



## Online monitoring of Transmission Line Using MATLAB

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**ABSTRACT:** *Continuous online monitoring of transmission line is required for proper functioning of power system. This paper presents two simulink model one for single transmission line, singly fed and the other for parallel transmission line doubly fed and presents the simulation result which shows the continuous variation in transmission line impedance before, during and after the fault. Power system fault identification using information conveyed by the wavelet analysis of power system transients is proposed for detecting types of transmission line faults. The work presented in this paper is focused on identification of simple power system faults. Discrete Wavelet Transform (DWT) analysis of the transient disturbance caused as a result of occurrence faults is performed. The maximum detail coefficient, energy of the signal and the ratio of energy change of each type of simple simulated fault are characteristic in nature and used for distinguishing fault types. Electromagnetic transients in power systems result from a variety of disturbances on transmission lines, such as faults, are extremely important.*

**Keywords:** *Distance protection, Mutual coupling effect, R-X plot, Series compensation, Type of faults.*

### I. INTRODUCTION

Recently, the electricity demand density has increased rapidly in metropolitan areas. All over the world, large scale underground power cable installations start to replace overhead transmission lines due to environmental concerns in densely populated areas. To operate combined transmission lines (lines consisting of overhead and underground cable portions) with high accuracy and efficiency, many related technologies are required. Today's protection algorithms are based on the properties of overhead lines which may differ considerable from those of underground cables. Since zero impedance changes with the complexity of the underground cable (location of joint boxes, groundings, crossholdings, fault location algorithm developed for overhead lines only cannot be used directly for underground cables. Therefore, a rise of accuracy in terms of fault section discrimination and fault location in combined transmission lines is more and more requested from the utilities. However, studies dealing with fault location for combined transmission lines are rarely reported except few papers using the traveling wave method for the calculation of the underground cable impedance. There are many fault location methods for transmission lines in solidly grounded system. Some of them have been proven to be successful in locating fault during system operation. In non-directly grounded industrial systems, such

as 35 kV and lower, not much research has been carried out on fault location methods except some line-selection devices. The main objective of fault studies is the calculation of fault currents and voltages in order to determine Circuit Breaker (CB) capacity and protective relay performance. So, it is widely used both at the planning stage to select the right equipment and set up the protection system, and, later, at the operational stage to examine reinforcement schemes and switching arrangements, to update the protection settings according to the most current system conditions, and, also, to study incidents involving suspect operation of protective gear or sequences of circuit breaker tripping. There are many fault location methods for transmission lines in solidly grounded system. Some of them have been proven to be successful in locating fault during system operation. In non-directly grounded industrial systems, such as 35 kV and lower, not much research has been carried out on fault location methods except some line-selection devices. In the non-directly grounded current is not directly related with the position of the fault point. Location of faults on transmission lines has long been one of the primary concerns in modern extra-high-voltage power systems necessitating high-speed fault clearance as well as improved transient stability. Particularly for sustained faults, accurate location of the fault results in faster maintenance and restoration of power supply. Methods of locating power system faults can be broadly classified into two categories, one based on the power frequency components and the other utilizing the high frequency contents of the transient fault signals.

## II. POWER TRANSMISSION LINE

### 2.1 Single Transmission Lines Equipped with Series Compensation

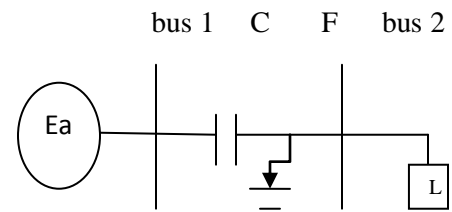


Fig.1 Single Transmission Lines Equipped with Series Compensation Capacitors

Series compensation is used to meet maximum power demand and to improve stability limit of power. In order to meet the high demand for power transmission capacity series capacitors are installed on power transmission lines. This allows the impedance of the line to be lowered, thus yielding increased transmission capability. The series capacitor makes sense because it's simple and it can provide the benefits of increased system stability, reduced system losses, and better voltage regulation. Protective distance relays, which make use of impedance measurements in order to determine the presence and location of faults, are "fooled" by installed series capacitance on the line when the presence or absence of the capacitor in the fault circuit is not known a priori. This is because the capacitance cancels or compensates some of the inductance of the line and therefore the relay may perceive a fault to be in its first zone when the fault is actually in the second or third zone of protection.

### 2.2 Transmission Line Faults

In transmission lines with a three-phase power source, there are ten types of faults that can occur. The faults in the order of decreasing frequency of occurrence are: three single-phase-

to ground faults (1LGs), three phase-to-phase faults (2Ls), three double-phase-to-ground faults (2LGs), and a three-phase fault (3Ls). Single line to ground faults (1LG) occur when one of the phases is shortened to the ground. During the fault the impedance,  $Z_{fag}$ , is not necessarily zero (bolted) but it might have a non-zero impedance but still much smaller than the line impedance. The magnitude of current in a faulty line rises significantly higher than the normal operative current while the voltage does not go through significant change in magnitude.

### 2.3 Protective Relays

There are three types of relays:

2.3.1 Electromechanical relays: The first relay developed used electrical and mechanical devices or a combination of both to switch the breaker.

2.3.2 Solid-state relays: Solid state relays use semiconductors and ICs to operate. It is a migration to electronic relays, which gives advantages such as smaller size, more accurate, and is easier to change the characteristics of the relay.

2.3.3 Digital relays: Digital relays use processor to do numerical analysis on the digitised data. Digital relays are modular and can be integrated with other protection functions

## III. ANALYSIS OF SINGLE TRANSMISSION LINE

Analysis of single transmission line:

3.1 under normal condition

3.1.1 without considering any effect

3.1.2 considering capacitive series compensation effect

3.2 Single phase to ground fault

3.2.1 without considering any effect

3.2.2 considering capacitive series compensation effect

3.3 Three phase to ground fault

3.3.1 without considering any effect

3.3.2 considering capacitive series compensation effect

## IV. ANALYSIS OF PARALLEL TRANSMISSION LINE

4.1 under normal condition

4.1.1 without considering any effect

4.1.2 considering mutual coupling effect

4.1.3 considering capacitive series compensation effect

4.1.4 considering mutual coupling and capacitive series compensation effect together.

4.2 single phase to ground fault

4.2.1 without considering any effect

4.2.2 considering mutual coupling effect

4.2.3 considering capacitive series compensation effect

4.2.4 considering mutual coupling and capacitive series compensation effect together

4.3 under three phase to ground fault condition

4.3.1 without considering any effect

4.3.2 considering mutual coupling effect

4.3.3 considering capacitive series compensation effect

4.3.4 considering mutual coupling and capacitive series compensation effect together

## V. CONCLUSION

Impedance seen by relay will depend upon the type of fault and also upon the factors like pre fault system condition, ground fault resistance, series compensation effect, mutual coupling effect (in case of parallel transmission line) etc. and none of the above factor can be ignored while designing an efficient relay. The experiment presented can monitor the transmission line under normal and fault conditions for both single and parallel transmission line. It can be conclude that there is effect of series compensation on single transmission line which may affect the reach accuracy of a relay and mutual coupling effect in case of parallel transmission line.

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