

Power Quality Enhancement using Custom Power Devices

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Abstract— A Power quality problem is an occurrence manifested as a nonstandard voltage, current or frequency that results in a failure or mis-operation of end use Equipments. Utility distribution networks, sensitive industrial loads, and critical commercial operations all suffer from various types of outages and service interruptions which can cost significant financial loss per incident based on process down-time, lost production, idle work forces, and other factors. With the restructuring of Power Systems and with shifting trend towards distributed and dispersed Generation, the issue of Power Quality is going to take newer dimensions. The aim therefore, in this work, is to identify the prominent concerns in the area and thereby to recommend measures that can enhance the quality of the power, keeping in mind their economic viability and technical repercussions. In this paper three custom power controllers: DVR, DSTATCOM (modelled in MATLAB/Simulink), PWM Switched Autotransformer (modelled in PSCAD/EMTDC & MATLAB/SIMULINK) are presented. Comprehensive results are presented to assess the performance of each device to mitigate the Voltage sag and economical device is proposed.

Index terms— Power Quality Problems, Voltage sag, DVR, DSTATCOM, PWM Switched Autotransformer

I. INTRODUCTION

Power quality is certainly a major concern in the present era; it becomes especially important with the introduction of sophisticated devices, whose performance is very sensitive to the quality of power supply. Modern industrial processes are based a large amount of electronic devices such as programmable logic controllers and adjustable speed drives. The electronic devices are very sensitive to disturbances [1] and thus industrial loads become less tolerant to power quality problems such as voltage dips, voltage swells, and harmonics. Voltage dips are considered one of the most severe disturbances to the industrial equipment. Swells and over

voltages can cause over heating tripping or even destruction of industrial equipment such as motor drives. Electronic equipments are very sensitive loads against harmonics because their control depends on either the peak value or the zero crossing of the supplied voltage, which are all influenced by the harmonic distortion.

This paper analyzes the key issues in the Power Quality problems. As one of the prominent power quality problems, the origin, consequences and mitigation techniques of voltage sag problem has been discussed in detail. The study describes the techniques of mitigating voltage sag in a distribution system by two power electronics based devices called Dynamic Voltage Restorer (DVR) and Distribution STATCOM (D-STATCOM) and a new mitigation technique called PWM Switched Autotransformer.

II. SOURCES AND EFFECTS OF POWER QUALITY PROBLEMS

The distortion in the quality of supply power can be introduced /enhanced at various stages; however, some of the primary sources of distortion [2] can be identified as below:

- A. Power Electronic Devices
- B. IT and Office Equipments
- C. Arcing Devices
- D. Load Switching
- E. Large Motor Starting
- F. Embedded Generation
- G. Electromagnetic Radiations and Cables
- H. Storm and Environment Related Causes etc.

Some of the common power quality issues and their prominent impact are summarized in the table below:

TABLE I

Problem	Effects
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M. Godoy Simões, Felix A. Farret



Power Quality Enhancement Using Custom Power Devices:

Power Quality Enhancement Using Custom Power Devices Arindam Ghosh, Gerard Ledwich, 2012-12-06 Power Quality Enhancement Using Custom Power Devices considers the structure control and performance of series compensating DVR the shunt DSTATCOM and the shunt with series UPQC for power quality improvement in electricity distribution Also addressed are other power electronic devices for improving power quality in Solid State Transfer Switches and Fault Current Limiters Applications for these technologies as they relate to compensating busses supplied by a weak line and for distributed generation connections in rural networks are included In depth treatment of inverters to achieve voltage support voltage balancing harmonic suppression and transient suppression in realistic network environments are also covered New material on the potential for shunt and series compensation which emphasizes the importance of control design has been introduced

Power Energy and Secure Smart Technologies Thanikanti Sudhakar Babu, Mallala Balasubbarreddy, Subramaniam M, Nnamdi Nwulu, Vigna Kumaran Ramachandaramurthy, Renu Sharma, 2025-07-16 This Book of Proceedings presents the collective research and insights shared at the conference on Power Energy and Secure Smart Technologies The event brings together leading minds from academia industry and research to explore innovations and address challenges in modern power systems sustainable energy solutions and secure smart technologies The papers compiled here reflect the latest developments case studies and forward looking ideas that contribute to the evolving landscape of intelligent and resilient energy systems We trust this volume will serve as a valuable resource for researchers professionals and students committed to advancing technology for a sustainable and secure energy future

Power System Harmonics and Passive Filter Designs J. C. Das, 2015-03-16 As new technologies are created and advances are made with the ongoing research efforts power system harmonics has become a subject of great interest The author presents these nuances with real life case studies comprehensive models of power system components for harmonics and EMTP simulations Comprehensive coverage of power system harmonics Presents new harmonic mitigation technologies In depth analysis of the effects of harmonics Foreword written by Dr Jean Mahseredijan world renowned authority on simulations of electromagnetic transients and harmonics

Integration of Renewable Energy Sources with Smart Grid M. Kathiresan, A. Mahaboob Subahani, G. R. Kanagachidambaresan, 2021-09-08 INTEGRATION OF RENEWABLE ENERGY SOURCES WITH SMART GRID Provides comprehensive coverage of renewable energy and its integration with smart grid technologies This book starts with an overview of renewable energy technologies smart grid technologies and energy storage systems and covers the details of renewable energy integration with smart grid and the corresponding controls It also provides an enhanced perspective on the power scenario in developing countries The requirement of the integration of smart grid along with the energy storage systems is deeply discussed to acknowledge the importance of sustainable development of a smart city The methodologies are made quite possible with highly efficient power convertor topologies and intelligent control schemes These control

schemes are capable of providing better control with the help of machine intelligence techniques and artificial intelligence. The book also addresses modern power converter topologies and the corresponding control schemes for renewable energy integration with smart grid. The design and analysis of power converters that are used for the grid integration of solar PV along with simulation and experimental results are illustrated. The protection aspects of the microgrid with power electronic configurations for wind energy systems are elucidated. The book also discusses the challenges and mitigation measure in renewable energy integration with smart grid. Audience: The core audience is hardware and software engineers working on renewable energy integration related projects, microgrids, smart grids and computing algorithms for converter and inverter circuits. Researchers and students in electrical electronics and computer engineering will also benefit reading the book.

Power Quality Enhancement Using Custom Power Devices Ghosh Arindam Et.Al, 2009-02-01 Proceedings of the 4th International Conference on Communication, Devices and Computing Dilip Kumar Sarkar, Pradip Kumar Sadhu, Sunandan Bhunia, Jagannath Samanta, Suman Paul, 2023-07-27. The book is a collection of best selected research papers presented at the Fourth International Conference on Communication Devices and Computing ICCDC 2023. The book covers new ideas, applications and experiences of research engineers, scientists, industrialists, scholars and students from in and around the globe. It covers research contributions from communication technologies which are from the areas such as 5G communication, next generation Wi-Fi, spread spectrum systems, satellite and high altitude platforms, radio over fiber, techniques, wireless sensor networks, modulation and diversity technique, ad hoc and mesh networks, cognitive radio, networking, optical, wireless and visible light communications, signal processing for secure communication, millimeter wave and terahertz communication, design, control and management of optical network, error control coding and information theory, printed antennas, performance analysis of wireless network, smart antennas and space time processing.

Artificial Intelligence and Machine Learning in Smart City Planning Vedik Basetti, Chandan Kumar Shiva, Mohan Rao Ungarala, Shriram S. Rangarajan, 2023-01-11. Artificial Intelligence and Machine Learning in Smart City Planning shows the reader practical applications of AIML techniques and describes recent advancements in this area in various sectors. Owing to the multidisciplinary nature, this book primarily focuses on the concepts of AIML and its methodologies such as evolutionary techniques, neural networks, machine learning, deep learning, block chain technology, big data analytics and image processing in the context of smart cities. The text also discusses possible solutions to different challenges posed by smart cities by presenting cutting edge AIML techniques using different methodologies as well as future directions for those same techniques. Reviews the smart city concept and teaches how it can contribute to achieving urban development priorities. Explains soft computing techniques for smart city applications. Describes how to model problems for effective analysis, intelligent decision making and optimal operation and control in the smart city paradigm. Teaches how to carry out independent projects using soft computing techniques in a vast range of areas in diverse fields like engineering, management,

and sciences

The Proceedings of the International Conference on Information Engineering, Management and Security 2014 JBV Subramanyam, Kokula Krishna Hari K, 2014-05-15 The Proceedings of the International Conference on Information Engineering Management and Security 2014 which happened at Christu Jyoti Institute of Technology *Power Quality Enhancement Using Custom Power Devices* Reza Sedaghati, Alireza Dehghani Pilehvarani, 2014-10-22 Power quality is very important issue recently due to the impact on electricity suppliers equipment manufacture and customers Power quality is described as the variation of voltage current and frequency in a power system Nowadays there are so many industries using high technology for manufacturing and process unit This technology requires high quality and high reliability of power supply Power Quality problems encompass a wide range of disturbances such as voltage sags swells flicker harmonics distortion impulse transient and interruptions Voltage sags is the most common type of power quality disturbance in the distribution system It can be caused by fault in the electrical network or by the starting of a large induction motor Voltage sags are a remarkable source of economic losses The purpose of this book is tried to analyze and identify voltage sags problem in power quality especially in a distribution system The simulation will be using PSCAD EMTDC software The mitigation techniques that will be studied are such as Dynamic Voltage Restorer DVR Distribution Static Compensator DSTATCOM and Solid State Transfer Switch SSTS

Standard Handbook for Electrical Engineers Sixteenth Edition H. Wayne Beaty, Donald Fink, 2012-08-30 THE MOST COMPLETE AND CURRENT GUIDE TO ELECTRICAL ENGINEERING For more than a century the Standard Handbook for Electrical Engineers has served as the definitive source for all the pertinent electrical engineering data essential to both engineering students and practicing engineers It offers comprehensive information on the generation transmission distribution control operation and application of electric power Completely revised throughout to address the latest codes and standards the 16th Edition of this renowned reference offers new coverage of green technologies such as smart grids smart meters renewable energy and cogeneration plants Modern computer applications and methods for securing computer network infrastructures that control power grids are also discussed Featuring hundreds of detailed illustrations and contributions from more than 75 global experts this state of the art volume is an essential tool for every electrical engineer Standard Handbook for Electrical Engineers 16th Edition covers Units symbols constants definitions and conversion factors Electric and magnetic circuits Measurements and instruments Properties of materials Generation Prime movers Alternating current generators Direct current generators Hydroelectric power generation Power system components Alternate sources of power Electric power system economics Project economics Transmission systems High voltage direct current power transmission Power system operations Substations Power distribution Wiring design for commercial and industrial buildings Motors and drives Industrial and commercial applications of electric power Power electronics Power quality and reliability Grounding systems Computer applications in the electric power industry Illumination Lightning and overvoltage protection Standards in electrotechnology telecommunications and

information technology Alternative Energy Systems M. Godoy Simões, Felix A. Farret, 2008 Durable and cost effective induction power generators have undergone numerous improvements that make them an increasingly attractive option for renewable energy applications particularly for wind and hydropower generation systems From fundamental concepts to the latest technologies Alternative Energy Systems Design and Analysis with Induction Generators Second Edition provides detailed and accurate coverage of all aspects related to the design operation and overall analysis of such systems Placing a greater emphasis on providing clear precise and succinct explanations this second edition features new revised and updated content as well as figures tables equations and examples Each chapter introduces a multi step chapter length problem relating the material to a real application The solution appears at the end of the chapter along with additional practice problems and references New Material in This Edition Updated definitions for generated power and efficiency Technological advances such as new applications using doubly fed induction generators New methodologies such as the magnetization curve representation for induction generators Additional focus on renewable energy applications such as sea wind and hydropower systems Alternative Energy Systems provides the tools and expertise for advanced students and professionals in electrical mechanical civil and environmental engineering involved in the development of power plants **Harmonic Compensation of Voltage and Current Using UPQC** Akshay Kumar, 2014-08-12 Research Paper postgraduate from the year 2014 in the subject Engineering Power Engineering grade 4 2 language English abstract In this paper a novel control method based on Synchronous Reference Frame Theory SRFT is proposed to compensate power quality problems through a three phase Unified Power Quality Conditioner UPQC under unbalanced and distorted load conditions The performance of the proposed system has been verified using MATLAB SIMULINK and are discussed in detail in this paper Understanding Power Quality Problems Math H. J. Bollen, 2000 Power quality problems have increasingly become a substantial concern over the last decade but surprisingly few analytical techniques have been developed to overcome these disturbances in system equipment interactions Now in this comprehensive book power engineers and students can find the theoretical background necessary for understanding how to analyze predict and mitigate the two most severe power disturbances voltage sags and interruptions This is the first book to offer in depth analysis of voltage sags and interruptions and to show how to apply mathematical techniques for practical solutions to these disturbances From UNDERSTANDING AND SOLVING POWER QUALITY PROBLEMS you will gain important insights into Various types of power quality phenomena and power quality standards Current methods for power system reliability evaluation Origins of voltage sags and interruptions Essential analysis of voltage sags for characterization and prediction of equipment behavior and stochastic prediction Mitigation methods against voltage sags and interruptions Sponsored by IEEE Power Electronics Society IEEE Industry Applications Society IEEE Power Engineering Society *6th International R&D Conference, Sustainable Development of Water and Energy Resources, Needs and Challenges, 13-16 February 2007, Lucknow, India : Proceedings: Energy*, 2007 Contributed

articles presented at the Conference TENCON 2004 ,2004 Power Quality Primer Barry W. Kennedy,2000-09-26 Make power deregulation work for you With deregulation the vast pool of power customers is up for grabs As a utility are you ready to compete As a customer are you ready to choose In Power Quality Primer Barry Kennedy gives you specifically designed ahead of the curve methods Utilities will learn how to Plan successful competitive strategies for every aspect of the business Market proactive solutions to customers before needs arise Improve transmission and distribution system quality efficiency and power factor performance Eliminate technical problems such as over voltages and poor grounding Design and deliver effective simulations Build customer winning customer keeping quality quality control and service into all facets of your enterprise As a customer you ll learn how to pick the utility that meets your power quality needs solve your own power quality problems and find cost effective solutions and perform your own power quality survey IEEE Transactions on Circuits and Systems ,2006 **Power Systems Harmonics** Enrique Acha,Manuel Madrigal,2001-06-11 The deregulation and restructuring of the power utilities industry has made the quality of power supply a worldwide issue Providing background theory and illustrative examples this text provides a broad introduction to the issues involved *CIREN: pt. 1. Contributions. Rapporteurs special reports and summaries* ,2001 Books in Print Supplement ,2002

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