2021 IEEE 4th Student Conference on Electric Machines and Systems (SCEMS 2021)

Huzhou, China 1 – 3 December 2021



IEEE Catalog Number: CFP21Q90-POD ISBN: 978-1-6654-3682-3

Copyright © 2021 by the Institute of Electrical and Electronics Engineers, Inc. All Rights Reserved

Copyright and Reprint Permissions: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

*** This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.

 IEEE Catalog Number:
 CFP21Q90-POD

 ISBN (Print-On-Demand):
 978-1-6654-3682-3

 ISBN (Online):
 978-1-6654-3681-6

Additional Copies of This Publication Are Available From:

Curran Associates, Inc 57 Morehouse Lane Red Hook, NY 12571 USA Phone: (845) 758-0400

Fax: (845) 758-2633

E-mail: curran@proceedings.com Web: www.proceedings.com



Table of Contents

EA-002	MPPT Control Strategy of Variable Speed Hydropower System Based on Improved Fuzzy Control1 Qiang Zhou, Derong Luo, Litao Dai, Bi Wu, Hongjun Luo
	Hunan University, China
EA-004	A Fuzzy plus Integral Composite Control Strategy of Switched Reluctance Motor for Electric Vehicles7
	<u>Fan Liu</u> , Yuwei Zhu, Peilin Liu, Chuang Liu, Yujie Qian
	Nanjing University of Aeronautics and Astronautics, China
EA-006	Novel Decoupling Control and Eigenstructure Assignment Strategies for Rigid Active
	Magnetic Bearing Rotor System13
	<u>Yuanwen Li</u> , Changsheng Zhu
	Zhejiang University, China
EA-007	A Position Control Based on Active Disturbance Rejection Controller Considering
	Parameter Variations of Harmonic Drive Gear Systems21
	<u>Xi Zeng</u> , Yilin Ma, Huan Yang
	Zhejiang University, China
EM-005	Design of a Novel Stator Water-cooling System for Yokeless and Segmented Armature
	Axial Flux Machine27
	<u>Wei Le</u> , Mingyao Lin, Lun Jia, Shuai Wang
	Southeast University, China
EM-009	Thermal Management of Open Air-cooled Induction Motor for Drilling31
	<u>Ziyi Xu</u> ¹ , Yongming Xu ² , Mengmeng Ai ¹ , Wenhui Liu ¹ , Yaodong Wang ³
	¹ Harbin University of Science and Technology, China, ² Changzhou Institute of Technology,
	China, ³ Durham University, U.K.
EM-011	Rotor Unbalanced Magnetic Pull Characteristics Properties in Synchronous Generators
	Due to Dynamic Air-gap Eccentricity Faults37
	<u>Kai Sun</u> , Yuling He, Minghao Qiu, Shuo Wang, Wenhao Zhang
	North China Electric Power University, China
EM-012	Effect of Rotor Interturn Short circuit degree and position on Stator Circulating Current
	inside Parallel Branches in Generators43
	Ming-xing Xu, Yu-ling He, De-rui Dai, Xiang-ao Liu, Wen-jie Zheng, Wen Zhang
	North China Electric Power University, China

Detection of Ending Winding Wear Regulation Acting by Electromagnetic Force in

EM-013

Synchronous Generators under both SISC and SAGE Conditions...50

<u>Wen Zhang</u>, Yu-Ling He, Yong Li, Ming-Xing Xu, De-Rui Dai North China Electric Power University, China

EM-014 A Novel Hybrid Excited Machine with DC Bias and Magnetic-Saturation-Alleviation...56

<u>Siwei Zhang</u>, Yulong Liu, Zewen Huang *Huagiao University, China*

EM-015 Design of Synchronous Reluctance Motors with Asymmetrical Flux Barriers for Torque Ripple Reduction...61

<u>Xuan Li</u>, Yawei Wang, Ronghai Qu *Huazhong University of Science & Technology, China*

EM-016 Sensitivity Analysis and Multi-objective Optimization of a PM-Assisted Synchronous Reluctance Motor with Rectangular Flux-Barriers...67

Yuhang Cheng, Yawei Wang, Dawei Li, Ronghai Qu Huazhong University of Science & Technology, China

EM-017 Design and Analysis of a Novel Integrated Starter-Generator Based on Brush DC Motor...75

Caiyong Ye¹, <u>Kailun Du</u>¹, Kaifeng Liu¹, Jianping Zhang¹, Yu Xiang¹, Ling Qin² *Huazhong University of Science and Technology, China, ²Jiang Su Huayuan Explosion-Proof Motor Co., China*

EM-018 Torque Calculation of PMa-SynRM Using the Magnetic Equivalent Circuit...82

Zaixun Ling¹, <u>Kang Shuai</u>², Cheng Cheng¹, Hao Chen², Jingwen Zheng¹, Jin Wang²

¹State Grid Hubei Electric Power Co., Ltd., China, ²Huazhong University of Science and Technology, China

EM-019 Optimum Design of Single Phase Induction Motor with Copper Rotor Based on Improved Polyhedron Method...87

Caiyong Ye¹, <u>Kailun Du</u>¹, Kaifeng Liu¹, Yang Zhao¹, Jianping Zhang¹, Ling Qin²

¹Huazhong University of Science and Technology, China, ²Jiang Su Huayuan Explosion-Proof Motor Co., China

EM-020 Design of Consequent Pole Permanent Magnet Vernier Motor for Downhole Electric Drilling System...93

Zheng Chen¹, Jin Wang¹, Zhijian Hu², Jianqiu Xiao², Libing Zhou¹, <u>Hu Wang</u>¹ *Huazhong University of Science and Technology, China, ²CNPC Engineering Technology R&D Company Limited, China*

EM-021 Study on the Pulse Transformer with energy recovery for Repetitive Pulsed High Magnetic Field...99

<u>Shan Jiang</u>, Heng Hu, Shuang Wang, Jinqiao Cheng, Tao Peng *Huazhong University of Science and Technology, China*

EM-022 A New System for Calibrating a Pulsed Field Magnetometer...104

Heng Hu, Jinqiao Chen, Shan Jiang, Tao Peng Huazhong University of Science and Technology, China

EM-025 Calculation of the Core Loss of High-Frequency High-Voltage Transformer Considering the Influence of Temperature...108

<u>Jinqiao Chen</u>, Heng Hu, Shan Jiang, Le Deng, Tao Peng <u>Huazhong University of Science and Technology, China</u>

EM-027 Thermal Analysis of a Hybride Excitation Flux-Switching Motor with Water-Cooling System...113

<u>Shunjie Ni¹</u>, Lihua Zhou², Hao Li¹, Ruiwu Cao¹

¹Nanjing University of Aeronautics and Astronautics, China, ²AVIC Nanjing Engineering Institute of Aircraft System, China

EM-028 A Capacitance Matrix Expansion Method for Parasitic Capacitance Extraction of Excitation Winding...118

Zezhong Chen¹, Renhua Jiang², Shushu Zhu¹, Yaohua Hu³

¹Nanjing University of Aeronautics and Astronautics, China, ²AVIC Leihua Electronic Technology Research Institute, China, ³Aviation Key Laboratory of Science and Technology on Aero Electromechanical System Integration, China

EM-029 Influence of Virtual Pole on Electromagnetic Characteristics and Equivalent Pole Pitch of Modular-secondary PMSLM...124

Jing Li, Xuzhen Huang, Bo Zhou

Nanjing University of Aeronautics and Astronautics, China

EM-030 Research on the Effect of Winding Connection Modes on Radial Force and Vibration of Two-Phase SRM...131

<u>Yujie Qian</u>¹, Chuang Liu¹, Shiwei Yan², Fan Liu¹

¹Nanjing University of Aeronautics and Astronautics, China, ²Jiangsu Leili Motor Co., Ltd, China

EM-031 General Analysis of Combinations of High Frequency Injected Auxiliary Coils in Displacement Sensorless Control...138

<u>Yi Zhang</u>, Yu Wang, Cheng-Gao Zhang, Wen-Juan Hao Nanjing University of Aeronautics and Astronautics, China

EM-032 Analysis of Flux Leakage in Slot and Circulating Current Loss of PMSM with Concentrated Winding...145

<u>Jing Wang</u>¹, Dongxu Liu¹, Qiang Li¹, Weiwei Geng¹, Lei Li¹, Zhuoran Zhang²

¹Nanjing University of Science and Technology, China, ²Nanjing University of Aeronautics and Astronautics, China

Thermal and Stress Analysis for a High-speed Permanent Magnet Motor with Solid Rotor...151 Zhenning Qi¹, Yue Zhang¹, He Zhang², Xiuhe Wang¹, Huijun Wang³, Lei He¹ 1Shandong University, China, ²University of Nottingham Ningbo, China, ³Beihang University, China

EM-035 Thermal Design and Simulation of winding cooling for permanent magnet synchronous motor of electric vehicle...156

<u>Yujun Guo</u>, Aiyuan Wang Shanghai Dianji University, China

EM-036 Investigation of Variable Flux Memory Machines with Hybrid Connected Delta-Type Permanent Magnets...161

Zicheng Zhou, Hao Hua, Bohu Zhang Shanghai Jiao Tong University, China

EM-037 The Structure of Symmetrical Stator Core Offset to Reduce Cogging Torque...168

<u>Tao Zhou</u>, Li Zhu *Shanghai Jiao Tong University, China*

EM-039 Study on Characteristics of Silicon Steel Sheet and Core of PMSM Used in Deep Sea...172 Zhibo Chen, Xiang Luo

Shanghai Jiao Tong University, China

EM-042 Comparison of Rotor Strength of Various Rotor Structures for Ultra-high-speed Permanent Magnet Synchronous Motor...176

Tao Pu¹, Guanghui Du¹, Jun Tong¹, Na Huang², Niumei Li¹, Wei Xu³

¹Xi'an University of Science and Technology, China, ²Xi'an Yonge Jieli Wind Energy Co. Ltd, China, ³Huazhong University of Science and Technology, China

EM-043 Comparation of Different Rotor Sleeves of High-speed Permanent Magnet Synchronous Motors Based on Multi-physics...182

<u>Lu Wang</u>¹, Guanghui Du¹, Jun Tong¹, Na Huang², Chengshuai Hu¹, Wei Xu³

¹Xi'an University of Science and Technology, China, ²Xi'an Yonge Jieli Wind Energy Co. Ltd, China, ³Huazhong University of Science and Technology, China

EM-044 Analytical calculation of Permanent Magnet Flux Linkage and Winding Inductance of Mover Permanent Magnet Double Salient Reluctance Linear Machines...187

<u>Huixian Zhang</u>, Gaoqi Chen, Kunlun Zhang Southwest Jiaotong University, China

EM-045 Generalized Analysis of Armature Windings MMF Harmonics...194

Ze-Zheng Wu^{1, 2}, Jian-Xin Shen^{1, 2}

¹Zhejiang University, China, ²Zhejiang Provincial Key Laboratory of Electrical Machine Systems, China

Coupled Thermo-Mechanical Stress Analysis of Insulation in Deep-Sea Oil-Filled Motors...200 EM-046 Rui Wang, Lingfeng Cai, Jian Zhang, Xiaoyan Huang, Youtong Fang Zhejiang University, China EM-047 Mechanical properties of transformer insulations under DC bias condition...206 Jing Wu¹, Jie Xu¹, Weiyan Zheng¹, Ming Jin¹, Xueqian Huang², Guoping Zou² ¹Zhejiang Dayou Industrial Co., Ltd., China, ²Zhejiang University, China Torque Analysis and Optimization of Synchronous Reluctance Motor Shielded by EM-050 Magnetic Stator Can...211 Bowen Li^{1, 2}, Hui Li^{1, 2}, Xuewei Xiang^{1, 2} ¹Chongging University, China, ²State Key Laboratory of Power Transmission Equipment & System Security and New Technology, China Effect of Slot Number on Performances of a Single-Side Axial-Flux Permanent Magnet EM-052 Generator...217 Chun-Yu Hsiao, Ketut Wirtayasa National Taiwan University of Science and Technology Design and Simulation of a Rectifier for Bidirectional Electric Vehicle Chargers...224 PE-002 Omes J. Bajwa, Shujun Zhang West Norway University of Applied Sciences, Norway PE-004 Common Mode Electromagnetic Interference Source Characteristics of SiC MOSFETs in Motor Drives...229 Yameng Chai, Xiaofeng Ding Beihang University, China PE-005 A Novel Stator Resistance Online Identification method based on ADRC...233 Shuai Wang, Mingyao Lin Southeast University, China **PE-006** An Improved Robust Deadbeat Predictive Current Control without Computational Delay...236 Xie Wu, Yunkai Huang, Fei Peng Southeast University, China PE-010 Variable Parameter PI Control based on Fuzzy Logic Strategy for Dual-Winding PMSM...242 Mingkai Cui, Yanjun Yu

PE-011 Modified Fault Diagnosis Method of Power Converter in SRM Based on Bridge Current Reconstruction Scheme...246

Debo Sun^{1, 2}, Yanfang Hu^{1, 2}, Zhiyong Kang^{1, 2}

Harbin Institute of Technology, China

¹Hebei University of Technology, China, ²State Key Laboratory of Reliability and Intelligence of Electrical Equipment, China

PE-012 Multi-mode Drive Control System of Switched Reluctance Motor Based on a Novel N+2 Power Converter...252

Zhiyong Kang^{1, 2}, Yanfang Hu^{1, 2}, <u>Debo Sun</u>^{1, 2}

¹Hebei University of Technology, China, ²State Key Laboratory of Reliability and Intelligence of Electrical Equipment, China

PE-013 Maximum Inductance Detection-based Fault-Tolerant Sensorless Control for SRM Drive...258

Qingguo Sun, Tianze Lan

Hebei University of Technology, China

PE-014 An Advanced Boost Chopper Converter-Based Direct Instantaneous Torque Control for SRMs...263

Qingguo Sun, Hantong Xie

Hebei University of Technology, China

PE-015 Modular Converter-Based Predictive Current Control of SRM for Torque Ripple Suppression...269

Qingguo Sun, <u>Limei Chen</u>, Gongmin Wei *Hebei University of Technology, China*

PE-016 Parameter Estimation Using Improved Adaline Neural Network for Sensorless Control of IPMSM...275

<u>Bi Wu</u>, Derong Luo, Mengqiu Li, Qiang Zhou *Hunan University, China*

PE-018 Multi-parameter identification of permanent magnet synchronous motor based on improved grey wolf optimization algorithm...281

Jinmei Jiang, Zhu Zhang

Hunan University of Science and Technology, China

PE-019 Improved PI Regulator with Integral Separation for Permanent Magnet Synchronous Motor Control...288

<u>Zewen Huang</u>, Yulong Liu *Huaqiao University, China*

PE-020 Active Disturbance Rejection Current Control for Synchronous Reluctance Motor...293

Zibo Li, Libing Zhou, Jin Wang

Huazhong University of Science and Technology, China

PE-021 Research on Predictive Current Suspension Control of Permanent Magnet Bearingless

Motor...298

<u>Yang Zhao</u> , Caiyong	Ye, Yongzihao	Dai, Kaifeng	Liu, Sifeng Zhao	, Cong Deng
Huazhong Universit	of Science an	nd Technology	, China	

PE-022 Study on Control Strategy for PMSM Fed by Differential Boost Inverter...302

Hu Wang, Jin Wang, Libing Zhou

Huazhong University of Science and Technology, China

PE-023 The High Efficiency Control Method of PMSMs Based on Gradient Descent Algorithm...308

Zaixun Ling¹, <u>Hao Chen²</u>, Cheng Cheng¹, Kang Shuai², Jingwen Zheng¹, Jin Wang²

¹State Grid Hubei Electric Power Co., Ltd., China, ²Huazhong University of Science and Technology, China

PE-024 On-line Suppression of Harmonic Currents Caused by Inverter Non-linearity for Sensorless Control of PMSMs...313

<u>Dongdong Chen</u>¹, Jin Wang¹, Fangyong Tian², Libing Zhou¹

¹Huazhong University of Science and Technology, China, ²Research Institute of Petroleum Engineering of Zhongyuan Oilfield, China

PE-026 Research on the Observation of the Rotor Flux Linkage Considering the Distribution of Rotor Current for Vector Control of Solid Rotor Induction Motors...318

<u>Dongkai Jiang</u>, Zhiquan Deng *Nanjing University of Aeronautics and Astronautics, China*

PE-028 Comparison and analysis of two power topologies for four-phase SRM...324

<u>Yuwei Zhu</u>, Yutai Mao, Peilin Liu, Chuang Liu, Yujie Qian, Xuezhong Zhu *Nanjing University of Aeronautics and Astronautics, China*

PE-030 Sensorless Control of a Seven-phase Non-sinusoidal Permanent Magnet Synchronous Machine Using High Frequency Signal Injection Method...331

Y. Huang¹, J. Gong, Y. Zhu¹, F. Tan¹, W. Tian¹, E. Semail², N-k. Nguyen²

TShandong University, China, ²Univ. Lille, France

PE-031 High quality Open-circuit Fault Tolerant Control of a Bi-harmonic Seven-Phase Permanent Magnet Synchronous Machine...337

<u>Y. Zhu</u>¹, J. Gong¹, J. Huang¹, F. Tan¹, W.Tian¹, N-k. Nguyen², E. Semail²

¹Shandong University, China, ²Univ. Lille, France

PE-032 An Enhanced SVPWM Method of Suppressing Common-Mode Voltage in Dual Three-Phase Motor...342

Bohu Zhang, Hao Hua, Zicheng Zhou Shanghai Jiao Tong University, China

PE-033 A Current Harmonic Suppression Strategy for Electrolytic Capacitor-less Drive System of PMSM Based on Resonant Controller...349

<u>Li Lei</u> , Xiang Lu	uo, Li	Zhu	
Shanghai Jiao	Tong	University,	China

PE-034 Research on Minimum Switching Loss SVPWM Control of Dual Three-Phase PMSM...353

Zhibo Chen, Xiang Luo

Shanghai Jiao Tong University, China

PE-035 A Current Harmonic Suppression Method of PMSM Based on Resonant Controller and Asymmetric-SVPWM Strategy...357

<u>Li Lei</u>, Xiang Luo, Li Zhu

Shanghai Jiao Tong University, China

PE-037 A Modified Method for Initial Rotor Position Detection of Brushless DC Motor Based on Voltage Vector Injection...362

<u>Lu Zhou</u>¹, Xinmin Li², Wei Chen², Tingna Shi³

¹Tianjin University, China, ²Tianjin Engineering Center of Electric Machine System Design and Control, China, ³Zhejiang University, China

PE-039 An Improved Type-2 Phase-Locked Loop -Based Sliding Mode Observer for Sensorless Control of SPMSM...368

Abd Alrahman Dawara¹, Zhe Chen¹, Xuxuan Zhang¹, Hang Zhang², Guangzhao Luo¹, Ralph Kennel³

Northwestern Polytechnical University, China, ²Xi'an University of Technology, China,

Technical University of Munich, Germany

PE-043 Synchronous Optimal Torque PWM with Low Torque Ripple under Low Carrier Ratio...374

Zhihao Song¹, Wenxi Yao¹, Senqing Zhuo², Wuhua Li¹

¹Zhejiang University, China, ²Ningbo Aux Electric Co., Ltd., China

PE-044 Common-Mode Resonance Suppression Strategy in High-Speed Compressor Drive...379 Can Sun^{1, 2}, Huan Yang^{1, 2}, Bo Qu³, Li Xiang⁴

¹Zhejiang University, China, ²Zhejiang Provincial Key Laboratory of Electrical Machine Systems, China, ³Zinsight Technology Co., Ltd., China, ⁴Nanjing University of Aeronautics and Astronautics, China

PE-046 A Novel Complex Vector Decoupling Control Method of IPMSM with Fuzzy Strategy...383

<u>Qidi Shen</u>, Hongyi Yang, Xiaoyan Huang, Feiyu Chen *Zhejiang University, China*

PE-049 An Energy-Optimal Reference Trajectory with Iterative Learning-Based Control...389

<u>Tong Zhou</u>^{1, 2}, Hui Li^{1, 2}, Xuewei Xiang^{1, 2}

¹Chongqing University, China, ²State Key Laboratory of Power Transmission Equipment & System Security and New Technology, China

PE-052 Motor bearing fault diagnosis based on multi-feature fusion and PSO-BP...394

<u>Yi Zhang</u>, Jianfeng Qu, Xiaoyu Fang, Guojian Luo Chongqing University, China

PE-054 Current-Loop Bandwidth Extension for PMSM Servo System Based on SiC Inverter and FPGA...399

Qiwei Xie, Jianqi Qiu Zhejiang University, China

PS-002 Power Grid Disturbance Prediction and Analysis Method Based on SIR Model...403

<u>Cheng Qian</u>, Aiyuan Wang *Shanghai Dianji University, China*

PS-004 The State Evaluation of Power Transformers Based on Grey Target Theory And Simulated Annealing...408

Lin Yao¹, Dingyong Liu¹, <u>Shaowei Rao</u>², Guoping Zou², Yu Du³, Yang Liu³, Shiyou Yang²

¹Daya Bay Nuclear Power Operation and Management Company, China, ²Zhejiang University, China, ³Suzhou Nuclear Power Research Institute, China

PS-005 Power Quality Test Data Processing and Comprehensive Analysis Software Design...413

Guoxin Li, <u>Linyun Li</u>, Sizheng Yu

China University of Mining and Technology, China

PS-006 Short-term Frequency Support Method for a Single-stage Photovoltaic Generator based on Residual Voltage Control...421

Zheng Fan^{1, 2}, Wei Chen^{1, 2}, Taiying Zheng^{1, 2}

¹Zhejiang University, China, ²Zhejiang Provincial Key Laboratory of Electrical Machine Systems, China

PS-007 Inrush Suppression Method of Transformer in an Offshore Power System...426

Xingchao Jiao^{1, 2}, Wei Chen^{1, 2}, Taiying Zheng^{1, 2}

¹Zhejiang University, China, ²Zhejiang Provincial Key Laboratory of Electrical Machine Systems, China

PS-008 Integration of a Protection/Measurement Current Transformer based on Compensation Algorithm...431

Jingmao Wen^{1, 2}, Wei Chen^{1, 2}, Xingchao Jiao^{1, 2}, Min Wu^{1, 2}, Taiying Zheng^{1, 2}

¹Zhejiang University, China, ²Zhejiang Provincial Key Laboratory of Electrical Machine Systems, China

PS-009 Simplified Analysis of the Influence Scope of DC Magnetic Bias...437

Shanzhong Ju^{1, 2}, Wei Chen^{1, 2}, Taiying Zheng^{1, 2}

¹Zhejiang University, China, ²Zhejiang Provincial Key Laboratory of Electrical Machine Systems, China

PS-010 Comparative Analysis of Inertia Control Methods for a PMSG-Based Wind Turbine Generator...442

Jingze Qian^{1, 2}, Wei Chen^{1, 2}, Taiying Zheng^{1, 2}

¹Zhejiang University, China, ²Zhejiang Provincial Key Laboratory of Electrical Machine Systems, China

PS-011 Research on Self-excitation Overvoltage of Offshore Interconnected Power System...447

<u>Jiawei Liu^{1, 2}</u>, Wei Chen^{1, 2}, Xinchao Jiao^{1, 2}, Taiying Zheng^{1, 2}

¹Zhejiang University, China, ²Zhejiang Provincial Key Laboratory of Electrical Machine Systems, China

PS-012 Design of Variable Speed Constant Frequency Small Hydropower System...452

<u>Hongjun Luo</u>, Derong Luo, Litao Dai, Qiang Zhou

Hunan University, China

PS-013 Quantification Index of Voltage Stability Based on Physical Mechanism of Reactive Power Distribution...457

<u>Haoliang Jiang</u>, Hengxu Zhang *Shandong University, China*

PS-014 Research on Correlation Analysis of Power User Behavior Based on Coupled Meteorological Factors...463

<u>Yixiao Li</u>¹, Tianguang Lv¹, Xin Zhao², Jiyan Liu³, Wenjie Ju³, Wanlei Xue²

¹Shandong University, China, ²Economic & Technology Research Institute of State Grid Shandong Electric Power Company, China, ³State Grid Shandong Electric Power Company, China