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Protection and Detection of Fault in 3-φ, 400kV Line Using Symmetrical Component Analysis

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Abstract - *Protection of power system always been a great area of research for the new researcher and research communities in this context many work has been done for the classification and detection of the fault for the analysis of the system. Three phase transmission line are soul of power system. In this paper different types of fault are classified in the three phase transmission line. In the present scenario the both end ratios are considered for the data acquisition of voltage and currents. These states are measured and fed to the control panel for the fault analysis and detection. These techniques are very much accurate for the short and medium transmission line. But for long transmission line classification needs the accuracy and actual detection of the fault and direction of the fault. For a 400kV, 100MVA, and 112km transmission is simulated and worked in MATLAB/SIMULINK environment*

Key Words: *Transmission Line, Fault Classification, L_G, LLG, LLL faults. Distance Protection*

1. INTRODUCTION

The performance of any power system network is greatly affected by the transmission line network fault, which raises the disruption in power flow. As to maintain un-interrupted supply and protection for the connected network one need to develop such a technology to achieve the same.

Disturbances at power network occurs temporary and permanent basis, occasionally. This fault may be nature caused, climatic effect, equipment failure, aging and human error. The occurrence of fault creates the condition (mostly short circuit), during which heavy current flows through the equipments. Ignorance of this heavy current may burn the system apparatus and affect the continuity of supply. The protection and fault classification has become a challenging job to the present installed system.

R. Abouzar et. al. had proposed an extensive study on the sequential component based fault identification for the three phase power transmission line. In his paper positive sequence component and negative sequence component are used to achieve the detection of faults at any position.[1]

A. Thompson had proposed method to generalise the fault transmission in power system in accordance with the current sequential components.[2]

P. Ray et. al. had given a machine learning based hybrid classification technique for the analysing fault, its detection and classification. In this paper discrete wavelet transformation is used for feature selection of fault and these features are source for the machine learning algorithm. [4]

H. Ben et al. proposed a method for detection of faults in Extra High voltage (EVHV) system using artificial neural network (ANN). The type and detection of fault location is done by treatment of voltage and current using ANN.[6]

Idea and purpose is to classify and detect fault based on the symmetrical components with their phase angle and magnitude of current. The phasor values of three phase system can be converted into the equivalent symmetrical components. Only, positive and negative components have been used in this paper to perform the classification of faults. In the present scenario, zero sequence components give the definite ground fault but during unbalanced system zero sequence component may present. Although in the un-faulted condition zero sequence may occur in the system.

1.1 Faults and Classification

In power system with single circuit line taken as system under study have various type of faults as L-G fault, LL fault, LL-G fault and LLL with and without ground. The grounded faults are more severe as compared to ungrounded fault. Since, grounded faults are more severe because of heavy current flows through the converter and amount of current cannot be limited by any method which further causes the disruption of power system and equipments.

In Figure 1 it is clear that the system may observe various type fault as per the occurrences and the severity level.

1.2 Types of Fault

Active Fault

- The fault is called active when actual current flows from one phase conductor to another (phase-to-phase), or alternatively from one phase conductor to earth (phase-to-earth) as commonly popular. This type of fault can also be further classified into two areas, namely the 'solid' fault and the 'incipient' fault.

- Increased damage at fault location. Fault energy = $=I^2Rt$ where t is time in seconds.
- Danger to operating personnel (flashes due to high fault energy sustaining for a long time).
- Danger of igniting combustible gas in hazardous areas, such as methane in coal mines which could cause horrendous disaster.
- Increased probability of earth faults spreading to healthy phases.
- Higher mechanical and thermal stressing of all items of plant carrying the fault current, particularly transformers whose windings suffer progressive and cumulative deterioration because of the enormous electromechanical forces caused by multi-phase faults proportional to the square of the fault current.
- Sustained voltage dips resulting in motor (and generator) instability leading to extensive shutdown at the plant concerned and possibly other nearby plants connected to the system.

The 'incipient' fault, on the other hand, is a fault that starts as a small thing and gets developed into catastrophic failure.

Like for example some partial discharge (excessive discharge activity often referred to as Corona) in a void in the insulation over an extended period can burn away adjacent insulation, eventually spreading further and developing into a 'solid' fault.

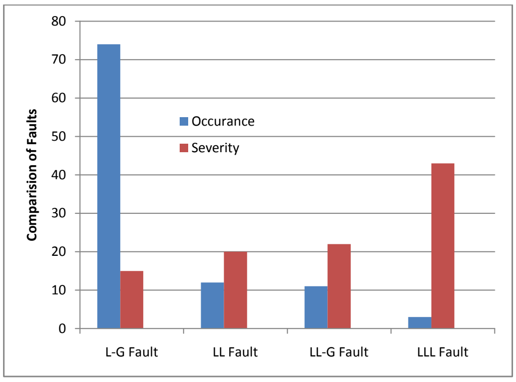

Figure 1 Chart showing the Occurrence and Severity of Various Faults

Passive Faults

- Reasons behind the active faults are generated by the cumulative actions of passive faults.
- Overloading leading to overheating of insulation (deteriorating quality, reduced life and ultimate failure).
- Overvoltage: Stressing the insulation beyond its withstand capacities.
- Under frequency: Causing plant to behave incorrectly.
- Power swings: Generators going out-of-step or out-of-synchronism with each other.
- It is therefore very necessary to monitor these conditions to protect the system against these conditions.[6-7]

With the development in power engineering and electrical power apparatus design protection system cannot remain untouched with it.

In the process of development one has seen the performance of electromechanical relay. Due to its high power consumption and slow response in dynamic condition it becomes obsolete for the new installations.

While performance and development in solid state relays replaced the electromechanical relays from the protection time line.

Table I: Data for 400kV, 112km, 3-phase line

Arrangements	Tower Specification
Phase Conductor	
Height at tower	24m
Height at midspan	12m
Phase Spacing	12m
Number of bundle	2
Radius of sub Conductor	1.521 cm
Spacing Between Sub-Conductor	40 cm
Geometrical Mean Radius (GMR)	1.2253 cm
DC Resistance	.0596 Ω/km
Ground Wire	
Height at Tower	33 m
Height at Midspan	20 m
Spacing	15.2 m
Radius	0.8 cm
DC resistance	0.3527 Ω/km

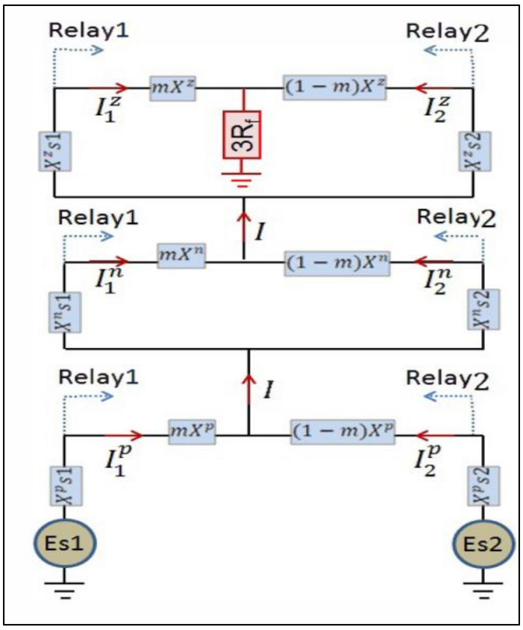

Figure 2 Equivalent Circuit of L-G Fault

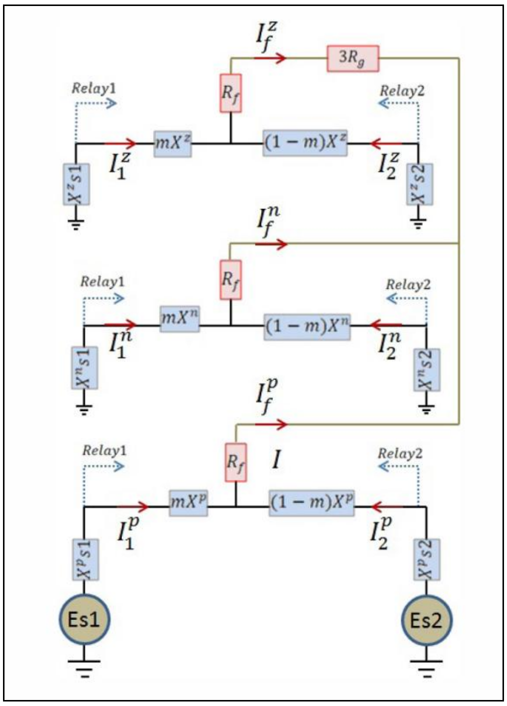

Figure 3 LL-G Fault

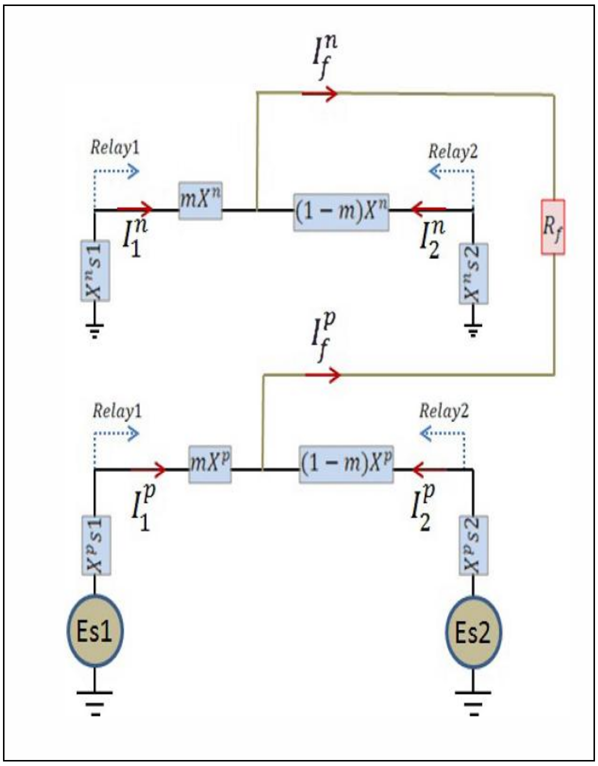

Figure 4 Line to Line Fault

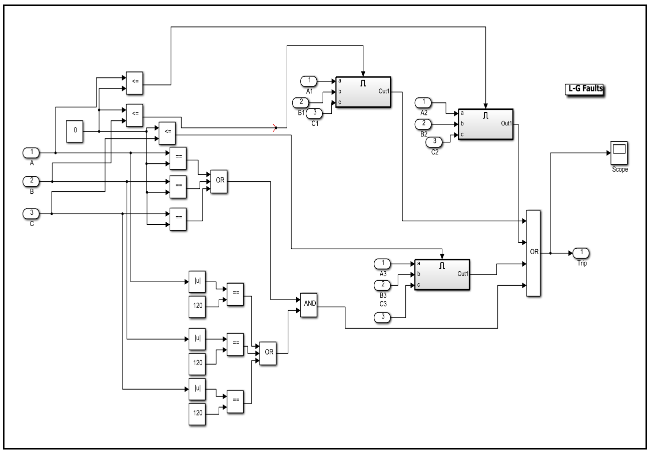

Figure 5 Condition modelling for Line to Ground Fault

Figure 2, figure-3 and Figure 4 are the equivalent circuit model for the different types of active fault. In this all the distance calculation and impedance calculation are kept constant for the analysis of fault and its behavior. In this work one may observe the system with condition of identification of fault in different types.

This identification of fault on different condition are made possible by the condition modelling of the system which generates the trip command to the network. Figure 5 and figure 6 are the model of the derived condition for the identification of the network faults.

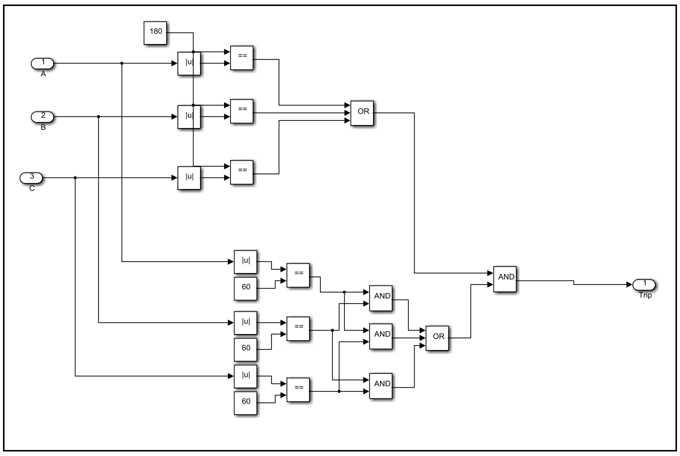

Figure 6 Condition modelling for Double-Line to Ground Fault

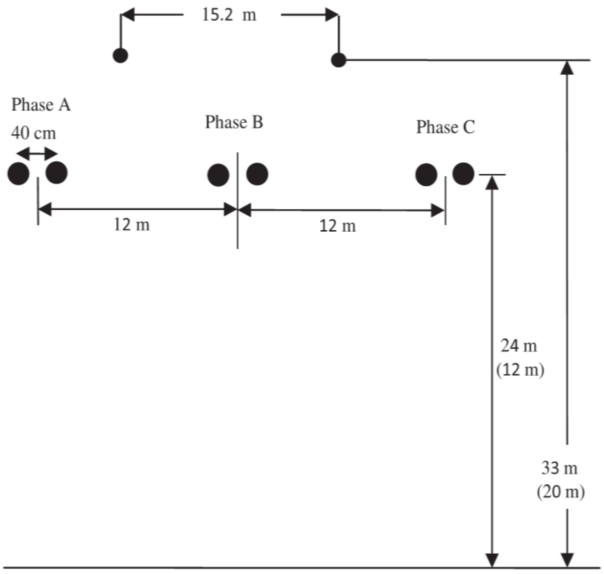

Figure 7 Tower specification of 400kV Transmission line tower and conductor configuration

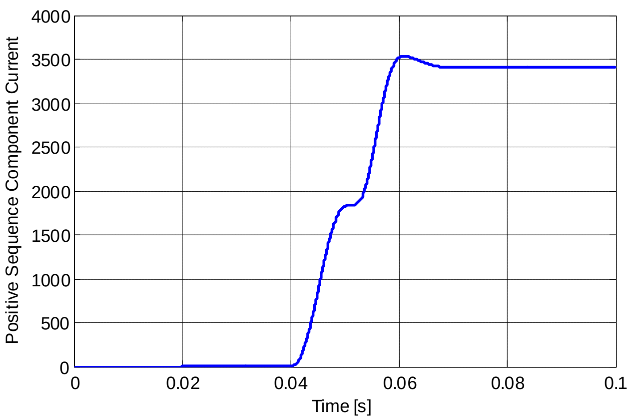

Figure 8 Positive Sequence Current Magnitude

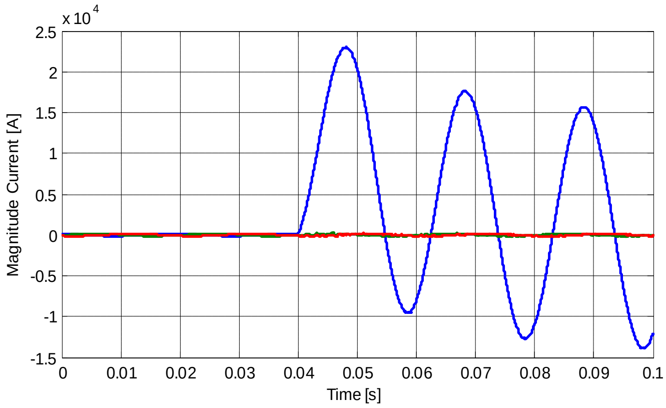

Figure 9 Fault Current.

3. CONCLUSIONS

Conclusively, after reviewing related literatures, we have successfully performed sequential component based protection strategy for protection of 400kV line. In this work MATLAB/SIMULINK software based modelling and analysis has been performed for different faults detection and their identification. One of the major point taken out is that this work requires data of only one end for the classification of fault and detection. This work proposes a method which does not require any transformation like wavelet and others.

Data acquisition can be locally and/or at far end whichever will suit the application obtain the information regarding fault. This work provides the actual calculation RLC-parameter for the modelling of the system which further avoids the malfunctioning of the system.

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