Analysis Of Sub Synchronous Resonance Ssr In Doubly Fed Induction Generator Dfig Based Wind Farms Synthesis

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EWING ALEAH

Simulation And Analysis Of Subsynchronous Resonance On The Koeberg Turbo-alternators Springer
Power System Small Signal Stability Analysis and Control, Second Edition analyzes severe outages due to the sustained growth of small signal oscillations in modern interconnected power systems. This fully revised edition addresses the continued expansion of power systems and the rapid upgrade to smart grid technologies that call for the implementation of robust and optimal controls. With a new chapter on MATLAB programs, this book describes how the application of power system damping controllers such as Power System Stabilizers and Flexible Alternating Current Transmission System controllers—namely Static Var Compensator and Thyristor Controlled Series Compensator —can guard against system disruptions. Detailed mathematical derivations, illustrated case studies, the application of soft computation techniques, designs of robust controllers, and end-of-chapter exercises make it a useful resource to researchers, practicing engineers, and post-graduates in electrical engineering. Considers power system small signal stability and provides various techniques to mitigate it Offers a new and straightforward method of finding the optimal location of PSS in a multi-machine power system Includes MATLAB programs and simulations for practical applications
Modelling and Analysis of Turbogenerators in Single Machine and Multi-machine Subsynchronous Resonance Studies John Wiley & Sons
This relevant and timely thesis presents the pioneering use of risk-based assessment tools to analyse the interaction between electrical and mechanical systems in mixed AC/DC power networks at subsynchronous frequencies. It also discusses assessing the effect of uncertainties in the mechanical parameters of a turbine generator on SSR in a meshed network with both symmetrical and asymmetrical compensation systems. The research presented has resulted in 12 publications including three top international journal papers (IEEE Transactions on Power Systems) and nine international conference publications, including two award-winning papers.
Advances in Power and Energy Engineering CRC Press
This project includes the study of Subsynchronous resonance (SSR) phenomenon which occurs in a power system having series capacitor compensated transmission line. Static VAR compensators can be used to damp SSR oscillations besides controlling the system voltage. The First IEEE benchmark model and eigenvalue techniques are applied in the project to study the behavior of turbo-generator connected to the series compensated transmission line.
Analysis and Mitigating of Subsynchronous Resonance in Power System Integrated with PV Power Station John Wiley & Sons
Conventionally transmission line power transfer capability can be increased by inserting the series compensation into the transmission lines. Though series compensation is an economical solution compared to building a new transmission line, it brings the risk of Sub-Synchronous Resonance in turbine-generator system-based power plants. In literature mitigation of SSR was actively studied using wind turbine generators and FACTS devices, where certain type of WTGs is vulnerable to SSR and FACTS devices are expensive and are not capable to exchange active power with the grid. The structure of PV farms can bring the can bring the capabilities of WTGs and FACTS devices together while addressing their problems at the same time. Among different renewables wind and solar are the fastest growing, according to DOE SunShot initiative studies by 2050 solar serves an estimated 27% of the U.S. electricity needs. The rapid growth in utility connected PV farms has opened new possibilities, and due to its flexibility and dispatchability PV farms can handle the grid support functions more effectively, whereas its ability to mitigate the SSR is rarely investigated. This thesis addresses the potential of PV Power Station to mitigate SSR problem particularly torque amplification in series compensated systems by augmenting the GSC control loop with damping controller using a control signal which is closely related to the network resonant mode, utility scale PV farms are a promising solution to combat the increasing demand and grid support functions simultaneously. The simulation studies are performed in MATLAB/Simulink software using IEEE Second Benchmark Model (SBM) for SSR studies.
Volume II Morgan & Claypool Publishers
Analysis of Subsynchronous Resonance in Power SystemsSpringer Science & Business Media
A Study of Subsynchronous Resonance in Power Systems Analysis of Subsynchronous Resonance in Power Systems
The new edition of POWER SYSTEM ANALYSIS AND DESIGN provides students with an introduction to the basic concepts of power systems along with tools to aid them in applying these skills to real world situations. Physical concepts are highlighted while also giving necessary attention to mathematical techniques. Both theory and modeling are developed from simple beginnings so that they can be readily extended to new and complex situations. The authors incorporate new tools and material to aid students with design issues and reflect recent trends in the field. Important Notice: Media content referenced within the product description or the product text may not be available in the ebook version.
Analysis and Control of Subsynchronous Resonance Cambridge University Press
Power System Oscillations deals with the analysis and control of low frequency oscillations in the 0.2-3 Hz range, which are a characteristic of interconnected power systems. Small variations in system load excite the oscillations, which must be damped effectively to maintain secure and stable system operation. No warning is given for the occurrence of growing oscillations caused by oscillatory instability, since a change in the system's operating condition may cause the transition from stable to unstable. If not limited by nonlinearities, unstable oscillations may lead to rapid system collapse. Thus, it is difficult for operators to intervene manually to restore the system's stability. It follows that it is important to analyze a system's oscillatory behavior in order to understand the system's limits. If the limits imposed by oscillatory instability are too low, they may be increased by the installation of special stabilizing controls. Since the late 60s when this phenomena was first observed in North American systems, intensive research has resulted in design and installation of stabilizing controls known as power system stabilizers (PSS). The design, location and tuning of PSS require special analytical tools. This book addresses these questions in a modal analysis framework, with transient simulation as a measure of controlled system performance. After discussing the nature of the oscillations, the design of the PSS is discussed extensively using modal analysis and frequency response. In the scenario of the restructured power system, the performance of power system damping controls must be insensitive to parameter uncertainties. Power system stabilizers, when well tuned, are shown to be robust using the techniques of modern control theory. The design of damping controls, which operate through electronic power system devices (FACTS), is also discussed. There are many worked examples throughout the text. The Power System Toolbox© for use with MATLAB® is used to perform all of the analyses used in this book. The text is based on the author's experience of over 40 years as an engineer in the power industry and as an educator.
Analysis of Subsynchronous Resonance in a Multi-machine Power System Anshan Pub
This book presents original, peer-reviewed research papers from the 4th Purple Mountain Forum –International Forum on Smart Grid Protection and Control (PMF2019-SGPC), held in Nanjing, China on August 17–18, 2019. Addressing the latest research hotspots in the power industry, such as renewable energy integration, flexible interconnection of large scale power grids, integrated energy system, and cyber physical power systems, the papers share the latest research findings and practical application examples of the new theories, methodologies and algorithms in these areas. As such book a valuable reference for researchers, engineers, and university students.
Analysis of Sub-synchronous Resonance (SSR) in Doubly-fed Induction Generator (DFIG)-Based Wind Farms MDPI
In an age where the amount of data collected from brain imaging is increasing constantly, it is of critical importance to analyse those data within an accepted framework to ensure proper integration and comparison of the information collected. This book describes the ideas and procedures that underlie the analysis of signals produced by the brain. The aim is to understand how the brain works, in terms of its functional architecture and dynamics. This book provides the background and methodology for the analysis of all types of brain imaging data, from functional magnetic resonance imaging to magnetoencephalography. Critically, Statistical Parametric Mapping provides a widely accepted conceptual framework which allows treatment of all these different modalities. This rests on an understanding of the brain's functional anatomy and the way that measured signals are caused experimentally. The book takes the reader from the basic concepts underlying the analysis of neuroimaging data to cutting edge approaches that would be difficult to find in any other source. Critically, the material is presented in an incremental way so that the reader can understand the precedents for each new development. This book will be particularly useful to neuroscientists engaged in any form of brain mapping; who have to contend with the real-world problems of data analysis and understanding the techniques they are using. It is primarily a scientific treatment and a didactic introduction to the analysis of brain imaging data. It can be used as both a textbook for students and scientists starting to use the techniques, as well as a reference for practicing neuroscientists. The book also serves as a companion to the software packages that have been developed for brain imaging data analysis. An essential reference and companion for users of the SPM software Provides a complete description of the concepts and procedures entailed by the analysis of brain images Offers full didactic treatment of the basic mathematics behind the analysis of brain imaging data Stands as a compendium of all the advances in neuroimaging data analysis over the past decade Adopts an easy to understand and incremental approach that takes the reader from basic statistics to state of the art approaches such as Variational Bayes Structured treatment of data analysis issues that links different modalities and models Includes a series of appendices and tutorial-style chapters that makes even the most sophisticated approaches accessible
2019 27th Iranian Conference on Electrical Engineering (ICEE) 1978.
Energy and power are playing pivotal roles in social and economic developments of the modern world. Energy and power engineers and technologists have made our lives much more comfortable and affordable. However, due to the demands of the global population on resources and the environment, innovations of more reliable and sustainable energy res
Analysis of Subsynchronous Resonance in Power Systems Academic Press
Power converters and electric machines represent essential components in all fields of electrical engineering. In fact, we are heading towards a future where energy will be more and more electrical: electrical vehicles, electrical motors, renewables, storage systems are now widespread. The ongoing energy transition poses new challenges for interfacing and integrating different power systems. The constraints of space, weight, reliability, performance, and autonomy for the electric system have increased the attention of scientific research in order to find more and more appropriate technological solutions. In this context, power converters and electric machines assume a key role in enabling higher performance of electrical power conversion. Consequently, the design and control of power converters and electric machines shall be developed accordingly to the requirements of the specific application, thus leading to more specialized solutions, with the aim of enhancing the reliability, fault tolerance, and flexibility of the next generation power systems.
Dynamics and Control of Electric Transmission and Microgrids John Wiley & Sons
Wind power penetration is rapidly increasing in today's energy generation industry. In particular, the doubly-fed induction generator (DFIG) has become a very popular option in wind farms, due to its cost advantage compared with fully rated converter-based systems. Wind farms are frequently located in remote areas, far from the bulk of electric power users, and require long transmission lines to connect to the grid. Series capacitive compensation of DFIG-based wind farm is an economical way to increase the power transfer capability of the transmission line connecting the wind farm to the grid. For example, a study performed by ABB reveals that increasing the power transfer capability of an existing transmission line from 1300 MW to 2000 MW using series compensation is 90% less expensive than building a new transmission line. However, a factor hindering the extensive use of series capacitive compensation is the potential risk of subsynchronous resonance (SSR). The SSR is a condition where the wind farm exchanges energy with the electric network, to which it is connected, at one or more natural frequencies of the electric or mechanical part of the combined system, comprising

the wind farm and the network, and the frequency of the exchanged energy is below the fundamental frequency of the system. This oscillatory phenomenon may cause severe damage in the wind farm, if not prevented. Therefore, this book studies the SSR phenomenon in a capacitive series compensated wind farm. A DFIG-based wind farm, which is connected to a series compensated transmission line, is considered as a case study. The book consists of two main parts: Small-signal modeling of DFIG for SSR analysis: This part presents a step-by-step tutorial on modal analysis of a DFIG-based series compensated wind farm using Matlab/Simulink. The model of the system includes wind turbine aerodynamics, a 6th order induction generator, a 2nd order two-mass shaft system, a 4th order series compensated transmission line, a 4th order rotor-side converter (RSC) controller and a 4th order grid-side converter (GSC) controller, and a 1st order DC-link model. The relevant modes are identified using participation factor analysis. Definition of the SSR in DFIG-based wind farms: This part mainly focuses on the identification and definition of the main types of SSR that occur in DFIG wind farms, namely: (1) induction generator effect (SSIGE), (2) torsional interactions (SSTI), and (3) control interactions (SSCI).

Power System Small Signal Stability Analysis and Control Cengage Learning

With contributions from worldwide leaders in the field, Power System Stability and Control, Third Edition (part of the five-volume set, The Electric Power Engineering Handbook) updates coverage of recent developments and rapid technological growth in essential aspects of power systems. Edited by L.L. Grigsby, a respected and accomplished authority in power engineering, and section editors Miroslav Begovic, Prabha Kundur, and Bruce Wollenberg, this reference presents substantially new and revised content. Topics covered include: Power System Protection Power System Dynamics and Stability Power System Operation and Control This book provides a simplified overview of advances in international standards, practices, and technologies, such as small signal stability and power system oscillations, power system stability controls, and dynamic modeling of power systems. This resource will help readers achieve safe, economical, high-quality power delivery in a dynamic and demanding environment. With five new and 10 fully revised chapters, the book supplies a high level of detail and, more importantly, a tutorial style of writing and use of photographs and graphics to help the reader understand the material. New Chapters Cover: Systems Aspects of Large Blackouts Wide-Area Monitoring and Situational Awareness Assessment of Power System Stability and Dynamic Security Performance Wind Power Integration in Power Systems FACTS Devices A volume in the Electric Power Engineering Handbook, Third Edition. Other volumes in the set: K12642 Electric Power Generation, Transmission, and Distribution, Third Edition (ISBN: 9781439856284) K12648 Power Systems, Third Edition (ISBN: 9781439856338) K12650 Electric Power Substations Engineering, Third Edition (9781439856383) K12643 Electric Power Transformer Engineering, Third Edition (9781439856291)

Power System Stability and Control, Third Edition Springer Nature

This book presents select papers presented during the 6th National Symposium on Rotor Dynamics, held at CSIR-NAL, Bangalore, and focuses on the latest trends in rotor dynamics and various challenges encountered in the design of rotating machinery. The book is of interest to researchers from mechanical, aerospace, tribology and power industries, engineering service providers and academics.

Subsynchronous Resonance in Power Systems Springer Science & Business Media

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

Subtitle Springer Science & Business Media

4. 2 Analysis of induction generator effect: frequency scanning method 83 4. 3 Analysis of torsional interaction(TI) 87 4. 4 State equations and eigenvalue analysis 96 4. 5 An algorithm for computing torsional modes 108 4. 6 Countermeasures for SSR III 4. 7 Torsional oscillations in parallel connected turbine generators 120 121 5. INTERACTIONS WITH POWER SYSTEM STABILIZER 5. 1 Introduction 121 5. 2 Basic concept in the application of PSS 122 5. 3 Design of PSS 126 5. 4 Torsional interaction with PSS 130 5. 5 A case study 132 6. INTERACTIONS WITH HVDC CONVERTER CONTROL 137 6. 1 Introduction 137 6. 2 HVDC converters and control 138 6. 3 Modelling of HVDC system for study of torsional interactions 147 6. 4 Analysis of torsional interactions -A simplified approach 153 6. 5 A case study 156 6. 6 A simplified damping torque analysis 161 6. 7 Control of torsional interaction 167 7. INTERACTIONS WITH SHUNT COMPENSATORS 169 7. 1 Introduction 169 7. 2 Static Var Compensator 171 7 . 3 Torsional Interactions with SVC 186 7. 4 Static Condenser(STATCON) 189 7. 5 Torsional interactions with STATCON 196 7. 6 A simplified analysis of torsional interaction with voltage controller 200 8. INTERACTIONS WITH SERIES COMPENSATORS 205 8. 1 Introduction 205 8. 2 Thyristor Controlled Series Compensator 206 8. 3 Modelling of TCSC for SSR studies 216 8. 4 Mitigation of SSR with TCSC 223 8. 5 Static Synchronous Series Compensator (SSSC) 229 8.

Suppression and Avoidance of Subsynchronous Resonance in Synchronous Generators Academic Press

A guide to the latest developments in grid dynamics and control and highlights the role of transmission and distribution grids Dynamics and Control of Electric Transmission and Microgrids offers a concise and comprehensive review of the most recent developments and research in grid dynamics and control. In addition, the authors present a new style of presentation that highlights the role of transmission and distribution grids that ensure the reliability and quality of electric power supply. The authors — noted experts in the field — offer an introduction to the topic and explore the basic characteristics and operations of the grid. The text also reviews a wealth of vital topics such as FACTS and HVDC Converter controllers, the stability and security issues of the bulk power system, loads which can be viewed as negative generation, the power limits and energy availability when distributed storage is used and much more. This important resource: Puts the focus on the role of transmission and distribution grids that ensure the reliability and quality of electric power supply Includes modeling and control of wind and solar energy generation for secure energy transfer Presents timely coverage of on-line detection of loss of synchronism, wide area measurements and applications, wide-area feedback control systems for power swing damping and microgrids-operation and control Written for students of power system dynamics and control/electrical power industry professionals, Dynamics and Control of Electric Transmission and Microgrids is a comprehensive guide to the recent developments in grid dynamics and control and highlights the role of transmission and distribution grids that ensure the reliability and quality of electric power supply.

Turbogenerator Analysis with Special Reference to Subsynchronous Resonance and Parameter Estimation Elsevier

The book is divided into five parts with a total of 14 chapters. The first part begins by introducing the basic concepts of stability. The second part develops the system model in detail. Part three presents the small signal stability analysis applied to the problem of low frequency oscillations. Part four presents the SSR phenomenon and part five deals with the transient stability problem. The basic concepts of voltage stability and methods of analysis are discussed in Appendix A.

Study of Subsynchronous Resonance and Its Countermeasure Using Static VAR Compensator John Wiley & Sons

Voltage-source converters (VSCs) have gained widespread acceptance in modern power systems. The stability and dynamics of power systems involving these devices have recently become salient issues. In the small-signal sense, the dynamics of VSC-based systems is dictated by its incremental output impedance, which is formed by a combination of 'passive' circuit components and 'active' control elements. Control elements such as control parameters, control loops, and control topologies play a significant role in shaping the impedance profile. Depending on the control schemes and strategies used, VSC-based systems can exhibit different incremental impedance dynamics. As the control elements and dynamics are involved in the impedance structure, the frequency-dependent output impedance might have a negative real-part (i.e., a negative resistance). In the grid-connected mode, the negative resistance degrades the system damping and negatively impacts the stability. In high-voltage networks where high-power VSC-based systems are usually employed and where sub-synchronous dynamics usually exist, integrating large VSC-based systems might reduce the overall damping and results in unstable dynamics. The objectives of this thesis are to (1) investigate and analyze the output impedance properties under different control strategies and control functions, (2) identify and characterize the key contributors to the impedance and sub-synchronous damping profiles, and (3) propose mitigation techniques to minimize and eliminate the negative impact associated with integrating VSC-based systems into power systems. Different VSC configurations are considered in this thesis; in particular, the full-scale and partial-scale topologies (doubly fed-induction generators) are addressed. Additionally, the impedance and system damping profiles are studied under two different control strategies: the standard vector control strategy and the recently-developed power synchronization control strategy. Furthermore, this thesis proposes a simple and robust technique for damping the sub-synchronous resonance in a power system.

Thyristor-Based FACTS Controllers for Electrical Transmission Systems CRC Press

A guide to the latest developments in grid dynamics and control and highlights the role of transmission and distribution grids Dynamics and Control of Electric Transmission and Microgrids offers a concise and comprehensive review of the most recent developments and research in grid dynamics and control. In addition, the authors present a new style of presentation that highlights the role of transmission and distribution grids that ensure the reliability and quality of electric power supply. The authors — noted experts in the field — offer an introduction to the topic and explore the basic characteristics and operations of the grid. The text also reviews a wealth of vital topics such as FACTS and HVDC Converter controllers, the stability and security issues of the bulk power system, loads which can be viewed as negative generation, the power limits and energy availability when distributed storage is used and much more. This important resource: Puts the focus on the role of transmission and distribution grids that ensure the reliability and quality of electric power supply Includes modeling and control of wind and solar energy generation for secure energy transfer Presents timely coverage of on-line detection of loss of synchronism, wide area measurements and applications, wide-area feedback control systems for power swing damping and microgrids-operation and control Written for students of power system dynamics and control/electrical power industry professionals, Dynamics and Control of Electric Transmission and Microgrids is a comprehensive guide to the recent developments in grid dynamics and control and highlights the role of transmission and distribution grids that ensure the reliability and quality of electric power supply.