

Synchronous Generator Subtransient Reactance Prediction Using Transient Circuit Coupled Electromagnetic Analyses & Odd Periodic Symmetry

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Abstract

For synchronous 3 phase electrical generator machine design, the ability to predict the subtransient reactance of a particular machine design is of prime importance. The subtransient reactance has a significant impact on the magnitude of the fault currents generated within the machine during an event such as a 3 phase short-circuit. Power system designers routinely use the generator subtransient reactance as a key parameter to aid in the design of the complete power generation system. For new generator designs the subtransient reactance is routinely tested for as part of a thorough evaluation of the generator performance characteristics. In this paper, a method is presented to calculate the subtransient reactance of a particular generator design using transient circuit coupled finite element electromagnetic analyses. The finite element modeling technique presented utilizes odd periodic symmetry along with a "moving" interface at the rotor-stator air-gap. The use of odd periodic symmetry allows for the simulations to be accomplished with half of the model size as compared to even periodic symmetry. The calculated generator subtransient reactance from the finite element modeling technique presented is compared to generator test data as well as previous calculation methods. Other key pieces of information which may be generated throughout the process are also documented, such as calculated voltage harmonics and the open-circuit saturation curve.

Introduction

Kato Engineering primarily manufactures synchronous 3 phase electrical generators. The ability to predict the subtransient reactance of a particular generator design is of prime importance. Power system designers routinely use the generator subtransient reactance as a key parameter to aid in the design of the complete electrical power generation system.

The subtransient reactance, X''_d , is the generator internal impedance element that is effective in the first cycles of a transient load event and determines the magnitude of the instantaneous fault current from the generator. The transient reactance, X'_d , becomes effective after approximately 6 cycles into a transient load event and determines the amount of voltage change seen at the generator terminals due to the step change in load. As stated, the reactances of a generator have a direct effect on the transient fault currents experienced in an electrical power generation system, as well as the motor starting capability of the generator. The magnitudes of the fault currents need to be calculated so that breakers, etc. can be sized accordingly. The peak magnitudes of the 3 phase fault currents are inversely proportional to the subtransient reactance of the generator. For new generator designs, the transient and subtransient reactances are routinely tested for as part of a thorough evaluation of the generator's performance characteristics.

Traditional reactance prediction methods have served engineers well when new designs closely mirror previous designs which have been tested and their reactance predictions validated. From the perspective of the machine designer, an uncomfortable level of uncertainty always accompanied a new design that deviated significantly from standard forms. In this paper, a method is presented to calculate the transient and subtransient reactance of a generator using transient dynamic circuit-coupled finite element electromagnetic analyses. Finite Element electromagnetic analysis offers a powerful tool to reduce the risk in new generator design.

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Synchronous Generator Subtransient Reactance Prediction:

Uncertainties in Modern Power Systems Ahmed F. Zobaa, Shady Abdel Aleem, 2020-10-26 Uncertainties in Modern Power Systems combines several aspects of uncertainty management in power systems at the planning and operation stages within an integrated framework This book provides the state of the art in electric network planning including time scales reliability quality optimal allocation of compensators and distributed generators mathematical formulation and search algorithms The book introduces innovative research outcomes programs algorithms and approaches that consolidate the present status and future opportunities and challenges of power systems The book also offers a comprehensive description of the overall process in terms of understanding creating data gathering and managing complex electrical engineering applications with uncertainties This reference is useful for researchers engineers and operators in power distribution systems Includes innovative research outcomes programs algorithms and approaches that consolidate current status and future of modern power systems Discusses how uncertainties will impact on the performance of power systems Offers solutions to significant challenges in power systems planning to achieve the best operational performance of the different electric power sectors

Dynamics and Control of Electric Transmission and Microgrids K. R. Padiyar, Anil M. Kulkarni, 2019-02-04 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

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author and consultant electrical engineer Martin Heathcote Major revisions have been made to the sections on semiconductors power generation transformers building automation systems electric vehicles electrical equipment for use in hazardous areas and electrical installation reflecting the changes introduced to the IEE Wiring Regulations BS7671 2001

Damping of Subsynchronous Resonance Using a Load Commutated Inverter Synchronous Motor Drive Soebagio (Mas.),1985 Power System Engineering Frederic de la Court Chard,1962 *Offshore Electrical Engineering* Geoff MacAngus-Gerrard,2013-10-22 Offshore Electrical Engineering is written based on the author s 20 years electrical engineering experience of electrical North Sea oil endeavor The book has 14 chapters and five important appendices The book starts with designing for electrical power offshore application especially with aspects that are different from land based structures such as space and weight limitations safety hazards at sea and corrosive marine environment The criteria for selecting prime movers and generators for example gas turbines and reciprocating engines depending on the type of applications are examined The machinery drives are then discussed whereby the different offshore electric motor ratings are considered As in any electrical system the use of ergonomically designed controls is important Distribution switchgear transformers and cables are described The book also explains the environmental considerations power system disturbances and protection In an offshore structure lighting requirements and subsea power supplies diving life support system and equipment protection are emphasized A reliability analysis is also included to ensure continuance of service from the equipment A general checklist to be used when preparing commissioning worksopes is included and due to space and weight limitations on offshore installation the rationale of maintenance and logistics options are explained The appendices can be used as guides to descriptions offshore installations typical commissioning test sheets computerized calculations program and a comparison of world hazardous area equipment The text is a suitable reading for offshore personnel oil rig administrators and for readers from all walks of life interested in some technical aspects of offshore structures *Electrical Engineering Transactions* ,1977 **Transactions of the American Institute of Electrical Engineers** American Institute of Electrical Engineers,1958 Index of current electrical literature Dec 1887 appended to v 5 *Power and the Engineer* ,1966 *The Engineer* ,1963 *Industrial Power Systems Handbook* Donald Beeman,1955 **Power** ,1966-07 **Conference Proceedings** IEEE Power Engineering Society. Winter Meeting,2000 *Electrical & Electronics Abstracts* ,1997 *Electricity Supply* M. F. Buchan,1967

Unveiling the Magic of Words: A Review of "**Synchronous Generator Subtransient Reactance Prediction**"

In a global defined by information and interconnectivity, the enchanting power of words has acquired unparalleled significance. Their capability to kindle emotions, provoke contemplation, and ignite transformative change is truly awe-inspiring. Enter the realm of "**Synchronous Generator Subtransient Reactance Prediction**," a mesmerizing literary masterpiece penned by a distinguished author, guiding readers on a profound journey to unravel the secrets and potential hidden within every word. In this critique, we shall delve in to the book is central themes, examine its distinctive writing style, and assess its profound affect the souls of its readers.

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