

# JOURNAL OF POWER ELECTRONICS

A PUBLICATION OF THE KOREAN INSTITUTE OF POWER ELECTRONICS

January 2019

Vol. 19, No. 1

pISSN 1598-2092

eISSN 2093-4718

## *Low Power Converters*

• Novel Single-inductor Multistring-independent Dimming LED Driver with Switched-capacitor Control Technique .....	Guozhuang Liang and Hanlei Tian	1
• New ZVZCT Bidirectional DC-DC Converter Using Coupled Inductors .....	Wei Qian, Xi Zhang, Zhe Li, Wenqiang Jin, and Jochen Wiedemann	11
• Analysis and Modeling of AC-AC Switched Capacitor Converters .....	Hui Cai, Liting Bao, Qian Guo, Ying Wang, and Weimin Chen	24
• Input Voltage Range Extension Method for Half-Bridge LLC Converters by Using Magamp Auxiliary Post-Regulator .....	Xiaoguang Jin, Huipin Lin, Jun Xu, and Zhengyu Lu	34
• Design of LLCL Filter for Single Phase Inverters with Confined Band Variable Switching Frequency (CB-VSF) PWM .....	Hussain A. Attia, Tan Kheng Suan Freddy, Hang Seng Che, and Ahmad H. El Khateb	44
• Multi-Output LED Driver Integrated with 3-Switch Converter and Passive Current Balance for Portable Applications .....	Sen Song, Kai Ni, Guipeng Chen, Yihua Hu, and Dongsheng Yu	58

## *High Power Converters*

• Self-Feeder Driver for Voltage Balance in Series-Connected IGBT Associations .....	A. F. Guerrero-Guerrero, A. J. Ustariz-Farfan, H. E. Tacca, and E. A. Cano-Plata	68
• Neutral-point Voltage Balancing Strategy for Three-level Converter based on Disassembly of Zero Level .....	Chenchen Wang, Zhitong Li, and Hongliang Xin	79
• Unbalance Control Strategy of Boost Type Three-Phase to Single-Phase Matrix Converters Based on Lyapunov Function .....	Yu-xiang Xu, Hong-juan Ge, and Hai Guo	89
• DC-Link Capacitor Voltage Balanced Modulation Strategy Based on Three-Level Neutral-Point-Clamped Cascaded Rectifiers .....	Pengcheng Han, Xiaoqiong He, Zhiqin Zhao, Haolun Yu, Yi Wang, Xu Peng, and Zeliang Shu	99
• DC-Link Voltage Balance Control Using Fourth-Phase for 3-Phase 3-Level NPC PWM Converters with Common-Mode Voltage Reduction Technique .....	Jun-Hyung Jung, Jung-Hoon Park, Jang-Mok Kim, and Yung-Deug Son	108
• Optimal Two Degrees-of-Freedom Based Neutral Point Potential Control for Three-Level Neutral Point Clamped Converters .....	Bo Guan and Shinji Doki	119
• Single-Phase Step-Up Five-Level Inverter with Phase-Shifted Pulse Width Modulation .....	Jianfei Chen, Caisheng Wang, and Jian Li	134

## *Adjustable Speed Drives*

• Hybrid PWM Modulation Technology Applied to Three-Level Topology-Based PMSMs .....	Yuanxi Chen, Xinhua Guo, Jiangyu Xue, and Yifeng Chen	146
• Comparative Study of Flux Regulation Methods for Hybrid Permanent Magnet Axial Field Flux-switching Memory Machines .....	Gongde Yang, Xinghe Fu, Mingyao Lin, Nian Li, and Hao Li	158
• Double-Objective Finite Control Set Model-Free Predictive Control with DSVM for PMSM Drives .....	Beishi Zhao, Hongmei Li, and Jingkui Mao	168

(Contents Continued on Next Page)



THE KOREAN INSTITUTE OF POWER ELECTRONICS

### ***Analysis, Modeling and Control***

---

- Predictive Current Control of Four-Quadrant Converters Based on Specific Sampling Method and Modified Z-Transform ..... Gang Zhang, Jianglin Qian, Zhigang Liu, and Zhongbei Tian 179
- Sampled-Data Modeling and Dynamic Behavior Analysis of Peak Current-Mode Controlled Flyback Converter with Ramp Compensation ..... Shuhan Zhou, Guohua Zhou, Shaohuan Zeng, Shungang Xu, and Taiqiang Cao 190
- Multimode Hybrid Control Strategy of LLC Resonant Converter in Applications with Wide Input Voltage Range ..... Yan Li, Kun Zhang, and Shuaifei Yang 201
- Three-coil Magnetically Coupled Resonant Wireless Power Transfer System with Adjustable-position Intermediate Coil for Stable Transmission Characteristics ..... Xuling Chen, Lu Chen, Weiwei Ye, and Weipeng Zhang 211

### ***Renewable Energy***

---

- Design and Analysis of Universal Power Converter for Hybrid Solar and Thermoelectric Generators ..... Sathiyathan M., Jaganathan S., and Josephine R. L. 220

### ***Power Quality and Utility Applications***

---

- Unbalanced Power Sharing for Islanded Droop-Controlled Microgrids ..... Yaoqin Jia, Daoyang Li, and Zhen Chen 234
- Fast FCS-MPC-Based SVPWM Method to Reduce Switching States of Multilevel Cascaded H-Bridge STATCOMs ..... Xiuqin Wang, Jiwen Zhao, Qunjing Wang, Guoli Li, and Maosong Zhang 244
- Seamless Mode Transfer of Utility Interactive Inverters Based on Indirect Current Control ..... Kyungbae Lim, Injong Song, Jaeho Choi, Hyeong-Jun Yoo, and Hak-Man Kim 254
- Direct Harmonic Voltage Control Strategy of Shunt Active Power Filters Suitable for Microgrid Applications ..... Hafiz Mudassir Munir, Jianxiao Zou, Chuan Xie, Kay Li, Talha Younas, and Josep M. Guerrero 265
- EMI Prediction and Reduction of Zero-Crossing Noise in Totem-Pole Bridgeless PFC Converters ..... Baihua Zhang, Qiang Lin, Jun Imaoka, Masahito Shoyama, Satoshi Tomioka, and Eiji Takegami 278
- Novel Average Value Model for Faulty Three-Phase Diode Rectifier Bridges ..... Mehdi Rahnama, Abolfazl Vahedi, Arta Mohammad Alikhani, Babak Nahid-Mobarakeh, and Nouredine Takorabet 288

### ***Devices and Components***

---

- Balance Winding Scheme to Reduce Common-Mode Noise in Flyback Transformers ..... Kaining Fu and Wei Chen 296
- Ringing Frequency Extraction Method Based on EMD and FFT for Health Monitoring of Power Transistors ..... Lei Ren and Chunying Gong 307

### ***Other Applications***

---

- Key Technologies of Supercapacitor Energy Storage System of IP Transmitter ..... Zhihui Zeng, Xiaowei Wang, Yanfang Wei, Zhiguo Hu, Yangxiao Yu, and Zhigang Zhang 316

# Journal of Power Electronics (JPE)

## Editor-in-Chief

**Jung-Ik Ha**  
Seoul National University, Korea  
E-mail: jungikha@snu.ac.kr

## Publication Editors

**Kyo-Beum Lee**  
Ajou University, Korea  
E-mail: kyl@ajou.ac.kr

**Sung-Jin Choi**  
University of Ulsan, Korea  
E-mail: sjchoi@ulsan.ac.kr

## Editor Board

**Subhashish Bhattacharya**  
North Carolina State University

**Frede Blaabjerg**  
Aalborg University

**Dushan Boroyevich**  
Virginia Polytechnic Inst. and State Univ.

**Liuchen Chang**  
University of New Brunswick

**Po-Tai Cheng**  
National Tsing Hua University

**Bo-Hyung Cho**  
Seoul National University

**Jaeho Choi**  
Chungbuk National University

**Ilhami Colak**  
Nisantasi University

**Braham Ferreira**  
Delft University of Technology

**Dong-Seok Hyun**  
Hanyang University

**Atsuo Kawamura**  
Yokohama National University

**Marian P. Kazmierkowski**  
Warsaw University of Tech.

**Ralph Kennel**  
Technical University of Munchen

**Johan W. Kolar**  
Swiss Federal Institute of Tech.

**Fujio Kurokawa**  
Nagasaki Institute of Applied Science

**Dong-Choon Lee**  
Yeungnam University

**Tsorig-Juu Liang**  
National Cheng-Kung University

**Jinjun Liu**  
Xi'an Jiaotong University

**Sanjib Kumar Panda**  
National University of Singapore

**Fang Z. Peng**  
Michigan State University

**John Shen**  
Illinois Institute of Technology

**Toshihisa Shimizu**  
Tokyo Metropolitan University

**Seung-Ki Sul**  
Seoul National University

**Jian Sun**  
Rensselaer Polytechnic Institute

**Pat Wheeler**  
University of Nottingham

**Dehong Xu**  
Zhejiang University

## Associate Editors

**Dukju Ahn**  
Incheon National University

**Seon-Ju Ahn**  
Chonnam National University

**Dianov Anton**  
Samsung Electronics

**Jong-Bok Baek**  
Korea Inst. of Energy Research

**Honnyong Cha**  
Kyungpook National University

**Wu Chen**  
Southeast University

**Chun-An Cheng**  
I-Shou University

**Younghoon Cho**  
Konkuk University

**Pooya Davari**  
Aalborg University

**Xiaoqiang Guo**  
Yanshan University

**Seon-Hwan Hwang**  
Kyungnam University

**Jee-Hoon Jung**  
UNIST

**Byungtaek Kim**  
Kunsan National University

**Jaehong Kim**  
Chosun University

**Jonghoon Kim**  
Chungnam National University

**Sungmin Kim**  
Hanyang University

**Sangshin Kwak**  
Chung-Ang University

**Byoung-Hee Lee**  
Hanbat National University

**Dong-Hee Lee**  
Kyungsung University

**Jaе-Beum Lee**  
Korea Railroad Research Inst.

**June-Seok Lee**  
Korea Railroad Research Inst.

**Kwang-Woon Lee**  
Mokpo Nat'l Maritime University

**Seongjun Lee**  
Chosun University

**Wook-Jin Lee**  
Chungnam National University

**Fuxin Liu**  
Nanjing Univ. of Aeron. and Astron.

**Hao Ma**  
Zhejiang University

**Saad Mekhilef**  
University of Malaya

**Minh-Khai Nguyen**  
Chosun University

**Jeong-Hu Park**  
Soongsil University

**N. Prabaharan**  
SASTRA Deemed University

**P. Sanjeevikumar**  
Aalborg University

**Jongwon Shin**  
Chung-Ang University

**Kai Sun**  
Tsinghua University

**Mahinda Vilathgamuwa**  
Queensland University of Technology

**Gaolin Wang**  
Harbin Institute of Technology

**Yijie Wang**  
Harbin Institute of Technology

**Zheng Wang**  
Southeast University

**Huiqing Wen**  
Xi'an Jiaotong-Liverpool Univ.

**Hongfei Wu**  
Nanjing Univ. of Aeron. and Astron.

**Xuerong Ye**  
Harbin Institute of Technology

**Zhonggang Yin**  
Xi'an University of Technology

**Sang-Won Yoon**  
Hanyang University

**Yong-Doo Yoon**  
Younggi University

**Liqiang Yuan**  
Tsinghua University

**Guoqiang Zhang**  
Harbin Institute of Technology

**Li Zhang**  
Hohai University

**Yun Zhang**  
Tianjin University

Managing Editor – Sejin Jung / Secretary

## The Korean Institute of Power Electronics (KIPE) Executive Board Officers (2019)

**Dong-Choon Lee, President**  
Yeungnam University

**Jung-Goo Cho, Vice President**  
Green Power Co., Ltd.

**Hanju Cha, Secretary**  
Chungnam National University

**Seung-Ho Song, Editor**  
Kwangwoon University

**Jong-Soo Kim, Technical Activities**  
Daejin University

**Chan-Ki Kim, Industrial Activities**  
KEPCO R&D Institute

**Honnyong Cha, International Activities**  
Kyungpook National University

**Jin-Woo Lee, Vice President**  
Doowon Technical College

**Jung-Ik Ha, Vice President**  
Seoul National University

**Woo-Jin Choi, Treasurer**  
Soongsil University

**Kyo-Beum Lee, Editor**  
Ajou University

**Byoung Kuk Lee, Researching Activities**  
Sungkyunkwan University

**Jin Hur, Planning Activities**  
Incheon National University

**Rae-Young Kim, International Activities**  
Hanyang University

**Taeck-Kie Lee, Vice President**  
Hankyong National University

**Se-Wan Choi, Auditor**  
Seoul Nat'l Univ. of Science & Tech.

**Dong-Hee Lee, Treasurer**  
Kyungsung University

**Sung-Jin Choi, Editor**  
University of Ulsan

**In-Soung Jung, Researching Activities**  
Korea Electronics Technology Inst.

**Seong-Mi Park, Planning Activities**  
Korea Lift College

**Jun-Keun Ji, Vice President**  
Soonchunhyang University

**Cheol-Won Lee, Auditor**  
CORE Electric Co., Ltd.

**Se-Kyo Chung, Editor**  
Gyeongsang National University

**Hag-Wone Kim, Technical Activities**  
Korea Nat'l Univ. of Transportation

**Shin-Hyeong Choi, Industrial Activities**  
Kangwon National University

**Jee-Hoon Jung, Planning Activities**  
UNIST

**Jun-Koo Kang, Vice President**  
LG Electronics

**Eun-Soo Kim, Secretary**  
Jeonju University

**Dong-Myung Lee, Editor**  
Hongik University

**Hong-Je Ryoo, Technical Activities**  
Chung-Ang University

**Ju-Won Baek, Industrial Activities**  
Korea Electrotechnology Research Inst.

**Yong-Sug Suh, International Activities**  
Chonbuk National University

**About the journal:** The official title of the journal is *Journal of Power Electronics* (pISSN 1598-2092; eISSN 2093-4718), and the ISO abbreviation of the journal title is 'J. Power Electron.' The first issue of *JPE* was in April 2001. *JPE* is published bimonthly, appearing on the 20<sup>th</sup> day of January, March, May, July, September, November each year. Hard copies of *JPE* are distributed to 51 associations related with the field of power electronics.

**Aims and Scope:** Its scope includes all topics in the field of Power Electronics. Included are techniques for high power converters, power quality and utility applications, renewable energy, low power converters, control in power electronics, motor drives, electric machines, analysis, simulation and control, power devices and components, sensors, integration and packaging, education, and other applications.

**Full Text Availability:** Full text is freely available at the following URL – <http://www.jpels.org>. Search articles by year, category, title, author, abstract, and keyword.

**Index/Abstracted in:** Science Citation Index Expanded (SCI E), Journal Citation Reports/Science Edition, Korea Citation Index, Scopus

**Fund Support:** This journal was supported by the Korean Federation of Science and Technology Societies Grant funded by the Korean Government (Ministry of Education).

**Hard Copy Subscription:** The subscription period and rate are renewed on a yearly basis. If you are in the middle of a year, you can choose the starting point either from this year or from next year. Annual Hard Copy Subscription Rates (USD) – Individual: \$ 100.00; Business/Library: \$ 300.00. For more information on subscriptions, please visit the *JPE* website: <http://www.jpels.org>

**Publisher:** The Korean Institute of Power Electronics (KIPE)

## Contact Information

The Korean Institute of Power Electronics

Rm. #1103, The Korean Science & Technology Bldg. (New Bldg.), 22, Teheran-ro 7gil, Gangnam-gu, Seoul 06130, Republic of Korea  
Tel: +82-2-554-0184, 0185; Fax: +82-2-554-0186; E-mail: [editor@kipe.or.kr](mailto:editor@kipe.or.kr); Website: <http://www.jpels.org>

© 2019. The Korean Institute of Power Electronics. All rights reserved. Responsibility for the contents rests upon the authors and not upon the KIPE.

# INSTRUCTIONS TO AUTHORS

Manuscripts submitted for the consideration should report the results of an original work. Also, survey papers from the field experts will be considered for the review.

## Details on the "original works"

Papers that have been previously published or submitted to other journals, conferences, or books in any language will not be considered for the *JPE* publication. However, the extended version of the paper presented at the conference, workshop, or symposium can be submitted to *JPE* for the consideration no later than 18 months from the presentation. After the due date, the submission will be invalid. In order to qualify for the review, the extended version of the paper should include significant improvements. The title and abstract of the paper should be different and at least 30% of the contents (introduction, main body, conclusion and references) should be modified with new ideas and improvements. If a significant overlap (e.g. higher than 30% in terms of text) between the original conference paper and the submitted manuscript is found through the plagiarism detection software, the manuscript will be returned or rejected immediately. Authors should clearly indicate at which conference, workshop or symposium the manuscript has been presented for the initial submission. Also, the original conference paper should be uploaded at the initial submission. The conference paper should be cited in the manuscript and be added in the reference list. Also in cover letter, mention as to which contents in the manuscript have been improved from the original conference paper. Any violation of the rules mentioned above may cause an infringement of the copyright as well as a self-plagiarism. Every co-authors bear the full responsibility for any legal issues.

## Plagiarism Policy

All the original conference papers and dissertations should be referred in manuscript. All the manuscripts for review should meet following requirements. Otherwise, the editorial committee refuses to review the manuscript or rejects to publish it.

1. Identify the original text body and form a reference mark. Even if a reference is made, the contents of the comparison/evaluation should be added.
2. The drawing, table or formula should be drawn or expanded as freshly as possible. If the original ones are imported, the author should resolve the license problem and reveal the courtesy copy
  - A. Imported ones from the graduation thesis must be licensed by university publisher and/or the copyright holder.
  - B. In case of articles, they must be licensed by the publisher.
3. Do not copy the original text body as it is.
4. Add new content as much as possible.

## Submission Guidelines for the *JPE*

These guidelines are specified by the *JPE* Editor-in-Chief. All authors are responsible for understanding these guidelines before submitting manuscripts to the *JPE*.

## Guidelines for Submitting a Manuscript for Review

Authors must submit manuscripts electronically to the *JPE* on-line review system at <http://manuscript.jpels.org>. All manuscripts must be in an electronic format (only '.pdf' files) and less than 10Mb. Please note that first-time users of the *JPE* system have to create an account and follow the submission instructions. Names of the authors and their affiliations must remain anonymous in the submitted manuscripts to make the evaluation process as fair as possible. However, when submitting a manuscript, the corresponding author's information must be entered into the submission form on the *JPE* author's page at the *JPE* website. It is the author's responsibility to ensure that the submitted files are fully viewable and in the intended format. Before making a submission, please confirm the style and format of your manuscript accordingly.

## Style of a Manuscript for Review

- Size of manuscript: 21cm x 27.8cm
- Formatted double columns with a single spaced 9.5pt fonts.
- Include all figures, tables and captions in the text and confirm their size and legibility.
- If a table or figure is too large for a single column, make it span the width of the entire page.
- Include the manuscript title, keywords and an abstract of not more

than 200 words on the first page.

- Do not include articles (a, an, the) and some adjectives such as new, novel, enhanced, improved in the title. They are allowed to be used only in exceptional cases.
- Capitalize the first letter of each word in the title except prepositions, articles and conjunctions.
- Indicate reference numbers in square brackets (e.g. [1], [2], and [3]) and give the reference details at the end of the paper.
- Please do not include authors' names, footnotes, photos, acknowledgements, biographies or any other information which could identify authors in the manuscript.

For a more detailed formatting guideline, you can download a template file for review at [http://jpels.org/submission/info\\_authors.asp](http://jpels.org/submission/info_authors.asp).

## Forms of Publication

*JPE* accepts original papers of research articles, invited papers.

- Original Paper: Original research articles on the wide areas of power electronics and its applications.
- Invited Paper: Articles which are invited to submit from the Editorial Committee of *JPE*.

## SI Unit

Please refer to the 'SI Unit' list in *JPE* website: <http://www.jpels.org>

## Peer Review

The KIPE employs a web-based manuscript submission portal for the peer-review. All manuscripts are treated as confidential. Each manuscript is peer-reviewed by at least two anonymous reviewers who are specialized in the field of power electronics. *JPE* reviewers are selected by the *JPE* Editorial Board depending on their career and contributions in the field of power electronics.

## Code of Ethics for Research

Prior to submitting your manuscript, please ensure that you carefully read the Code of Ethics for Research of the Korean Institute of Power Electronics. The Code of Ethics for Research is available from - [http://jpels.org/submission/info\\_authors.asp](http://jpels.org/submission/info_authors.asp)

## Guidelines for Submitting a Final Manuscript for Publication

Once a manuscript has been accepted for the publication, the authors will be notified by the *JPE* Editorial board. At that point, a special format will be required for the publication. Your final manuscript for the publication must contain author biographies and photos and be saved in MS-Word ('.doc' file) which is less than 10Mb. Before submitting your final manuscript, please check the template file at [http://jpels.org/submission/info\\_authors.asp](http://jpels.org/submission/info_authors.asp) and format your manuscript accordingly. Submit your final manuscript to the *JPE* on-line review system with your author's ID and also send it to the *JPE* Editor by e-mail at [editor@kipe.or.kr](mailto:editor@kipe.or.kr). A signed copyright agreement form is also required before publication.

## Copyright Policy

It is KIPE policy to obtain the copyright for all KIPE published technical contributions. To comply with this policy, authors are required to sign a KIPE copyright agreement form before publication. This form is provided upon approval of a manuscript. Authors should submit a signed copy of the copyright form along with their final manuscript. The KIPE copyright agreement form can be downloaded at [http://jpels.org/submission/copyright%20agreement/Copyright\\_Agreement.doc](http://jpels.org/submission/copyright%20agreement/Copyright_Agreement.doc) and submitted to the *JPE* on-line review system at <http://manuscript.jpels.org>.

## Page Charges

After the final manuscript has been submitted, the *JPE* editor will estimate the length of the paper. The authors will be notified in advance of page charges. Page charges will be billed at \$30 per page. Authors must commit to paying page charges before the publication.

## Contact Information

*Journal of Power Electronics*

### The Korean Institute of Power Electronics

Rm. #1103, The Korean Science & Technology Bldg. (New Bldg.)  
22, Teheran-ro 7gil, Gangnam-gu, Seoul 06130, Republic of Korea  
Tel: +82-2-554-0184, 0185; Fax: +82-2-554-0186  
E-mail: [editor@kipe.or.kr](mailto:editor@kipe.or.kr); Website: <http://www.jpels.org>

## **INDEXED/ABSTRACTED IN**

.....  
**Science Citation Index Expanded (SCIE)**  
**Journal Citation Reports/Science Edition**  
**Korea Citation Index**  
**Scopus**



**THE KOREAN INSTITUTE OF POWER ELECTRONICS**

**<http://www.jpels.org>**

## **Journal of Power Electronics**

A Publication of the Korean Institute of Power Electronics  
Rm. #1103, The Korean Science & Technology Bldg. (New Bldg.)  
22, Teheran-ro 7gil, Gangnam-gu, Seoul 06130, Republic of Korea  
Phone : +82-2-554-0184, 0185; Fax: +82-2-554-0186  
E-mail : [editor@kipe.or.kr](mailto:editor@kipe.or.kr)

## Table of Contents

**Journal of Power Electronics Vol. 19, No. 1 January 2019**

### Low Power Converters

---

Novel Single-inductor Multistring-independent Dimming LED Driver with Switched-capacitor Control Technique .....	Guozhuang Liang and Hanlei Tian	1
New ZVZCT Bidirectional DC-DC Converter Using Coupled Inductors .....	Wei Qian, Xi Zhang, Zhe Li, Wenqiang Jin, and Jochen Wiedemann	11
Analysis and Modeling of AC-AC Switched Capacitor Converters .....	Hui Cai, Liting Bao, Qian Guo, Ying Wang, and Weimin Chen	24
Input Voltage Range Extension Method for Half-Bridge LLC Converters by Using Magamp Auxiliary Post-Regulator .....	Xiaoguang Jin, Huipin Lin, Jun Xu, and Zhengyu Lu	34
Design of LLCL Filter for Single Phase Inverters with Confined Band Variable Switching Frequency (CB-VSF) PWM .....	Hussain A. Attia, Tan Kheng Suan Freddy, Hang Seng Che, and Ahmad H. El Khateb	44
Multi-Output LED Driver Integrated with 3-Switch Converter and Passive Current Balance for Portable Applications .....	Sen Song, Kai Ni, Guipeng Chen, Yihua Hu, and Dongsheng Yu	58

### High Power Converters

---

Self-Feeder Driver for Voltage Balance in Series-Connected IGBT Associations .....	A. F. Guerrero-Guerrero, A. J. Ustariz-Farfan, H. E. Tacca, and E. A. Cano-Plata	68
Neutral-point Voltage Balancing Strategy for Three-level Converter based on Disassembly of Zero Level .....	Chenchen Wang, Zhitong Li, and Hongliang Xin	79
Unbalance Control Strategy of Boost Type Three-Phase to Single-Phase Matrix Converters Based on Lyapunov Function .....	Yu-xiang Xu, Hong-juan Ge, and Hai Guo	89
DC-Link Capacitor Voltage Balanced Modulation Strategy Based on Three-Level Neutral-Point-Clamped Cascaded Rectifiers .....	Pengcheng Han, Xiaoqiong He, Zhiqin Zhao, Haolun Yu, Yi Wang, Xu Peng, and Zeliang Shu	99
DC-Link Voltage Balance Control Using Fourth-Phase for 3-Phase 3-Level NPC PWM Converters with Common-Mode Voltage Reduction Technique .....	Jun-Hyung Jung, Jung-Hoon Park, Jang-Mok Kim, and Yung-Deug Son	108
Optimal Two Degrees-of-Freedom Based Neutral Point Potential Control for Three-Level Neutral Point Clamped Converters .....	Bo Guan and Shinji Doki	119
Single-Phase Step-Up Five-Level Inverter with Phase-Shifted Pulse Width Modulation .....	Jianfei Chen, Caisheng Wang, and Jian Li	134

### Adjustable Speed Drives

---

Hybrid PWM Modulation Technology Applied to Three-Level Topology-Based PMSMs .....	Yuanxi Chen, Xinhua Guo, Jiangyu Xue, and Yifeng Chen	146
Comparative Study of Flux Regulation Methods for Hybrid Permanent Magnet Axial Field Flux-switching Memory Machines .....	Gongde Yang, Xinghe Fu, Mingyao Lin, Nian Li, and Hao Li	158
Double-Objective Finite Control Set Model-Free Predictive Control with DSVM for PMSM Drives		

***Analysis, Modeling and Control***

---

Predictive Current Control of Four-Quadrant Converters Based on Specific Sampling Method and Modified Z-Transform  
 ..... Gang Zhang, Jianglin Qian, Zhigang Liu, and Zhongbei Tian 179

Sampled-Data Modeling and Dynamic Behavior Analysis of Peak Current-Mode Controlled Flyback Converter with Ramp Compensation ..... Shuhan Zhou, Guohua Zhou, Shaohuan Zeng, Shungang Xu, and Taiqiang Cao 190

Multimode Hybrid Control Strategy of LLC Resonant Converter in Applications with Wide Input Voltage Range  
 ..... Yan Li, Kun Zhang, and Shuaifei Yang 201

Three-coil Magnetically Coupled Resonant Wireless Power Transfer System with Adjustable-position Intermediate Coil for Stable Transmission Characteristics ..... Xuling Chen, Lu Chen, Weiwei Ye, and Weipeng Zhang 211

***Renewable Energy***

---

Design and Analysis of Universal Power Converter for Hybrid Solar and Thermoelectric Generators  
 ..... Sathiyathan M., Jaganathan S., and Josephine R. L. 220

***Power Quality and Utility Applications***

---

Unbalanced Power Sharing for Islanded Droop-Controlled Microgrids  
 ..... Yaoqin Jia, Daoyang Li, and Zhen Chen 234

Fast FCS-MPC-Based SVPWM Method to Reduce Switching States of Multilevel Cascaded H-Bridge STATCOMs  
 ..... Xiuqin Wang, Jiwen Zhao, Qunjing Wang, Guoli Li, and Maosong Zhang 244

Seamless Mode Transfer of Utility Interactive Inverters Based on Indirect Current Control  
 ..... Kyungbae Lim, Injong Song, Jaeho Choi, Hyeong-Jun Yoo, and Hak-Man Kim 254

Direct Harmonic Voltage Control Strategy of Shunt Active Power Filters Suitable for Microgrid Applications  
 ..... Hafiz Mudassir Munir, Jianxiao Zou, Chuan Xie, Kay Li, Talha Younas, and Josep M. Guerrero 265

EMI Prediction and Reduction of Zero-Crossing Noise in Totem-Pole Bridgeless PFC Converters  
 ..... Baihua Zhang, Qiang Lin, Jun Imaoka, Masahito Shoyama, Satoshi Tomioka, and Eiji Takegami 278

Novel Average Value Model for Faulty Three-Phase Diode Rectifier Bridges  
 ..... Mehdi Rahnama, Abolfazl Vahedi, Arta Mohammad Alikhani, Babak Nahid-Mobarakeh, and Nouredine Takorabet 288

***Devices and Components***

---

Balance Winding Scheme to Reduce Common-Mode Noise in Flyback Transformers  
 ..... Kaining Fu and Wei Chen 296

Ringing Frequency Extraction Method Based on EMD and FFT for Health Monitoring of Power Transistors  
 ..... Lei Ren and Chunying Gong 307

***Other Applications***

---

Key Technologies of Supercapacitor Energy Storage System of IP Transmitter  
 ..... Zhihui Zeng, Xiaowei Wang, Yanfang Wei, Zhiguo Hu, Yangxiao Yu, and Zhigang Zhang 316