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Study on Differential Protection of Transmission Line Using Wireless Communication

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ABSTRACT: Pilot wire differential protection is one of the most common methods for protecting short transmission lines. The conventional protection scheme has drawbacks, such as malfunction due to line disconnection and limited line length. The protection algorithm is based on current signals measured at both ends of the transmission line. The data is exchanged through the wireless communication network. The relay decision is based on data sharing obtained through wireless communication network. Current differential protection using pilot wire is applied widely on transmission lines as the main protection. Vector difference between the measured currents at the two ends of the transmission line is used for the operation of most current differential relays. The length of the line that can be protected by the pilot wire differential protection is limited by the effect of resistance and capacitance of the pilot wire. Here PIC 16F877A controls the entire system. The PIC compares the values of both the end of the transmission line with the help of Mikro C program. The instant value of voltage, current and frequency is measured and monitored with the help of an LCD arrangement which is connected to the port D of the microcontroller. The status of both the end is transferred with the help of a wireless communication through ZigBee. The systems consist of master and slave section and the master will control the relay in both the section. The relay arrangement which connected in the master station will trip the circuit whenever a fault occurs.

KEYWORDS: Differential protection, ZigBee module, Efficient Communication.

I.INTRODUCTION

Now a days there are several problems associated with electricity. The flashover of lightning and other faults in the transmission line leads to shortage of electricity. There are so many methods to overcome this problem and one such method is implemented in this paper. Differential protection can be done through pilot wires and also through wireless communication. Pilot wire differential protection is one of the most common methods for protecting short transmission lines. The main requirements of line protection is that in the case of a short circuit, the circuit breaker nearest to the fault should open, all other circuits remaining in a closed position. The conventional protection scheme has several drawbacks.

The differential protection is applied only with the help of pilot wires .These methods are already used in transformers, generators and bus bars since small length of pilot wires are required. The pilot wires are made up of aluminum and copper wires, but the cost is very high. The transmission line requires lengthy wires to follow the procedure so it is not economical. The resistance and capacitance effect may change the value of current and causes the continuous tripping of relay without any fault. These problems are eliminated by the arrival of a wireless media so we are not using any of the wired equipment. This paper eliminates the above problem and also the problems associated with pilot wire disconnection.

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There are many previous works carried out for the protection of transmission line. A brief description about the literatures that have been carried is given below.

K. M. Abdel-Latif et al [1] suggested a wireless communication network supported with Wi-Fi protocol for data handling. Pilot wire differential protection is one of the most common methods for protecting short transmission lines. The wireless communication network offers advantages over conventional techniques such as no pilot wire that can break, faster response, lower cost compared to leased lines. The protection algorithm is based on current signals measured at both ends of the transmission line. The data is exchanged through the wireless communication network and the relay decision is based on data sharing obtained through it. M. M. Eissa et al [2] introduced a new protection technique for short length transmission line using IEEE802.11 protocol. When relays communicate with each other, they can exchange information which help the relay to take an accurate decision. The suggested protection system collects currents data from both ends of transmission line through Intelligent Electronic Device (IED) and communicate with each other to share the data. X. R. Wang et al [3] suggested a system protection scheme to augment traditional backup relay methods in the transmission system. Agents are used to give each protection component its own thread of control as well as the ability to communicate with others. This leads to greater capabilities to self-check and self–correct. This method naturally points towards a new philosophy for backup protection. Simulations are used to illustrate the concepts, using a simulation engine that combines the EMTDC/PSCAD power simulator with the NS2 network communications simulator. I. Voloh et al [4] presents both problems and practical solutions for applying digital line current differential protection over copper wires. Digital current differential protection has the advantages of application simplicity, operation speed, and high sensitivity. Pilot wire analog differential relays are commonly used for protection of short lines. G. S. Hope et al [5] introduce an algorithm for transmission line protection based on one term of a Fourier series expansion to determine the fundamental component of the signals and phase impedance. The proposed algorithm has been implemented in real time using a minicomputer. Jingde Xia et al [6] proposes a kind of new Individual Phase Impedance (IPI) and a novel pilot protection scheme for transmission line based on the IPI. The IPI is calculated by the ratio of the voltage difference of fault superimposed component to the current difference of fault-superimposed component at both terminals of the protected line. The IPI has accurate mathematical expressions and reasonable physical definitions for various line models.

By going through all these papers we decided to do a project on differential protection using wireless communication. We use ZigBee module as the wireless communication device.

II.SYSTEM MODEL AND WORKING

Differential protective relaying is the most positive in selectivity and in action. It operates on the principle of comparison between the phase angle and magnitudes of two or more similar electrical quantities exceed a pre-determined amount. The two ends of a line may be many kilometres apart and for comparison of two currents, a costly pilot wire circuit is required. This expense may be justified but generally less costly protective schemes may be used. So here the differential protection is applied through wireless communication. Differential protection is generally unit protection. The protected zone is exactly determined by the location of CTs and PTs. Here the transmission line is connected with the master through the current transformer arrangement and this sense the value of current that appears in the line. The block diagram of the proposed method is shown in Fig.1.The system consists of 2 sections namely master section and slave section. Here both the relay is controlled by the master section while the slave section has no permission to trip the relay. Current from the two sides of the line are collected by the CT and is compared with the reference value inside the processor. The vectorial difference is checked. If the differential current is zero then the current flows through the transmission line else it will be cut by the relay. Thus the transmission line can be protected.

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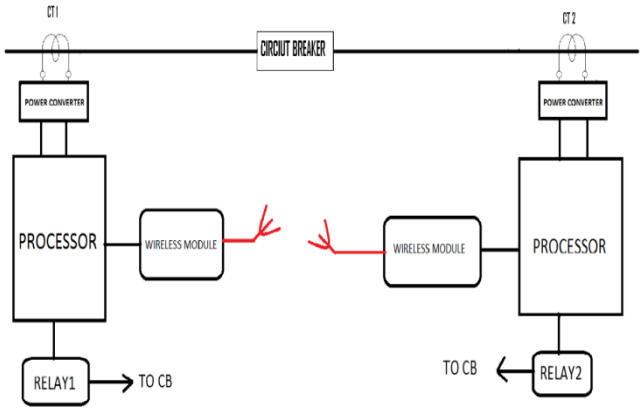

Fig.1: Basic Block Diagram

A pair of CTs is fitted on either end of the section to be protected. The current in CT1 (i.e. the CT in the master section) will be given to the PIC at the master section and similarly in the case of slave section. Normally when there is no fault the current in the two CTs secondaries are equal and the relay operating coil, therefore, does not carry any current since the vectorial difference of current considered to be flowing in the relay coil is zero. So that current flows continuously through the transmission line. When a short circuit develop anywhere between the two CTs the current flow at the secondaries of the CTs no longer remains the same. So whenever a fault occurs the differential current flowing through the relay coil is not zero and if the differential current exceeds the relay's pick-up value, the relay coil will be actuated. Therefore no current flows through the transmission line. Thus the transmission line can be protected.

SECTION1: MASTER

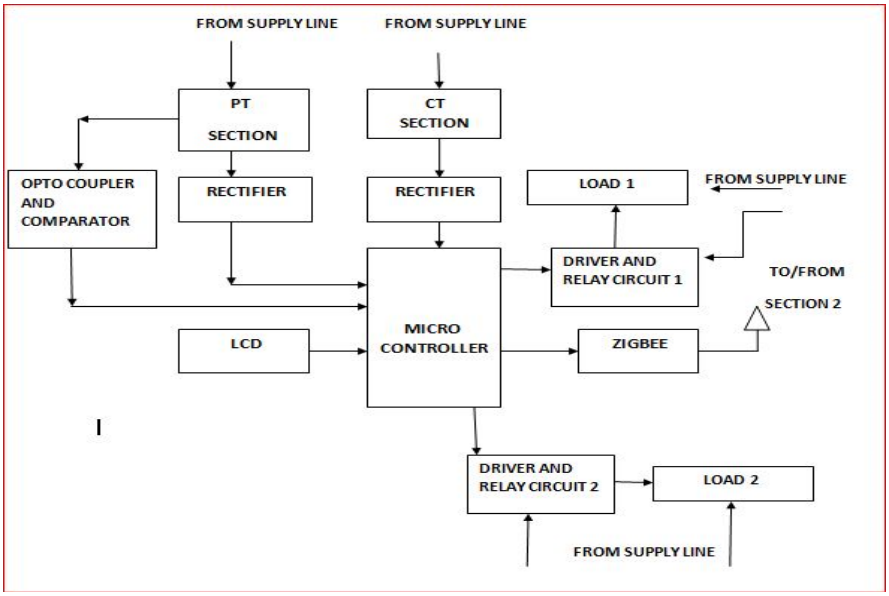

Fig.2: Block diagram of Master section

The block diagram shows the master section. Here the microcontroller used is the PIC 16F877A and all the other devices are connected with this. The transmission line is connected with the master with Current Transformer arrangement and this Current Transformer will sense the value of current that appears in the line. The Potential

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transformer is connected only to identify the value of voltage. The supply frequency measurement is done by using an optocoupler and a comparator circuit is also being used.

Both the relay is controlled by the master section and the slave has no permission to trip the relay. The master will trip the relay only on the basis of the change in the value of current which was measured by the current transformer. The change in parameter like voltage, current and the frequency is monitored by an LCD (16*2 alphanumeric). On both the side the data is exchanged with the help of a ZigBee wireless transmitting module.

SECTION2: SLAVE

In slave section the working is same as the master. The only difference is that the slave has no right to trip the relay and the duty is to transfer the signal or the value to master section. It is having the same component like the master and the only difference is that the relay present here does not trip the line. The voltage, current and the frequency is indicated with help of an LCD module.

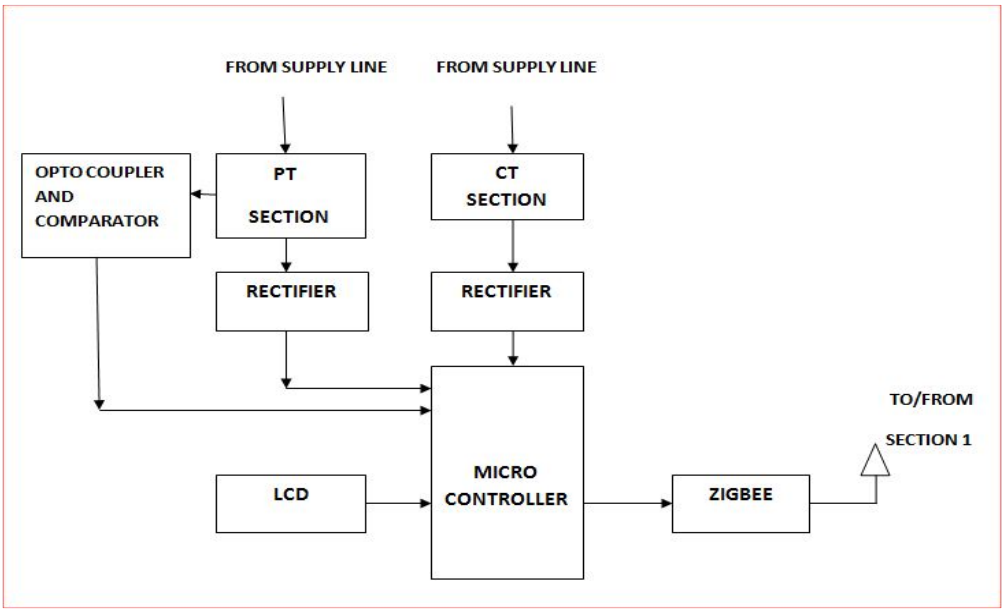

Fig.3:Block diagram of Slave section

III.EFFICIENT COMMUNICATION

Zigbee has some technical advantages over bluetooth, WiFi, infrared rays etc. Zigbee is a kind of low power consuming communication technology for coverage area surrounded by 200m, with a data rate ranging from 20Kbps to 250Kbps and is appropriate for use in home area networks, mainly for the remote control of electric home appliances. The efficiency is high due to wireless communication and with the help of processor accurate reading of current is obtained. ZigBee is a specification for a suite of high-level communication protocols used to create personal area networks built from small, low-power digital radios. ZigBee is based on an IEEE 802.15 standard. Though its low power consumption limits transmission distances to 10100 meters line-of-sight, depending on power output and environmental characteristics, ZigBee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. ZigBee is typically used in low data rate applications that require long battery life and secure networking (ZigBee networks are secured by 128 bit symmetric encryption keys.) ZigBee has a defined rate of 250kbit/s, best suited for intermittent data transmissions from a sensor or input device. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, other consumer and industrial equipment that requires short-range low-rate wireless data transfer.

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IV.CONCLUSION AND FUTURE SCOPE

The differential protection of transmission lines using wireless communication helps to protect the transmission lines from different faults such as overvoltage, lightning, short circuit etc. The proposed method eliminates the problems of the existing method such as pilot wire disconnection, resistance, capacitance effects and increase in cost. Thus in the existing method differential protection of the transmission line is used which enhances the safety level of all the electrical equipments. The values of current, voltage and frequency are displayed in the LCD modules. Here the wireless communication using ZigBee module helps to improve the efficiency of this method.

The proposed system is not only applicable for the short transmission lines but also applied in all levels of transmission line such as 11kv, 33kv and >33kv. Here we are using ZigBee as the wireless module which can be used only up to 1.5km and is possible to transmit the data between stations. Instead of this we can use GSM with GPS time synchronization for high level data transmission such as 10km and above. By this method we can find out the exact location or area where the problem arises with a small modification in the kit.

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