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# DESIGN AND FAULT ANALYSIS OF 110KV TRANSMISSION LINE

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***Abstract:*** The main aim of our project work is to develop a MATLAB based Simulation model for analyzing 3- phase symmetrical and unsymmetrical faults. Generally, these faults are occurred in the long transmission line system such as single line to ground fault (L-G), double line to ground (2L-G), triple line to ground fault (3LG) and Line to line fault (L-L). Fault analysis for different sorts of faults has been done and it impacts are appeared in simulation output e.g. voltage, current. This research approaches to the MATLAB software in which transmission line modal is simulated. The analysis will be based on a 110KV, 100km, 50HZ 3 Phase Transmission Line deigned for 500KVA. The system behavior in case of fault and fault current limitation techniques are also studied and developed in this project.

***Index Terms* – Transmission Line, MATLAB, 110KV, Fault Analysis**

## I. INTRODUCTION

Now-a-days the demand of electricity or power are increases day by day this results to transmits more power by increasing the transmission line capacity from one place to the other place. But during the transmission some faults are occurred in the system, such as L-L fault (line to line), 1L-G fault (single line to ground) and 2L-G fault (double line to ground). These faults affect the power system equipment's which are connected to it. The main aim of this paper is to study or analysis of various faults and also identifies the effect of the fault in transmission line along with bus system which is connected to transmission line. This paper approaches to the MATLAB software in which transmission line model is designed and various faults will be occurred by using fault tool box which has discussed above. After that, various effects on bus system due to different faults are shown such as voltage, current, power voltage and current output in terms of waveforms.

When different faults occur in the system then the fault analysis helps in the determination of the bus voltage and the line current. While dealing with the power system the term bus voltage and the line current are very important. In the power system mainly two type of the fault occur. The first one is the symmetrical fault and the other one is the unsymmetrical fault e.g. single line to ground fault, line to line fault, double line to ground fault, double line fault [1]. The analysis of transmission line fault analysis for the protection of the power system. For the protection of the power system we use the circuit breaker and relay system as per the triple line fault. This is because of the reason that the triple line fault is very high as compare to the other faults in the transmission system. Therefore, by using the MATLAB software the simulation of the transmission line fault can be easily carried out. The main purpose of the research work is to study the general types of the fault e.g. balanced and unbalanced fault of the transmission line of the power system [2]. This research also leads to the various parameters like voltage, currents from simulation on those types of faults using MATLAB. A. Unsymmetrical faults These are very common and less severe than symmetrical faults. There are mainly three types namely line to ground (LG), line to line (L-L), double line to ground (L-L-G) faults. Line to ground faults is most common fault and 65-70% of faults are of this type. It causes the conductor to make contact with earth or ground.15 to 20 percent of faults are the double line to ground and causes the two conductors to make contact with the ground. Line to line faults occur when two conductors make contact with each other mainly while swinging of lines due to winds and 5-10 percent of the faults are of this type. These are also called unbalanced faults since their occurrence causes unbalance in the system [4]. Unbalance of the system means that that impedance values are different in each phase causing unbalanced current to flow in the phases. These are more difficult to analyze and are carried by per phase basis similar to three phase balanced faults B. Causes of electrical faults Climate conditions: It consists of heavy amount of rain, lighting strokes, deposition of salt on the overhead transmission line conductor, accumulation of snow or ice on the transmission lines etc.

These conditions of environment disturb the power supply and causes the damage to the electrical equipment. Equipment failure: Electrical equipment like electrical generator, motor, transformer, reactor, switching devices etc causes short circuit faults due to their failure of insulation of cables, ageing, malfunctioning operations of the relay [5]. These types of failure in the power system cause high amount of currents to flow through the equipment which results in the future damage to the equipment. Human errors: Human errors also a reason to create the electrical faults in the system. The errors are the selections of the improper ratings of the equipment and devices, forgetting metallic and electrical conducting parts after switching circuits or after maintenance while it goes in to services. Fire due to smoke particles, ionization of air surrounding the transmission lines causes the spark between the conductor and the insulation. The insulator loses the insulating property due to flashover. C. Effects of electrical faults Over-current flow: when electrical faults occur in the system, the low impedance path is results to flow of the fault current. A high amount of the current is drawing from the power supply causes tripping of the relay, damaging the electrical equipment. Danger to operating personnel: occurrence of electrical faults may cause shocks to the individual. The probability of the shock is depending upon the amount of the currents and voltages at the fault point and even may leads to death. Equipment loss: due to high amount of current flow in the line during the faults, the components of the electrical systems may burn which results in the loss of the electrical equipment. Sometimes fire also produces which completely burnt the devices.

## II. Need of Project

When different types of fault occurs in power system then in the process of transmission line fault analysis, determination of bus voltage and the rms line current are possible. While consulting with the power system the terms bus voltage and rms current of line are very important. In case of three phase power system mainly two faults occurs, three phase balance fault and unbalance fault on transmission line of power system, such as line to ground fault, double line to ground fault and double line fault. The transmission line fault analysis helps to select and develop a better for protection purpose. For the protection of transmission line we place the circuit breakers and its rating is depends on triple line fault.

## III. Objectives

Project has bellow design objectives that should be satisfied at the end of the project.

- Understanding the design and analysis of fault current levels under different kind of symmetrical and unsymmetrical faults.
- Based on fault current level design of reactors and circuit breaker trip circuit is an important part of this project.
- Analysis of power transfer efficiency and voltage regulation of line for performance analysis should also be done in this project.

## IV. Literature Survey

Introduction Electric power is generated, transmitted and distributed by large interconnected power systems[1]. Any power system can be analyzed by calculating the system voltages and currents under normal & abnormal scenarios. The fault currents caused by short circuits may be several orders of magnitude larger than the normal operating currents and are determined by the system impedance between the generator voltages and the fault, under the worst scenario if the fault persists, it may lead to long-term power loss, blackouts and permanently damage to the equipment. To prevent such an undesirable situation, the temporary isolation of the fault from the whole system it is necessary as soon as possible. This is accomplished by the protective relaying system.

To complete this task successfully, fault analysis has to be conducted in every location assuming several fault conditions. The goal is to determine the optimum protection scheme by determining the fault currents & voltages. In reality, power system can consist of thousands of buses which complicate the task of calculating these parameters without the use of computer software's such as Matlab. In 1956, L.W. Comber and D. G. Lewis proposed the first fault analysis program. Many exiting texts offer an extensive analysis in fault studies and calculation. Two worth mentioning are Analysis of Faulted Power System by Paul Anderson and Electrical Power Transmission System Engineering Analysis and Design by Turan Gonen[2]. In addition to offer a very illustrative and clear analysis in the fault studies, they also offer an impressive guideline for the power systems analysis understanding in general.

Method of analysis in order to analyze any unbalanced power system, C.L. Fortescue introduced a method called symmetrical components in 1918 to solve such system using a balanced representation. This method[3] is considered the base of all traditional fault analysis approaches of solving unbalanced power systems. The theory suggests that any unbalanced system can be represented by a number of balanced systems equal to the number of its phasors. The balanced systems representations are called symmetrical components. 2.3 Review of Fault In an electric power system, a fault is unusual electric current. A short circuit is also considered as a fault in which current bypasses the normal load. An open-circuit fault occurs if a circuit is interrupted by some failure. In three-phase systems, a fault may involve one or more phases and ground, or may occur only between phases. In a "ground fault" or "earth fault", charge flows into the earth. The prospective short circuit current of a fault can be calculated for power systems. In power systems, protective devices detect fault conditions and operate circuit breakers and other devices to limit the loss of service due to a failure.

## V. Block Diagram

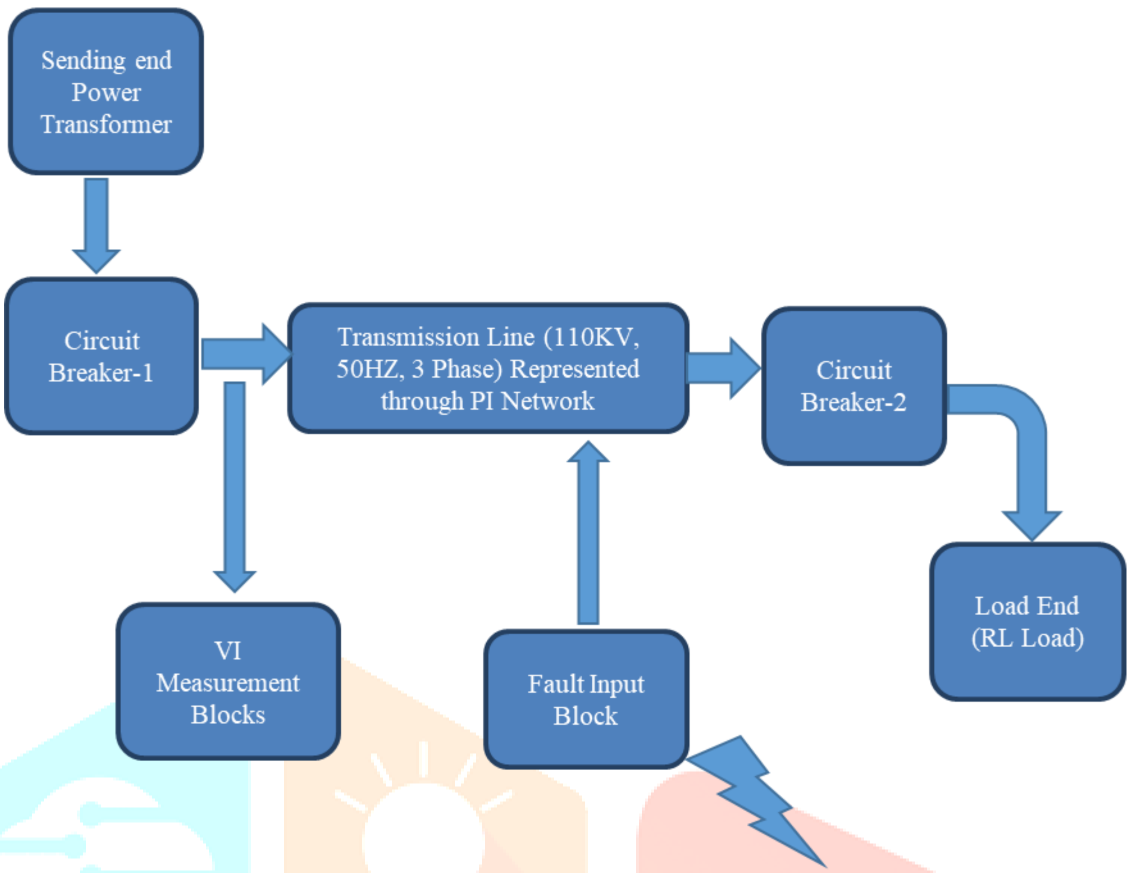


Figure 1: System Block Diagram

## VI. Circuit Diagram

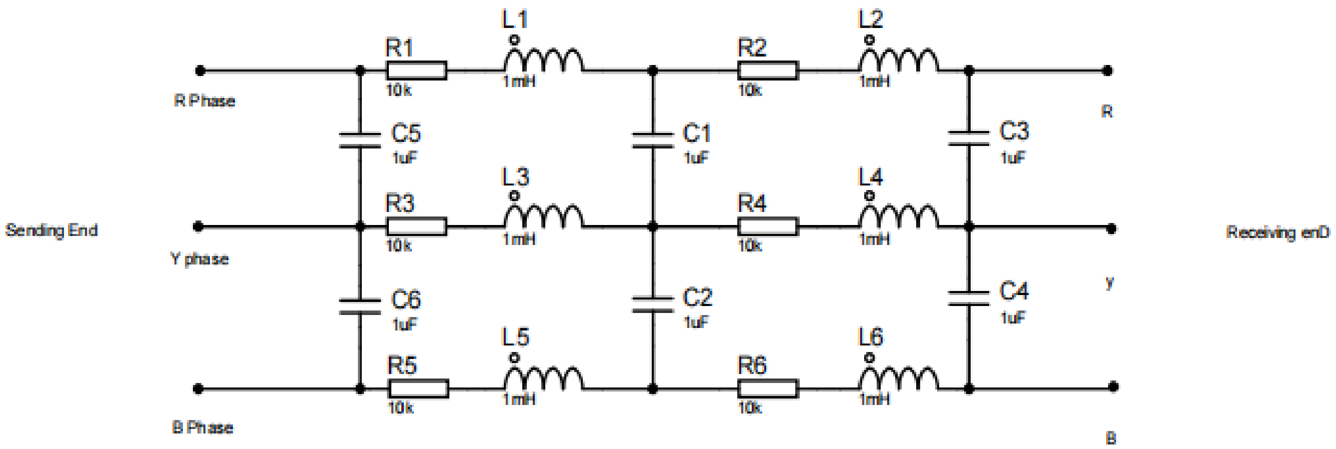


Figure 2: Connection Diagram

## VII. Calculation

Calculation of selected parameters for project .
System voltage rating = 110KV, 3 Ph
System frequency = 50HZ
System power rating = 5MVA
Line current = Power / Line voltage
= 5MVA/110KV
= 45.45 Amps = Phase current (3ph, 3 wire line)
Apparent power: S = 5MVA
Active power: P = V*I*Cos(Ø)
consider power factor = 0.85

Active Power = 5e6 * 0.85

= 4.25e6 MW

Reactive power: Q =V x I sin(Ø)

phase angle = Cos-1(0.85)

= 31.78 degrees

Sin (Ø) = Sin (31.78)

= 0.5267

Reactive power =5e6* Sin (Ø)

= 2.633 MVAR

**VIII. RESULT:**

6.1 Three Phase To Ground Fault Now simulation and modeling on three phases to ground fault occurs their three phases is short to the ground. When the magnitude of the faults current line are higher than the normal input current and the voltage are change on the magnitude is zero and the fault the impedance is not necessary zero and output waveform shows the gradually rise of current where three phases to ground fault occur on transmission line. Figure: 6.1 three phase fault current & voltage waveform © Daffodil International University 36 In this actual case, the Distribution system model is runs for a Three Phase to Ground Fault. The simulation is done for 0.05 sec, so that the waveforms can be seen more clearly. The sampling frequency is taken to be 50 Hz. The system voltage is taken as 11 kV and the line length is taken as 300 kms, with fault occurring at 150 kms. Fault is started at 0.3 secs. These parameters have been kept constant for other test cases as well. Indicates the current and voltage waveforms for the given specifications. Upon injecting these signals to the relay it has been seen that the relay trips after 45 ms and the status of its coil is shown in the simulated results. As this is a self-reset relay, the trip status comes back to 0 upon clearing the fault, but for a manual reset relay, it stays 1 till the reset button is pressed manually. The proposed matlab model can be ran standalone or on the GUI to view the plots.

6.2 Double Line to Ground Fault Now simulation and modeling on double line to ground fault occurs their two phases is short to the ground. When the magnitude of the faults current line are higher than the normal input current and the voltage are change on the magnitude is zero and the fault the impedance is not necessary zero and output waveform shows the gradually rise of current where 2L-G fault occur on transmission line. Figure: 6.2 Double Line to Ground Fault current & voltage Waveform from scope © Daffodil International University 37 In this actual case, the Distribution system model is runs for a line-line and ground Fault. The simulation is done for 0.05 sec, so that the waveforms can be seen more clearly. The sampling frequency is taken to be 50 Hz. The system voltage is taken as 11 kV and the line length is taken as 300 kms, with fault occurring at 150 kms. Fault is started at 0.3 secs. There are indicates the current and voltage waveforms for the given specifications. Upon injecting these signals to the relay it has been seen that the relay trips after 45 ms and the status of its coil is shown in the simulated results. As this is a self-reset relay, the trip status comes back to 0 upon clearing the fault, but for a manual reset relay, it stays 1 till the reset button is pressed manually. The proposed matlab model can be ran standalone or on the GUI to view the plots. 6.3 Line to Ground FAULT Here I have simulation and modeling on L-G fault occurs their one phase is short to the ground and the fault the impedance is not zero. When their output waveform shows the rise of current on L-G fault occurs on transmission line. Figure:

6.3 L-G fault Matlab current & voltage Waveform In this actual case, the Distribution system model is runs for a Line to ground Fault. The simulation is done for 0.05 sec, so that the waveforms can be seen more clearly. The sampling frequency is taken to be 50 Hz. The system voltage is taken as 11kV and the line length is taken as 300 kms, with fault occurring at 150 kms. Fault is © Daffodil International University 38 started at 0.3. These parameters have been kept constant for other test cases as well. There are indicates the current and voltage waveforms for the given specifications. Upon injecting these signals to the relay it has been seen that the relay trips after 45 ms and the status of its coil is shown in the simulated results. As this is a self-reset relay, the trip status comes back to 0 upon clearing the fault, but for a manual reset relay, it stays 1 till the reset button is pressed manually. The proposed matlab model can be ran standalone or on the GUI to view the plots.

6.4 Three Phase To Ground Fault with Transformer Now simulation and modeling on three phases to ground fault occurs their three phases is short to the ground. When the magnitude of the faults current line are higher than the normal input current and the voltage are change on the magnitude is zero and the fault the impedance is not necessary zero and output waveform shows the gradually rise of current where three phases to ground fault occur on transmission line. I see the same occurs in the transmission lines connected to transformer and with to transformer. Figure: 6.4 Three phase to ground fault © Daffodil International University 39 In this actual case, the Distribution system model is runs for a three phase to ground fault. The simulation is done for 0.05 sec, so that the waveforms can be seen more clearly. The sampling frequency is taken to be 50 Hz. The system voltage is taken as 11kV and the line length is taken as 300 kms, with fault occurring at 150 kms.

Fault is started at 0.3. These parameters have been kept constant for other test cases as well. There are indicates the current and voltage waveforms for the given specifications. Upon injecting these signals to the relay it has been seen that the relay trips after 45 ms and the status of its coil is shown in the simulated results. As this is a self-reset relay, the trip status comes back to 0 upon clearing the fault, but for a manual reset relay, it stays 1 till the reset button is pressed manually. The proposed matlab model can be ran standalone or on the GUI to view the plots.

6.5 Double Line To Ground Fault Now simulation and modeling on double line to ground fault occurs their two phases is short to the ground. When the magnitude of the faults current line are higher than the normal input current and the voltage are not change on magnitude and the fault the impedance is not necessary zero and output waveform shows the gradually rise of current where

2L-G fault occur on transmission line. I see the same occurs in the transmission lines connected to transformer and with to transformer. © Daffodil International University 40 Figure: 6.5 Line-Line-ground Fault In this actual case, the Distribution system model is runs for a Line-Line-ground Fault. The simulation is done for 0.05 sec, so that the waveforms can be seen more clearly. The sampling frequency is taken to be 50 Hz. The system voltage is taken as 11kV and the line length is taken as 300 kms, with fault occurring at 150 kms. Fault is started at 0.3. These parameters have been kept constant for other test cases as well. There are indicates the current and voltage waveforms for the given specifications. Upon injecting these signals to the relay it has been seen that the relay trips after 45 ms and the status of its coil is shown in the simulated results.

As this is a self-reset relay, the trip status comes back to 0 upon clearing the fault, but for a manual reset relay, it stays 1 till the reset button is pressed manually. The proposed matlab model can be ran standalone or on the GUI to view the plots. 6.6 L-G FAUL Here I have simulation and modeling on L-G fault occurs their one phase is short to the ground and the fault the impedance is not zero. When their output waveform shows the rise of current on L-G fault occurs on transmission line. I see the same occurs in the transmission lines connected to transformer and without to transformer. © Daffodil International University 41 Figure: 6.6 L-G FAULT In this actual case, the Distribution system model is runs for a L-G FAULT. The simulation is done for 0.05 sec, so that the waveforms can be seen more clearly. The sampling frequency is taken to be 50 Hz.

The system voltage is taken as 11kV and the line length is taken as 300 kms, with fault occurring at 150 kms. Fault is started at 0.3. These parameters have been kept constant for other test cases as well. There are indicates the current and voltage waveforms for the given specifications. Upon injecting these signals to the relay it has been seen that the relay trips after 45 ms and the status of its coil is shown in the simulated results. As this is a self-reset relay, the trip status comes back to 0 upon clearing the fault, but for a manual reset relay, it stays 1 till the reset button is pressed manually. The proposed matlab model can be ran standalone or on the GUI to view the plots

## IX. Conclusion & Future scope

The simulation and analysis of three phase fault to achieve results of the transmission line parameter is convenient by using MATLAB software. In this paper simulation of three phase transmission line fault analysis system is proposed. Single Line to Ground fault, Double Line fault etc in transmission line is also simulated. This system opens the way to redesign the bus system of the power system according to its results. The proposed work can able to implement for a larger power system geographically apart.

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