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A Comprehensive Guide to Fault Analysis of High Voltage DC (HVDC)

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Abstract:

Electrical energy is significantly used for industrial, commercial, agricultural, household, and social reasons in modern civilizations. Proper protective mechanisms and logic, however, are not yet as developed for the current HVDC system as they are for its AC counterpart. This work uses PSCAD to demonstrate the fault analysis for the protection of the HVDC grid (65-765kv range). The DC transmission line's faults are examined. This research also examines how the system reacts to various problems. We can distinguish between AC and DC faults because they exhibit different signatures. Here, the fault current's increase time is displayed. Analysis of load variations is also performed in comparison to fault cases.

Keywords —Fault **Currents, Load Change, IGBT, VSC, and HVDC Protection**

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I. INTRODUCTION

The future of bulk power transmission is High Voltage Direct Current (HVDC) transmission. Beyond a certain distance, such as typically around 700 KM for overhead lines and 40 KM for underground lines, the transmission losses and capital investments are ultimately larger for AC systems. It can be challenging to directly link two AC systems with different resonant frequencies. In certain scenarios, HVDC is advantageous. In addition, compared to HVAC systems, HVDC systems have little environmental effects. Using the HVDC system would make it simpler to integrate renewable energy sources into the grid. The HVDC point-to-point lines can be controlled in a variety of ways, however the protection system is still trailing behind AC systems. The targeted mesh lacks an appropriately rated protective device and logic.HVDC devices. Making a reliable rapid protection system for the future transmission system and designing the circuit breaker (CB) for HVDC are difficult tasks.

II. LITERATURE REVIEW

1. "Impact of SFCL on the Four Types of HVDC Circuit Breakers by Simulation (Lee J G et al., 2016)" article. In order to quantify the consequences of combining fault current limiters and traditional DC breakers, the use of resistive Superconducting Fault Current Limiters (SFCL) on several types of HVDC CB was described. Four different DC breaker topologies, including mechanical CBs utilizing a black-box arc model, passive CBs with resonance, inverse CBs with current injection, and hybrid HVDC CBs, were modelled for the simulation work. In order to confirm its interruption characteristic and distribute energy over the HVDC CB, a resistive SFCL was additionally modelled and added to the DC breakers. According to the modeling results, the maximum fault current, interruption time, and energy dissipation. Applying SFCL could reduce stress on the HVDC CB. The passive resonance CB with SFCL, one of four forms of HVDC CB, was also shown to have the best observable boost.

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2. The hybrid HVDC breaker, its design principles, and test results are covered in full in the publication titled "The Hybrid HVDC Breaker," by M. Callavik et al., published in November 2012. The hybrid breaker's modular design for HVDC applications is detailed. Additionally, the use of the hybrid breaker in conjunction with the creation of an HVDC switchyard will be covered.

3. The article X. Li et al. (2013)'s "Protection of Nonpermanent Faults on DC Overhead Lines in MMC- Based HVDC Systems" For nonpermanent defects on dc lines, a protective method is proposed that will implement quick fault clearance and automatic recovery. Double a Thy switches enable the dc-link fault current to freely decline to zero while removing the freewheeling effect of diodes. The insulation on the short-circuit location can then be repaired and the dc arc can be put out naturally. Through the use of MMC arms, the thyristor switches transform a dc-link defect into an ac short circuit of the ac grid. All thyristor switches need only be turned off in order to clear the ac short-circuit current. Circuit breakers are not tripped when clearing a fault, thus MMC

4. The paper "Protection of Nonpermanent Faults on DC Overhead Lines in MMC- Based HVDC Systems" by X. Li et al. A preventative strategy that will execute speedy fault clearance and automated recovery for nonpermanent problems on dc lines is offered. Double a Thy switches eliminate the freewheeling effect of diodes and allow the dc-link fault current to freely decrease to zero. The dc arc can then be put out naturally when the insulation at the short-circuit spot has been restored. The thyristor switches convert a dc-link fault into an ac short circuit of the ac grid by using MMC arms. The ac short-circuit current can be cleared by simply turning off all of the thyristor switches. When clearing, circuit breakers are not tripped.

5. This study, "Locating and Isolating DC Faults in Multi:Terminal DC Systems (L. Tang and B. T. Ooi, 2007)" a method based on disabling all of the ac-circuit breakers (ac-CBs) that the VSCs are already outfitted with on the ac-sides to shut off the dc fault current was presented. Prior to restoring the MTDC system by re-closing all the ac-CBs, it is required to identify which dc line is the faulted line (in the event that it is a permanent fault) so that it can be isolated by fast dc switches (which are far more cost-effective than the dc circuit breakers). This paper describes the handshaking approach, which restores the MTDC without communication by locating and isolating the defective dc line. Problem statement, third Regarding the present HDVC.

III. METHODOLOGY

On transmission lines of electrical power systems, faults are categorised as L-G fault, 2L-G fault, and 3LG fault. In three phase electrical power systems, two faults—three phase balance fault and three phase imbalance fault—occur most frequently. The extra high voltage transmission line fault detection and analysis aid in the selection and development of new technologies for improved transmission line protection.

Two 865 KV single lines with a combined length of 300 km make up the power system under consideration. As seen in the block diagram, generators at 13.8 KV are used to feed the single lines. Distributed parameter lines are used in the single line models.The parameters R, L, and C/km are given with the assumption that the lines are transposed.Faults in electrical power systems' transmission lines are divided into three categories: L-G fault, 2L-G fault, and 3LG fault. Two faults—three phase balancing fault and three phase imbalance fault—occur most commonly in three phase electrical power systems. Selection and development of innovative technologies for enhanced transmission line protection are aided by the extra high voltage transmission line fault detection and investigation.

The electricity system in question consists of two 865 KV single lines, each 300 km long. The single lines are fed by generators at 13.8 KV, as shown in the block diagram. In the single line models, distributed parameter lines are employed.With the understanding that the lines are inverted, the parameters R, L, and C/km are provided.

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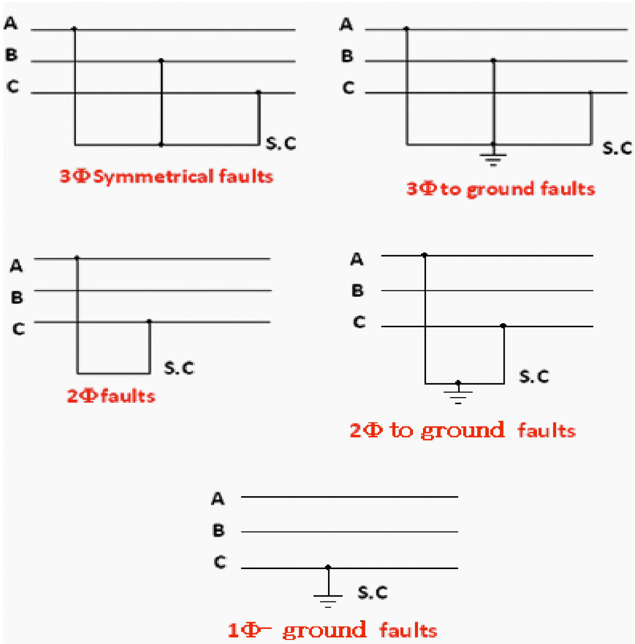

Fig:1. All types of faults.

IV. IMPLEMENTATION DETAILS

A. *MATLAB*

A programming environment specifically created for quick and simple scientific calculations and I/O is called MATLAB, or Matrix Laboratory. It features literally hundreds of built-in functions for performing a wide range of computations, as well as numerous toolboxes created for different study fields, such as measurements, improvement, the layout of fractional differential circumstances, and information analysis.

The best language for specialized processing is MATLAB. It combines computation, vision, and programming in a straightforward environment where problems and solutions are explained in legible scientific documentation. Common applications include data analysis, exploration, and visualization.

You should see the MATLAB window appear on your screen. It appears that:

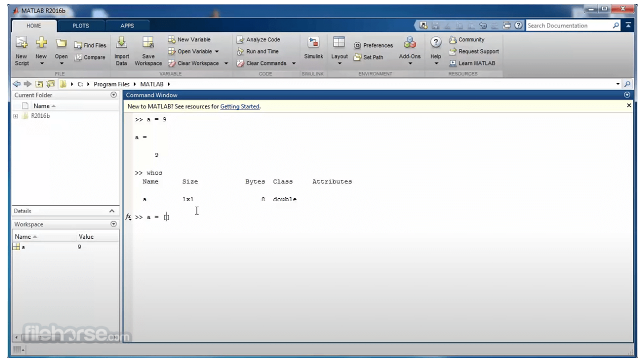

Fig:2. Mat lab.

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V. RESULT

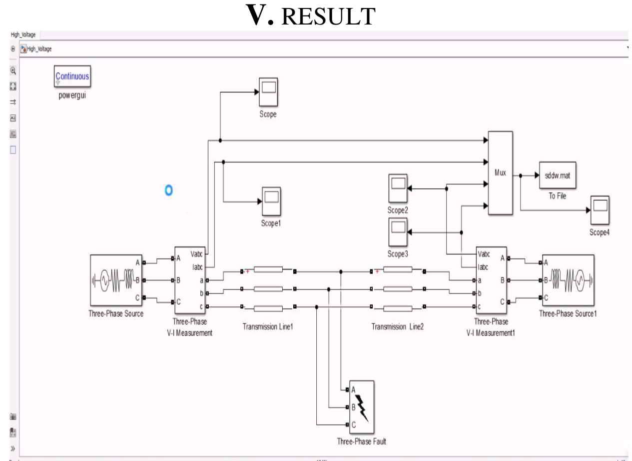

Fig: 3. HighvoltageDevelopmentModel

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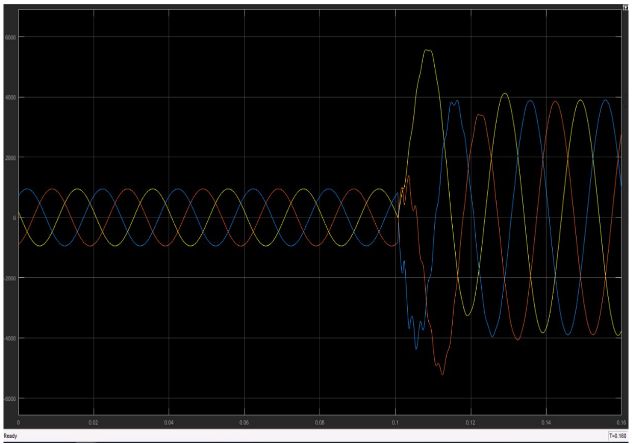

Fig :4.singlephase to groundfaultatthesending end

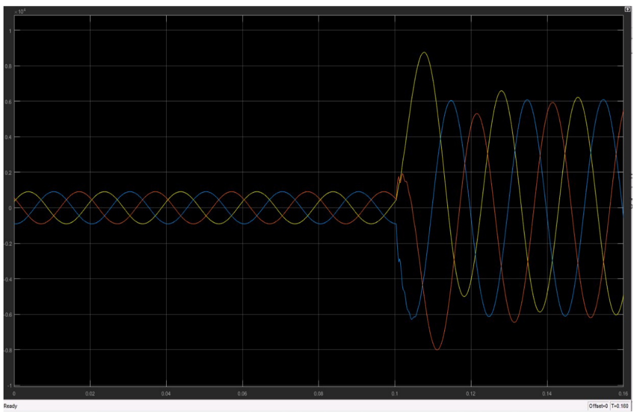

Fig:5. twophase to groundfaultatthesending end

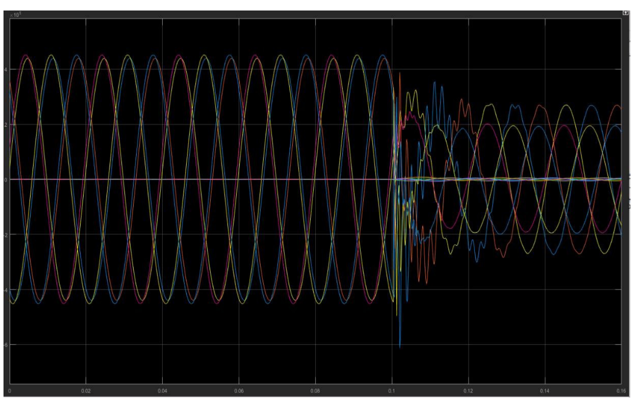

Fig:6. Threephase to groundfaultat the sending end

VI. CONCLUSION

This proposed work examines the response of the AC system to various failures on the AC side while analyzing various fault characteristics of the AC system. Additionally, numerous fault simulations, including single, two, and three phase-to-ground, and DC line-to-line faults, are carried out at various points of the test system in the simulation analysis stage. Next, the transient response of the AC system and the DC transmission system are compared when both systems are subjected to disturbances.

VII. FUTURE WORK

Future efforts will test the system with DC faults at the multi-terminal network and examine various potential fault criteria. This would pave the road for figuring out the quantitative specifications for the HVDC system's protective logic. Additionally, we assessed the transient DC current's rate of change, from which we deduced that the fastest transient was caused by a DC fault and the slower transient was caused by a load shift.

VIII. REFERENCES

1. Lee, J.-G., Khan, U. A., Lee, H.-Y., & Lee, B.-W. (2016). Impact of SFCL on the Four Types of HVDC Circuit Breakers bySimulation. IEEE Transactions on Applied Superconductivity, 26(4), 1–6. doi:10.1109/tasc.2016.2542847
2. M.Callavik,A. Blomberg,J.Hafner,andB.Jacobson,“The HybridHVDCBreaker,”
3. ABBGridSystemsTech.paper,Nov2012. X. Li, Q. Song, W. Liu, H. Rao, S. Xu, and L. Li, "Protection of NonpermanentFaults on DC Overhead Lines in MMC:Based HVDC Systems,"IEEE Transactions on Power Delivery, vol. 28, pp. 483:490, 2013.
4. C. M. Franck, “HVDC Circuit Breakers: A Review Identifying Future Research Needs” Power Delivery, IEEE Transactions on vol. 26, pp. 998-1007, 2011.
5. L. Tang and B. T. Ooi, “Locating and Isolating DC Faults in Multi-Terminal DC Systems,” IEEE Transactions on Power Delivery, vol. 22, pp. 1877-1884, 2007.

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