

ISSN 0258 - 8013
CODEN ZDGXER

中国电机工程学报

第四十二卷 第一期 2022年1月

Proceedings of the CSEE

Vol.42 No.2 January 2022

中国电机工程学报

半月刊

第 42 卷 第 2 期

Proceedings of the CSEE

SEMIMONTHLY

Vol.42 No.2



1月
2022
2022-01-20 出版

ISSN 0258-8013



9 770258 801223



中国电机工程学会主办
THE CHINESE SOCIETY FOR ELECTRICAL ENGINEERING



中国电机工程学报

ZHONGGUO DIANJI GONGCHENG XUEBAO

第 42 卷

第 2 期 (总第 685 期)

2022 年 1 月 20 日

目 次

(论文电子版 <http://www.pcsee.org/CN/column/home.shtml>)

· 面向新型电力系统的电力物联网关键技术 ·

- 面向能源互联网数字孪生的电力物联网关键技术及展望 赵鹏, 蒲天骄, 王新迎, 韩笑 (447)
电力工业安全影像解译: 基本概念与技术框架 马富齐, 王波, 董旭柱, 姚良忠, 王红霞 (458)
基于主动割集的电力信息物理系统饱和防御方法 杨挺, 闫鹏, 蔡绍堂, 侯昱丞 (475)

· 快报与评论 ·

- 电力系统数字孪生的概念、特点及应用展望 沈沉, 曹仟妮, 贾孟硕, 陈颖, 黄少伟 (487)

· 大电网规划与运行 ·

- 电力电子设备接入电压支撑强度量化评估指标综述 于琳, 孙华东, 徐式蕴, 赵兵, 张健, 李宗翰 (499)
能源转型下我国新能源替代的关键问题分析 刘永奇, 陈龙翔, 韩小琪 (515)
考虑风光出力不确定性的电-气互联系统脆弱线路辨识 南璐, 何川, 刘天琪 (524)
基于时序生成对抗网络的月度风光发电功率场景分析方法 李辉, 任洲洋, 胡博, 王强钢, 李文沅 (537)
时变幅频信号下的三相系统动态过程有功及无功功率物理概念理解与数学计算 杨晖, 袁小明 (548)
考虑风-光-光热联合直流外送的源-网-荷多时段优化调度方法 崔杨, 李崇钢, 赵钰婷, 仲悟之, 王茂春, 王铮 (559)

· 智能电网 ·

- 考虑冷热电需求耦合响应特性的园区综合能源系统优化运行策略研究 赵海彭, 苗世洪, 李超, 张迪, 涂青宇 (573)
考虑事故-经济重构共同影响的配电网智能终端规划

- 吕小东, 高红均, 叶圣永, 李海波, 杨睿, 刘俊勇, 孙洪剑 (589)
计及 Crowbar 状态改进识别的双馈风电场等值建模方法 吴志鹏, 曹铭凯, 李银红 (603)
基于农村新型产业结构的“能源-环境-经济”鲁棒优化模型 滕云, 孙鹏, 张明理, 陈哲 (614)
基于区间鲁棒控制的配电信息物理双层设备协调配置方法 刘文霞, 李涵深, 周予昊, 杨梦瑶 (631)

· 发电 ·

- 超临界二氧化碳动力循环中印刷电路板换热器芯体机械应力和热应力耦合分析
..... 吴家荣, 李红智, 杨玉, 张旭伟, 乔永强 (640)
超临界二氧化碳循环关键部件成本模型研究进展 王雪, 孙恩慧, 徐进良, 乔加飞, 王兵兵 (650)
离子风对静电除尘器中颗粒物脱除的影响机制研究 王伊凡, 高文超, 邵凌宇, 伍致承, 李廉明, 郑成航, 高翔 (663)
基于 EKF 在线辨识的多堆燃料电池系统最大效率点跟踪控制方法 李奇, 刘强, 王天宏, 陈维荣 (673)
汽流激振下汽轮机各向异性转子振动特性分析 曹丽华, 颜洪, 司和勇 (684)
磁流变液阻尼器控制下贯流式机组轴系碰摩振动特性分析 张雷克, 唐华林, 王雪妮, 张金剑, 马震岳, 吴嵌嵌 (693)

· 电力电子与电力传动 ·

- 电能路由器中压交流端口多形态的多维解耦控制 文武松, 赵争鸣, 袁立强, 姬世奇, 李凯, 魏树生 (702)
基于傅里叶级数解析热扩散角的功率模块热阻抗物理模型

- 陈宇, 吴强, 周宇, 常垚, 罗皓泽, 李武华, 何湘宁 (715)
碳化硅器件的短路保护: 设计准则和电路 党子越, 彭晗, 彭皓, 康勇 (728)
用于分布式电压调控的 AC-AC 型主动电力弹簧 刘闯, 陈皓楠, 韩子娇, 郭东波, 蔡国伟, 葛延峰, 朱炳达 (737)
一种柔性多模态宽范围全桥 LLC 变换器控制方法 缪哲语, 全昊, 姚文熙, 吕征宇 (747)
电网不平衡工况下高频链矩阵变换器非线性反步控制策略 宋金秋, 段彬, 付程, 丁文龙, 李祥杰, 张承慧 (761)

· 电机与电器 ·

- 变母线电压工况下开绕组 PMSM 单矢量模型预测转矩优化控制
..... 魏佳丹, 徐家扬, 陶文杰, 王艺威, 周波, 周开放 (772)

- 无刷直流电机单相电感检测法无位置传感器控制(英文) 方红伟, 陈奇, 王瑜 (783)
考虑参数不确定的永磁同步电机 MTPA 控制综述 付兴贺, 陈锐, 董婷, 付春雨, 刘光伟 (796)
微小型继电器的刚柔耦合碰撞动力学建模方法与弹跳行为分析 刘兰香, 杨文英, 柴玉阳, 翟国富 (808)
基于 Kriging 模型的双十二相高速永磁发电机优化设计 戴睿, 张岳, 王惠军, 张凤阁, 张何 (818)

· 高电压技术 ·

- ZnO 压敏微球/硅橡胶复合材料介电弛豫特性 何金良, 孙岗, 胡军, 谢竟成, 黄智文, 袁之康 (827)
表层非线性电导盆式绝缘子表面电荷分布与沿面放电特性

- 梁虎成, 王雨帆, 杜伯学, 姜金鹏, 王禹淮, 李进, 李忠华 (835)
基于模态相似性度量的开关电器状态表征研究 刘洋, 刘树鑫, 曹云东 (844)

· 英文概述见论文电子版 ·

期刊基本参数: CN11-2107/TM * 1964 * S * A4 * 406 * zh * P * ¥84.00 * 4000 * 35 * 2022-01 版权所有 未经许可不得转载及上网

**PROCEEDINGS OF THE CHINESE SOCIETY FOR
ELECTRICAL ENGINEERING**
(PROCEEDINGS OF THE CSEE)

Vol.42 No.2 (Ser. 685)

Jan. 20, 2022

CONTENTS

(Electronic Journals <http://www.pcsee.org/EN/column/current.shtml>)

• Key Technologies of Power Internet of Things for the New Power System •

- Key Technologies and Perspectives of Power Internet of Things Facing With Digital Twins of the Energy Internet ZHAO Peng, PU Tianjiao, WANG Xinying, HAN Xiao (447)
Safety Image Interpretation of Power Industry: Basic Concepts and Technical Framework MA Fuqi, WANG Bo, DONG Xuzhu, YAO Liangzhong, WANG Hongxia (458)
Research on Saturation Defense Method of Power Cyber-physical System Based on Active Cut Set YANG Ting, YAN Peng, CAI Shaotang, HOU Yucheng (475)

• Letters and Reviews •

- Concepts, Characteristics and Prospects of Application of Digital Twin in Power System SHEN Chen, CAO Qianni, JIA Mengshuo, CHEN Ying, HUANG Shaowei (487)

• Large Power Grid Planning and Operation •

- Overview of Strength Quantification Indexes of Power System With Power Electronic Equipment YU Lin, SUN Huadong, XU Shiyun, ZHAO Bing, ZHANG Jian, LI Zonghan (499)
The Key Problem Analysis on the Alternative New Energy Under the Energy Transition ... LIU Yongqi, CHEN Longxiang, HAN Xiaoqi (515)
Vulnerable Lines Identification of Integrated Electricity and Natural Gas Systems Considering Wind and Photovoltaic Generation Uncertainties NAN Lu, HE Chuan, LIU Tianqi (524)
A Sequential Generative Adversarial Network Based Monthly Scenario Analysis Method for Wind and Photovoltaic Power LI Hui, REN Zhouyang, HU Bo, WANG Qianggang, LI Wenyuan (537)
Physical Concept Understanding and Mathematical Calculation of Active/Reactive Power in Dynamic Process of Three-phase System Under Time-varying Amplitude-frequency Signals YANG Hui, YUAN Xiaoming (548)
Source-grid-load Multi-time Interval Optimization Scheduling Method Considering Wind-photovoltaic-photothermal Combined DC Transmission CUI Yang, LI Chonggang, ZHAO Yuting, ZHONG Wuzhi, WANG Maochun, WANG Zheng (559)

• Smart Grid •

- Research on Optimal Operation Strategy for Park-level Integrated Energy System Considering Cold-heat-electric Demand Coupling Response Characteristics ZHAO Haipeng, MIAO Shihong, LI Chao, ZHANG Di, TU Qingyu (573)
Intelligent Terminal Planning Strategy Considering Reliability and Economy Reconfiguration for Distribution Network LYU Xiaodong, GAO Hongjun, YE Shengyong, LI Haibo, YANG Rui, LIU Junyong, SUN Hongjian (589)
An Equivalent Modeling Method of DFIG-based Wind Farm Considering Improved Identification of Crowbar Status WU Zhipeng, CAO Mingkai, LI Yinhong (603)
Robust Optimization Model of “Energy-environment-economy” Based on the New Rural Industrial Structure TENG Yun, SUN Peng, ZHANG Mingli, CHEN Zhe (614)
Coordinated Configuration Method of Cyber and Physical Equipment in Distribution Networks Based on Interval Robust Control LIU Wenxia, LI Hanshen, ZHOU Yuhao, YANG Mengyao (631)

• Power Generation •

- Coupling Analysis of Mechanical Stress and Thermal Stress of Printed Circuit Heat Exchanger Core in Supercritical Carbon Dioxide Power Cycle WU Jiarong, LI Hongzhi, YANG Yu, ZHANG Xuwei, QIAO Yongqiang (640)
Cost Models of Key Components of Supercritical Carbon Dioxide Cycle: Research Progress WANG Xue, SUN Enhui, XU Jinliang, QIAO Jiafei, WANG Bingbing (650)
Effects of Ionic Wind on Particle Removal in an Electrostatic Precipitator WANG Yifan, GAO Wencho, SHAO Lingyu, WU Zhicheng, LI Lianming, ZHENG Chengchang, GAO Xiang (663)
Maximum Efficiency Point Tracking Control Method of Multi-stack Fuel Cell System Based on EKF Online Identification LI Qi, LIU Qiang, WANG Tianhong, CHEN Weirong (673)
Vibration Characteristics Analysis of Steam Turbine Anisotropic Rotor Under Steam Flow Excited Vibration CAO Lihua, YAN Hong, SI Heyong (684)

- Analysis of Rub-impact Vibration Characteristics of Tubular Hydro-generator Set Shaft System Controlled by Magneto-rheological Fluid Damper ZHANG Leike, TANG Hualin, WANG Xueni, ZHANG Jinjian, MA Zhenyue, WU Qianqian (693)

• Power Electronics and Drives •

- Decoupling Control Strategy for Multi-function-form Realization of Medium-voltage AC Port of Electric Energy Router WEN Wusong, ZHAO Zhengming, YUAN Liqiang, JI Shiqi, LI Kai, WEI Shusheng (702)
Physics-based Thermal Impedance Model for Power Module by Analytic Fourier Series Based Heat Spreading Angle CHEN Yu, WU Qiang, ZHOU Yu, CHANG Yao, LUO Haoze, LI Wuhua, HE Xiangning (715)
SiC MOSFET Short Circuit Protection: Design Principles and Circuit DANG Ziyue, PENG Han, PENG Hao, KANG Yong (728)
AC-AC Based Active Electric Spring (AC-AES) for Distributed Voltage Regulation LIU Chuang, CHEN Haonan, HAN Zijiao, GUO Dongbo, CAI Guowei, GE Yanfeng, ZHU Bingda (737)
A Flexible Variable-mode Control Method for Wide-range Full-bridge LLC Converter MIAO Zheyu, TONG Hao, YAO Wenxi, LYU Zhengyu (747)
Nonlinear Backstepping Control Strategy for High-frequency Link Matrix Converter Under Unbalanced Grid Conditions SONG Jinqiu, DUAN Bin, FU Cheng, DING Wenlong, LI Xiangjie, ZHANG Chenghui (761)

• Electric Machines and Apparatus •

- Optimization Method of Single Vector Model Predictive Torque Control for Open-winding PMSM in Variable DC Bus Voltage Condition WEI Jiadan, XU Jiayang, TAO Wenjie, WANG Yiwei, ZHOU Bo, ZHOU Kaifang (772)
Sensorless Control of Brushless DC Motor With Single-phase Inductance Detection FANG Hongwei, CHEN Qi, WANG Yu (783)
Review of MTPA Control of Permanent Magnet Synchronous Motor Considering Parameter Uncertainties FU Xinghe, CHEN Rui, DONG Ting, FU Chunyu, LIU Guangwei (796)
Modeling Method of Rigid-Flexible Coupling Impact Dynamics and Analysis of Bounce Behavior of the Micro-Relay LIU Lanxiang, YANG Wenying, CHAI Yuyang, ZHAI Guofu (808)
Optimal Design of Dual 12-phase High Speed Permanent Magnet Rectified Generator Based on Kriging Model DAI Rui, ZHANG Yue, WANG Huijun, ZHANG Fengge, ZHANG He (818)

• High Voltage Engineering •

- Dielectric Relaxation Characteristics of ZnO Microvaristor/silicone Rubber Composite HE Jinliang, SUN Gang, HU Jun, XIE Jingcheng, HUANG Zhiwen, YUAN Zhikang (827)
Surface Charge Distribution and Discharge Behaviors of Basin Spacer With Surface Nonlinear Conductivity LIANG Hucheng, WANG Yufan, DU Boxue, JIANG Jinpeng, WANG Yuhuai, LI Jin, LI Zhonghua (835)
Research on State Characterization of Switching Device Based on Modal Similarity Measurement LIU Yang, LIU Shuxin, CAO Yundong (844)

• For Extended Summaries, Please See the Electronic Journals •