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Analysis of Active and Reactive Power Oscillation in Transmission Line

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Abstract: This thesis proposes to investigate the mixing of VSC HVDC technology into conventional AC systems. The analysis is run for type of aspects which mainly around AC/DC system stability issues, and also because the control interactions between VSC HVDC and AC system components. The identified problems and interactions can mainly thanks to the effect of VSC HVDC controls on the AC system electromechanical oscillations, the potential control interactions between VSC HVDC and versatile AC transmission systems (FACTS) and also the active power support capability of VSC HVDC for improving AC system stability. The proposed technique is employed to investigate the active, reactive power oscillation, voltage balance of both rectifier and inverter side by using MATLAB/SIMULINK
Keywords: VSC based HVDC, Active and Reactive power, FACTS devices and AC/DC system stability

I. INTRODUCTION

The HVDC gear mechanism technology using current source converters, commutated thyristor switches, referred to as traditional HVDC or classic HVDC, or by voltage source converters the primary HVDC cable using VSC was installed in 1997 in Gotland (Sweden). the necessity for safer wattage grids and increasing environmental concerns still drive the worldwide deployment of HVDC technology. HVDC is characterized by sort of benefits lower overall cost, and smaller environmental footprint, easier integration with renewable energy sources, and particularly, higher transmission stability And power quality.. The world's first VSC-based HVDC system using pulse width modulation (PWM) IGBT converter was installed. Since then, more VSC-HVDC light systems are installed worldwide.

II. SYSTEM DESCRIPTION

The main scope of this project is to build a AC and VSC-HVDC transmission system model and study its operational performance using the MATLAB/SIMULINK software package. The system for both rectifier and inverter stations is to be designed. Design of controllers and optimization of gains at both converter stations in keeping with transmission of active and reactive power flow in either direction is additionally an element of the scope. Detailed studies must regarding independent control of active and reactive power at sending and receiving ends which could be achieved.The HVDC transmission includes a rectifier converting electricity (AC) power into DC power; an inverter converting the DC power into the AC power; DC transmission lines transmitting the DC power.

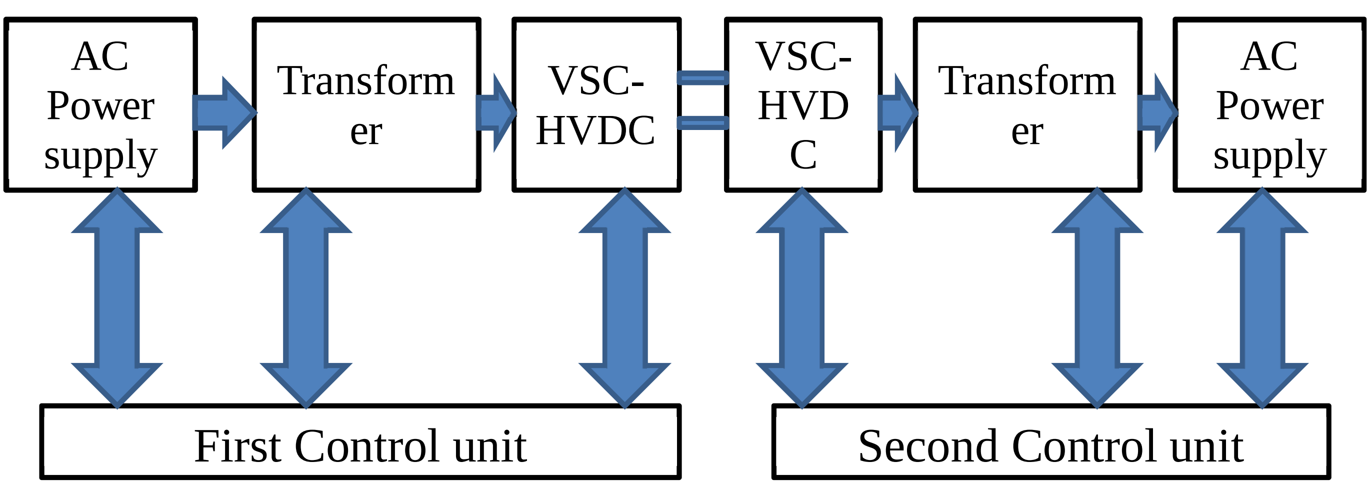

Figure.1.BLOCK DIAGRAM OF AC/DC TRANSMISSION SYSTEM

Thefigure.1 shows the block diagram of AC/DC transimission system. First active power input to the rectifier a second active power measurement unit measuring second active power output from the inverter and a primary control unit controlling the operations of the rectifier and therefore the inverter supported the primary active power measured and therefore the second active power measured, wherein the primary control unit senses oscillation generated within the HVDC gear and generates an impression signal for damping the sensed oscillation to regulate one or more of the rectifier and therefore the inverter. The damping signal could be a power control signal (active or reactive). The frequency of the oscillation is additionally sensed and suppression is attempted on condition that the frequency is during a p letter. These limits define the utmost electrical power which may be efficiently transmitted through the line without causing any damage to the electrical equipments and therefore the transmission lines. this is often normally achieved by bringing changes within the facility layout. However this is often not feasible and in our own way of achieving maximum power transfer capability with none changes within the facility layout.
In conventional AC gear mechanism, the flexibility to transfer AC power is restricted by several factors like thermal limits, transient stability limit, voltage limit, tangency current limit etc.

A. VSC-HVDC Modeling and Its Characteristics

The figure 2.1 shown A VSC1 and VSC2 has the same structure for a high order filter with small capacity. Transformer provides an interface for power exchanging between the AC system and VSC-HVDC transmission line.

$$P = (UsUc/Xc)sin\delta$$

$$Q = (Us(Us - Uc\cos\delta)\ /\ Xc$$

On the AC side, VSC takes AC bus voltage or reactive power as control object.DC side, VSC takes DC voltage or active power or DC current as control object. a minimum of one VSC-HVDC to stay DC voltage stable for providing a traditional operation point for the full VSC-HVDC. The research interest is principally placed on the VSCHVDC control operation for enhance power grid stability.

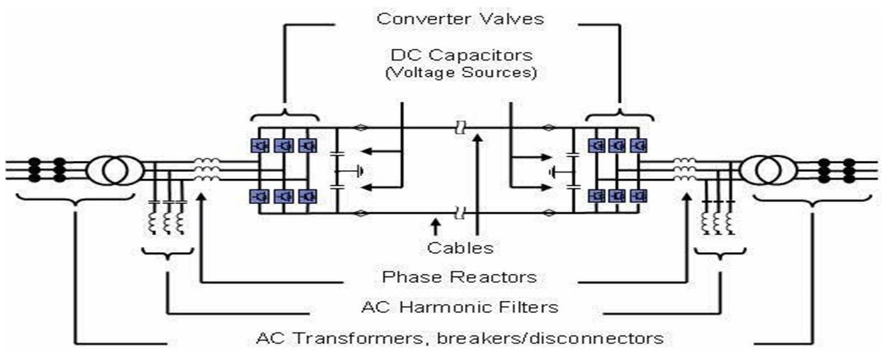

Figure.2.1.Two level VSC-HVDC transmission line

B. Area Mode Oscillation Signal Choosing

In figure 22 shown in two - area facility with AC and VSC HVDC tie lines. The controllability of VSC-HVDC can't only adjust the ability flow between the 2 area in normal steady state, but also damping the oscillation by some Disturbance, if proper ancillary damping policy has been made prior to. There are some phenomena may be observed and brought as evidence to work out that area oscillation happens.

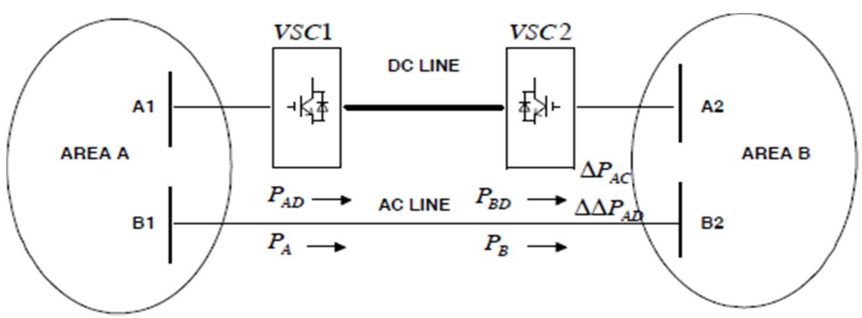

Figure.2.2.Two level VSC-HVDC transmission line

Actually the active power flow of the AC tie line which may be measured locally is a perfect signal and sensitive enough for detecting the oscillation. it's assumed VSC2 works within the mode of controlling the ability flow of the VSC- HVDC line. Under this circumstance, the ability of AC tie line to be measured is chosen at the tip near Area B thanks to short distance. To damping oscillation, the change of active power, △PAC and therefore the change speed of active power, △△PAC have to be sent to the ancillary damping controller of VSC2.

III. SIMULATION COMPONENTS

Simulink Math Works, is a data flow graphical programming language tool for modeling, simulating and analyzing multi domain dynamic systems. Its primary interface is a graphical block diagramming tool and a customizable set of block libraries. It offers tight integration with the rest of the MATLAB environment and can either drive MATLAB or be scripted from it.

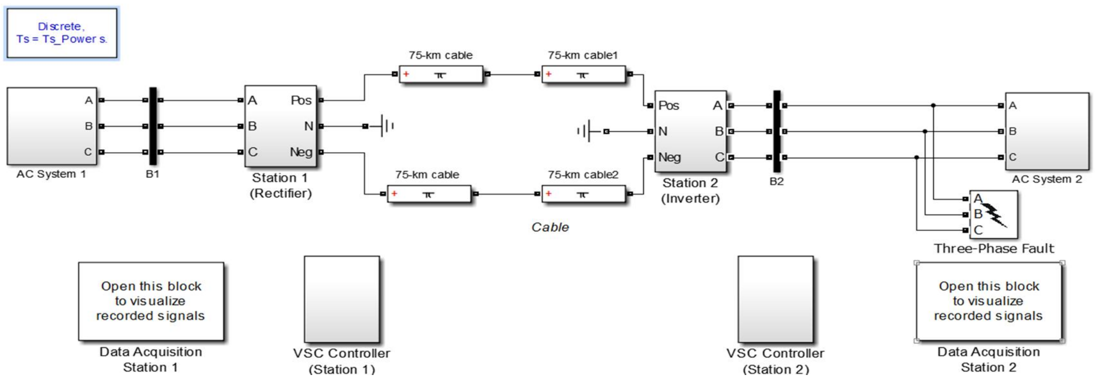

Figure.3.1.simulink diagram

For performance evaluation of the proposed control mechanisms, an VSC-HVDC light system is simulated in MATLAB using Sim Power Systems. A three-level neutral-point-clamped VSC is used at both stations for improved power quality.The figure 3.1 is shown Simulink of VSC-HVDC transmission system. Table 3.1.1 shows the parameters and values used in the matlab simulink

COMPONENT	PARAMETERS	VALUE
AC System 1& 2	Line Voltage Frequency	100 KV 50 Hz
Transmission line parameters of AC system 1 & 2	Positive Sequence R,L,C	0.0127 Ω/Km, 0.934Mh/km, 12.74nF/Km
	Zero Sequence R,L,C	0.386Ω/km, 4.126mH/7Km, 7.751Nf/km
	Length	50 km
27 th AC filter in AC system 1 & 2	Reactive power	18MVar
	Tuning frequency	1620Hz
	Quality factor	15
54 th AC filter in AC system 1&2	Reactive power	22MVar
	Tuning frequency	3240Hz
	Quality factor	15
	Frequency for Pi line Specification	60Hz
	Pi line R,L,C Pi Line Length	0.0139Ω/km 159µH/km 0.231µF/km 75 Km

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COMPONENT	PARAMETER	VALUE
Power Converter	Switching Frequency	1620 Hz
Grid –filter	Resistance	0.75Ω
	Inductance	0.2 H
DC Capacitor	Capacitance C p, C n	70μF
DC filter (3^{rd} Harmonic)	Capacitance C p, C n	12μF
	Inductor (R,L)	0.1474Ω 32.6 mH
Smoothing reactor	Inductor(R,L)	0.0251Ω 8mH

Table 3.1 Parameter of individual VSC Components

A. Simulink Results

The simulation result of VSC-HVDC based transmission line system performance are discussed.Simulation waveforms are shown in figure 3.1.1 thus the waveforms are Active and Reactive power and three phase current and bus voltage

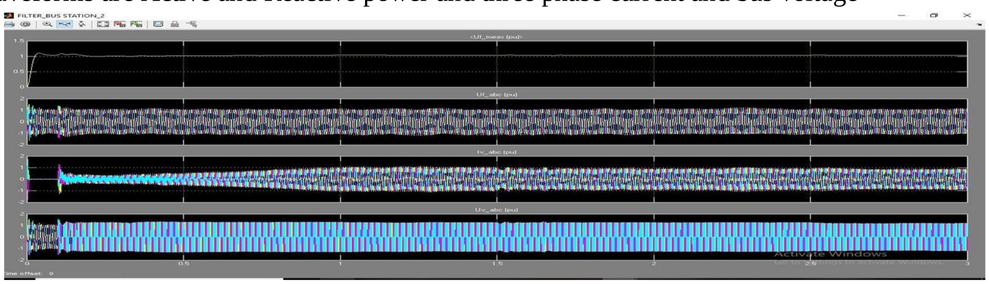

Figure:3.2 (a)Real power(b)Reactive power (c) Three phase bus voltage (d)Three phase bus current

IV. CONCLUSION

This project evaluates the analyzing the control techniques to required in an exceedingly line and therefore the modeling of the key components and therefore the associated controls within the AC and DC sides of the system has been described thoroughly. However, integrated AC/DC system models for power grid stability studies are often supported simplified AC or DC side models. The AC system inter-area oscillation is especially laid low with the operating point of the DC link (power flow) and therefore the VSC AC voltage control. Installation of a paralleled VSC HVDC link usually affects the damping of the connected AC system inter-area mode, which not only depends on the AC system structure but also on the sort of controls employed within the converter terminals. Another major conclusion is that a fast acting AC voltage regulation at the receiving end of the VSC HVDC link reduces the damping of the low frequency inter-area mode, which not only depends on the AC system structure but also on the type of controls employed in the converter terminals reduces the damping of the low frequency inter-area mode, whereas it would improve damping at the sending end. The control strategies are analyzed with the help of MATLAB/SIMULINK.

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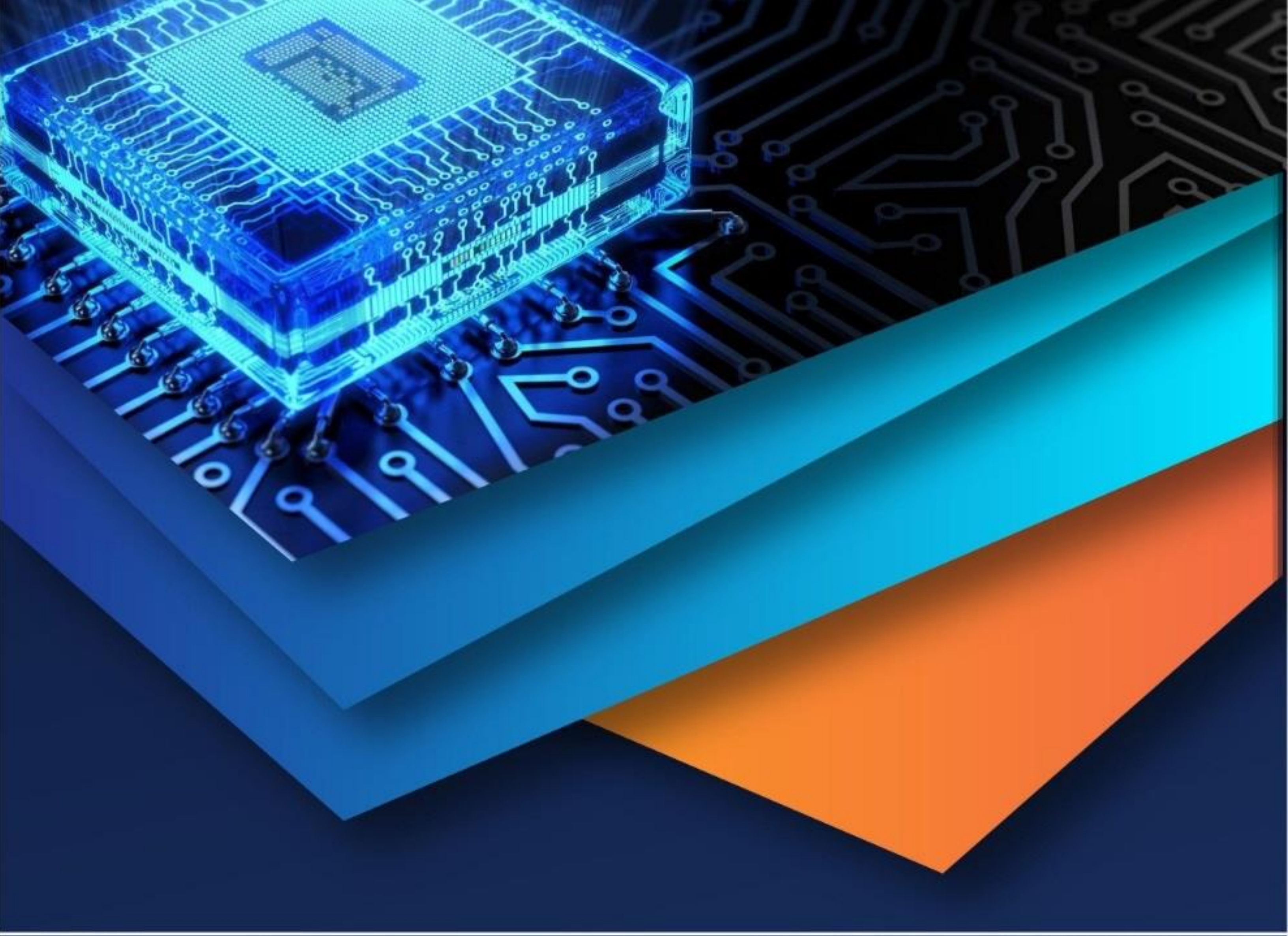

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