A Mini Project Report

on

UNDERGROUND CABLE FAULT DISTANCE LOCATOR

submitted in the partial fulfilment of the requirement for the award of the degree of

Bachelor of Technology in Electrical & Electronics Engineering

By

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CERTIFICATE

This is to certify that the mini project report on **UNDERGROUND CABLE FAULT DISTANCE LOCATOR** that is being submitted by **J.Vydehi (16251A0223), E. Manisha (16251A0213), G. Shravya(16251A0214), G. Gayathri(16251A0220), K. Priyanka(17255A0206)** in partial fulfilment for the award of B. Tech. in Electrical and Electronics Engineering to the Jawaharlal Nehru Technological University Hyderabad is a record of bonafide work carried out by her under our guidance and supervision. The results embodied in this thesis have not been submitted to any other University or Institution for the award of any degree or diploma.

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ABSTRACT

Cable faults are damage to cables which affects the resistance in the cable. If allowed to persist, this can lead to a voltage breakdown. To locate a fault in the cable, the cable must first be tested for faults. This prototype uses the simple concept of OHMs law. The current would vary depending upon the length of fault of the cable. This prototype is assembled with a set of resistors representing cable length in Kilo meters and fault creation is made by a set of switches at every known Kilo meter's to cross check the accuracy of the same. The fault occurring at what distance and which phase is displayed on a 16X2 LCD interfaced with the microcontroller. The program is burned into ROM of microcontroller. The power supply consists of a step down transformer 230/12V, which steps down the voltage to 12V AC. This is converted to DC using a Bridge rectifier. The ripples are removed using a capacitive filter and it is then regulated to +5V using a voltage regulator 7805 which is required for the operation of the microcontroller and other components. In this project, a way for sleuthing underground cable fault distance locator is done by using microcontroller. The target of this project is to work out the gap of underground cable fault through base station in kilometers. It uses the straight forward conception of Ohm's law, voltage drop can vary counting on the length of fault in cable, since the current varies. A group of resistors are used to represent the length of cable in kilometers and a dc voltage is fed at one end and the fault is detected the change in voltage using analog to voltage converter. The fault occurring at what distance is shown on LCD which is interfaced with the microcontroller that is used to make the necessary calculations.

LIST OF FIGURES

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1. INTRODUCTION

This project proposes fault location model for underground power cable using microcontroller.

The aim of this project is to determine the distance of underground cable fault from base station in kilometers. This project uses the simple concept of Ohm's law. When any fault like short circuit occurs, voltage drop will vary depending on the length of fault in cable, since the current varies. A set of resistors are therefore used to represent the cable and a dc voltage is fed at one end and the fault is detected by detecting the change in voltage using a analog to voltage converter and a microcontroller is used to make the necessary calculations so that the fault distance is displayed on the LCD display.

Till last decades cables were made to lay overhead & currently it is lay to underground cable which is superior to earlier method. Because the underground cable are not affected by any adverse weather condition such as storm, snow, heavy rainfall as well as pollution. But when any fault occur in cable, then it is difficult to locate fault. So we will move to find the exact location of fault. Now the world is become digitalized so the project is intended to detect the location of fault in digital way. The underground cable system is more common practice followed in many urban areas. While fault occurs for some reason, at that time the repairing process related to that particular cable is difficult due to not knowing the exact location of cable fault.

Fault in cable is represented as:

•Any defect,

•Inconsistency,

•Weakness or non-homogeneity that affect performance of cable .

•Current is diverted from the intended path .

•Caused by breaking of conductor& failure of insulation

2. REVIEW OF LITERATURE

Cable faults are damage to cables which effect a resistance in the cable. If allowed to persist, this can lead to a voltage breakdown. There are different types of cable faults, which must first be classified before they can be located. The insulation of the cable plays a significant role in this. While paper-impregnated cables are particularly susceptible to external chemical and thermal influences, in high-voltage PE or XLPE cables the polyethylene insulation of the conductor is affected, leading to partial breakdowns and cracks that "eat away" the insulation.

2.1. Screening faults:

A contact between conductor and screen generates a varying resistance.

2.2. Phase faults:

The contact between multiple conductors generates a varying resistance.

2.3. Sheath faults:

Sheath faults are damage of the cable sheath that allows the surroundings contact with the cable screen.

2.4. Faults due to moisture:

Water penetrates into the cable sheath and contacts the conductors. Impedance changes at the fault location make measuring more difficult. The resistance usually lies in the low-ohmic range.

2.5. Disruptions:

Combination of series and parallel resistances, usually in the form of a wire break. The voltage is interrupted, i.e. $\Omega=\infty$.

2.6. Cable testing:

To locate a fault in the cable, the cable must first be tested for faults. Cable testing is therefore usually performed first in cable fault location. During the cable test, flash-overs are generated at the weak points in the cable, which can then be localized.

2.7. Locating the cable fault:

Fault location technique on-site

The measures necessary for determining fault locations can be subdivided into individual steps.

2.8. Fault classification:

Insulation and resistance measurement provides information on the fault characteristics. An insulation test measures the insulation resistance between conductor and screen; from the periodic measurement of resistance you can derive the absorption properties of the insulating material.

2.9. Pre-location:

Pre-location is used to determine the fault distance. There are predominantly two methods for this.

2.10. Pulse reflection method:

A pulse induced at the starting end of the cable reaches the cable fault with a speed of v/2 and then is reflected back toward the starting end of the cable. The elapsed time multiplied by the diffusion speed v/2 gives the distance to the source of the fault.

2.11. Transient method:

In the transient method, a breakdown is triggered at the cable fault. This effects a low- resistance short circuit for a few milliseconds. This in turn produces two travelling waves diffusing in opposite directions. These waves are reflected at the cable ends so that they then travel toward each other again in the direction of the cable fault.

The waves are unable to pass the fault because of the arc produced by the short circuit, so they are therefore reflected back again as with the pulse reflection method, which due to the burning short circuit results in a reversal of polarity.

There are various ways to decouple and analyse these transients.

2.12. Route tracing and pinpointing:

Route tracing is used to determine where the faulty cable lies and pinpointing is the process of determining the exact position of the cable fault.

2.13. Cable identification:

In cable identification, the faulty cables are identified from the fault-free cables at the already determined site.

3. BLOCK DIAGRAM AND DESCRIPTION

3.1. Block diagram

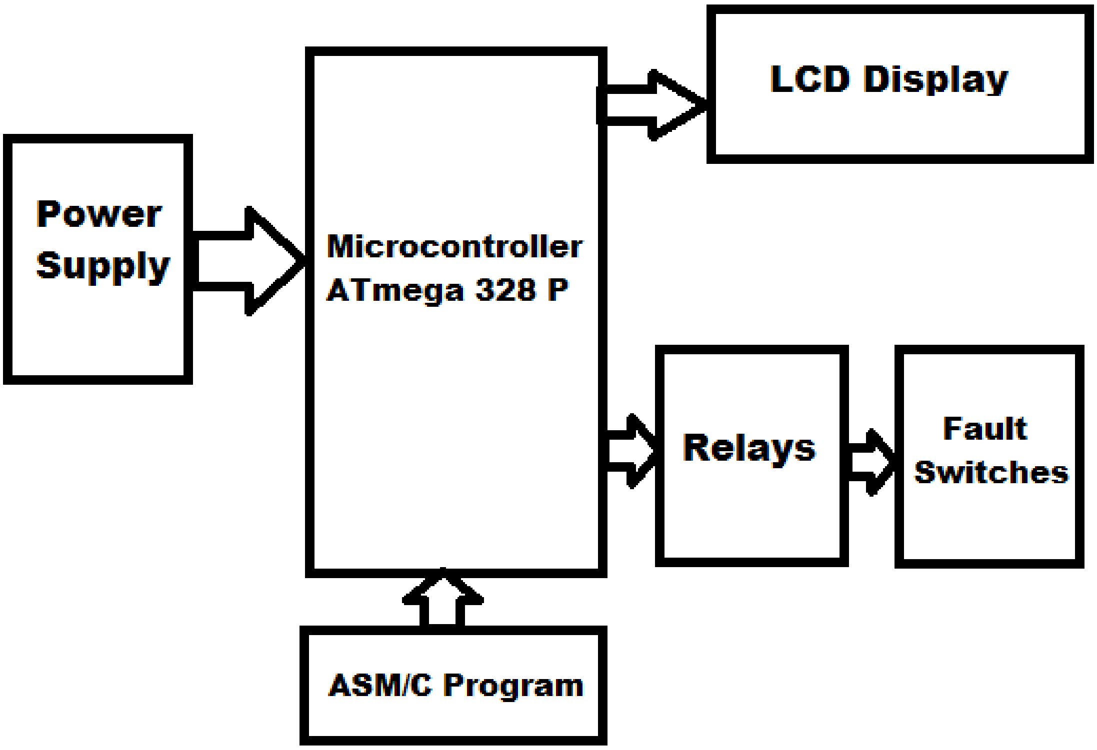


Fig1.1: Block Diagram.

3.2. Block description

In this project simple OHM's law is used to locate the short circuit fault. A DC voltage is applied at the feeder end through a series resistor, depending upon the length of fault of the cable current varies. The voltage drop across the series resistor changes accordingly, this voltage drop is used in determination of fault location.

The microcontroller used is Atmega328p which is a High Performance Low Power CMOS 8-Bit Microcontroller. 8 bit microcontroller means CPU or ALU can process 8 bit data at a time. Means it has to take 8 bit data from memory (which it has to process). Thus each location in memory is 8 bit and data bus is also 8 bit. Registers in RAM has to be 8 bit for temporary storage of results. This microcontroller has 32KBytes of In-System Flash program memory. Our program is burned into flash memory. It is having a 6 channel PWM (Pulse Width Modulation) channel. One of them is used for LCD back light control. As width of pulse changes back light intensity of LCD varies. Atmega328P consist of 6 channel 10 bit analog to digital converter. This analog to digital converter is used to detect the minor changes in voltage drop across LDR (Light Dependent Resistor) and this change is responsible for change in back light of LCD.
The relay driver consist of transistor BC547 which is used as a switch to control relay. We are using only two relay hence it is economical to use BC547. If we want to connect more number of relay then relay driver IC ULN2003 can be used instead of transistor. Relay operates on 5V dc supply. One relay is used for switch warning alarm and second one is for indication purpose. We are using array of LED as indicator.
Power supply is the DC supply which provides 5V DC to microcontroller, Ultrasonic sensor and LCD. For relay and indicator another power supply circuitry is used. Power supply block consist of rectifier, filter, regulator. As +5V DC is needed, we are using positive voltage regulator IC 7805 which provides continues +5 volt DC. Minimum input to IC 7805 should be 7 volts.

4. CIRCUIT DIAGRAM

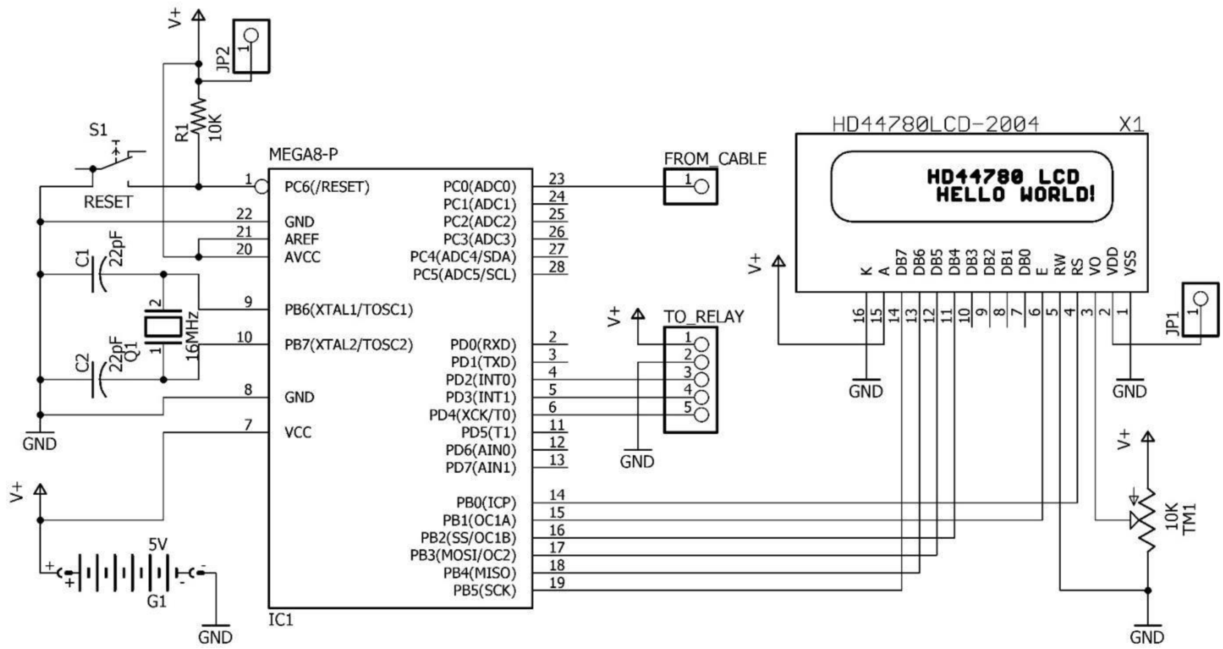


Fig. 2.1(a) Circuit diagram of Underground Cable Fault Detector

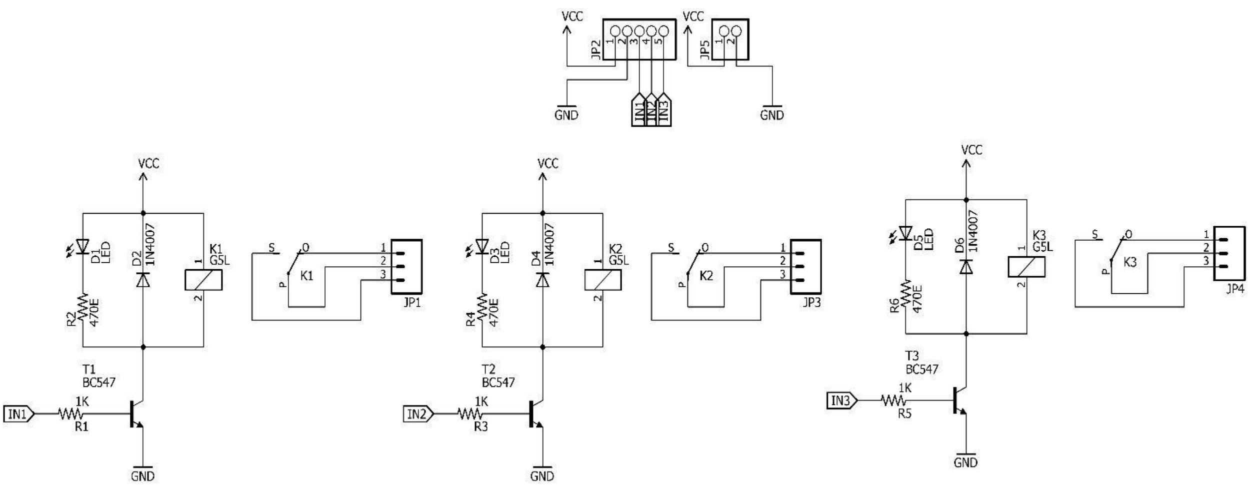


Fig. 2.1(b) Circuit diagram of Underground Cable Fault Detector

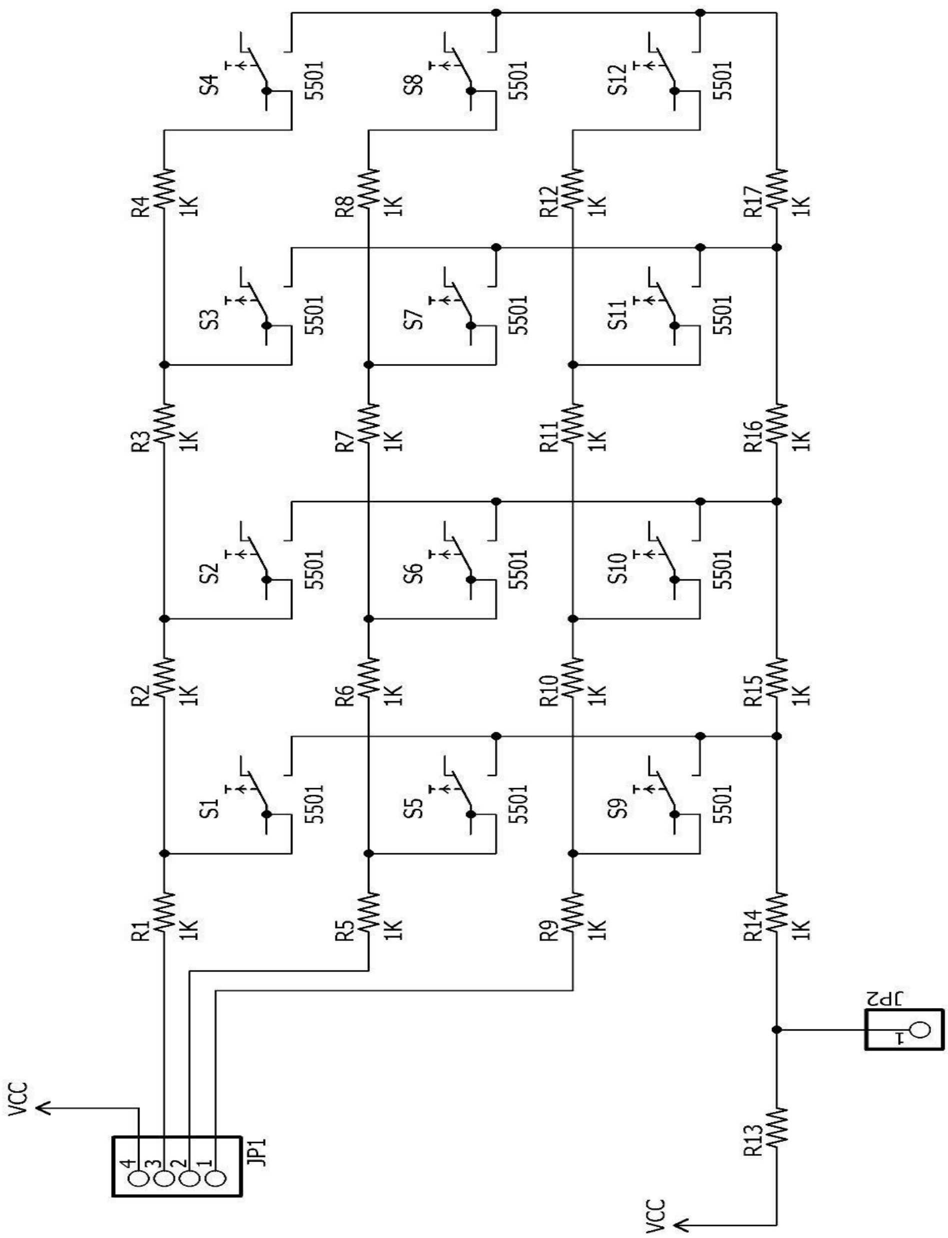


Fig. 2.1(c) Circuit diagram of Underground Cable Fault Detector

5. CIRCUIT DESCRIPTION

The objective of this project is to determine the distance of underground cable fault from the base station in kilometers. An underground cable system is quite common in many urban areas wherein it becomes very difficult to repair in case of any faults because finding the exact location of the fault in such cable system is quite difficult. With the proposed system, finding the exact location of the fault is possible.

This project uses a standard concept of Ohms law, i.e., when a low DC voltage is applied at the feeder end through series resistor (assuming them as cable lines), then the current would vary depending upon the location of the fault in the cable.

In case of a short circuit (line to ground), the voltage across the series resistors changes which is then fed to an ADC, to develop a precise digital data that gets displayed on the LCD.

The project is assembled with a set of resistors representing cable length in km and fault creation is made by a set of switches at every known km to cross check the accuracy of the same. The fault that occurs at a particular distance of a particular phase is displayed on the LCD interfaced to the microcontroller.

Furthermore, this project can be enhanced by using a capacitor in an AC circuit to measure the impedance which can even locate an open-circuited cable, unlike short-circuited fault only using resistors in DC circuit as followed in the above proposed project.

While any of the 12 switches (representing as fault switches) are operated they impose conditions like line to ground (LG), line to line (LL), line to line to line(3L) fault as per the switch operation. The program while executed continuously scans by operating the 3relays in sequence of 1sec interval. Thus, any NO point while driven to GND through the common contact point of the relay develops a current flow through R1 & any of the cable by the fault switch depending on the created fault. Thus, the voltage drop at the analog to digital (ADC) pin varies depending on the current flow which is inversely proportional to the resistance value representing the length of cable in kilometers. This varying voltage is fed to the ADC to develop an 8-bit data to the microcontroller port1. Program while executed displays an output in the LCD display upon the distance of the fault occurring in km's. In a fault situation it displays R=3km if the 3km's switch is made ON. Accordingly, all other faults are indicated.

5.1. ATMega328P:

Features:

High Performance, Low Power CMOS 8-Bit
Microcontroller 32 x 8 (256) General Purpose
Working Registers
High Endurance Non-volatile
Memory Segments 32KBytes of In-
System Flash program memory Data
retention: 20 years at 85°C/100
years at 25°C 2KBytes Internal
SRAM
1KBytes EEPROM
Max. Operating Frequency 20MHz

8-bit microcontroller means CPU or ALU can process 8-bit data at a time. Means it has to take 8-bit data from memory (which it has to process). Thus, each location in memory is 8-bit and data bus is also 8-bit. Registers in RAM has to be 8-bit for temporary storage of results.

Peripheral Features:

Two 8-bit Timer/Counters
One 16-bit Timer/Counter
Six PWM Channels
6-channel 10-bit ADC
On-chip Analog Comparator

Temperature range: -40°C to 85°C

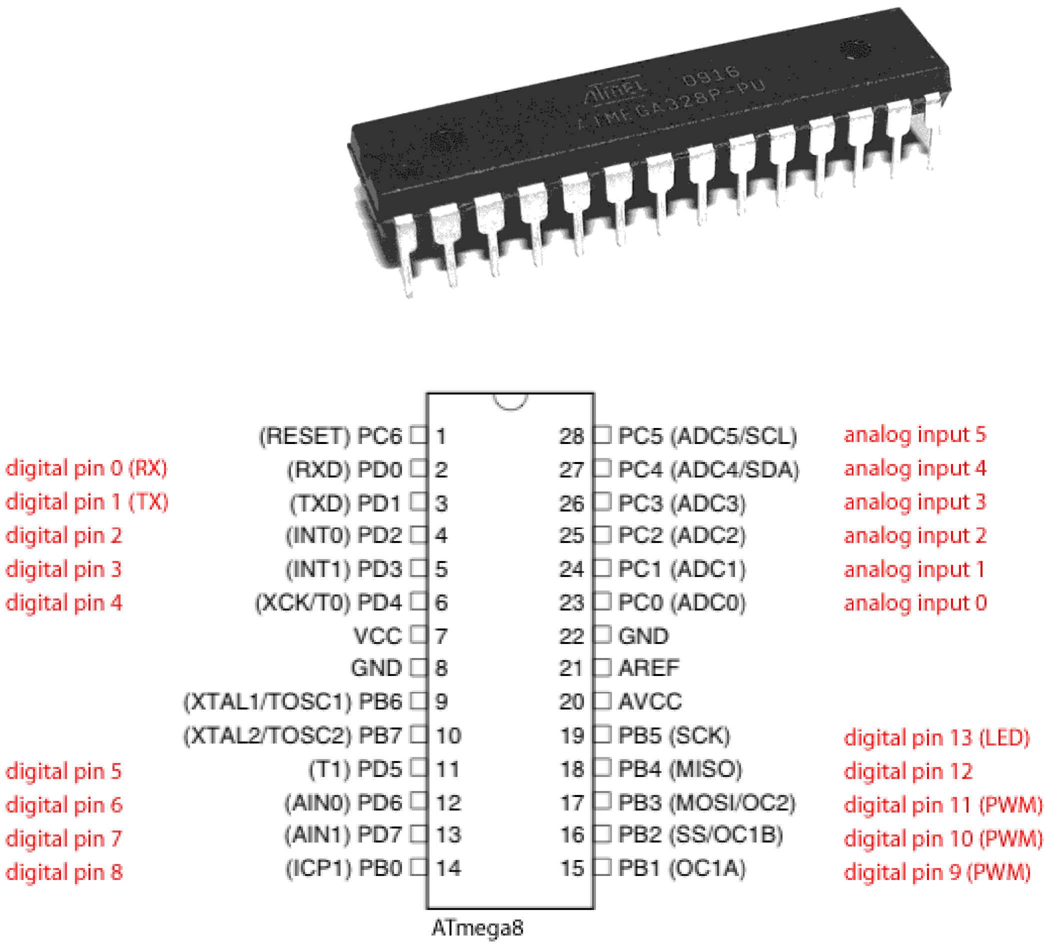


Fig.3.1: ATmega328P-PU

AREF (Analog Reference): Reference voltage for the analog inputs.

AVCC: It is power for the analog circuitry (Port C pins and internal A/D).

Digital Pins (2-6, 11-19): The digital pins can be used for general purpose input and output via the pinMode(), digitalRead(), and digitalWrite() commands. The maximum current per pin is 40 mA.

Serial: 2 (RX) and 3 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins cannot be used for digital I/O if you are using serial communication (e.g. Serial.begin).

External Interrupts: 4 and 5. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.

PWM: 5, 11, 12, 15, 16 and 17. Provide 8-bit PWM output with the analogWrite() function. PWM output is available only on pins 15, 16 and 17.

SPI: 16 (SS), 17 (MOSI), 18 (MISO), 19 (SCK). These pins support SPI (Serial Peripheral Interface) communication.

The Serial Peripheral Interface or SPI bus is a synchronous serial data link, named by Motorola, that operates in full duplex mode. It is used for short distance, single master communication, for example in embedded systems, sensors, and SD cards.
Devices communicate in master/slave mode where the master device initiates the data frame. Multiple slave devices are allowed with individual slave select lines. Sometimes SPI is called a four-wire serial bus. SPI is often referred to as SSI (Synchronous Serial Interface).

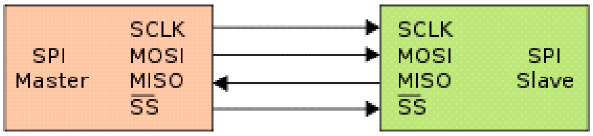


Fig.3.1: Synchronous Serial Interface

The SPI bus specifies four logic
signals: CLK/SCK: Serial Clock
(output from master).
MOSI: Master Output, Slave Input (output
from master). MISO: Master Input, Slave
Output (output from slave). **SS/CSN/CS:**
Slave Select (active low, output from master).

Analog Pins (23-28): The analog input pins support 10-bit analog-to-digital conversion (ADC) using the analogRead() function. Most of the analog inputs can also be used as digital pins.

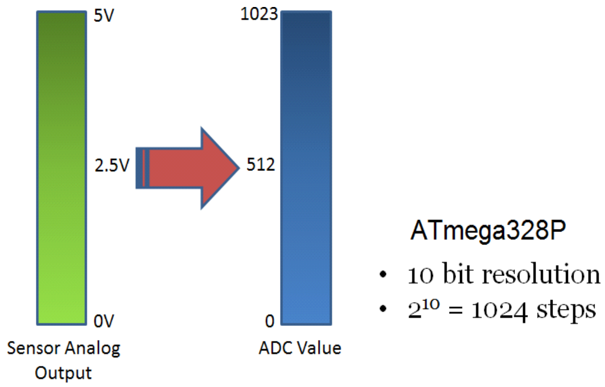


Fig.3.1: ADC Conversion

5.2. Liquid crystal display:

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

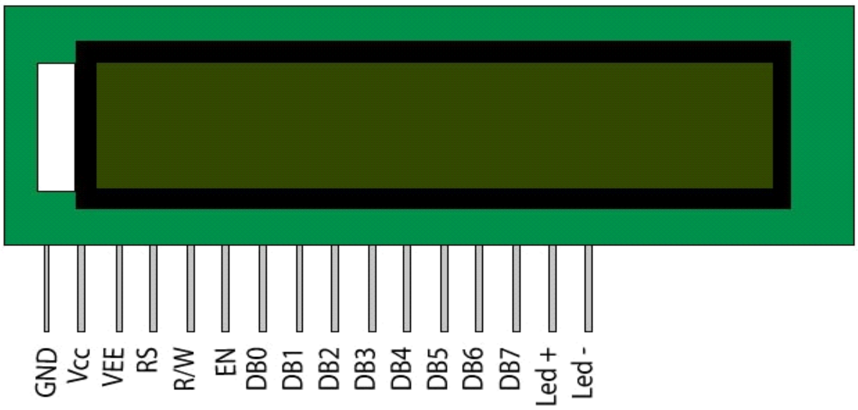


Fig.4.1: LCD pin diagram

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	V_{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight V_{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

Table1: Pin function of LCD display

5.3. Relay:

Relay is sensing device which senses the fault &send a trip signal to circuit breaker to isolate the faulty section. A relay is automatic device by means of which an electrical circuit is indirectly controlled & is governed by change in the same or another electrical circuit. There are various types of relay: Numerical relay, Static relay & electromagnetic relay. Relay are housed in panel in the control room.

5.4. Advantages:

1) Less maintenance
2) It has higher efficiency
3) Less fault occurs in underground cable
4)Underground cable fault location model is applicable to all types of cable ranging from 1kv to 500kv&other types of cable fault such as-Short circuit fault, cable cuts, Resistive fault, Sheath faults, Water trees, Partial discharges.
5) Improved public safety.

6. SOFTWARE

6.1. Arduino IDE:

Arduino integrated development environment (IDE), which is a cross-platform application written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, and syntax highlighting, and provides simple one-click mechanisms to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus.

A program written with the IDE for Arduino is called a sketch Sketches are saved on the development computer as text files with the file extension .ion. Arduino Software (IDE) pre-

saved sketches with the extension .pde.

The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

FEATURES:

Unlimited Breakpoint Capabilities including access, conditional, and execution breakpoints.

Simulated peripherals fully synchronized with program execution.

Power-down and idle modes are fully simulated.

Full timing and execution analysis with Code Coverage, Trace, Timing Profile, Logic Analyzer.

Input signal generation from a script language; synchronized with program execution (single-stepping).

Simulation is timing accurate and in correct relation to peripherals.

7. PROGRAM CODE

```
#include<LiquidCrystal.h>
LiquidCrystallcd(8,9,10,11,12,13);
int phase[3]={2,3,4};
int distance(int inputVoltage)
{
if(inputVoltage>=890&&inputVoltage<920)
{
return 8;
}
else if(inputVoltage>=850&&inputVoltage<890)
{
return 6;
}
else if(inputVoltage>=750&&inputVoltage<850)
{
return 4;
}
else if(inputVoltage>=600&&inputVoltage<750)
}
return 2;
}
else return 0;
}
void setup()
{
lcd.begin(16,2);
for(int j =0;j<3;++)
{
pinMode(phase[j],OUTPUT);
}
lcd.setCursor(0,0);
lcd.print('Underground Cable');
lcd.setCursor(0,1);
lcd.print('Fault Detector');
delay(3000);
lcd.setCursor(0,0);
lcd.print(' ');
lcd.setCursor(0,1);
lcd.print(' ');
}
void loop()
{
digitalWrite(phase[0],HIGH);
delay(500);
int dist1=distance(analogRead(A0));
if(dist1==0)
{
lcd.setCursor(0,0);
```

```
lcd.write('R');
lcd.setCursor(0,1);
lcd.write('NF');
}
else
{
lcd.setCursor(0,0);
lcd.write('R');
lcd.setCursor(0,1);
lcd.print(dist1);
lcd.setCursor(1,1);
lcd.write('KM');
}
digitalWrite(phase[0],LOW);
digitalWrite(phase[1],HIGH);
delay(500);
int dist2= distance(analogRead(A0));
if (dist2==0)
{
lcd.setCursor(7,0);
lcd.write('G');
lcd.setCursor(7,1);
lcd.write('NF');
}
else
{
lcd.setCursor(7,0);
lcd.write('G');
lcd.setCursor(7,1);
lcd.print('dist2');
lcd.setCursor(8,1);
lcd.write('KM');
}
digitalWrite(phase[0],LOW);
digitalWrite(phase[1],HIGH);
delay(500);
int dist3= distance(analogRead(A0));
if (dist3==0)
{
lcd.setCursor(13,0);
lcd.write('Y');
lcd.setCursor(13,1);
lcd.write('NF');
```

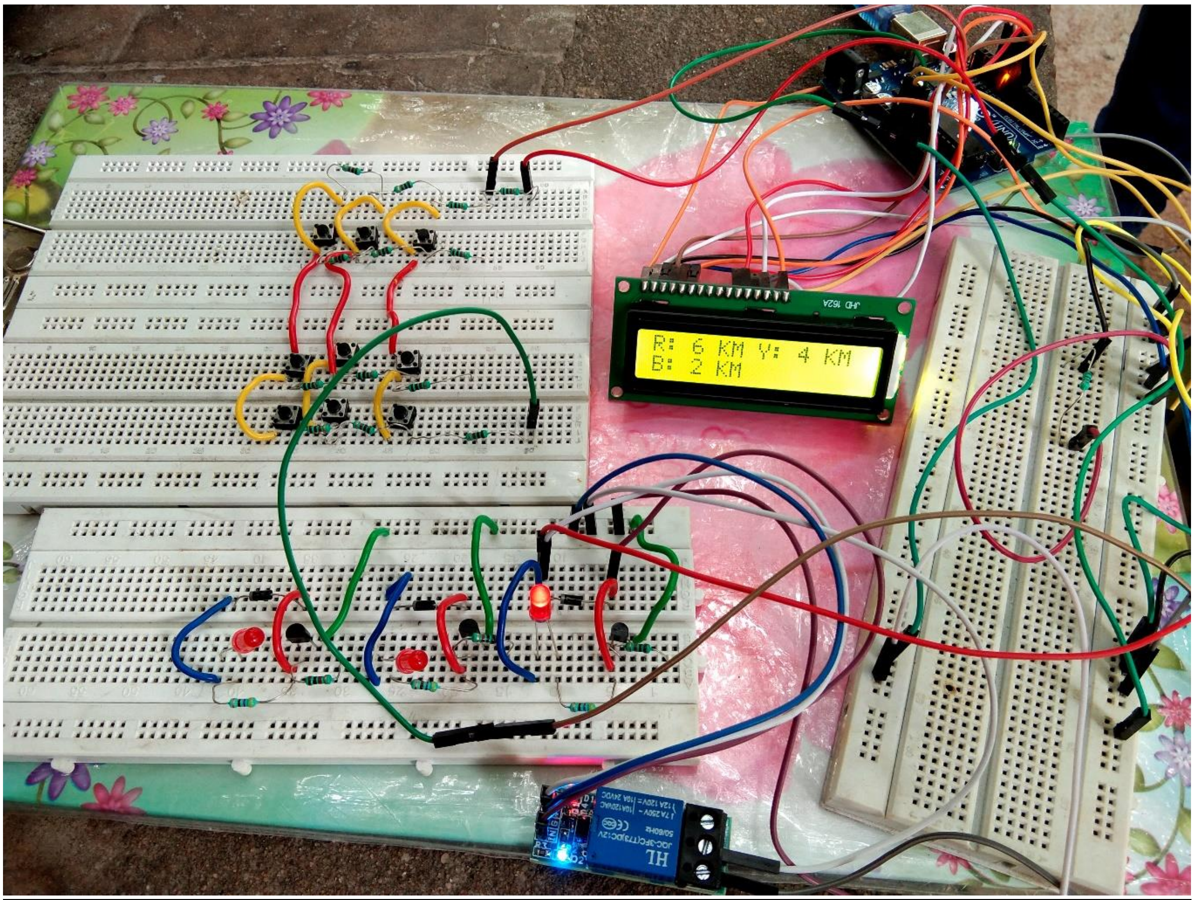
```
}
else
{
lcd.setCursor(13,0);
lcd.write('Y');
lcd.setCursor(13,1);
lcd.print('dist3');
lcd.setCursor(14,1);
lcd.write('KM');
}
digitalWrite(phase[2],LOW);
}
```

8. ADVANTAGES

This includes aesthetics, higher public acceptance, and perceived benefits of protection against electromagnetic field radiation (which is still present in underground lines), fewer interruptions, and lower maintenance costs. Failure rates of overhead lines and underground cables vary widely, but typically underground cable outage rates are about half of their equivalent overhead line types. Potentially far fewer momentary interruptions occur from lightning, animals and tree branches falling on wires which de-energize a circuit and then reenergize it a moment later.

- Lower storm restoration cost
- Lower tree-trimming cost
- Increased reliability during severe weather (wind related storm damage will be greatly reduced for an underground system, and areas not subjected to flooding and storm surges experience minimal damage and interruption of electric service.
- Less damage during severe weather.
- Far fewer momentary interruptions Improved utility relations regarding tree trimming Improved Public Safety.
- Fewer motor vehicle accidents
- Reduced live-wire contact injuries
- Fewer Fires
- Improved aesthetics (removal of unsightly poles and wires, enhanced tree canopies). Fewer structures impacting sidewalks.

9. RESULT



Demonstration of working of circuit

10. FUTURE SCOPE

1. In this project we detect only the location of short circuit fault in underground cable line, but we also detect the location of open circuit fault, to detect the open circuit fault capacitor is used in ac circuit which measure the change in impedance & calculate the distance of fault.

2. It is used in neural network structure for fault section and fault location estimation.

11. CONCLUSION

This is proposed model of underground cable fault distance locator using microcontroller. It is classified in four parts –DC power supply part , cable part, controlling part, display part.

DC power supply part consist of an adapter of 230V AC to 12V DC.

The cable part is denoted by set of resistors along with switches. Current sensing part of cable represented as set of resistors & switches are used as fault creators to indicate the fault at each location. This part senses the change in current by sensing the voltage drop.

Next is controlling part which consist of analog to digital converter which receives input from the current sensing circuit, converts this voltage into digital signal and feeds the microcontroller with the signal. The microcontroller also forms part of the controlling unit and makes necessary calculations regarding the distance of the fault. The microcontroller also drives a relay driver which in turn controls the switching of a set of relays for proper connection of the cable at each phase. The display part consists of the LCD display interfaced to the microcontroller which shows the status of the cable of each phase and the distance of the cable at the particular phase, in case of any fault.

REFERENCE

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- www.elprocus.com
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