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EFFECTS OF FACTS DEVICE (STATCOM/SVC) ON ZONES AND POWER SWING SETTINGS IN DISTANCE NUMERICAL RELAY OF TRANSMISSION LINE

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Abstract: *This paper present the study on the performance of Numerical Distance relays settings on transmission lines (zones i.e. Z-1, Z-2, Z-3 and power swing setting) compensated by FACTS (Flexible AC transmission system). The FACTS are used for controlling voltage and power flow, reactive power. The total impedance of line i.e Zp and secondary impedance Zs and zones setting without FACTS and with FACTS are protected by numerical relay are calculated and investigated. The modified setting Zones of protection have been calculated to improve the performance of Distance numerical relay and prevent unnecessary tripping of respected breaker. The simulation results are performed in MATLAB software and MD2000 software and show the impact of change in settings in zones and power swing settings.*

Keywords:: *Transmission line, Numerical Distance relay, Primary and secondary impedance, Setting of Zones and power Swing settings. FACTS device i.e SVC, TCR and TSC.*

I. INTRODUCTION

In recent times the load demand increases an d due to that transmission lines are increased and also high voltage KV lines are introduced like 200KV, 400KV and 765 KV. High voltage KV lines are introduced and to maintain voltage profile FACTS devices are introduced in mid or at end of line for compensation. The FACTS are used for solving various power system steady state control problem and optimum utilization of the system capability. The application of SVC devices was load compensation and now in long lines it is used to improves stability with fast acting voltage regulation, damping sub synchronous frequency oscillation.

The SVC parameters affect the impedance of long line. The variation affects the protective zone settings and power swing settings. The over reach and under reach of fault point of relay is affected.

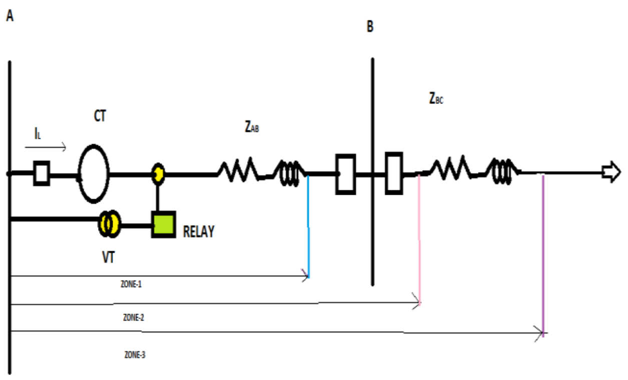
The zone-1 covers 80% of impedance of line and fast operation. And zone-2 is 100% of first line and 50% of second line impedance or 120% of line impedance. And zone-3 is 100% of first line and 100% second line and 25% third line or 140% of line impedance.

Power swing in distance protection is introduced to avoid damage and unnecessary tripping of breaker which lead to failure of grid. Power swing is important in power system stability. The just touching of tree or kite door gives the tripping to breaker to avoid tripping the power swing is introduced and power swing gives one pole tripping of breaker i.e. is called Auto reclose. If fault persist for 20ms then tripping will occurred. The FACTS device also

The paper discuss about the Zones setting (Z-1, Z-2, Z-3),fault in zone-1, and power swing setting for numerical relay on a 400KV transmission line with FACTS device installed at midpoint of this line. The investigation concern for fault zone in R-X circle with or without FACTS device (SVC)

II. NUMERICAL DISTANCE RELAY SETTING FOR TRANSMISSION LINE

Distance relay operation is based on the impedance at the relaying point. The measured impedance by distance protection relay is the actual impedance of the line section between the fault and the relaying points. when the fault resistance is equal to zero. The distance along the transmission line (ZL) between bus bar A and B as shown in figure. The distance protection measures distance to fault by means of a measured voltage to measured current ratio computation. The zones forward are calculated as under.



The setting of zones for protected transmission line without FACTS devices are as under
Positive sequence of line per Km

Let it be
(R+jX) x Km= Zp (Primary impedance)

Z (Secondary Impedance= Zp x CTR/PTR (CTR Current transformer Ratio/Potential transformer ratio)

R+jX = (0.10486+j 0.4187)

Zp= (0.0109956+.1753096)½ X 250 = 70.04
Zs=70.04 X 0.22=15.41 ohm
CT Ratio= 800/1 and PT Ratio= 400KV/110

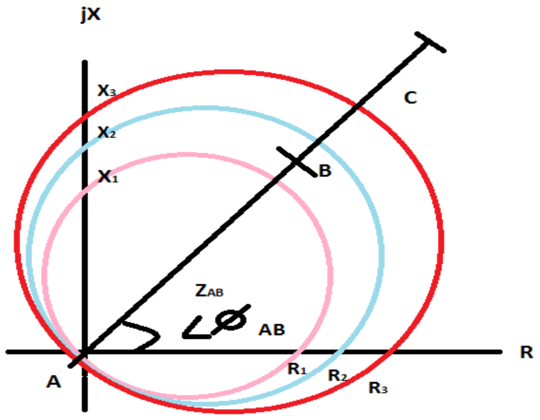
Zone-1= Z-1= 80%Zs

Z-2= 120%Zs or 100% Zs+ 50%Zs2 (Secondary impedance of Next line)
Zs2= (R1+jX1)X CTR/PTR

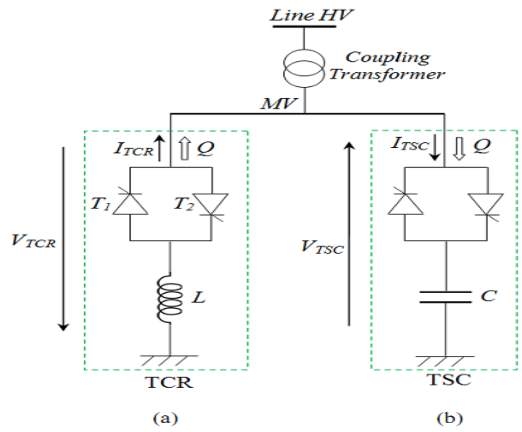
Z-3= 140% of Zs or 100% Zs+ 100% Zs2 (Secondary impedance of Next longest line)+ 25% of Zs3 (Secondary impedance of shortest longest line)
Zs3=(R2+jX2)X CTR/PT

Z-1=12.33 Ohm
Z-2= 18.492 Ohm
Z-3= 21.574 Ohm

The R-X characteristics of distance relay is shown as under:-



The presence of SVC has affect on the impedance on protected line. The SVC is connected at mid point is considered as reactor Xf=1/BSVC) and lead to new settings of zones which are as under:-



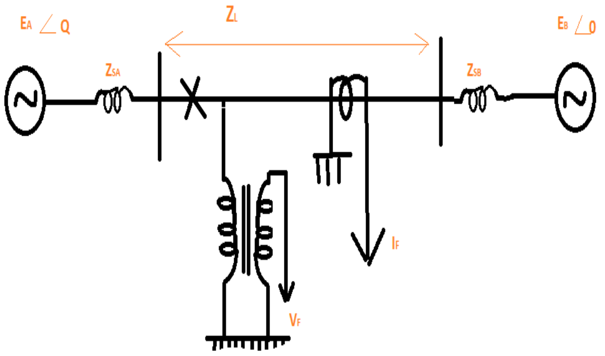
SVC
Zone-1= Z-1= 80% (Zs/2 // Xf +Zs/2)

Z-2= 120% (Zs/2 // Xf +Zs/2) or 100% (Zs/2 // Xf +Zs/2) + 50% Zs2 (Secondary impedance of Next line)
Zs2= (R1+jX1)X CTR/PTR

Z-3= 140% Zs/2 // Xf +Zs/2) or 100 % (Zs/2 // Xf +Zs/2) + 100% Zs2 (Secondary impedance of Next longest line) + 25% of Zs3 (Secondary impedance of shortest longest line

III.POWER SWING IN DISTANCE PROTECTION

Measured impedance during the power swing and used current and voltage by relay as shown in Fig. voltage and current are stated as.

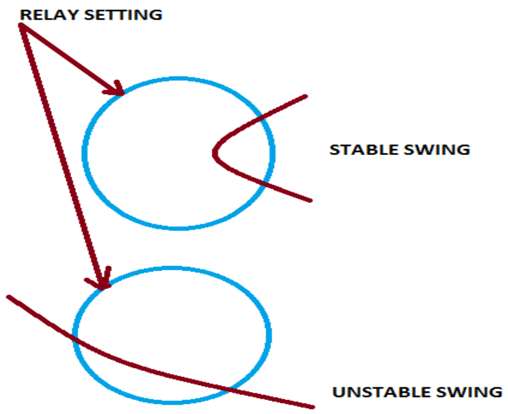


The relay current and measured impedance of the distance relay is as under

$Ir=Ea\angle\delta-Eb\angle 0/ZT$
$ZT=Zsa+ZL+Zsb$

By simplifying the equations, We get

$ZT+ Ea\angle\delta/Ir - Eb\angle 0/Ir=0$
$Zr=-Zsa+Ea\angle\delta/Ir-f(\delta)$
$Zr=Vr/Ir$
$|Vn|/|Vm|=n$



Power swing diagram will be circular is expressed

$C= ZT/n2-1$

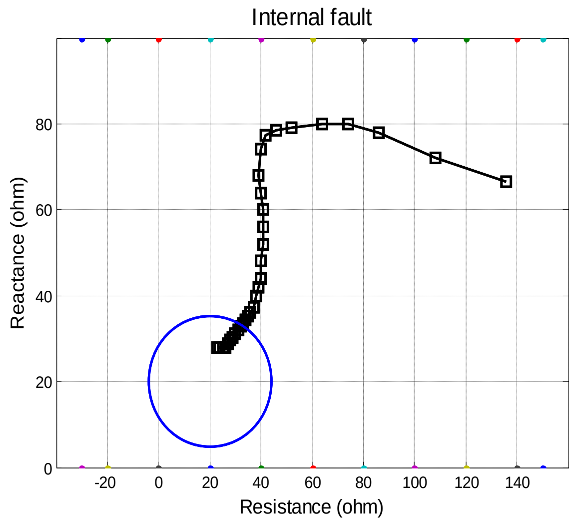
When Vn/Vm=n power swing radius is calculated by the equation

$nZT/n2-1$

Measured impedance by relay is function of rotor angle(δ). When the rotor angle increases, apparent impedance will reach to electrical system relay centre. Thus it is possible to enter the relay zone and relay mal operation. In this case, the relay will not act due to stable power swing.
The svc affects the power swing setting. It can be unstable due to svc value. It can be change the value of ZT and Zr due to that it affects the power swing settings.

III.CASE STUDY AND SIMULATION

The typical simulation of the 400KV and 250 Km long Dehar Panipat line transmission line. In addition, when a fault occurs on transmission lines, the voltage and current signals are severely distorted. This signal may contain decaying dc components, high frequency oscillation quantities, subsystem frequency transients, and etc. The higher frequency components, high frequency components can be eliminated using low pass anti aliasing filters with appropriate cut off frequency, but the anti aliasing filters cannot revoke decaying dc components and reject low frequency components. This makes the phase very difficult to be quickly estimated and affects the performance of digital relaying. Therefore we usually use the mimic filter to remove the dc offset components.



If fault occurs in zone-1 the characteristics shows fault in zone-1 without STATCOM.

Many filters have been proposed to eliminate the DC offset harmonicas from the waveforms.

A Digital filter based solution is proposed to remove the unwanted disturbances using digital filter design techniques. In addition, the required property of a measuring algorithm in protective relay is to trace a given feature of signal(such as magnitude and phase) that may serve as an initial quantity for certain operating principles, which changes abruptly due to faults in power system.

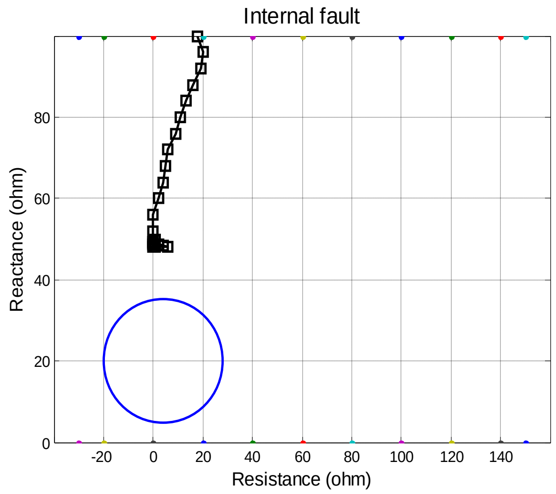
The MATLAB GUI is used to find the results for the case of STATCOM used in transmission line and not used STATCOM in transmission line.

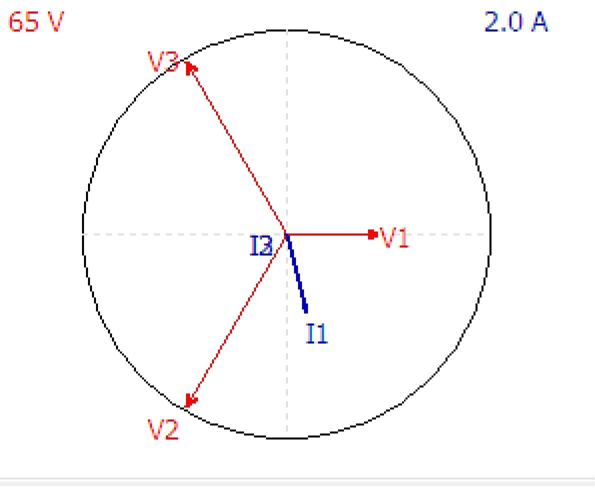
In this simulation STATCOM is connected at the midpoint and taking the results with and without STATCOM at different zones.

If fault occurs in zone one then results with and without STATCOM are ::

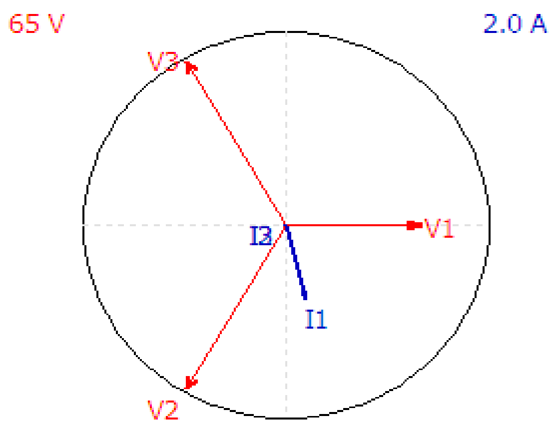
It is seen that, the fault is in Zone-1 but the characteristics shows it is just out of zone1, statcom is in fault zone that's why there is effect as shown.

If fault occurs in zone-1, the characteristic are as shown



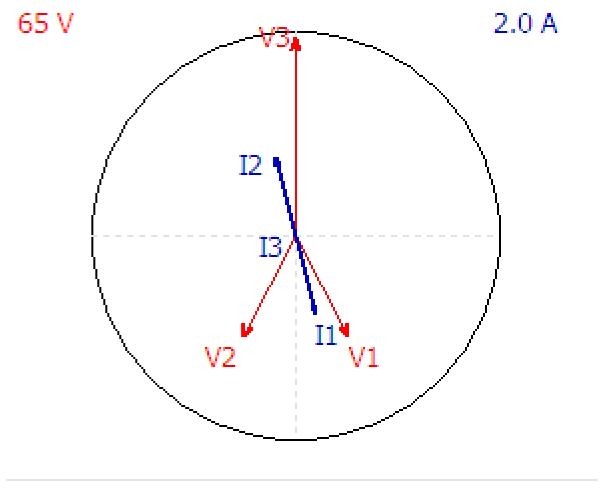


a) After

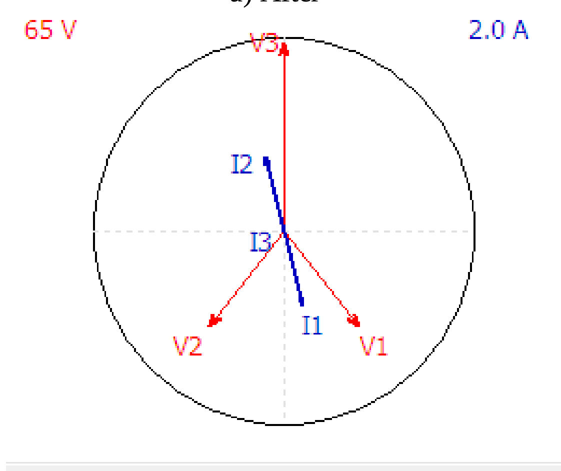


b) Before

Fig:: Phase to earth fault

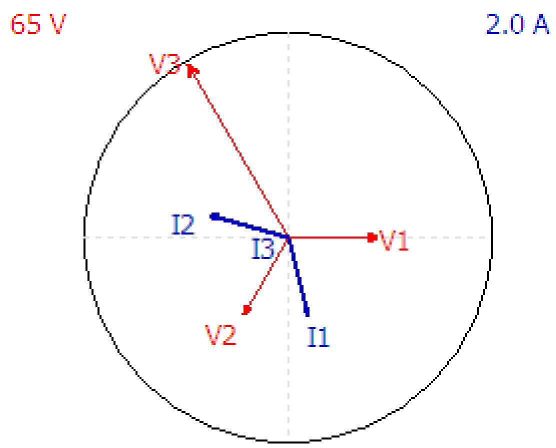


a) After

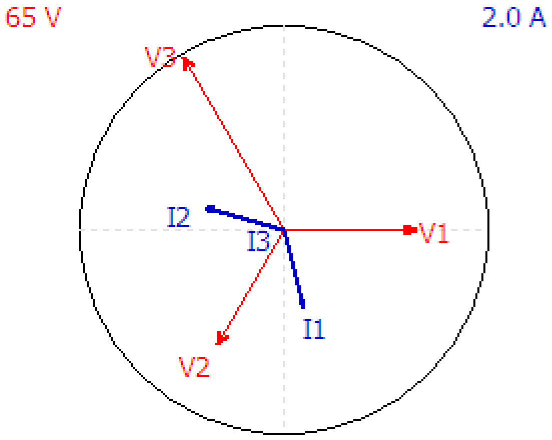


b) Before

Fig:: Red phase to yellow phase fault

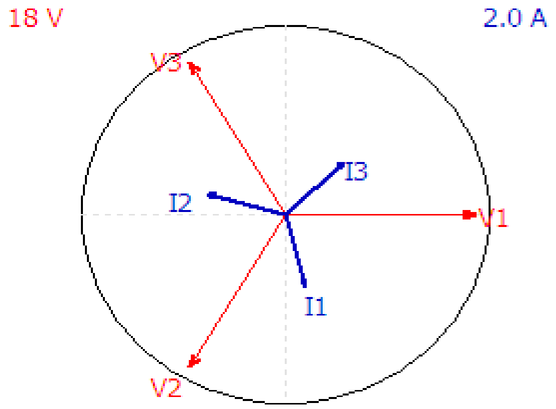


a) After

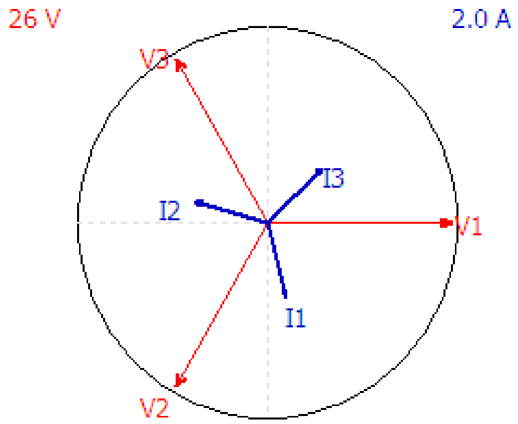


b) Before

Fig:: Red Yellow phase to earth



a) After



b) Before

Fig:: Red yellow and blue phase fault

It is seen that the fault occurs in zone-1 but characteristics shows it is out of zone when STATCOM is connected in the line. STATCOM is in fault loop therefore it has great impact on distance relay get mal-operate.

It is seen that in power swing fault there is not much effect due to STATCOM in Z-1, and in Z-2 it worse and in Z-3 it worst.

IV. CONCLUSION

The paper present a detailed simulation model of a transmission system of 400KV and 250KM long having three zones and employing STATCOM for reactive power compensation and plotted the numerical characteristics. Fault is created in zone-1 results with STATCOM and without STATCOM. When STATCOM is in fault loop then it has adverse effect on distance relay. Distance relay get mal operate when STATCOM is in fault loop.

FUTURE SCOPE

In this simulation all faults in Z-1 is taken in future the results are compare for different faults in Z-2& Z-3 and mitigate this mal operation of distance relay.

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