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SIMULATION OF DIFFERNTIAL PROTECTION FOR THREE PHASE TRANSMISION LINE

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ABSTRACT: Protection of electrical power systems is the major issue in power industry and for the protection of these electric power systems, current differential relays are widely applied due to their inherent simplicity, excellent sensitivity on internal faults and high stability on external faults. This paper deals with investigation of novel fault detection for the protection of transmission line. These schemes are mainly the charge comparison that are based on composition of modal voltage and current measurements at both ends ties that are partially or fully independent on current phasor and that employed the wavelet techniques. Conceptually the difference of the average quantities for phase active power entering and leaving the lines are compared Computation of these quantities is carried out via simulating a tie line connecting two power system networks using MATLAB. Two main concepts are observed which deal with the issue of phasor synchronization for line differential protection.

I. INTRODUCTION

Protection of electrical power systems is the major issue in power industry and for the protection of these electric power systems, current differential relays are widely applied due to their inherent simplicity, excellent sensitivity on internal faults and high stability on external faults. But this concept faced many problems such as problems of sampling misalignment and communication delay arising due to the distance between the line ends, which make accurate current comparison difficult to achieve. This problem arises due to phasor synchronization, time delay of the data communication channel, line capacitive charging currents, errors in current transformers (CTs) and protection system.

A different prospective is again applied in which current differential protection has been reported, which is based on composition of modal voltage and current measurements at both ends. Though this approach provides improvement to the relay sensitivity, the data at both ends are unsynchronized. Efficient application of this concept particularly with the current differential scheme reveals several problems, which postponed the expansion of this scheme in the field. Two main concepts are observed which deal with the issue of phasor synchronization for line differential protection. The first concept deals with the application of a global positioning system (GPS) satellite to measure phasor quantities with higher precision[7],[8]. The second concept dealt with is the development of new algorithms operated on quantities that are fully or partially independent on current phasors. Schemes based on the second approach are more practical as the GPS is a sophisticated system and may suffer interruption, which is not under the control of the power system protection engineer. These schemes are mainly the charge comparison that are based on composition of modal voltage and current measurements at both ends ties that are partially or fully independent on current phasor and that employed the wavelet techniques [5].

Amongst all the charge comparison schemes it seems to be the most practical one, as it is inherently immune to the sampling misalignment. However, it depends totally on the current zero crossings, which may cause a slow response under some fault conditions. In sympathy with these methods, a novel power differential concept has been recently proposed [1]. This concept is based on computing the active power margins during normal operation, internal and external faults. From these margins, discrimination of internal faults can be achieved. In this paper, investigation of a novel Power Differential Protection (PDP) technique for transmission line protection is used. Conceptually the difference of the average quantities for phase active power entering and leaving the lines is compared. Sensitive detection for high impedance internal faults and avoiding mal operation for external fault conditions is verified. Response of the active power fault detector is computed for internal and external fault for a wide range of fault resistance and different line lengths. Fig. 1.1 below shows the block diagram of transmission line system which includes source, load, circuit breakers, transmission line and the protective algorithm for protection of transmission line.

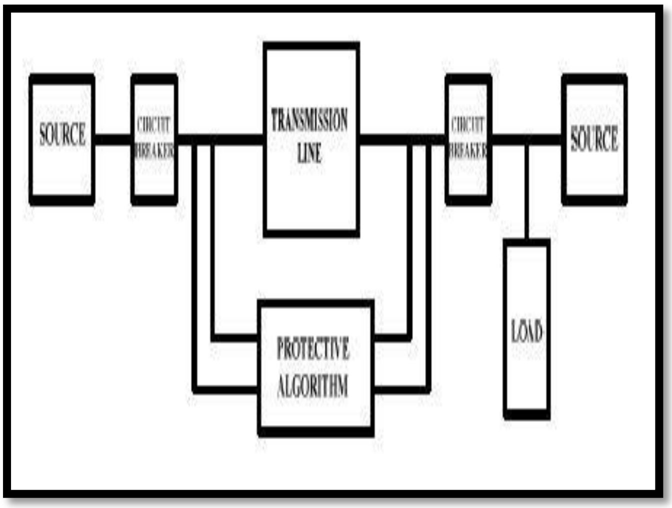

Fig.1.1.Block Diagram of transmission line system.

II. PROBLEM STATEMENT

Transmission lines are situated in wide area these lines unfortunately struck with severe geographical as well as atmospheric conditions; due to this several faults took place. EHV lines are the very most important aspect in power transportation and to keep healthy operation continuously becomes very crucial task for maintaining system reliability. That is why prevention of transmission system is necessary in modern power system. Due to the occurrence of more than 80% of disturbances or short-circuit faults in an overhead line, this section has become the most vulnerable part of the electrical system. Therefore, it is necessary having designed a power system protection include speed, selectivity, sensitivity, security, dependability and reliability to protect against disturbances.

Protection of electrical power systems is the major issue in power industry and for the protection of these electric power systems, current differential relays are widely applied due to their inherent simplicity, excellent sensitivity on internal faults and high stability on external faults. This paper deals with investigation of novel fault detection for the protection of transmission line. Conceptually the difference of the average quantities for phase active power entering and leaving the lines are compared Computation of these quantities is carried out via simulating a tie line connecting two power system networks using MATLAB. Two main concepts are observed which deal with the issue of phasor synchronization for line differential protection. The first concept deals with the application of a global positioning system (GPS) satellite to measure phasor quantities with higher precision. The second concept dealt with is the development of new algorithms operated on quantities that are fully or partially independent on current phasors. These schemes are mainly the charge comparison that are based on composition of modal voltage and current measurements at both ends ties that are partially or fully independent on current phasor and that employed the wavelet techniques. Amongst all the charge comparison schemes it seems to be the most practical one, as it is inherently immune to the sampling misalignment. However, it depends totally on the current zero crossings, which may cause a slow response under some fault conditions.

In sympathy with these methods, a novel power differential concept has been recently proposed. The sensitivity of the proposed detector for internal fault and stability for external fault are observed for wide range of fault resistance. The purpose of an electrical power system is to generate and supply electrical energy to consumers. The system should be designed and managed to deliver this energy to the utilization points with both reliability and economy. Severe disruption to the normal routine of modern society is likely if power outages are frequent or prolonged, placing an increasing emphasis on reliability and security of supply. As the requirements of reliability and economy are largely opposed, power system design is inevitably a compromise.

Many items of equipment are very expensive, and so the complete power system represents a very large capital investment. To maximize the return on this outlay, the system must be utilized as much as possible within the applicable constraints of security and reliability of supply. More fundamental, however, is that the power system should operate in a safe manner at all times. No matter how well designed, faults will always occur on a power system, and these faults may represent a risk to life and/or property. The destructive power of a fault arc carrying a high current is very great; it can burn through copper conductors or weld together core laminations in a transformer or machine in a very short time – some tens or hundreds of milliseconds. This is the measure of the importance of protection systems as applied in power system practice and of the responsibility vested in the Protection Engineer. The provision of adequate protection to detect and disconnect elements of the power system in the event of fault is therefore an integral part of power system design. Only by so doing can the objectives of the power system be met and the investment protected [1]. Differential protection is based on the fact that any fault within an electrical equipment would cause the current entering it, to be different, from that leaving it. Thus, we can compare the two currents either in magnitude or in phase or both and issue a trip output if the difference exceeds a predetermined set value. This method of detecting faults is very attractive when both ends of the apparatus are physically located near each other. A typical situation, where this is true, is in the case of a transformer, a generator or a bus bar. In the case of transmission lines, the ends are too far apart for conventional differential relaying to be directly applied. There is no tendency for the current to spill into the over-current relay. The over-current relay connected in the spill path is wired to trip the two circuit breakers on either side of the equipment being protected.

III. OBJECTIVE

- An accurate fault detection, classification and direction estimation of double end fed transmission lines using Differential protection method.
- The Matlab simulation is done using Differential protection techniques for this purpose and the simulation results also compared with other control techniques.

PROPOSED WORK

The probability of fault occurrence on the overhead lines is much more due to their greater lengths and exposure to atmospheric conditions. There are several methods available for the protection of transmission and distribution lines [69]. The first group of non unit type of protection includes time graded over current protection; current graded over current protection and distance protection. Such non unit type protections don't have pilots. The other group of protection of line includes pilot wire differential protection, carrier current protection based on phase comparison methods, etc. They fall in to the category of unit protection. In these schemes some electrical quantities at the two ends of the transmission line are compared and hence they require some sort of interconnection channel over which information can be transmitted, from one end to another. Such an interconnection channel is called as a pilot. In pilot wire differential protection a differential relay is used which responds to vector difference between two or more similar electrical quantities. This vector difference is achieved by suitable connection of current or voltage transformer secondary. Most of the differential relays in which vector difference between the current entering the winding and current leaving the winding is used for the relay operation. This differential protection is directionally secure and is simple to implement and set. Current differential protection using pilot wire is mainly applied for short transmission lines protection. Vector differences between the currents at both ends of transmission line are used for relay operation.

Single line diagram of the laboratory model is shown in Fig.4.1. It consists of two relays. The two relays make final decision based on signals sent in both directions through a wireless communication network

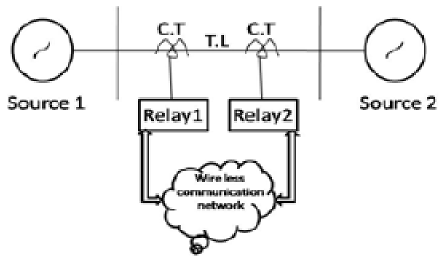

Fig.4.1. Single line diagram of differential protection

The structure of laboratory model for differential protection of short transmission line
is shown in Fig.4.2. It mainly consists of the following six different components.

- Power system model
- Sensing transformers
- Signal conditioning circuits
- Data conversion circuits
- Communication network
- Software required

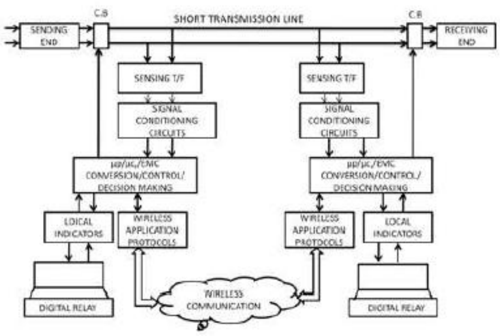

Fig.4.2. Laboratory model of the protection system

- In this paper, investigation of a novel Power Differential Protection (PDP) technique for transmission line protection is used.
- Conceptually the difference of the average quantities for phase active power entering and leaving the lines is compared.
- Sensitive detection for high impedance internal faults and avoiding mal operation for external fault conditions is verified.
- Response of the active power fault detector is computed for internal and external fault for a wide range of fault resistance and different line lengths.
- Fig. 1.1 shows the block diagram of transmission line system which includes source, load, circuit breakers, transmission line and the protective algorithm for protection of transmission line.
- Transmission lines are situated in wide area these lines unfortunately struck with severe geographical as well as atmospheric conditions; due to this several faults took place.
- EHV lines are the very most important aspect in power transportation and to keep healthy operation continuously becomes very crucial task for maintaining system reliability.
- That is why prevention of transmission system is necessary in modern power system. Due to the occurrence of more than 80% of disturbances or short-circuit faults in an overhead line, this section has become the most vulnerable part of the electrical system.
- Therefore, it is necessary having designed a power system protection include speed, selectivity, sensitivity, security, dependability and reliability to protect against disturbances.

IV. SIMULATION & RESULTS

Differential protection scheme

The probability of fault occurrence on the overhead lines is much more due to their greater lengths and exposure to atmospheric conditions. There are several methods available for the protection of transmission and distribution lines. The first group of non-unit type of protection includes time graded over current protection; current graded over current protection and distance protection. Such non unit type protections don't have pilots. The other group of protection of line includes pilot wire differential protection, carrier current protection based on phase comparison methods, etc. They fall in to the category of unit protection. In these schemes some electrical quantities at the two ends of the transmission line are compared and hence they require some sort of interconnection channel over which information can be transmitted, from one end to another. Such an interconnection channel is called as a pilot. In pilot wire differential protection a differential relay is used which responds to vector difference between two or more similar electrical quantities. This vector difference is achieved by suitable connection of current or voltage transformer secondary.

Most of the differential relays in which vector difference between the current entering the winding and current leaving the winding is used for the relay operation. This differential protection is directionally secure and is simple to implement and set. Current differential protection using pilot wire is mainly applied for short transmission lines protection. Vector differences between the currents at both ends of transmission line are used for relay operation [1]. Another type of differential protection uses balanced voltage principle across two ends of transmission line [1]. Pilot wire schemes are usually economical only for short distances with the restriction of voltage drop due to impedance of the wire, inaccurate system impedance and loss of relay function due to line disconnection. These in turn cause energy loss. The reliability of communication obviously impacts the reliability of the protection system. Pilot protection schemes may send analog values between the relays at each end of the line or they may use simple ON /OFF, permissive or blocking signals between relays. The advancement of this protection relaying allows high speed communication among protective relays called peer to peer communication [2].

There are many methods to send these signals. The most common methods currently in use are twisted pair cable, coaxial cable, fibre optic cable, power line communication and wireless communication. Wireless communication is the challenging media for the upcoming deregulated power system and smart grid applications [4]. A fibre optic pair available for exclusive use by the relays provides optimal performance for digital communications. Dedicated fibre gives a fast and error-free point-to-point connection. The main drawback is that a fibre cut will cause a channel interruption for long period of time. Many utilities lack expertise and equipment for replacing and splicing a damaged fibre cable. Of course, the installation and material costs for a dedicated fibre compared to conventional communication channels limits its availability for relaying.

To overcome the drawbacks of all conventional protection communication schemes and to maintain high reliability and reduction of energy loss, it is essential to use accurate communication medium like wireless communication protocol between the relays [3-5]. Now a day, there are many advanced robust communication techniques that can be used to improve protection, control, speed outage restoration, operation analysis, maintenance and planning. A laboratory investigation of transmission line protection using wireless RF communication is proposed in this chapter. It collects correct data from both ends of transmission line through intelligent electronic devices to communicate with each other and for relay decision. This method provides high degree of accuracy, reliability, energy efficient and cost effective.

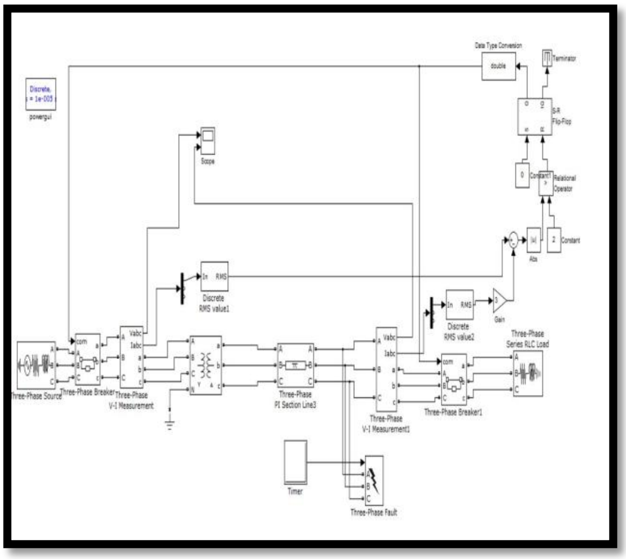

Fig Matlab Simulation of Differential protection for Transmission line

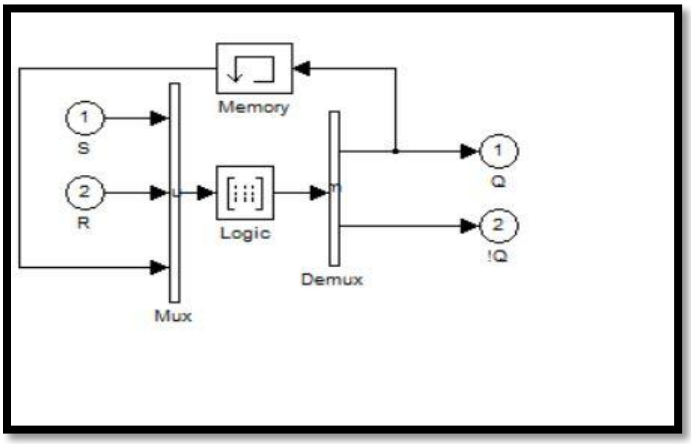

Fig S-R Flip Flop Control logic

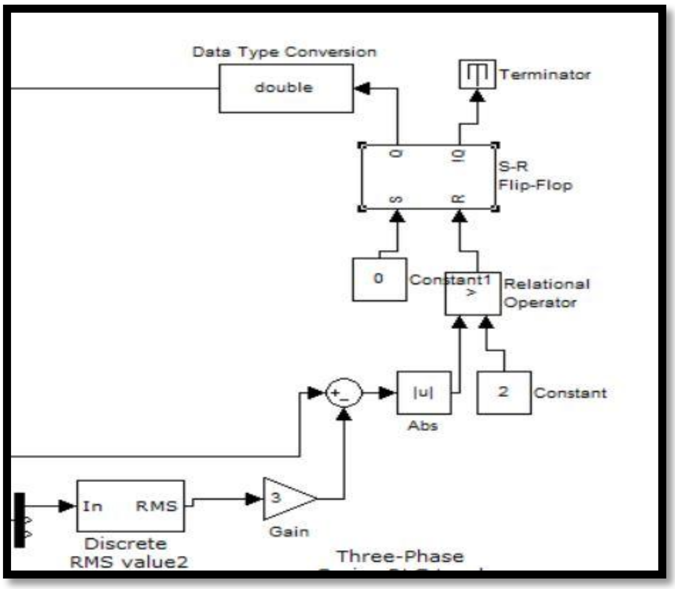

Fig Differential Protection scheme

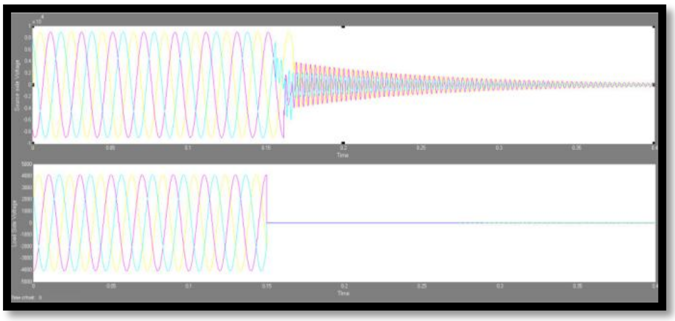

Fig LLL-G Fault Analysis using Differential protection

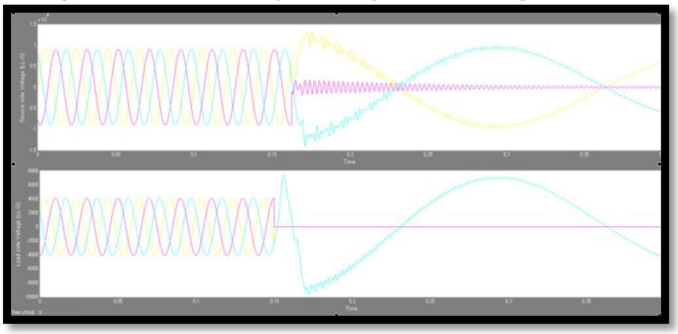

Fig LL-G Fault Analysis using Differential protection

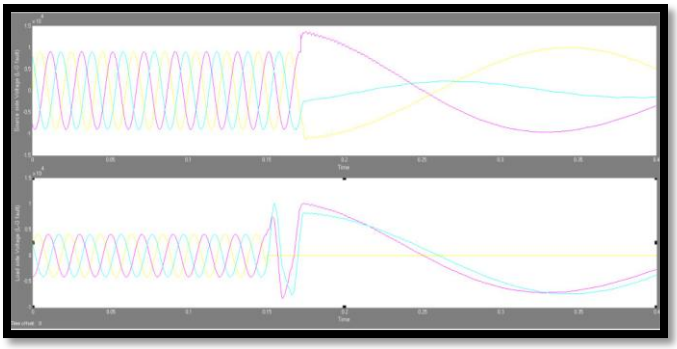

Fig L-G Fault Analysis using Differential protection

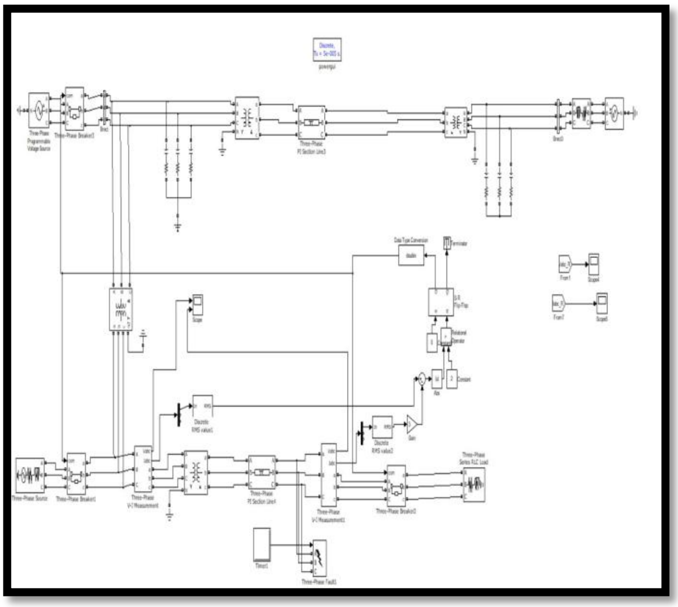

Fig Proposed system with Differential protection

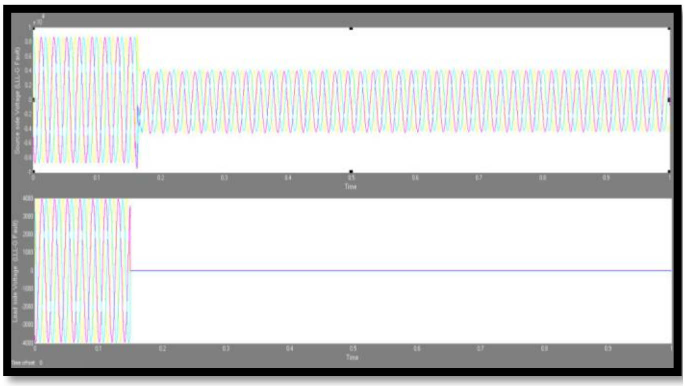

Fig LLL-G Fault Analysis using Differential protection

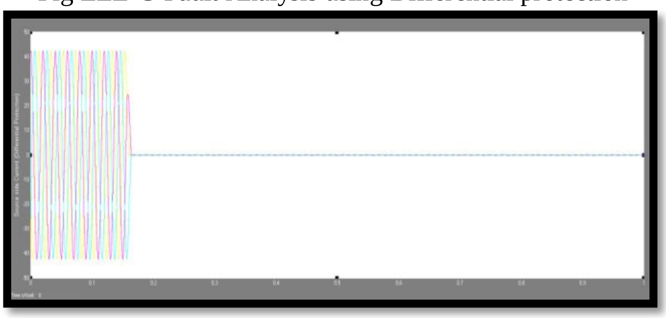

Fig Current control using Differential protection

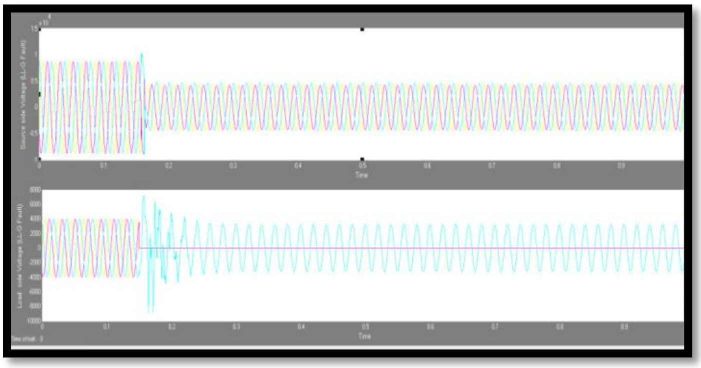

Fig LL-G Fault Analysis using Differential protection

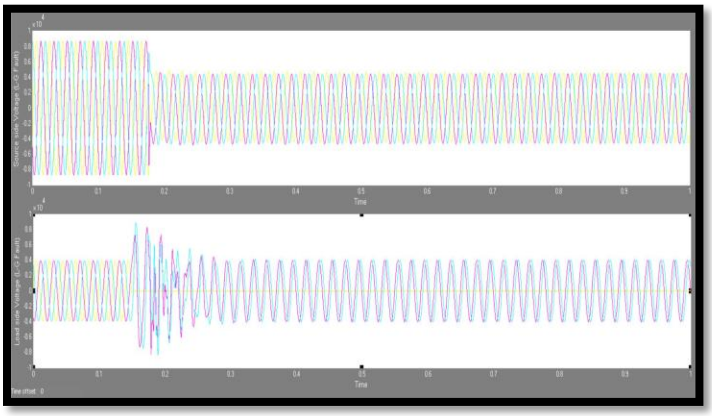

Fig L-G Fault Analysis using Differential protection

V. CONCLUSION

This paper with investigation of novel fault detection for the protection of transmission line. Conceptually the difference of the average quantities for phase active power entering and leaving the lines are compared Computation of these quantities is carried out via simulating a tie line connecting two power system networks using MATLAB. The sensitivity of the proposed detector for internal fault and stability for external fault are observed for wide range of fault resistance. The test result shows remarkable stability during external faults and also depicts distinguished performance of the proposed power differential concept in detecting internal faults. The Matlab simulation of Fault conditions and controlling with differential protection is successfully done using Matlab-Simulink for different case studies

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