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A Technique To Detect Fault Location For Two-Terminal Multisection Compound Transmission Lines Using Synchronized Measurements

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ABSTRACT:

In this thesis fault location technique for two terminal multi section compound transmission lines which combine overhead line with underground power cables using phase synchronized measurement and compare results one end and two end (matrix method) with differentfault resistances (0Ω, 5Ω, 10Ω, 30Ω, 50Ω) and grounding system Y_g and isolated system Y and compare with them, find fault location for single line model, single line with load and multi terminal multisession. Further developed and implemented a computational routine of algorithm for fault location in two terminal and multi terminal transmission lines and use two way simulation by using Impedance method and Y bus method for find fault location for single line model, single line with load and multi terminal multi section, simulation used for all type models with time of one cycle and fault started from 0.5second to 1 seconds. Also evaluated and discussed to estimate the fault location using ground system for neutral source with isolated system Y and their effects for different types of faults by using MATLAB.

Keywords: fault location technique, Impedance method, multi terminal transmission lines, Y bus method.

INTRODUCTION:

A fault is define as flow of a large current which could cause equipment damage. If the current is very large, it might lead to interruption of power in the network. Moreover, voltage level will change, which can affect equipment insulation. Voltage below its minimum level could sometimes cause failure to equipment. It is important to study a power system under fault conditions in order to provide system protection. Analysis of Faulted Power System by Paul Anderson and Power System Analysis by A.Nagoor Kani in fault studies and calculations. Background The purpose of this research is to provide the overview of different methods to calculate the fault distance on a transmission line. Different methods based on two principles – impedance theory and traveling-wave theory. On a test system to calculate a fault distance under different types of faults. A comparative analysis was performed to compare the calculation errors in the implemented methods. In order to understand how to calculate the fault distance on a transmission line, the following topics need to be explained.Fault on the transmission line needs to be restored as quickly as possible. The sooner it is restored, the less the risk of power outage, damage of equipment of grid Many algorithms have been developed to calculate the fault distance on the transmission line. This thesis gives the general overview of fault location calculation on transmission line using impedance based method transmission line model, its sequence components, symmetrical components for fault analysis, impedance measurements based approach for transmission line fault location, change current and voltage at point fault can detected by impedance measured where get minimum value for impedance This thesis compares and evaluates different methods for classification of fault type.

In this type of faults there is increase of voltage and frequency and decrease of current level in the faulted phases. Example: opening of one or twolines by circuit breakers. Shunt faults are the unbalance between phases or between ground and phases. This research only consider shunt fault. In this type of faults there is increase of current and decrease of frequency and voltage level in the faulted phases. AFULT locators gained a very growing interest among protective devices in the recent few years, this is mainly due to their role in improving the reliability of

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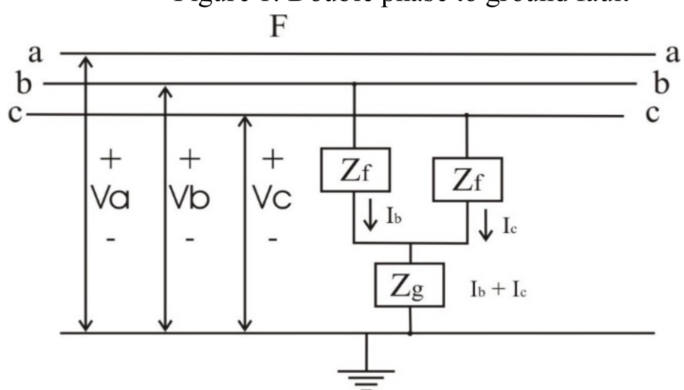
high capacity power systems, transmission lines usually experience a variety of faults resulting in disconnecting the power feeding to the loads. Hence, its restoration process can be expedited if the location of the fault is either known or can be estimated with a reasonable accuracy, different benefits are gained by utilizing fault locators in power networks including reducing maintenance times, increasing the power availability, improving the power quality and avoiding future accidents, this can be interpreted as a cost reduction or a profit increasing which is an essential concept for competitive and de-regulated markets. Fault location algorithms can be categorized based on the extracted fault features, the number of measurement terminals and the line parameter availability. Impedance-based algorithm depends on synchronized phasor measurement where the network is modeled in the faulty conditions and the model is solved in order to determine the fault distance as an unknown variable [5]. Utilizing transient signals or depending on the extracted travelling surges were proposed as reported in. Regarding the utilized number of terminals, fault locators are categorized as one-terminal, two or multi-terminal fault location methods. Multi-terminal fault locators greatly eliminate the effects of fault resistance, remote feeding currents, line untransposition, weak sources and heavy loads [5], accordingly, double-end algorithms are interesting to locate the fault point in transmission systems accurately. Regarding line modeling, either lumped or distributed line parameters. Conventionally, accurate fault location can be realized when the line parameters are well-defined and the fundamental phasors are correctly measured and accurately synchronized, to reduce the requirements for data synchronization, fault locators with unsynchronized data parameter less fault locators were as addressed in, such methods were mathematically formulized considering.

Double Phase to ground fault

In this type of fault, two phases established the connection with the ground.

Figure 1: Double phase to ground fault



Three phase fault

In this type of fault, three phase makes connection with the ground. This is severe fault.

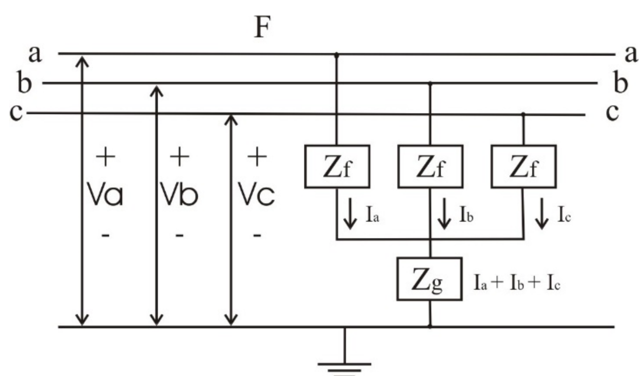


Figure 2: 3phase fault

Sequence Network for Double phase to ground fault

Assuming the phase b and the phase c are connected to the ground through the faultimpedance (Z_f).

So, fault current on phase a, I_a= 0.

Since the phase b and the phase c make connection, fault voltages at phase b and phase c are

$V_b = V_c = Z_f(I_b + I_c)$ (1.16)

Fault currents is present in the phase b and the phase c, equation (1.6) will be

$$\begin{bmatrix} I_a^0 \\ I_a^+ \\ I_a^- \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & \propto & \propto^2 \\ 1 & \propto^2 & \propto \end{bmatrix}\begin{bmatrix} I_a = 0 \\ I_b \\ I_c \end{bmatrix} \quad (1.17)$$

$weget I_a^0 = \frac{1}{3}(I_b + I_c)$ (1.17)

$V_b = V_c = Z_f 3\, I_a^0$ (1.18)

$$\begin{bmatrix} V_a^0 \\ V_a^+ \\ V_a^- \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & \propto & \propto^2 \\ 1 & \propto^2 & \propto \end{bmatrix}\begin{bmatrix} V_a \\ 0 \\ 0 \end{bmatrix} \quad (1.19)$$

Equation (1.19) implies that

$$V_a^0 = V_a^+ = V_a^-$$
$$I_a^0 = I_a^+ + I_a^- = 0$$

Since the zero, the positive and the negative sequence voltages are equal which imply that the sequence networks must be in parallel [13].

$V_a^0 = \frac{1}{3}(V_a + V_b + V_c)$ (1.20)

Since $V_b = V_c$

$3V_a^0 = (V_a + 2V_b) = V_a^0 + V_a^+ + V_a^- + 2(Z_f\, 3I_a^0)$ (1.21)

From (1.18) we get $V_a^+ = V_a^-$

$3V_a^0 = V_a^0 + 2V_a^+ + V_a^- + 2(Z_f\, 3I_a^0)$ (1.22)

$2V_a^0 - 2(Z_f\, 3I_a^0) = 2V_a^+$ (1.23)

$V_a^+ = V_a^0 - (3Z_f I_a^0)$ (1.24)

Fault current, $I_a^+ = \frac{V_f}{Z_f + \left[\frac{Z_2(Z_0 + 3Z_f)}{Z_2 + Z_0 + 3Z_f}\right]}$ (1.25)

$I_a^0 = -\frac{Z_2}{Z_2 + Z_0 + 3\,Z_2} I_a^+$ (1.26)

$I_a^- = -\frac{Z_0 + Z_f}{Z_2 + Z_0 + 3\,Z_2} I_a^+$ (1.28)

In this way sequence current and voltage are calculated for double phase to ground fault.

Sequence Network for Phase to Phase Fault

Assume fault current (I_f)occur when the phase b and the phase c make connectionwith each other and taking(Z_f)as the fault impedance.

$V_b - V_c = I_b Z_f$ (1.29)

Since the phase c makes connection the phase b, at point of connection $V_b = V_c$Equation (1.13) can be written as

$$\begin{bmatrix} V_a^0 \\ V_a^+ \\ V_a^- \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & \propto & \propto^2 \\ 1 & \propto^2 & \propto \end{bmatrix}\begin{bmatrix} V_a \\ V_b = V_c \\ V_c \end{bmatrix} \quad (1.30)$$

Equation (1.29) implies that

$V_a^+ = V_a^-$ (1.31)

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Since fault current is present in the phase b and the phase c only, equation (1.6) will be

$$\begin{bmatrix} I_a^0 \\ I_a^+ \\ I_a^- \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & \propto & \propto^2 \\ 1 & \propto^2 & \propto \end{bmatrix}\begin{bmatrix} 0 \\ I_f \\ -I_f \end{bmatrix} \quad (1.32)$$

Equation (1.31) implies that

$$I_a^0 = 0 \text{And} I_a^+ = I_a^- \quad (1.33)$$

From Equation (1.24) we get,

$$I_a^+ = \frac{1}{3} \propto -\propto^2)I_f = \frac{jI_f}{\sqrt{3}} \quad (1.34)$$

$$I_f = -j\sqrt{3}I_a^+$$

In this way sequence voltages and currents are calculated for the phase to phase fault.

Fault location Algorithm by Saha

A fault point in a three phase transmission line is determined by measurement of current and voltage data at both side of the transmission line. In this algorithm the fault type; single phase/multi-phase ground fault/phases-to phase fault is determined and the parameters in a quadric equation are used to calculate distance to fault on a transmission line. The equation is based from the electrical relationship, between the complex values of the line impedance, the source impedance, and current and voltage. The equation eliminates the use of fault resistance and possible zero-sequence components. The parameters are determined by the type of fault and the equation is solved by means of a numerical square root method. Fault location equation by Saha, notify that the values for (Vs), (Is) and (I_{fs}) are different for each fault type according to table2.1.

$$V_s = I_s * m * Z_l + I_{fs} * \left(\frac{R_f}{D}\right) \quad (2.18)$$

$$D = \frac{(1-m)*Z_L+Z_s}{Z_s+Z_L+Z_R} \quad (2.19)$$

The line section (Z_l) is a known parameter and (Z_s) may be known, but not if the parameter can be calculated by the measured values of current and voltages at the bus bar (S). Input value (Z_R) may also be unknown; the parameter should be estimated with an acceptable degree of accuracy the variable (D) is the distributions factor for the positive sequence and negative sequence networks.

Z_L = the impedance of the line section

Z_s = Source impedance of network lying behind the section (near end)

Z_R = Source impedance of network lying ahead of the section (remote end)

I_{fs} = Current change at point S due to the fault (I_{fs} = D * I_f)

Since equation of parameter (D) is a linear function of m the general equation will be nonlinear and written as follows equation(2.20).

$$m^2 - m * k_1 + k_2 - k_3 * R_f \quad (2.20)$$

Where:

$$k_1 = \frac{V_s}{I_s*Z_L} + 1 + \frac{Z_R}{Z_L} \quad (2.21)$$

$$k_2 = \frac{V_s}{I_s*Z_L} * \frac{Z_R}{Z_L} + 1 \quad (2.22)$$

$$k_3 = \frac{I_{fs}}{I_s*Z_L} * \left(\frac{Z_S+Z_R}{Z_L} + 1\right) \quad (2.23)$$

The values of (V_S), (Is) and (Ifs) may be calculated from current and voltages measured locally at the end point S according .The distribution factors of (k_1), (k_2) and (k3) is a complex factor and by separate the complex equation into real and imaginary parts, the unknown fault resistance The real and imaginary parts of the complex factors can be eliminated.

$$m^2 + B * m + C = 0 \quad (2.24)$$

Where:

$$B = \frac{Re(K_1)*Im(K_3) - Im(K_1)*Re(K_3)}{Re(K_3)} \quad (2.25)$$

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$$C = \frac{Im(K_2)*Re(K_3)-Re(K_2)*Im(K_3)}{Re(K_3)} \quad (2.26)$$

When solving equations relative distance to fault:

$$m_1 = \frac{-B+\sqrt{B^2-4C}}{2} \quad (2.27)$$

$$m_2 = \frac{-B-\sqrt{B^2-4C}}{2} \quad (2.28)$$

The Saha algorithm can also be written as following quadratic equation with use of symmetrical components:

$$A_2m^2 + A_1m + A_0 + A_{00} * R_f = 0 \quad (2.29)$$

Transmission network with single lines complex coefficients used for determining fault current distribution factor for positive and negative-sequence.

Where:

$$A_2 = -Z_{L1} * Z_{L1} \quad (2.30)$$

$$A_1 = (Z_{L1} + Z_{R1}) - \left(-Z_{L1} * \frac{V_s}{I_s}\right) \quad (2.31)$$

$$A_0 = Z_{L1} * \frac{V_s}{I_s} \quad (2.32)$$

$$A_{00} = Z_{S1} + Z_{R1} + Z_{L1} * \left(\frac{I_{sup}}{I_s}\right) \quad (2.33)$$

Equation (2.35) will be calculated as following to eliminate use of (R_f) :

$$B_2m^2 + B_1m + B_0 = 0 \quad (2.34)$$

Where:

$$B_2 = Re(A_2) * Im(A_{00}) - Im(A_2) * Re(A_{00}) \quad (2.35)$$

$$B_1 = Re(A_1) * Im(A_{00}) - Im(A_1) * Re(A_{00}) \quad (2.36)$$

$$B_0 = Re(A_0) * Im(A_{00}) - Im(A_0) * Re(A_{00}) \quad (2.37)$$

Relative distance to fault when solving equation (2.38) with use of symmetrical components:

$$m_1 = \frac{\left(-B_1 - \sqrt{{B_1}^2 - 4B_2 * B_0}\right)}{2B_2} \quad (2.38)$$

$$m_1 = \frac{\left(-B_1 + \sqrt{{B_1}^2 - 4B_2 * B_0}\right)}{2B_2} \quad (2.39)$$

Fault location algorithm by Wisziewski

Fault location algorithms by Wisziewski are based on standard calculations of line resistance; reactance and the correction error by the fault resistance. The algorithm utilizing the general fault loop model and the general formula of calculation fault current, and the apparent resistance and reactance measurement at one end of the line. In cases of interphase short- circuits the fault resistance in general very low, therefore the expected errors are also limited. In cases of ground fault high fault resistance may be assumed; hence the errors affect the precision of short circuit location. The general formula of the algorithm uses calculation of fault loop model of resistance and reactance measured by the fault recorder or distance relay.

$$Z_{sp} - mZ_{l1} - \frac{R_f}{k_1} * \frac{I_{sup}}{I_s * e^{-i\gamma}} \quad (2.40)$$

The input signal is available at one end of the line; it can be assumed that the phase angle γ of the line impedance and phase angle of the distributed factor (d) are known. Now we separate the imaginary and real part separately.

$$Z_{sp} = \frac{V_{sp}}{I_{sp}} = R_{sp} + iX_{sp} \quad (2.41)$$

$$R_{sp} - mR_{L1} - \frac{R_f}{K_1} a = 0 \quad (2.42)$$

$$X_{sp} - mX_{L1} - \frac{R_f}{K_1} b = 0 \quad (2.43)$$

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Where:

$$a = real\left(\frac{I_{sup}}{I_s * e^{-iT}}\right) \quad (2.44)$$

$$b = Imag\left(\frac{I_{sup}}{I_s * e^{-iT}}\right) \quad (2.45)$$

To eliminate the unknown term (R_f/k_1) from above equation, the condition of symmetrical components ((X_{L1}/R_{L1})= tan (ϕ)) may be utilized [8]. The following equation forms a solution of the set of equations is as follows.

$$d = \frac{X_{sp}}{X_{L1}} - \frac{\frac{R_{sp}}{X_{L1}} * tan(\phi) - \frac{X_{sp}}{X_{L1}}}{\frac{a}{b} * tan(\phi) - 1} \quad (2.46)$$

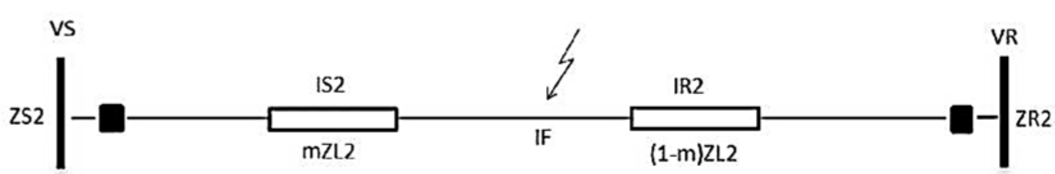
Two-Ended fault location algorithm

Two-ended fault location estimation is fundamentally similar to the one-terminal algorithm. But the method can improve the accuracy of fault distance measurements significantly by using data from the two ends of the line to cancel the effect of fault resistance and infeed [3]. Two-end and multi-end fault location algorithms divided in two main categories, unsynchronized and synchronized measurement. The algorithms process signals from both terminals of the line and a large amount of information is utilized. Therefore, performance of the two-end algorithm is generally superior in comparison to the one-end approaches.

Two end Negative sequence method

The developed algorithm inuse negative-sequence voltage obtained from both side of its symmetrical components at the fault point. By using negative-sequence components, the effects of pre-fault power flow and fault resistance are eliminated. Unlike one-end methods, negative sequence requires source impedance to perform fault location estimation.

Figure 3: Single transmission model and illustration of input data.



The general formula of the algorithm uses calculation from both sides of the transmission line with elimination of the fault voltage (V_f).

At S-side:

$$V_f = -I_{S2} * (Z_{S2} + mZ_{L2}) \quad (2.47)$$

At R-side:

$$V_f = -I_{R2} * (Z_{R2} + (1-m)Z_{L2}) \quad (2.48)$$

By eliminating fault voltage, the resulting expression follows:

$$|I_{R2}| = \frac{|(I_{S2} * Z_{S2}) + m * (I_{S2} * Z_{S2})|}{|(Z_{R2} * Z_{L2}) - m * Z_{L2}|} \quad (2.49)$$

The further equation simplifies above formula, and the expanding rearranging term produces a quadratic equation of the form with following input but first separate the imaginary part from the real part.

Where:

$$I_{S2} * Z_{S2} = a_1 + jb_1$$

$$I_{S2} * Z_{L2} = a_2 + jb_2$$

$$Z_{R2} * Z_{L2} = a_3 + jb_3$$

$$Z_{L2} = a_4 + jb_4$$

$$A * m^2 + B * m + C = 0 \qquad (2.50)$$

Equation (2.50) is solved for distance to fault (m) using quadratic solution model. The coefficients (A),(B) and (C) are given below.

Where:

$$A = |I_{R2}|^2 * (a_4 + jb_4)^2 - (a_2 + jb_2)^2$$
$$B = -2 * |I_{R2}|^2 * (a_3 * a_4 + jb_3 * jb_4) - 2(a_1 * a_2 + jb_1 * jb_2)$$
$$C = |I_{R2}|^2 * (a_3 + jb_3)^2 - (a_1 + jb_1)^2$$

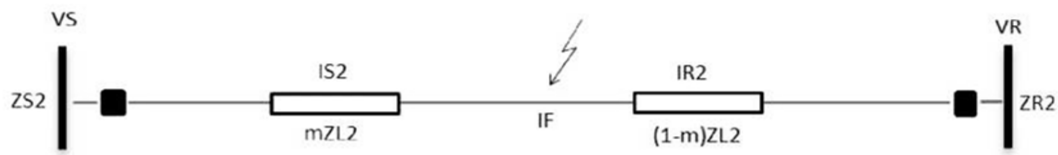
Two-Ended fault location algorithm

Two-ended fault location estimation is fundamentally similar to the one-terminal algorithm. But the method can improve the accuracy of fault distance measurements significantly by using data from the two ends of the line to cancel the effect of fault resistance and infeed [3]. Two-end and multi-end fault location algorithms divided in two main categories, unsynchronized and synchronized measurement. The algorithms process signals from both terminals of the line and a large amount of information is utilized. Therefore, performance of the two-end algorithm is generally superior in comparison to the one-end approaches [4].

Two end Negative sequence method

The developed algorithm use negative-sequence voltage obtained from both side of its symmetrical components at the fault point. By using negative-sequence components, the effects of pre-fault power flow and fault resistance are eliminated.

Figure 4: Single transmission model and illustration of input data.

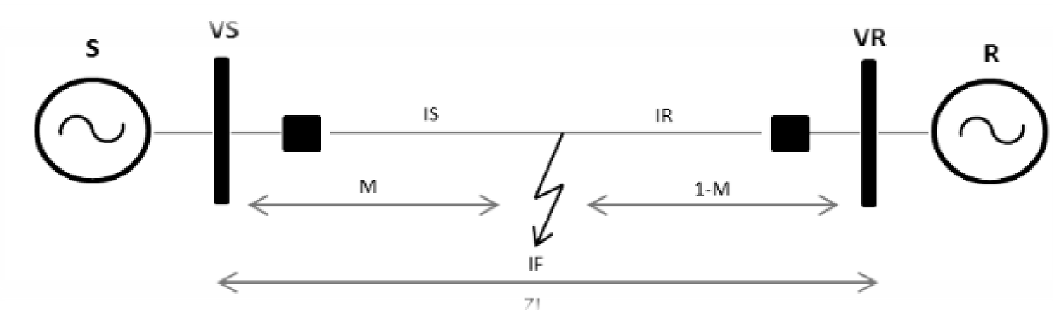


Symmetrical components at the fault point in figure 3.5 by using negative-sequence components where have two parts for transmission line m $*Z_{l2}$where m per unit fault Z_{l2} impedance negative sequence and another part (1-m) Z_{l2}.

Analysis method impedance in program

In program fault location depend on impedance method where calculated actual impedance for each voltage and current at all sample.

Figure 5: Two source ended, V_S, V_R, transmission line



Two source that meaning two ended ,V_S,V_R ,transmission line divided two part M,1-Mas figure 3.6 where m per unit value m where fault occur Z_L actual impedance for total line assume have sample at along transmission line where change V,I that meaning change Z. It's necessary find impedance at each point Zi for each variable Ii andVi for each point forsample, then

$$Zi=Vi/Ii \qquad (3.51)$$

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To findfault location for any point may be occur fault notes M represents to fault location, but calculated forall sample that meaning enter include loop butits possible find M by analysis circuit as

$V_f = V_1 - M*Z_L*I_1$ from send side (3.52)

$V_f = V_2 - (l-M)*I_2*Z_2$ from receive (3.53)

Where V_f voltage fault

$V_1 - M*Z_L*I_1 = V_2 - (l-M)*I_2*Z_L$ (3.54)

$M = (V_1 - V_2 + l*Z_L*I_2) / (Z_L*(I_1+I_2))$ (3.55)

Now M is known and (1-M) also known

For one side $V_2=0$, $I_2=O$ then

$M = V_1/Z_L*I_1$ (3.56)

Effect of fault resistance

Fault resistance effects the accuracy of short-circuit location, when distance to fault is determined at one or two ends of the transmission line. The effect of the fault resistance occurs because of the current through the fault resistance is phases-shifted compared to the measured current at the end of the line, due to the pre-fault current. As a result, the fault resistance behaves as apparent impedance with both resistive and reactive components, which is responsible for the error in the fault location with an increased fault resistance. Some methods eliminate the influence of fault resistance and present a good distance to fault accuracy even with an increasing fault resistance, the single line to ground fault shows a better accuracy than the multi-phase fault for most of the testing scenarios. This verification shows that the apparent resistance measured at one end of the line requires methods with certain corrections to eliminate the fault resistance effect in proportional to the distance to fault.

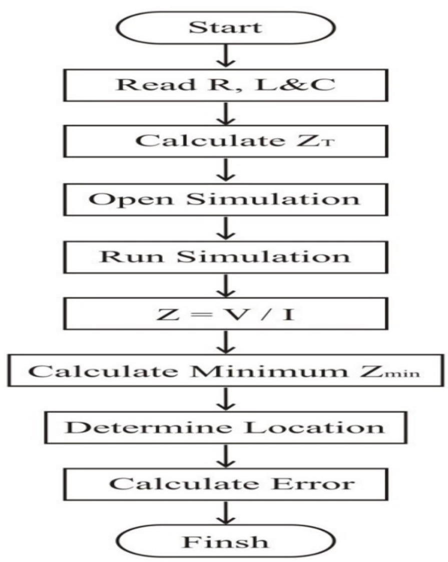

Figure 6: Flowchart for steps simulation findminimum impedance

This method depend on value Z, where measuring all values of V_i and I_i and calculate Z, then find minimum impedance through that minimum Z can determine fault location.[9]

In flow chart in figure 3.8 use impedance method for find fault location and based on Equation(3.51),(3.56)where depend on Vi/Ii meaning Z then choose minimum value for Z which represents to fault location by impedance after that calculated error by

$$Lf\% = \frac{Lfactual - Lfcomputed}{L}$$

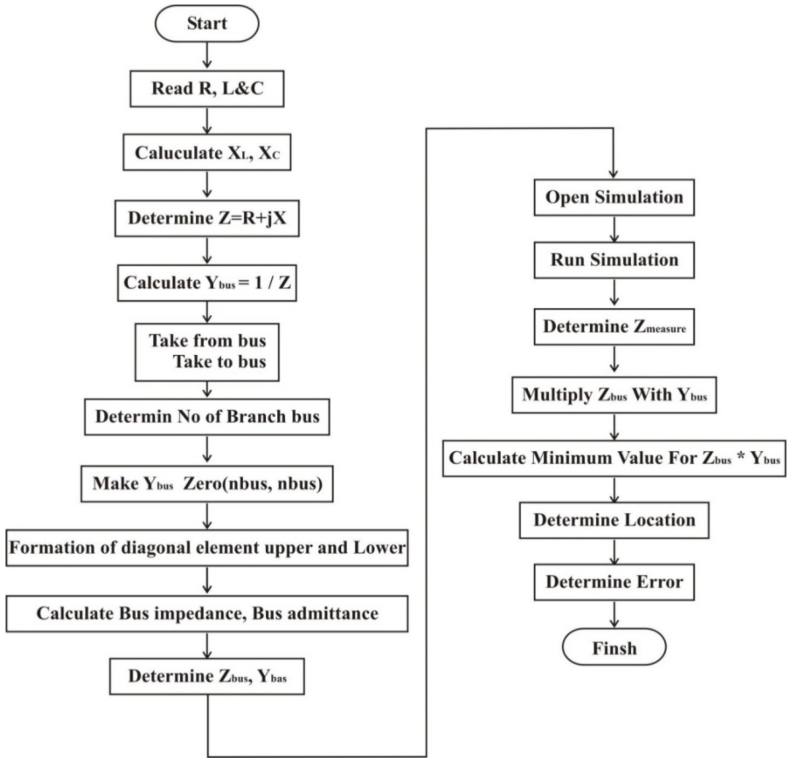

Figure 7: Flowchart for find fault location by use Ybus

Where

This method depend on $Y_{bus}$where Y_{bus} = 1/Z and take from bus to bus and then determine Z_{bus} and Y_{bus}admittance measured impedance by mat lab Z_{bus} * Y_{bus} and find minimum Z_{bus} * Y_{bus} then determine location.

Ground neutral system and un grounding neutral system

The neutral point of star connected three phase winding of generator tolow resistance ground either directly or through some circuit element like resistance or reactance neutral grounding very important for design and protection the current and voltage during ground fault connection influenced by type of grounding of neutral some advantage for neutral grounding arcing ground is eliminated and voltage for healthy phase=voltage phase is fixed do not increase 1.732times normal value as case ungrounded system and phase voltage fault =0 that mean in design equipment then cost is lowand we can use over current relay for detection fault and last is greater safety to personnel and equipment.in ideal case we assume fault at phase A will get $V_{A=}0$,$V_{B=}$ $V_{C=}V_{PHASE}$ is fixed not change and for current $I_{B=}I_{C=0,}I_{A=}I_F$[11],[12],[1].

For isolated system or ungrounded system the neutral is not connected to the ground the voltage of the neutral is not fixed and may float freely if occur fault at single line to ground fault then healthy phases will increase to line voltage which cause insulator breakdown in this case not use earth fault protection and use over current relay in ideal case $V_{A=}0$, $V_{B=}$ $V_{C=}V_{LINE}$ if fault occur at phase AN.

Double circuit model

Figure 4.5 shows double circuit line model has twelve sections for each line, four cable underground [10] and eight overhead line different length and different parameters with two source phase to phase RMS voltage 138 kV, 50Hz length L_1=5km, L_2=5km, L_3=20km, L_4=20km, L_5=20km, L_6=20kmand L_7=5km, L_8=5km, L_9=20km, L_{10}=20km, L_{11}=20km, L_{12}=20km in parallel figure.4.5 shows blocks for measurementalong transmission line with two sourcephase to phase RMS voltage 138 kV and two parallel line have same length for two lines and same parameter for each section with five transformers two winding 132/33kVdifferent capacity with different load where for double line with five transformers with load and two lines each line has 90km in figure 4.5 shows measuring fault where can change this measuring at any point in transmission line using different types fault as ABC, AN, BC, BCN figure 4.5 represented to double circuit line model This model different from single line without load and single line with load model where consists two line in parallel some factor effects on calculations like mutual coupling and shunt capacitance and transposed in this studies assume no mutual coupling and no shunt capacitancein figure 4.5 shows different capacity transformers and different loads where occur fault location these transformers will fed point fault location in figure 4.5 shows no take distance from main line to transformers and loads. Figure 4.5 refers to double circuit model.

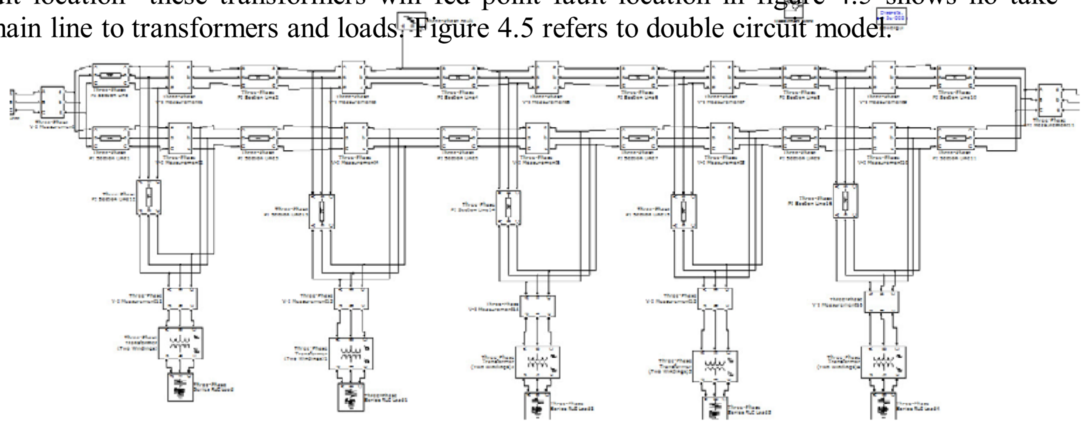

Figure 8: Double Circuit Model

Simulation result with use neutral by Y_g grounded system

Insimulation used four methods for get result and after get result will compare between these simulation first method use one ended and second method use two ended and minimum impedance method with Y_{bus} method by use $Y_g$neutral and Yneutral. Where Y_g grounded system the neutral is grounded either directly or through resistance or reactance the neutral grounding provides return path to zero sequence current.The neutral point of star connected three phase winding of generator to low resistance ground either directly or through some circuit element like resistance or reactance neutral grounding very important for design and protection the current and voltage during ground fault connection influenced by type of grounding of neutral some advantage for neutral grounding arcing ground is eliminated and voltage for healthy phase=voltage phase is fixed do not increase 1.732 times normal value as case ungrounded system and phase voltage fault =0 that mean in design equipment then cost is low and we can use over current relay for detection fault and last is greater safety to personnel and equipment.in ideal case we assume fault at phase A will get $V_{A}=0, V_{B}= V_{C}=V_{PHASE}$ is fixed not change and for current $I_{B}=I_{C=0}, I_{A}=I_{F}$ [11],[12],[1].

Fault Location at 70km Single line two ended without loadby use impedance matrix (Y_g)

Type Fault	Measured Location	Actual Location	%Error
ABC	70.4979	70	0.5532
AN	70.430	70	0.5534
BC	70.4974	70	0.5530
BCN	70.5030	70	0.5599

Table 1: Resistance fault at 0.001ohms two ended at 70km

In table 1 fault resistance 0.01ohms and different type fault, ABC, AN, BC, BCNactual fault occur at 70 km shows measured location and error from result error not acceptableand lessaccuracy in table 4.22we can see that different value for fault type for AN=0.5534and forBC=0.5530 some swing in calculation but all value is agree with value expected for two ended by use matrix method.

Type Fault	Measured Location	Actual Location	%Error
ABC	70.9957	70	1.1064
AN	70.9602	70	1.0669
BC	70.9957	70	1.10641
BCN	71.0060	70	1.1178

Table 2: Resistance fault at 5 ohms two ended at 70km

Intable 2 fault resistance 5ohmsand different type fault, ABC, AN, BC, BCN actual fault occur at 70 km shows measured location and error from result error very acceptable and accuracy in table 4.23 we can see that different value for fault type for AN=1.0669and forBC=1.10641 some swing in calculation but all value is agree with value expected for two ended by use matrix method

Table 3: Resistance fault at 10ohms two ended at 70km

Type Fault	Measured Location	Actual Location	%Error
ABC	71.4336	70	1.6596
AN	71.4433	70	1.6003
BC	71.4336	70	1.6596
BCN	71.5090	70	1.6767

Intable 3 fault resistance 10ohms and different type fault, ABC, AN, BC, BCN actual fault occur at 70 km showsmeasured location and error from result error very acceptable and accuracy in table 3 we can see thatthe different value for fault type for% error AN=1.6003and forBC=1.6596 some swing in calculation but all value is increased for two ended by use matrix method.

Table 4: Resistance fault at 30 ohms two ended at 70 km

Type Fault	Measured Location	Actual Location	%Error
ABC	71.9915	70	2.218
AN	71.9204	70	2.1337
BC	71.9915	70	2.2128
BCN	72.012	70	2.2356

Intable 4 fault resistance 30ohms and different type fault ,ABC,AN,BC,BCN actual fault occur at 70 km the measured location and error from result error very acceptable and accuracy different value for fault type for% error AN=2.1337and forBC=2.2128 some swing in calculation but all value is agree with value expected.

Table 5: resistance fault at 50 ohms two ended at 70 km

Type Fault	Measured Location	Actual Location	%Error
ABC	72.4894	70	2.7660
AN	72.4004	70	2.6672
BC	72.4894	70	2.7680
BCN	72.515	70	2.7945

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In table 5 fault resistance 50ohms and different type fault, ABC, AN, BC, BCN actual fault occur at 70 km the measured location and error from result error high and not accuracy in table 4.26 we can see that different value for fault type for %error AN=2.6672and forBC=2.768 some swing in calculation but all value is not acceptable.

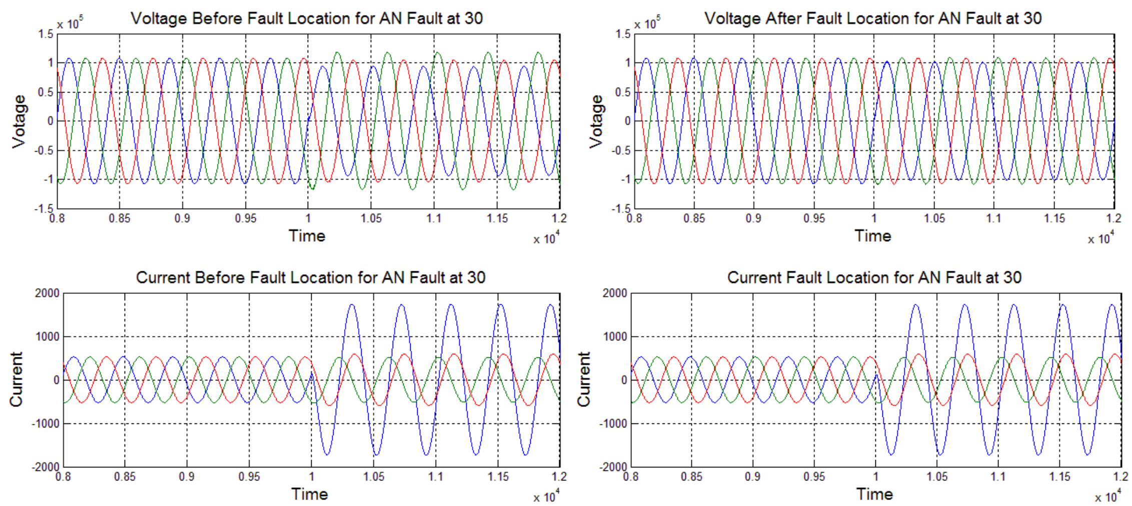

Figure 9: Wave form for voltage and current for ANfault at 30 ohms at 70kmfor matrix

Figure 9 shows the voltage before fault location for AN fault at 30 ohms all phases normal A,B,C and phase A is normal before fault and for amplitude 113kV sine normal A,B,C and phase A is normal before fault and for amplitude 113kV sine wave result from source phase to phase RMS 138kVwere $V_{m=}138*\sqrt{2}/\sqrt{3} = 113$kV for sample time 12000 sample in figure 4.16shows voltage after fault location for AN fault at location4(50km) The change voltage at AN fault is zero for current before fault at AN fault at 30 ohms has value is stable and normal because not load but after occur fault location at 70 km increased current for phase A to 1200 represented to ground fault current $I_{A=}I_F$ by use neutral source by Y_g the neutral is grounded either directly or through resistance or reactance the neutral grounding provide return path to zero sequence current advantage for this grounding eliminated arcing and voltage of healthy phases normal value $V_B=V_{PHASE=}113$kV, $V_C=V_{PHASE=}113$kV they do not increase to1.732times normal value as in case of ungrounded system. While faulty phase $V_A=0$ these condition are clear at point fault location 5(70km) but here some value for voltage V_A to find fault resistance 30 ohmsand this very important for design all equipment and current for healthy phases $I_{B=0}$, $I_{C=0}$ but fault current ground $I_{A=}I_F$ is high and sufficient to operate over current relay as protection and not use over voltage under voltage as protection and avoid arcing ground figure 4.17shows decrease fault current ground $I_{A=}I_{F..}$

Figure 10: wave form for voltage and current for BCfault at 10 ohms at 70km for matrix method

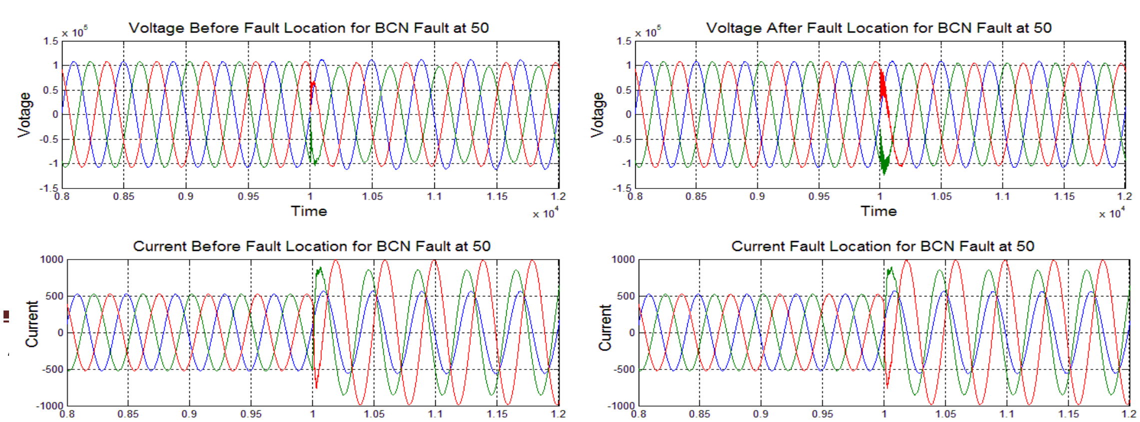

Figure 10 shows the voltage before fault location for BC fault at 10ohms all phases normal and phases BC is normal before fault and for amplitude 113kVsine wave voltage for BC fault the change voltage at Fault has value with decrease phase C for current before fault at BC fault at 10 ohms have value is stable and normal but after occur fault location at 70 km increased current for BC phases to 4000A after fault location.

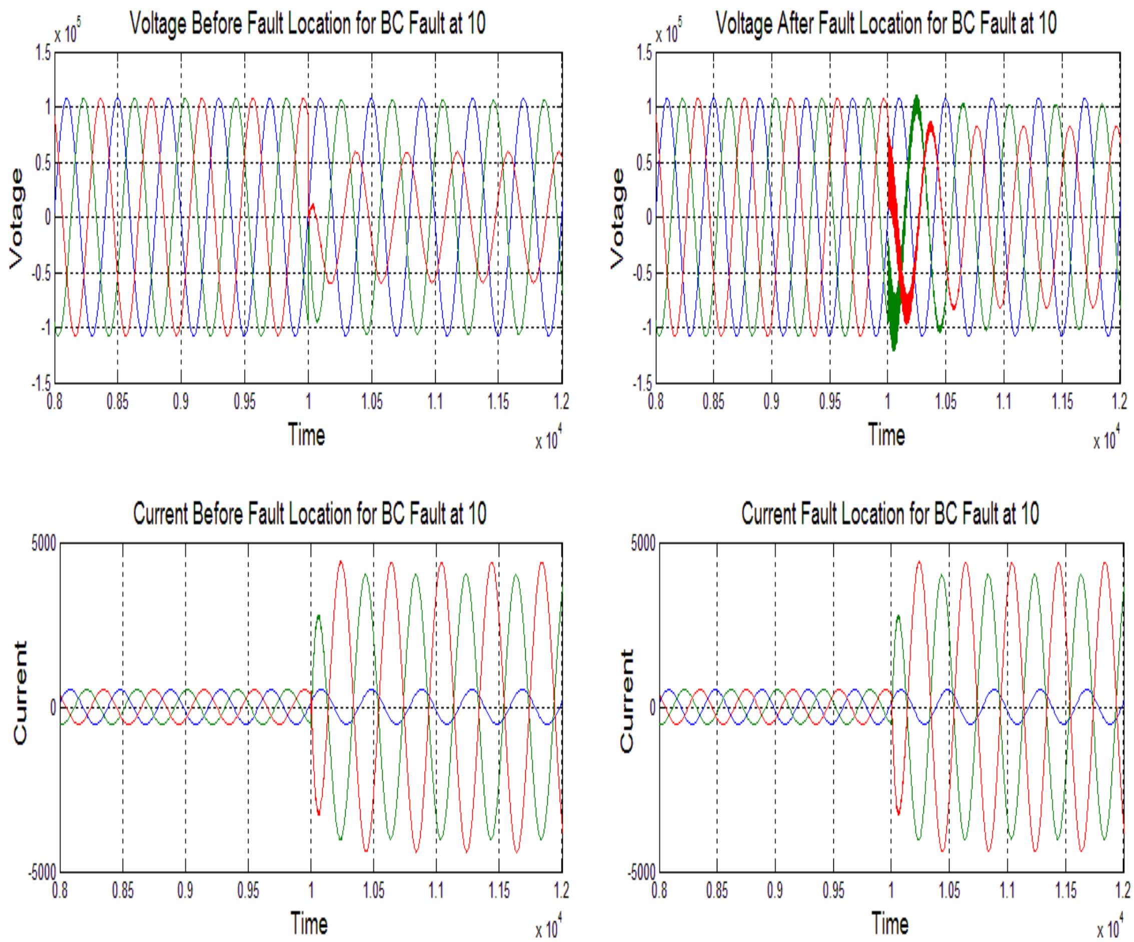

Figure 11: Wave form for voltage and current for BCN fault at 50ohms at 70kmfor matrix method

Figure 11 shows the voltage before fault location for BCN fault at50 ohms all phases normal A,B,C and phases BC is normal before fault at location4(50km) and for amplitude 113kV sine wave result from source phase to phase RMS 138kVwere $V_{m=}138*\sqrt{2}/\sqrt{3} = 113$kV for sample time 12000 sample in figure 4.11shows voltage after fault location for BCN fault at location4(50km) The change voltage phases BC is not zero because find resistance fault but for phase A=V_{PHASE} for current before fault at ABC at50 ohm has value is stable and normal but after occur fault location at 70 km increased current for phases BC 1000A represented to ground fault current by use neutral source by Y_g the neutral is grounded either directly or through resistance or reactance the neutral grounding provide return path to zero sequence current advantage for this grounding eliminated arcing and voltage of healthy phases normal value V_A=$V_{PHASE=}$113kV they do not increase to1.732times normal value as in case of ungrounded system these condition are clear at point fault location 5(70km).

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Fault Location at 70km Single line two endedwith load by use matrix

Type Fault	Measured Location	Actual Location	%Error
ABC	70.5785	70	0.6428
AN	70.5700	70	0.633
BC	70.5701	70	0.633
BCN	70.570	70	0.634

Table 6: Resistance fault at 0.001ohmsimpedance matrix for single line with load

Intable 6 fault resistance 0.001ohms and different type fault,ABC,AN,BC,BCN actual fault occur at 70 km shows measuredlocation and error from result error notacceptable and less accuracy in table 4.27 we can see thatdifferent value for fault type for% error AN=0.633and forBC=0.633 some swing in calculation but all value is agree with value expected for two ended by use matrix method for single line with load.

Type Fault	Measured Location	Actual Location	%Error
ABC	72.314	70	2.57
AN	72.2799	70	2.533
BC	72.2789	70	2.533
BCN	72.279	70	2.5332

Table 7: Resistance fault at 5 ohms impedance matrix for single line with load

Intable 7 fault resistance 5ohmsand different type fault, ABC, AN, BC, BCN actual fault occur at 70 km shows measured location and error from result error very acceptable and accuracy also we see different value for fault type for% errorAN=1.265and for% errorBC=1.266 some swing in calculation but all value is agree with value expected for two ended by use matrix method for single line with load.

Table.8: Resistance fault at 10ohms impedance matrix for single line with load

Type Fault	Measured Location	Actual Location	%Error
ABC	71.7352	70	1.9283
AN	71.7099	70	1.899
BC	71.7098	70	1.899
BCN	71.7099	70	1.899

Intable 8 fault resistance 5ohms and different type fault, ABC, AN, BC, BCN .actual fault occur at 70 km shows measured location and error from result error very acceptable and accuracy in table 8 we can see that different value for fault type for% error AN=1.899and forBC=1.899 some swing in calculation but all value is agree with value expected for two ended by use matrix method for single line with load.

Intable 9 fault resistance 30ohms and different type fault, ABC, AN, BC, BCN actual fault occur at 70 km shows measured location and error from result error notacceptable and less accuracy in table4.30 we can see that different value for fault type for %error AN=2.533and forBC=2.533 some swing in calculation but all value is agree with value expected for two ended by use matrix method for single line with load.

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Type Fault	Measured Location	Actual Location	%Error
ABC	71.1570	70	1.2855
AN	71.1399	70	1.265
BC	71.1399	70	1.266
BCN	71.1399	70	1.265

Table 9: Resistance fault at 30 ohms impedance matrix for single line with load

Type Fault	Measured Location	Actual Location	%Error
ABC	72.89	70	3.2138
AN	72.84	70	3.166
BC	72.85	70	3.167
BCN	72.849	70	3.160

Tabl.10: resistance fault at 50 ohms impedance matrix for single line with load

In table 11 fault resistance 5ohms and different type fault, ABC, AN, BC, BCNactual fault occur at 70 km shows measured location and error from result error very acceptable and accuracy the different value for fault type for %error AN=3.166and forBC=3.167 some swing in calculation but all value is agree with value expected for two ended by use matrix method for single line with load.

Figure 12: Wave form for voltage and current for AN fault at 5ohms at 70kmfor matrix

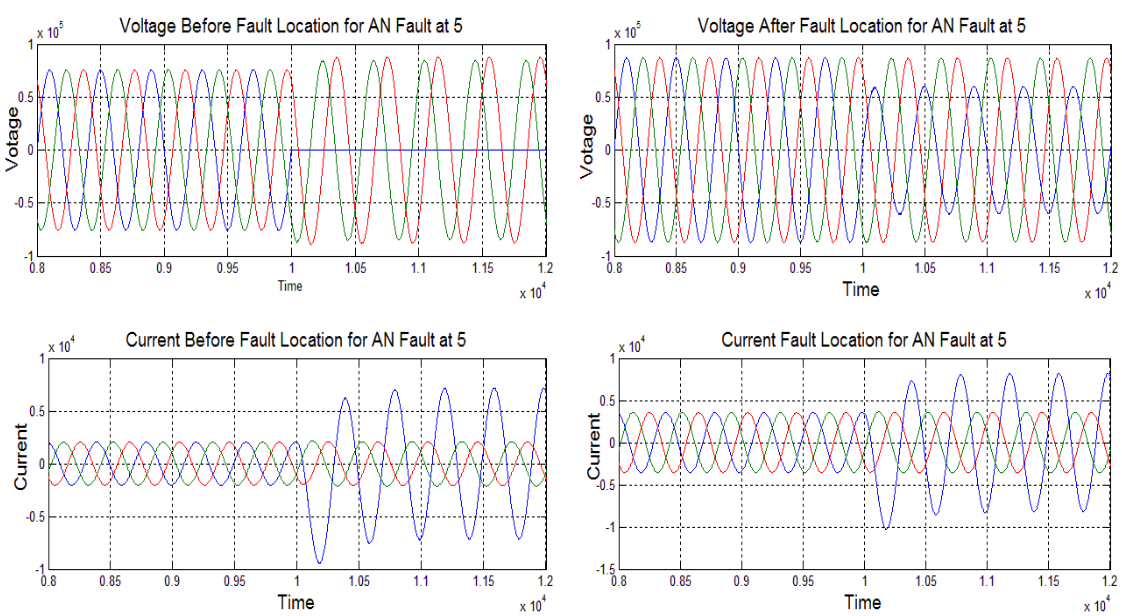

Figure 12 shows the voltage before fault location for AN fault at 5 ohms before and after fault location at location4(50km) and 6(90km) while point fault location at location 5(70km) all phases normal A,B,C and phase A is normal before fault and for amplitude 113kV sine wave result from source phase to phase RMS 138kVwere $V_{m=}138*\sqrt{2}/\sqrt{3} = 113$kV for sample time 12000 sample in figure 4.19 shows voltage after fault location for AN fault at location4(50km) The change voltage at AN fault is not zero because resistance fault 5ohm will increase voltage for AN for current before fault at AN fault at 5 ohms has value is stable and normal because not load but after occur fault location at 70 km increased current for phase A between 6000A represented to ground fault current $I_{A=}I_F$ by use neutral source by Y_g the neutral is grounded either directly or through resistance or reactance the neutral grounding provide return path to zero sequence current advantage for this grounding eliminated arcing and voltage of healthy phases normal value $V_B=V_{PHASE=}113$kV, $V_C=V_{PHASE=}113$kV they do not increase to1.732times normal value as in case of ungrounded system. While faulty phase $V_A=0$ these condition are clear at point fault location 5(70km) at ideal case resistance fault =0but here some value for voltage V_A to find fault resistance 5 ohms and this very important for design all equipment and current for healthy phases $I_{B=0}$, $I_{C=0}$ but fault current ground $I_{A=}I_F$ is high and sufficient to operate over current relay as protection and not use over voltage under voltage as protection and avoid arcing ground

Double circuit line by use impedance matrix

Type Fault	Measured Location	Actual Location	%Error
ABC	70.2472	70	0.2747
AN	70.5818	70	0.646
BC	70.5897	70	0.6553
BCN	70.5818	70	0.6464

Table 13: Resistance fault at 0.001ohmsDouble circuit line for matrix method

Intable 13 fault resistance 0.001ohms and different type fault, ABC, AN, BC, BCN actual fault occur at different distance fault location the measured location and error from result error acceptable and accuracy the different value for fault type for% error AN=0.646 at10kmand forBC=0.6553 at 70km some swing in calculation but all value is agree with value expected for two ended by use matrix method for double circuit line.

Type Fault	Measured Location	Actual Location	%Error
ABC	70.4944	70	0.5494
AN	70.1636	70	1.292
BC	70.1795	70	1.310
BCN	70.1636	70	1.2928

Table 14: Resistance fault at 5 ohmsdouble circuit line for matrix method

In table 14 fault resistance 5ohms and different type fault, ABC, AN, BC, BCN actual fault occur at 70 km fault location themeasured location and error from result error increased and accuracy is less the different value for fault type for %error AN=1.292 at70kmand forBC=1.310 at 70km some swing in calculation but all value is agree with value expected for two ended by use matrix method for double circuit line.

Type Fault	Measured Location	Actual Location	Error%
ABC	70.7417	70	0.8241
AN	70.7453	70	1.9393
BC	70.7692	70	1.9658
BCN	70.7453	70	1.9393

Table 15: Resistance fault at 10ohmsdouble circuit line for matrix method

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In table 15 fault resistance 10ohms and different type fault, ABC, AN, BC, BCN actual fault occur at 70 km fault location shows measured locationand error from result error increased and accuracy is less the different value for fault type for AN=1.939 at10kmand forBC=1.9658 at 70km some swing in calculation but all value is agree with value expected for two ended by use matrix method for double circuit line.

Type Fault	Measured Location	Actual Location	%Error
ABC	70.98895	70	1.0988
AN	70.327	70	2.585
BC	70.358	70	2.6210
BCN	70.327	70	2.585

Table 16: Resistance fault at 30 ohms Double circuit line for matrix method

In table 16 fault resistance 30ohms and different type fault, ABC, AN, BC, BCN actual fault occur at different distance fault location notes measured location and error from result error not acceptable.

Table 17: Resistance fault at 50 ohms Double circuit line for matrix method

Type Fault	Measured Location	Actual Location	Error%
ABC	70.2361	70	1.373
AN	70.909	70	3.2322
BC	70.9487	70	3.2763
BCN	7.9086	70	3.232

In table 17 fault resistance 30ohms and different type fault ,ABC,AN,BC,BCN actual fault occur at different distance fault location in table 4.36 measured location and error from result error not acceptable is very high and compare with Takagi method for same resistance fault and same distance then Takagi method is more accuracy for non homogenies system.

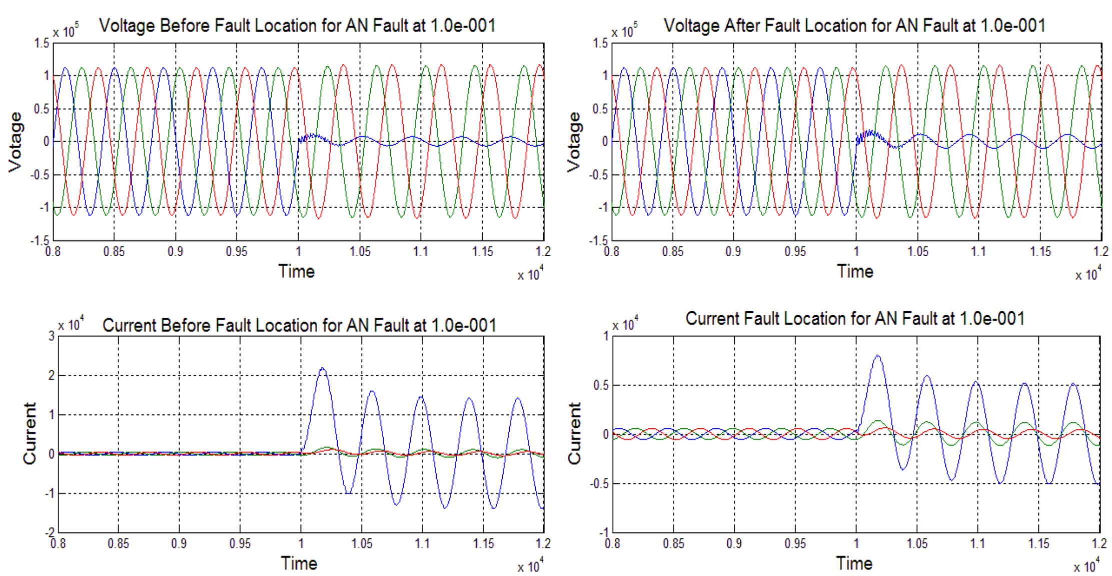

Figure 13: Wave form for voltage and current for ANfault at 0.001 ohms at 70km Double circuit line for matrix method

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Figure 13 shows the voltage before fault location for AN fault at 0.001 ohms all phases normal A,B,C and phase A is normal before fault and for amplitude 113kV sine wave result from source phase to phase RMS 138KVwere $V_{m}=138*\sqrt{2}/\sqrt{3} = 113kV$ for sample time 12000 sample in figure 4.20shows voltage after fault location for AN fault at location4(50km) The change voltage at AN fault is zero for current before fault at AN fault at 0.001 ohms has value is stable and normal because not load but after occur fault location at 10 km increased current for phase A between 15000A to 20000A represented to ground fault current $I_{A}=I_{F}$ by use neutral source by Y_g the neutral is grounded either directly or through resistance or reactance the neutral grounding provide return path to zero sequence current advantage for this grounding eliminated arcing and voltage of healthy phases normal value $V_B=V_{PHASE}=113kV$, $V_C=V_{PHASE}=113kV$ they do not increase to1.732times normal value as in case of ungrounded system. While faulty phase $V_A=0$ these condition are clear at point fault location 5(70km) and this very important for design all equipment and current for healthy phases $I_{B}=0$, $I_{C}=0$ but ground fault current $I_{A}=I_F$ is high and sufficient to operate over current relay as protection and not use over voltage under voltage as protection and avoid arcing ground.

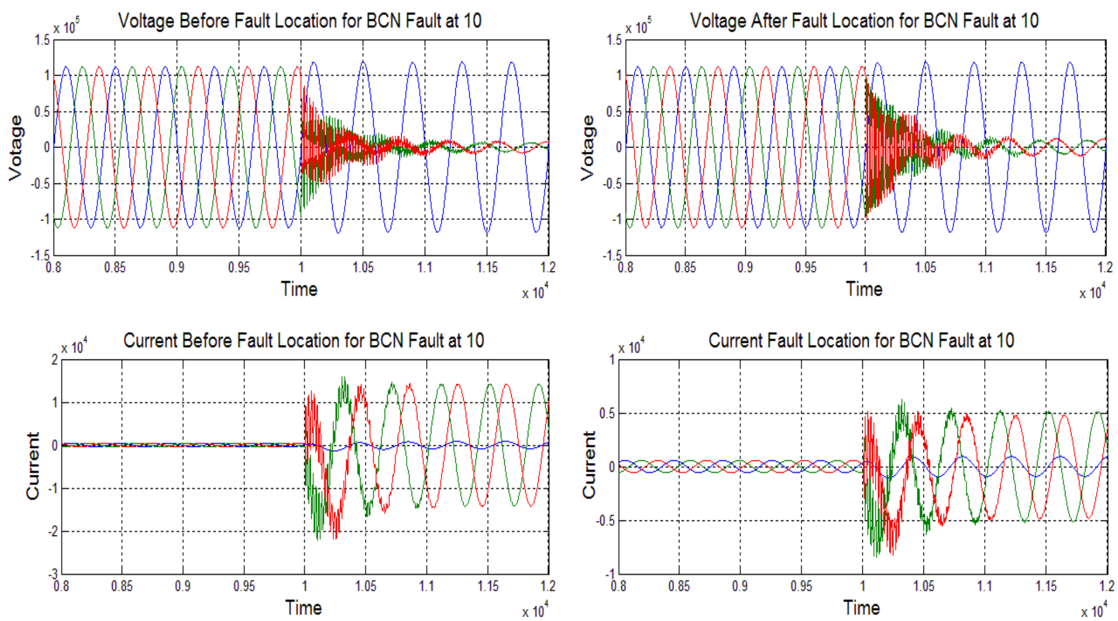

Figure 14: Wave form for voltage and current for BCN fault at 10 ohms at 70km Double circuit line for matrix method

Figure 14 shows the voltage before fault location for BCN fault at10ohms all phases normal A,B,C and phases BC is normal before fault at location4(50km) and for amplitude 113kV sine wave result from source phase to phase RMS 138kVwere $V_{m}=138*\sqrt{2}/\sqrt{3} = 113kV$ for sample time 12000 sample in figure 4.21shows voltage after fault location for BCN fault at location4(50km) The change voltage phases BC is zero but for phase $A=V_{PHASE}$ for current before fault at ABC at5 ohm has value is stable and normal because not load but after occur fault location at 70 km increased current for phases BC between 12000A represented to ground fault current by use neutral source by Y_g the neutral is grounded either directly or through resistance or reactance the neutral grounding provide return path to zero sequence current advantage for this grounding eliminated arcing and voltage of healthy phases normal value $V_A=V_{PHASE}=113kV$, $V_B=V_{C}=0$they do not increase 1.732times normal value as in case of ungrounded system these condition are clear at point fault location 5(70km) and this very important for design all equipment and current for healthy phases $I_{A}=0$ while current faulty phases is high and use over current relay as protection and for detection fault.

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Find fault location by used minimum impedanceMethod

This application described in this thesis focus on faults that cause voltage sags. Voltage sag is a temporary decrease in the RMS voltage magnitude between 10% and 90% of the declared voltage for durations of one-half cycle to 1 minute. Its frequency of occurrence is between a few tens and several hundred times per year, its duration of mostly less than 1 s and voltage drops rarely below 40%.

Type fault	Actual location	Estimation location	% Error
ABC	70	70.9058	1.004
AN	70	70.6334	0.703
BC	70	70.5469	0.607
BCN	70	70.1576	0.175

Table 18: fault location at 70km for 0.001Ohms.

In table 18 actual fault location at 70km and 0.001ohms for different fault type fault,ABC, AN, BC, BCN actual fault occur at 70km the measured locationand error from result error acceptable and accuracy the different value for fault type for% error AN=0.703 at70kmand for BC=0.607 at 70km some swing in calculation but all value is for BCN isvery small for 70 km %error=0.175 And estimation location by useminimum value for V/I by using program.

Table 19: fault location at 70km for 5 Ohm.

Type fault	Actual location	Estimation location	% Error
ABC	70	70.9058	1.006
AN	70	70.6524	0.724
BC	70	70.5569	0.618
BCN	70	70.15878	0.1761

In table 19 actual fault location at 70km and 5ohm for different fault type fault, ABC, AN, BC, BCN actual fault occur at 70km the measured location and error from result error acceptable and accuracy the different value for fault type for% error AN=0.724 at70kmand for BC=0.618at 70km some swing in calculation but all value is agree with value expectedfor BCN type fault is very small for 70 km for %error=0.1761

Table 20: fault location at 70km for 10 Ohms.

Type fault	Actual location	Estimation location	% Error
ABC	70	70.9417	1.0458
AN	70	70.7387	0.8242
BC	70	70.5952	0.6616
BCN	70	70.2453	0.27181

In table 20 actual fault location at 10ohmsfor different fault type fault, ABC,AN,BC,BCN actual fault occur at 70kmfault type for% error AN=0.8242 at70kmAnd for% error BC=0.6616 these values are acceptable.

Type fault	Actual location	Estimation location	% Error
ABC	70	70.9889	1.0987
AN	70	70.8218	1.0175
BC	70	70.6595	0.7323
BCN	70	70.2491	0.2766

Table 21: Fault location at 70km for 30 Ohms.

In table 21 actual fault location at 70km and 30ohms for different fault type fault, ABC, AN, BC, BCN actual fault occur at 70km the measured location and error from result error acceptable and some increases value different fault for% error AN=1.0175 at70kmand for% error forBC=0.7323at 70km some swing in calculation but all value is agree with value expectedfor BCN type fault is very small for 70 km for %error=0.2761

Type fault	Actual location	Estimation location	% Error
ABC	70	71.1171	1.2455
AN	70	70.9387	1.0433
BC	70	70.7952	0.8807
BCN	70	70.4456	0.4961

Table 22: fault location at 70km for 50 Ohm.

In table 22 actual fault location at 70km and 50ohms for different fault type fault, ABC, AN, BC, BCN actual fault occur at 70km the measured location and error from result error acceptable and some increases valuedifferent fault for% error AN=1.0433 at70km and for %error for BC=0.8807at70km in table 4.41we can see that from table4.37 at 0.001ohm and table 4.41 for 50 ohm that meaning any increase resistance fault will increased% error.

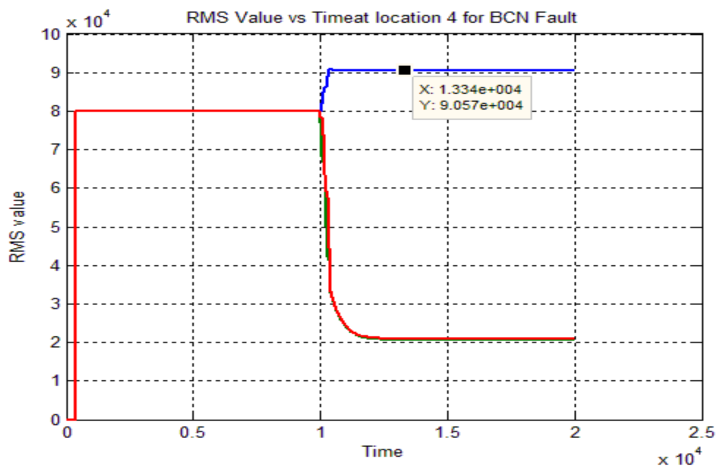

Figure 15: Voltage at location 4(50km) effect from fault BCN at location 5(70km) for single linewithout load

Figure 15 shows fault occurs on a transmission line at 70km, the voltage at the point of fault suddenly reduces to a low value, voltage measuring as shown figure 4.22 at location 4(50km) effect from fault BCN at location 5(70)km for single line without load shows fault location and measuring point at different point for two phases B and C where dropped to 20kVbut for third phase A is voltage RMS increased to 90kV increased 10kVwhere root mean square voltage $=V_m/\sqrt{2}$for sine wave in figure 4.22 we can see that R.M.S=$113/\sqrt{2}$=80kV small increase from normal value 80kVat distance location 50km.

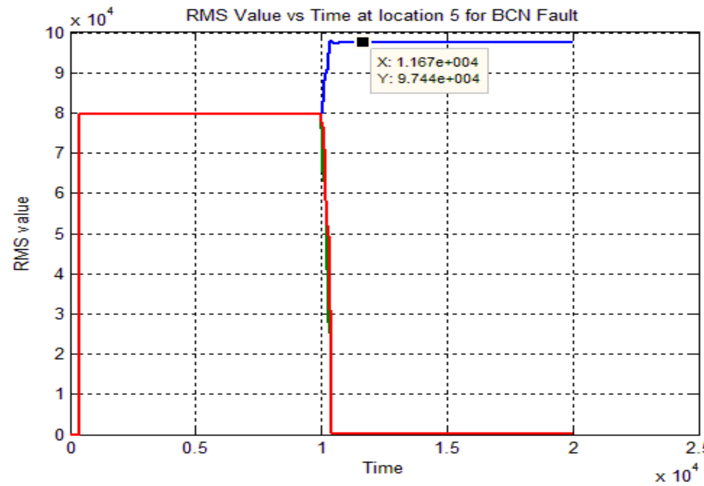

Figure 16: Voltage at location 5(70) effect from fault BCN at location 5(70km) for single line without load

Figure 16 fault occurs on a transmission line at70km, the voltage at the point of fault suddenly reduces to a low value,voltage measuring as shown in figure 4.23 at location 5(70) effect from fault BCN at location 5(70)km for single line without load as shown in figure 4.23 fault location and measuring point for two phases BC where dropped B and C to zero but for third phase A is voltage increased to 97kV this very critical for insulation equipment while normal voltage and we can use for detection fault earth fault relay but sensitive is very small therefore from better use over current relay, 97kV for third phase A where root mean square voltage =Vm/√*2*=80Kv for sine wave in figure 4.23 we can see that some drop voltage 113kV, then R.M.S=113/√*2*=80kV.

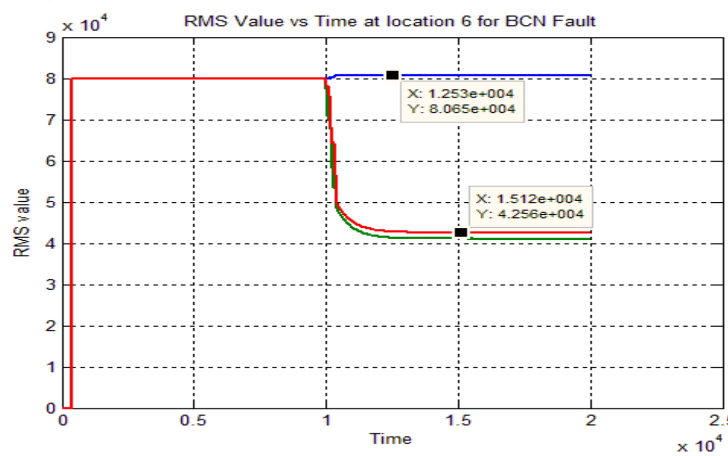

Figure 17: Voltage at location 6(90) effect from fault BCN at location 5(70km) for single line without load

Figure 17 shows the voltage when a fault occurs on a transmission line at 70km, the voltage at the point of fault suddenly reduces to a low value, voltage measuring as shown figure 4.24 at location 6(90km) effect from fault BCN at location 5(70)km for single line without load shown in figure 4.24 fault location and measuring point for two phases BC where dropped B and C to 42kV but for third phase A is voltage increased to 80.5kV this very critical for insulation equipment while normal voltage and we can use for detection fault earth fault relay but sensitive is very small therefore from better use over current relay, 80.5kV for third phase A where root mean square voltage =Vm/√*2*=80KVfor sine wave in figure 4.24 we can see that some drop voltage 113kVin source, then R.M.S=113/√*2*=80kV.

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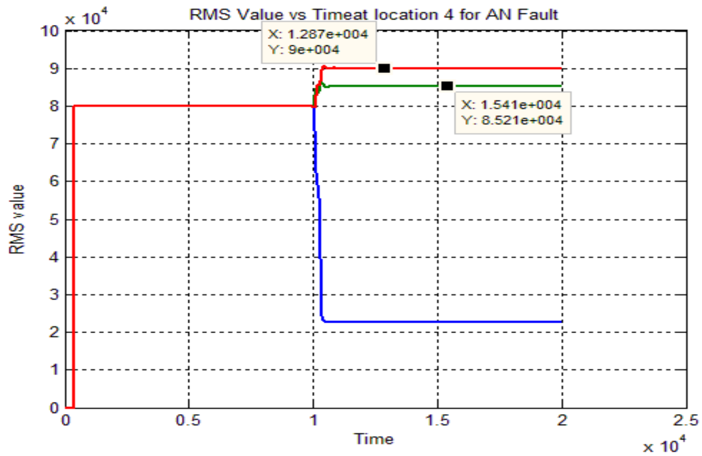

Figure 18: Voltage at location 4(50) effect from fault AN at location 5(70km) for single line without load

Figure 18 shows thevoltage at location 4(50) effect from fault AN at location 5(70km) for single line without load, as shown in figure 4.25 fault location occurred at same point measuring fault AN dropped to 24kV start from 1second while another phasesB and C voltageRMS increased for phase B=90kV for C=85.5kV this cause problem , for damage equipment insulationwhere root mean square voltage $Vm/\sqrt{2}$=80kVfor sine wave in figure 4.25we can see that some drop voltage 113kv in source, then R.M.S=$113/\sqrt{2}$=80kV.In figure 4.25 we can see that grounded source Y_g that meaning some impedance in neutral and for current I_A=fault current I_B=0,Ic=0and we can use for detection fault earth fault relay but sensitive is very small therefore from better use over current relay.

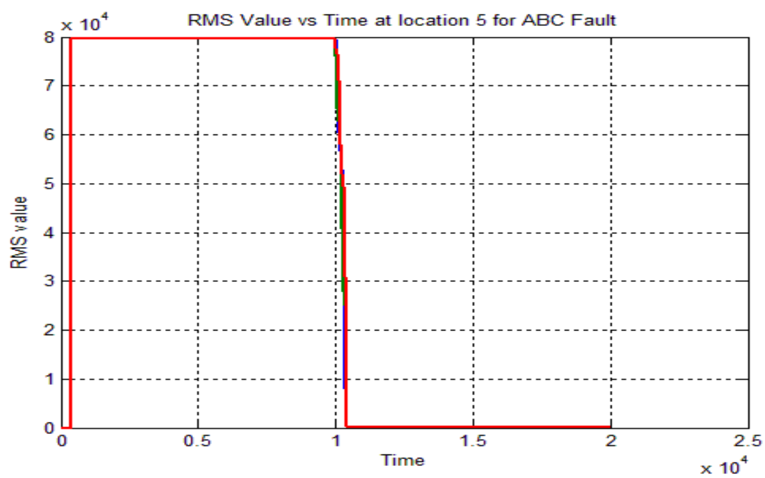

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Figure 19: Voltage at location 5(70) effect from fault ABC at location 5(70km) for single line without load

Figure 19 shows the voltage when a fault occurs on a transmission line at 70km for type fault ABC, the voltage at the point of fault suddenly reduces to a low valuefor phases A, B, C, voltage measuring as shown figure 19 at location 5(70km) effect from fault BCN 5(70)km for three phases short circuit fault without load.

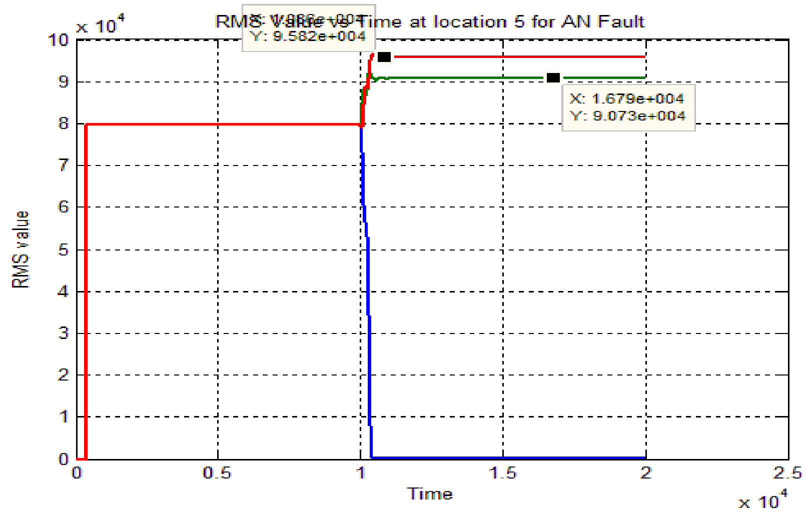

Figure 20: Voltage at location 5(70km) effect from fault AN at block 5(70km) for single line without load

Figure 20 shows the voltage at location 5(70) effect from fault AN at block 5(70km) for single line without load, as shown in figure 4.27 fault location occurred at same point measuring fault AN dropped to zero start from 1second while another phases B and C voltage RMS increased for phase B=95KV for C=90.5kVthis cause problem for damage equipment insulation where root mean square voltage $=Vm/\sqrt{2}=80kV$ for sine wave in figure 4.27we can see that some drop voltage 113kV in source, then $R.M.S=113/\sqrt{2}=80kV$. In figure 4.27 we can see that grounded source Yg for neutral source that meaning some impedance in neutral and for current Ia=fault current Ib=0,Ic=0and we can use for detection fault earth fault relay but sensitive is very small therefore from better use over current relay.

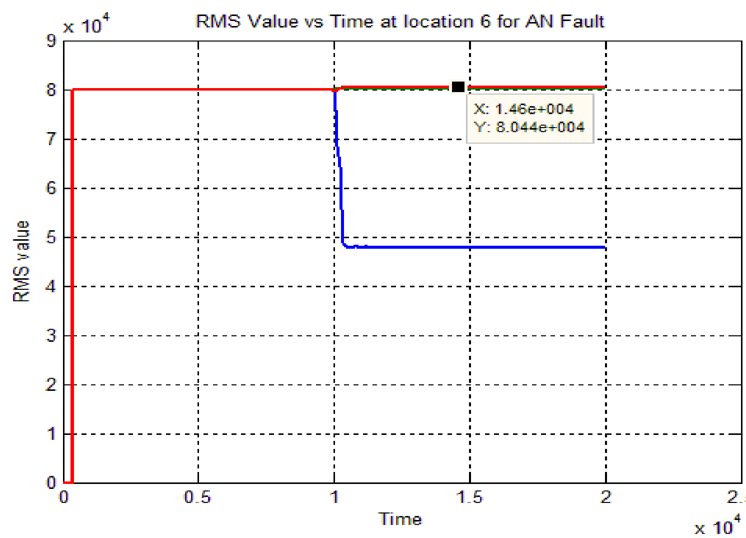

Figure 21: Voltage at location 6(90) effect from fault AN at location 5(70km) for single line without load

Figure 21 shows voltage at location 6(90km) effect from AN fault at location5 (70km) for single line with load figure 4.28 shows the fault phase to ground phase AN is dropped to 47kV while another two phases RMSvalue increased to 80.5kV, B and C voltageRMS this cause problem, for damage equipment insulationwhere root mean square voltage $=Vm/\sqrt{2}=80kV$for sine wave in figure 4.28we can see that some drop voltage 113kv in source, then $R.M.S=113/\sqrt{2}=80kV$. In figure 4.28 we can see that grounded source Y_g for neutral source that meaning some impedance in neutral and for current I_A=fault current $I_B=0,I_C=0$

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Fault Location Single line without loadby use YBUS method

Type fault	Actual location	Estimation location	% Error
ABC	70	70.9417	1.0458
AN	70	70.7387	0.8242
BC	70	70.5952	0.6616
BCN	70	70.2453	0.27181

Table 23: fault location at 70km for 50 Ohms.

In table 23 voltage at 70km for ABC fault, 70km for AN fault, 70 km for BC fault, 70km for BCN fault for 50 ohm and after run program get these result with error, in table 4.42, we can see that %error for AN is small for 70 km.

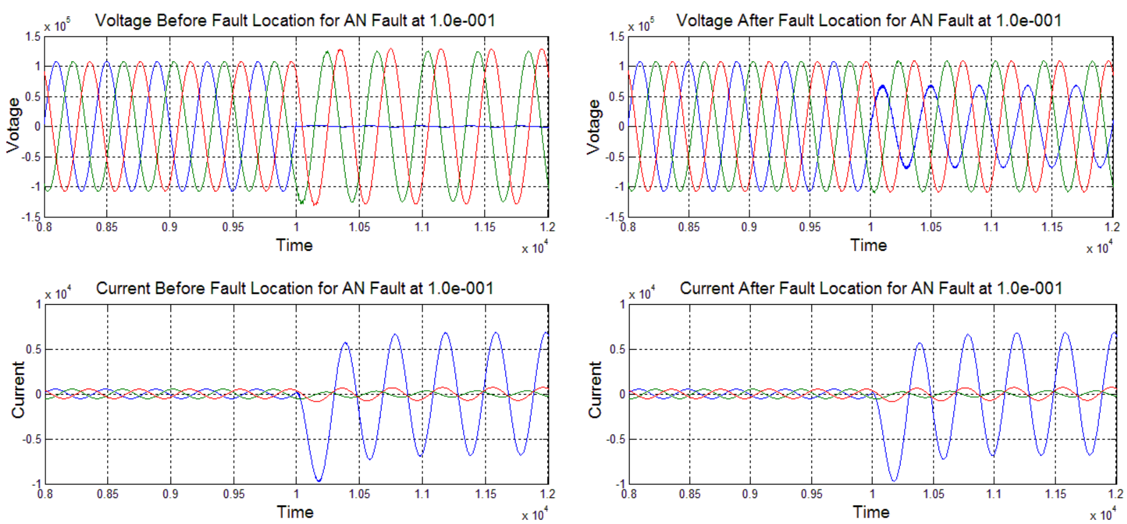

Figure 22: Wave form for voltage and current for ANfault at 0.001 ohms at 70kmfor Y_{bus}

Figure 22 shows the voltage before fault location for AN fault at 0.001 ohms all phases normal A,B,C and phase A is normal before fault and for amplitude 113kV sine wave result from source phase to phase RMS 138kVwere $V_{m=}138*\sqrt{2}/\sqrt{3} = 113$kV for sample time 12000 sample in figure 4.29 shows voltage after fault location for AN fault at location4(50km) The change voltage at AN fault is zero for current before fault at AN fault at 0.001 ohms has value is stable and normal because not load but after occur fault location at 70 km increased current for phase A between 6000A represented to ground fault current $I_{A=}I_F$ by use neutral source by Y_g the neutral is grounded either directly or through resistance or reactance the neutral grounding provide return path to zero sequence current advantage for this grounding eliminated arcing and voltage of healthy phases normal value $V_B=V_{PHASE=}113$kV, $V_C=V_{PHASE=}113$kV they do not increase to1.732times normal value as in case of ungrounded system. While faulty phase $V_A=0$ these condition are clear at point fault location 5(70km) and this very important for design all equipment and current for healthy phases $I_{B=0}$, $I_{C=0}$ but ground fault current $I_{A=}I_F$ is high and sufficient to operate over current relay as protection and not use over voltage under voltage as protection and avoid arcing ground.

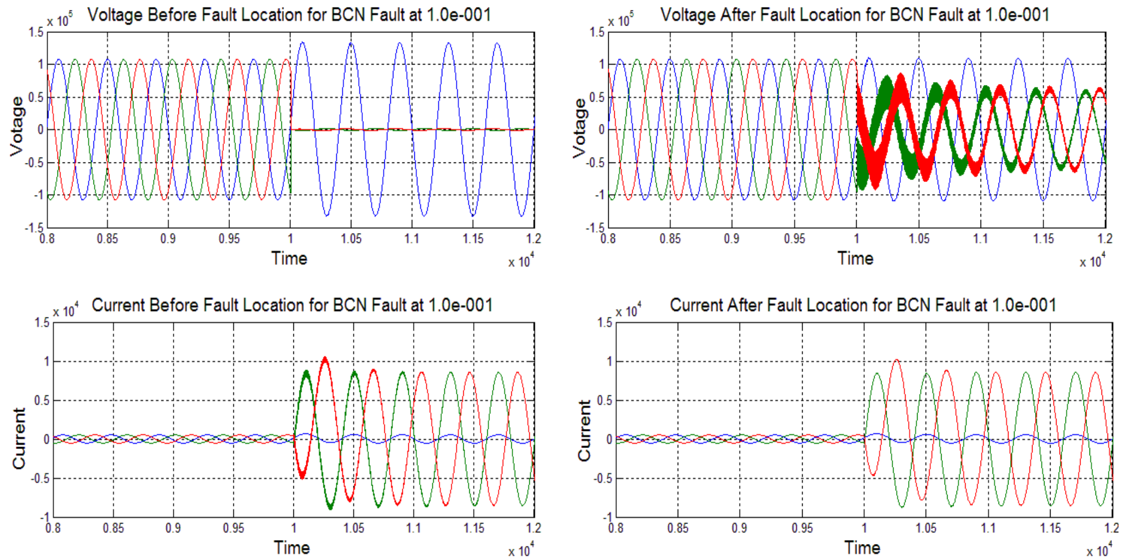

Figure 23: Wave form for voltage and current for BCNfault at 0.001 ohms at 70kmfor Y_{bus}

Figure 23 shows the voltage before fault location for BCN fault at 0.001 ohms all phases normal A,B,C and phases BC is normal before fault at location4(50km) and for amplitude 113kV sine wave result from source phase to phase RMS 138kVwere $V_{m=}138*\sqrt{2}/\sqrt{3} = 113$kV for sample time 12000 sample in figure 4.30shows voltage after fault location for BCN fault at location4(50km) The change voltage phases BC is zero but for phase A=V_{PHASE} for current before fault at ABC at 0.001ohms has value is stable and normal because not load but after occur fault location at 70 km increased current for phases BC 8000A represented to ground fault current by use neutral source by Y_g the neutral is grounded either directly or through resistance or reactance the neutral grounding provide return path to zero sequence current advantage for this grounding eliminated arcing and voltage of healthy phases normal value $V_A=V_{PHASE=}113$kV, $V_B=V_{C=}$ 0they do not increase to1.732times normal value as in case of ungrounded system these condition are clear at point fault location 5(70km) and this very important for design all equipment and current for healthy phases $I_{A=0}$.and use over current relay as protection and for detection fault.

CONCLUSION:

This thesis compares and evaluates different methods for classification of fault types and calculation of distance to faults. The purpose of this thesis is to examine the applications of conventional one-side and two-side based fault location methods for transmission line. For two-sided estimates the margin of fault is much greater, Two-side algorithm Impedance matrix method provide better fault location estimation in the verification. Two-side methods provide fault location estimation with acceptable error. But in reality, two-sided algorithms are more accurate than one-sided algorithms, compare two method by using impedance method depend on minimum impedance and impedance method by using y_{bus} this method is accuracy and better , and result about 0.5%while for two side method(matrix method) and 3.3% .

- Accuracy of Takagi method is 0.5% and for matrix method 3.3%for unhomogenies system.
- Accuracy ofy_{bus} method is 0.05% and for impedance method 1.4%for un homogenies system.
- Using grounding Y_g or isolated system Y not effected at fault location as distance while effect Y on fault ground as AN ,BCN where increased value voltage at fault for healthy phases to line voltage 1.732times normal value while for Y_g same phase voltage.

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