

# Reluctance Synchronous Machines And Drives

International Conference on Electrical Machines and Drives  
 Permanent-magnet-assisted Reluctance Synchronous Machine Drives  
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 Design of Rotating Electrical Machines  
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## BRYLEE SWANSON

**International Conference on Electrical Machines and Drives** John Wiley & Sons

A presentation of the theory of brushless d.c. drives to help engineers appreciate the potential of such motors and apply them more widely, by taking into account developments in permanent-magnet materials, power semiconductors, electronic control and motor design.

**Permanent-magnet-assisted Reluctance Synchronous Machine Drives** Newnes

Switched reluctance motors have steadily increased in commercial importance since their introduction in the early 1980's, while their technology - especially of their electronic control - has made great progress. Their unique characteristics introduce a delicate balance, in which the copper and iron are diminished in quantity, complexity and cost, in favour of a greater reliance on sophistication in the controller. Thus mastery of the control is the key challenge in the application of these machines. This book is intended for engineer's in industry and in the large research community in electrical machines and drives. It introduces the techniques for controlling switched reluctance machines, starting from first principles and building up to the most advanced forms of sensorless control. It covers the recent advances in electronic control and includes aspects of motion control, automation, acoustic noise reduction and energy efficiency. Covers the recent changes in control technology Includes up-to-date equipment and methods Contains applications and case studies

**Design and Evaluation of a Converter Optimized Synchronous Reluctance Motor Drive** MDPI

Despite two decades of massive strides in research and development on control strategies and their subsequent implementation, most books on permanent magnet motor drives still focus primarily on motor design, providing only elementary coverage of control and converters. Addressing that gap with information that has largely been disseminated only in journals and at conferences, Permanent Magnet Synchronous and Brushless DC Motor Drives is a long-awaited comprehensive overview of power electronic converters for permanent magnet synchronous machines and control strategies for variable-speed operation. It introduces machines, power devices, inverters, and control, and addresses modeling, implementation, control strategies, and flux weakening operations, as well as parameter sensitivity, and rotor position sensorless control. Suitable for both industrial and academic audiences, this book also covers the simulation, low cost inverter topologies, and commutation torque ripple of PM brushless DC motor drives. Simulation of the motor drives system is illustrated with MATLAB® codes in the text. This book is divided into three parts—fundamentals of PM synchronous and brushless dc machines, power devices, inverters; PM synchronous motor drives, and brushless dc motor drives. With regard to the power electronics associated with these drive systems, the author: Explores use of the standard three-phase bridge inverter for driving the machine, power factor correction, and inverter control Introduces space vector modulation step by step and contrasts with PWM Details dead time effects in the inverter, and its compensation Discusses new power converter topologies being considered for low-cost drive systems in PM brushless DC motor drives This reference is dedicated exclusively to PM ac machines, with a timely emphasis on control and standard, and low-cost converter topologies. Widely used for teaching at the doctoral level and for industrial audiences both in the U.S. and abroad, it will be a welcome addition to any engineer's library.

**Switched Reluctance Motor Drives** John Wiley & Sons

Electric energy is arguably a key agent for our material prosperity. With the notable exception of photovoltaic generators, electric generators are exclusively used to produce electric energy from mechanical energy. More than 60% of all electric energy is used in electric motors for useful mechanical work in various industries. This book presents the modeling, performance, design, and

control of reluctance synchronous and flux-modulation machines developed for higher efficiency and lower cost. It covers one- and three-phase reluctance synchronous motors in line-start applications and various reluctance flux-modulation motors in pulse width modulation converter-fed variable speed drives. FEATURES Presents basic and up-to-date knowledge about the topologies, modeling, performance, design, and control of reluctance synchronous machines. Includes information on recently introduced reluctance flux-modulation electric machines (switched- flux, flux-reversal, Vernier, transverse flux, claw pole, magnetic-g geared dual-rotor, brushless doubly fed, etc.). Features numerous examples and case studies throughout. Provides a comprehensive overview of all reluctance electric machines.

**Electrical Machines and Drives** CRC Press

The comprehensive reference on synchronous reluctance machines, which offer high power density at low cost and support the electrification in the transport sector. This book, written by top academic and industry experts, covers all topics required to design these machines.

**Advanced Electrical Drives** Reluctance Synchronous Machines and Drives

"Permanent magnet synchronous motors (PMSMs) have been used in the field of electric vehicles due to their high-power density, large torque to inertia ratio, and high reliability. This book presents an improved Field-oriented control (FOC) strategy, for optimal proportional-integral (PI) parameters for robust stability, faster dynamic response, and higher efficiency in the flux-weakening region. Combined design of a PI current regulator and a varying switching frequency PWM is presented, including improved linear model predictive control (MPC) control strategy. This book is aimed at researchers and graduate students in electrical Engineering, systems and control, and electric vehicles. Features: Implements evolutionary optimization algorithms are directly implemented to improve Permanent Magnet Synchronous Machines (PMSM) performance. Provides coverage of PMSM control design in the flux weakening region. Proposes a modern control method of model predictive control is proposed to improve the dynamic performance of interior PMSM. Studies the dynamic performance of two kinds of the PMSMs that of surface mounted and interior permanent magnet types. Includes several case studies and illustrative examples with MATLABa. This book is aimed at researchers, graduate students, and libraries in electrical engineering with specialization in systems and control and electric vehicles"--

*Switched Reluctance Motor Drives* Elsevier

Permanent Magnet, Reluctance, and Self-Synchronous Motors discusses the theory, design, and control of permanent magnet materials. The book describes permanent magnets and their applications to electric machines as well as their performance characteristics and limitations. It presents the performance and calculations of PM commutator motors and an approach to their design. Permanent magnet synchronous motors, finite-element calculations, design methodologies, and rectangular and sinusoidal current control are discussed. It presents reluctance motors, their topologies and performance analyses as well as reluctance synchronous motors, with very large rotor saliency ratios, and their vector control. Numerical examples and data of practical interest are provided throughout the book. The book will be very useful to engineers involved in the design and manufacturing of permanent magnet and reluctance motors and high-performance drives, as well as electrical engineering students and educators.

*Design and Control of a Synchronous Reluctance Machine Drive* Academic Press

Electric Motors and Drives: Fundamentals, Types and Applications, Fifth Edition is intended primarily for non-specialist users or students of electric motors and drives, but many researchers and specialist industrialists have also acknowledged its value in providing a clear understanding of the fundamentals. It bridges the gap between specialist textbooks (too analytical for the average user) and handbooks (full of detail but with little insight) providing an understanding of how each motor and drive system works. The fifth edition has been completely revised, updated and expanded. All of the most important types of motor and drive are covered, including d.c., induction, synchronous

(including synchronous reluctance and salient Permanent Magnet), switched reluctance, and stepping. There has been significant innovation in this area since the fourth edition, particularly in the automotive, aircraft and industrial sectors, with novel motor topologies emerging, including hybrid designs that combine permanent magnet and reluctance effects. We now include a physical basis for understanding and quantifying torque production in these machines, and this leads to simple pictures that illuminate the control conditions required to optimise torque. The key converter topologies have been brought together, and the treatment of inverter switching strategies expanded. A new chapter is devoted to the treatment of Field Oriented control, reflecting its increasing importance for all a.c. motor drives. A unique physically-based approach is adopted which builds naturally on the understanding of motor behaviour developed earlier in the book: the largely non-mathematical treatment dispels much of the mystique surrounding what is often regarded as a difficult topic. Helps users acquire knowledge and understanding of the capabilities and limitations of motors and drives without struggling through unnecessary math and theory Presents updated material on the latest and most widely-used motors and drives, including brushless servo motors Includes additional diagrams and worked examples throughout this updated edition Includes a physical basis for the understanding and quantifying torque production

*Advancements in Electric Machines* John Wiley & Sons

This Special Issue deals with improvements in the energy efficiency of electric devices, machines, and drives, which are achieved through improvements in the design, modelling, control, and operation of the system. Properly sized and placed coils of a welding transformer can reduce the required iron core size and improve the efficiency of the welding system operation. New structures of the single-phase field excited flux switching machine improve its performance in terms of torque, while having higher back-EMF and unbalanced electromagnetic forces. A properly designed rotor notch reduces the torque ripple and cogging torque of interior permanent magnet motors for the drive platform of electric vehicles, resulting in lower vibrations and noise. In the field of modelling, the torque estimation of a Halbach array surface permanent magnet motor with a non-overlapping winding layout was improved by introducing an analytical two-dimensional subdomain model. A general method for determining the magnetically nonlinear two-axis dynamic models of rotary and linear synchronous reluctance machines and synchronous permanent magnet machines is introduced that considers the effects of slotting, mutual interaction between the slots and permanent magnets, saturation, cross saturation, and end effects. Advanced modern control solutions, such as neural network-based model reference adaptive control, fuzzy control, senseless control, torque/speed tracking control derived from the 3D non-holonomic integrator, including drift terms, maximum torque per ampere, and maximum efficiency characteristics, are applied to improve drive performance and overall system operation.

*Energy Efficiency in Electric Devices, Machines and Drives* Springer

This book provides a unique approach to derive model-based torque controllers for all types of Lorentz force machines, i.e. DC, synchronous and induction machines. The rotating transformer model forms the basis for the generalized modeling approach of rotating field machines, which leads to the development of universal field-oriented control algorithms. Contrary to this, direct torque control algorithms, using observer-based methods, are developed for switched reluctance machines. Tutorials are included at the end of each chapter, and the reader is encouraged to execute these tutorials in order to gain familiarity with the dynamic behavior of drive systems. This updated edition uses PLECS® simulation and vector processing tools that were specifically adopted for the purpose of these hands-on tutorials. Hence, Advanced Electrical Drives encourages “learning by doing” and the experienced drive specialist may find the simulation tools useful to design high-performance torque controllers. Although it is a powerful reference in its own right, when used in conjunction with the companion texts Fundamentals of Electrical Drives and Applied Control of Electrical Drives, this book provides a uniquely comprehensive reference set that takes readers all the way from understanding the basics of how electrical drives work, to deep familiarity with advanced features and models, to a mastery of applying the concepts to actual hardware in practice. Teaches readers to perform insightful analysis of AC electrical machines and drives; Introduces new modeling methods and modern control techniques for switched reluctance drives; Updated to use PLECS® simulation tools for modeling electrical drives, including new and more experimental results; Numerous tutorials at end of each chapter to learn by doing, step-by-step; Includes extra material featuring “build and play” lab modules, for lectures and self-study.

**Electric Motors and Drives** CRC Press

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.

**Permanent Magnet Synchronous Machines and Drives** John Wiley & Sons

Recently, AI techniques have received increased attention world-wide and at present 2 industrial drives incorporate some form of AI. This is the first comprehensive book which discusses numerous AI applications to electrical machines and drives.

*Electrical Machine Drives Control* CRC Press

A comprehensive resource providing basic principles and state-of-the-art developments in sensorless control technologies for permanent magnet synchronous machine drives Sensorless Control of Permanent Magnet Synchronous Machine Drives highlights the global research achievements over the last three decades and the sensorless techniques developed by the authors and their colleagues, and covers sensorless control techniques of permanent magnet machines, discussing issues and solutions. Many worked application examples are included to aid in practical understanding of concepts. Written by two pioneering authors in the field, Sensorless Control of Permanent Magnet Synchronous Machine Drives covers sample topics such as: Permanent magnet brushless AC and DC drives Single three-phase, dual three-phase, and open winding machines Modern control theory based sensorless methods, covering model reference adaptive system, sliding mode observer, extended Kalman filter, and model predictive control Flux-linkage and back-EMF based methods for non-salient machines, and active flux-linkage and extended back-EMF methods for salient machines Pulsating and rotating high frequency sinusoidal and square wave signal injection methods with current or voltage response, at different reference frames, and selection of amplitude and frequency for injection signal Sensorless control techniques based on detecting third harmonic or zero-crossings of back-EMF waveforms Parasitic effects in fundamental and high frequency models, impacts on position estimation, and compensation schemes, covering cross-coupling magnetic saturation, load effect, machine saliency and multiple saliencies, inverter non-linearities, voltage and

current harmonics, parameter asymmetries, and parameter mismatches Techniques for rotor initial position estimation, magnetic polarity detection, and transition between low and high speeds Describing basic principles, examples, challenges, and practical solutions, Sensorless Control of Permanent Magnet Synchronous Machine Drives is a highly comprehensive resource on the subject for professionals working on electrical machines and drives, particularly permanent magnet machines, and researchers working on electric vehicles, wind power generators, household appliances, and industrial automation.

**Brushless Permanent-magnet and Reluctance Motor Drives** Springer Science & Business Media

Based on author Ion Boldea's 40 years of experience and the latest research, Linear Electric Machines, Drives, and Maglevs Handbook provides a practical and comprehensive resource on the steady improvement in this field. The book presents in-depth reviews of basic concepts and detailed explorations of complex subjects, including classifications and practical topologies, with sample results based on an up-to-date survey of the field. Packed with case studies, this state-of-the-art handbook covers topics such as modeling, steady state, and transients as well as control, design, and testing of linear machines and drives. It includes discussion of types and applications—from small compressors for refrigerators to MAGLEV transportation—of linear electric machines.

Additional topics include low and high speed linear induction or synchronous motors, with and without PMs, with progressive or oscillatory linear motion, from topologies through modeling, design, dynamics, and control. With a breadth and depth of coverage not found in currently available references, this book includes formulas and methods that make it an authoritative and comprehensive resource for use in R&D and testing of innovative solutions to new industrial challenges in linear electric motion/energy automatic control.

*Power Electronics and Motor Drives* CRC Press

Classical synchronous motors are the most effective device to drive industrial production systems and robots with precision and rapidity. However, numerous applications require efficient controls in non-conventional situations. Firstly, this is the case with synchronous motors supplied by thyristor line-commutated inverters, or with synchronous motors with faults on one or several phases.

Secondly, many drive systems use non-conventional motors such as polyphase (more than three phases) synchronous motors, synchronous motors with double excitation, permanent magnet linear synchronous motors, synchronous and switched reluctance motors, stepping motors and piezoelectric motors. This book presents efficient controls to improve the use of these non-conventional motors. Contents 1. Self-controlled Synchronous Motor: Principles of Function and Simplified Control Model, Francis Labrique and François Baudart. 2. Self-controlled Synchronous Motor: Dynamic Model Including the Behavior of Damper Windings and Commutation Overlap, Ernest Matagne. 3. Synchronous Machines in Degraded Mode, Damien Flieller, Ngac Ky Nguyen, Hervé Schwab and Guy Sturtzer. 4. Control of the Double-star Synchronous Machine Supplied by PWM Inverters, Mohamed Fouad Benkhoris. 5. Vectorial Modeling and Control of Multiphase Machines with Non-salient Poles Supplied by an Inverter, Xavier Kestelyn and Éric Semail. 6. Hybrid Excitation Synchronous Machines, Nicolas Patin and Lionel Vido. 7. Advanced Control of the Linear Synchronous Motor, Ghislain Remy and Pierre-Jean Barre. 8. Variable Reluctance Machines: Modeling and Control, Mickael Hilairet, Thierry Lubin and Abdelmounaim Tounzi. 9. Control of the Stepping Motor, Bruno Robert and Moez Feki. 10. Control of Piezoelectric Actuators, Frédéric Giraud and Betty Lemaire-Semail.

*Linear Electric Machines, Drives, and MAGLEVs Handbook* John Wiley & Sons

The modern world hungers for electricity. Traditionally, this hunger was sated with predominantly constant-speed-regulated, synchronous generators. However, new demands require the stable, quick, and efficient delivery and control offered by variable-speed generators. Surveying all of the technologies used to satisfy the world's demand for o

**Electronic Control of Switched Reluctance Machines** Springer Nature

The Industrial Electronics Handbook, Second Edition combines traditional and newer, more specialized knowledge that will help industrial electronics engineers develop practical solutions for the design and implementation of high-power applications. Embracing the broad technological scope of the field, this collection explores fundamental areas, including analog and digital circuits, electronics, electromagnetic machines, signal processing, and industrial control and communications systems. It also facilitates the use of intelligent systems—such as neural networks, fuzzy systems, and evolutionary methods—in terms of a hierarchical structure that makes factory control and supervision more efficient by addressing the needs of all production components. Enhancing its value, this fully updated collection presents research and global trends as published in the IEEE Transactions on Industrial Electronics Journal, one of the largest and most respected publications in the field. Power Electronics and Motor Drives facilitates a necessary shift from low-power electronics to the high-power varieties used to control electromechanical systems and other industrial applications. This volume of the handbook: Focuses on special high-power semiconductor devices Describes various electrical machines and motors, their principles of operation, and their limitations Covers power conversion and the high-efficiency devices that perform the necessary switchover between AC and DC Explores very specialized electronic circuits for the efficient control of electric motors Details other applications of power electronics, aside from electric motors—including lighting, renewable energy conversion, and automotive electronics Addresses power electronics used in very-high-power electrical systems to transmit energy Other volumes in the set: Fundamentals of Industrial Electronics Control and Mechatronics Industrial Communication Systems Intelligent Systems

**The Electric Generators Handbook - 2 Volume Set** CRC Press

This book offers an essential compendium on the analysis and design of synchronous motors for variable-speed applications. Focusing on synchronous reluctance and ferrite permanent-magnet (PM) synchronous reluctance machines, it provides a broad perspective on three-phase machines for variable speed applications, a field currently dominated by asynchronous machines and rare-earth PM synchronous machines. It also describes synchronous reluctance machines and PM machines without rare-earth materials, comparing them to state-of-the-art solutions. The book provides readers with extensive information on and finite element models of PM synchronous machines, including all relevant equations and with an emphasis on synchronous-reluctance and PM-assisted synchronous-reluctance machines. It covers ferrite-assisted machines, modeled as a subcase of PM-assistance, fractional slot combinations solutions, and a quantitative, normalized comparison of torque capability with benchmark PM machines. The book discusses a wealth of techniques for identifying machine parameters, with an emphasis on self-commissioning algorithms, and presents methods for automated machine design and optimization, including a software tool developed for this purpose. Addressing an important gap in the field of PM-less and less-PM electrical machines, it is intended as a self-contained reference guide for both graduate students and professional machine designers, and as a useful text for university courses on automated and/or optimized design of electrical machines and drives.

*Position Sensorless Control Techniques for Permanent Magnet Synchronous Machine Drives* Monographs in Electrical and E

The book focuses on position sensorless control for PMSM drives, addressing both basic principles and experimental evaluation. It provides an in-depth study on a number of major topics, such as

model-based sensorless control, saliency-based sensorless control, position estimation error ripple elimination and acoustic noise reduction. Offering a comprehensive and systematic overview of position sensorless control and practical issues it is particularly suitable for readers interested in the sensorless control techniques for PMSM drives. The book is also a valuable resource for researchers, engineers, and graduate students in fields of ac motor drives and sensorless control.

**Electric Drives, Second Edition** Springer

Surveying the technologies used to satisfy the world's demand for open, efficient, and clean electricity, Variable Speed Generators provides an in-depth examination of variable-speed generators for both stand-alone and grid-connected applications. Part of The Electric Generators Handbook, Two-Volume Set, this work offers authoritative, tightly focused treatment of the topologies, steady state and transients modeling, performance, control, design, and testing of stand-

alone and grid-connected generators operating at variable speeds. Variable Speed Generators thoroughly covers all types of variable-speed generators currently in progress in distributed generation and renewable energy applications around the world. It delves into the steady state, transients, control, and design of claw-pole rotor synchronous, induction, permanent magnet-assisted synchronous, and switched reluctance starter alternators for hybrid-electric vehicles. It also discusses PM synchronous, transverse-flux PM, and flux-reversal PM generators for low-speed wind and hydro energy conversion as well as linear-motion alternators for residential and spacecraft applications. Numerous design and control examples illustrate the discussion. The promise of renewable, sustainable energy rests on our ability to design innovative power systems that are able to harness energy from a variety of sources. Variable Speed Generators supplies the tools necessary to design, validate, and deploy the right power generation technologies to fulfill tomorrow's complex energy needs.

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