

# Modern Electrical Drives: Trends, Problems, and Challenges

Krzysztof Szabat <sup>1,\*</sup>, Tomasz Pajchrowski <sup>2</sup> and Tomasz Tarczewski <sup>3</sup> 

- <sup>1</sup> Department of Electrical Machines, Drives and Measurement, Wrocław University of Science and Technology, 50-370 Wrocław, Poland
  - <sup>2</sup> Institute of Robotics and Machine Intelligence, Poznań University of Technology, 60-965 Poznań, Poland; tomasz.pajchrowski@pwt.poznan.pl
  - <sup>3</sup> Institute of Engineering and Technology, Nicolaus Copernicus University in Toruń, 87-100 Toruń, Poland; ttarczewski@furyka.umk.pl
- \* Correspondence: krzysztof.szabat@pwr.edu.pl

## 1. Introduction

Modern electrical drives possess many advantages. Electrical energy, compared to other sources, is easy to transport and can be environmentally friendly (if it comes from renewable sources). Electrical drives convert energy with high efficiency and have flexible control characteristics. They offer a wide range of speed, torque, and power operations. Furthermore, in general, they can serve as electrical generators.

With the growing demand for high-performance electrical drives, many universities and industrial researchers have focused on the problems surrounding the efficient, robust, precise, and fault-tolerant controls of these drives. In various industries, accurate control of electrical drives is crucial, from high-power drives evident in mining and petrochemical areas, to medium (automotive industries, robot arm drives, CNC machines) and small power drives (actuators), MEMS, etc.

In this Special Issue, the topics related to trends, problems, and challenges linked to the design and exploitation of modern electrical drives are presented. The submitted manuscripts, and those finally selected for publication in this Special Issue, focus on the trends, problems, and challenges in modern electrical drives. Very often, they are multidisciplinary works. In this Special Issue, 10 manuscripts were published that deal with the following topics: control strategies for different types of electrical motors [1–3], estimations of non-measurable states and parameters [3], sensorless control of electrical drives [1,2], the application of advanced control methodologies for high performance control of electrical drives [4–6], diagnoses, monitoring, and prognoses in electrical drives [7–10], and control of complex mechatronic systems, while taking the mechanical part of the system into account [3,4,6].

This publication is divided into two important sections: a short review of the contributions, where important contributions to the development of electric drives are presented, and a summary of the work.

## 2. A Short Review of the Contributions in This Issue

The main idea of the article [1] is to create a buffer power supply system for an asynchronous electrical drive, and to develop a strategy for a control system for this buffer power by using a bidirectional DC–DC converter. The article describes the process of creating a model of an electric drive, buffer source, control system, and frequency regulation based on MATLAB–Simulink. Simulations of the operations of this system were carried out together with a buffer source based on the supercapacitors. The adequacy and accuracy of the calculated mathematical expressions were proven. An algorithm for the operation of the control system for the buffer power source was proposed.

In [2], Bednarski et al. proposed and experimentally examined a family of generalized microstepping signal shapes for stepper motors. The authors provided the mathematical



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# Modern Electrical Drives

**Ion Boldea, Syed A. Nasar**



## Modern Electrical Drives:

Modern Electrical Drives H. Bülent Ertan, M. Yildirim Üçtug, Ron Colyer, Alfio Consoli, 2013-06-29 Electrical drives lie at the heart of most industrial processes and make a major contribution to the comfort and high quality products we all take for granted They provide the controller power needed at all levels from megawatts in cement production to milliwatts in wrist watches Other examples are legion from the domestic kitchen to public utilities The modern electrical drive is a complex item comprising a controller a static converter and an electrical motor Some can be programmed by the user Some can communicate with other drives Semiconductor switches have improved intelligent power modules have been introduced all of which means that control techniques can be used now that were unimaginable a decade ago Nor has the motor side stood still high energy permanent magnets semiconductor switched reluctance motors silicon micromotor technology and soft magnetic materials produced by powder technology are all revolutionising the industry But the electric drive is an enabling technology so the revolution is rippling throughout the whole of industry Advanced Electric Drives Ned Mohan, 2014-07-22 With nearly two thirds of global electricity consumed by electric motors it should come as no surprise that their proper control represents appreciable energy savings The efficient use of electric drives also has far reaching applications in such areas as factory automation robotics clean transportation hybrid electric vehicles and renewable wind and solar energy resource management Advanced Electric Drives utilizes a physics based approach to explain the fundamental concepts of modern electric drive control and its operation under dynamic conditions Author Ned Mohan a decades long leader in Electrical Energy Systems EES education and research reveals how the investment of proper controls advanced MATLAB and Simulink simulations and careful forethought in the design of energy systems translates to significant savings in energy and dollars Offering students a fresh alternative to standard mathematical treatments of dq axis transformation of a b c phase quantities Mohan s unique physics based approach visualizes a set of representative dq windings along an orthogonal set of axes and then relates their currents and voltages to the a b c phase quantities Advanced Electric Drives is an invaluable resource to facilitate an understanding of the analysis control and modelling of electric machines Gives readers a physical picture of electric machines and drives without resorting to mathematical transformations for easy visualization Confirms the physics based analysis of electric drives mathematically Provides readers with an analysis of electric machines in a way that can be easily interfaced to common power electronic converters and controlled using any control scheme Makes the MATLAB Simulink files used in examples available to anyone in an accompanying website Reinforces fundamentals with a variety of discussion questions concept quizzes and homework problems *Fundamentals of Electrical Drives* André Veltman, Duco W.J. Pülle, R.W. de Doncker, 2007-06-14 Electrical drives in general play a key role in power generation household appliances automotive and industrial applications The rapidly expanding area of adjustable speed drives as used in robotics wind turbines and hybrid vehicles is driven by innovations in machine design power semi

conductors digital signal processors and simulation software

Fundamentals of Electrical Drives is for readers with a basic engineering knowledge who have a need or desire to comprehend and apply the theory and simulation methods which are applied by drive specialist throughout the world

**Applied Control of Electrical Drives** Duco W. J. Pulle, Pete Darnell, André Veltman, 2015-09-17 Provides an overall understanding of all aspects of AC electrical drives from the motor and converter to the implemented control algorithm with minimum mathematics needed Demonstrates how to implement and debug electrical drive systems using a set of dedicated hardware platforms motor setup and software tools in VisSim™ and PLECS™ No expert programming skills required allowing the reader to concentrate on drive development Enables the reader to undertake real time control of a safe low voltage and low cost experimental drive This book puts the fundamental and advanced concepts behind electric drives into practice Avoiding involved mathematics whenever practical this book shows the reader how to implement a range of modern day electrical drive concepts without requiring in depth programming skills It allows the user to build and run a series of AC drive concepts ranging from very basic drives to sophisticated sensorless drives Hence the book is the only modern resource available that bridges the gap between simulation and the actual experimental environment Engineers who need to implement an electrical drive or transition from sensed to sensorless drives as well as students who need to understand the practical aspects of working with electrical drives will greatly benefit from this unique reference

Electric Drives and Electromechanical Systems Richard Crowder, 2019-10-19 Electric Drives and Electromechanical Devices Applications and Control Second Edition presents a unified approach to the design and application of modern drive system It explores problems involved in assembling complete modern electric drive systems involving mechanical electrical and electronic elements This book provides a global overview of design specification applications important design information and methodologies This new edition has been restructured to present a seamless logical discussion on a wide range of topical problems relating to the design and specification of the complete motor drive system It is organised to establish immediate solutions to specific application problem Subsidiary issues that have a considerable impact on the overall performance and reliability including environmental protection and costs energy efficiency and cyber security are also considered Presents a comprehensive consideration of electromechanical systems with insights into the complete drive system including required sensors and mechanical components Features in depth discussion of control schemes particularly focusing on practical operation Includes extensive references to modern application domains and real world case studies such as electric vehicles Considers the cyber aspects of drives including networking and security

**Handbook of Modern Electric Railway Methods and Practices** American Transit Association, 1925

**Electric Drives** Ion Boldea, Syed A. Nasar, 2016-09-15 Electric Drives provides a practical understanding of the subtleties involved in the operation of modern electric drives The Third Edition of this bestselling textbook has been fully updated and greatly expanded to incorporate the latest technologies used to save energy and increase productivity stability and reliability Every

phrase equation number and reference in the text has been revisited with the necessary changes made throughout In addition new references to key research and development activities have been included to accurately reflect the current state of the art Nearly 120 new pages covering recent advances such as those made in the sensorless control of A C motor drives have been added as have two new chapters on advanced scalar control and multiphase electric machine drives All solved numerical examples have been retained and the 10 MATLAB Simulink programs remain online Thus Electric Drives Third Edition offers an up to date synthesis of the basic and advanced control of electric drives with ample material for a two semester course at the university level

**Electrical News. Generation, Transmission and Application of Electricity**, 1923 **Fundamentals of Electrical Drives** Andre Veltman, Duco W.J. Pulle, R.W. de Doncker, 2016-06-10 The purpose of this book is to familiarize the reader with all aspects of electrical drives It contains a comprehensive user friendly introductory text

**Dynamics and Control of Electrical Drives** Wach Piotr, 2011-04-28 Dynamics is a science concerned with movement and changes In the most general approach it relates to life processes as well as behavior in nature in rest It governs small particles technical objects conversion of matter and materials but also concerns people groups of people in their individual and in particular social dimension In dynamics we always have to do with causes or stimuli for motion the rules of reaction or behavior and its result in the form of trajectory of changes This book is devoted to dynamics of a wide class of specific but very important objects such as electromechanical systems This is a very rigorous discipline and has a long tradition as its theoretical bases were formulated in the first half of the XIX century by d Alembert Lagrange Hamilton Maxwell and other prominent scientists but their crucial results were based on previous pioneering research of others such as Copernicus Galileo Newton This book in its theoretical foundations is based on the principle of least action which governs classical as well as relativistic mechanics and electromagnetism and leads to Lagrange s equations which are applied in the book as universal method to construct equations of motion of electromechanical systems It gives common and coherent grounds to formulate mathematical models for all lumped parameters electromechanical systems which are vital in our contemporary industry and civilized everyday life From these remarks it seems that the book is general and theoretical but in fact it is a very practical one concerning modern electrical drives in a broad sense including electromechanical energy conversion induction motor drives brushless DC drives with a permanent magnet excitation and switched reluctance machines SRM And of course their control which means shaping of their trajectories of motion using modern tools their designed autonomy in keeping a track according to our programmed expectations The problems presented in the book are widely illustrated by characteristics trajectories dynamic courses all computed by use of developed simulation models throughout the book There are some classical subjects and the history of the discipline is discussed but finally all modern tools and means are presented and applied More detailed descriptions follow in abstracts for the particular chapters The author hopes kind readers will enjoy and profit from reading this book

Mechanical World, 1929 Applications of

Modern Control to Electrical Drives Sergio Martínez Pitarch,1997      *Proceedings of National Electric Light Association*  
National Electric Light Association. Convention,1930      **The Electric Journal** ,1924      **New York Review of the**  
**Telegraph and Telephone and Electrical Journal** ,1907      **The Electrician** ,1911      **Industrial Arts Index** ,1927  
    **Modern Pulp and Paper Making; a Practical Treatise** George Strong Witham,1920      *Soviet Electrical Engineering*  
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