella², G. Scelba²
¹*University of Messina, Italy;* ²*University of Catania, Italy*

Theoretical Analysis and Comparison of Capacitor Requirement in Modular Converters for Grid Integration of High Power Solar PV 5514
Shambhu Sau, Arun Chandrasekharan Nair, B.G. Fernandes
Indian Institute of Technology Bombay, India

Thermal and Performance Comparison of Active Neutral-Point-Clamped (ANPC) and Dual Flying-Capacitor ANPC (DFC-ANPC) Inverters 5522
Arash Khoshkbar-Sadigh¹, Roozbeh Naderi², Vahid Dargahi³, Keith Corzine³
¹*Pennsylvania State University, United States*; ²*TAE Technologies, Inc., United States*;
³*University of California-Santa Cruz, United States*

Session 123: DC-DC Isolated Converter 2
Chair(s): Diego G. Lamar, Jaclyn Lynch

A Comparison of DC and AC Output Inductors in Tunable Piezoelectric Transformer based DC/DC Converters 5529
Le Wang¹, Qiong Wang¹, Rolando P. Burgos¹, Khai D.T. Ngo¹, Alfredo Vazquez Carazo²
¹*Virginia Polytechnic Institute and State University, United States*; ²*Micromechatronics Inc., United States*

Adaptive Resonant Energy Realization in FB-ZCS DC-DC Converter using Dual-Capacitor Circuit 5536
Rohit Suryadevara¹, Leila Parsa²
¹*Rensselaer Polytechnic Institute, United States*; ²*University of California-Santa Cruz, United States*

A New Fully Magnetically Coupled SiC-Based DC/DC Step-up LLC Resonant Converter with Inherent Balanced Voltage Sharing for Renewable Energy Systems with a Medium Voltage DC Grid 5542
Mehdi Abbasi¹, Reza Emamalipour¹, Muhammad Ali Masood Cheema², John Lam¹
¹*York University, Canada*; ²*Northern Transformer, Canada*

A Parallel-Resonant Isolated Bidirectional DC-DC Converter with Low Current Ripple for Battery Storage Systems 5548
Yangbin Zeng, Hong Li, Zhi Zhang, Trillion Q. Zheng, Zhan Shang, Zhidong Qiu, Lutian Yuan, Yuhang Ding
Beijing Jiaotong University, China

Session 124: Small-Signal Modeling for Stability
Chair(s): Khurram Afridi, Paolo Mattavelli

Generalized Average Model of Triple Active Bridge Converter 5554
Shota Okutani, Pin-Yu Huang, Yuichi Kado
Kyoto Institute of Technology, Japan

Small Signal Dynamic Model and Stability Analysis of a Self-Synchronizing Grid-Tied Current Regulated Inverter 5561
B.P. McGrath, P. Mu, A.A. Nazib, D.G. Holmes, C.A. Teixeira
RMIT University, Australia

Impedance Modeling and Stability Analysis of Grid-tied Universal Droop Control Inverter 5569
Mohammad Amin¹, Qing-Chang Zhong²
¹*Norwegian University of Science and Technology, Norway*; ²*Illinois Institute of Technology, United States*

Analysis of an Impedance Modeling Approach for Droop-Controlled Inverters in System DQ Frame	5576
Francesco Cavazzana, Aram Khodamoradi, Hossein Abedini, Paolo Mattavelli <i>University of Padova, Italy</i>	

Session 125: Model Predictive Control
Chair(s): Rostan Rodrigues, Ralph Kennel

Model Predictive Control of PWM Rectifier under Unbalanced and Distorted Network without AC Voltage Sensor	5584
Yongchang Zhang ¹ , Jian Jiao ¹ , Jie Liu ¹ , Haitao Yang ¹ , Qingzhu Wan ¹ , Wei Xu ² ¹ North China University of Technology, China; ² Huazhong University of Science and Technology, China	

A Modulated Model Predictive Control Method based on Vector Analysis for Four-State Multilevel Converters	5590
Sai Tang ¹ , Xin Yin ¹ , Daming Wang ¹ , Chao Zhang ¹ , Jun Wang ¹ , Z. John Shen ² ¹ Hunan University, China; ² Illinois Institute of Technology, United States	

High Frequency Bidirectional Isolated Matrix Converter for AC-Motor Drives with Model Predictive Control	5597
Shuai Wang ¹ , Hang Gao ¹ , Jahangir Afsharian ² , Dewei Xu ¹ ¹ Ryerson University, Canada; ² Murata Power Solutions, Canada	

Model Predictive Control without Weighting Factors for T-type Multilevel Inverters with Magnetic-Link and Series Stacked AC-DC Modules	5603
Shakil Ahamed Khan, Youguang Guo, Md. Noman Habib Khan, Yam Siwakoti, Jianguo Zhu <i>University of Technology Sydney, Australia</i>	

Session 126: Permanent Magnet Machines 1
Chair(s): Nicola Bianchi, Sara Roggia

A Closed-Loop Magnetization State Controller for Variable-flux IPMSMs	5610
Akrem Mohamed Aljehaimi ¹ , Pragasen Pillay ² ¹ Misurata University, Libya; ² Concordia University, Canada	

Analysis of Dual 3-Phase Fractional-Slot Concentrated Winding PM Synchronous Machines with Different Angle Displacements	5616
P.L. Xu ¹ , Z.Q. Zhu ¹ , B. Shao ¹ , S.S. Wang ¹ , S. Cai ¹ , J.H. Feng ² , S.Y. Guo ² , Y.F. Li ² , S.Z. Feng ² ¹ The University of Sheffield, United Kingdom; ² CRRC Zhuzhou Institute Co. Ltd., China	

Dynamic Modeling of Surface-Mounted Permanent Magnet Motors considering Saturation	5624
Zhaokai Li ¹ , Yuzheng Chen ² , Xiaoyan Huang ¹ , Xinru Li ³ , Wuchengg Yin ³ , Boyang Shen ³ , Lijian Wu ¹ , Youtong Fang ¹ , Teng Long ³ ¹ Zhejiang University, China; ² University of Nottingham, United Kingdom; ³ University of Cambridge, United Kingdom	

Correction of Finite-Element Calculated Efficiency Map using Experimental Measurements	5629
Solmaz Kahourzade ¹ , Amin Mahmoudi ² , Wen L. Soong ¹ , Simone Ferrari ³ , Gianmario Pellegrino ³ ¹ University of Adelaide, Australia; ² Flinders University, Australia; ³ Politecnico di Torino, Italy	

Session 127: Thermal Analysis of Electric Machines

Chair(s): Mircea Popescu, Nick Simpson

Direct Air Cooling of High-Power Permanent Magnet Machines 5637

Xiang Shen¹, Barrie Mecrow¹, Xu Deng¹, Christopher Donaghy-Spargo², Richard Whalley¹,
Nilanjan Chakraborty¹

¹Newcastle University, United Kingdom; ²Durham University, United Kingdom

Direct Oil Cooling of End-Windings in Torus-Type Axial-Flux Permanent-Magnet Machines 5645

Federico Marcolini, Giulio De Donato, Federico Caricchi
University of Rome "La Sapienza", Italy

Design Considerations of Windings formed with Hollow Conductors Cooled with Phase Change Material 5652

Sabrina Ayat, Benjamin Dagusé, Rabih Khazaka
Safran, France

Resource Efficient Determination of Electrical Machine Thermal Parameters 5659

S. Collins, D. North, P.H. Mellor, N. Simpson
University of Bristol, United Kingdom

Session 128: PM Motor Drives

Chair(s): Lei Hao, Wu Lijian

Design Criteria for Flux-Weakening Control Bandwidth and Voltage Margin in IPMSM Drives considering Transient Conditions 5667

Jose Jacob¹, Sandro Calligaro¹, Omar Bottesi¹, Roberto Petrella²

¹Free University of Bolzano, Italy; ²University of Udine, Italy

Study of Copper Loss by Inter Turn short fault of Interior Permanent Magnet Synchronous Motor 5675

Seong-Hwan Im, Bon-Gwan Gu
Kyungpook National University, Republic of Korea

A Speed and Current Cascade Continuous Control Set Model Predictive Control Architecture for Synchronous Motor Drives 5682

Paolo Gherardo Carlet, Francesco Toso, Andrea Favato, Silverio Bolognani
University of Padova, Italy

Resolver Emulation for PMSMs using Low Cost Hall Effect Sensors 5689

Daniel Fernandez, Diego Fernandez, Maria Martinez, David Reigosa, Alberto B. Diez, Fernando Briz
University of Oviedo, Spain

Session 129: Gate Drive and Auxiliary Circuit

Chair(s): Mark J. Scott, Zheyu Zhang

A High Speed SiC Thyristor Gate Driver for Pulse Power Applications 5694

Mohammed Agamy¹, Fengfeng Tao², Ahmed Elasser³

¹University at Albany - State University of New York, United States; ²Tesla, United States;

³GE Global Research, United States

Optimized method for protection of SiC JFET based Converters against Failure of Auxiliary Power Supply 5700
Rostan Rodrigues, Utkarsh Raheja
ABB Inc., United States

Output-Current Measurement of a PWM Inverter with a Tiny PCB Rogowski Sensor Integrated into an IGBT Module 5707
Kazunori Hasegawa¹, Shun Sho¹, Masanori Tsukuda¹, Ichiro Omura¹, Mao Ichiki¹, Tohru Kato²
¹Kyushu Institute of Technology, Japan; ²National Institute of Advanced Industrial Science and Technology, Japan

Design of Modular Auxiliary Gate Driver Power Supply for Medium Voltage Converter System 5712
Sanket Parashar, RajKumar Kokkonda, Subhashish Bhattacharya
North Carolina State University, United States

Session 130: Wireless Power Transfer 4
Chair(s): Zhonghui Bing, Burak Ozpineci

Three-Phase Integrated PFC AC-AC Resonant Inverter with Weak Coupled Coils for Induction Heating Application 5720
Ruan C.M. Gomes, Montiê A. Vitorino, Diego A. Acevedo-Bueno, Maurício B.R. Corrêa
Federal University of Campina Grande, Brazil

A Multi-MHz Large Air-gap Capacitive Wireless Power Transfer System utilizing an Active Variable Reactance Rectifier Suitable for Dynamic Electric Vehicle Charging 5726
Sreyam Sinha, Brandon Regensburger, Ashish Kumar, Khurram K. Afridi
Cornell University, United States

Comparison of Leakage Magnetic Field from Matched and Mismatched Double-D Coil based Wireless Charging System for Electric Vehicles 5733
Mostak Mohammad¹, Jason Pries³, Omer Onar³, Saeed Anwar², Veda P. Galigekere³, Gui-Jia Su³, Jonathan Wilkins³
¹University of Akron, United States; ²University of Tennessee-Knoxville, United States;
³Oak Ridge National Lab, United States

A 2m Quasi-Wireless Capacitive Power Transfer (CPT) System using Earth Ground as the Current-Returning Path 5740
Hua Zhang, Fei Lu
Drexel University, United States

Thursday, October 3

Session 131: Hybrid Energy Storage Systems
Chair(s): Wasi Uddin, Akanksha Singh

A Series-Parallel Switched-Capacitor Equalizer for the Hybrid Energy Storage System 5744
Lizhou Liu, Peibang Han, Wenbin Sun, Ruikun Mai, Zhengyou He, Wu Dong
Southwest Jiaotong University, China

Energy Management of Multi-energy Storage Systems using Energy Path Decomposition 5747
Sima Aznavi¹, Poria Fajri¹, Arash Asrari², Reza Sabzehgar³
¹University of Nevada, Reno, United States; ²Southern Illinois University, United States;
³San Diego State University, United States

An Improved Feed-Forward Load Compensation Method for Hybrid Energy Storage Systems 5753

Yue Wu^{1,2}, Zhiwu Huang^{1,2}, Hongtao Liao^{1,2}, Yanhui Zhou^{1,2}, Yongjie Liu^{1,2}, Heng Li^{1,2},
Xiaoyong Zhang^{1,2}, Jun Peng^{1,2}

¹Central South University, China; ²Hunan Engineering Laboratory of Rail Vehicles Braking Technology, China

An Integrated State of Health (SOH) Balancing Method for Lithium- Ion Battery Cells 5759

Sifat Chowdhury, Mohammad Noor Bin Shaheed, Yilmaz Sozer
University of Akron, United States

Session 132: Power and Energy Management in Smart Grid and Microgrid Systems

Chair(s): Youim (Kelly) Tray, Zeljko Pantic

Reconfigurable and Dynamic Distribution Systems Enabled using Self-Sustainable Minimal-Microgrids with Region based Stability Guarantees 5764

Yuxi Men¹, Xiaonan Lu¹, Jianzhe Liu², Chen Chen², Bo Chen²

¹Temple University, United States; ²Argonne National Laboratory, United States

Coordinated Power and Energy Management using Cluster of Microgrids to Improve Grid Availability and Resiliency 5770

Somasundaram Essakiappan¹, Rasik Sarup¹, Ndeye Rama Mbacke¹, Madhav Manjrekar¹, Stuart Laval²,
Kevin Schneider³

¹University of North Carolina-Charlotte, United States; ²Duke Energy Corporation, United States;

³Pacific Northwest National Laboratory, United States

Stability Analysis for Interconnected DC Microgrids with Constant Power Loads 5778

Bhanu Babaiahgari, Yeonho Jeong, Jae-Do Park
University of Colorado-Denver, United States

A Partial Power Converter Interface for Battery Energy Storage Integration with a DC Microgrid 5783

Vishnu Mahadeva Iyer¹, Srinivas Gulur¹, Subhashish Bhattacharya¹, Ramanujam Ramabhadran²

¹North Carolina State University, United States; ²GE Aviation, United States

Session 133: Power Converters for Solid State Transformers

Chair(s): Alex Huang, Hui Li

Design of a Medium Voltage Solid-State Transformer based on Modular AC-AC Resonant Converter and an Input-Series-Output-Parallel Architecture 5791

Xin Zhao, Yang Lei, Haoming Wang, Xiangjun Quan, Alex Q. Huang
The University of Texas-Austin, United States

Voltage Balancing of Series Connected Clamping Diodes in Medium Voltage NPC Converter enabled by Gen-3 10 kV SiC MOSFETs for Asynchronous Micro-Grid Power Conditioning System (AMPCS) 5798

Venkat N. Jakka, Ashish Kumar, Sanket Parashar, Sagar Kumar Rastogi, Nithin Kolli,
Ronak Jaiswal, Subhashish Bhattacharya
North Carolina State University, United States

Solid State Transformer for Low-Voltage Distribution System with DC/DC Stage-Controlled Split-Capacitor 5805

Shaodi Ouyang, Jinjun Liu, Shuguang Song, Xingxing Chen, Yue Yang, Hongda Wu
Xi'an Jiaotong University, China

Circulating Current Suppression in Multi-cell Series-parallel Converter for Cost-effective Medium-voltage Solid-state Transformer 5810
Jehyuk Won, Hao Feng, Xinyu Liang, Srdjan Srdic, Srdjan Lukic
North Carolina State University, United States

Session 134: Renewable Energy Integration

Chair(s): Jason Lai, Paolo Mattavelli

Active Harmonic Filtering in STATCOMs for Enhanced Renewable Energy Integration 5816
Juan Carlos Pérez Campión¹, Eneko Olea Oregi², Colin Edward Thomas Foote³
¹Iberdrola Renovables, Spain; ²Ingeteam Power Technology, Spain; ³SP Energy Networks, Scotland

A Medium Voltage DC Collection Grid for Large Scale PV Power Plant with SCR Converter and Integrated Solid-State Transformer (SST) 5824
Salwan Sabry, Erick I. Pool-Mazun, Prasad Enjeti
Texas A&M University, United States

Voltage and Power Balancing in Solar and Energy Storage Converters 5832
Emanuel Serban¹, Martin Ordonez¹, Cosmin Pondiche², Dan Hulea³
¹University of British Columbia, Canada; ²Schneider Electric Solar Canada, Canada; ³University Politehnica of Timisoara, Romania

Artificial Neural Network-Based Adaptive Voltage Regulation in Distribution Systems using Data-Driven Stochastic Optimization 5840
Krishna Sandeep Ayyagari, Reynaldo Gonzalez, Yufang Jin, Miltiadis Alamaniotis, Sara Ahmed, Nikolaos Gatsis
University of Texas-San Antonio, United States

Session 135: Electric Drivetrains

Chair(s): Subrata Saha, Sabrina Ayat

Development of a 100 kW SiC Switched Tank Converter for Automotive Applications 5848
Ze Ni, Yanchao Li, Chengkun Liu, Mengxuan Wei, Dong Cao
North Dakota State University, United States

A Fault Tolerant Modulation Strategy for Dual Inverter Traction Drives 5856
Rishi Menon, Sheldon S. Williamson, Najath A. Azeez, Arvind H. Kadam
University of Ontario Institute of Technology, Canada

High-density High-power DC-to-DC Converter Architectures for Future Electrified Transportation Applications 5862
Zhentao Stephen Du, Parikshith Channegowda, Parag Kshirsagar, Suman Dwari
United Technologies Research Center, United States

Evaluation of Posicast Compensator Robustness for the Reduction of Torsional Vibrations 5870
Constanza Ahumada¹, Patrick Wheeler²
¹Universidad de Chile, Chile; ²University of Nottingham, United Kingdom

Session 136: Single Phase Multilevel Converters

Chair(s): Petar Grbovic, Marco di Benedetto

Multilevel Single-Phase PWM Converters with Shared Legs and Cascaded Transformers 5878
João Paulo R.A. Mélllo, Cursino B. Jacobina, Amanda P. Monteiro
Federal University of Campina Grande, Brazil

Single-Phase AC-DC-AC Multilevel Converter based on Parallel-/Series-Connected Three-Leg Modules 5886
Rodrigo P. de Lacerda¹, Cursino B. Jacobina¹, Edgard L.L. Fabricio²
¹*Federal University of Campina Grande, Brazil*; ²*Federal Institute of Paraíba, Brazil*

A Nine-Level Inverter for Single Phase PV Applications 5894
T. Sreekanth, Abhijit Kshirsagar, Sanchit Mishra, Ned Mohan
University of Minnesota, United States

A Single-Phase to Single-Phase Three-Wire Power Converter based on Two-Level and Three-Level Legs 5900
Bruna S. Gehrke¹, Cursino B. Jacobina¹, Reuben P.R. Sousa¹, Italo R.F.M.P. da Silva²,
João Paulo R. A. Mélllo¹, Nayara B. de Freitas¹
¹*Federal University of Campina Grande, Brazil*; ²*Federal Rural University of Pernambuco, Brazil*

Session 137: Modular Multilevel Converters 2

Chair(s): Xiaofeng Yang, Qin Lei

Impact of the Circulating Current Control on Transient Submodule Voltage Stresses for Grid-Tied Modular Multilevel Converters during Grid Faults 5908
Zhijian Yin¹, Huan Qiu², Yongheng Yang¹, Yi Tang², Huai Wang¹
¹*Aalborg University, Denmark*; ²*Nanyang Technological University, Singapore*

A Multilevel Chain-link Topology for Low Voltage, Variable Frequency Applications 5914
Luca Tarisciotti¹, Alessandro Costabeber², Francesco Tardelli³, Roberto Cardenas⁴
¹*Universidad Andres Bello, Chile*; ²*University of Nottingham, United Kingdom*; ³*Amantys Power Electronics Limited, United Kingdom*; ⁴*University of Chile, Chile*

Integration of Coupled Inductors for Compact Design of Flying-Capacitor Modular Multilevel Converters 5922
Duc Dung Le, Dong-Choon Lee
Yeungnam University, Republic of Korea

The Current Shaping Modular Multilevel DC/DC Converter with Current Doubling 5928
P.A. Gray, P.W Lehn
University of Toronto, Canada

Session 138: DC-DC Isolated Converter 3

Chair(s): Yan Xing, Martin Ordonez

Ultra-Wide Output Voltage Range DC Power Supply with Multiple Power Modules Series/Parallel Variable Structure and Automatic Voltage/Current Sharing 5935
Mengxi Li¹, Hongfei Wu¹, Chengzhi Qu², Yuhui Ji², Yangjun Lu¹, Yan Xing¹, Kai Sun³
¹*Nanjing University of Aeronautics and Astronautics, China*; ²*Shanghai Institute of Space Power-Sources, China*; ³*Tsinghua University, China*

Multi-cell Multi-port Bidirectional Flyback based on GaN devices 5941
Ander Avila¹, Asier Garcia-Bediaga¹, Alberto Rodriguez², Luis Mir¹, Alejandro Rujas¹
¹IKERLAN Technological Research Centre, Spain; ²University of Oviedo, Spain

Design and Implementation of an Interleaved Forward Converter with Magnetizing Energy Recycled 5949
Chuan-Min Ke, Tsong-Juu Liang, Wei-Jing Tseng, Guo-Lung Jiang
National Cheng Kung University, Taiwan

Modal Analysis Method of DAB based on Phase Shift Control 5954
Liang Guan¹, Fan Xiao¹, Chunming Tu¹, Zheng Lan²
¹Hunan University, China; ²Hunan University of Technology, China

Session 139: Modulation 2

Chair(s): Liuchen Chang, Santanu Kapat

A Modulation method for DCX LLC Converter to achieve Fixed Voltage Gain and Bidirectional Power Transfer with Power Limitation Capability 5960
Chen Xiaoying, Guo Xu, Xie Shiming, Su Mei, Wang Hui, Liu Yonglu, Dan Hanbing
Central South University, China

New Commutation Method based on State Machine for Three-phase HF AC Link Inverter with Passive Loads 5965
Minjeong Kim, Taoufik Sekkat, Michael Hornick, Kraig Orcutt, Robert S. Balog
Texas A&M University, United States

A Carrier-Based Discontinuous PWM for Three-Level T-type Converters with Neutral-Point Potential Balancing 5973
Jiayu Zhou¹, Olorunfemi Ojo², Fen Tang¹, Josiah Haruna³, Poh Chiang⁴
¹Beijing Jiaotong University, China; ²Tennessee Tech University, United States;
³Chinese University of Hong Kong, China

Low Harmonic Loss PWM for a Dual Inverter Drive using a Floating Capacitor Inverter 5981
Sukhjit Singh, Chatumal Perera, Gregory J. Kish, John Salmon
University of Alberta, Canada

Session 140: Reliability Modeling and Monitoring

Chair(s): Frede Blaabjerg, Tomoyuki Mannen

Thermal Monitoring of Power Electronic Modules with Minimal Sensing Effort 5989
Christoph H. van der Broeck, Rik W. De Doncker
RWTH Aachen University, Germany

Overload Operation of LV-Side Inverter in Smart Transformer 5997
Rongwu Zhu, Vivek Raveendran, Marco Liserre
Christian-Albrechts-Universität zu Kiel, Germany

Real-Time Grid Impedance Estimation using a Converter 6005
Jarno Kukkola, Mikko Routimo, Marko Hinkkanen
Aalto University, Finland

A Carrier-based Modulation Method for the NPC Wind Power Converter Thermal Management During Low-Voltage Ride-Through 6013
Jiuyang Zhou, Po-tai Cheng
National Tsing Hua University, Taiwan

Session 141: Energy Storage System Control
Chair(s): Qin Lei, Jason Lai

Virtual Synchronous Machine Control for Low-Inertia Power System Considering Energy Storage Limitation 6021
Chu Sun¹, Syed Qaseem Ali², Geza Joos¹, Francois Bouffard¹
¹McGill University, Canada; ²OPAL-RT TECHNOLOGIES Inc., Canada

Power Distribution and Individual Phase Control of Asymmetrical Three-Phase Cascaded Multilevel Hybrid Energy Storage System in Star Configuration 6029
Yue Zhang¹, Zhao Liu¹, Jianshou Kong¹, Junmou Feng¹, Shanshan Zhao¹, Liang Dong¹, Mengxuan Feng¹, Qingyuan Hua²
¹Nanjing University of Science and Technology, China; ²Nanjing Rail Transit Systems Co., Ltd., China

Cooperative Charging of Supercapacitor Trams with Current Ripple Suppression 6035
Zhiwu Huang^{1,2}, Xianqi Lu^{1,2}, Hongtao Liao^{1,2}, Heng Li^{1,2}, Yongjie Liu^{1,2}, Fu Jiang^{1,2}, Yingze Yang^{1,2}, Jun Peng^{1,2}
¹Central South University, China; ²Hunan Engineering Laboratory of Rail Vehicles Braking Technology, China

Control of Circulating Current to Minimize the Rating of the Energy Storage Device in Modular Multilevel Converters 6041
Mohammed Alharbi, Semih Isik, Subhashish Bhattacharya
North Carolina State University, United States

Session 142: Electric Machines for Transportation 2
Chair(s): Andrea Cavagnino, Takashi Kato

Design of Hybrid Variable Flux Motors for Enhanced Wide-Speed Performance 6046
Maged Ibrahim¹, Pragasen Pillay²
¹National Research Council Canada, Canada; ²Concordia University, Canada

A Proposal of a Delta-Type Salient Pole Variable Flux Memory Motor having Large Flux Barrier for Traction Applications 6054
Ren Tsunata, Masatsugu Takemoto, Satoshi Ogasawara, Koji Orikawa
Hokkaido University, Japan

Design Considerations for Magnet Configurations in IPM Rotor for High Speed Traction Applications 6062
Tausif Husain, Seong T. Lee
BorgWarner Inc., United States

Design and Optimization of Synchronous Motors for Low-Voltage Electric Vehicles 6070
Cristian Babetto¹, Grazia Berardi¹, Nicola Bianchi¹, Giorgio Benedetti²
¹University of Padova, Italy; ²Askoll Holding S.r.l., Italy

Session 143: High Speed and Bearingless Machines 2

Chair(s): Eric Severson, Wolfgang Gruber

Comprehension and Estimation of Windage Losses in Rotor Slotted Air Gaps of Electrical Machines using CFD-LES Methods 6078

Sara Sadr¹, Abdenour Abdelli¹, Ayoub Ben-Nachouane², Guy Friedrich³, Stephane Vivier³
¹IFP Energies Nouvelles, France; ²Valeo, France; ³University of Technology of Compiègne, France

Printed Circuit Board Structural Properties and Spiral Groove Trace Conductors for Hydrodynamic Gap Maintenance in Axial Flux Rotating Machines 6084

Ryan Knippel, Marisa Tisler, Daniel C. Ludois
University of Wisconsin-Madison, United States

A New Mechanical-Strength-Oriented Rotor Parametric Model Design for the Optimization of a Very-High-Speed IPMSM 6092

Guoyu Chu¹, Alireza Pouramin¹, Rukmi Dutta¹, M.F. Rahman¹, Howard Lovatt², Bulent Sarlioglu³
¹University of New South Wales, Australia; ²CSIRO, Australia; ³University of Wisconsin-Madison, United States

Smart Current Limitation Technique for a Multiphase Bearingless Machine with Combined Winding System 6099

Zhuang Wen, Giorgio Valente, Andrea Formentini, Luca Papini, Pericle Zanchetta, Christopher Gerada
University of Nottingham, United Kingdom

Session 144: Electric Machines: Actuators, Linear, Non-conventional and Transformers

Chair(s): Bryan P. Ruddy, Jose Antonino-Daviu

Radial-Force-Based Swirling Actuator with Surface-Permanent-Magnet Structure for Low-Speed High-Torque Applications 6106

Lingyu Chen¹, Adrien Thabuis², Akira Chiba¹, Masao Nagano³, Kimiaki Nakamura³
¹Tokyo Institute of Technology, Japan; ²École Polytechnique Fédérale de Lausanne, Switzerland;
³Honda R&D Co., Ltd., Japan

Novel Dual-Sided Permanent Magnet Machines with Different Stator Magnet Arrangements 6114

Hui Yang¹, Ya Li¹, Heyun Lin¹, Wei Liu¹, Xing Zhao²
¹Southeast University, China; ²Hong Kong Polytechnic University, China

A Single-Phase Electromagnetic Transformer with an Adjustable Output Voltage 6122

Junwei Cui, Liyan Qu, Wei Qiao
University of Nebraska-Lincoln, United States

Modeling and Design of a Linear Electric-Hydraulic Conversion Machine for Electrification of Off-Highway Vehicles 6126

Anvar Khamitov¹, Jenny Swanson², James Van de Ven², Eric L. Severson¹
¹University of Wisconsin-Madison, United States; ²University of Minnesota, United States

Session 145: IPM Motor Drives

Chair(s): David Diaz Reigosa, Giulio De Donato

- Remedial Strategies of Cascaded CSIs-fed Dual Three-phase PMSM Drives under One-phase Open-circuit Faults** 6134
Pengcheng Liu, Zheng Wang, Xueqing Wang, Ming Cheng
Southeast University, China
- Implementation of Low Inductance Permanent Magnet Machine Drive with LC Filter for Field Oriented Control** 6140
Cheng-Chung Hsu, Shih-Chin Yang, Jyun-You Chen
National Taiwan University, Taiwan
- Closed-loop Current Control of Synchronous Motor Drives with Position Sensing Harmonics** 6147
Prerit Pramod, Krishna MPK Namburi
Nexteer Automotive Corporation, United States
- Design and Robustness Analysis of 2DOF PI Synchronous-Frame Current Regulator for Salient PMSM Drives** 6155
Hussain A. Hussain
Kuwait University, Kuwait

Session 146: SiC Reliability and Protection

Chair(s): Joseph Vitale, Huai Wang

- Investigation of Current Mirror based Overcurrent Protection for 1200V 800A High Power SiC MOSFET Modules** 6161
Yujia Cui, Zhe Zhang, Peizhong Yi, Lixiang Wei
Rockwell Automation, United States
- Investigation of Aging's Effect on the Conduction and Switching Loss in SiC MOSFETs** 6166
Fei Yang¹, Enes Ugur¹, Shi Pu¹, Bilal Akin¹, Mrinal Das²
¹The University of Texas-Dallas, United States; ²Texas Instruments, United States
- Investigation on Degradation of SiC MOSFET under Accelerated Stress in PFC Converter** 6174
Jianjun Chen, Xi Jiang, Zongjian Li, Hengyu Yu, Jun Wang
Hunan University, China
- Current Saturation Characteristics and Single-Pulse Short-Circuit Tests of Commercial SiC MOSFETs** 6179
Diang Xing, Boxue Hu, Susanna Yu, Yue Zhang, Tianshi Liu, Arash Salemi, Minseok Kang, Jin Wang, Anant Agarwal
The Ohio State University, United States

Session 147: Magnetic Component Design

Chair(s): Xuning Zhang, Chengcheng Yao

- Increase High Frequency Impedance of Ferrite Toroid Inductors based on Electromagnetic Energy Analysis** 6184
Yiming Li, Juntao Yao, Shuo Wang
University of Florida, United States

Optimize the Winding Structure of Flyback Transformers with Arbitrary Phase-Shifted Current Waveforms 6192
Yiming Li¹, Shuo Wang¹, Honggang Sheng², Srikanth Lakshminathan²
¹University of Florida, United States; ²Google Inc., United States

An Integrated Passive Device for Multi-Channel LED Driver 6200
Cheng Deng^{1,2}, Yun Yu¹, Andrés Escobar-Mejía²
¹Xiangtan University, China; ²Hunan Province Cooperative Innovation Center for Wind Power Equipment and Energy Conversion, China; ³Universidad Tecnológica de Pereira, Colombia

Optimal Winding Layer Allocation for Minimizing Copper Loss of Secondary-Side Center-Tapped Forward Transformer with Parallel-Connected Secondary Windings 6206
Tomohide Shirakawa¹, Kazuhiro Umetani¹, Eiji Hiraki¹, Yuki Ito², Takashio Hyod²
¹Okayama University, Japan; ²OMRON Corporation, Japan

Session 148: Systems for Renewable Energy
Chair(s): Alex De Abreu-Garcia, Qiang Wei

Grid-connected Inverter Impedance Estimation Considering Grid Impedance and Frequency Coupling in the Stationary Frame 6214
Junliang Liu¹, Xiong Du¹, Ying Shi¹, Heng-Ming Tai²
¹Chongqing University, China; ²University of Tulsa, United States

A Closed-loop Global Synchronous PWM Method for Immunizing Parameters Uncertainty in Distributed Parallel-Connected VSIs 6219
Tao Xu, Feng Gao, Tianqu Hao, Kangjia Zhou, Futian Qin
Shandong University, China

Reduced Voltage Stress Thirteen-Level Extendable Switched Capacitor Multilevel Inverter 6224
Abhinandan Routray, Kharan Shiluveru, Akash Singh, Rajeev Kumar Singh, Ranjit Mahanty
Indian Institute of Technology Varanasi, India

Medium Voltage DC Bus enabled by Series Connection of SiC Mosfet based Three Port DC-DC Converters 6231
Ritwik Chattopadhyay¹, Srinivas Gulur¹, Viju Nair¹, Subhashish Bhattacharya¹, Paul R. Ohodnicki²
¹North Carolina State University, United States; ²National Energy Technology Laboratory, United States

Session 149: Microgrid Control 1
Chair(s): Mauricio Cespedes, Thomas Podlesak

A Current Source Three-Phase AC-AC Converter using Current Unfolding and Active Damping Principles 6239
N. Ha Pham¹, Tomoyuki Mannen², Keiji Wada³
¹University of Technology Sydney, Australia; ²University of Tsukuba, Japan; ³Tokyo Metropolitan University, Japan

Control Algorithms to Establish Hybrid AC/DC Distribution Systems using Conventional Three Phase Inverters 6246
Ali Elrayah
Hamad Bin Khalifa University, Qatar

Protection Coordination System Design for a Converter Dominated Standalone DC Microgrid	6254
Md Rifat Kaisar Rachi, Mehnaz Akhter Khan, Iqbal Husain North Carolina State University, United States	
Enhanced Voltage Droop Control Strategy for DC Microgrid System with State Variable Feedback	6262
Mohammad Noor Bin Shaheed, Sifat Chowdhury, Yilmaz Sozer, J. Alex De Abreu-Garcia University of Akron, United States	
Session 150: Microgrid Control 2	
Chair(s): Xiaoqiang Guo, Xin Zhang	
Auto-Tuning for Military Microgrids	6270
Thomas Podesak ¹ , Joseph Vitale ¹ , Blane Wilson ¹ , Frank Bohn ¹ , Michael Gonzalez ¹ , Richard Bosse ¹ , Stefan Siegfried ¹ , Jaclyn Lynch ¹ , William Barnhill ² ¹ U.S. Army C5ISR Center, United States; ² Polaris Alpha Advanced Systems, Inc., United States	
A Distributed Economic Dispatch Algorithm for Islanding Microgrid considering Unreliable Communication Links	6278
Meiqin Mao, Chengqi He, Liuchen Chang, Yunhui Liu Hefei University of Technology, China	
Islanding of a Microgrid using a Distributed Multi-Agent Control System	6286
Mohamad Fares Al Jajeh ¹ , Syed Qaseem Ali ² , Geza Joos ¹ , Ilja Novickij ¹ ¹ McGill University, Canada; ² OPAL-RT TECHNOLOGIES Inc., Canada	
Development of a Converter based Microgrid Test Platform	6294
Dingrui Li ¹ , Yiwei Ma ¹ , Chengwen Zhang ¹ , He Yin ¹ , Ishita Ray ¹ , Yu Su ¹ , Lin Zhu ¹ , Fred Wang ^{1,2} , Leon M. Tolbert ^{1,2} ¹ University of Tennessee-Knoxville, United States; ² Oak Ridge National Lab, United States	
Session 151: Hybrid AC/DC Microgrids	
Chair(s): Tsai-Fu Wu, Kai Sun	
A Virtual Inertia Control Strategy of Interlinking Converters in Islanded Hybrid AC/DC Microgrid	6301
Jingyi Xiao ¹ , Alian Chen ¹ , Zhengyu Lin ² , Haihua Xue ¹ ¹ Shandong University, China; ² Loughborough University, United Kingdom	
Mitigating Communication Delay Impact on Microgrid Stability using a Compensator based on Smith Predictor	6309
Hadi Akbari Haghghat, Necmi Altin, Adel Nasiri University of Wisconsin-Milwaukee, United States	
An Optimal-Oriented Quasi-Droop Control of Interlinking Converter in Hybrid Microgrid	6314
Fanfan Lin ¹ , Xin Zhang ¹ , Huanyue Liao ¹ , Xiaochao Hou ² ¹ Nanyang Technological University, Singapore; ² Central South University, China	
A Compact Interlinking Converter Modular for Hybrid AC/DC/DS Microgrids with a Decentralized Power Management Strategy	6320
Zhe Zhang, Chi Jin, Chaoyu Dong, Pengfeng Lin, Yi Tang, Peng Wang Nanyang Technological University, Singapore	

Session 152: Applications of Electric Traction / Propulsion

Chair(s): Subrata Saha, Gilsu Choi

Reduction of AM Radio Noise of a VVVF Inverter for an Electric Railway Car and a Simulation Model of Noise Current 6328

Satoshi Azuma¹, Daisuke Itoh¹, Takahito Ishida¹, Kengo Sugahara², Shigeo Morimoto³
¹Mitsubishi Electric Corp., Japan; ²Kindai University, Japan; ³Osaka Prefecture University, Japan

A Partial Capacity Converter for Advanced Co-phase Traction Power Supply System 6333

Yujie Hu^{1,2}, Zixin Li^{1,2}, Ming Lei^{1,2}, Cong Zhao^{1,2}, Hang Zhang^{1,2}, Ping Wang^{1,2}, Yaohua Li^{1,2}
¹Chinese Academy of Sciences, China; ²University of Chinese Academy of Sciences, China

A Transformerless Noncascaded Quadratic-based Step-Down Converter without Pulsating Input Current for Automotive Applications 6338

Carlos Arturo Antuna-Fiscal¹, Ma Guadalupe Ortiz-Lopez², Jesus Leyva-Ramos¹, Luis Humberto Diaz-Saldierna¹
¹Instituto Potosino de Investigación Científica y Tecnológica, Mexico;
²Universidad Politécnica de San Luis Potosí, Mexico

Traction Power Inverter Design for EV and HEV Applications at General Motors: A Review 6346

Mohammad Anwar, Mohammed Khorshed Alam, Sean E. Gleason, Jeff Setting
General Motors, United States

Session 153: Multilevel Converters Control

Chair(s): Pericle Zanchetta, Luca Solero

Current Control of a New Five-Level Nested T-type Converter with Model Predictive Control 6352

Dianxun Xiao, Mehdi Narimani
McMaster University, Canada

Hybrid Model Predictive Control of Active-Neutral-Point-Clamped Multilevel Converters 6357

Dehong Zhou, Zhongyi Quan, Yunwei Li
University of Alberta, Canada

Deadbeat Control for Circulating Harmonic Currents Suppression of a Level-Increased NLM based Modular Multilevel Converter 6364

Xingxing Chen, Jinjun Liu, Shuguang Song, Shaodi Ouyang, Di Wang, Zhifeng Deng
Xi'an Jiaotong University, China

A Novel Harmonic Control Method for MMC Combining Improved Nearest Level Control and Selective Harmonic Elimination Method 6368

Yu Jin^{1,2}, Songda Wang², Qian Xiao^{2,3}, Yiqi Liu⁴, Yunfei Mu³, Yanchao Ji¹, Sanjay K. Chaudhary², Remus Teodorescu²
¹Harbin Institute of Technology, China; ²Aalborg University, Denmark; ³Tianjin University, China;
⁴Northeast Forestry University, China

Session 154: Multilevel Converters Applications 2

Chair(s): Po Tai Cheng, Wuhua Li

A Fault-Tolerant Hybrid Cascaded H-Bridge Topology 6376

Haider Mhiesan¹, Alan Mantooth, Yam P. Siwakoti
¹University of Arkansas, United States; ²University of Technology Sydney, Australia

Three-Port Full-Bridge Cell for Multilevel Converters with Battery Energy Storage 6382
Sebastian Neira¹, Javier Pereda¹, Michael Merlin², Felix Rojas³
¹Pontificia Universidad Católica de Chile, Chile; ²University of Edinburgh, United Kingdom;
³Universidad de Santiago de Chile, Chile

Multi-port Converter with Square-wave-voltage Multilevel Converter and Active Power Filter Connected in Series 6388
Jun-ichi Itoh¹, Mitsuru Miyashita¹, Keisuke Kusaka¹, Yuichi Noge², Masaki Ishibashi³
¹Nagaoka University of Technology, Japan; ²Tokyo University of Agriculture and Technology, Japan;
³Tokyo Metropolitan College of Industrial Technology, Japan

Failure Mode Analysis of the 3-Phase 5-Level E-Type Converter 6396
M. di Benedetto¹, A. Lidozzi¹, L. Solero¹, F. Crescimbeni¹, P.J. Grbović²
¹Roma Tre University, Italy; ²University of Innsbruck, Austria

Session 155: DC-DC Isolated Converter 4
Chair(s): Wenkang Huang, Kai Sun

Design and Implementation of a Dual-Input LLC Converter with Semi-Active Rectifiers for PV Applications 6404
Xi Chen¹, Seyed Milad Tayebi², Issa Batarseh¹
¹University of Central Florida, United States; ²University of Texas-Austin, United States

Design and Implementation of Three-Level Half-Bridge Bidirectional CL3C Resonant DC Converter 6412
Jun-Xian Huang, Tsorng-Juu Liang, Wei-Jing Tseng, Zhao-Wei Chen
National Cheng Kung University, Taiwan

High Frequency Transformer Core Loss Analysis in Isolated Modular Multilevel DC-DC Converter for MVDC Application 6419
Rachit Agarwal, Sandro Martin, Yanjun Shi, Hui Li
Florida State University, United States

A Zero-Current-Switched PWM Full Bridge DC-DC Converter 6424
Anirban Pal, Kaushik Basu
Indian Institute of Science, Bangalore, India

Session 156: Power Converter EMI 1
Chair(s): Shuo Wang, Hong Li

Common-Mode EMI Comparison of NSPWM, DPWM1, and SVPWM Modulation Approaches 6430
Yichao Zhang, Cong Li, Michael Schutten, Carlos Feliz De Leon, Satish Prabhakaran
GE Global Research, United States

Active EMI Reduction Technique of Active Front End (AFE) Drives based on Randomized Switching Frequency PWM 6438
Zhe Zhang¹, Lixiang Wei², Yujia Cui², Puneeth Srikanta Murthy², Peizhong Yi²
¹University of Connecticut, United States; ²Rockwell Automation, Inc., United States

Study on EMI Failure of Controller Area Network caused by a Buck Converter 6443
Ryo Shirai, Toshihisa Shimizu
Tokyo Metropolitan University, Japan

Spread Spectrum Technique for Current-Fed LLC Resonant Converter with Tight Output Voltage Regulation 6449
Mina Kim, Hwa-Pyeong Park, Jee-Hoon Jung
Ulsan National Institute of Science and Technology, Republic of Korea

Session 157: Converter Control

Chair(s): Katherine Kim, Seth Sanders

Application of High Performance FPGA to Boost Bandwidth of SiC Shunt Active Power Filter 6454
Li Yang, Yukun Luo, M.A. Awal, Wensong Yu, Iqbal Husain
North Carolina State University, United States

Drain-Source Synchronous Rectification Efficiency and Light-Load Stability Improvement through Multi-Level Turn-Off for LLC-based DC-DC Converters 6462
Oscar Yu, Chih-Shen Yeh, Moonhyun Lee, Jih-Sheng Lai
Virginia Polytechnic Institute and State University, United States

A Novel Dual-input Dual-output Converter and Dynamic Energy Management for PV/Battery Systems 6468
Qingxin Tian¹, Guohua Zhou¹, Minrui Leng¹, Xianyan Fan¹, Tiesheng Yan²
¹*Southwest Jiaotong University, China;* ²*Xihua University, China*

Design and Implementation of a Bipolar-Unipolar Switched Boundary Current Mode (BCM) Control GaN-Based Single-Phase Inverter 6473
Kamal Sabi, Daniel Costinett
University of Tennessee, United States

Session 158: Grid-Connected Converter Control 1

Chair(s): Brendan McGrath, Toshihisa Shimizu

On the Control of a Solid State Transformer for Multi-MW Utility-Scale PV-Battery Systems 6481
Yibin Zhang, Oluwaseun Akeyo, Jiangbiao He, Dan M. Ionel
University of Kentucky, United States

Efficiency Improvement of a Dual-Input LLC Converter for PV Applications using Burst-mode Control Strategy 6487
Xi Chen¹, Seyed Milad Tayebi², Issa Batarseh¹
¹*University of Central Florida, United States;* ²*University of Texas-Austin, United States*

Virtual Friction Control for Power System Oscillation Damping with VSC-HVDC Links 6495
Alberto Rodríguez-Cabero¹, Javier Roldán-Pérez¹, Milan Prodanovic¹, Jon Are Suul², Salvatore D'Arco²
¹*IMDEA Energy Institute, Spain;* ²*SINTEF Energy Research, Norway*

Model Predictive Control of Cascaded Multilevel Battery Assisted Quasi Z-Source PV Inverter with Reduced Computational Effort 6501
Abderezak Lashab, Dezso Sera, Josep M. Guerrero
Aalborg University, Denmark

Session 159: PMSM and Wound Field Synchronous Machines

Chair(s): Rakib Islam, Rukmi Dutta

Comparative Analysis of Novel Fractional Slot Nonoverlapping Winding Hybrid Excited Machines having different Consequent Pole Rotor Topologies 6508

Shun Cai¹, Z.Q. Zhu¹, Srinivas Mallampalli¹, Jean-Claude Mipo², Sophie Personnaz²

¹The University of Sheffield, United Kingdom; ²Valeo, France

Multi-Material Magneto-Structural Topological Optimization of Wound Field Synchronous Machines 6516

Feng Guo, Ian P. Brown

Illinois Institute of Technology, United States

Design of a Variable-Flux Permanent Magnet Machine using Alnico 9 and Comparison with a Baseline Interior Permanent Magnet Machine 6524

Peng Peng, Julia Zhang

The Ohio State University, United States

Self-Excited Diode Rectifying Wound-Field Synchronous Motor utilizing Space Harmonics and Flux-Intensifying with Carrier Harmonics 6532

Masahiro Aoyama, Toshihiko Noguchi

Shizuoka University, Japan

Session 160: Switched Reluctance and Flux Switching Machines 2

Chair(s): Takashi Kosaka, Rajesh Deodhar

Analytical Derivation of Phase Current Waveform for Eliminating Torque Ripple and Input Current Ripple of Switched Reluctance Motors under Magnetically Saturated Operation 6540

Takayuki Kusumi, Kosuke Kobayashi, Kazuhiro Umetani, Eiji Hiraki

Okayama University, Japan

Investigate of a Flux Switching Permanent Magnet Machine with Alternative Flux Bridges 6548

Ziyi Liang, Yuting Gao, Dawei Li, Ronghai Qu

Huazhong University of Science and Technology, China

Surface-Mounted and Flux-Switching PM Structures Trade-off for Automotive Smart Actuators 6555

Mostafa Ahmadi Darmani¹, Emir Poškovic², Gerd Bramerdorfer³, Silvio Vaschetto¹,

Andrea Cavagnino¹, Alberto Tenconi¹

¹Politecnico di Torino, Italy; ²Università degli Studi di Padova, Italy; ³Johannes Kepler University Linz, Austria

Investigation of the Self-Cooling Characteristics of a Novel Flux-Switching Permanent Magnet Machine 6562

Hao Ding, William Sixel, Lewis Francisco Handy-Cardenas, Bulent Sarlioglu

University of Wisconsin-Madison, United States

Session 161: Electric Drives for Transportation

Chair(s): Jiangbiao He, Di Pan

Design and Evaluation of a 150-kVA SiC-MOSFET based Three Level TNPC Phase-leg PEBB for Aircraft Motor Driving Application 6569

Zhao Yuan, Amol Deshpande, Balaji Narayanasamy, Hongwu Peng, Asif Imran Emon, Reece Whitt,

Bakhtiyar Mohammad Nafis, Fang Luo, David Huitink

University of Arkansas, United States

A Band-Pass based Position Filter for Electrical Machines against Low-Order Harmonic Distortion 6575
Annegret Klein-Hessling, Iliya Ralev, Rik W. De Doncker
RWTH Aachen University, Germany

Brushless Fast Starter for Automotive Start/Stop Application 6581
Lei Hao, Chandra Namuduri, Suresh Gopalakrishnan, Chunhao Lee, Neeraj Shidore
General Motors, United States

Advanced Control of Matrix Converter Drive with Active Damping of the Input Resonance 6589
Galina Mirzaeva¹, Graham Goodwin¹, Pericle Zanchetta², Liliana De Lillo², Lee Empringham²
¹The University of Newcastle, Australia; ²University of Nottingham, United Kingdom

Session 162: Model Predictive Control for Electric Drives

Chair(s): Shafiq Ahmed Odhano, Yukai Wang

Sequential MPC Strategy for High Performance Induction Motor Drives: A Detailed Analysis 6595
Valerio Vodola¹, Shafiq Odhano², Margarita Norambuena³, Cristian Garcia⁴, Silvio Vaschetto¹,
Pericle Zanchetta², Jose Rodriguez⁵, Radu Bojoi¹
¹Politecnico di Torino, Italy; ²University of Nottingham, United Kingdom; ³Universidad Tecnica Federico Santa
Maria, Chile; ⁴Universidad de Talca, Chile; ⁵Universidad Andres Bello, Chile

An Improved Modulated Model Predictive Torque and Flux Control for High-Speed IPMSM Drives 6601
S.M. Showybul Islam Shakib, D. Xiao, R. Dutta, Kazi Saiful Alam, Ilham Osman, M.F. Rahman
University of New South Wales, Australia

An Error Tracking Dead-Beat Model Predictive Torque Control for Open-Winding Permanent Magnet Synchronous Motor with Common DC Bus 6608
Yifei Cheng, Dan Sun, Wenhan Chen, Heng Nian
Zhejiang University, China

On-line Continuous Control Set MPC for PMSM Drives Current Loops at High Sampling Rate using qpOASES 6615
Francesco Toso, Paolo Gherardo Carlet, Andrea Favato, Silverio Bolognani
University of Padova, Italy

Session 163: Magnetic Component and Modeling

Chair(s): Shuo Wang, Maeve Duffy

Integrated Matrix Transformer with Optimized PCB Winding for High-Efficiency High-Power-Density LLC Resonant Converter 6621
Shuo Wang¹, Hongfei Wu², Fred C. Lee¹, Qiang Li¹
¹Virginia Polytechnic Institute and State University, United States;
²Nanjing University of Aeronautics and Astronautics, China

Soft Magnetic Materials Characterization for Power Electronics Applications and Advanced Data Sheets 6628
Seung Ryul Moon¹, Paul Ohodnicki¹, Kevin Byerly¹, Richard Beddingfield^{1,2}
¹National Energy Technology Laboratory, United States; ²ORISE fellow at NETL, United States

Improved Inductance Calculation in Variable Power Inductors by Adjustment of the Reluctance Model through Magnetic Path Analysis 6634
Sarah Saeed¹, Jorge Garcia¹, Marina S. Perdigão^{2,3}, Valter S. Costa^{2,4}, Bruno Baptista⁵, André M.S. Mendes^{2,4}
¹University of Oviedo, Spain; ²Instituto de Telecomunicações, Portugal; ³Coimbra Polytechnic – ISEC, Portugal;
⁴Universidade de Coimbra, Portugal; ⁵WEGeuro - Indústria Eléctrica, S.A., Portugal

Data-driven Leakage Inductance Modeling of Common Mode Chokes 6641
Zhou Dong¹, Ren Ren¹, Bo Liu², Fred Wang^{1,3}
¹University of Tennessee, United States; ²United Technologies Research Center, United States;
³Oak Ridge National Lab, United States

Session 164: Gate Drive for Wide Band Gap Device 2

Chair(s): Maja Harfman Todorovic, Dong Jiang

Gate Drive for Very Fast Resonant Conversion using SiC Switch 6647
Zikang Tong, Lei Gu, Kawin Surakitbovorn, Juan M. Rivas-Davila
Stanford University, United States

Smart Self-driving Gate Driver for Fast Switching and Crosstalk Suppression of SiC MOSFETs 6655
Chunhui Liu, Zhengda Zhang, Yifu Liu, Yunpeng Si, Qin Lei
Arizona State University, United States

Development and Verification of Protection Circuit for Hard Switching Fault of SiC MOSFET by using Gate-Source Voltage and Gate Charge 6661
Shinya Yano, Yusuke Nakamatsu, Takeshi Horiguchi, Shinnosuke Soda
Mitsubishi Electric Corp., Japan

Voltage Balancing of Four Series-Connected SiC MOSFETs under 2 kV Bus Voltage using Active dv/dt Control 6666
Emma Raszmann, Keyao Sun, Rolando Burgos, Igor Cvetkovic, Jun Wang, Dushan Boroyevich
Virginia Polytechnic Institute and State University, United States

Session 165: Topics in PV-Battery Systems

Chair(s): Rangarajan Tallam, Hengzhao Yang

Robust Allocation of Residential Solar Photovoltaic Systems Paired with Battery Units in South Australia 6673
Mehrdad Aghamohamadi¹, Amin Mahmoudi¹, Mohammed H. Haque²
¹Flinders University, Australia; ²University of South Australia, Australia

A Symmetric Transformerless Hybrid Converter with Leakage Current Suppression 6680
Zhongting Tang¹, Yongheng Yang², Mei Su¹, Hua Han¹, Frede Blaabjerg²
¹Central South University, China; ²Aalborg University, Denmark

Flexible Control for PV Integrated Battery Energy Storage System 6686
Yashi Singh, Bhim Singh, Sukumar Mishra
Indian Institute of Technology Delhi, India

Battery Lifetime Analysis for Residential PV-Battery System used to Optimize the Self Consumption – A Danish Scenario 6693
Didier Farinet, Mathias Maurer, Luca Vacca, Sergiu Viorel Spataru, Daniel-Ioan Stroe
Aalborg University, Denmark

Session 166: Topics in Alternative Energy Systems

Chair(s): Ke Ma, David Dorrell

A Multifunctional Reduced Sensor Control for Grid-Interfaced Dual VSC based Doubly Fed Induction Generator 6699

Souvik Das, Sambasivaiah Puchalapalli, Bhim Singh
Indian Institute of Technology Delhi, India

A Power Management Circuit for an Impact-type Piezoelectric Micro-wind Energy Harvester 6706

Nan Chen, Tingcun Wei, Liu Yang
Northwestern Polytechnical University, China

Hybrid Fuel Cell/Supercapacitor using a Series Converter 6711

Apinya Siangsanoh¹, Matheepot Phattanasak², Wattana Kaewmanee², Mathieu Weber¹,
Roghayeh Gavagsaz-Ghoachani¹, Jean-Philippe Martin¹, Serge Pierfederici¹, Sophie Didierjean¹
¹Universite de Lorraine, France; ²King Mongkut's University of Technology North Bangkok, Thailand

Optimal Variable Load Scheduling for Hybrid Energy Systems 6717

Avinash Rajendra, Jun Zhang, Adel Nasiri
University of Wisconsin-Milwaukee, United States

Session 167: Converters for Renewable Energy Systems

Chair(s): Junichi Itoh, Fei Gao

A Four-port Bidirectional DC-DC Converter for Renewable Energy-Battery-DC Microgrid System 6722

Jiahong Ning, Jianwu Zeng, Xia Du
Minnesota State University, United States

Transformerless Minimum Phase Interleaved Hybrid Converter with Low Leakage Current 6728

Simanta Kumar Samal, R.K. Singh, R. Mahanty
Indian Institute of Technology Varanasi, India

A Novel Solar PV Inverter Topology based on an LLC Resonant Converter 6734

Necmi Altin^{1,2}, Saban Ozdemir^{1,2}, Adel Nasiri¹
¹University of Wisconsin-Milwaukee, United States; ²Gazi University, Turkey

Grid Connection Power Converter and Speed Controller for Slip-Synchronous Wind Generators 6741

Dillan K. Ockhuis, Maarten J. Kamper
Stellenbosch University, South Africa

Session 168: V2G and G2V

Chair(s): Ali Emadi, Burak Ozpineci

A Day-Ahead Peak Shaving Strategy using Aggregated Electric Vehicles 6749

Khizir Mahmud, Animesh K. Sahoo, Jayashri Ravishankar
University of New South Wales, Australia

DC Ripple Component Cancellation Method of Isolated AC-DC Converter with Matrix Converter for Input Current Harmonics Reduction 6754

Shunsuke Takuma, Keisuke Kusaka, Jun-ichi Itoh
Nagaoka University of Technology, Japan

Analysis of Multi-Pickup Inductive Power Transfer System with LCC Compensation for Maglev Train 6762
Shuo Wang¹, Zhenpo Wang¹, Junjun Deng¹, Ying Yang¹, David G. Dorrell²
¹Beijing Institute of Technology, China; ²University of KwaZulu-Natal, South Africa

Time Synchronization and an Encoded Wireless Gate-signal Transfer Method for a High-power and Bi-directional Contactless Power Transfer System for Vehicle-to-Grid Applications 6768
Keisuke Ishikawa, Masanori Ishigaki, Kosuke Tahara, Makoto Kusakabe, Takahide Sugiyama
Toyota Central R&D Labs., Inc., Japan

Session 169: Modular Converters for Smart Grids

Chair(s): Bhim Singh, Srdjan Lukic

Tree-shaped Networked Control System for Modular Power Converters with Sub- μ s Latency and NS-scale Synchronization Accuracy 6775
Benoît Steinmann, Gabriel Fernandez, Nicolas Cherix
Imperix Ltd., Switzerland

STATCOM Operation of Parallel-Hybrid Modular Multilevel Converter 6783
Ibhan Chand Rath¹, Siba Kumar Patro², Anshuman Shukla¹
¹Indian Institute of Technology Bombay, India; ²Visvesvaraya National Institute of Technology, India

Low Loss Submodule Cluster for Modular Multilevel Converters Suitable for Implementation with SiC MOSFETs 6790
Keijo Jacobs, Stefanie Heinig, Baris Ciftci, Staffan Norrga, Hans-Peter Nee
KTH Royal Institute of Technology, Sweden

System-Level Power Loss Evaluation of Modular Multilevel Converters 6797
Yi Zhang¹, Huai Wang¹, Zhongxu Wang¹, Frede Blaabjerg¹, Maryam Saeedifard²
¹Aalborg University, Denmark; ²Georgia Institute of Technology, United States

Session 170: Other Topics in Transportation Electrification Applications

Chair(s): Arash Nassiri Bavili, Poria Fajri

A Low-Inductance Sectional Busbar for Snubberless Operation of SiC-based EV Traction Inverters 6805
Srdjan Srdic, Chi Zhang, Srdjan Lukic
North Carolina State University, United States

Optimization of DC-Link Decoupling Snubber Circuit for SiC-based EV Traction Inverters 6810
Chi Zhang, Srdjan Srdic, Srdjan Lukic
North Carolina State University, United States

Optimal Blending of Regenerative and Friction Braking at Low Speeds for Maximizing Energy Extraction in Electric Vehicles 6815
Shoeib Heydari¹, Poria Fajri¹, Reza Sabzehgar², Arash Asrari³
¹University of Nevada, Reno, United States; ²San Diego State University, United States;
³Southern Illinois University, United States

FPGA based High Bandwidth Motor Emulator for Interior Permanent Machine utilizing SiC Power Converter 6820
Yukun Luo, M.A. Awal, Li Yang, Wensong Yu, Iqbal Husain
North Carolina State University, United States

Session 171: DC-DC Isolated Converter 5

Chair(s): Somasundaram Essakiappan, Hidemine Obara

Voltage Control Method with Non-linear Compensation and DC-Offset Elimination for One-leg T-type Dual Active Bridge Converter using Multi-Operation Mode 6828

Hayato Higa¹, Hiroki Watanabe², Keisuke Kusaka², Jun-ichi Itoh²
¹Meidensha Corporation, Japan; ²Nagaoka University of Technology, Japan

A Modulation Strategy Providing Efficiency Enhancement at Light Load for the DAB Converter with DC Blocking Capacitors 6836

Peng Liu, Shanxu Duan, Hongsheng Hu
Huazhong University of Science and Technology, China

DCM Forward-Flyback Converter with Cockcroft-Walton Voltage Multiplier: Steady-state Analysis considering the Influence of Parasitic Capacitances at Very Low Power Consumption and Very High Voltage Gain 6841

Juan Antonio Serrano, Pedro Alou, Jesus A. Oliver
Universidad Politecnica de Madrid, Spain

6.6 kW High-Frequency Full-Bridge LLC DC/DC Converter with SiC MOSFETs 6848

Yuequan Hu, Jianwen Shao, Teik Siang Ong
Wolfspeed, A Cree Company, United States

Session 172: Modular Multilevel Converters 1

Chair(s): Milijana Odavic, Frank Bohn

A Hybrid Nine-arm Modular Multilevel Converter based on Half-Bridge and Unidirectional Current Full-Bridge Submodule 6854

Futian Qin, Feng Gao, Tao Xu, Decun Niu, Zhan Ma
Shandong University, China

A Novel Modular Multilevel Converter with Coupled-inductor Semi-bridge Submodules 6860

D. Lyu¹, Y. Sun^{1,2}, C.A. Teixeira³, D.G. Holmes³, B. McGrath³, Q. Wang¹
¹Nanjing Normal University, China; ²Jiangsu Collaborative Innovation Center for Smart Distribution Network;
³MIT University, Australia

Operation Range Analysis and Capacitor Voltage Regulation of a Dual-AC-Terminal MMC based on Bifurcated-Arm Topology 6868

Lin Jin¹, Zhiqian Dong¹, Yan Deng¹, Leyuan Zhou¹, Yi Lu², Yong Yang³
¹Zhejiang University, China; ²State Grid Zhejiang Electric Power Research Institute, China;
³State Grid Zhejiang Electric Power Co. Ltd., China

On Facilitating the Modular Multilevel Converter Power Scalability through Branch Paralleling 6875

Stefan Milovanović, Dražen Dujčić
École Polytechnique Fédérale de Lausanne, Switzerland

Session 173: Multilevel Converters

Chair(s): Richard Bosse, Marcello Pucci

Capacitor Voltage Balancing Control of a Modular Matrix Converter in Conditions of Startup and Low Output Frequency 6883

Kota Yamamoto, Koki Muku, Takaharu Takeshita
Nagoya Institute of Technology, Japan

Circulating Currents Suppression and Neutral-Point Potential Balancing Strategy for Parallel Three-Level T-type DC-AC Converters 6891
Jiayu Zhou¹, Olorunfemi Ojo², Josiah Haruna³, Fen Tang¹
¹Beijing Jiaotong University, China; ²Tennessee Tech University, United States

A Predictive Submodule Choosing Algorithm for Soft-Switching Modular Multilevel Converters with Nearest Level Modulation Scheme 6898
Xueni Zhou, Lei Lin, Kai Hu, Chen Xu, Weihong Song
Huazhong University of Science and Technology, China

Arm-Current Sensor-less Control of MMC for Circulating Current Suppression 6905
Govind Avinash Reddy, Anshuman Shukla
Indian Institute of Technology Bombay, India

Session 174: Grid-Connected Converter Control 2
Chair(s): Teuvo Suntio, Kyo-Beum Lee

An Accurate Power-flow Control Method with Harmonic Compensation in Voltage-source-inverter Grid-tied System 6911
Mingzhi Gao, Bodong Li, Bin Zhao, Yue Li, Miao Yu
Zhejiang University, China

High-Frequency Harmonic Current Control of Power Converters 6915
Sante Pugliese, Steffen Flacke, Zhixiang Zou, Marco Liserre
Christian-Albrechts-Universität zu Kiel, Germany

Linear Current Controller with Fast Transient Response and Low Switching Frequency 6922
Diego Pérez-Estévez, Jesús Doval-Gandoy
University of Vigo, Spain

Compensation Alternatives for Power Sharing Errors in Multi-Port Converters for Hybrid DC/AC Microgrids 6929
Geber Villa, Sarah Saeed, Pablo García, Carlos Gómez-Aleixandre, Ramy Georgious
University of Oviedo, Spain

Session 175: Power Converter EMI 2
Chair(s): Shuo Wang, Hong Li

An Improved Variable Switching Frequency Modulation Strategy for Three-Level Converters with Reduced Conducted EMI 6937
Jianan Chen, Dong Jiang, Wei Sun, Zewei Shen, Yechi Zhang
Huazhong University of Science and Technology, China

A Voltage-injected Active Gate Driver for Improving the Dynamic Performance of SiC MOSFET 6943
Hong Li, Yanfeng Jiang, Chao Feng, Zhichang Yang
Beijing Jiaotong University, China

Common-mode Current Analysis and Cancellation Technique for Dual Active Bridge Converter based DC System 6949
Saurabh Kumar, Sai Kiran Voruganti, Ghanshyamsinh Gohil
The University of Texas-Dallas, United States

Investigation of Radiated EMI in Non-isolated Power Converters with Power Cables in Automotive Applications 6957
Juntao Yao¹, Mohammed El-Sharkh¹, Yiming Li¹, Zhedong Ma¹, Shuo Wang¹, Zheng Luo²
¹University of Florida, United States; ²Monolithic Power Systems, Inc., United States

Session 176: Design Optimization
Chair(s): Sombuddha Chakraborty, Carl Ho

Optimal Design of the Resonant Tank of the Soft-Switching Solid-State Transformer 6965
Mickael J. Mauger, Prasad Kandula, Deepak Divan
Georgia Institute of Technology, United States

Levelized-Cost-of-Electricity-Driven Design Optimization for Medium-Voltage Transformerless Photovoltaic Converters 6973
Gab-Su Seo¹, Satyaki Mukherjee², Jinia Roy¹, Kyle Goodrick², Rahul Mallik³, Branko Majmunovic², Soham Dutta³, Dragan Maksimović², Brian Johnson³
¹National Renewable Energy Laboratory, United States; ²University of Colorado-Boulder, United States; ³University of Washington, United States

Reduction of Low-Frequency Ripples in Single-Phase Switched Boost Inverter using Active Power Decoupling 6981
Pramit Nandi, Ravindranath Adda
Indian Institute of Technology Guwahati, India

An Auxiliary Resonant Switching Arm for a Buck-Boost Converter 6989
J. Alejandro Pichardo-Iniesta, Ismael Araujo-Vargas, Ilse Cervantes-Camacho
Instituto Politécnico Nacional, Mexico

Session 177: Electric Machines: Diagnostics, Noise and Vibration 2
Chair(s): Shanelle Foster, Hamid Toliyat

On-Line Motor Insulation Capacitance Monitoring using Low-Cost Sensors 6996
Igor Tsyokhla¹, Antonio Griffo², Jiabin Wang²
¹Sphere Fluidics, United Kingdom; ²The University of Sheffield, United Kingdom

Remaining Useful Life Estimation of Stator Insulation using Particle Filter 7004
William R. Jensen, Shanelle N. Foster
Michigan State University, United States

An Improved Broadband Common-mode Electrical Machine Model for Online Condition Monitoring of Stator Insulation Degradation 7012
Dayong Zheng, Pinjia Zhang
Tsinghua University, China

Flux-based Detection of Non-adjacent Rotor Bar Damage in Squirrel Cage Induction Motors 7019
Yonghyun Park¹, Hanchun Choi¹, Sang Bin Lee¹, Konstantinos Gyftakis²
¹Korea University, Republic of Korea; ²University of Edinburgh, United Kingdom

Session 178: Permanent Magnet Machines 2

Chair(s): Sara Roggia, Khwaja Rahman

Line-Start Axial-Flux PM Motors: Introduction of a New Machine Topology 7027

Solmaz Kahourzade¹, Amin Mahmoudi², Rahil Ravji¹, Wen L. Soong¹

¹University of Adelaide, Australia; ²Flinders University, Australia

Flux Weakening Surface Mounted Permanent Magnet Servo Motors Design with Enhanced Self-Sensing Properties 7035

Huthaifa Mohammad Flieh¹, Timothy Slininger¹, Robert D. Lorenz¹, Shao-Chuan Chien², Li-Hsing Ku²

¹University of Wisconsin-Madison, United States; ²Delta Electronics, Inc., Taiwan

Maximum Torque per Ampere Control of Interior Permanent Magnet Synchronous Motor via Optimal Current Excitation 7043

Taowen Chen, Pengyuan Chen, Jingchen Liang, Sen Li, Babak Fahimi

The University of Texas-Dallas, United States

Multi-Harmonic Design and Optimization of PMSMs 7049

Gerd Bramerdorfer¹, Stephan Lanser², Wolfgang Amrhein¹

¹Johannes Kepler University Linz, Austria; ²ASA Astrosysteme GmbH, Austria

Session 179: Induction Motor Drives 2

Chair(s): Thomas Wolbank, Giacono Scelba

Torque Ripple Reduction in Stator Resistance Estimation using DC Current Injection for Induction Motor Sensorless Drives 7057

Jiwon Yoo¹, Joohyun Lee¹, Seung-Ki Sul¹, Noor Aamir Baloch²

¹Seoul National University, Republic of Korea; ²Yaskawa Electric Corporation, Japan

Guidelines for Selecting Minimum Capacitance for a Floating Bridge Dual Inverter Drive 7064

Chatumal Perera, Gregory J. Kish, John Salmon

University of Alberta, Canada

Control of Five-Phase Open-End Induction Machine Drive Topology with Floating Capacitors at optimized DC Voltage 7072

Xiangwen Sun, Zicheng Liu, Dong Jiang, Wubin Kong

Huazhong University of Science and Technology, China

Speed Adaptive Voltage Closed-Loop Field-Weakening Control for Induction Motor Drives 7078

Bo Wang, Jing Zhang, Yong Yu, Xu Zhang, Dianguo Xu

Harbin Institute of Technology, China

Session 180: Switched Reluctance Motor Drives

Chair(s): Prerit Pramod, Zhe Zhang

Modeling of a Bearingless Synchronous Reluctance Motor with Combined Windings 7084

Maksim Sokolov¹, Wolfgang Gruber², Seppo E. Saarakkala¹, Marko Hinkkanen¹

¹Aalto University, Finland; ²Johannes Kepler University Linz, Austria

Current Harmonics Injection Method for Simultaneous Torque and Radial Force Ripple Mitigation to Reduce Acoustic Noise and Vibration in SRMs 7091
Omer Gundogmus¹, Yilmaz Sozer¹, Lavanya Vadamodala¹, John Kutz², Joshua Tylanda³, Ronnie L. Wright²
¹University of Akron, United States; ²DCS Corporation, United States;
³US Army Tank Automotive Command, United States

Flux Profiling Control-Based Noise and Vibration Reduction of SR Motor for Automobile Traction Drive 7098
Takashi Kosaka, Sungyong Shin, Soshi Morishita, Daisuke Mizutani, Hiroaki Matsumori, Nobuyuki Matsui
Nagoya Institute of Technology, Japan

Small Signal Model of Mutually Coupled Switched Reluctance Motors based on Net Flux Method 7105
Siddharth Mehta¹, Iqbal Husain¹, Prerit Pramod², Md Ashfanoo Kabir³
¹North Carolina State University, United States; ²Nexteer Automotive, United States;
³ABB Corporate Research, United States

Session 181: Advanced Material and Passive Devices

Chair(s): Mona Ghassemi, Jon Zhang

Loss and Thermal Modeling of Metal Oxide Varistors (MOV) under Standard Current Surge Mission Profile 7113
Ionut Vernica¹, Per Thåstrup Jensen², Huai Wang¹, Francesco Iannuzzo¹, Susanne Otto², Frede Blaabjerg¹
¹Aalborg University, Denmark; ²FORCE Technology, Denmark

Computationally Efficient Estimation of the Electric-Field Maximums for the MFT Insulation Coordination 7118
Marko Mogorovic, Drazen Dujic
École Polytechnique Fédérale de Lausanne, Switzerland

Nonlinear Resistive Electric Field Grading in High-Voltage, High-Power Wide Bandgap Power Module Packaging 7124
Maryam Mesgarpour Tousi, Mona Ghassemi
Virginia Polytechnic Institute and State University, United States

Design of Low Inductance Busbar for 500 kVA Three-Level ANPC Converter 7130
Handong Gui¹, Ruirui Chen¹, Jiahao Niu¹, Zheyu Zhang², Fred Wang^{1,3}, Leon M. Tolbert^{1,3}, Daniel J. Costinett^{1,3}, Benjamin J. Blalock¹, Benjamin B. Choi⁴
¹University of Tennessee-Knoxville, United States; ²Clemson University, United States;
³Oak Ridge National Lab, United States; ⁴NASA Glenn Research Center, United States