






Received 12 May 2023; revised 27 June 2023; accepted 10 July 2023. Date of publication 13 July 2023;
date of current version 21 July 2023. The review of this paper was arranged by Associate Editor Hiralal Murliidhar Suryawanshi.
Digital Object Identifier 10.1109/JIE.2023.1054000

Shipboard DC Systems—A Critical Overview: Challenges in Primary Distribution, Power-Electronics-Based Protection, and Power Scalability

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This work was supported by the Netherlands Enterprise Agency through the MEXENS Project under Grant M02B20012.

ABSTRACT This article gives an overview of challenges in primary distribution, protections, and power scalability for shipboard dc systems. Given that dc technology is in development, several aspects of shipboard systems have not yet been sufficiently devised to ensure the protection and efficiency demanded. Several issues in dc systems arise from the lack of complete relevant standardization from different regulation bodies. Unipolar and bipolar bus architectures have application-specific advantages that are discussed and compared. The placement of power electronics in dc systems creates opportunities for switchboard design, and this article compares the centralized and distributed approaches. Likewise, protection architectures for shipboard dc systems have challenges. Breaker-based protection utilizes slow fuses, mechanical circuit breakers, and solid-state circuit breakers. In addition, power-electronics-based protection embeds the protective circuit in the power converters, but its development lags. This article compares the state-of-the-art technologies, reviewing their main features. Finally, the power requirement of various applications and the low production rate of vessels force the designers to utilize commercial off-the-shelf converters to scale up power. The misuse of such converters, the modular topologies, and power electronics building blocks are exposed highlighting challenges and opportunities toward the mass adoption of dc systems onboard maritime vessels.

INDEX TERMS DC circuit breakers, dc systems, power-electronics-based protection, power electronics building blocks (PEBBs), power scalability, shipboard dc systems.

NOMENCLATURE

APU	Auxiliary power unit.
COTS	Commercial off-the-shelf.
DAB	Dual-active bridge converter.
EP	Electrical propulsion.
ESS	Energy storage system.
HCB	Hybrid circuit breaker.
HP	Hybrid propulsion.
ICE	Internal combustion engine.
IGBT	Insulated gate bipolar transistor.
IGCT	Integrated gate-commutated thyristor.

JFET	Junction-gate field-effect transistor.
LVDC	Low voltage direct current.
MCB	Mechanical circuit breaker.
MMC	Modular multilevel converter.
MOSFET	Metal-oxide-semiconductor field-effect transistor.
MOV	Metal-oxide varistor.
MP	Mechanical propulsion.
MVDC	Medium voltage direct current.
SSCB	Solid-state circuit breaker.
TRL	Technology readiness level.

Shipboard Power Protection Solution Overview

Kathleen Armour

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Fault Analysis and Protection System Design for DC Grids Abhisek Ukil, Yew Ming Yeap, Kuntal Satpathi, 2020-04-13 This book offers a comprehensive reference guide to the important topics of fault analysis and protection system design for DC grids at various voltage levels and for a range of applications. It bridges a much needed research gap to enable wide scale implementation of energy efficient DC grids. Following an introduction, DC grid architecture is presented covering the devices, operation and control methods. In turn, analytical methods for DC fault analysis are presented for different types of faults, followed by separate chapters on various DC fault identification methods using time frequency and time frequency domain analyses of the DC current and voltage signals. The unit and non unit protection strategies are discussed in detail while a dedicated chapter addresses DC fault isolation devices. Step by step guidelines are provided for building hardware based experimental test setups as well as methods for validating the various algorithms. The book also features several application driven case studies.

Recent Advancements in Computational Intelligence and Design Engineering Dac-Nhuong Le, Abhishek Dhar, Ranjan Kumar, Saravanan Muthaiyah, Saurabh Adhikari, 2025-02-14 International Conference on Computational Intelligence and Design Engineering ICCIDE 2023 is a multidisciplinary conference focused on bringing together recent advancements in the field of engineering, computer science and Mathematics. The key features of the conference include a common platform for research and innovation work related to next generation computation, Mathematics in computation as well as engineering research to achieve industry 5.0 mission. The conference covers different aspects of science and technology like applications of AI and ML for sustainable manufacturing and production systems, computational modelling, mathematics and computing.

Practical Applications and Solutions Using LabVIEW™ Software Silviu Folea, 2011-08-01 The book consists of 21 chapters which present interesting applications implemented using the LabVIEW environment belonging to several distinct fields such as engineering, fault diagnosis, medicine, remote access, laboratory, internet, communications, chemistry, physics etc. The virtual instruments designed and implemented in LabVIEW provide the advantages of being more intuitive, of reducing the implementation time and of being portable. The audience for this book includes PhD students, researchers, engineers and professionals who are interested in finding out new tools developed using LabVIEW. Some chapters present interesting ideas and very detailed solutions which offer the immediate possibility of making fast innovations and of generating better products for the market. The effort made by all the scientists who contributed to editing this book was significant and as a result new and viable applications were presented.

Direct Current Fault Protection Isik C. Kizilyalli, Z. John Shen, Daniel W. Cunningham, 2023-05-23 The lack of effective DC fault protection technology remains a major barrier for the DC paradigm shift. In addressing the key challenges, *Direct Current Fault Protection: Basic Concepts and Technology Advances* starts with an introduction to the advantages of DC power systems before moving on to an in depth review of DC fault protection technologies including mechanical circuit breaker

MCB solid state circuit breaker SSCB hybrid circuit breaker HCB converter based breakerless protection and fault current limiter FCL Coverage includes a comprehensive comparison of various DC fault interruption technologies and their suitable applications state of the art DC fault protection concepts and advances in research identification of fundamental challenges and future directions in the field and commercialization aspects This book will be a valuable reference for practicing engineers researchers and graduate students in the field of power electronics and DC power systems **Advances in Brain Inspired Cognitive Systems** Derong Liu,Cesare Alippi,Dongbin Zhao,Amir Hussain,2013-06-03 This book constitutes the refereed proceedings of the 6th International Conference on Brain Inspired Cognitive Systems BICS 2013 held in Beijing China in June 2013 The 45 high quality papers presented were carefully reviewed and selected from 68 submissions BICS 2013 aims to provide a high level international forum for scientists engineers and educators to present the state of the art of brain inspired cognitive systems research and applications in diverse fields **RETRACTED BOOK: Control Design of Multiagent Discrete-Time Systems** MagdiSadek Mahmoud,Bilal J. Karaki,2022-03-16 This book describes an effective approach to the cooperative and coordinated control of multivehicle systems This rigorous analytic approach guarantees the stability of coordinated and cooperating vehicles using distributed protocols and uses low energy event triggered mechanisms for networked vehicle control The text covers design of a cooperative protocol to achieve consensus for multivehicle systems allowing cooperation that is resistant to the effects of packet loss and or adversarial attack analysis and synthesis of an event triggering mechanism for cooperative multivehicle systems over uncertain networks and the problem of distributed leader following consensus and methods for compelling multivehicle systems to reach consensus Throughout the book cooperation problems are transformed into stability problems Lyapunov theory is used to guarantee cooperation among agents The distributed approach is applied to triggering mechanisms the cooperation process and the impact of cyber attacks Discrete time analysis shows how the event based structure can be designed to match the performance of continuous time counterparts The book details applications and computer simulation with several practical examples This book is of interest to a wide audience from the graduate student through the academic researcher to the industrial practitioner all of them sharing a common interest in the stability and security of multiagent systems **Index of Specifications and Standards** ,2005 Marine Engineers Review ,2002 **Pacific Marine Review** Alexander J. Dickie, Frank A. Stanley, 1921 *Naval Engineers Journal* ,1999 ELECTRIMACS 2022 Serge Pierfederici, Jean-Philippe Martin, 2023-06-13 This book collects a selection of papers presented at ELECTRIMACS 2021 the 14th international conference of the IMACS TC1 Committee held in Nancy France on 16th 19th May 2022 The conference papers deal with modelling simulation analysis control power management design optimization identification and diagnostics in electrical power engineering The main application fields include electric machines and electromagnetic devices power electronics transportation systems smart grids renewable energy systems energy storage like batteries and supercapacitors fuel cells and wireless power transfer The contributions

included in Volume 1 will be particularly focused on electrical engineering simulation aspects and innovative applications

Department Of Defense Index of Specifications and Standards Alphabetical Listing Part I July 2005 ,

Technical Abstract Bulletin , College of Engineering University of Michigan. College of Engineering, 1978

Congressional Record United States. Congress, 2009 **Expert Crafting of Ships Electric Energy Systems** Mukesh

Rajan, 2025-02-20 Expert Crafting of Ships Electric Energy Systems is an essential guide for maritime engineers shipbuilders and anyone involved in designing and operating modern ships Authored by leading experts this comprehensive volume delves into the intricate details of shipboard electric power systems providing invaluable insights into the latest technologies and best practices We cover a wide range of topics from electrical engineering fundamentals to advanced concepts like power distribution propulsion systems and energy management Readers will learn how to optimize energy efficiency enhance safety and comply with regulatory requirements while designing and implementing electric energy systems for ships of all sizes and types Drawing on real world examples and case studies we offer practical guidance on selecting components and equipment troubleshooting common issues and minimizing downtime Whether you re a seasoned professional or a newcomer to the field Expert Crafting of Ships Electric Energy Systems is an indispensable resource for staying at the forefront of maritime technology With clear explanations insightful analysis and practical advice this book is a trusted companion for anyone involved in shipboard electric power systems Analysis and Design of Hybrid Energy Storage Systems Jorge

Garcia, 2020-04-17 The most important environmental challenge today s society is facing is to reduce the effects of CO2 emissions and global warming Such an ambitious challenge can only be achieved through a holistic approach capable of tackling the problem from a multidisciplinary point of view One of the core technologies called to play a critical role in this approach is the use of energy storage systems These systems enable among other things the balancing of the stochastic behavior of Renewable Sources and Distributed Generation in modern Energy Systems the efficient supply of industrial and consumer loads the development of efficient and clean transport and the development of Nearly Zero Energy Buildings nZEB and intelligent cities Hybrid Energy Storage Systems HESS consist of two or more storage devices with complementary key characteristics that are able to behave jointly with better performance than any of the technologies considered individually Recent developments in storage device technologies interface systems control and monitoring techniques or visualization and information technologies have driven the implementation of HESS in many industrial commercial and domestic applications This Special Issue focuses on the analysis design and implementation of hybrid energy storage systems across a broad spectrum encompassing different storage technologies including electrochemical capacitive mechanical or mechanical storage devices engineering branches power electronics and control strategies energy engineering energy engineering chemistry modelling simulation and emulation techniques data analysis and algorithms social and economic analysis intelligent and Internet of Things IoT systems and so on applications energy systems renewable energy generation industrial

applications transportation Uninterruptible Power Supplies UPS and critical load supply etc and evaluation and performance size and weight benefits efficiency and power loss economic analysis environmental costs etc **Masters Theses in the Pure and Applied Sciences** Wade H. Shafer, 2012-12-06 Masters Theses in the Pure and Applied Sciences was first conceived published and disseminated by the Center for Information and Numerical Data Analysis and Synthesis CINDAS at Purdue University in 1957 starting its coverage of theses with the academic year 1955 Beginning with Volume 13 the printing and dissemination phases of the activity were transferred to University Microfilms Xerox of Ann Arbor Michigan with the thought that such an arrangement would be more beneficial to the academic and general scientific and technical community After five years of this joint undertaking we had concluded that it was in the interest of all concerned if the printing and distribution of the volumes were handled by an international publishing house to assure improved service and broader dissemination Hence starting with Volume 18 Masters Theses in the Pure and Applied Sciences has been disseminated on a worldwide basis by Plenum Publishing Corporation of New York and in the same year the coverage was broadened to include Canadian universities All back issues can also be ordered from Plenum We have reported in Volume 37 thesis year 1992 a total of 12 549 thesis titles from 25 Canadian and 153 United States universities We are sure that this broader base for these titles reported will greatly enhance the value of this important annual reference work While Volume 37 reports theses submitted in 1992 on occasion certain universities do report theses submitted in previous years but not reported at the time *University of Michigan Official Publication* University of Michigan, 1980 Each number is the catalogue of a specific school or college of the University **Electrical World** , 1909

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