UNDERGROUND CABLE FAULT DETECTION USING ARDUINO

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ABSTRACT

The objective of this paper is to determine the location of fault in underground cable lines from the source station to exact location of fault in any units, here in kilometers. Whenever a fault occurs in the underground cable line for some reason, the repairing process relating to that faulted cable becomes difficult owing to lack of proper system for tracking the exact fault location and the type of fault occurred in the cable. For this, a system has to be developed to find the exact location of the fault in the distribution line system for all the three phases R, Y & B for different type of situations of faults. Here in this paper single line to ground, double line to ground & three phase faults have been considered. Here a system is developed which consists of a microcontroller, LCD display, Fault Sensing Circuit Module, IoT Wi-Fi Module and proper power supply arrangement with regulated power output. Hence, if there is a short circuit in the form of line to ground in any phase/phases, the voltage across series resistors changes accordingly and an analog signal in the form of voltage drop is generated by the fault sensing circuit of the introduced system, which is then fed to an ADC inbuilt in already programmed microcontroller to create the exact digital data and after processing the data the output will be displayed in the connected LCD with the exact location of fault occurred in kilometers from the source station and simultaneously also indicate the corresponding R, Y, B phase where fault occurred with the exact distance. The same processed information output will appear in the webpage through connected IoT Wi-Fi Module. In this system, AT mega 328P micro controller is used. Here the current sensing of circuits made with a combination of resistors is interfaced to ATmega328 micro controller with the help of internally inbuilt ADC for providing the digital data to microcontroller. The fault sensing circuit is made with the combination of set of series resistors &the set of switches alongside each resistor. The relays are controlled by the relay driver. A 16x2 LCD display is connected to the microcontroller to display the information of phase/phases and location of fault in kilometers.

Keywords : LCD display & cable fault detection

1.INTRODUCTION

Use of underground power cable is expanding due to safety considerations and enhanced reliability in the distribution systems in recent times. Due to safety reasons and high-power requirements in densely populated areas, use of underground cable has seen a sharp hike. The underground cable systems have the advantages of not getting affected by any adverse weather condition such as storm, snow, heavy rainfall as well as pollution. But it has its own drawback for immediate tracking of fault in the underground cable lines. Study of cable failures and development of accurate fault detection and location methods has been interesting research topics in the past and present. Fault tracking entails determination of the presence of a fault, while fault location detection includes the determination of the physical location of the fault. However, this fault detection and fault location detection technology for underground power distribution systems is still in developing stages. Before fixing any fault in cables, the fault has to be identified first. There are many ways to find the cable fault location. This paper deals with the method to locate faults and identify the phase line in damaged cables. A basic idea of fault location and phase identification in the pictorial view is undernoted.

2. FAULTS IN UNDERGROUND CABLES:

2.1 Open circuit faults

These faults occur due to the failure of one or more conductors. The most common causes of these faults include joint failures of cables and overhead lines, and failure of one or more phase of circuit breaker and also due to melting of a fuse or conductor in one or more phases. Open circuit faults are also called as series faults. These are unsymmetrical or unbalanced type of faults except open circuit fault.

2.2 Short circuit faults

A short circuit can be defined as an abnormal connection of very low impedance between two points of different potential, whether made intentionally or accidentally. These are the most common and severe kind of faults, resulting in the flow of abnormal high currents through the equipment or transmission lines. If these faults are allowed to persist even for a short period, it leads to the extensive damage to the equipment. Short circuit faults are also called as shunt faults. These faults are caused due to the insulation failure between phase conductors or between earth and phase conductors or both. The various possible short circuit fault conditions include three phases to earth, phase to phase, single phase to earth, two phases to earth and phase to phase. In single line to ground fault, fault occurs between any one of the three lines and the ground. In double line to ground fault, fault occurs between any two of the three lines and the ground. In line to line fault, fault occurs between any two lines. When fault occurs, there is an abrupt change in voltage. This change in voltage may cause serious damages to the system if not corrected in time. So immediate step of fault correction is isolation of the faulty part from the rest of the system.

2.3 WORKING PRINCIPAL

The operation of the system states that when the current flows through the fault sensing circuit module the current would vary depending upon the length of the cable from the place of fault that occurred if there is any short circuit fault with the Single Line to ground fault, or double line to ground fault, or three phase to ground fault. The voltage drops across the series resistors changes accordingly and then the fault signal goes to internal ADC of the microcontroller to develop digital data. Then microcontroller will process the digital data and the output is being displayed in the LCD connected to the microcontroller in kilometers and phase as per the fault conditions. This Output is also displayed in the webpage through the IoT Wi-Fi Module ESP8266 connected to the system. The power supply given to the system is 230V ac supply. This 230 V supply is fed to the two Adapter Modules (12 V,1 Amps. each). The adaptor module 1 and 2 converts the AC voltage to DC. The ripple in output of adaptor module 1 is then removed with the help of a 1000 microfarad electrolytic capacitor. Since a constant 5 V voltage source is desired for our system, because the Microcontroller (ATmega328), 16x2 LCD (Liquid Crystal Display), Relay Drivers and Relays, Fault Sensing Circuit Module, IoT Wi-Fi Module etc. and the other components work at 5V supply, hence we are using three voltage regulators (7805). These voltage regulators convert the filtered output to 5V constant supply voltage.

3. LITERATURE SURVEY

Frequent fault in underground cables due to the breakdown of paper plastic insulation. Due to chemical reaction or poor workmanship during installation and the difficulties in locating the approximate fault area have been a serious problem. Most Underground Faults are located by unearthing the entire length of cable to enable visual inspection to be carried out. In case where visual inspection is not helpful then the entire length of cable is replaced. This manual method is not only expensive but also results in heavy loss of revenue to the power distribution company. This research is aimed at designing an underground cable fault location distance detection to solve this problem. The research work will help in identification and location of underground cable fault without unearthing the entire length of the cable before repair or replacing entire cable due to difficulty in locating the fault.

4. EXISTING METHOD

To determine the location of fault in underground cable lines from the source station to exact location of fault in any units, here in kilo meters. Whenever a fault occurs in the underground cable line for some reason, the repairing process relating to that faulted cable becomes difficult owing to lack of proper system for tracking the exact fault location and the type of fault occurred in the cable. For this, a system has to be developed to find the exact location of the fault in the distribution line system for all the three phases R, Y & B for different type of situations of faults.

5. PROPOSED METHOD

The operation of the system states that when the current flows through the fault sensing circuit module the current would vary depending upon the length of the cable from the place of fault that occurred if there is any short circuit fault with the Single Line to ground fault, or double line to ground fault, or three phase to ground fault. The voltage drops across the series resistors changes accordingly and then the fault signal goes to internal ADC of the microcontroller to develop digital data. Then microcontroller will process the digital data and the output is being displayed in the LCD connected to the Arduino controller in kilometers and phase as per the fault conditions.

6. MICROCONTROLLER CIRCUIT:

The microcontroller circuit is connected with reset circuit, crystaloscillatorcircuit, led circuit the reset circuit is the one which is an external interrupt which is designed to reset the program. And the crystal oscillator circuit is the one used to generate the pulses to microcontroller and it also called as the heart of the microcontroller here we have used 12mhz crystal which generates pulses up to 12000000 frequency which is converted it machine cycle frequency when divided by 12 which is equal to 1000000hz to find the time we have to invert the frequency so that we get one micro second for each execution of the instruction.

The LCD that is liquid crystal display which is used to display the what we need the LCD has fourteen pins in which three pins for the command and eight pins for the data. If the data is given to LCD it is write command which is configured by the programmer otherwise it is read command in which data read to microcontroller the data pins are given to the to port0 and command pins are given to the port2.Other than these pin a one pin configured for the contrast of the LCD. Thus, the microcontroller circuit works.

6.1 WIFI

It is the name of a popular wireless networking technology that radio waves to provide wireless high-speed internet and network connection.

A common misconception that the term Wi-Fi is short for" Wireless Fidelity"

The Protocol:

- Built on the IEEE802.11 standards
- Wireless local area network (WLAN)

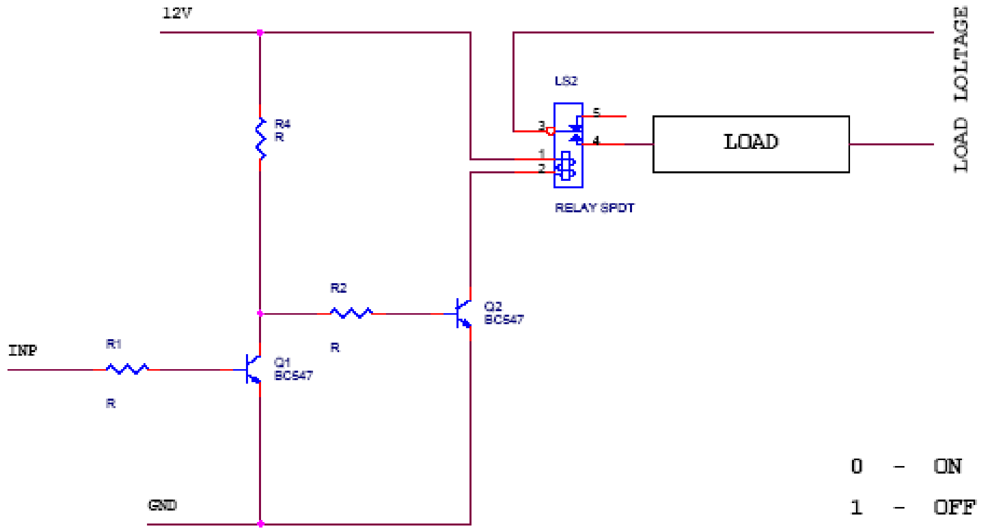
A computer's wireless adapter translate into a radio signal and transmit it using an antenna. A wireless router receives the signal and decode it. The router sends the information to the Internet Ethernet connection. Wi-Fi communication can transmit and receive radio waves. They transmit at frequencies of2.4 GHZ or 5 GHZ. The higher frequency allows the signal to carry more data.

6.2 Relay:

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example, a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timer IC is 200mA so these devices can supply relay coils directly without amplification.

RELAY CIRCUIT - SPST



Relays are usually SPDT or DPDT but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available. Most relays are designed for PCB mounting but you can solder wires directly to the pins providing you take care to avoid melting the plastic case of the relay. The animated picture shows a working relay with its coil and switch contacts. You can see a lever on the left being attracted by magnetism when the coil is switched on. This lever moves the switch contacts. There is one set of contacts (SPDT) in the foreground and another behind them, making the relay DPDT.

7. CIRCUIT DESCRIPTION:

This circuit is designed to control the load. The load may be motor or any other load. The load is turned ON and OFF through relay. The relay ON and OFF is controlled by the pair of switching transistors (BC 547). The relay is connected in the Q2 transistor collector terminal. A Relay is nothing but electromagnetic switching device which consists of three pins. They are Common, Normally close (NC) and Normally open (NO).

The relay common pin is connected to supply voltage. The normally open (NO) pin connected to load. When high pulse signal is given to base of the Q1 transistors, the transistor is conducting and shorts the collector and emitter terminal and zero signals is given to base of the Q2 transistor. So, the relay is turned OFF state.

When low pulse is given to base of transistor Q1 transistor, the transistor is turned OFF. Now 12v is given to base of Q2 transistor so the transistor is conducting and relay is turned ON. Hence the common terminal and NO terminal of relay are shorted. Now load gets the supply voltage through relay.

Voltage Signal from Microcontroller or PC	Transistor Q1	Transistor Q2	Relay
1	on	off	off
0	off	on	on

7.1 Power supply

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

7.2 BLOCK DIAGRAM:

7.3 Working principle

7.3.1 Transformer

The potential transformer will step down the power supply voltage (0-230V) to (0-6V) level. Then the secondary of the potential transformer will be connected to the precision rectifier, which is constructed with the help of op–amp. The advantages of using precision rectifier are it will give peak voltage output as DC; rest of the circuits will give only RMS output.

7.3.2 Bridge rectifier

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners.

Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.

The path for current flow is from point B through D1, up through RL, through D3, through the secondary of the transformer back to point B. this path is indicated by the solid arrows. Waveforms (1) and (2) can be observed across D1 and D3.

One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through RL, through D2, through the secondary of T1, and back to point A. This path is indicated by the broken arrows. Waveforms (3) and (4) can be observed across D2 and D4. The current flow through RL is always in the same direction. In flowing through RL this current develops a voltage corresponding to that shown waveform (5). Since current flows through the load (RL) during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier.

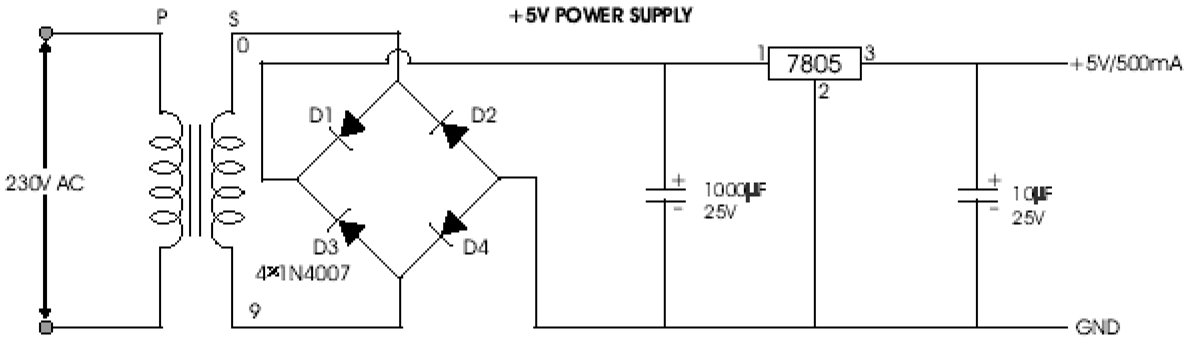
One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

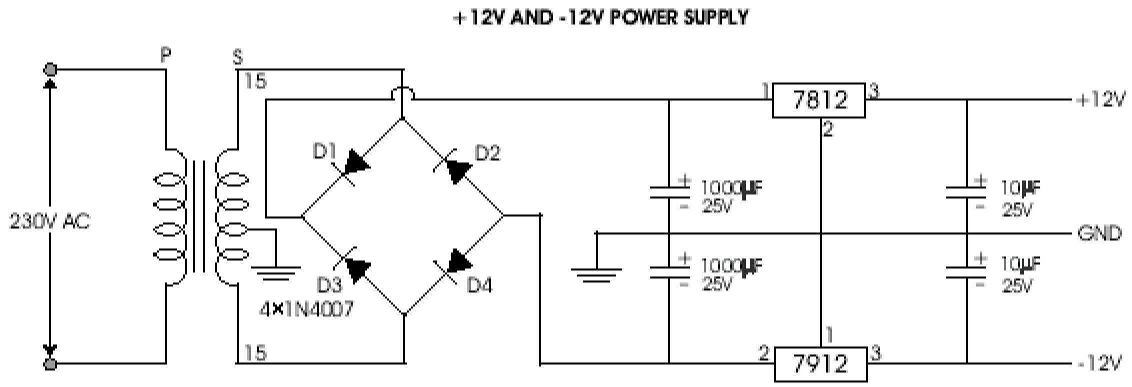
This may be shown by assigning values to some of the components shown in views A and B. assume that the same transformer is used in both circuits. The peak voltage developed between points X and y is 1000 volts in both circuits. In the conventional full-wave circuit shown—in view A, the peak voltage from the center tap to either X or Y is 500 volts. Since only one diode can conduct at any instant, the maximum voltage that can be rectified at any instant is 500 volts.

The maximum voltage that appears across the load resistor is nearly-but never exceeds-500 v0lts, as result of the small voltage drop across the diode. In the bridge rectifier shown in view B, the maximum voltage that can be rectified is the full secondary voltage, which is 1000 volts. Therefore, the peak output voltage across the load resistor is nearly 1000 volts. With both circuits using the same transformer, the bridge rectifier circuit produces a higher output voltage than the conventional full-wave rectifier circuit.

7.4 IC VOLTAGE REGULATOR:

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.





A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground.

The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.

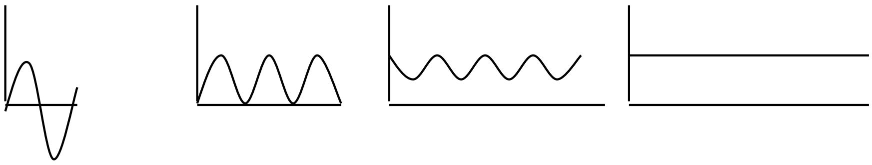
- For ICs, microcontroller, LCD --------- 5 volts
- For alarm circuit, op-amp, relay circuits ---------- 12 volts

7.5 POWER SUPPLIES

7.5.1 INTRODUCTION:

The present chapter introduces the operation of power supply circuits built using filters, rectifiers, and then voltage regulators. Starting with an ac voltage, a steady dc voltage is obtained by rectifying the ac voltage, then filtering to a dc level, and finally, regulating to obtain a desired fixed dc voltage. The regulation is usually obtained from an IC voltage regulator unit, which takes a dc voltage and provides a somewhat lower dc voltage, which remains the same even if the input dc voltage varies, or the output load connected to the dc voltage changes.

A block diagram containing the parts of a typical power supply and the voltage at various points in the unit is shown in fig 19.1. The ac voltage, typically 120 V rms, is connected to a transformer, which steps that ac voltage down to the level for the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit can use this dc input to provide a dc voltage that not only has much less ripple voltage but also remains the same dc value even if the input dc voltage varies somewhat, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of a number of popular voltage regulator IC units.



7.5. 2 IC VOLTAGE REGULATORS:

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. Although the internal construction of the IC is somewhat different from that described for discrete voltage regulator circuits, the external operation is much the same. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage.

A power supply can be built using a transformer connected to the ac supply line to step the ac voltage to a desired amplitude, then rectifying that ac voltage, filtering with a capacitor and RC filter, if desired, and finally regulating the dc voltage using an IC regulator. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milliwatts to tens of watts.

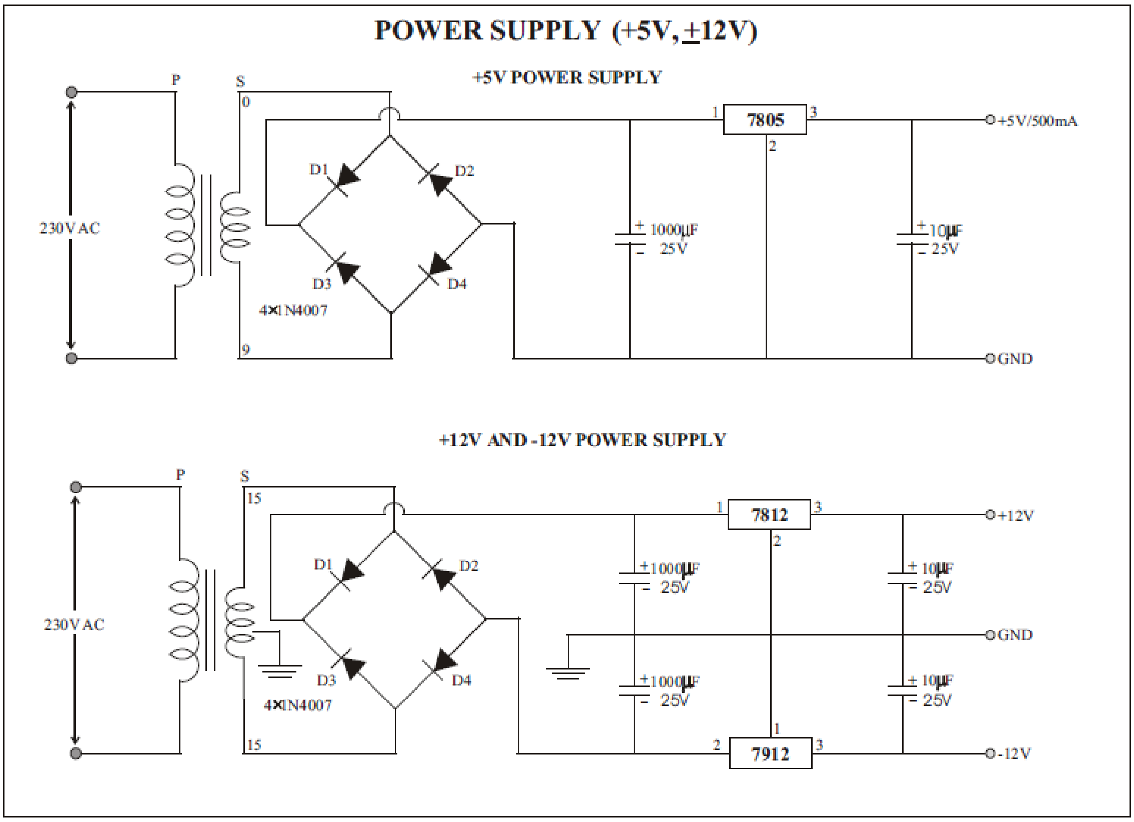
7.6 THREE-TERMINAL VOLTAGE REGULATORS:

Fig shows the basic connection of a three-terminal voltage regulator IC to a load. The fixed voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated output dc voltage, Vo, from a second terminal, with the third terminal connected to ground. For a selected regulator, IC device specifications list a voltage range over which the input voltage can vary to maintain a regulated output voltage over a range of load current. The specifications also list the amount of output voltage change resulting from a change in load current (load regulation) or in input voltage (line regulation).

The series 78 regulators provide fixed regulated voltages from 5 to 24 V. Figure 19.26 shows how one such IC, a 7812, is connected to provide voltage regulation with output from this unit of +12V dc. An unregulated input voltage Vi is filtered by capacitor C1 and connected to the IC's IN terminal. The IC's OUT terminal provides a regulated + 12V which is filtered by capacitor C2 (mostly for any high-frequency noise). The third IC terminal is connected to ground (GND). While the input voltage may vary over some permissible voltage range, and the output load may vary over some acceptable range, the output voltage remains constant within specified voltage variation limits. These limitations are spelled out in the manufacturer's specification sheets. A table of positive voltage regulated ICs is provided in table

7.6.1 Positive Voltage Regulators in 7800 series

IC Part	Output Voltage (V)	Minimum Vi (V)
7805	+5	7.3
7806	+6	8.3
7808	+8	10.5
7810	+10	12.5
7812	+12	14.6
7815	+15	17.7
7818	+18	21.0
7824	+24	27.1



8. CONCLUSION

In this way the venture on Underground link shortcoming recognition utilizing Arduino was done and the separation of the flaw from the base station in kilometers was shown for the three individual stages R,Y and B. Circuit can be tried with various resistor esteems to reenact different deficiency conditions In this task issues up to a separation of 4km can be identified. When the deficiency switches are worked to blame condition then the stage comparing to that specific switch is considered as the flawed stage. So, the flawed segment can undoubtedly be found.

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