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Analysis of Performance of VSC based HVDC Power Transmission System by using 9 Bus 3 Generator system

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Abstract: In this paper a modified design of HVDC power transmission system with VSC by using 9 Bus system is given. An over-all stage is presented to learn the high voltage dc transmission links which is the subtleties of power systems. Small-signal stability, interaction phenomena, and voltage stability of power systems with voltage-source- converter HVDC (VSC-HVDC) are spoken using the proposed platform. In journey of high efficiency, power density and problems of bulk/high power transmission over long distance, prerequisite of full control over power transmission and increasing attentiveness to unite renewable energy source into the grid has controlled to develop a new age of high voltage direct current (HVDC) transmission system. VSC based HVDC transmission is one of the HVDC conformation. Their high efficiency, compact size, high reliability, short installation and appointing period and low operating and maintenance cost make it suitable choice for HVDC transmission. The HVDC system with power converter acts as a backbone and provides high reliability with a long useful life to support the AC electrical system. The power conversion i.e. rectification or inversion is achieved by electronic switches which is controllable in a 3-phase bridge structure. The wide spread use of AC-DC converters for various applications has resulted in power quality pollution leading to failure of sensitive equipment's, reduced efficiency, etc.

Keywords— Dynamics, high-voltage dc (HVDC) systems, Voltage source converter, power system molding.

I. INTRODUCTION

The growing number of HVDC transmission links in forthcoming power system, forces the thoughtful dares on power system control and stability analysis. While better controllability and improvement of inclusive power-system stability is offer by some of HVDC systems, But due to these system various problems on ac bus like simultaneous commutation disappointment of converters, small signal swinging therefore harm voltage quality or cause high above-voltage of bus bar, this all are the local instability's in the system. The increase in voltage level is not always feasible in AC transmission. The movement of power in AC transmission depends on difference of phase angle in vector voltage that varies with the load demand. To investigate the flora and reasons of all this uncertainties, suitable investigative representations of power systems and HVDC links are essential. Today thyristor and thermistor are available in the high power converters technology, which can be called as the fully controlled semiconductor technology. In the converter which is based on voltage source these technologies are adopted appropriately. The technologies associated with the flexible ac transmission system (FACTS) and HVdc power transmission systems carry on towards advancement as they having various challenges in the commercial applications. HVdc and FACTS schemes are supporting to the recent power system in their own way, and these are the important skills, in many cases, these schemes are fully or moderately derestricted in several nations. Insulated gate bipolar transistor (IGBTs) and gate turn-off thyristors (GTOs) are used in the forced-commutated VSCs. sometimes IGBTs are used in the most industrial cases. Figure 2 shows the VSC-HVdc configuration with the IGBT converter connected in back to back topology. This technology is deep-rooted technology for intermediate power levels.

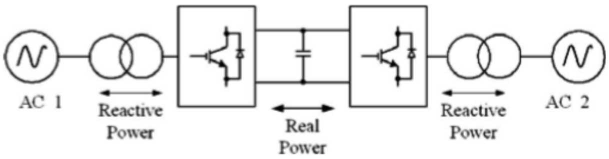

Figure 1: HVDC system based on VSC technology built with IGBTs.

II. VSC-HVDC POWER TRANSMISSION FUNDAMENTAL CONCEPTS

Now, figure 1 shows the straightforward VSC-HVdc system, which encompasses of two converter stations constructed with topologies which is based on VSC. The modest topology of VSC is the predictable three-phase two level bridge is shown in figure 2.

Characteristically, in order to distribute a higher blocking voltage competence for the converter, many IGBTs are series-connected which is used for each semiconductor shown in figure 7, and consequently increase the HVdc systems dc bus voltage level. Likewise to guaranties the converter operation of four quadrant an antiparallel diode are required. Also to control the power flow of the system and dc harmonics which introduced in the system can be filtered by using capacitor which is connected in dc bus. That capacitor mainly provides the storage which is necessary for filtering and power flow.

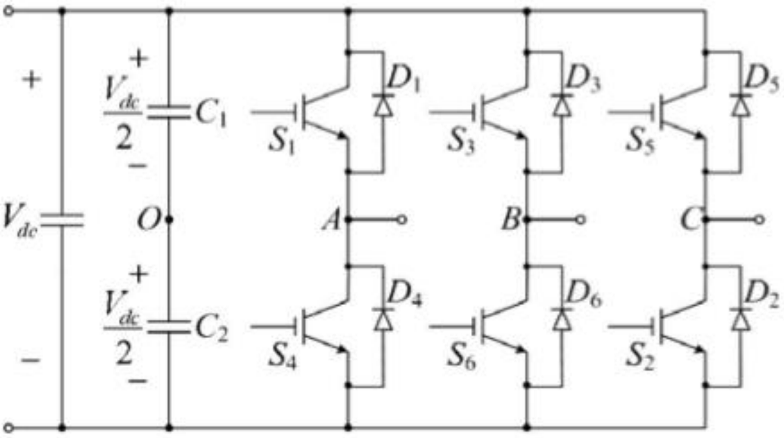

Figure 2: Conventional three-phase two-level VSC topology.

III. FEEDBACK CONTROL SYSTEM MODELING

For the development of complete power system, the feedback control system model is necessary to develop. These model is the ac hybrid model, which consist of 3 synchronous machine with the different ratings. The ac network hybrid model means that the model is divided into two parts, specifically, the dynamic and static parts. The part where HVdc converter is not connected is the static part which is the part of the ac network. In static area, the ac components are demonstrated in phasor theory using as constant admittances. The HVDC converter comes under dynamic area or else dynamic part, that HVdc system is surrounded with the ac components which includes transformers, ac power lines that are demonstrated animatedly via the space vector theory. The voltage source converter (VSC) is the prime unit of a VSC based HVDC system, therefore, its design and performance evaluation is most important to have desired results. This chapter deals with design, modeling and control of VSC for back-to-back AC interconnection and long distanced transmission between two AC networks using HVDC system.

The general operating principle is based on the figure3 and figure 4 where line reactor is connected in between two ac voltage sources. The affiliation of voltage drops across the line reactor and the comparative position of the phasors of the sinusoidal two ac quantities is shown with the phasors in the figure 4. To justify the direction of active power, two voltages are generated and comparative results decides the direction of the flow of active power, where the one voltage is generated by the VSC and the other one is the ac system voltage. At the fundamental frequency, the phasor relationship defines the active and reactive powers, pretentious is that the ac system reactor connected between the converters is ideal that is lossless, δ is the phase angle between the Vr at the fundamental frequency and the voltage phasors Vs.

$$P=\frac{Vs\sin\delta}{X_L}Vr \qquad (1)$$

$$Q=\frac{Vs\cos\delta-Vr}{X_L}Vr \qquad (2)$$

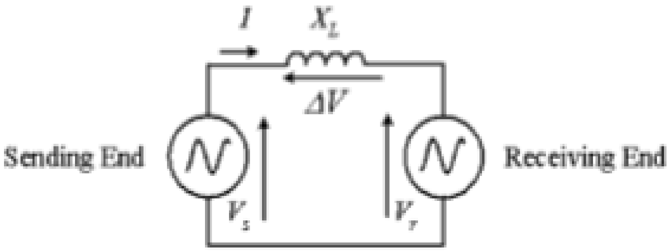

Figure 3: Interconnection of two ac voltage sources through a lossless reactor.

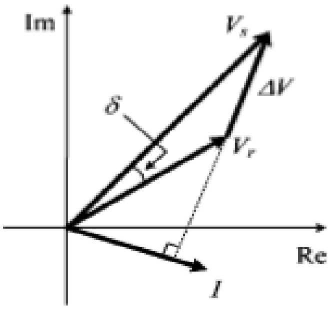

Figure 4: Phasor diagram of two ac voltage sources interconnected through a lossless reactor.

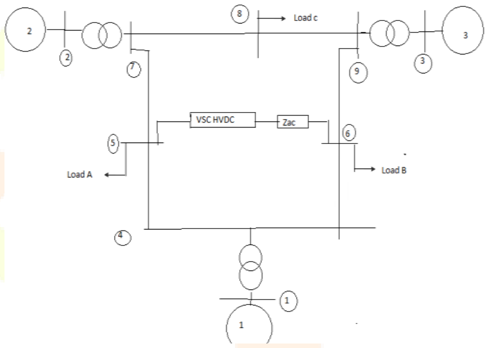

Figure 5: IEEE 9-bus test system with VSC HVDC link

IV. **VERIFICATION OF FCS VOLTAGE SOURSE CONVERTER MODELING**

The simulation of IEEE 9-bus system is carried out to validate the FCS model. Two different case studies are presented: first it is assumed that there is no HVDC link in the system; second, the transmission line between bus 5 and 6 is replaced by VSC-HVDC link. In first case study, there is no active part in the ac network, i.e., the network model is the power-flow. A step change of 0.84896 pu is applied to the input mechanical torque of generator No.2, and the responses of all three generators are illustrated in Figure.4, where it is shown how the results from the FCS model are consistent with those from the MATLAB simulation.

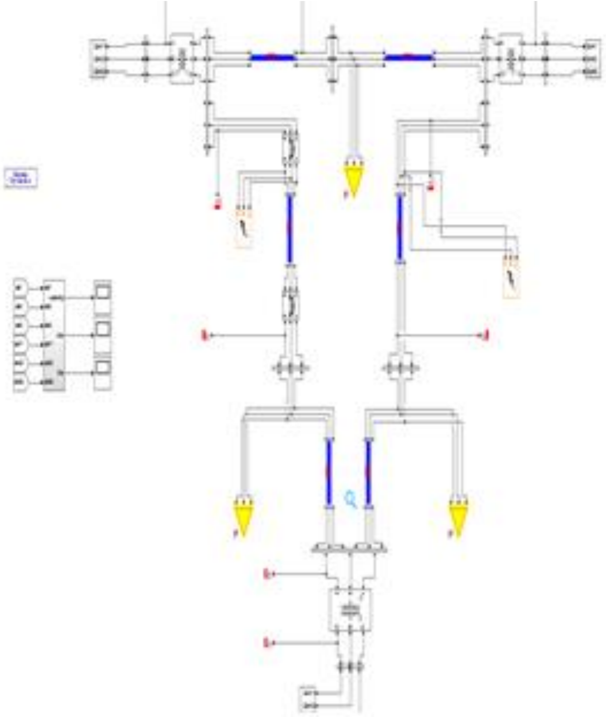

Figure 6: Simulation model of IEEE 9-bus test system without VSC HVDC.

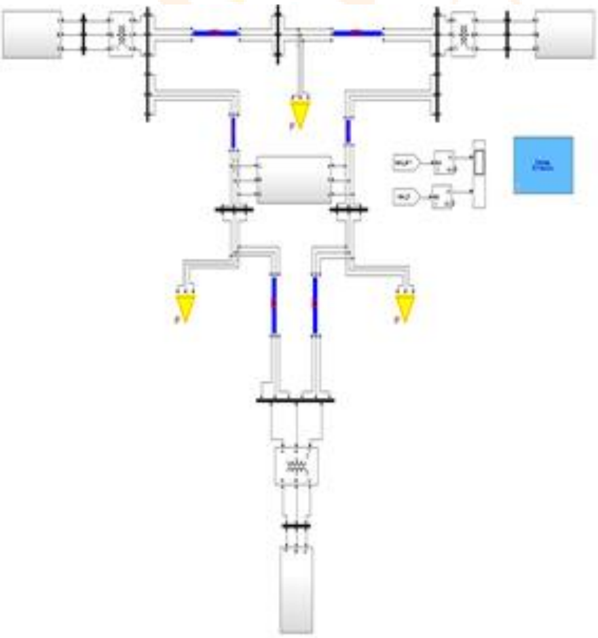

Figure 7: Simulation model of IEEE 9-bus test system without VSC HVDC.

In second case study, there are active parts in the ac network (active part in Figure. 3). The inverters of both HVDC links are connected to bus 6.The model of the active part is shown by using MATLAB simulation in Figure 5, and the model of the static area is shown in Figure 4. In this case study, a step of 0.14 pu is applied to the reference value of the VSC-HVDC inverter active power. Figs.6–9 show the responses of different outputs to this change.

V. SIMULATION AND EXPERIMENTAL RESULTS

The MATLAB simulation of IEEE 9bus with and without VSC HVdc converter is shown below

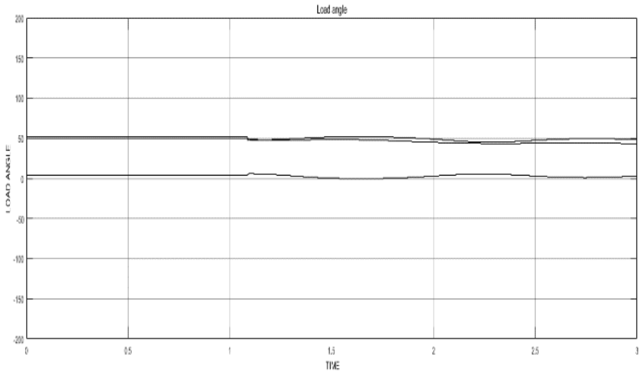

Figure 8: Generator responses to a step change in load angle without fault

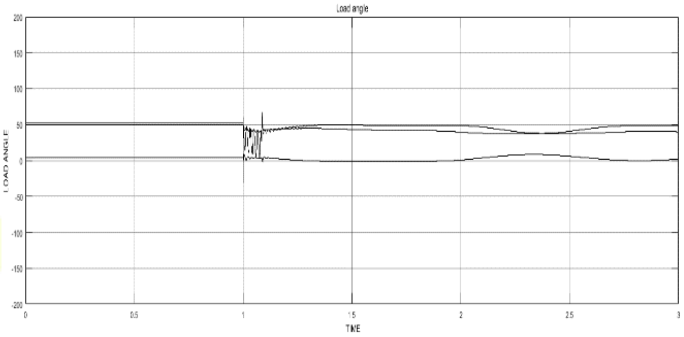

Figure 9: Generator responses to a step change in load angle at 3 phase fault in between bus 5 and 7.

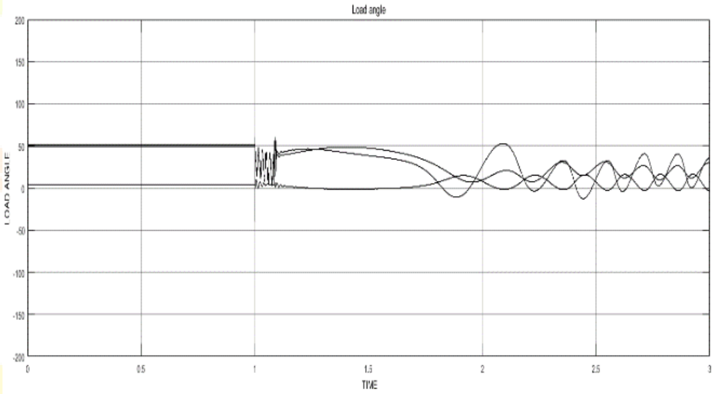

Figure 10: Generator responses to a step change in load angle with 3 phase fault in between bus5 and 7, and bus6 and 9

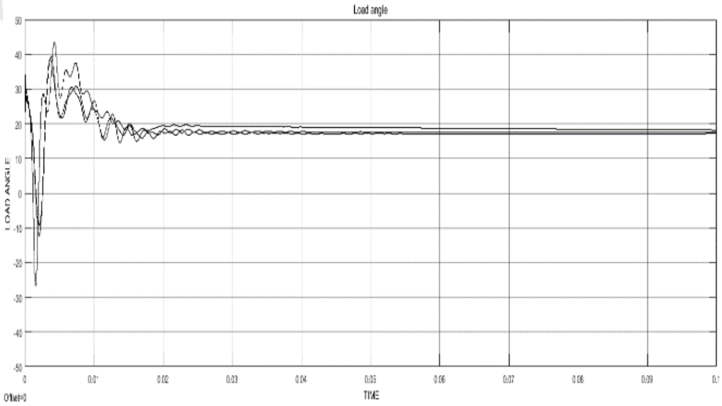

Figure 11: Generator responses to a step change in load angle with fault in VSC HVdc system

CONCLUSION

In this paper an integrated model of power system with voltage source converter of HVDC transmission links (VSC-HVDC) was proposed as a multivariable feedback control system (FCS), which simplifies the voltage stability analyses. The enlargement of high-voltage high-power semiconductor have successfully aided services to exploit the benefit of the static converter interlinking two ac system through HVdc with a number of key benefits, namely independent control of active and reactive power through the PWM control of the converter, and opportunity to connect ac island with no synchronous generation in the grid. It is long-established that development associated with VSC-HVdc technology have delivered system at voltage levels up to 350kV and power level up to 400 MW. VSC-HVdc unquestionably will continue to provide resolution in many areas of the power system.

REFERENCES

[1] ”Power System Stability Analysis Using Feedback Control System Modeling Including HVDC Transmission Links” Ali Bidadfar, Hans-Peter Nee, *Senior Member, IEEE,* Lidong Zhang, *Member, IEEE*, Lennart Harnefors, *Senior Member, IEEE* , Sanaz Namayantavana, Mehrdad Abedi, Mehdi Karrari, and Gevork B. Gharehpetian, *Senior Member, IEEE*

[2] D. Lee and G. Andersson, “Analysis of voltage and power interactions in multi-infeed HVDC systems,” *IEEE Trans. Power Del.*, vol. 28, no. 2, pp. 816–824, Apr. 2013.

[3] B. Gao, G. K. Morison, and P. Kundur, “Voltage stability evaluation using modal analysis,” *IEEE Trans. Power Syst.*, vol. 7, no. 4, pp. 1529–1542, Nov. 1992.

[4] P. M. Anderson and A. A. Fouad, *Power System Control and Stability*, 2nd ed. New York, NY, USA: IEEE, 2003.

[5] L. Zhang and H.-P. Nee, “Multivariable feedback design of VSC-HVDC connected to weak ac systems,” in *Proc. PowerTech*, Bucharest, Romania, 2009, pp. 1–8.