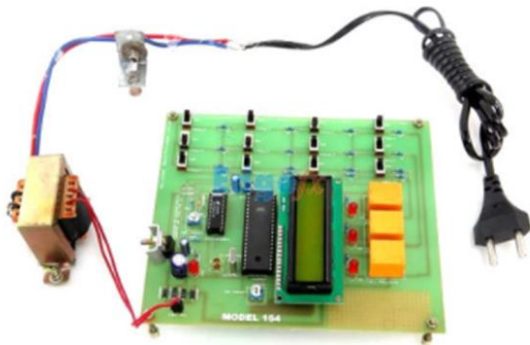


Underground Cable Fault Distance Locator

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Abstract- *This project suggests fault location model for underground power cable using microcontroller. The main concept of this project is to find the distance of underground cable fault from the base station in kilometers. In many urban areas, cable fault is a common problem. when a fault occurs due to some reasons, the process of fault tracking without knowing the location related to that particular cable is very difficult the proposed system is designed to track the exact location of the fault occurred in the cable. this project uses the ohm's law concept when a low voltage DC is applied to the feeder end through a series resistor, then the current would differ based on the location of fault occurred in the cable. in case is there any short circuit occurred from line to ground, then the voltage across series resistor alters accordingly, then it is fed to an analog to digital converter to develop exact data, which the preprogramed 8051 microcontrollers will display in kilometers.*



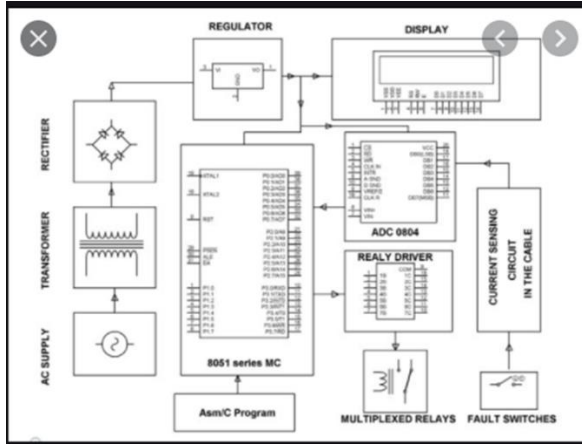
Indexed Terms- *8051 microcontroller, Resistors, LCD display, ohm's law, DC voltage, analog to voltage converter.*

I. INTRODUCTION

Till the last decades, a million miles of cables are threaded in the air across the country. But currently, it is laid in the underground, which is larger than an earlier method. Because, underground cables are not affected by any adverse weather conditions like pollution, heavy rainfall, snow, and storm, etc. But, when any problem occurs in cable, it is very difficult to find the exact location of the fault due to not knowing the exact location of the cable. Day by day, the world is becoming digitized so the project is proposed to find the location of the



fault in a digital way. When the fault occurs, the process of repairing related to that particular cable is very difficult. The fault of the cable mainly occurs due to many reasons. They are: inconsistent, any defect, weakness of the cable, insulation failure, and breaking of the conductor. To overcome this problem, here is a project namely an underground cable fault distance locator, used to find the location of the fault for underground cable.



II. TYPES OF UNDERGROUND CABLE FAULTS

Cables are generally laid directly in the ground or in ducts in the underground distribution system. For this reason, there are little chances of faults in underground cables. However, if a fault does occur, it is difficult to locate and repair the fault because conductors are not visible. Nevertheless, the following are the faults most likely to occur in underground cables:

1. Open_circuit fault
 2. Short_circuit fault
 3. Earth fault
1. Open_circuit fault: When there is a break in the conductor of a cable, it is called open_circuit fault. The open_circuit fault can be checked by a megger. For this purpose, the three conductors of the 3_core cable at the far end are shorted and earthed. Then resistance between each conductor and earth is measured by a megger. The megger will indicate zero resistance in the circuit of the conductor that is not broken. However, if the conductor is broken, the megger will indicate infinite resistance in its circuit.
 2. Short_circuit fault: When two conductors of a multi_core cable come in electrical contact with each other due to insulation failure, it is called a short_circuit fault. Again, we can seek the help of a megger to check this fault. For this purpose, the two terminals of the megger are connected to any two conductors. If the megger gives zero reading, it indicates short_circuit fault between these

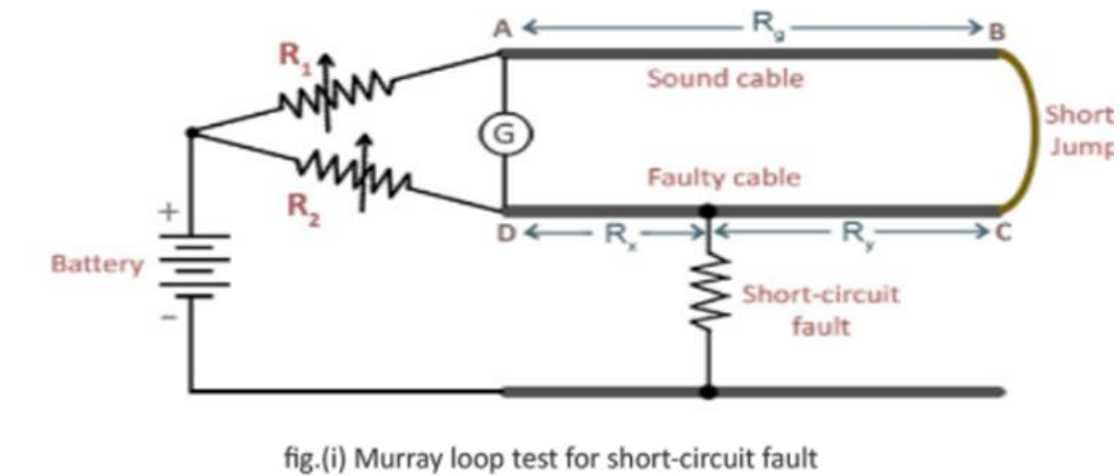
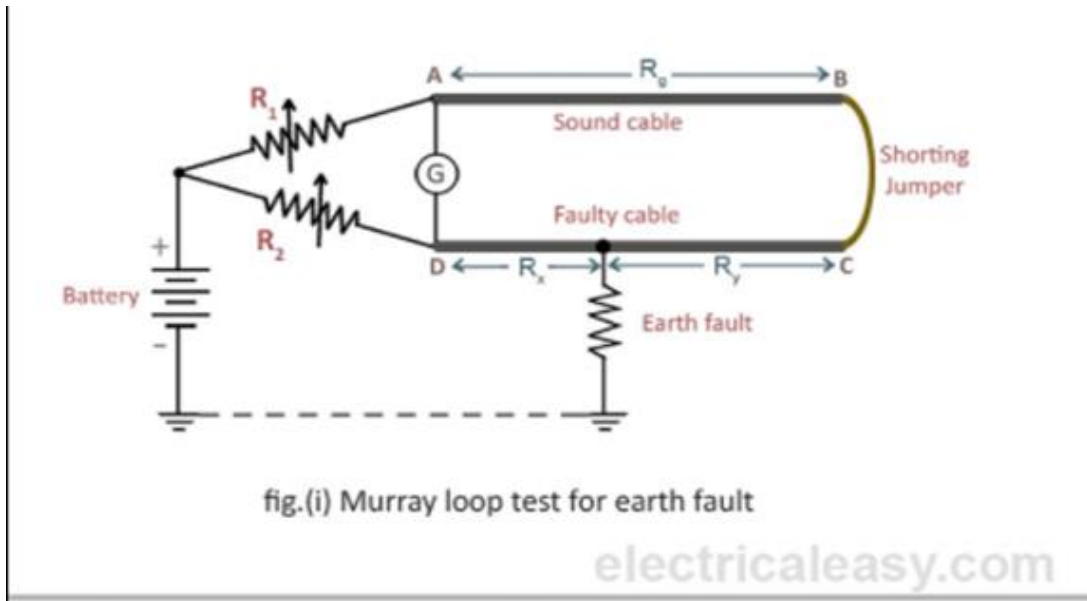
conductors. The same step is repeated for other conductors taking two at a time.

3. Earth fault: When the conductor of a cable comes in contact with earth, it is called earth fault or ground fault. To identify this fault, one terminal of the megger is connected to the conductor and the other terminal connected to the earth. If the megger indicates zero reading, it means the conductor is earthed. The same procedure is repeated for other conductors of the cable.

III. LOOP TESTS FOR LOCATION OF FAULTS IN UNDERGROUND CABLES

1. Sectionalizing: This procedure risks reducing cable reliability, because it depends on physically cutting and splicing the cable. Dividing the cable into successively smaller sections and measuring both ways with an ohmmeter or high_voltage insulation resistance (IR) tester enable to narrow down search for a fault. This laborious procedure normally involves repeated cable excavation.
2. Time domain reflectometry (TDR): The TDR sends a low_energy signal through the cable, causing no insulation degradation. A theoretically perfect cable returns that signal in a known time and in a known profile. Impedance variations in a “real_world” cable alter both the time and profile, which the TDR screen or printout graphically represents. One weakness of TDR is that it does not pinpoint faults.
3. Murray loop test: Murray loop test is the most common and accurate method for locating earth faults and short-circuit faults. However, to perform the Murray loop test, it is necessary that a sound (good) cable runs along the faulty cable. This test employs the principle of Wheatstone bridge for fault location.

To perform the Murray loop test, the alongside sound cable and the faulty cable are shorted with a jumper conductor at the far end. The test side end is connected through a pair of resistors to a voltage source. Also, a null detector or galvanometer is connected between the two conductors at the test end. The circuit diagram is as shown in the image below.



Once the connections are made as shown in the above circuit, adjust the values of R_1 and R_2 so the null detector/galvanometer shows zero reading. That is, bring the bridge to the balance. Now, in the balanced position of Wheatstone bridge, we have,

$$\frac{R_1}{R_2} = \frac{R_g + R_y}{R_x}$$

Or $\frac{R_1}{R_2} + 1 = \frac{R_g + R_y}{R_x} + 1$

Or $\frac{R_1 + R_2}{R_2} = \frac{R_g + R_y + R_x}{R_x}$

Now, if r is the resistance of each cable,

then, $R_x + R_y + R_g = 2r$

Putting this in the above equation,

$$\frac{R_1 + R_2}{R_2} = \frac{2r}{R_x}$$

$$R_x = \frac{R_2}{R_1 + R_2} \times 2r$$

We know, the value of resistance is proportional to the length of the cable. Therefore, the value of R_x is proportional to the length L_x . Therefore,

$$L_x = \frac{R_2}{R_1 + R_2} \times 2L$$

Where L is the total length of the cable under test. (The value of L is proportional to the value of R_g .)

IV. VARLEY LOOP TEST

Varley loop test is also for locating short-circuit and earth faults in underground cables. This test also employs the principle of the wheatstone bridge. However, the difference between Murray loop test and Varley loop test is that, in Varley loop test resistances R_1 and R_2 are fixed, and a variable resistor is inserted in the faulted leg. If the fault resistance is high, the sensitivity of Murray loop test is reduced and Varley loop test may be more suitable.

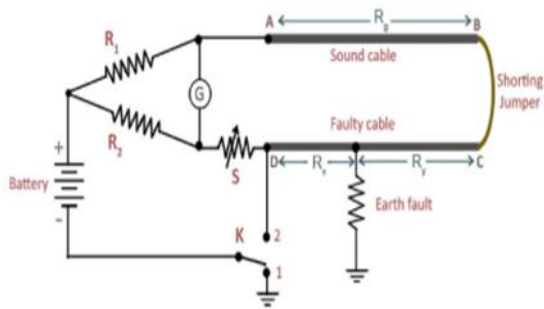


fig (iii) Varley loop test for earth fault

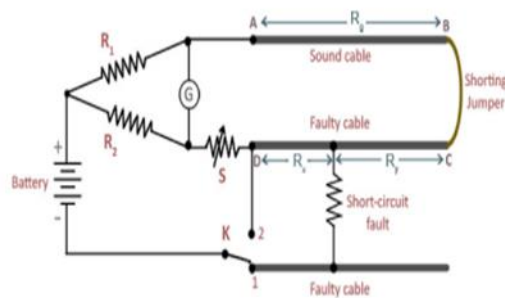


fig (iv) Varley loop test for short-circuit fault

To perform Varley loop test, connections are done as shown in the circuit diagram above. Resistors, R_1 and R_2 are fixed and the resistor S is variable. In this test, the switch K is first thrown to the position 1. Then the variable resistor S is varied till the galvanometer shows zero deflection (i.e., bridge is balanced). Let's say, the bridge is balanced for the

value of S equal to S_1 . Then,

$$\frac{R_1}{R_2} = \frac{R_g + R_y}{R_x + S_1}$$

Let, $R_g + R_y = R_3$

$$\frac{R_1 + R_2}{R_2} = \frac{R_3 + R_x + S_1}{R_x + S_1}$$

$$R_x + S_1 = \frac{R_2 (R_3 + R_x + S_1)}{R_1 + R_2}$$

$$R_x = \frac{R_2 (R_3 + R_x) - R_1 S_1}{R_1 + R_2} \dots \dots \dots \text{eq. (i)}$$

Now, the switch K is thrown to the position 2 and the bridge is balanced by varying the resistor S . Say, the bridge is

$$\frac{R_1}{R_2} = \frac{R_3 + R_x}{S_2}$$

$$R_1 S_2 = R_2 (R_3 + R_x) \dots \dots \dots \text{eq. (ii)}$$

balanced at the value of resistor S is equal to S_2 . Then,

Now, putting the result of eq.(ii) in eq.(i),

$$R_x = \frac{R_1 (S_2 - S_1)}{R_1 + R_2}$$

Since the values of R_1 , R_2 , S_1 and S_2 are known, R_x can be calculated. When R_x is known, the distance from the test end to the fault point L_x can be calculated as,

$$L_x = R_x / r$$

Where, r = resistance of the cable per meter.

CONCLUSION

This hardware model can locate the exact fault location in underground cable. Further in this project we can locate the open circuited cable by using capacitor in an ac circuit, and also locate the short-circuited fault by using resistors in dc circuit as followed in the above proposed project. A

microcontroller is used to make the necessary calculations so that the fault distance is displayed on the LCD display.

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