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Transmission line fault analysis using actuating relays and Atmega 328P controller

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ABSTRACT

Since transmission lines account for 80–86% of power system problems, protecting transmission lines is a critical concern. This research proposes a method to identify and categorize various short circuit defects on transmission lines. Various operational and fault circumstances on the transmission of high voltage lines, including L-L fault, single phase to earth fault, and double line fault, double line Three fault scenarios triple line fault, triple line to ground fault, and triple line are simulated using MATLAB software. These flaws damage the linked devices to the power grid. The main motto of this work is to analyze various kinds of faults and also to detect the type of the fault in transmission line. In order to simulate and evaluate the various faults, a 100 km transmission line model was created. A sim power system block library had a fault block, and the harmonic content of the various faults was studied using the FFT tool, the effect of faults was observed. Based on the analysis, a hardware model is designed to identify the faults in transmission line using actuating relays and Atmega 328P microcontroller and display the fault type and parameters like fault impedance, and distance at which fault occurred.

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1. INTRODUCTION

Transmission lines deliver large amounts of electricity at a high voltage to customers through distribution lines in order to minimize losses along the transmission line. Different faults and anomalies commonly occur in transmission lines. A fault in any power system network or circuit is any failure that interferes with the proper flow of electric current. This can be unexpected creation of conducting path, says short circuit fault and interruption to the flow of electric current says open-circuit fault [1], [2]. When fault current flows in a power system network, the short circuit electric current will become typically high say about six to ten times more than the proper or standard full load electric current in such power system circuit [2], [3]. Typical faults in an electric power system circuit is said to take place when conductors or any two transmission lines comes in contact with each other or earth, such includes; single line fault, single line to ground fault, double line fault, double line to ground fault, triple line fault, and triple line to ground fault [4]–[8]. These faults are also referred to as short circuit faults, which are common to transmission line. Heavy short-circuit currents must be prevented from flowing via the power transmission system, which by cutting off the malfunctioning part of the system, could compromise employee safety and damage large pieces of equipment permanently [9], [10]. The safe disconnection can be guaranteed if the current does not exceed the capacity of

the circuit protecting equipment. Professionally in such situation these abnormal current flows need to be mathematically evaluated and its obtained results compared with the ratings of the various protective device such as circuit breakers as a routine practice aim at enhancing preventive maintenance of the system [11]–[15]. Depending on the location, the nature, the time involved and as well as the system network condition grounding, short circuits can result to: i) Interference of electromagnetic discharge with conductors found within such vicinity; and ii) Thermal or mechanical stress (that is, damage effect on equipment, personnel danger).

Transmission line parameters include conductance, capacitance, inductance, and resistance. The performance of the electricity transmission line system is determined by these factors. The power loss in the line, the sending end voltage, the sending end currents, the sending end power factor, transmission line efficiency [16]–[19] and transmission, regulation and limit of power flow under steady-state and transient situations conditions are all considered to be aspects of performance [20]–[22]. A transmission line fault has an impact on the availability and continuity of operations of the power system. This is because when faults occur and it's not cleared immediately it causes power outages which may result in interruption of service. In addition, when fault is experienced or takes place, it endangers the life of personnel and equipment.

Triple line fault determines the circuit breaker's rating [23], [24]. The cause of triple line fault current is that significantly higher than other fault currents [25]. Thus, examination of transmission line faults may be done easily utilizing MATLAB simulation on a computer. Also based on the analysis result of various parameters (impedance, voltage, distance) from the hardware model are obtained. This research work is aimed at analyzing and detecting faults on a power system transmission line in order to recommend the proper selection of protective devices to enable utility companies to provide services to consumers with the required safety of personnel and equipment at an affordable cost.

2. METHOD

The Figure 1 explains the block diagram of transmission line fault detection using actuating relays and Atmega 328P microcontroller. The main components are Atmega 328P microcontroller, switching circuit, relays and LCD screen. The 3 phases R, Y, B are represented by connecting 3 single phase transformers (230/12 V) and the supply is rectified using bridge rectifier, voltage regulators (LM7805) and filter circuits for a constant 5 V supply to microcontroller and 4 channel relays. The switch circuit outputs are connected to Vcc and A0 pins of microcontroller and relay. The digital pins 2 to 5 and pins 11, 12 of microcontroller are connected to LCD display which displays the type and distance of fault.

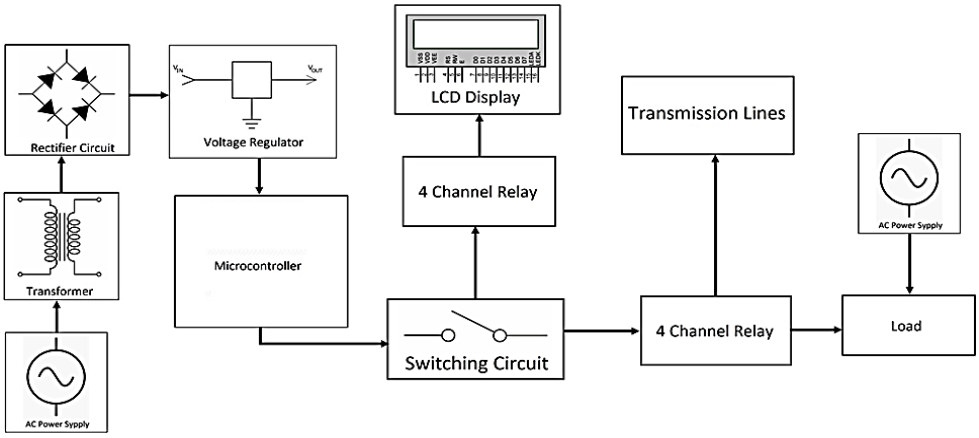

Figure 1. Transmission line fault analysis and detection block diagram

Load actuating relays are connected to microcontroller and bulbs for indication of voltage drop in the line. Switch circuit consists of analog switches separated with 1 Kohm resistance as representation of 2 km distance in transmission line. The project works as follows:

i) The single-phase supply is given to the circuit for the operation of loads.
ii) As no fault is created from switch circuit the LCD display shows no fault (NF) in every phase.
iii) The creation of fault is done by using switch circuit which resembles the three phases of transmission lines.
iv) When a fault is created from switch circuit by pressing the analog switch. The nominal value of resistance of respective line gets reduced. An analog signal is generated which is sensed by actuating relay.

v) As switch circuit is connected to microcontroller A0 which converts the analog input to digital output.
vi) The generated digital signal is processed and the fault created in respective phase is displayed in the LCD as illustrated in Figure 2. The hardware model of transmission line fault analysis and detection using actuating relays and Atmega 328P controller is shown in Figure 3.
vii) When the fault is created it resembles a short circuit fault hence there will be a reduction in voltage.
viii) The reduced voltage is observed from the load representation bulbs RYB.

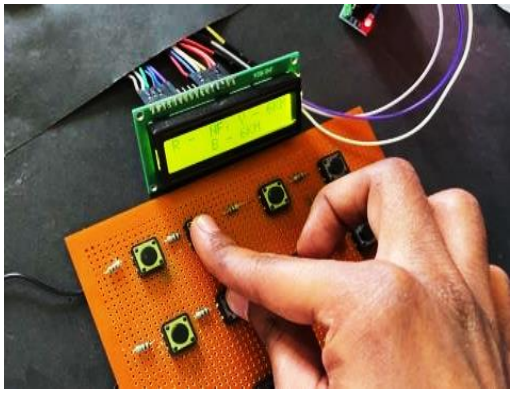

Figure 2. Prototype testing

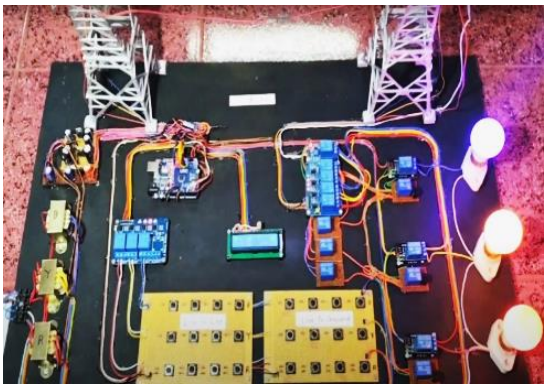

Figure 3. Hardware model of transmission line fault analysis and detection using actuating relays and Atmega 328P controller

3. RESULTS AND DISCUSSION

When fault is created in respective phase by switch circuit the set impedance is reduced and voltage will be dropped as illustrated in Table 1. Thus, the fault is sensed by actuating relay and sends signal to microcontroller to display the type of fault and distance where it occurred as illustrated in Figure 4. In the fault analysis by creating different faults from fault block the variation in three phase voltages and currents were observed. The respective phase voltages and currents for different types of faults are illustrated in Table 2. It can be inferred from the results that the problem occurred at about 0.01 seconds. According to the Vabc data, the voltage decreases to 0 at this particular moment, while the current in Iabc rises unexpectedly. The voltage and current become stable and stay stable after the period are identified at 0.15 s as illustrated in Figure 5.

Table 1. Fault analysis (detection model)

Fault impedance	Distance	Voltage	Current
Z = 2.33 Kohm	2 km	0.34 V	2.32 A
Z = 3.63 Kohm	4 km	0.24 V	2.16 A
Z = 3.42 Kohm	6 km	0.18 V	1.92 A
Z = 3.61 Kohm	8 km	0.12 V	1.63 A

Table 2. Fault analysis (Simulink model)

Type of Fault	Voltage (pu)			Current(pu)		
	Vr	Vy	Vb	Ir	Iy	Ib
LL	1.12	0.32	0.033	60.1	20.6	60.5
LG	1.36	1.3	0.012	60.2	60.3	20.4
LLLG	0.19	0.12	0.013	64.6	65.9	62.8

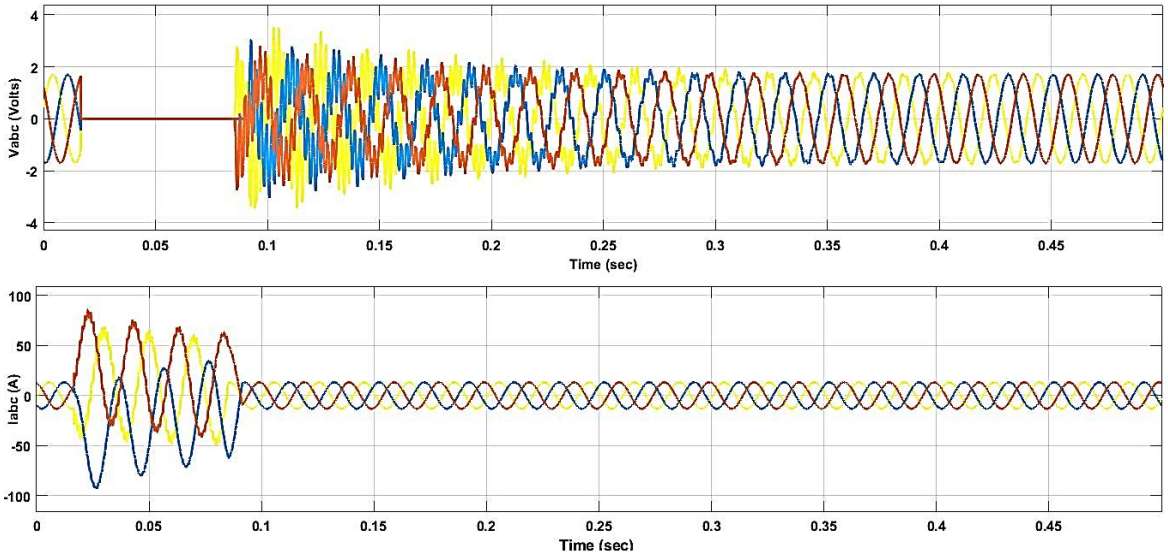

Figure 4. LLL fault

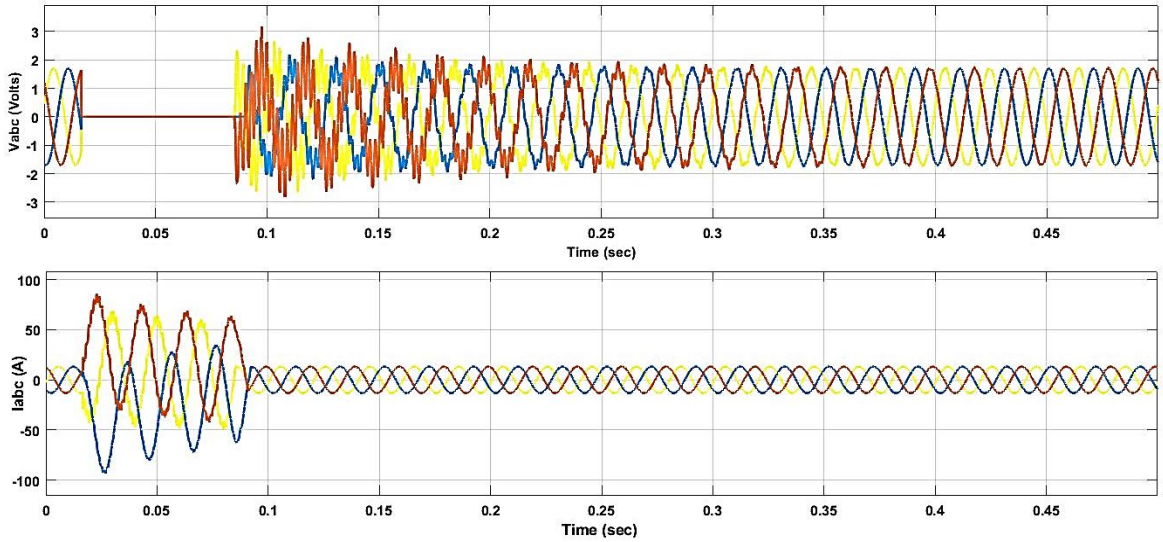

Figure 5. LLLG fault

4. CONCLUSION

Transmission lines transmit huge power from the generating station to consumers through distribution lines, it does this at high voltage to reduce losses along transmission line. But, when transmission line breakdowns happen, the delivery of power is interrupted. In this study, a system for finding transmission line defects is presented. The transmission line fault locator has undergone successful testing. This hardware variant is capable of pinpointing the precise site of a transmission line fault. This work can be expanded further by using IoT technology and GPS to know the type of fault and fault location in mobile devices.

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