Transmission Line Protection using Distance Relays

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Abstract

The key challenge to the cable protection lies in faithfully police work and uninflected faults compromising the protection of the system. during this paper reciprocal ohm Characteristics and Frequency Dependent (Phase) model sort cable square measure modelled and simulated victimisation PSCAD/EMTDC package. a quick Fourier remodel block in PSCAD/EMTDC has been accustomed extract the basic part. Unsymmetrical and symmetrical faults at totally different zones were performed to review the performance of the relay characteristics and to research the consistency of the relay models generated with the planned methodology. The network utilized in this paper is 230kv systems.

Keywords: *Line protection, Mho relay, Symmetrical faults, Unsymmetrical faults, Zone protection*

INTRODUCTION

Importance of cable Protection: Transmission lines square measure an important a part of the electrical distribution system, as they supply the trail to transfer power between generation and cargo. Transmission lines operate at voltage levels from 69kV to 765kV, and square measure ideally tightly interconnected for reliable operation. Any fault, if not detected and isolated quickly can cascade into a system wide disturbance inflicting widespread outages for a tightly interconnected system operative near its limits. Transmission protection systems square measure designed to spot the placement of faults and isolate solely the faulted section. The key challenge to the cable protection lies in faithfully police work and uninflected faults compromising the protection of the system. The high level factors influencing line protection embody the criticality of the, fault clearing time necessities for system stability, line length, the system feeding the road, the configuration of the road, the road loading, the kinds of communications obtainable, and failure modes of assorted protection instrumentality. the most objectives of cable protection square measure minimizing the length of a fault, service continuity, improved voltage regulation, reduced power losses, finally Quality output power. while not correct protection system, it's not possible to realize higher than edges. once a fault happens, the characteristic values might amendment from existing values to totally different values until the fault is cleared. Once the fault takes place, voltage and current values deviates from their nominal ranges.

The faults in grid causes over current, beneath voltage, unbalance of the phases, reversed power and high voltage surges. This ends up in the interruption of the conventional operation of the network, failure of equipments, electrical fires, etc. during this paper, the performance of the relay characteristics for unsymmetrical and symmetrical faults at totally different zones were simulated victimisation PSCAD package and analysed to research the consistency of the relay models. PSCAD is graphical programme, provides powerful suggests that of visualizing the transient behaviour of the systems. PSCAD/EMTDC provides a quick and correct answer for the simulation of wattage systems.

FAULTS: SYMMETRICAL AND UNSYMMETRICAL

Faults that occur in transmission lines square measure broadly speaking classified into open and short faults and once more these will be symmetrical and unsymmetrical faults. In symmetrical faults, all the 3 phases square measure short-circuited to every different and sometimes to earth. Such fault is balanced within the sense that the systems stay symmetrical, or the lines displaced by Associate in Nursing equal angle. These square measure terribly severe sort of faults involving high currents and occur sometimes within the power systems. These are known as as balanced faults and are of 2 sorts specifically L-L-L-G and L-L-L faults.

Unsymmetrical faults square measure quite common and fewer severe than symmetrical faults. These square measure chiefly 3 sorts specifically line to ground (L-G), line to line (L-L) and double line to ground (LL-G) faults.

DISTANCE RELAYS

Distance relay, that functions relying upon the space of fault within the line. additional specifically, the relay operates relying upon the resistance between purpose of fault and therefore the point wherever relay is put in. Distance relays square measure designed to guard power systems against basic styles of faults LG, LL-G, LL and 3 section faults. the essential principle of distance protection involves the division of the voltage at the relaying purpose by the measured current.

The apparent resistance therefore calculated is compared with the reach purpose resistance. If the measured resistance is a smaller amount than the reach purpose resistance, it's assumed that a fault exists on the road between the relay and therefore the reach purpose.

The reach purpose of a relay is that the purpose on the road resistance locus that's intersected by the boundary characteristic of the relay. Since this can be captivated with the quantitative relation of voltage and current and therefore the phase between them, it will be planned on Associate in Nursing R/X diagram. The fault resistance calculation formula for every type of faults square measure shown in Table one.

Table 1: Fault resistance calculations on totally different faults

Distance Element	Formula
Phase A	$Z_A = V_A/(I_A + 3kI_0)$
Phase B	$Z_B = V_B/(I_B + 3kI_0)$
Phase C	$Z_C = V_C/(I_C + 3kI_0)$
Phase A-Phase B	$Z_{AB} = V_{AB}/(I_A - I_B)$
Phase B-Phase C	$Z_{BC} = V_{BC}/(I_B - I_C)$
Phase C- Phase A	$Z_{CA} = V_{CA}/(I_C - I_A)$

Where, k = (Z0-Z1) / Z1, Z0 and Z1 square measure zero sequence and positive sequence impedances.

Zones of Protection: To limit the extent of the ability system that's disconnected once a fault happens, protection is organized in zones as shown in Fig.1. Ideally, the zones of protection ought to overlap, in order that no a part of the ability system is left unprotected. For sensible physical and economic reasons, this ideal isn't continuously achieved, accommodation for current transformers being in some cases obtainable solely on one facet of the circuit breakers. This leaves a neighbourhood between this transformer and therefore the breaker that's not fully protected against faults.

Distance relays can have instant directional zone one protection and one or longer delayed zones. 3 protection zones within the direction of the fault square measure utilized in order to hide a neighbourhood of line and to supply back-up protection to remote sections. Some relays have one or 2 further zones within the direction of the fault and another within the opposite sense, the latter acting as a back-up to guard the busbars.

Within the majority of cases the setting of the reach of the 3 main protection zones is created in accordance with the subsequent criteria: reciprocal ohm relay characteristics for 3 zones of protection as shown within the Fig. 1. Relay is found at A. Z1, Z2 and Z3 square measure the setting resistance of the reciprocal ohm relay for zone1, zone2 and zone3. AD is that the total cable resistance divided into 3 zones AB, BC and CD.

Zone 1: this can be set to hide between eighty and eighty-five per cent of the length of the protected line;

Zone 2: this can be set to hide all the protected line and fifty per cent of the shortest next line;

Zone 3: this can be set to hide all the protected line and one hundred per cent of the second longest line and twenty-five per cent of the shortest next line.

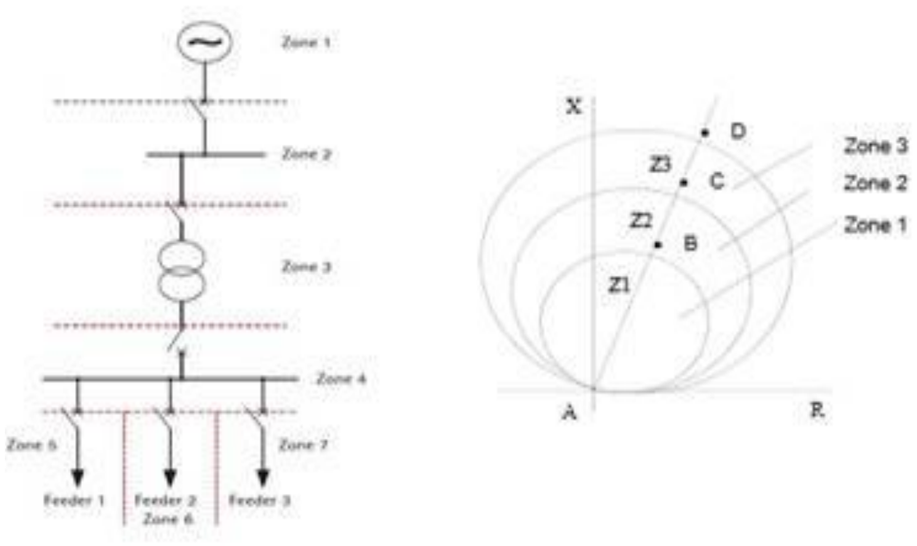

Fig. 1: Division of grid into protection zones and its reciprocal ohm relay characteristics

RESULTS AND DISCUSSIONS

The doubly fed cable has been described victimisation the Frequency Dependent (Phase) model, that operative at 230kV, 50 Hz. Relay is found at bus-1 as shown in Fig. 3. The supply knowledge is R=9.186 Ω, L=138mH and therefore the cable positive sequence resistance is zero.12312+j0.663 Ω/km and nil sequence resistance is 0.08844+j0.2397 Ω/km

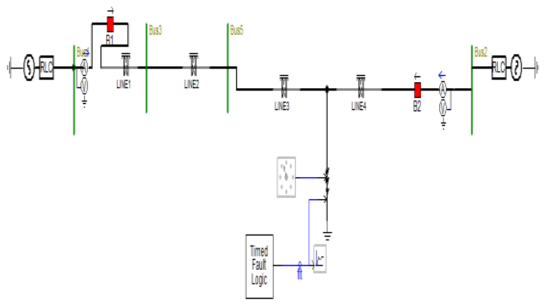

Fig. 2: A pair of cable model

When a cable is subjected to a fault, the voltage signals and current signals contain decaying dc elements, higher order frequency elements and lower order frequency elements. This affects the performance of digital relay. Therefore, the separate Fourier remodel is sometimes accustomed take away the dc-offset elements. The quick Fourier remodel may be a quick algorithmic program for economical computation of DFT. FFT reduces the quantity of arithmetic operations and memory needed to cipher the DFT. Fig. four shows reciprocal ohm relay modelling algorithmic program, that uses FFT block in PSCAD/EMTDC for extracting the basic frequency part.

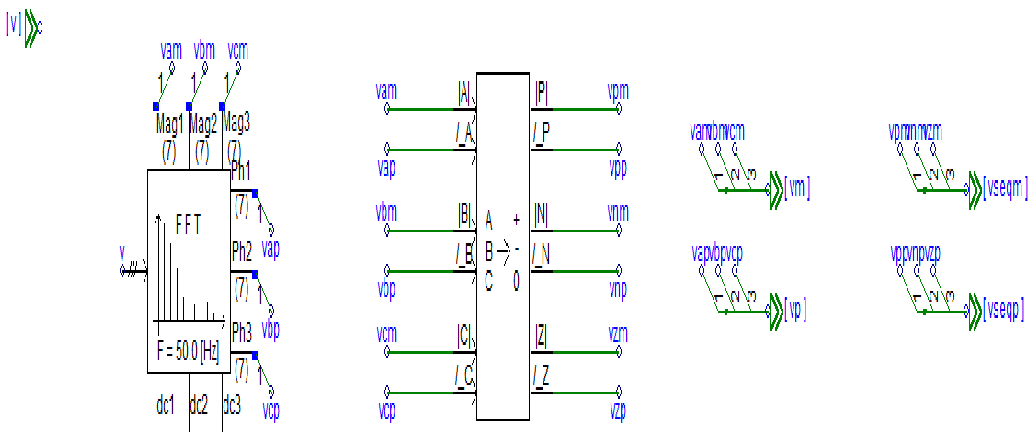

Fig.3 quick Fourier remodel block in PSCAD

Setting of reciprocal ohm relay:

Zone-1 = fifty three.95 Ω (80 take advantage of protected line AB).

Zone-2 = one zero one.16 Ω (100 take advantage of protected line AB + fifty take advantage of the protected line BC).

Zone-3 = 151.75 Ω (100 take advantage of protected line AB + 100% of the protected line BC+25% of the protected line CD). resistance settings for the 3 zones square measure given in Table a pair of.

Table 2: Settings of Zones of Protection

Zone	R	X
1	9.84	53.04
2	18.46	99.48
3	27.7	149.2

To study the behaviour of the developed reciprocal ohm relay characteristics for symmetrical and unsymmetrical faults at totally different locations on the 230kV, 300km cable were simulated victimisation PSCAD/EMTDC package. The behaviour of the reciprocal ohm relay is as explained here in when.

Case 1: - Unsymmetrical faults at totally different distances from the relay location

When Single line to ground fault was attack the 230kV, three hundred metric linear unit cable model at a distance of 60km from the placement of bus-1, simulation results square measure shown in Fig. 4.

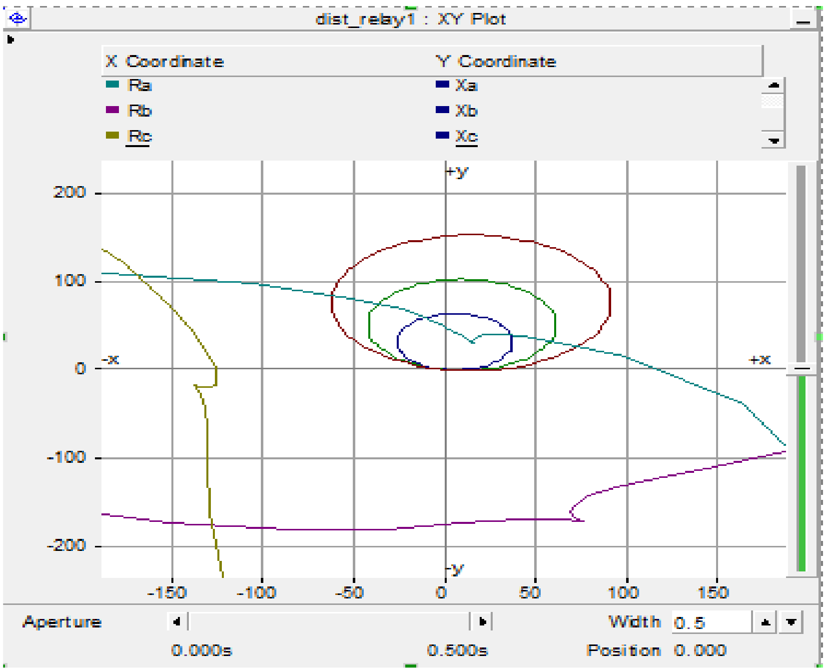

Fig.4: LG fault at sixty metric linear unit from bus-1 (zone 1)

When single line to ground fault was attack the cable model at a distance of 50kmfrom bus-3, simulation results square measure shown in Fig.5.

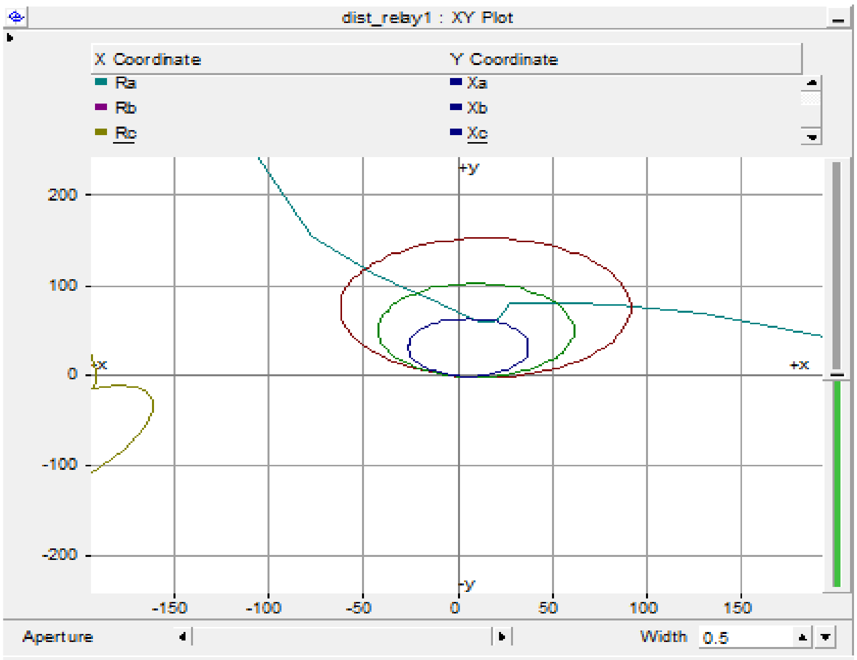

Fig.5 LG fault at five0 metric linear unit from bus-3 (zone 2)

When single line to ground fault was attack the cable model at a distance of 25kmfrom bus-5, simulation results square measure shown in Fig.6.

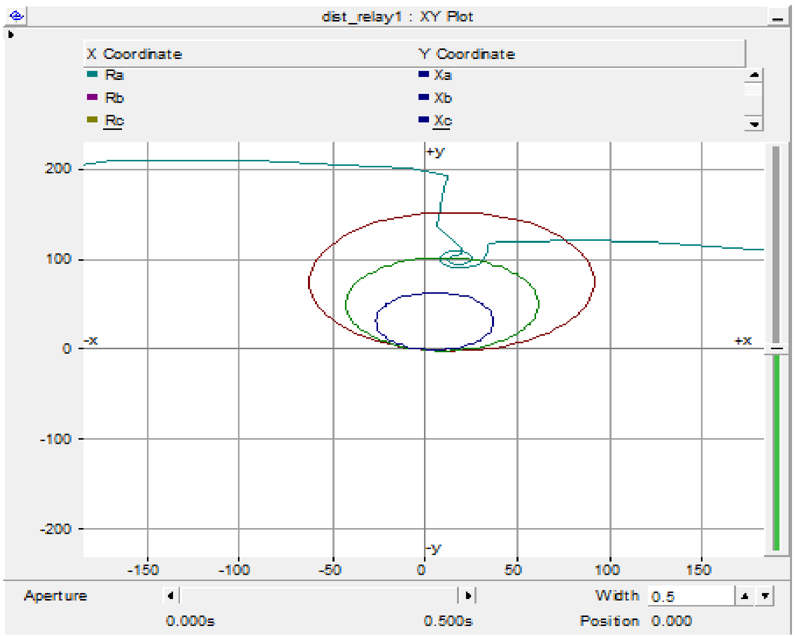

Fig.6 LG fault at twenty five metric linear unit from bus-5 (zone 3)

Double line to ground fault was attack the 230kV, three hundred metric linear unit cable model at a distance of 60km from the placement of bus-1. Simulation results square measure shown in Fig. 7.

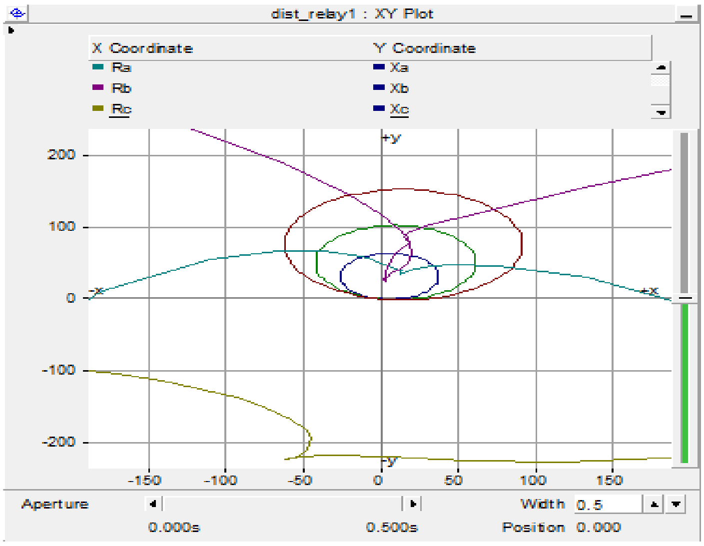

Fig.7: LLG fault at sixty metric linear unit from bus-1 (zone 1)

Double line to ground fault was attack the cable model at a distance of 50km from the placement of bus-3. Simulation results square measure shown in Fig. 8.

Double line to ground fault was attack the cable model at a distance of 25km from the placement of bus-5. Simulation results square measure shown in Fig. 9.

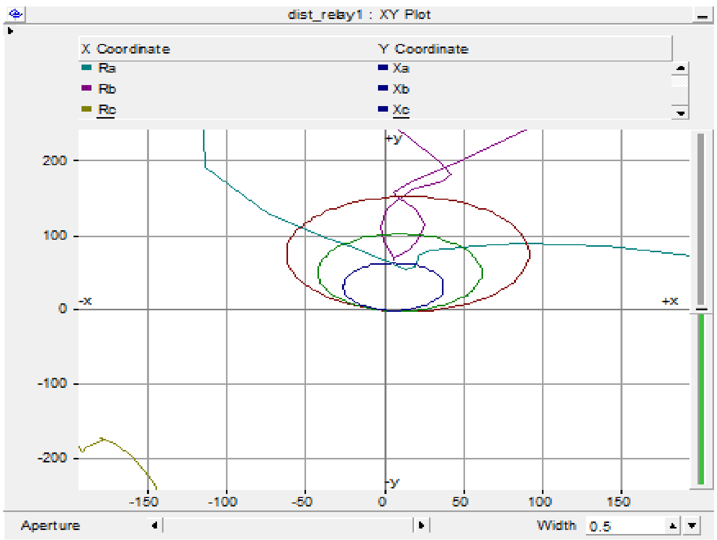

Fig.8: LLG fault at fifty metric linear unit from bus-3 (zone 2)

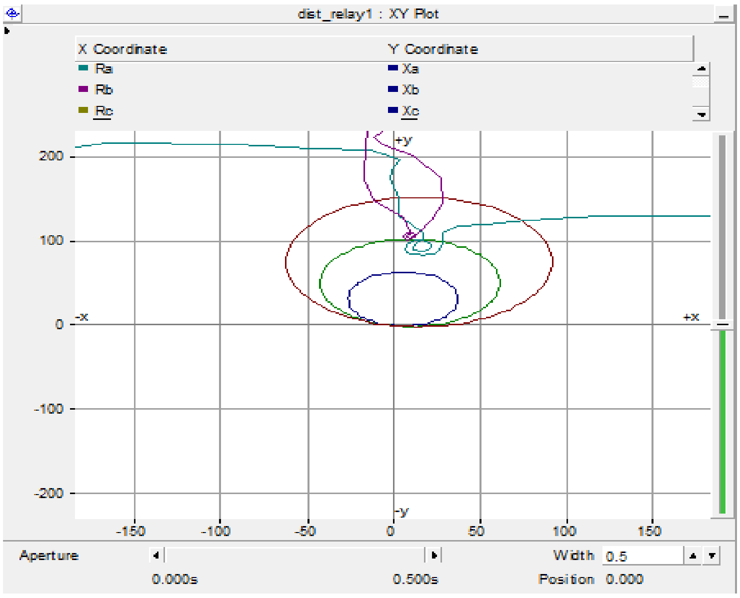

Fig.9: LLG fault at twenty five metric linear unit from bus-5 (zone 3)

Case 2: - Symmetrical faults at totally different distances from the relay location

Three section fault was attack the 230kV, three hundred metric linear unit cable model at a distance of 60km from the placement of bus-1. Simulation results square measure shown in Fig. 10.

Three section fault was attack the cable model at a distance of 50km from the placement of bus-3. Simulation results square measure shown in Fig. 11.

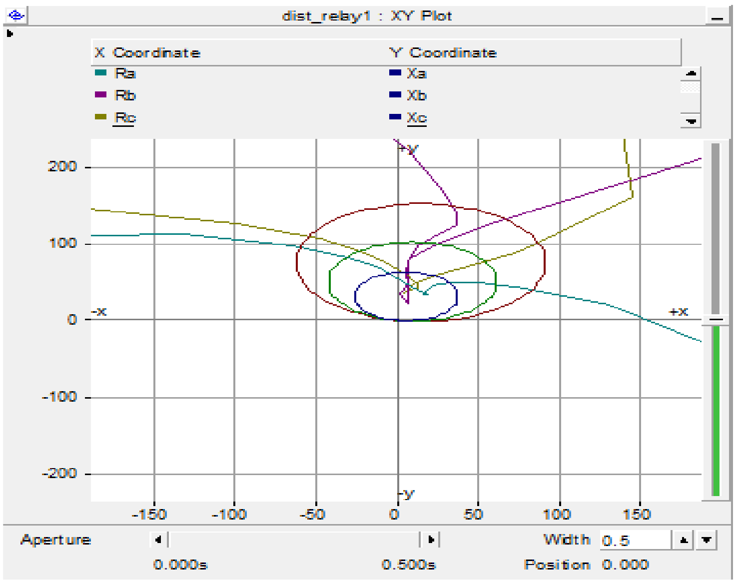

Fig.10: LLL fault at sixty metric linear unit from bus-1 (zone 1)

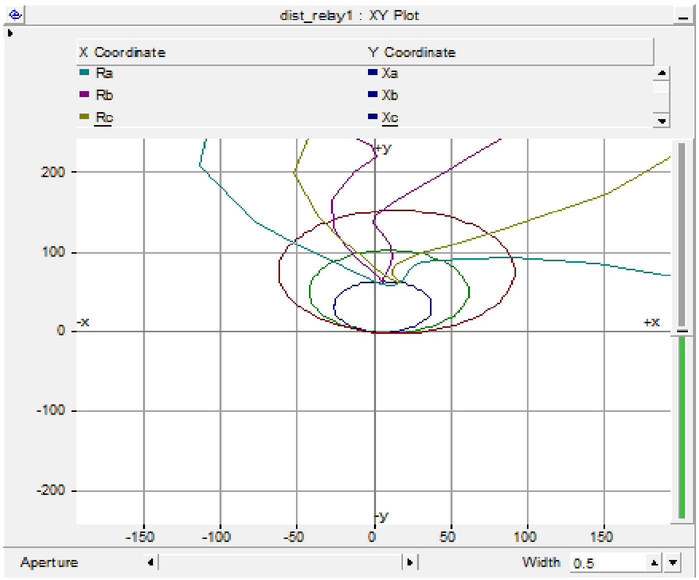

Fig.11: LLLfault at fifty metric linear unit from bus-3 (zone 2)

Three section fault was attack the cable model at a distance of 25km from the placement of bus-5. Simulation results square measure shown in Fig. 12.

Three section to ground fault was attack the 230kV, three hundred metric linear unit cable model at a distance of 60km from the placement of bus-1, bus-3 and bus-5. Simulation results square measure shown in Fig. 13.

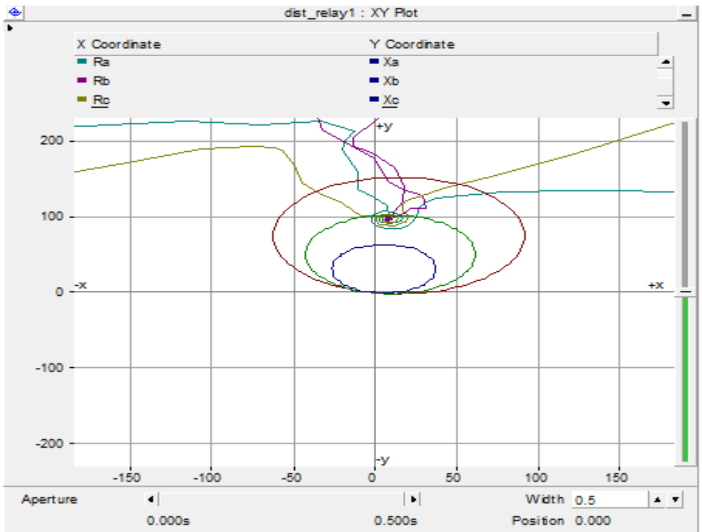

Fig.12: LLL fault at twenty five metric linear unit from bus-5 (zone 3)

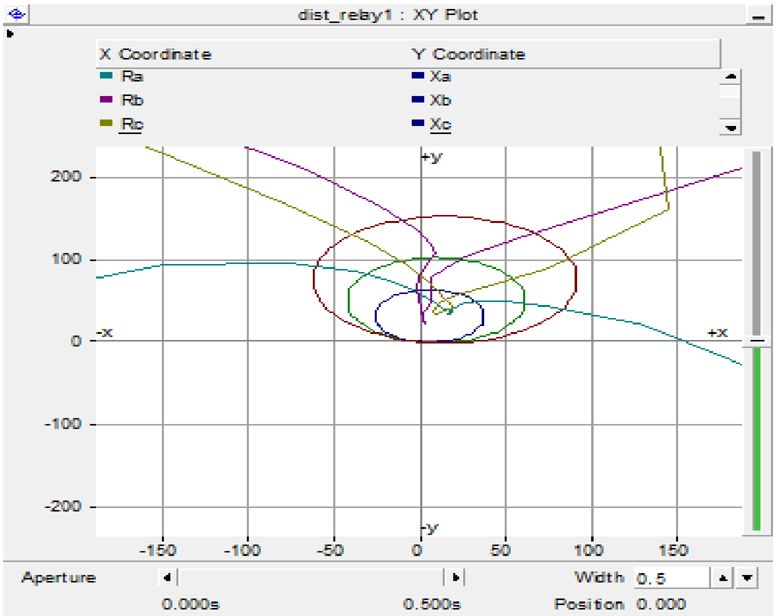

Fig.13: LLLG fault at sixty metric linear unit from bus-1 (zone 1)

Three section to ground fault was attack the cable model at a distance of 50km from the placement of bus-3. Simulation results square measure shown in Fig. 14.

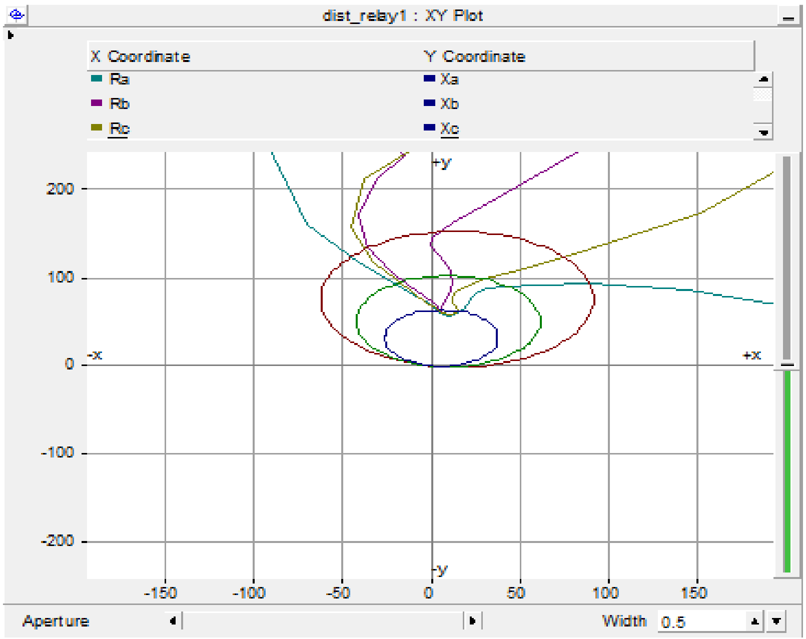

Fig.14: LLLGfault at fifty metric linear unit from bus-3 (zone 2)

Three section to ground fault was attack the cable model at a distance of 25km from the placement of bus-5. Simulation results square measure shown in Fig. 15.

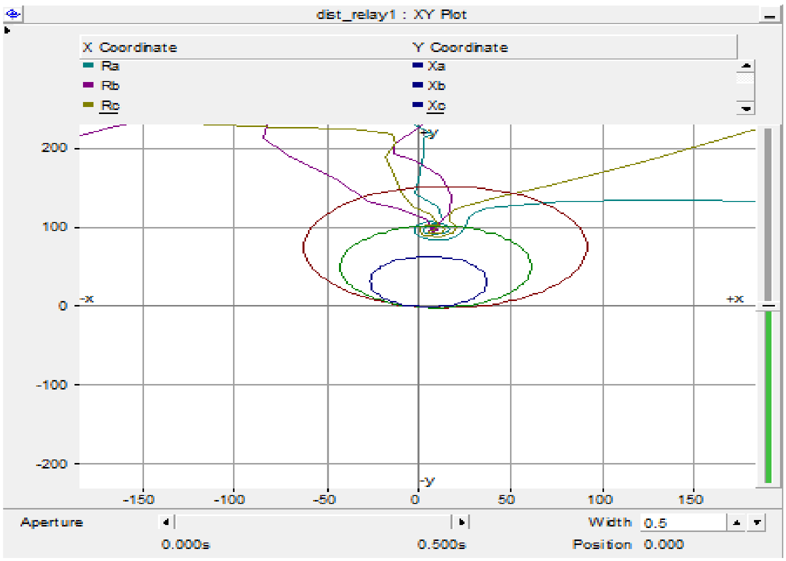

Fig.15LLLG fault at twenty five metric linear unit from bus-5 (zone 3)

The voltage and current waveforms of a cable model for 3 section fault square measure shown in Fig.16

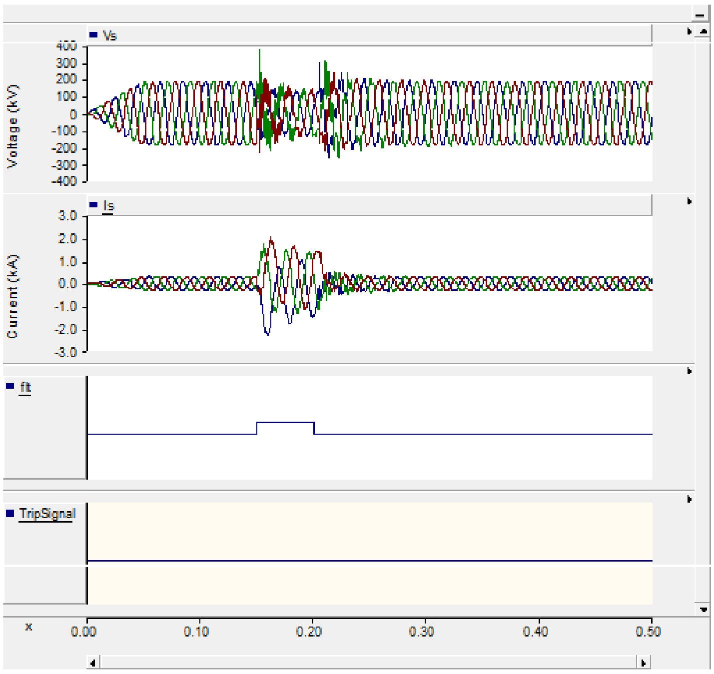

Fig.16 Voltage and Current waveforms for 3 section fault

CONCLUSION

In this paper doubly fed cable has been thought-about to review the reciprocal ohm relay characteristics victimisation PSCAD. The performance characteristics of reciprocal ohm relay are evaluated at totally different locations with symmetrical and unsymmetrical faults. totally different case studies are conferred maybe the response of reciprocal ohm relay characteristics at varied zones with differing kinds of faults. The voltage and current waveforms of a cable square measure conferred to guage the response because of the fault.

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