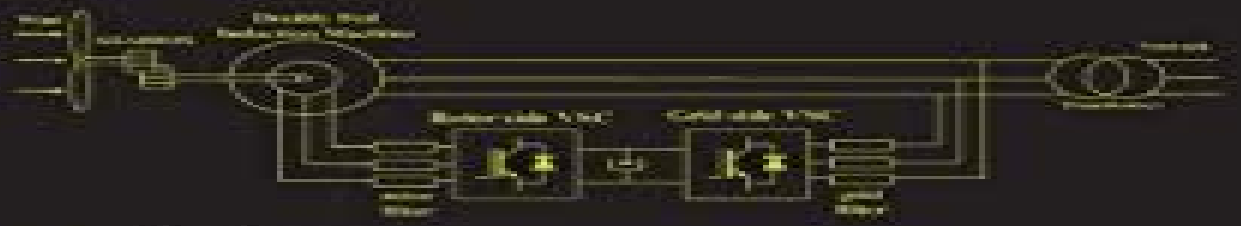
# Doubly Fed Induction Machine

## Modeling and Control for Wind Energy Generation



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# Doubly Fed Induction Machine Modeling And Control For Wind Energy Generation

Christian Johannes Georg Dirscherl

**Doubly Fed Induction Machine Modeling And Control For Wind Energy Generation:**

**Doubly Fed Induction Machine** Gonzalo Abad,Jesus Lopez,Miguel Rodriguez,Luis Marroyo,Grzegorz Iwanski,2011-09-28 This book will be focused on the modeling and control of the DFIM based wind turbines In the first part of the book the mathematical description of different basic dynamic models of the DFIM will be carried out It will be accompanied by a detailed steady state analysis of the machine After that a more sophisticated model of the machine that considers grid disturbances such as voltage dips and unbalances will be also studied The second part of the book surveys the most relevant control strategies used for the DFIM when it operates at the wind energy generation application The control techniques studied range from standard solutions used by wind turbine manufacturers to the last developments oriented to improve the behavior of high power wind turbines as well as control and hardware based solutions to address different faulty scenarios of the grid In addition the standalone DFIM generation system will be also analyzed *Modeling and Analysis of Doubly Fed Induction Generator Wind Energy Systems* Lingling Fan,Zhixin Miao,2015-04-16 Wind Energy Systems Modeling Analysis and Control with DFIG provides key information on machine converter modelling strategies based on space vectors complex vector and further frequency domain variables It includes applications that focus on wind energy grid integration with analysis and control explanations with examples For those working in the field of wind energy integration examining the potential risk of stability is key this edition looks at how wind energy is modelled what kind of control systems are adopted how it interacts with the grid as well as suitable study approaches Not only giving principles behind the dynamics of wind energy grid integration system but also examining different strategies for analysis such as frequency domain based and state space based approaches Focuses on real and reactive power control Supported by PSCAD and Matlab Simulink examples Considers the difference in control objectives between ac drive systems and grid integration systems **Model Predictive Control of Wind Energy Conversion Systems** Venkata Yaramasu,Bin Wu,2016-11-23 Model Predictive Control of Wind Energy Conversion Systems addresses the predicative control strategy that has emerged as a promising digital control tool within the field of power electronics variable speed motor drives and energy conversion systems The authors provide a comprehensive analysis on the model predictive control of power converters employed in a wide variety of variable speed wind energy conversion systems WECS The contents of this book includes an overview of wind energy system configurations power converters for variable speed WECS digital control techniques MPC modeling of power converters and wind generators for MPC design Other topics include the mapping of continuous time models to discrete time models by various exact approximate and quasi exact discretization methods modeling and control of wind turbine grid side two level and multilevel voltage source converters The authors also focus on the MPC of several power converter configurations for full variable speed permanent magnet synchronous generator based WECS squirrel cage induction generator based WECS and semi variable speed doubly fed induction generator based WECS Furthermore this book Analyzes a wide variety of practical

WECS illustrating important concepts with case studies simulations and experimental results Provides a step by step design procedure for the development of predictive control schemes for various WECS configurations Describes continuous and discrete time modeling of wind generators and power converters weighting factor selection discretization methods and extrapolation techniques Presents useful material for other power electronic applications such as variable speed motor drives power quality conditioners electric vehicles photovoltaic energy systems distributed generation and high voltage direct current transmission Explores S Function Builder programming in MATLAB environment to implement various MPC strategies through the companion website Reflecting the latest technologies in the field Model Predictive Control of Wind Energy Conversion Systems is a valuable reference for academic researchers practicing engineers and other professionals It can also be used as a textbook for graduate level and advanced undergraduate courses **Protection of Grid-Connected Wind Energy Systems** Heba A. Mahmoud,Adel A. Elbaset,Montaser Abdelsattar,2025-03-13 Protection Improvement of Electrical Network Connected Wind Energy Systems Case Studies Strategies and Techniques from the Egyptian Power System focuses on improving the protection of wind energy systems linked to an electrical network It explores various protection strategies and techniques to enhance the wind energy systems capability of withstanding low voltage ride through LVRT and reduce the total annual cost The book addresses the advantages and disadvantages of each protection strategy providing a comprehensive evaluation of the protection techniques employed to improve LVRT capabilities The authors use the Al Zafarana Wind Energy Conversion System as a case study system for simulation tests in a MATLAB Simulink environment *Doubly Fed Induction Generators* Edgar N. Sanchez,Riemann Ruiz-Cruz,2016-08-05 Doubly Fed Induction Generators Control for Wind Energy provides a detailed source of information on the modeling and design of controllers for the doubly fed induction generator DFIG used in wind energy applications Focusing on the use of nonlinear control techniques this book Discusses the main features and advantages of the DFIG Describes key theoretical fundamentals and the DFIG mathematical model Develops controllers using inverse optimal control sliding modes and neural networks Devises an improvement to add robustness in the presence of parametric variations Details the results of real time implementations All controllers presented in the book are tested in a laboratory prototype Comparisons between the controllers are made by analyzing statistical measures applied to the control objectives *Modeling and Control Aspects of Wind Power Systems* S. M. Muyeen,Ahmed Al-Durra,2013-03-20 This book covers the recent development and progress of the wind energy conversion system The chapters are contributed by prominent researchers in the field of wind energy and cover grid integration issues modern control theories applied in wind energy conversion system and dynamic and transient stability studies Modeling and control strategies of different variable speed wind generators such as switched reluctance generator permanent magnet synchronous generator doubly fed induction generator including the suitable power electronic converter topologies for grid integration are discussed Real time control study of wind farm using Real Time Digital Simulator RTDS is

also included in the book along with Fault ride through street light application integrated power flow solutions direct power control wireless coded deadbeat power control and other interesting topics **Advanced Controls for Wind Driven Doubly Fed Induction Generators** Mahmoud K. Abdelhamid,Mahmoud A. Mossa,Ahmed A. Hassan,2023-12-22 Advanced Controls for Wind Driven Doubly Fed Induction Generators discusses the most advanced control algorithms used for enhancing the dynamics of a doubly fed induction generator DFIG operating at fixed and variable speeds and which are used for different utilization purposes standalone and grid connection Extensive generator performance analysis has been introduced using various control topologies Features Presents modeling of wind energy conversion systems WECS including a wind turbine as a prime mover a DFIG as a generation unit for electrical energy and a three phase induction motor as an isolated load Explores a detailed description for the presented control algorithms in order to visualize the base principle of each method Introduces a comprehensive performance analysis for the DFIG using the formulated predictive voltage control scheme and other control techniques under different operating conditions Examines the formulation of new control approaches which overcome the shortages present in previous DFIG control schemes Presents a detailed comparison between different control topologies for the DFIG to outline the most effective procedure in terms of dynamic response structure simplicity ripples total harmonic distortion and computational burdens The book is written for researchers and academics working on advanced control systems and those interested in areas such as machine drives renewable energy systems adaptive control modeling of WECS and optimization theory Advanced Control of Doubly Fed Induction Generator for Wind Power Systems Dehong Xu,Frede Blaabjerg,Wenjie Chen,Nan Zhu,2018-08-14 Covers the fundamental concepts and advanced modelling techniques of Doubly Fed Induction Generators accompanied by analyses and simulation results Filled with illustrations problems models analyses case studies selected simulation and experimental results Advanced Control of Doubly Fed Induction Generator for Wind Power Systems provides the basic concepts for modelling and controlling of Doubly Fed Induction Generator DFIG wind power systems and their power converters It explores both the challenges and concerns of DFIG under a non ideal grid and introduces the control strategies and effective operations performance options of DFIG under a non ideal grid Other topics of this book include thermal analysis of DFIG wind power converters under grid faults implications of the DFIG test bench advanced control of DFIG under harmonic distorted grid voltage including multiple loop and resonant control modeling of DFIG and GSC under unbalanced grid voltage the LFRT of DFIG including the recurring faults ride through of DFIG and more In addition this resource Explores the challenges and concerns of Doubly Fed Induction Generators DFIG under non ideal grid Discusses basic concepts of DFIG wind power system and vector control schemes of DFIG Introduces control strategies under a non ideal grid Includes case studies and simulation and experimental results Advanced Control of Doubly Fed Induction Generator for Wind Power Systems is an ideal book for graduate students studying renewable energy and power electronics as well as for research and development

engineers working with wind power converters **Modeling and Control of Wind Turbine Systems with Doubly-fed Induction Machines** Christian Johannes Georg Dirscherl,2022 Proceedings of Second International Conference on Electrical Systems, Technology and Information 2015 (ICESTI 2015) Felix Pasila,Yusak Tanoto,Resmana Lim,Murtiyanto Santoso,Nemuel Daniel Pah,2016-02-10 This book includes the original peer reviewed research papers from the 2nd International Conference on Electrical Systems Technology and Information ICESTI 2015 held in September 2015 at Patra Jasa Resort Villas Bali Indonesia Topics covered include Mechatronics and Robotics Circuits and Systems Power and Energy Systems Control and Industrial Automation and Information Theory It explores emerging technologies and their application in a broad range of engineering disciplines including communication technologies and smart grids It examines hybrid intelligent and knowledge based control embedded systems and machine learning It also presents emerging research and recent application in green energy system and storage It discusses the role of electrical engineering in biomedical industrial and mechanical systems as well as multimedia systems and applications computer vision and image and signal processing The primary objective of this series is to provide references for dissemination and discussion of the above topics This volume is unique in that it includes work related to hybrid intelligent control and its applications Engineers and researchers as well as teachers from academia and professionals in industry and government will gain valuable insights into interdisciplinary solutions in the field of emerging electrical technologies and its applications **Advances in Energy and Power Systems** Sri Niwas Singh,Fushuan Wen,Monika Jain,2018-05-31 This book comprises select proceedings of the International Conference on Advancement in Energy Drives and Control It covers pioneering topics in the field of renewable energy and power management including energy storage distribution and control It also discusses methods of optimizing power distribution and generation systems This book is of use to researchers professionals and students from across engineering disciplines *Energy Efficiency of Modern Power and Energy Systems* Shady H E Abdel Aleem,Murat Erhan Balci,Muhyaddin Jamal Hosin Rawa,2024-08-15 Energy Efficiency and Management of Power and Energy Systems introduces students and researchers to a broad range of power system management challenges technologies and solutions This book begins with an analysis of system technology s current state the most pressing problems and the background to challenges in integrating renewable energy sources Technologies including smart grids green building and worker requirements are covered Subsequent chapters break down potential management solutions including specific problem solving for solar wind and hybrid systems Finally specific case studies from a global geographical range zero in on critical questions facing the present industry Providing meticulously researched literature reviews for guiding deeper reading Energy Efficiency and Management of Power and Energy Systems leads readers from contextual understanding to specific case studies and solutions for sustainable power systems Addresses the challenges and solutions related to integrating renewable energy sources into the power grid focusing on maintaining power quality and enhancing energy efficiency Provides a

comprehensive reference with extensive guidance on deeper reading Develops understanding and solution design using case studies from a global range of geographies with differing power needs and resources Guides readers through evaluation and analysis of the capabilities and limitations of a range of modern technologies *Control of a Wind Driven Doubly Fed Induction Generator During Grid Faults* Mahmoud Mossa,2013-02-06 Master s Thesis from the year 2013 in the subject Engineering Power Engineering grade none course Electrical engineering Renewable energy language English abstract Wind electrical power systems are recently getting lot of attention because they are cost competitive environmental clean and safe renewable power source as compared with fossil fuel and nuclear power generation A special type of induction generator called a doubly fed induction generator DFIG is used extensively for high power wind applications They are used more and more in wind turbine applications due to ease controllability high energy efficiency and improved power quality This thesis aims to develop a method of a field orientation scheme for control both the active and reactive powers of a DFIG driven by a wind turbine The proposed control system consists of a wind turbine that drives a DFIG connected to the utility grid through AC DC AC link The main control objective is to regulate the dc link voltage for operation at maximum available wind power This is achieved by controlling the and axes components of voltages and currents for both rotor side and line side converters using PI controllers The complete dynamic model of the proposed system is described in detail Computer simulations have been carried out in order to validate the effectiveness of the proposed system during the variation of wind speed The results prove that better overall performances are achieved quick recover from wind speed disturbances in addition to good tracking ability Generally any abnormalities associated with grid asymmetrical faults are going to affect the system performance considerably During grid faults unbalanced currents cause negative effects like overheating problems and mechanical stress due to high torque pulsations that can damage the rotor shaft gearbox or blade assembly Therefore the dynamic model of the DFIG driven by a wind turbine during grid faults has been analyzed and developed using the method of symmetrical components The dynamic performance of the DFIG during unbalanced grid conditions is analyzed and described in detail using digital simulations A novel fault ride through FRT capability is proposed i e the ability of the power system to remain connected to the grid during faults with suitable control strategy in this thesis In this scheme the input mechanical energy of the wind turbine during grid faults is stored and utilized at the moment of fault clearance instead of being dissipated in the resistors of the crowbar circuit as in the existing FRT schemes **Advanced Control of Variable Speed Wind Turbine Based on Doubly-fed Induction Generator** Lei Wang,2012 This thesis deals with the modeling control and analysis of doubly fed induction generators DFIG based wind turbines DFIG WT The DFIG WT is one of the mostly employed wind power generation systems WPGS due to its merits including variable speed operation for achieving the maximum power conversion smaller capacity requirement for power electronic devices and full controllability of active and reactive powers of the DFIG The dynamic modeling of DFIG WT has been carried out at first in Chapter 2 with the conventional vector control VC

strategies for both rotor side and grid side converters The vector control strategy works in a synchronous reference frame aligned with the stator flux vector became very popular for control of the DFIG Although the conventional VC strategy is simple and reliable it is not capable of providing a satisfactory transient response for DFIG WT under grid faults As the VC is usually designed and optimized based on one operation point thus the overall energy conversion efficiency cannot be maintained at the optimal point when the WPGS operation point moves away from that designed point due to the time varying wind power inputs Compared with VC methods which are designed based on linear model obtained from one operation point nonlinear control methods can provide consistent optimal performance across the operation envelope rather than at one operation point To improve the asymptotical regulation provided by the VC which can t provide satisfactory performance under voltage sags caused by grid faults or load disturbance of the grid input output feedback linearization control IOFLC has been applied to develop a fully decoupled controller of the active reactive powers of the DFIG in Chapter 3 Furthermore a cascade control strategy is proposed for power regulation of DFIG WT which can provide better performance against the varying operation points and grid disturbance Moreover to improve the overall energy conversion efficiency of the DFIG WT FLC based maximum power point tracking MPPT has been investigated The main objective of the FLC based MPPT in Chapter 4 is to design a global optimal controller to deal with the time varying operation points and nonlinear characteristic of the DFIG WT Modal analysis and simulation studies have been used to verify the effectiveness of the FLC based MPPT compared with the VC The system mode trajectory including the internal zero dynamic of the FLC MPPT are carefully examined in the face of varied operation ranges and parameter uncertainties In a realistic DFIG WT the parameter variability the uncertain and time varying wind power inputs are existed To enhance the robustness of the controller a nonlinear adaptive controller NAC via state and perturbation observer for feedback linearizable nonlinear systems is applied for MPPT control of DFIG WT in Chapter 5 In the design of the controller a perturbation term is defined to describe the combined effect of the system nonlinearities and uncertainties and represented by introducing a fictitious state in the state equations As follows a state and perturbation observer is designed to estimate the system states and perturbation leading to an adaptive output feedback linearizing controller which uses the estimated perturbation to cancel system perturbations and the estimated states to implement a linear output feedback control law for the equivalent linear system Case studies including with and without wind speed measurement are carried out and proved that the proposed NAC for MPPT of DFIG WT can provide better robustness performance against the parameter uncertainties Simulation studies for demonstrating the performance of the proposed control methods in each chapter are carried out based on MATLAB SIMULINK *Modeling and Control of a Wind Turbine Power System Under Variable Wind Speeds Using Doubly-fed Induction Machine* Goutham Gonti,2013 A Novel Robust Control and Fault Ride Through for Wind Turbines with Doubly Fed Induction Generator Operating in Weak Grids Manoj Rathi,2005 **CIEP ...** ,2000 **Model Predictive Control of Wind Energy Conversion**

**Systems** Venkata Yaramasu,Bin Wu,2016-12-19 Model Predictive Control of Wind Energy Conversion Systems addresses the predicative control strategy that has emerged as a promising digital control tool within the field of power electronics variable speed motor drives and energy conversion systems The authors provide a comprehensive analysis on the model predictive control of power converters employed in a wide variety of variable speed wind energy conversion systems WECS The contents of this book includes an overview of wind energy system configurations power converters for variable speed WECS digital control techniques MPC modeling of power converters and wind generators for MPC design Other topics include the mapping of continuous time models to discrete time models by various exact approximate and quasi exact discretization methods modeling and control of wind turbine grid side two level and multilevel voltage source converters The authors also focus on the MPC of several power converter configurations for full variable speed permanent magnet synchronous generator based WECS squirrel cage induction generator based WECS and semi variable speed doubly fed induction generator based WECS Furthermore this book Analyzes a wide variety of practical WECS illustrating important concepts with case studies simulations and experimental results Provides a step by step design procedure for the development of predictive control schemes for various WECS configurations Describes continuous and discrete time modeling of wind generators and power converters weighting factor selection discretization methods and extrapolation techniques Presents useful material for other power electronic applications such as variable speed motor drives power quality conditioners electric vehicles photovoltaic energy systems distributed generation and high voltage direct current transmission Explores S Function Builder programming in MATLAB environment to implement various MPC strategies through the companion website Reflecting the latest technologies in the field Model Predictive Control of Wind Energy Conversion Systems is a valuable reference for academic researchers practicing engineers and other professionals It can also be used as a textbook for graduate level and advanced undergraduate courses *DFIG-based Wind Power Conversion System Connected to Grid* Akshay Kumar,2014-08-14 Master s Thesis from the year 2014 in the subject Engineering Power Engineering grade 7 8 Ajay Kumar Garg Engineering College course M Tech language English abstract Wind generation has become the most important alternate energy source and has experienced increased progress in India during the past decade While it has great potential as an alternative to less environmentally friendly energy sources there are various technical challenges that cause wind to be considered negatively by many utilities Wind energy conversion systems suffer from the fact that their real power generation is closely dependent on the local environmental conditions The Doubly Fed Induction Generator DFIG based wind turbine with variable speed variable pitch control scheme is the most popular wind power generator in the wind power industry This machine can be operated either in grid connected or standalone mode In this thesis a detailed electromechanical model of a DFIG based wind turbine connected to power grid as well as separately operated wind turbine system with different sub systems is developed in the MATLAB SIMULINK environment and its equivalent generator and turbine control structure is

realized In this regard following configurations have been considered DFIG with Battery storage sub system DFIG with Buck Boost converter DFIG with transformer DFIG with 3 winding transformer Addition of battery storage and buck boost converter sub systems into the system enables not only dispatching of generator power but also decreases the variability in their reactive power requirements The full control over both active and reactive power is possible by the use of transformer between DFIG and rotor side converter The steady state behavior of the overall wind turbine system is presented and the steady state reactive power ability of the DFIG is analyzed It has been shown that major part of the reactive power should be supplied from rotor side converter to reduce the overall rating of the generator The DFIG with above mentioned sub systems is connected to grid The total harmonic distortion analysis and efficiency are carried out It is found that DFIG with transformer in between machine and rotor side converter has lowest THD 2 29% and DFIG with 3 winding transformer has maximum efficiency above 93% **Modeling, Analysis and Enhancement of the performance of a Wind Driven DFIG During steady state and transient conditions** Mohmoud Mossa,2014-01-01 Recently wind electrical power systems are getting a lot of attention since they are cost competitive environmentally clean and safe renewable power source as compared with the fossil fuel and nuclear power generation A special type of induction generator called a doubly fed induction generator DFIG is used extensively for high power wind applications They are used more and more in wind turbine applications due to the ease of controllability the high energy efficiency and the improved power quality This research aims to develop a method of a field orientation scheme for control both the active and the reactive powers of a DFIG that are driven by a wind turbine Also the dynamic model of the DFIG driven by a wind turbine during grid faults is analyzed and developed using the method of symmetrical components Finally this study proposes a novel fault ride through FRT capability with a suitable control strategy i e the ability of the power system to remain connected to the grid during faults

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## Doubly Fed Induction Machine Modeling And Control For Wind Energy Generation Introduction

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