A Performance Analysis of Statcom on Distance Protection Relay

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Abstract— Legacy Transmission system protection schemes are mainly based on distance relaying. However, performance of distance relay is affected in presence of shunt Flexible AC Transmission System Devices (FACTS) like Static synchronous Compensator (STATCOM) which are mostly used to enhance the transferring capacity of transmission system. The study about the protection system like transmission protection by using Distance Relay Specially mho relay and its zone wise tripping characteristics. The detailed idea about FACTS, type of FACTS, Advantages of FACTS and application of FACTS. For various purpose like power handling capacity by injecting or absorbing reactive power. The STATCOM has adverse effect on protection like distance protection ,distance relay mal-function when STATCOM is connected to the Line, when STATCOM is in fault loop then have a great impact on relay tripping characteristics. Distance relay simulation in MATLAB plays an important role.

Key words: Distance relay, MATLAB, STATCOM

I. INTRODUCTION

The protection of the transmission is very important aspect when we consider the security of the power system as it is used to transfer bulk power from one area to other. Various protection schemes are used to protect the transmission line like over-current protection, distance protection, etc. The distance protection of the transmission line gives us the more reliable and fast decision making capability to detect and locate fault in the zone of protection and provides the information about trip or no trip. Traditional updating of a transmission system by constructing new transmission lines becomes extremely difficult because of economic and environmental pressures. High efficiency in terms of better utilization of existing transmission lines, without compromising on the quality and reliability of electrical power apply has thus to be found via alternative means. In this respect, due to the recent advances in high power semiconductor technology,

FACTS technology has been proposed to solve this problem the installation of the FACTS devices such as static synchronous compensator (STATCOM) in the transmission line enhances the power transfer capability of transmission line and provides optimum utilization of the system capability. To utilize the maximum capacity of the transmission line the best suited point for the installation of the shunt connected FACTS device is mid-point of the transmission line. STATCOM is one of the most widely used FACTS devices. It is based on a voltage source convert and can inject an almost sinusoidal current with variable magnitude and in quadrature with the connecting line voltage. It widely used at the mid-point of a transmission line or heavy load area to maintain the connecting point voltage by supplying or absorbing reactive power into the power system It is well documented in the literature that the introduction of the FACTS devices has great influence on the power system dynamics. As power system dynamics changes, many sub-systems are affected, including protection systems. Therefore it is important to study the effect of FACTS devices on the protection system, which is the main protective device at HV and EHV levels .In presence of shunt compensator, the conventional distance relay characteristics are greatly subjected to mal-operation in the form of under-reaching and over-reaching the fault point. When shunt compensator is installed at the relaying bus the shunt compensator is always present in the fault loop and has great impact on relay tripping characteristics. While, when shunt compensator is installed at end of the line, it is not present in the fault loop for the first zone of distance protection hence, it has less effect on relay tripping characteristics. When shunt compensator is installed at mid-point of the transmission line, the fault location plays the important role. When fault is before the shunt compensator, the shunt compensator is not in the fault loop and have less effect on tripping characteristics while, when fault is after the shunt compensator, it is present in fault loop and have great effect on the tripping characteristics. Also the effect of modes of operation of compensator affects the relay tripping characteristics.

II. STATCOM (STATIC SYNCHRONOUS COMPENSATOR)

The FACTS technology is not a single high power controller but rather a collection of controllers, which can be applied individually or in coordination with others to control one or more of the interrelated system parameters as discussed. A well-chosen FACTS controller can overcome the specific limitations of a designated transmission line or a corridor. Because all FACTS controllers represent applications of the same basic technology their production can eventually take advantage of technologies of scale. FACTS technology also lends itself to extending usable transmission limits in a step-by-step manner with incremental investment as and when required. The possibility that current through a line can be controlled at a reasonable cost enables a large potential of increasing the capacity of existing lines with larger conductors, and use of one of the FACTS Controllers to enable corresponding power to flow through such lines under normal and contingency conditions. These opportunities arise through the ability of FACTS Controllers to control the interrelated parameters that govern the operation of transmission systems including series impedance, shunt impedance, current, voltage, phase angle and the damping of oscillations at various frequencies below the rated frequency. These constraints cannot be overcome, while maintaining the required system reliability, by mechanical means without lowering the useable transmission capacity. By providing added flexibility, FACTS Controllers can enable a line to carry power closer to its thermal rating. Mechanical switching needs to be supplemented by rapid-response power electronics. It must be emphasized that STATCOM is capable of generating and

/or absorbing reactive power whose output can be varied so as to maintain control of specific parameters of electrical power system. On transmission level, Systems are normally balanced, but during fault condition system get disturbed. The controller input is an error signal obtained from the reference voltage and the rms value of the terminal voltage measured. Such error is processed by a PI controller the output is the angle, which is provided to the PWM signal generator.

The principle of STATCOM operation is as follows, the VSI generates a controllable AC voltage source behind the leakage reactance. This voltage is compared with the AC bus voltage system; when the AC bus voltage magnitude is above that of the VSI voltage magnitude, the AC system sees the STATCOM as an inductance connected to its terminals. Otherwise, if the VSI voltage magnitude is above that of the AC bus voltage magnitude, the AC system sees the STATCOM as a capacitance connected to its terminals. If the voltage magnitudes are equal, the reactive power exchange is zero. If the STATCOM has a DC source or energy storage device on its DC side, it can supply real power to the power system. This can be achieved adjusting the phase angle of the STATCOM terminals and the phase angle of the AC power system. When the phase angle of the AC power system leads the VSI phase angle, the STATCOM absorbs real power from the AC system; if the phase angle of the AC power system lags the VSI phase angle, the STATCOM supplies real power to AC system. Following figure show typical application of STATCOM.

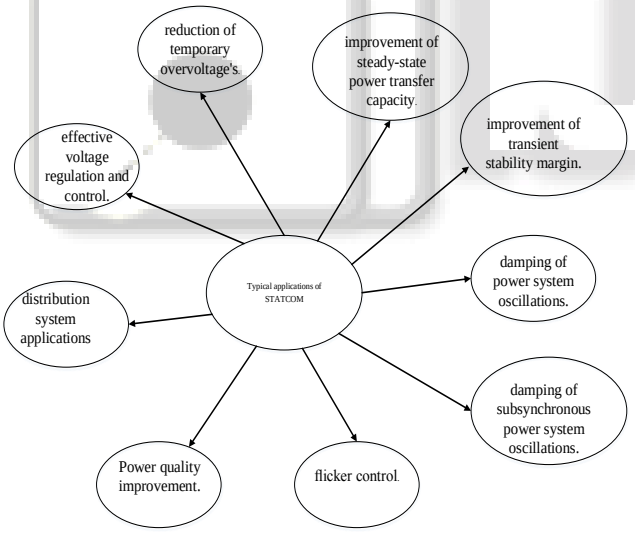

Fig. 1: Typical application of STATCOM.

III. DISTANCE RELAY

Distance protection is considered the most popular type of protection principle applied globally for protecting transmission lines due to their capability to meet the requirements of reliability and speed needed to protect these lines. The basic principle of distance relay relies on the fact that line impedance is fairly constant along the line and proportional to the length of the line. That is virtually true independent of the magnitudes of the voltage and current.

Therefore, the impedance from the relay location to any fault point along the line is proportional to distance from the relay to the fault point and hence the fault location can be determined if it falls within the protected line. As a result, the protective relay, which operates based on the measurement distance, is referred to as distance relay. Though the techniques in which signals are processed and computed differ from manufacturer to manufacturer, all of them work by calculating the impedance from the three-phase voltages and currents. The basic principle of operation of distance relay is that if the impedance measured by the relay is less than the setting impedance (normally in percentage of the transmission line impedance being protected), then the relay would conclude that there is a fault in the protected transmission line. Sometimes distance relays are also called as under impedance relays for this reason.

Frequency variation, earth fault resistance in the single-phase to earth faults, and power swing are some of the phenomena adversely affect distance protection performance. Among these, frequency variation and power swing are related to dynamic states of power systems. There are three types of distance relays namely reactance relay, impedance relay and mho relay. But performance of these relays gets affected by factors like power swing, arc resistance. The quadrilateral distance relay is quite better option for the protection of transmission line as it covers minimum area in R-X diagram and it is closer to ideal distance relay characteristics. When a short-circuit fault occurs on a transmission line, distance relays gives protection and trips the circuit breaker by disconnecting the faulty portion from the healthy section.

IV. EFFECT OF STATCOM ON TRANSMISSION LINE DISTANCE RELAYING

This presents the measured impedance at the relaying point in the presence of a shunt Flexible Alternating Current Transmission System (FACTS) devices like STATIC synchronous Compensators (STATCOM). The presence of shunt compensation on the transmission line has a great influence on the tripping characteristic of distance relays. Distance relay tripping characteristic itself depends on the power system structural conditions, short circuit levels at the line ends, pre fault conditions, load angle and voltage magnitude ratio of the line ends and especially the ground fault resistance. In the presence of shunt compensator, its controlling parameters as well as its installation location also affect the tripping characteristic. Therefore, to analyze the effect of shunt compensation on ideal tripping characteristics of distance relay, the various locations are considered for simulation. The installation locations considered for simulation are at the near end, at the mid-point and at the far end of the transmission line. With the help of measured impedance characteristic, it can be analyzed that how much a distance relay is subjected to mal-operation in the presence of shunt compensation located at the different locations.

A. At the End of Line

- It is not present in the fault loop for the first zone of distance protection hence, it have less effect on relay tripping characteristics.

B. At Midpoint of line

- The fault location plays the important role. When fault is before the shunt compensator, the shunt compensator

is not in the fault loop and have less effect on tripping characteristics while, when fault is after the shunt compensator, it is present in fault loop and have great effect on the tripping characteristics. Also the effect of modes of operation of compensator affects the relay tripping characteristics.

V. SIMULATION SCHEME

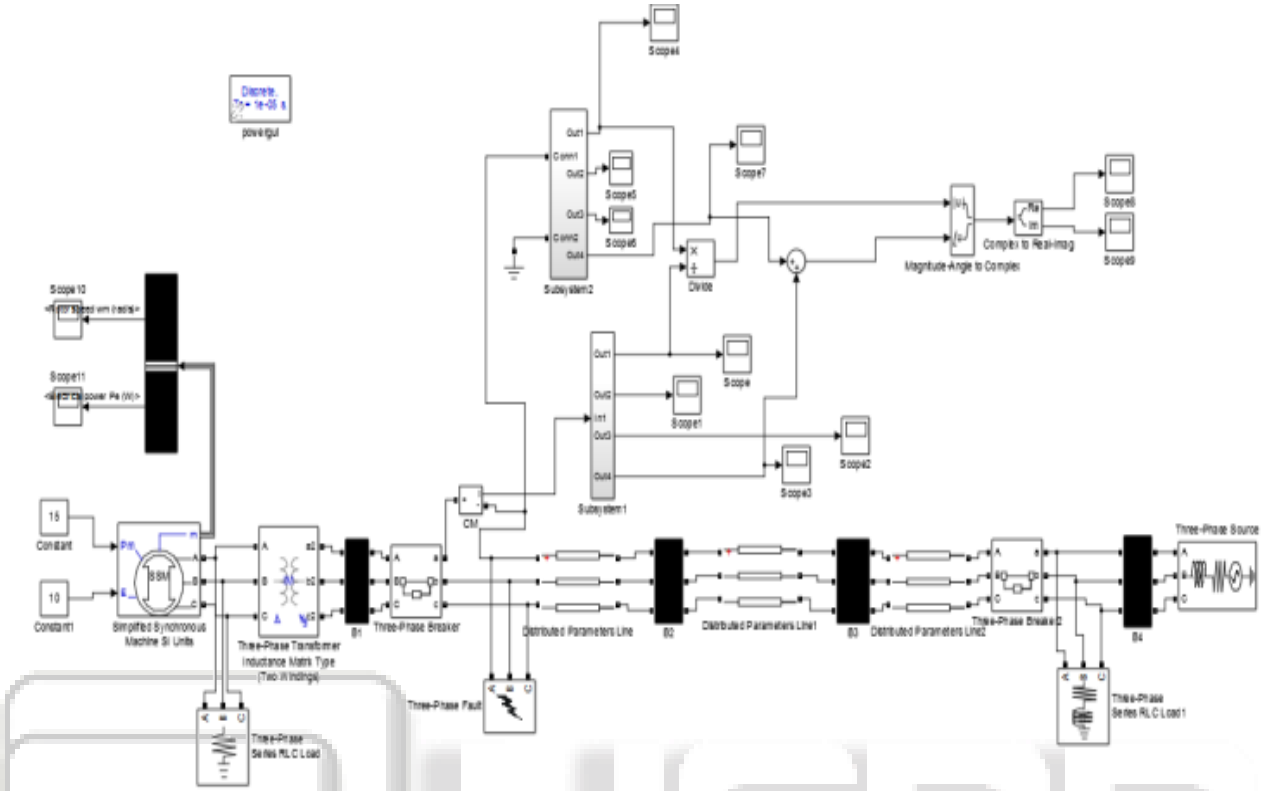

Fig. 2: Simulation model of distance relay.

A. *Results*

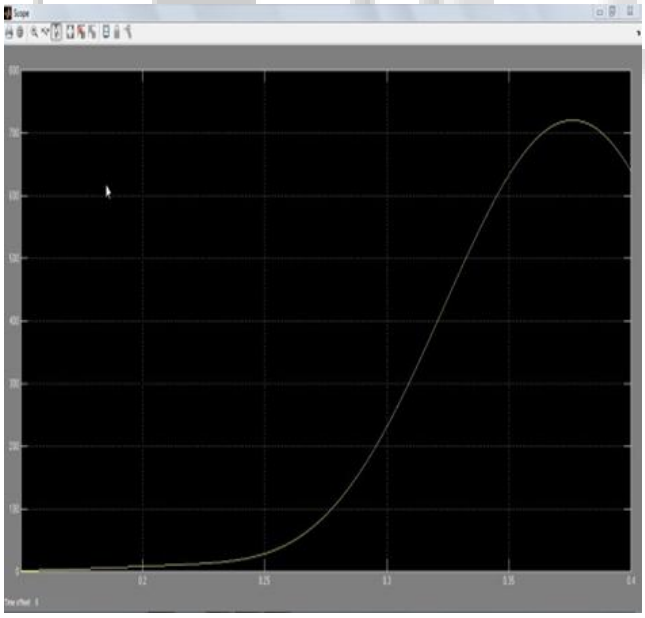

Fig. 3: Simulation model of distance relay at initial level.

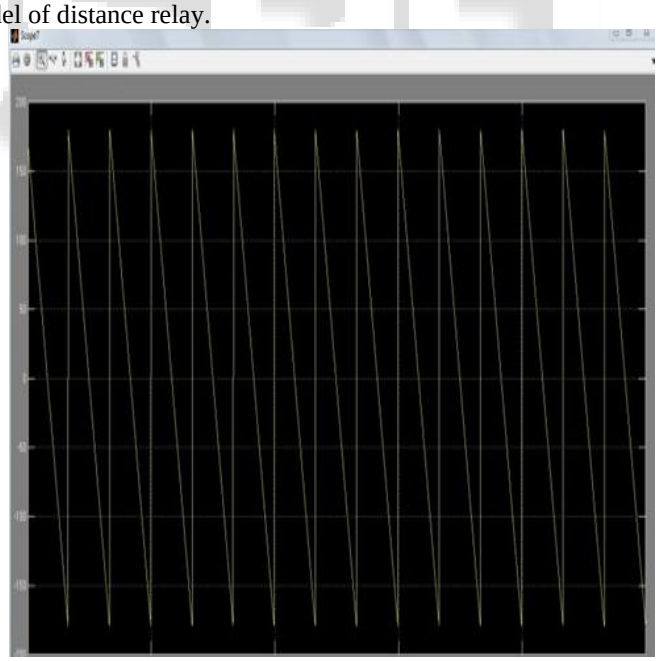

Fig. 4: Simulation model of distance relay at intermediate level.

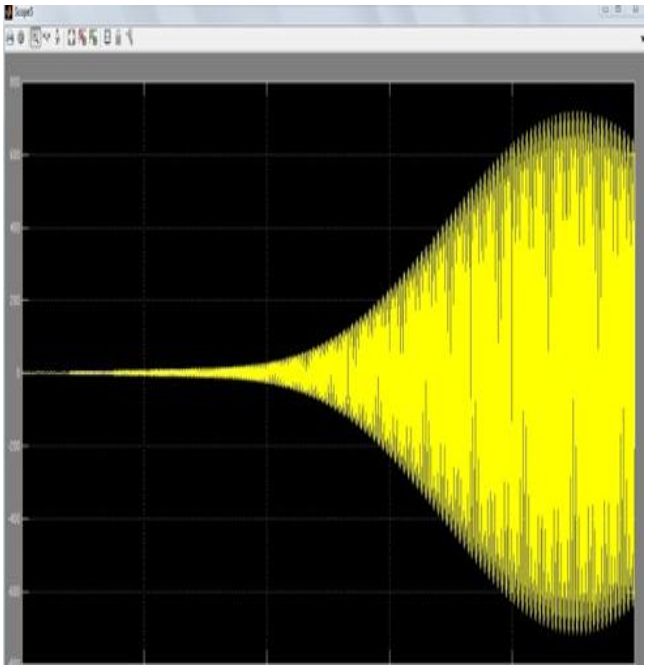

Fig. 5: Simulation model of distance relay at end level.

VI. CONCLUSIONS

It shows that Simulation model of a distance relay having three zones and study of STATCOM for reactive power compensation. And plotted the mho characteristics. With the help of measured impedance characteristic, it can be analyzed that how much a distance relay is subjected to mal-operation in the presence of shunt compensation located at the different locations. Also studied relay tripping characteristics as in MATLAB software

VII. FUTURE SCOPE

In this simulation fault is taken in results are comparing for different faults and mitigate this maloperation of distance relay by that way we can minimize the unwanted tripping of relay also with the help of STATCOM we can improve the power handling capacity of transmission line to some extent and study the result of transmission line with and without STATCOM.

REFERENCES

[1] GorakshanathAbande, M.F.A.R. Satarkar, Maroofa H. Rawoot, Mohan Thakre, Dr.V.S. Kale, "Impact of STATCOM ON Distance Relay" held on 20th and 21st March 2014.IEEE international conference on circuit, power and computing technologies-2014.

[2] N. G. Hingorani and L. Gyugyi, Understanding FACTS: Concepts & Technology of Flexible AC Transmission Systems. Hoboken, New Jersey: IEEE Press, 1999.

[3] M. Khederzadeh, "The impact of facts device on digital multifunctional protective relays," IEEE Power Eng. Soc. Transmission and Distribution Conf. Exhibit., Asia Pacific, vol. 3, p. 20432048, Oct. 610 2002.

[4] S. J. A. Kazemi and H. Shateri, "Effects of statcom on distance relay tripping characteristic," IEEE/PES Transmission and Distribution Conference and Exhibition. 2005.

[5] P. G. F. A. T.S. Sidhu, R.K. Varma and G.R.Ortiz, "Performance of distance relays on shunt facts compensated transmission lines," IEEE Trans. on Power Delivery, vol. 20, July 2005.

[6] T. S. F.A. Albasri and R. Varma, "Performance comparison of distance protection schemes for shunt-facts compensated transmission lines," IEEE Trans. on Power Delivery, vol. 22, Oct. 2007.

[7] S. Nilsson, "Special application considerations for Custom Power systems," in Proc. IEEE Power Eng. Soc., Winter Meeting 1999, vol. 2,1999, pp. 1127–1130.

[8] Olimpoanaya-lara and e.acha, "Modeling and analysis of custom power systems by pscad/emtdc," IEEE Trans. on power delivery, vol. 17, no. 1, january 2002.

