



Ernest Nkusi

# Flexible AC Transmission System (FACTS) Devices

Possibilities, limits and costs in comparison to power system extension

 Akademiker Verlag

# Flexible Ac Transmission System Facts Devices Possibilitieslimits And Costs In Comparison To Power System Extension

**Nikolaos P. Athanasiadis**



## **Flexible Ac Transmission System Facts Devices Possibilitieslimits And Costs In Comparison To Power System Extension:**

**Understanding FACTS** Narain G. Hingorani, Laszlo Gyugyi, 2000 The Flexible AC Transmission System FACTS a new technology based on power electronics offers an opportunity to enhance controllability stability and power transfer capability of ac transmission systems Two pioneers in the field provide in depth discussions on power semiconductor devices voltage sourced and current sourced converters specific FACTS controllers and major FACTS applications in the U S Flexible AC Transmission Systems: Modelling and Control Xiao-Ping Zhang, Christian Rehtanz, Bikash Pal, 2012-02-24 The extended and revised second edition of this successful monograph presents advanced modeling analysis and control techniques of Flexible AC Transmission Systems FACTS The book covers comprehensively a range of power system control problems from steady state voltage and power flow control to voltage and reactive power control to voltage stability control to small signal stability control using FACTS controllers In the six years since the first edition of the book has been published research on the FACTS has continued to flourish while renewable energy has developed into a mature and booming global green business The second edition reflects the new developments in converter configuration smart grid technologies super power grid developments worldwide new approaches for FACTS control design new controllers for distribution system control and power electronic controllers in wind generation operation and control The latest trends of VSC HVDC with multilevel architecture have been included and four completely new chapters have been added devoted to Multi Agent Systems for Coordinated Control of FACTS devices Power System Stability Control using FACTS with Multiple Operating Points Control of a Looping Device in a Distribution System and Power Electronic Control for Wind Generation *Flexible Ac Transmission Systems (FACTS)* Yong-Hua Song, Allan T. Johns, 1999 Provides a comprehensive guide to FACTS covering all the major aspects in research and development of FACTS technology **Modelling Flexible AC Transmission Systems (FACTS) Devices on Weak Transmission Lines in the Nigerian Power Network** Olalekan Olagunju, 2020-02-26 Research Paper postgraduate from the year 2019 in the subject Electrotechnology language English abstract The aim of the study is to model FACTS devices on weak transmission line in the Nigeria power network and consider their effect on the bus voltages reactive and active power using genetic algorithm GA approach for loss minimization The Nigeria 330KV existing network to be considered consist of nine 9 generating stations thirty 30 Buses and forty one 41 transmission lines which will be modelled and simulated using Matlab Version 7 10 The study is limited to Nigeria 330kV existing power network with the focus on the comparison of the Bus voltages and power flow on the transmission lines when FACTS devices are incorporated and when the FACTS devices are not incorporated Research Questions For the realization of the objectives mentioned above and the aim the following research questions were set as a guide 1 What is the significant effect of FACTS devices on weak transmission lines 2 Can FACTS device be used with genetic algorithm for optimization of power loss and improvement of the bus voltages

3 What is the limitation of using just genetic algorithm without FACTS device for the optimization of power loss and the improvement of the bus voltages This research work is divided into five chapters with each chapter buttressing more on minimization of power loss The scope of the work the objective and aim of the research work to be achieved is addressed in chapter one 1 Chapter two 2 focus on the literature review of other researchers on FACTS device in the improvement of the power network the concept of FACTS device and the choice of FACTS device to be used was also addressed in chapter two 2 of this research work Chapter three focus on the methodology used for this study The simulation of the 330kV Nigeria power network was done on MATLAB SIMULINK 7 5 Also the chapter three focused on the use of power flow analysis toolbox which is a collection of a written codes of m files that has a compatible interface with MATLAB to generate the load flow of the power network instead of using ETAP The genetic algorithm was also discussed as an optimization tool deployed to optimize the losses on the transmission line Chapter four focus on the research findings with possible explanation as to some of the result obtained Finally chapter five talks about the conclusion of this research work and highlight some areas to explore in the future

**Application of Flexible AC Transmission System Devices in Wind Energy Conversion Systems** Ahmed Abu-Siada, Farhad Shahnia, A. M. Shiddiq Yunus, 2017-09-28 This book presents information about the application of various flexible AC transmission system devices to wind energy conversion systems Devices such as unified power flow controllers superconducting magnetic energy storage and static synchronous compensators are covered in this book Chapters detail features of the topology and basic control systems of each device Additionally case studies are presented where necessary to demonstrate practical applications This book is a reference for students and technicians studying wind power and AC transmission systems in advanced engineering courses

**Flexible AC Transmission Systems (FACTS)** Suman Bhowmick, 2018-09-03 Flexible AC Transmission Systems FACTS Newton Power Flow Modeling of Voltage Sourced Converter Based Controllers introduces different voltage sourced converter VSC based FACTS controllers and VSC based high voltage direct current VSC HVDC systems and their working principles explaining how FACTS controllers exchange real and reactive power with systems Subsequently the book Describes the Newton Raphson method and its application for solving the power flow problem Presents the Newton power flow modeling of the static synchronous series compensator SSSC unified power flow controller UPFC interline power flow controller IPFC generalized unified power flow controller GUPFC and static synchronous compensator STATCOM accommodating the practical device constraint limits because of the unique modeling strategy the existing Newton power flow codes can be reused Develops a unified Newton power flow model of AC systems incorporating multiterminal VSC HVDC systems with pulse width modulation PWM control schemes directly yielding the VSC modulation indices from the power flow solution Provides numerous case studies for validation of Newton power flow models elaborating on the occurrences and checking of unrealistic power flow solutions in isolated cases Includes detailed derivations of all the difficult formulae as well as solved problems on typical VSC based FACTS controllers Flexible AC

Transmission Systems FACTS Newton Power Flow Modeling of Voltage Sourced Converter Based Controllers assumes at least an undergraduate level understanding of engineering mathematics network analysis electrical machines electrical power systems and power electronics Thus the book provides a valuable reference for practitioners as well as senior undergraduate and graduate students in electrical engineering and electrical power systems **Flexible A. C.**

**Transmission System (FACTS) Devices with Energy Storage Systems** Kantilal Joshi, 2019-04-10 This book is basically the work done by me during my PhD work at G H Raison College of Engineering Nagpur The book contains a survey of Energy storage systems Simulations in MATLAB for Supercapacitors and SMES and applications to power systems The book can be useful for all Undergraduate and Post graduate students of Electrical Engineering interested in this area **New**

**Types of Voltage Source Converters Applied in Flexible AC Transmission System Devices** Peng Li, 2015 The uses of flexible alternating current transmission system FACTS controllers in next generation smart grids are encouraged by the increased uses of decentralized and highly meshed grid structures that may affect the stability of power systems Voltage source converter VSC based FACTS devices have reduced footprint and offer increased control flexibility extended range and faster reaction time than line commutated thyristor based equivalent solutions The performance of commonly used FACTS devices that employ a two level converter is summarized Then multilevel converters and direct AC AC converters which are viable for FACTS applications are reviewed The outcomes of the literature surveys are refined to identify new features that may be critical for future centralised and decentralized smart grids such as control range extension improved efficiency and power density at reduced hardware cost To pursue these features three novel VSC topologies are proposed and analysed An AC voltage doubled ACVD topology with an internal inverting buck boost cell in each phase leg is able to synthesize twice the output voltage of a conventional two level VSC for the same dc link voltage is proposed **Flexible AC Transmission System (FACTS)**

Florida Power Corporation, Southern Company Services, Inc, Electric Power Research Institute, 1993 **Flexible AC Transmission Systems (FACTS)**, 1994 **Flexible AC Transmission Systems (FACTS)** Song, 2009-01-01

The rapid development of power electronics technology provides exciting opportunities to develop new power system equipment for better utilisation of existing systems Deregulation of electricity supply industries worldwide and the resultant arrival of competition is forcing power utilities to utilise their existing facilities to ever higher levels of efficiency enabled by advances in power electronics technology In the 1990s a number of control devices collectively known as FACTS technology have come into widescale operation and offer further opportunities to improve the control of transmission systems Much research activity continues in this field and this book aims to describe the state of the art internationally It will be widely welcomed throughout the power industry **An Investigation of the Impact of Distributed Flexible AC Transmission System (D-Facts)**

**Devices on Transmission Line Protection** Hussain Beled, 2020 This thesis explores the effects of inductive Distributed Flexible AC Transmission System D FACTS device implementations on the performance of different transmission line

protection schemes The reliability and sensitivity of the trip decision of the protection elements is crucial for delivering safe and reliable power to customers Furthermore accurate fault location information can help significantly reduce outage duration operating costs and the number of consumer complaints Inductive D FACTS devices offer a distributed solution for managing and relieving the congestion in transmission lines However their interaction with protection and fault location elements may potentially cause unnecessary tripping relay mis operation or misleading fault location information The operation of these devices may also lead to unpredictable changes in transmission line impedance and fault current limitation due to their dynamic behavior before and during the disturbances This work studies these negative aspects of D FACTS devices and proposes solutions and alternatives to mitigate their impact An inductive D FACTS model was developed in the ATP version of the Electromagnetic Transients Program EMTP and then the steady state performance of these devices was validated against the existing D FACTS model in PowerWorld using the IEEE 12 bus test system Once the model was validated a more practical system with D FACTS implementation is simulated using ATP Lastly the generated fault event files are played back into commercial relays and a protective relay software model for evaluation This work examines the influence of two different implementations of inductive D FACTS on the most common protection elements and schemes under different fault scenarios The types of D FACTS devices implementations studied were dispersed distributing the D FACTS along the length of the line and compressed distributing them at specific distances on the line Additionally the impact of placing D FACTS devices on adjacent lines was studied Protection schemes studied in this thesis include distance elements mho or quadrilateral elements communication aided distance schemes permissive overreaching transfer trip POTT and fault location schemes Furthermore the influence of fault resistance and mutual coupling between parallel lines on relay response is studied in the presence of D FACTS devices Dispersed or compressed D FACTS implementation can cause underreaching of distance elements This may lead to a delay in the tripping time or in fact a failure to trip in a POTT scheme The simulation results show that using dispersed D FACTS implementation can reduce the error compared to the compressed implementation and increase the ability of performing correction for these devices under some operating conditions This work also examined the effect of D FACTS devices on distance elements performance in presence of a fault resistance and mutual coupling between the parallel lines The results illustrated how the direction of the power flow influences the fault resistance coverage of distance elements in the presence of D FACTS devices The D FACTS may help to reduce the distance elements underreach for forward faults and increase the underreach behavior for the reverse fault The results show that mutual coupling influence on distance elements would be not impacted by addition of the D FACTS devices Lastly we investigated how implementing inductive D FACTS devices on the adjacent line affects the dynamic behavior of mho distance elements and the calculated effective impedance tilt of quadrilateral distance elements response Inserting the D FACTS behind the relay can help expand the mho circles for forward faults and contract them for reverse faults As a result fault

resistance coverage can be improved. On the other hand this may cause underreaching or overreaching of the quadrilateral distance elements response when a fault resistance is present in a ground fault. To deal with the challenges in the implementation of D FACTS devices and minimize their influence on transmission line protection system performance this thesis proposes mitigation for creating reliable protection and fault location schemes. The work concludes by offering recommendations for D FACTS device implementation and protective relays settings.

*Modelling, Control and Design of Flexible AC Transmission System (FACTS), Custom Power Devices and Variable Speed Drives for Transmission and Distribution Architectures* Nikolaos P. Athanasiadis, 1999

*Flexible AC Transmission Systems (FACTS)*, 1991

**Power Division Colloquium on "Flexible AC Transmission Systems (FACTS) - the Key to Increased Utilisation of Power Systems"**, 1994

*A Study of the Impact of Flexible AC Transmission System Devices on the Economic-secure Operation of Power Systems* Julie Griffin, 1995

This thesis examines how Flexible AC Transmission Systems FACTS devices can improve the secure economic operation of a power system. More specifically the benefits of FACTS devices in a network are evaluated in terms of four areas of power system study: system security, economic dispatch, operation maximum network loadability and electric industry deregulation. Simulations of a simple network are made to evaluate how a FACTS device can be used to increase the security region of a network. Based on this analysis simulations are performed using the 24 bus IEEE reliability test network to assess the possible savings in generation costs, the increase in maximum network loadability and the improvements in flexibility of exchanges resulting from the use of a FACTS device in this network. The results demonstrate that FACTS devices can be used effectively to increase the security region of a network thereby allowing for a better optimum operating point in any optimization problem performed over such a region.

**Flexible AC Transmission Facts-technology and Novel Control Strategies for Power System Stabilization Enhancement** Mohamed Shawky ElMoursi, 2005

**Modelling, Control and Design of Flexible AC Transmission Systems (FACTS), Custom Power Devices and Variable Speed Drives for Transmission and Distribution Architectures** Nikolaos P. Athanasiadis, 2000

**Evaluation of Flexible AC Transmission System (FACTS) Technologies on the Tennessee Valley Authority's Transmission System** General Electric Power Systems, Electric Power Research Institute, 1996

**Flexible AC Transmission Systems (FACTS)** General Electric Company, Power Technologies, inc, Electric Power Research Institute, 1990

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