



# Permanent Magnet Motor Designs

**Wei Tong**



## **Permanent Magnet Motor Designs:**

**Brushless Permanent-magnet Motor Design** Duane C. Hanselman, 1994 Written for electrical electronics mechanical engineers responsible for designing specifying motors the book provides details of brushless DC synchronous motors as well as both radial axial motor topologies Beginning with a discussion of the fundamentals of generic motor design it logically progresses to a set of more advanced yet easily understandable concepts for designing brushless permanent magnet motors In addition the author fully explains techniques for magnetic modeling circuit analysis shows how magnetic circuit analysis applies to motor design describes all major aspects of motor operation design in simple mathematical terms develops rigorous design equations for radial flux axial flux motors illustrates basic motor drive schemes All common motor design terms are clearly defined a wealth of charts tables equations are included *Permanent Magnet Motor Technology* Jacek F. Gieras, 2009-08-25 The importance of permanent magnet PM motor technology and its impact on electromechanical drives has grown exponentially since the publication of the bestselling second edition The PM brushless motor market has grown considerably faster than the overall motion control market This rapid growth makes it essential for electrical and electromechanical engineers and students to stay up to date on developments in modern electrical motors and drives including their control simulation and CAD Reflecting innovations in the development of PM motors for electromechanical drives *Permanent Magnet Motor Technology Design and Applications Third Edition* demonstrates the construction of PM motor drives and supplies ready to implement solutions to common roadblocks along the way This edition supplies fundamental equations and calculations for determining and evaluating system performance efficiency reliability and cost It explores modern computer aided design of PM motors including the finite element approach and explains how to select PM motors to meet the specific requirements of electrical drives The numerous examples models and diagrams provided in each chapter facilitate a lucid understanding of motor operations and characteristics This 3rd edition of a bestselling reference has been thoroughly revised to include Chapters on high speed motors and micromotors Advances in permanent magnet motor technology Additional numerical examples and illustrations An increased effort to bridge the gap between theory and industrial applications Modified research results The growing global trend toward energy conservation makes it quite possible that the era of the PM brushless motor drive is just around the corner This reference book will give engineers researchers and graduate level students the comprehensive understanding required to develop the breakthroughs that will push this exciting technology to the forefront **Design of Brushless Permanent-magnet Motors** J. R. Hendershot, Timothy John Eastham Miller, 1994-01-01 **Design of Brushless Permanent-magnet Machines** J. R. Hendershot, Timothy John Eastham Miller, 2010-01-01 Brushless permanent magnet motors provide simple low maintenance and easily controlled mechanical power Written by two leading experts on the subject this book offers the most comprehensive guide to the design and performance of brushless permanent magnetic motors ever written Topics range

from electrical and magnetic design to materials and control Throughout the authors stress both practical and theoretical aspects of the subject and relate the material to modern software based techniques for design and analysis As new magnetic materials and digital power control techniques continue to widen the scope of the applicability of such motors the need for an authoritative overview of the subject becomes ever more urgent Design of Brushless Permanent Magnet Motors fits the bill and will be read by students and researchers in electric and electronic engineering Permanent Magnet Motor Technology Jacek F. Gieras, 2002-01-22 Co authored by a world renowned expert in the field Permanent Magnet Motor Technology Design and Applications Second Edition demonstrates the construction of PM motor drives and supplies ready to implement solutions for common roadblocks The author presents fundamental equations and calculations to determine and evaluate system performance efficiency and reliability explores modern computer aided design of PM motors including the finite element approach and covers how to select PM motors to meet the specific requirements of electrical drives The numerous examples models and diagrams provided in each chapter give the reader a clear understanding of motor operations and characteristics

**Motor design for maximum material exploitation and magnetization procedure with in-line quality check for mass production** Dinca, Christian, 2017-03-09 To reduce the amount of Rare earth Elements in high efficient permanent magnet electric motors the magnetic stray flux has to be reduced Additionally a temperature reduction inside the motor reduces the necessary amount of the so called Heavy Rare earth Elements which account for the bulk part of the magnet material costs In this thesis a permanent magnet motor in wet rotor configuration for an automotive application is designed It was shown that by simple thermal improvements of the electric insulation system the maximum temperature of the stator can be reduced Extensive measurements on different combinations of insulation material of the stator and the development of a new thermal model for orthocyclic wound stators were performed Due to the use of fiber cans eddy current losses could be eliminated and the stray flux minimized In a second stage a magnetizing fixture was build up which is able to magnetize the buried magnets inside the rotor The rotor and the magnetizing fixture was developed so that the magnets can be optimal magnetized To check the quality of the magnets the magnetizing coil was developed in a way such that the hysteresis curve of every single magnet during magnetization can be measured Different magnets were tested and ways to calculate parasitics are given Um die Menge an Selten Erden in hoch effizienten permanent erregten Elektromotoren zu reduzieren muss der magnetische Streufluss verringert werden Eine Temperaturreduktion im Motor verringert zudem die n tige Menge an so genannten schweren Selten Erden welche einen Gro teil der Kosten der Magnetmaterialien ausmachen In dieser Arbeit wird dazu ein permanent erregter Nassl ufer f r eine automotive Anwendung ausgelegt Es konnte gezeigt werden dass durch einfache Ma nahmen im Bereich der elektrischen Isolation die maximale Temperatur im Stator reduziert werden konnte Umfangreiche Messungen an verschiedenen Kombinationen von elektrischen Isolationen des Stators und die Entwicklung eines neuen thermischen Models f r orthozyklisch gewickelte Statoren wurden get tigt Durch Einsatz von

Spaltrohren aus Faserverbundwerkstoffen konnten die Wirbelstromverluste beseitigt werden und der Streufluss minimiert werden. In einem zweiten Schritt wurde eine Magnetisiervorrichtung aufgebaut mit der die zu Anfang unmagnetisierten eingebetteten Magneten im Rotor aufmagnetisiert werden konnten. Der Rotor wurde zudem zusammen mit der Magnetisierungsspule so ausgelegt, dass die Magnete optimal magnetisiert werden können. Um die Qualität der Magnete zu testen, wurde die Magnetisierungsspule zudem so ausgelegt, dass eine Messung der Hysteresekurve jedes einzelnen Magneten während der Magnetisierung möglich ist. Verschiedene Magnete wurden vermessen und Möglichkeiten zur Bestimmung von parasitären Effekten gegeben.

Mechanical Design of Electric Motors Wei Tong, 2014-04-28. Rapid increases in energy consumption and emphasis on environmental protection have posed challenges for the motor industry as has the design and manufacture of highly efficient, reliable, cost-effective, energy-saving, quiet, precisely controlled and long-lasting electric motors. Suitable for motor designers, engineers and manufacturers as well.

*Permanent Magnet Synchronous and Brushless DC Motor Drives* Ramu Krishnan, 2017-12-19. 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.

**Introduction to AC Machine Design** Thomas A. Lipo, 2017-10-06. The only book on the market that emphasizes machine design beyond the basic principles of AC and DC machine behavior. AC electrical machine design is a key skill set for developing competitive electric motors and generators for applications in industry, aerospace and defense.

This book presents a thorough treatment of AC machine design starting from basic electromagnetic principles and continuing through the various design aspects of an induction machine. Introduction to AC Machine Design includes one chapter each on the design of permanent magnet machines, synchronous machines, and thermal design. It also offers a basic treatment of the use of finite elements to compute the magnetic field within a machine without interfering with the initial comprehension of the core subject matter. Based on the author's notes as well as after years of classroom instruction, Introduction to AC Machine Design brings to light more advanced principles of machine design, not just the basic principles of AC and DC machine behavior. It introduces electrical machine design to neophytes while also being a resource for experienced designers. Fully examines AC machine design beginning with basic electromagnetic principles. Covers the many facets of the induction machine design. Introduction to AC Machine Design is an important text for graduate school students studying the design of electrical machinery and it will be of great interest to manufacturers of electrical machinery. **Multidisciplinary Design**

**Optimization Methods for Electrical Machines and Drive Systems** Gang Lei, Jianguo Zhu, Youguang Guo, 2016-02-05

This book presents various computationally efficient component and system level design optimization methods for advanced electrical machines and drive systems. Readers will discover novel design optimization concepts developed by the authors and other researchers in the last decade, including application-oriented multi-disciplinary multi-objective multi-level deterministic and robust design optimization methods. A multi-disciplinary analysis includes various aspects of materials, electromagnetics, thermotics, mechanics, power electronics, applied mathematics, manufacturing technology, and quality control and management. This book will benefit both researchers and engineers in the field of motor and drive design and manufacturing, thus enabling the effective development of the high-quality production of innovative high-performance drive systems for challenging applications such as green energy systems and electric vehicles. *Designing Electrical Machines with*

*COMSOL* Ovidiu CRAIU, 2024-02-29 This book presents the author's experience in modeling electrical machines using numerical Finite Element Method (MEF) models. Each of the studies presented in the book has specific and added complexity. Some of the FEM models were coupled with electric circuit equations; steady-state analysis was completed with transient dynamic studies, and on occasions, mechanical equations were coupled to field circuit formulations. For each of the applications presented, the author provides some insight regarding the more complex parts of the model implementation in COMSOL: what type of solver to use and how to process and interpret the obtained results. Providing some screen shots from COMSOL model implementation may assist the user in developing their own similar applications. **Analysis and Design**

**of Heating, Ventilating, and Air-Conditioning Systems, Second Edition** Herbert W. Stanford III, Adam F.

Spach, 2019-04-01 Analysis and Design of Heating, Ventilating, and Air Conditioning Systems, Second Edition provides a thorough and modern overview of HVAC for commercial and industrial buildings, emphasizing energy efficiency. This text combines coverage of heating and air conditioning systems design with detailed information on the latest controls.

technologies It also addresses the art of HVAC design along with carefully explained scientific and technical content reflecting the extensive experience of the authors Modern HVAC topics are addressed including sustainability IAQ water treatment and risk management vibration and noise mitigation and maintainability from a practical point of view

*Multi-objective Design Optimization of Switched Reluctance Motor Drive Systems* Xiaodong Sun, Kaikai Diao, Gang Lei, Jianguo Zhu, 2024-12-20 This book presents the design optimization method for switched reluctance motors SRMs and drive systems It covers an in depth literature review on the status and potential trend of design optimization techniques for SRMs including design theory modeling methods topologies control methods and techniques for optimization efficiency and effects Readers will discover new design methods based on the specific nonlinear characteristics of SRMs and multi objective optimization methods for the design of high quality switched reluctance drive systems without or with the consideration of uncertainties i e the deterministic and robust approaches Multi mode design optimization method regarding SRMs is investigated and some examples are presented In addition some essential trends in design optimization development are presented and highlighted as future perspectives This book benefits students researchers engineers and companies in the field of electrical drive design and manufacturing The focuses of this book are different from those of the published books The advanced optimization methods including deterministic optimization robust optimization and system level optimization are not discussed in these books Besides new design method based on the nonlinear characteristic and multi mode optimization combined with specific application will be introduced to the design of high performance of switched reluctance machines

Switched Reluctance Motor Drives Berker Bilgin, James Weisheng Jiang, Ali Emadi, 2019-04-29 Electric motors are the largest consumer of electric energy and they play a critical role in the growing market for electrification Due to their simple construction switched reluctance motors SRMs are exceptionally attractive for the industry to respond to the increasing demand for high efficiency high performance and low cost electric motors with a more secure supply chain Switched Reluctance Motor Drives Fundamentals to Applications is a comprehensive textbook covering the major aspects of switched reluctance motor drives It provides an overview of the use of electric motors in the industrial residential commercial and transportation sectors It explains the theory behind the operation of switched reluctance motors and provides models to analyze them The book extensively concentrates on the fundamentals and applications of SRM design and covers various design details such as materials mechanical construction and controls Acoustic noise and vibration is the most well known issue in switched reluctance motors but this can be reduced significantly through a multidisciplinary approach These methodologies are explained in two chapters of the book The first covers the fundamentals of acoustic noise and vibration so readers have the necessary tools to analyze the problems and explains the surface waves spring mass models forcing harmonics and mode shapes that are utilized in modeling and analyzing acoustic noise and vibration The second applies these fundamentals to switched reluctance motors and provides examples for determining the sources of any acoustic

noise in switched reluctance motors In the final chapter two SRM designs are presented and proposed as replacements for permanent magnet machines in a residential HVAC application and a hybrid electric propulsion application It also shows a high power and compact converter design for SRM drives Features Comprehensive coverage of switched reluctance motor drives from fundamental principles to design operation and applications A specific chapter on electric motor usage in industrial residential commercial and transportation applications to address the benefits of switched reluctance machines Two chapters address acoustic noise and vibration in detail Numerous illustrations and practical examples on the design modeling and analysis of switched reluctance motor drives Examples of switched reluctance motor and drive design *The Proceedings of the 17th Annual Conference of China Electrotechnical Society* Qingxin Yang, Jian Li, Kaigui Xie, Jianlin Hu, 2023-03-28 This book gathers outstanding papers presented at the 17th Annual Conference of China Electrotechnical Society organized by China Electrotechnical Society CES held in Beijing China from September 17 to 18 2022 It covers topics such as electrical technology power systems electromagnetic emission technology and electrical equipment It introduces the innovative solutions that combine ideas from multiple disciplines The book is very much helpful and useful for the researchers engineers practitioners research students and interested readers **Modern Electric, Hybrid Electric, and Fuel Cell Vehicles** Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, 2004-12-20 Air quality is deteriorating the globe is warming and petroleum resources are decreasing The most promising solutions for the future involve the development of effective and efficient drive train technologies This comprehensive volume meets this challenge and opportunity by integrating the wealth of disparate information found in scattered page **Mechanical Design and Manufacturing of Electric Motors** Wei Tong, 2022-05-19 This Second Edition of Mechanical Design and Manufacturing of Electric Motors provides in depth knowledge of design methods and developments of electric motors in the context of rapid increases in energy consumption and emphasis on environmental protection alongside new technology in 3D printing robots nanotechnology and digital techniques and the challenges these pose to the motor industry From motor classification and design of motor components to model setup and material and bearing selections this comprehensive text covers the fundamentals of practical design and design related issues modeling and simulation engineering analysis manufacturing processes testing procedures and performance characteristics of electric motors today This Second Edition adds three brand new chapters on motor breaks motor sensors and power transmission and gearing systems Using a practical approach with a focus on innovative design and applications the book contains a thorough discussion of major components and subsystems such as rotors shafts stators and frames alongside various cooling techniques including natural and forced air direct and indirect liquid phase change and other newly emerged innovative cooling methods It also analyzes the calculation of motor power losses motor vibration and acoustic noise issues and presents engineering analysis methods and case study results While suitable for motor engineers designers manufacturers and end users the book will also be of interest to maintenance



personnel undergraduate and graduate students and academic researchers      **Sustainable Design and Manufacturing**

Steffen G. Scholz, Robert J. Howlett, Rossi Setchi, 2023-01-01 The book consists of peer reviewed papers presented at the International Conference on Sustainable Design and Manufacturing SDM 2022 Leading edge research into sustainable design and manufacturing aims to enable the manufacturing industry to grow by adopting more advanced technologies and at the same time improve its sustainability by reducing its environmental impact Relevant themes and topics include sustainable design innovation and services sustainable manufacturing processes and technology sustainable manufacturing systems and enterprises and decision support for sustainability Application areas are wide and varied The book provides an excellent overview of the latest developments in the sustainable design and manufacturing area      Automotive Power Transmission Systems Yi Zhang, Chris Mi, 2018-07-18 Provides technical details and developments for all automotive power transmission systems The transmission system of an automotive vehicle is the key to the dynamic performance drivability and comfort and fuel economy Modern advanced transmission systems are the combination of mechanical electrical and electronic subsystems The development of transmission products requires the synergy of multi disciplinary expertise in mechanical engineering electrical engineering and electronic and software engineering Automotive Power Transmission Systems comprehensively covers various types of power transmission systems of ground vehicles including conventional automobiles driven by internal combustion engines and electric and hybrid vehicles The book covers the technical aspects of design analysis and control for manual transmissions automatic transmission CVTs dual clutch transmissions electric drives and hybrid power systems It not only presents the technical details of key transmission components but also covers the system integration for dynamic analysis and control Key features Covers conventional automobiles as well as electric and hybrid vehicles Covers aspects of design analysis and control Includes the most recent developments in the field of automotive power transmission systems The book is essential reading for researchers and practitioners in automotive mechanical and electrical engineering      *Power Magnetic Devices* Scott D. Sudhoff, 2014-01-30 Presents a multi objective design approach to the many power magnetic devices in use today Power Magnetic Devices A Multi Objective Design Approach addresses the design of power magnetic devices including inductors transformers electromagnets and rotating electric machinery using a structured design approach based on formal single and multi objective optimization The book opens with a discussion of evolutionary computing based optimization Magnetic analysis techniques useful to the design of all the devices considered in the book are then set forth This material is then used for inductor design so readers can start the design process Core loss is next considered this material is used to support transformer design A chapter on force and torque production feeds into a chapter on electromagnet design This is followed by chapters on rotating machinery and the design of a permanent magnet AC machine Finally enhancements to the design process including thermal analysis and AC conductor losses due to skin and proximity effects are set forth Power Magnetic Devices Focuses on the design process as it

relates to power magnetic devices such as inductors transformers electromagnets and rotating machinery Offers a structured design approach based on single and multi objective optimization Helps experienced designers take advantage of new techniques which can yield superior designs with less engineering time Provides numerous case studies throughout the book to facilitate readers comprehension of the analysis and design process Includes Powerpoint slide based student and instructor lecture notes and MATLAB based examples toolboxes and design codes Designed to support the educational needs of students Power Magnetic Devices A Multi Objective Design Approach also serves as a valuable reference tool for practicing engineers and designers MATLAB examples are available via the book support site

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