IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 1 Issue 10, December 2014.
www.ijiset.com
ISSN 2348 – 7968

Distance Relay Setting and Apparent Impedance Calculation for 3-Phase and L-G Fault In Long Transmission Line

Jayachandra S[1], Vijayasanthi M[2]

1 Department of EEE/Y.I.T.S,
Tirupati, A.P ,517507, India

2 Department of CSE/ S.V.C.E,
Sri perambadur, T.N,602105 , India

Abstract

EHV long transmission transmits large power.it is very important to clear any fault occurred in the transmission line. 3-phase fault is the most severse fault compared with any other fault. This paper studies the relay tripping characteristics for 3-phase fault and compares for L-G fault and 3-phase fault with and without capacitance effect. To set the distance relay without considering the distributed capacitance will cause serious over reaching or under reaching. This paper analyzes the effect of distributed capacitance on the relay tripping characteristics for L-G fault and 3-phase fault.

Keywords*: long transmission line, distance relay tripping characteristics, distributed capacitance, L-G fault and 3-phase fault.*

1. Introduction

Distance relays are widely used as primary or backup protection for UHV/EHV lines, as they are independent of communication channels, and their reaches are insensitive to system condition[1]. A distance relay operates by measuring the electrical circuit distance between the relay location and the point of fault (apparent impedance) to determine if a fault is in its protection zone. It is apparent that the protection zones need to be set accurately to avoid overreaching or under reaching, and ensure the reliability and selectivity. Normally the protection zones can be set without considering the distributed capacitance, as the impedance of the distributed capacitance is too big compared with the line impedance. With the transmission distance increasing, however, the distributed capacitance of the whole line increases correspondingly. Meanwhile, to improve the economical and transmission efficiency over long distance, higher voltage levels are adopted, which brings higher distributed capacitance per unit of transmission lines[7]. The impedance of the distributed capacitance is comparable with the line impedance, thus its effects on the distance relay need to be considered, to ensure the distance relay's reliable operation [2].

2. Apparent Impedance Calculation With Capacitance For 3-Phase Fault.

In the case of zero fault resistance, the measured impedance by distance relay is the exact impedance of the line section between the fault and the relaying points. From Fig.1., this impedance is equal to dZ1L, where d is per unit length of the line section between the fault and the relaying points and Z1L is the line positive sequence impedance in ohms. For a non-zero fault resistance, the measured impedance at the relaying point is not equal to the mentioned magnitude. In this case, the structural and operational conditions of the power system affect the measured impedance. The operational conditions prior to the fault instances can be represented by the load angle of the line 'δ' and the voltage magnitude ratio at the line ends 'h' or in general EN / EM= he-jδ. The structural conditions are evaluated by the short circuit levels at the line ends[3]. The measured impedance at the relaying point can be expressed by the following equations The measured impedance at the relaying point can be expressed by the following equations.

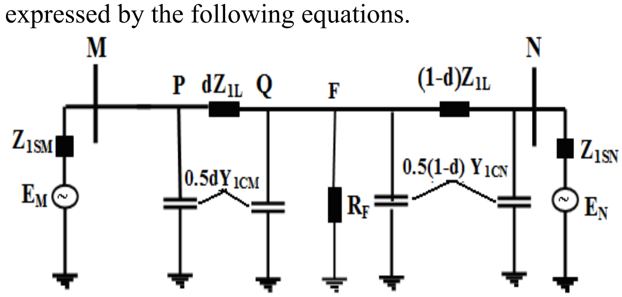

Fig.1 Single line diagram of long transmission line for 3-phase fault including shut capacitance and fault resistance R_F

Z1LM=d*Z1L; (1)

Z1LN=(1-d)*Z1L; (2)
Z1M=Z1SM+Z1LM; (3)
Z1N=Z1SN+Z1LN; (4)
Z1CM=1/(j*W*P*C1/2); (5)
Z1CN=1/(j*W*P*C1/2); (6)
Z1C=1/(j*W*P*C1/2); (1) (7)
Y1CM1=(1/2)*d*Y1C; (1) (8)
Y1CN1=(1/2)*(1-d)*Y1C; (9)
Z1CM1=1/Y1CM1; (10)
Z1CN1=1/Y1CN1; (11)
W=100*pi; (12)
Zeq=(Z1Meq*Z1Neq)/(Z1Meq+Z1Neq); (13)
ZAPP=Z1Meq+((Z1Meq+Z1Neq)/Z1Neq)*RF; (14)

3. Apparent Impedance Calculation Without Capacitance For 3-Phase Fault

If capacitance is not considered for the fig1. the apparent impedance at the relaying point can be expressed with the help of above equations and by the following equation.

ZAPP=Z1M*Z1N/(Z1M+Z1N); (15)

4. Apparent Impedance Calculation Without Capacitance For L-G Fault

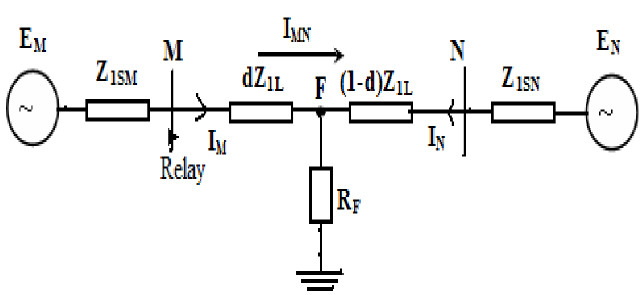

Fig. 2 Line -to-ground fault without consideration of line capacitance.

ZAPP=Z1LM+3*RF/((Zeq+3*RF) (16)

5. Apparent Impedance Calculation With Capacitance For L-G Fault

If capacitance is considered for the fig2. The apparent impedance at the relaying point can be expressed by the following equation.

KC1= IPREL1*d*Z1L; (17)
KC2=IPREL2+2*d*Z1L; (18)

ZAPP=(3*RF+KC1)/KC2; (19)

6. Tripping Characteristics

Knowing the structural and operational conditions, i.e. the short circuit levels, the load angle'δ', and the voltage magnitude ratio 'h', the distance relay ideal tripping characteristic can be defined[5]. This characteristic shown in fig3,fig 4,fig 5,fig 6,fig7,fig 8,fig 9,fig 10 has four boundaries. First boundary is the measured impedance for zero fault resistance; fault location varies from near end up to the far end of the line. In the second boundary, the fault point is at the far end; fault resistance varies between 0 and 200 ohms. Third boundary is the result of the fault point variation along the line for the fault resistance of 200 ohms. Forth is achieved by variation of the fault resistance between 0 and 200 ohms for the faults on the near end of the line[6],[7].

7. Distance Relay Tripping Characteristics For 3-Phase Fault With Capacitance

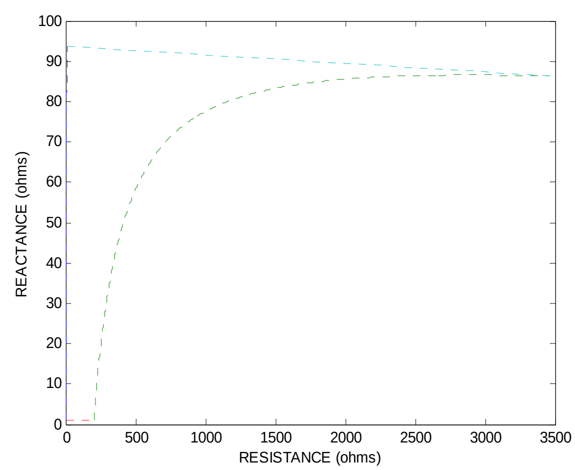

Fig. 3 Distance relay tripping characteristic zone for 3-phase fault With Capacitance (or) RX plot with capacitance .

The Fig 3.shows the relay tripping characteristics for 3-phase fault with capacitance for p = 300, h= 0.96, 'δ'=16, where p is the line length, 'δ' is the load angle, 'h' is the voltage magnitude ratio at the line ends

IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 1 Issue 10, December 2014.
www.ijiset.com
ISSN 2348 – 7968

8. Distance Relay Tripping Characteristics For 3-Phase Fault Without Capacitance

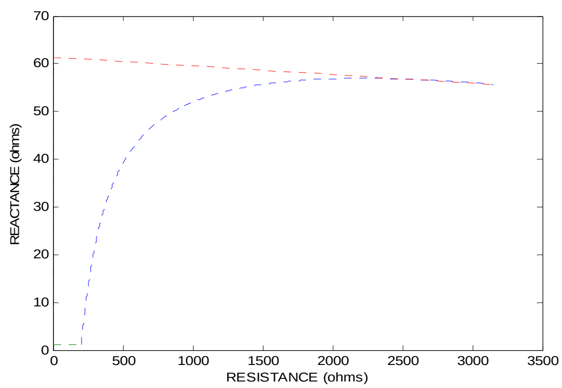

Fig. 4 Distance relay tripping characteristic zone for 3-phase fault With out Capacitance (or) RX plot without capacitance

The Fig. 4 shows the relay tripping characteristics for 3-phase fault without capacitance for p = 300, h= 0.96, ‘δ’=16.

9. Distance Relay Tripping Characteristics For 3-Phase Fault With and Without Capacitance

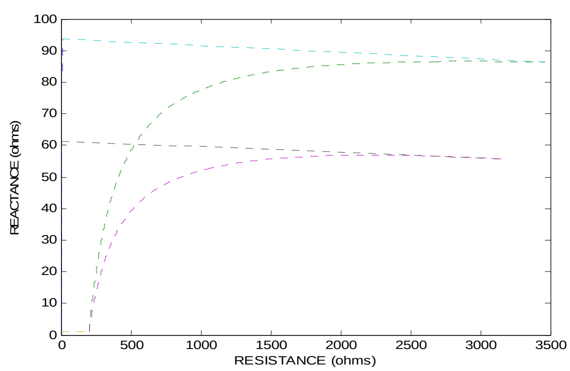

Fig. 5 Distance relay tripping characteristic zone for 3-phase fault with and without Capacitance (or) RX plot with capacitance

The Fig. 5 shows the relay tripping characteristics for 3-phase fault with and without capacitance for p = 300, h= 0.96, ‘δ’=16.

10. Distance Relay Tripping Characteristics For L-G Fault With Capacitance

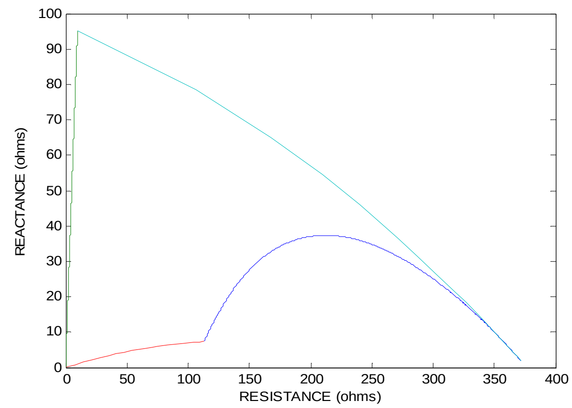

Fig. 6 Distance relay tripping characteristic zone for L-G fault With Capacitance (or) RX plot with capacitance

The Fig. 6 shows the relay tripping characteristics for L-G fault with capacitance for p = 300, h= 0.96, ‘δ’=16.

11. Distance Relay Tripping Characteristics For L-G Fault Without Capacitance

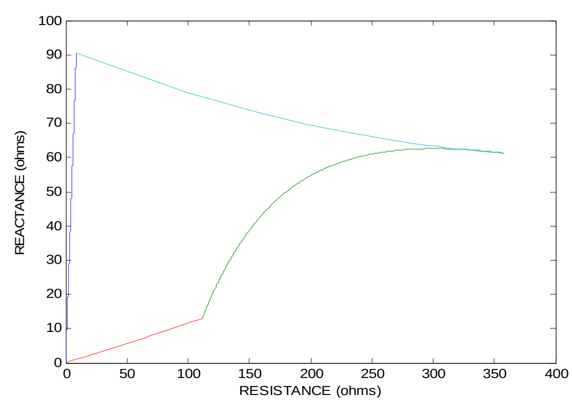

Fig. 7 Distance relay tripping characteristic zone for L-G fault Without Capacitance (or) RX plot with capacitance

The Fig.7 shows the relay tripping characteristics for 3-phase fault without capacitance for p = 300, h= 0.96, ‘δ’=16.

ISSN 2348 – 7968

12. Distance Relay Tripping Characteristics For L-G Fault With And Without Capacitance

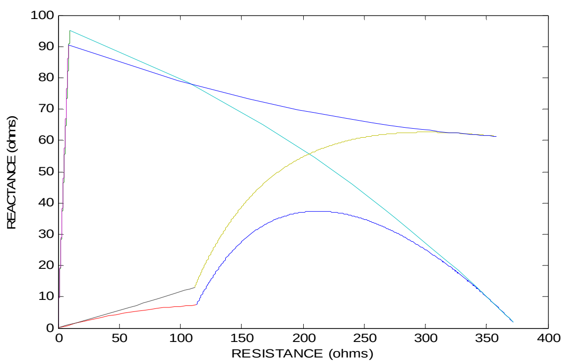

Fig. 8 Distance relay tripping characteristic zone for L-G fault With and without Capacitance (or) RX plot with capacitance

The Fig. 8 shows the relay tripping characteristics for L-G fault with and without capacitance for p = 300, h= 0.96, ‘δ’=16.

13. Distance Relay Tripping Characteristics For 3-Phase Fault and L-G Fault With Capacitance

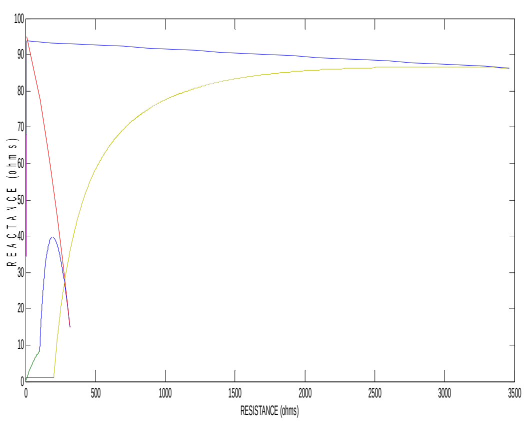

Fig. 9 Distance relay tripping characteristic zone for 3-phase fault and L-G fault With Capacitance (or) RX plot with capacitance

The Fig. 9 shows the relay tripping characteristics for 3-phase fault and L-G fault with capacitance for p = 300, h= 0.96, ‘δ’=16.

14. Distance Relay Tripping Characteristics For 3-Phase Fault And L-G Fault With Out Capacitance

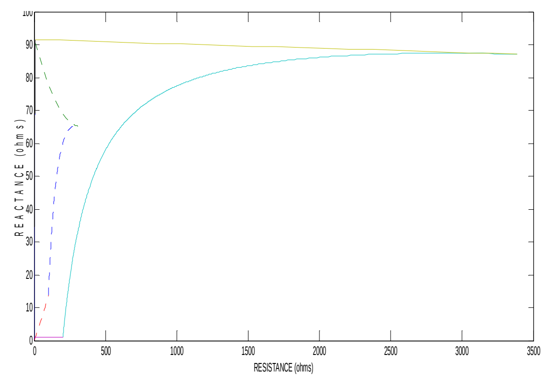

Fig. 10 Distance relay tripping characteristic zone for 3-phase fault and L-G fault With out Capacitance (or) RX plot without capacitance

14.Conclusion

An adaptive relay setting scheme for stand-alone digital distance protection has been proposed [4]. The distance relay tripping characteristics changes with change in fault resistance , change in h ,change in line length p, change in angle delta. The relay tripping characteristics for 3-phase and L-G fault with and without capacitance is seen. It is also seen that significant change in relay tripping characteristics with and without considering capacitance. It is very important to consider the capacitance effect for ideal tripping characteristics .

15. References

[1] Anderson P M., “Power system protection ”McGraw- Hill IEEE Press, 1999, New York.

[2] IEEE guide for protective relay applications to transmission lines, standard C37,113-1999,Feb.29,2000

[3] Y. Q. Xia, K. K. Li, A. K. David, "Adaptive Relay Setting for Stand-alone Digital Distance Protection", IEEE Trans. Power Delivery, Vol. 9, No. 1, pp. 480-491, Jan. 1994.

[4] A. K. Pradhan, Geza Joos “Adaptive Distance Relay Setting for Lines Connecting Wind Farms”, IEEE Trans. on Energy Conversion, Vol. 22, No. 1, March. 2007

[5] Bin Su, Jianping Wang, Ying Yang, Weixing Gong, and Yongsheng Xu,“ Setting Considerations of Distance Relay for UHV/EHV Long Transmission Lines”, 2007 IEEE Conference

[6] K. K. Li, L. L. Lai, A. K. David, "Stand alone Intelligent Digital Distance Relay", IEEE Trans. Power Systems, Vol. 15, No. 1, pp. 137-142, Feb. 2000.

[7] K.K Li and L.L. Lai, "ideal operating region of digital distance relay under high resistance earth fault,” international journal of electric power system research, Vol,43,no.3,pp.215-219,dec.1997.