PES UNIVERSITY

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Report on

'Automatic Underground Cable Fault Detection'

Submitted by

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under the guidance of

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FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGG

PROGRAM B. TECH

CERTIFICATE

This is to certify that the Report entitled

'Automatic Underground Cable Fault Detection'

is a Bonafede work carried out by

GAYATRI ANIRUDDHA (01FB15EEC081)

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In partial fulfillment for the completion of 8^{th} semester course work in the Program of Study B.Tech in Electronics and Communication Engineering, under rules and regulations of PES University, Bengaluru during the period Jan – Apr. 2019. It is certified that all corrections/suggestions indicated for internal assessment have been incorporated in the report. The report has been approved as it satisfies the 8^{th} semester academic requirements in respect of project work.

Signature with date & Seal	*Signature with date & Seal*	*Signature with date & Seal*
(Prof Santha Meena S)	*Dr. Anuradha M*	*Dr. B. K. Keshavan*
Internal Guide	*Chairperson*	*Dean – Faculty of Engg & Technology*

Name and signature of the examiners:

1.

2.

3.

DECLARATION

We,

GAYATRI ANIRUDDHA (01FB15EEC081)

GOWRI A JOSHI (01FB15EEC082)

*GURU MAHESH D (01FB15EEC083)***,**

hereby declare that the report entitled, '***Automatic Underground Cable Fault Detection'*****,** is an original work done by us under the guidance of **Prof. Santha Meena S**, *Designation*, ECE Department and is being submitted in partial fulfillment of the requirements for completion of 8th Semester course work in the Program of Study B.Tech in Electronics and Communication Engineering.

PLACE: BENGALURU
DATE:

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ABSTRACT

Transmission lines are mainly used to transmit power over large distance with minimum loss.

Transmission lines can be overhead line or underground cables. In modern times. Underground transmission lines have become more common. With the underground cables running across the network, the faults also become more frequent.

Faults in underground lines can be due to over current, over voltage or also under voltage condition. And in cases of fault, as the cable are laid underground, it becomes a huge task to repair the line. Also, the fault detection itself becomes tedious as it involves digging the entire length of the cable line to find out the exact range and hence the location of the fault.

Thus, the main aim of our project is to make the task of tapping the range and hence the location of the fault easier. We implement this by adding substations at equal intervals, across the line. These substations monitor the transmission line for any abnormalities in the current flow of the line. In case of a fault, the substation will report it back to the control station, narrowing down the possible length for fault occurrence.

The faults can be short circuit or open circuit. In our project, we have used switches to create open circuit faults in a common transmission line. In case of open circuit faults, the substations beyond the fault region will not update any value, thereby confirming that there is a fault in that region.

In case of short circuit, we have used 100mA fuses which burn out on over loading. Thus, the last updated time being the moment before short circuit, and the fault is detected as short circuit if all the substations stop updating at once.

The project demonstrates both the conditions of wired and wireless substation. In case of wired substation, a common wire running across substations will carry the station response back to the control station. In case of wireless substation, the updates are sent via a common IP, which is connected to control station through a hotspot.

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1. INTRODUCTION

The need for electric power is continuously growing. And with these growing needs, it becomes necessary to design an effective way of transmitting the generated power. Long distance power transmission can be done through cables. A cable is a bundle of electric conductors carrying electricity. The cables could be either overhead cables or underground cables.

Figure 1.1 – Overhead Transmission Line

Overhead cables, though low cost and easy to install, have their own disadvantages like high risk of safety due to its exposure to external environment, obstructions as it runs over head, vulnerable to environmental extremities.

Thus, underground cables are becoming more popular.

1.1 UNDERGROUND TRANSMISSION LINES

Since the utilization of underground transmission is relied upon to keep developing in prominence, it is imperative to understand what underground electric transmission links are.

An underground transmission line has one or more conductors wrapped in protective cover. The commonly used protective covers for insulation are cambric or impregnated paper.

Below are the few known advantages and disadvantages of underground transmission lines

1.1.1 Advantages: -

- Underground cables are safer compared to underground cables, mainly because they are not exposed to external dangers.

- Maintenance costs of underground cables are much lesser when compared to overhead lines. Though the initial installation cost of underground cables is higher, once installed it is far less likely that the cables should be repaired more often when compared to overhead lines.
- Underground transmission of power is related with unwavering quality. This is on the grounds that occasions of steady disturbance in the supply of power because of issues that are related with overhead transmission lines are not normal when control transmission lines are laid underground.

Underground cables are preferred in urban areas due the stated advantages.

1.1.2 Disadvantages: -

- It is hard to discover and fix the wire breaks if there should be an occurrence of system failure. Additionally, it takes days or weeks to defeat the issue.
- Underground cable system maintenance though cheaper, is more difficult than overhead cables, due to underground cabling.
- Overhead cables can be easily updated to carry more power, which is not the same case when it comes to underground cables.

Figure 1.2 – Underground Transmission Line

Given the problem of detecting system failure in case of underground cable Systems, we have a prototype to make the task simpler.

1.2 TYPES OF FAULT IN UNDERGROUND SYSTEMS

1.2.1 Open Circuit Faults

Open circuit faults occur due to one or more conductor failures. The figure below depicts the open circuit faults for one, two and three conductors present in open conditions.

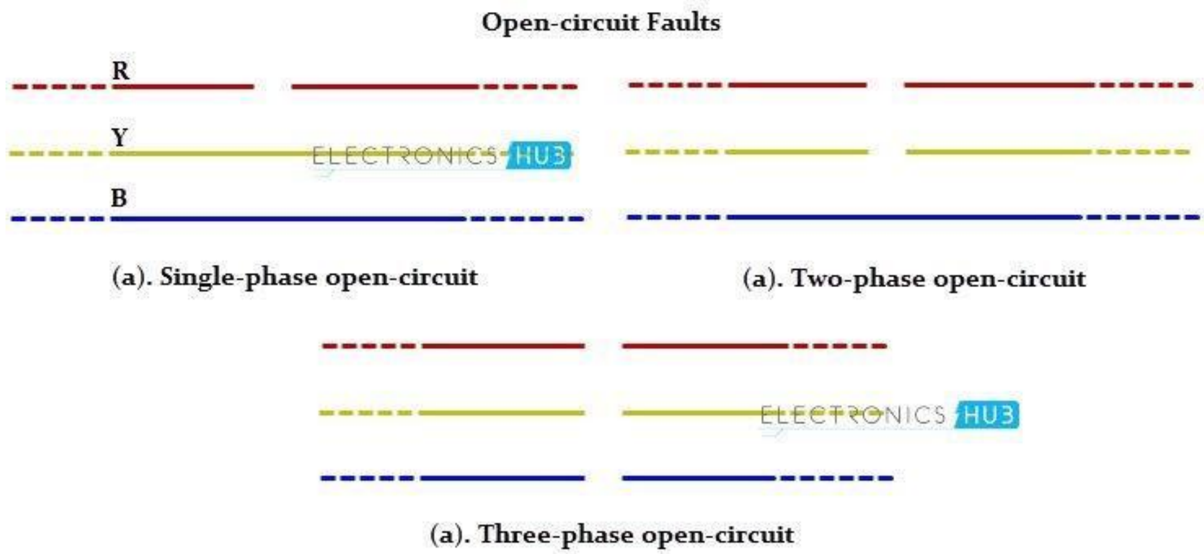

Figure 1.3 – Open Circuit Faults

The main reason for open circuit faults includes joint failure of overhead lines and cables and circuit breaker failure for one or more phases and conductor or fuse melting of one or more phases.

They are known as series faults They are unbalanced except when all phases fail simultaneously.

It can be caused due to malfunctioning of circuit breakers or due to broken conductors

Open circuit faults can be permitted for a prolonged duration when compared to short circuit faults. But they need to be dealt with as soon as possible to avoid great damage.

1.2.2 Short Circuit Faults

A short circuit is described as accidental or intentional connection abnormality of less impedance between two points of various potential. It is usually caused due to high amount of current flowing through the transmission line. It causes extensive damage even if allowed to hold up for a short period of time.

These are also known as shunt faults and are caused due to failure of insulation between the phases or conductors or between ground and the conductors.

The three phase faults clear of earth and the three-phase fault to earth are balanced cable faults. While the other types of faults are unbalanced.

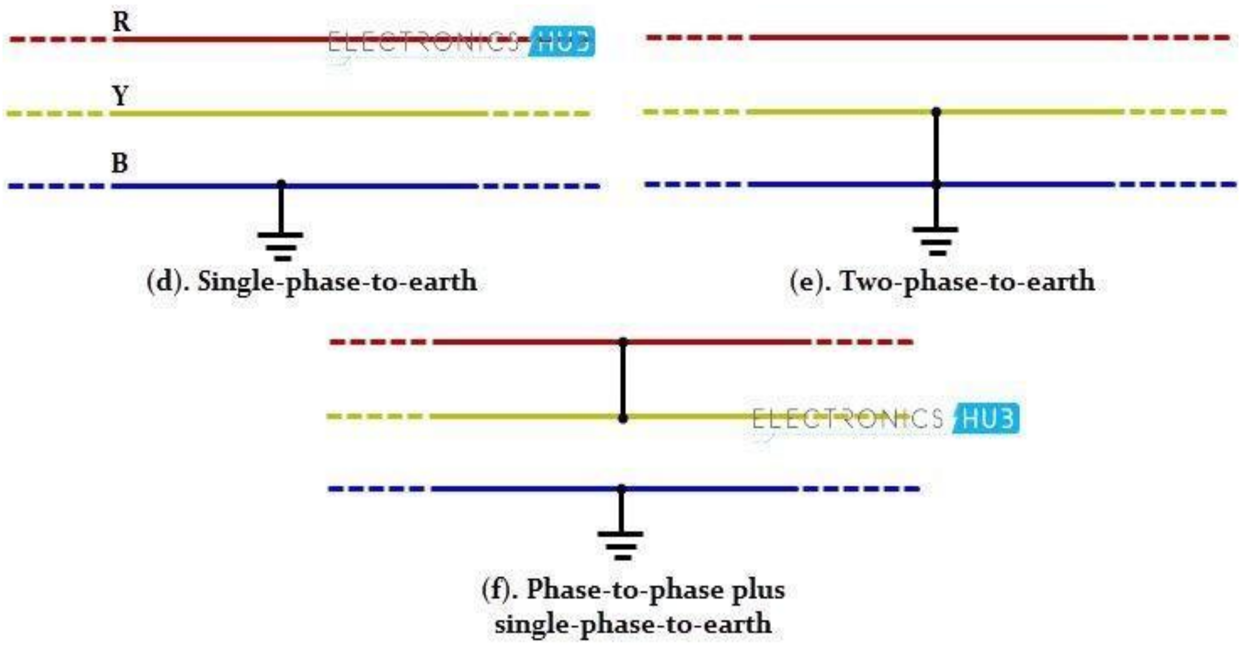

Figure 1.4 – Short Circuit Faults

1.3 DETECTION OF FAULTS

Cable faults can be categorized as:-

1.3.1 Online Method

In this process, we receive and analyze the voltages and current, which are sampled, to detect the location of the fault. This procedure for underground transmission lines are less when compared to the procedures for overhead transmission lines.

1.3.2 Offline Method

Special instruments are used in this method to test the service of the cables in the field. It is further categorized as below

1) Tracer Method
2) Terminal Method

1.3.2.1 Tracer Method

In this method, the cable fault is recognized by walking over the line. The fault is indicated by audible signal or electromagnetic signal. This method is useful to accurately pinpoint the location of the fault.

1.3.2.2 Terminal Method

In this method, the fault location from both ends is detected without tracing. This is used to locate general area of the fault without having to dig the entire length of the buried cable.

1.4 THE PROPOSED SOLUTION

As discussed above, the major problem with the underground cable system is the detecting the system failure. In case of overhead cables, the fault location is easily detected. But in case of any fault in an underground system, the entire length of the cable must be traversed, or even worse, must be dug to find the point of occurrence of the fault as they are buried deep in soil. This causes a huge loss of money and manpower.

So, it becomes necessary to detect the actual location of the fault in case of underground cable systems. Our project aims at reducing the area of fault occurrence by installing underground substations at regular intervals. By continuously monitoring the status of these substations at the control stations, we will be able to narrow down the length of the cable within which the fault might have occurred.

The wired substation data are directly sent to the main station. While the wireless substation data are pushed on to public cloud - ThingSpeak. Finally, both the data from wired and wireless stations are accessed using an MIT app, for convenience.

2. LITERATURE SURVEY

2.1 BASE PAPER: -

"AUTOMATIC UNDERGROUND CABLE FAULT DETECTION WITH SMS ALERT"

N.Gayathri, V.Kowsalya, M.Kalidas, S.Deepika

Student, Pollachi Institute of Engineering and Technology, Pollachi.

Assistant Professor, Pollachi Institute of Engineering and Technology, Pollachi.

The principle objective of this paper is, any distribution network is probably going to get faults, on and off the provider just as client. Significantly a supply line can be influenced by states of over voltage and over current, and furthermore under voltage condition. Amid the occasion of any fault, the occasion goes unreported for long period of time. Manual revealing can prompt long interference. To beat this issue, a framework is built up that will distinguish the progressions in voltage and current rules and utilizing a small-scale controller based circuit. The faults can be ordered dependent on correlation between the qualities got from evaluated rules of the conveyance side electrical cables. At whatever point the preset partitioning line is crossed, the micro controller in a flash starts a message to the zone lineman and the control station expressing the accurate road area where fault is occurring. The genuine motivation behind identifying issue progressively is to secure the transformer at the soonest.

The project uses the simple concept of Ohm's law where allow DC voltage is applied at the feeder end through a series resistor. The current would vary depending upon the length of fault of the cable in case there is a short circuit of LL or 3L or LG etc.

The series resistor voltage drop changes accordingly which is then fed to an ADC to develop precise digital data which the programmed microcontroller would display the same in KM's. The project is assembled with a set of resistors representing cable length in KMs and fault creation is made by a set of switches at every known KM to cross check the accuracy of the same. This is proposed model of underground cable fault using microcontroller. It is classified in four parts -
DC power supply part, cable part, controlling part, display part. DC power supply part consist of ac supply of 230v is step down using transformer, bridge rectifier converts ac signal to dc & regulator is used to produce constant dc voltage. 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 convertor 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 . It is fault occur in relay will be open ,to current flow in open condition .To send a message using GSM Modem in mobile phone, intimate alarm to faulty section ."

2.2 "Industrial Underground Power Cable Fault Identification Using Arduino Controller" by

Prabakaran, Arjun Balage, Joseph Kevin Singh, Muthupattan

The paper is proposed to identify the area of fault in underground link lines from the base station to correct area in kilometers utilizing an Arduino micro controller kit. In the urban zones, the power link keeps running in undergrounds rather than overhead lines. At

whatever point the issue happens in underground link it is hard to recognize the correct fault area for procedure of fixing that specific link. The proposed innovation utilizes Arduino controller to recognize the flaw and it is shown in LCD show in kilometers. Principle preferences of this framework is minimal effort, less intricacy, long remove applications.

Here the current detecting circuits made with a mix of resistors are interfaced to Arduino micro controller unit to help of the internal ADC device for giving digital information to the microcontroller representing the link length in kilometers. The fault creation is made by the arrangement of switches. The relays are controlled by relay driver. A 16x2 LCD show associated with the microcontroller to show the data.

2.3 “Arduino based Underground Cable Fault Detection”

Akash Jagtap,JayeshPatil,BhushanPatil,DipakPatil,Aqib Al HusanAnsari,AtulBarhate

The goal of this paper is to decide the distance of the fault of the underground link in the base station utilizing one kilometer of Arduino board. Underground link framework is a typical practice in numerous urban zones. Regardless of whether a fault happens for reasons unknown, around then the fix procedure identified with this specific link is troublesome as a result of not knowing the definite area of link disappointment. The task utilizes the idea of the Ohms law, when a low voltage toward the finish of the power supply gadget is connected over an arrangement resistor the current changes relying upon the area of the Fault the link. On account of a short out (grounded line), the voltage over the arrangement resistors changes as needs be, at that point contribution to the ADC builds the Arduino board to create precise computerized information for the in kilometer. The venture is mounted with an opposition speaking to the length of the link in KM and making absconds is executed by a lot of switches in each known KM to check its exactness. Disappointment happens at a given separation and the particular stage is shown on a LCD screen associated with the Arduino board.

3.COMPONENT SPECIFICATIONS

3.1 AtMega328 Microcontroller

A microcontroller is a little PC on a solitary consolidated circuit. A microcontroller contains no less than one CPUs (processor focuses) close by memory and programmable information yield peripherals. The ATmega328 is a solitary chip microcontroller made by Atmel. It has a modified Harvard designing 8-bit RISC processor focus.

The Atmel 8-bit AVR RISC-based microcontroller consolidates 32 kB ISP streak memory with read-while-compose capacities, 1 kB EEPROM, 2 kB SRAM, 23 broadly useful I/O lines, 32 broadly useful working registers, three adaptable clock/counters with think about modes, inward and outer intrudes on, sequential programmable USART, a byte-arranged 2-wire sequential interface, SPI sequential port, 6-channel 10-bit A/D converter (8-directs in TQFP and QFN/MLF bundles), programmable guard dog clock with interior oscillator, and five programming selectable power sparing modes. The gadget works between 1.8-5.5 volts. The gadget accomplishes throughput moving toward 1 MIPS for each MHz.

RISC (Reduced Instruction Set Computer) is used in flexible contraptions as a result of its ability adequacy. For Example, Apple iPod and Nintendo DS. RISC is a sort of microchip structure that uses significantly propelled course of action of rules. RISC does the reverse, diminishing the cycles per guidance to the detriment of the quantity of guidance per program. Pipelining is one of the intriguing component of RISC.

3.1.1 PIN DIAGRAM

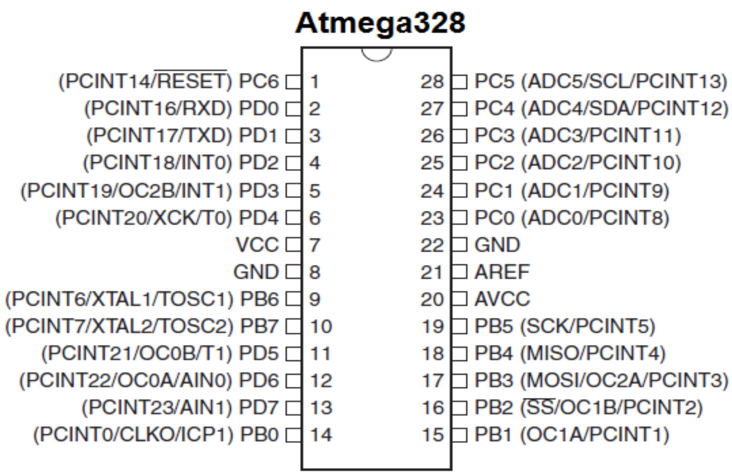

Figure 3.1 – Atmega328

3.1.2 PARALLEL PROGRAMMING MODE:-

Programming signal	Pin name	I/O	Function
RDY/BSY	PD1	O	High means that the MCU is now ready for a new command, otherwise it is busy.
OE	PD2	I	Output Enable (Active low)
WR	PD3	I	Write Pulse (Active low)
BS1	PD4	I	Byte Select 1 (“0” = Low byte, “1” = High byte)
XA0	PD5	I	XTAL Action bit 0

XA1	PD6	I	XTAL Action bit 1
PAGEL	PD7	I	Program memory and EEPROM Data Page Load
BS2	PC2	I	Byte Select 2 (“0” = Low byte, “1” = 2nd High byte)
DATA	PC[1:0]:PB[5:0]	I/O	Bi-directional data bus (Output when OE is low)

3.1.3 SERIAL PROGRAMMING MODE

Symbol	Pins	I/O	Description
MOSI	PB3	I	Serial data in
MISO	PB4	O	Serial Data out
SCK	PB5	I	Serial Clock

3.2 WiFi Module ESP8266

The ESP8266 is a WiFi microchip with full TCP/IP stack along with microcontroller capability. Listed are a few sailent features of Esp8266 : -

- Processor: L106 32-
  bit RISC microprocessor core based on the TensilicaXtensa Diamond Standard 106 Micro running at 80 MHz
- Memory:
  - 32 KiB instruction RAM
  - 32 KiB instruction cache RAM
  - 80 KiB user-data RAM
  - 16 KiB ETS system-data RAM

- External QSPI flash: up to 16 MiB is supported
- IEEE 802.11 b/g/n Wi-Fi
  - Integrated TR switch, balun, LNA, power amplifier and matching network
  - WEP or WPA/WPA2 authentication, or open networks
- 16 GPIO pins
- SPI
- I2C (software implementation)
- I2S interfaces with DMA (sharing pins with GPIO)
- UART on dedicated pins, plus a transmit-only UART can be enabled on GPIO2
- 10-bit ADC (successive approximation ADC)

3.2.1 PIN DIAGRAM

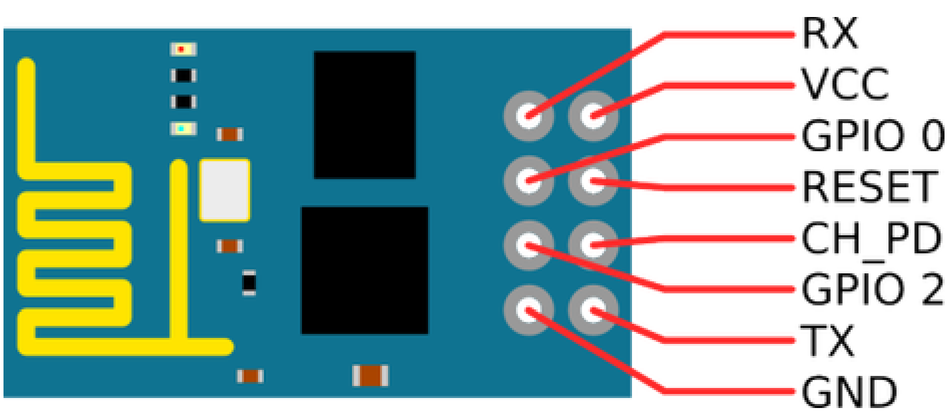

Figure 3.2 – WiFi Module

The pin details are as follows :- "

- VCC, Voltage (+3.3 V; can handle up to 3.6 V)
- GND, Ground (0 V)
- RX, Receive data bit X
- CH_PD, Chip power-down
- TX, Transmit data bit X

  RST, Reset
- GPIO 0, General-purpose input/output No. 0
- GPIO 2, General-purpose input/output No. 2

3.3 Voltage Regulator IC 7805

A voltage controller is a coordinated circuit (IC) that gives an unfaltering fixed yield voltage regardless to an alteration in the heap or info voltage. All voltage sources can't be prepared to give fixed yield in light of differences in the circuit. For getting steady and tenacious yield, the voltage controllers are completed. The organized circuits which are used for the rule of voltage are named as voltage controller ICs.

Here, we can analyze the IC 7805. The voltage controller IC 7805 is extremely a person from the 78xx course of action of voltage controller ICs It is a fixed direct voltage controller The xx present in 78xx addresses the estimation of the fixed yield voltage that the particular IC gives.

For 7805 IC, it is +5V DC coordinated power supply. This controller IC similarly incorporates a game plan for a glow sink. The data voltage to this voltage controller can be up to 35V, likewise, this IC can give an enduring 5V for any estimation of information not a ctually or equal to 35V which is beyond what many would consider possible.

3.3.1 PIN DIAGRAM

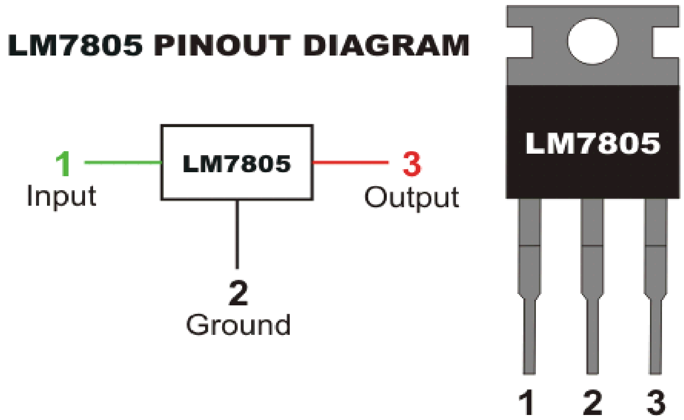

Figure 3.3 – Voltage Regulator

PIN 1-INPUT

The function of this pin is to give the input voltage. It should be in the range of 7V to 35V.Unregulated voltage is applied to this pin for regulation. For 5V input, the PIN achieves its maximum efficiency.

PIN 2-GROUND

Ground is connected to this pin.. For output and input, this pin is equally neutral (0V).

PIN 3-OUTPUT

Regulated output is taken through this pin.

3.4 BRIDGE RECTIFIER

A bridge rectifier is a sort of full wave rectifier which utilizes at least four diodes in a bridge circuit arrangement to efficiently change over the Alternating Current (AC) into Direct Current (DC).

The bridge rectifier is made up of four diodes namely D1, D2, D3, D4 and load resistor RL. The 4 diodes are connected in a closed loop configuration, known as Bridge configuration, to efficiently convert the Alternating Current (AC) into Direct Current (DC).The advantage of this bridge configuration is that it does not require an expensive center tapped transformer, which reduces its cost and size.

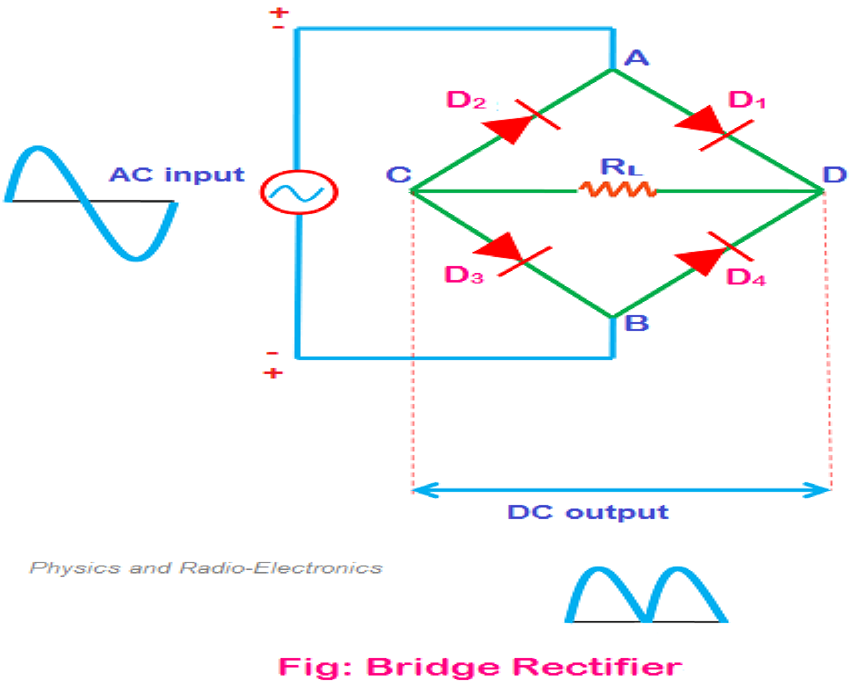

Figure 3.4 Bridge Rectifier

The input AC signal is applied across two terminals A and B and the output DC signal is obtained across the load resistor RL which is connected between the terminals C and D.

The four diodes D1, D2, D3, D4 are arranged in series with only 2 diodes allowing electric current during each half cycle. For example, diodes D1 and D3 are considered as one pair which allows electric current during the positive half cycle whereas diodes D2 and D4 are considered as another pair which allows electric current during the negative half cycle of the input AC signal.

4. METHODOLOGY PROPOSED

4.1: Introduction -

Any network is likely to get faults. A supply line can be affected by:

1.over voltage

2.over current,

3.under voltage condition.

Here, we are trying to develop a system that will detect the changes ***in voltage and current*** using a micro controller-based circuit.

Whenever a fault is detected, the microcontroller instantly sends a message to the control station giving the exact range of the fault.

Our aim is to get the “EXACT” range of the fault, without digging up the entire area!We develop “systems” which are placed at equal intervals between the source and the destination of a Transmission line.These systems will record real time values of the transmission line.The difference in these values will lead us to the faults and the locations of the same!

4.2 Explaining with an Example -

A transmission line is set up from PES University to Town Hall. This spans around 8 KM. We place our systems, approximately every 2 km from the source to the destination. Thus, every time there is a fault that occurs, we don’t have to dig up the entire area. We just have to dig up the relevant region. In case, we want to improve the efficiency of the system, we can place the system after every 1.5 kms or 1 km.

Below, is an image showing the approximate distance and time taken for travel.

Figure 4.1 Transmission Line Example

4.3 Proposed Solution

4.3.1 Proposed Solution - Wired Systems.

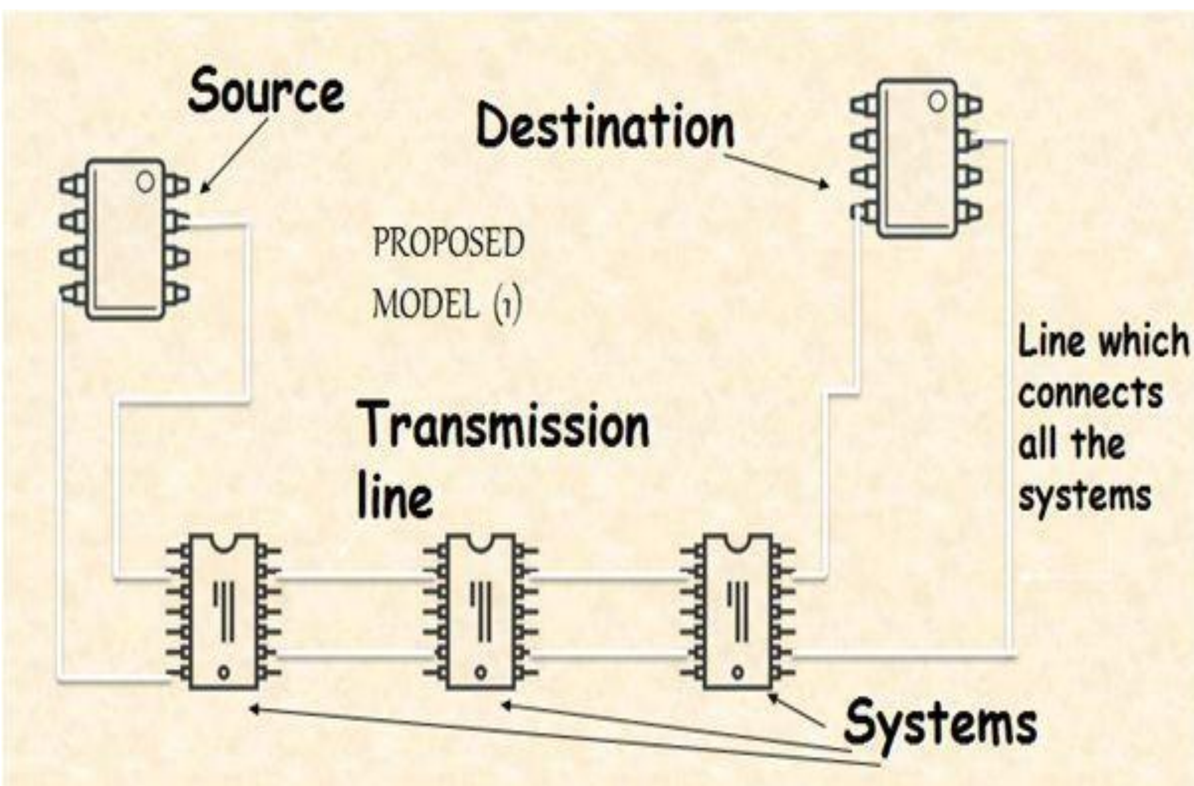

Figure 4.2 – Proposed Solution 1

Here, we can see the following components in the diagram:

1) Source
2) Destination
3) Transmission Line
4) Sub - systems
5) Line which connects all the sub - systems.

Thus, this picture gives a rough idea of how we are going to proceed in this project. These sub stations are going to be connected to each other with the help of a wire. The communication between these sub stations is going to be wired.

4.3.2 Proposed Solution - Wireless Sub Station

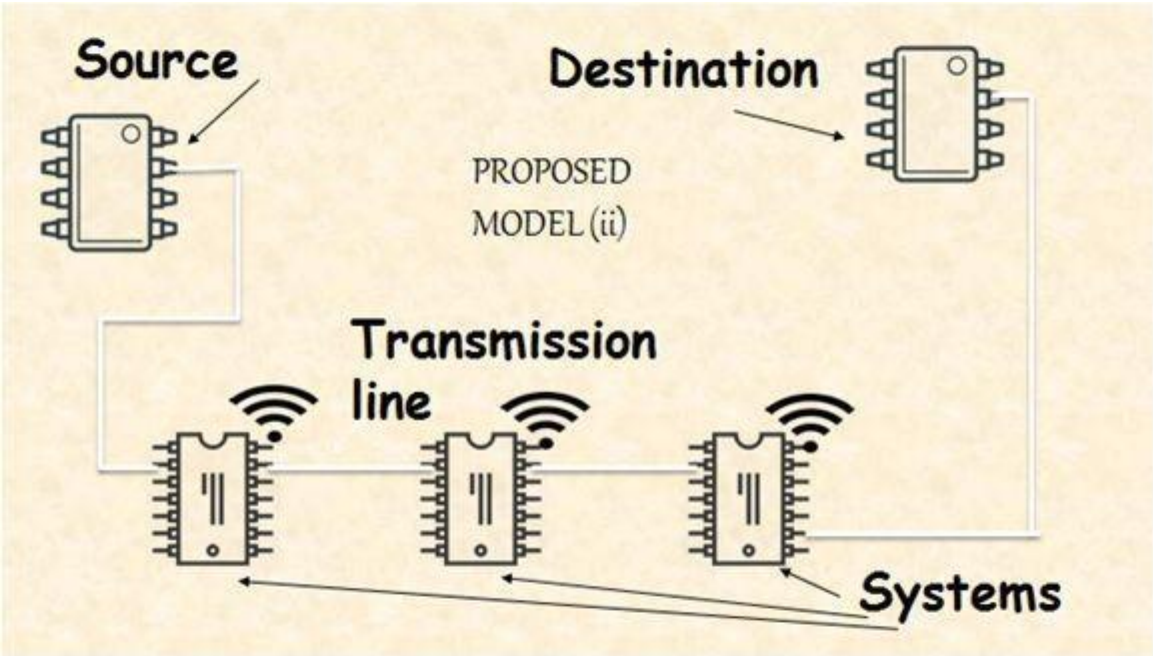

Figure 4.3 – Proposed Solution 2

Here, the different substations are going to communicate with each other in a "Wireless" manner. Here, they are going to communicate with each other using the WiFi Module, which would be explained in detail, later in the report.

4.3.3 Final Proposed Circuit Diagram

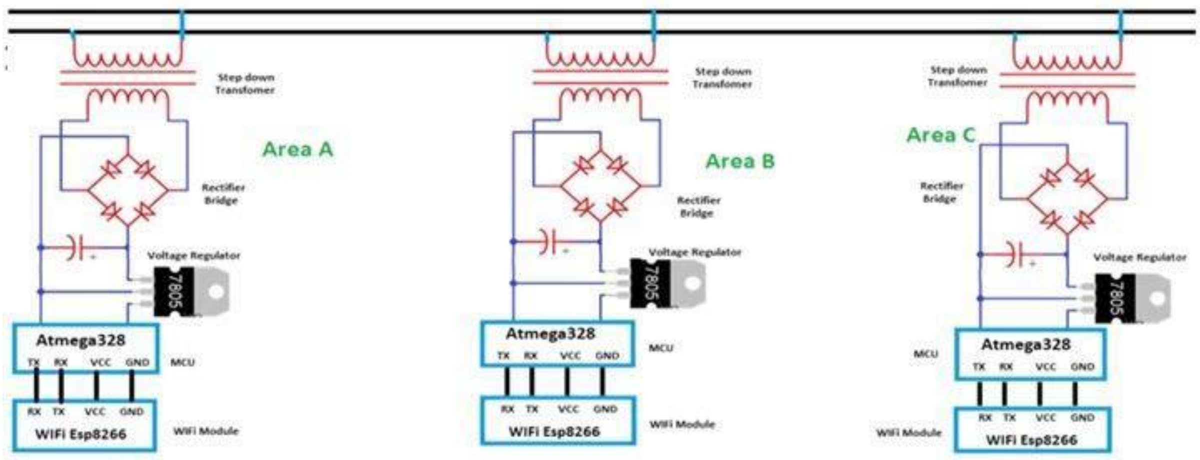

Figure 4.4 – Final Circuit Diagram

This diagram shows a picture of our proposed circuit diagram. Here, the three areas indicate the three substations which we are going to deploy between the source and the destination. Each of these sub stations have a Step-Down Transformer, rectifier, filter, voltage regulator, microcontroller Atmega328 and a WiFi Module Esp8266. Below, we have mentioned the use of each of the components. Taking one sub system at a time,

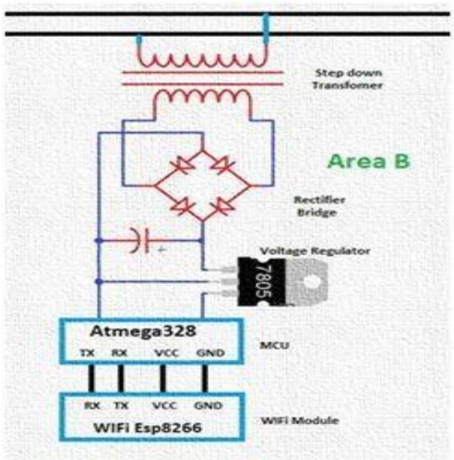

Figure 4.5 – Single Sub Station Diagram

1. **Step Down Transformer** – To step down 220V AC to a 12V AC which is supported by the hardware.
2. **Rectifier** – IN4007. It is a bridge rectifier used to convert 12V AC to a 12V DC.
3. **Filter** – 1000 Micro Farad/ 25V capacitor, connected in parallel, to remove all the AC components from the rectifier output.
4. **Voltage Regulator**- IC 7805. It maintains an input voltage level of 5V.
5. **Microcontroller Atmega328**: This takes care of all the Analog to digital conversion and other calculations.
6. **Wi-Fi Module Esp8266**: This transmits data to the control station from each substation.

4.3.4 Wireless Sub Station:

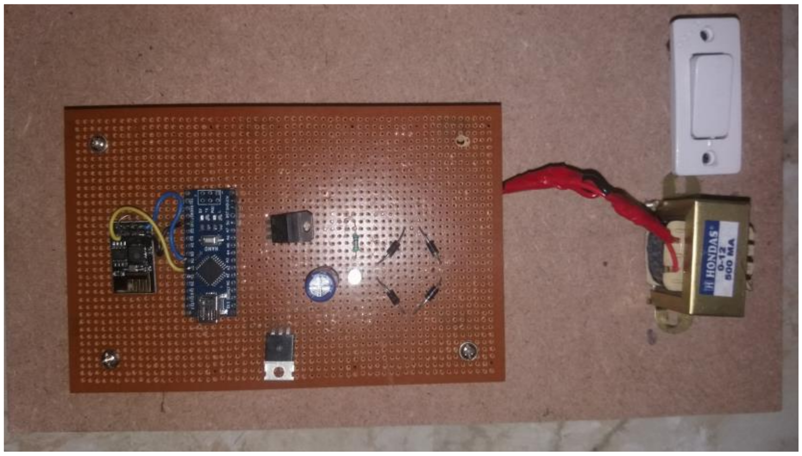

Figure 4.6 – Wireless Sub Station

4.3.5 Wired Sub Station:

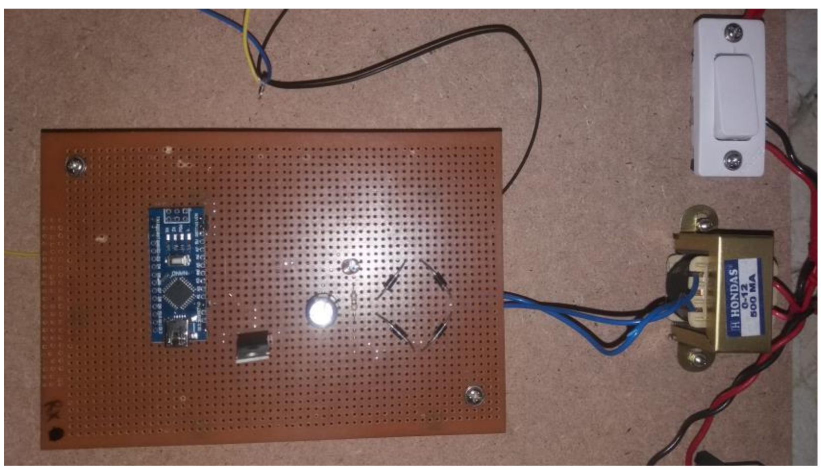

Figure 4.7 – Wired Sub Station

4.3.6 Overall Diagram:

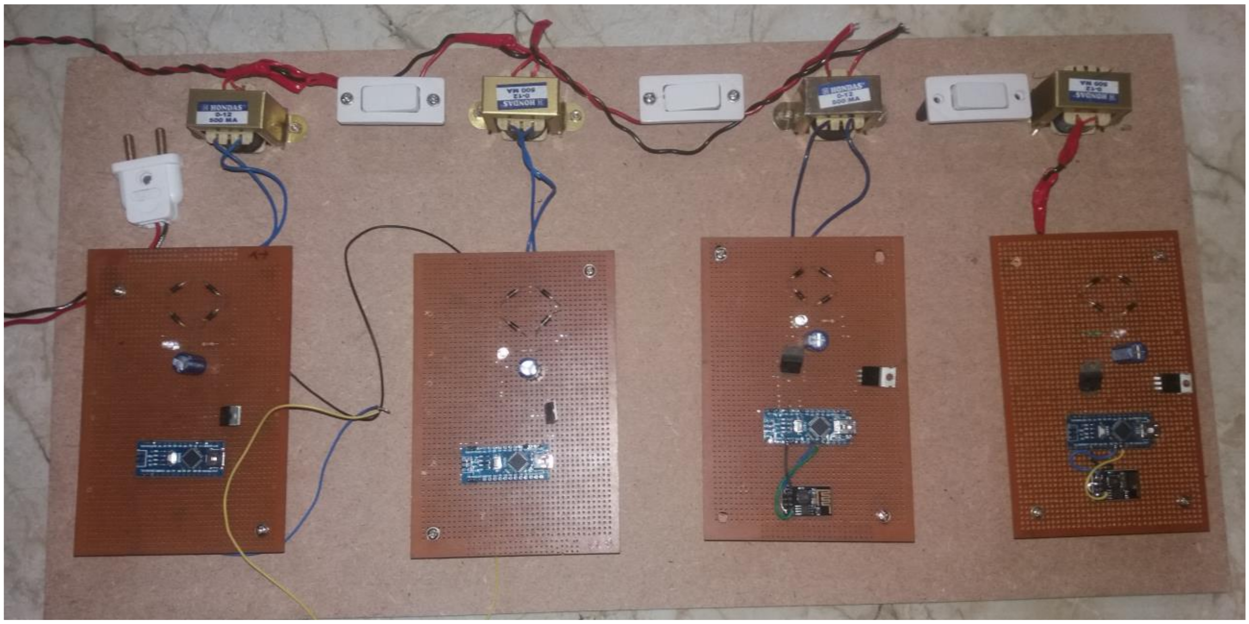

Figure 4.8 Overall Diagram

4.3.7 How exactly are we saving the distance by employing these sub systems?

Imagine the distance between our Source and Destination is 10 Km. Say, we have installed 3 sub – systems in between. In case of a fault, we don't have to dig up the entire distance: 10 km. We will at max, must dig up only 3 km. If we want more precision, we will have to increase the number of sub systems that we install. We can then install sub stations for every 2 or 1.5 km.

4.4 Use of Voltage Regulator 7805 vs Voltage Divider Circuit :

Volage Regulator Circuit :

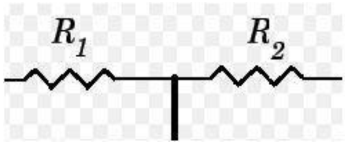

Figure 4.9 – Voltage Divider Circuit

7805 Circuit :

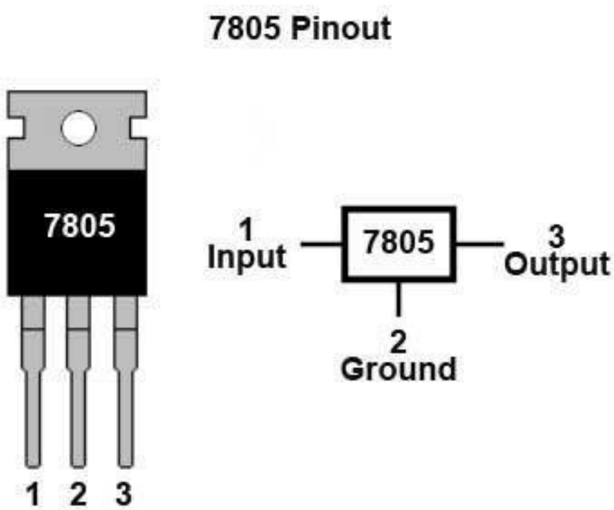

Figure 4.10 7805 Circuit

Here, 7805 is a Voltage Regulator. We need it to detect the voltage level. However, If we need to determine the exact Voltage Levels, we will use a voltage divider circuit, instead of Voltage Regulator.

In a voltage divider circuit, we will use 2 Resistances. It will scale the Input Voltage between 0 to 5V.

- 220 V will be mapped to -> 5V
- 110 V will be mapped to -> 2.5V

4.5 Handling Short Circuit Faults

Figure 4.11

Here, we have proposed a solution for handling short circuit faults in the Underground Cable. We have mentioned the reasons when Short Circuit Faults occur and have then proposed our solution for the fault.

When the two live wires come in contact with each other because of wear and tear of insulation around the wires, it leads to short circuit. Short circuit makes the voltage across the cable to drop to zero.This can be avoided by using a ***circuit breaker circuit*** in each substation.

The circuit breaker in the substation would hold on the voltage turning to zero further from our substation. This will help us in finding the location of the fault.

5. WORKING OF THE SUB STATIONS

5.1 Diagram

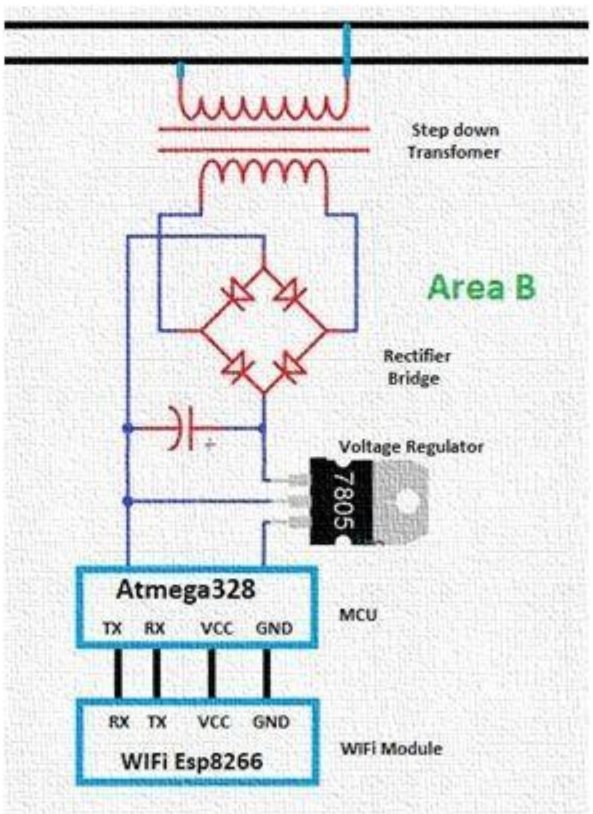

Figure 5.1 Wireless Sub Station Diagram

Working of each Sub Station -

Four wires between Atmega328 and WIFI Module: Tx, Rx, VCC and Ground.

Atmega328

Tx line is connected to Wi-Fi 33 Module's Rx. Similarly, WIFI Module's Tx line is connected to Atmega328's Rx line. Any fault that occurs in Atmega328, it will be written onto the WI-FI Module. Wi-Fi Module is connected with any Wi-Fi router or hotspot.

In case of hotspot connection, we will get dedicated IP for each of the areas. With the help of these IPs, we will get the status of these areas. If the status is 1: Till that Area, transmission is Okay, "No Fault". If the status if 0: Some fault is there from that point.

5.2 Flow Charts

We have also included the relevant Flow Charts for the working of the Wired and Wireless Sub Systems.

5.2.1 Wired Sub Systems Flow Chart

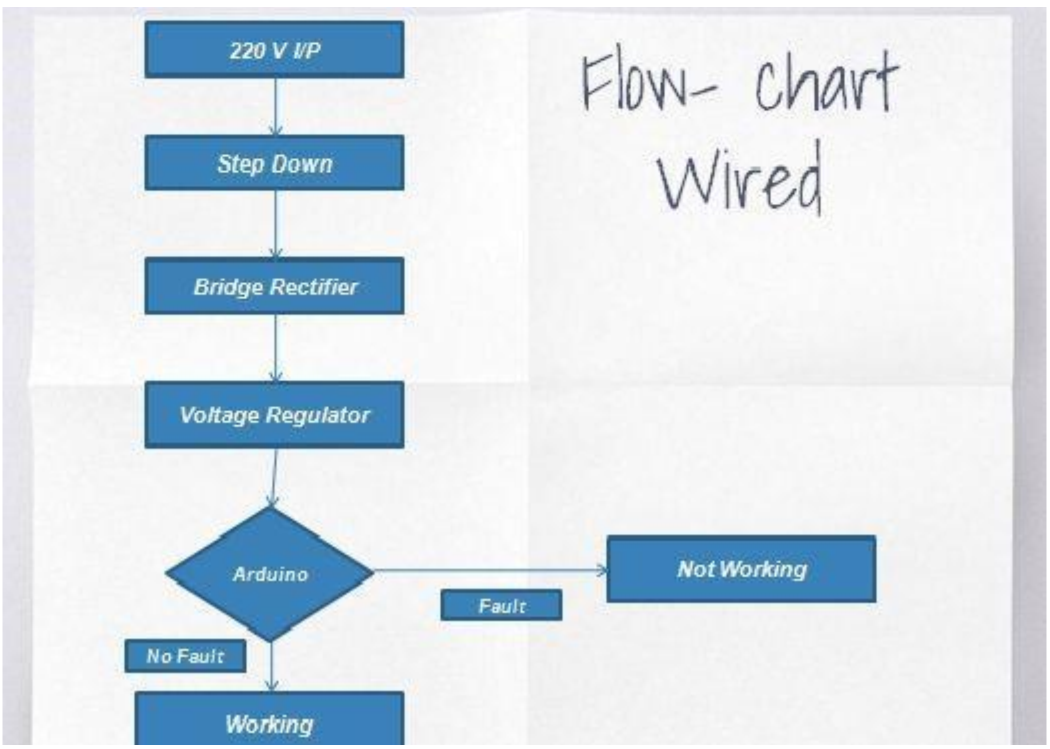

Figure 5.2 Wired Sub Station Flow Chart

Here, the 220 V Input is stepped down and then given to the Bridge Rectifier. Then, it is further given to the Voltage Regulator. From there, it is detected by the Arduino. In case, if there is no fault, the system is working. In case there is a fault, the system does not work. Thus, the flow is relatively simpler when compared to the flow of a Wireless Sub System

5.2.2 Wireless Sub Systems Flow Chart

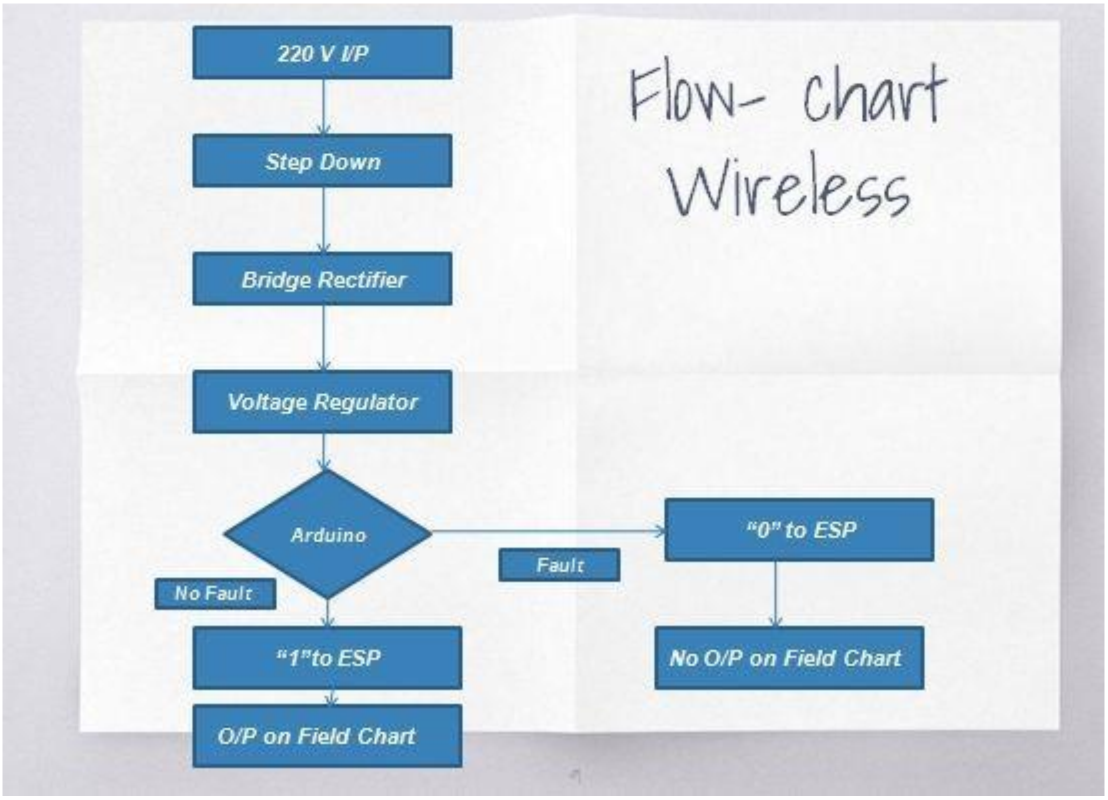

Figure 5.3 Wireless Sub Station Flow Chart

Here, the 220 V Input is stepped down and then given to the Bridge Rectifier. Then, it is further given to the Voltage Regulator. From there, it is detected by the Arduino. In case there is a fault, “0” is sent to the ESP and there is no Output on the Field Chart. Similarly, when there is a fault, “1”is sent to the ESP, and we can observe some Output on the Field Chart.

6. WORKING OF THE APP

Currently the wired substation output is on the serial monitor. We aim to get the output on a platform where the output can be accessed from anywhere and anytime. The platform would be in the form of a mobile application through the online cloud platform. Here, the Arduino output would be connected to the Python program, which would be connected to Firebase which would be later connected to the MIT Inventor App. The flow chart of the Working of the mobile application is as follows:

6.1 Wired Substation Flow Chart:

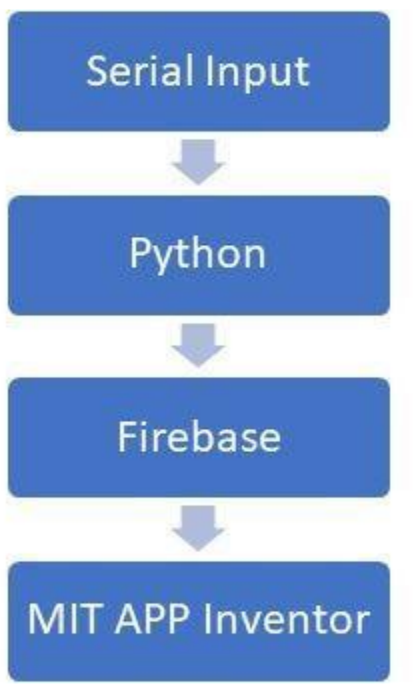

Figure 6.1 – Wired Subsystem Flow Chart

The wired Output which is initially displayed in the Serial Monitor can now be viewed in the MIT Inventor App.

6.1.1 Python

It is a high level, Interpreted, General Purpose Programming language. The Python code written is responsible for sending the serial output from the Arduino to the online database i.e Firebase.

6.1.2 Firebase:

It provides a real time database and backend as a service. This service allows application developers an Application Interface Program that allows user to synchronize data across clients and to store on Firebase cloud. This firebase acts as a bridge between the python Program and the MIT APP Inventor and stores the real time statuses of the substations that are connected through the transmission line. It provides a URL for the project created which is used in the python program for connecting to the database. It also provides a WEB API Key that helps us to connect to the MIT APP Inventor.

Firebase Platform:

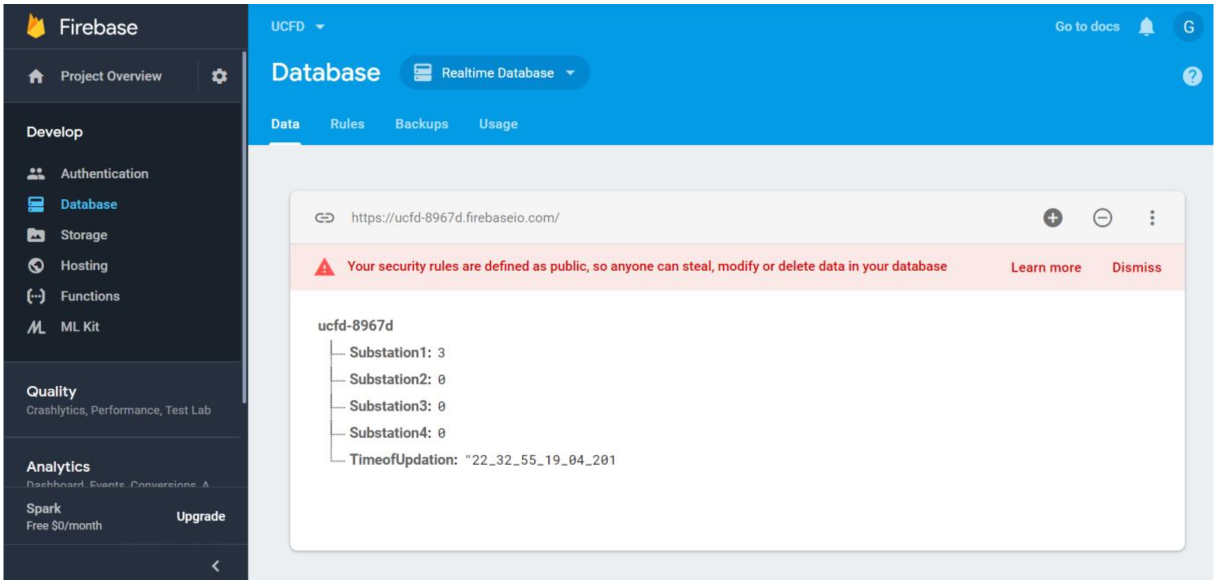

Figure 6.2 Firebase Platform

6.1.3 MIT APP INVENTOR:

It is an intuitive, visual programming environment that allows us to build fully functional apps for smartphones and tablets. The blocks-based tool facilitates the creation of complex, high-impact apps in significantly less time than the traditional programming environments. This is the end platform that a user can visualize about the status of the substation. The backend part of the application is written in code blocks.

Codeblocks:

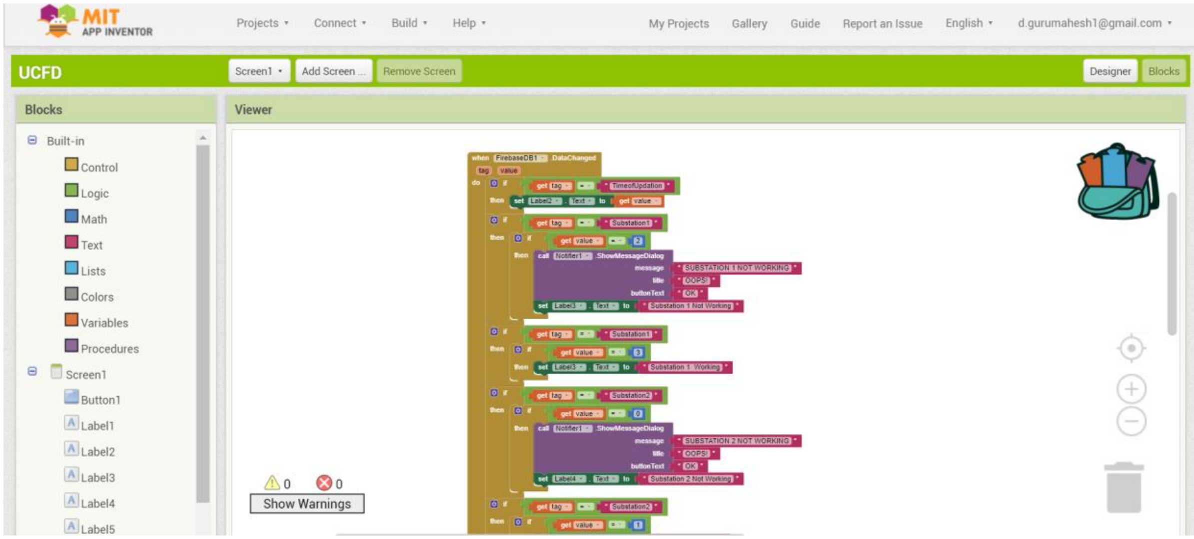

Figure 6.3 MIT App Inventor I

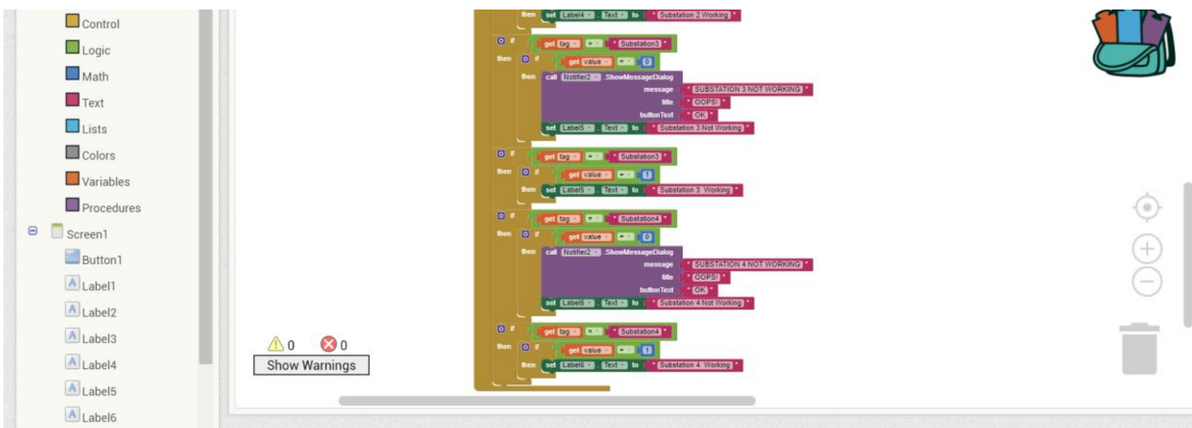

Figure 6.4 MIT App Inventor II

6.2 Wired Substation output:

Front end of app would contain the status of the substations:

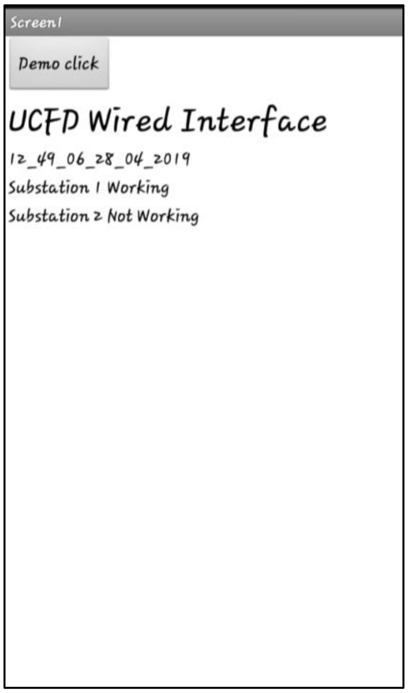

Figure 6.5 – App Messages

It would also show a notification if the Substation stopped working:

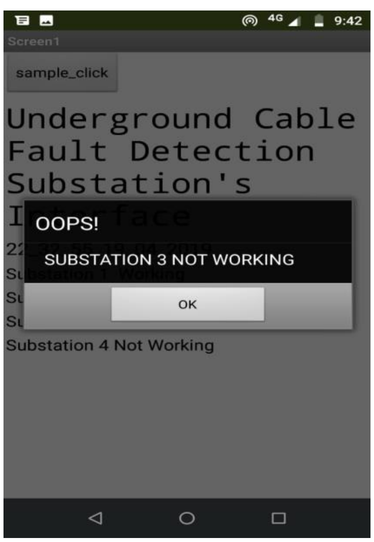

Figure 6.6 – App Notification

6.3 Wireless Substation output:

The Wireless Substation output is shown in the platform ThingsSpeak. The field acts as a channel and each field represents a different Substation. When the substation is ON the channel gets updated with value 1 else the updation stops. Thus, the Status of Substation is Interpreted by the last time of updation

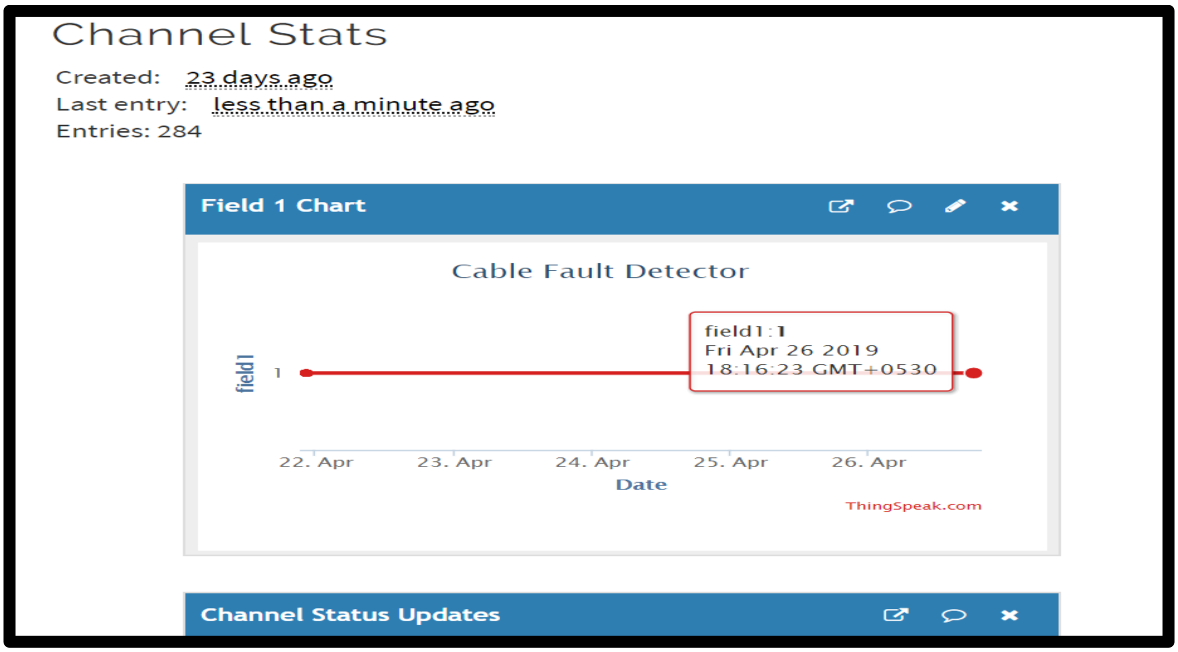

Figure 6.7 Channel Status Information ThingsSpeak

7. RESULT AND ANALYSIS

We have implemented the following:

○ "Open Circuit Faults" - A small demo of the same using using switches.

○ "Short Circuit Faults"- A small demo of the same using a 3V DC supply and a 100mA fuse.

Whenever, there is a fault between the sub-stations, we are immediately notified. The Output of the Wired sub - station is captured on the Arduino Serial Monitor which is sent to the firebase cloud which is in turn linked to MIT App Inventor where we can see the output in the mobile Application. The figure below shows the screen of the mobile application where one can see the statuses of the substation.

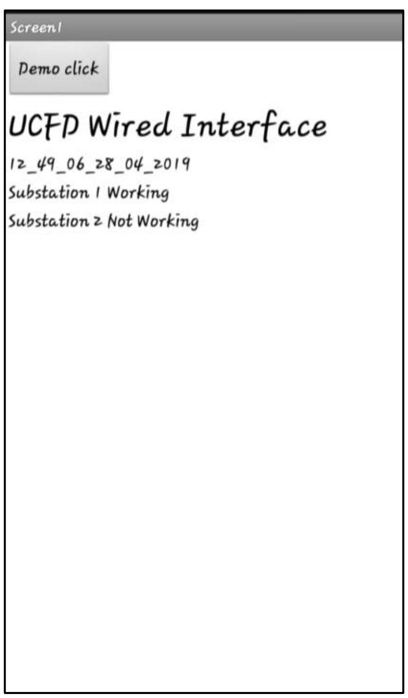

Figure 7.1 – App Messages

The Output of the Wireless sub - station is captured on the cloud. The status of each wireless substation gets updated in the Things Speak platform as shown in the below diagram.

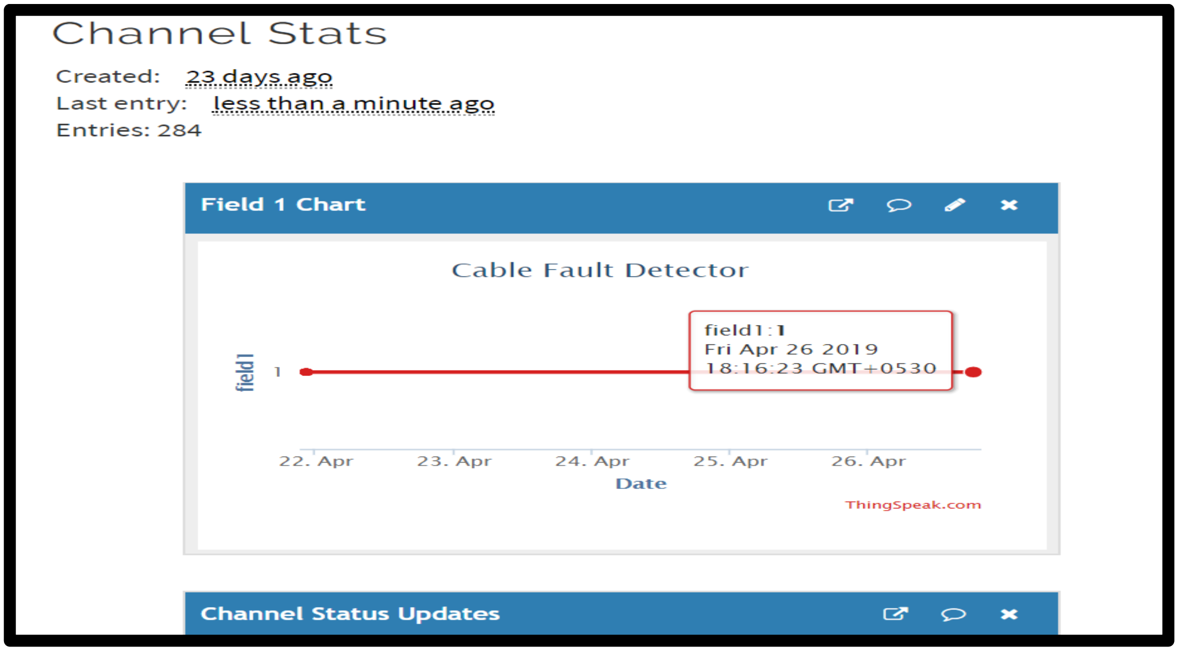

Figure 7.2 Channel Status Information ThingsSpeak

Hence, we need to further look at only the required area or region of fault by analyzing the outputs from the cloud platform.

8. FUTURE SCOPE

Thus, we can implement this project in rural, urban and industrial areas where a lot of Underground Cables have been laid for Transmission. These Systems should be made easily available by the Government as they have the following advantages :

- ○Lesser Cost.
- ○Higher Efficiency.
- ○Provides Improved Public Safety.
- ○Applicable for all types of cables and all types of faults.

9. REFERENCES

[1] International Research Journal of Engineering and Technology (IRJET), Volume: 05 Issue: 02 | Feb-2018 "AUTOMATIC UNDERGROUND CABLE FAULT DETECTION WITH SMS ALERT"

N.Gayathri, V.Kowsalya, M.Kalidas : Students, Pollachi Institute of Engineering and Technology, Pollachi.
S.Deepika, Assistant Professor, Pollachi Institute of Engineering and Technology, Pollachi.

[2] "A Bayesian Approach for fault location in medium voltage grids with underground cables" IEEE Power and Energy Technology system Journal Volume 2,No.4 December 2016

Yu Xiang and Joseph F.G.Cobben

[3] "Fault detection technique to Pinpoint Incipient Fault for Underground Cables" , International Journal of Engineering Research and General science volume 3 issue 3, May-June, 2016

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[4] "Design and implementation of wireless live wire fault detector in remote areas" IEEE (2015), Vol 97, No 17

Raghu Raja Kalia,Preeti Abrol

10. APPENDIX

Data Sheet for Atmega328 Microcontroller

Features

- High Performance, Low Power AVR® 8-Bit Microcontroller
- Advanced RISC Architecture
  - 131 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 20 MIPS Throughput at 20 MHz
  - On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory Segments
  - 4/8/16/32K Bytes of In-System Self-Programmable Flash progam memory (ATmega48P/88P/168P/328P)
  - 256/512/512/1K Bytes EEPROM (ATmega48P/88P/168P/328P)
  - 512/1K/1K/2K Bytes Internal SRAM (ATmega48P/88P/168P/328P)
  - Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
  - Data retention: 20 years at 85°C/100 years at 25°C[1]
  - Optional Boot Code Section with Independent Lock Bits
    In-System Programming by On-chip Boot Program
    True Read-While-Write Operation
  - Programming Lock for Software Security
- Peripheral Features
  - Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
  - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
  - Real Time Counter with Separate Oscillator
  - Six PWM Channels
  - 8-channel 10-bit ADC in TQFP and QFN/MLF package
    Temperature Measurement
  - 6-channel 10-bit ADC in PDIP Package
    Temperature Measurement
  - Programmable Serial USART
  - Master/Slave SPI Serial Interface
  - Byte-oriented 2-wire Serial Interface (Philips I²C compatible)
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - On-chip Analog Comparator
  - Interrupt and Wake-up on Pin Change
- Special Microcontroller Features
  - Power-on Reset and Programmable Brown-out Detection
  - Internal Calibrated Oscillator
  - External and Internal Interrupt Sources
  - Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby
- I/O and Packages
  - 23 Programmable I/O Lines
  - 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF
- Operating Voltage:
  - 1.8 - 5.5V for ATmega48P/88P/168PV
  - 2.7 - 5.5V for ATmega48P/88P/168P
  - 1.8 - 5.5V for ATmega328P
- Temperature Range:
  - -40°C to 85°C
- Speed Grade:
  - ATmega48P/88P/168PV: 0 - 4 MHz @ 1.8 - 5.5V, 0 - 10 MHz @ 2.7 - 5.5V
  - ATmega48P/88P/168P: 0 - 10 MHz @ 2.7 - 5.5V, 0 - 20 MHz @ 4.5 - 5.5V
  - ATmega328P: 0 - 4 MHz @ 1.8 - 5.5V, 0 - 10 MHz @ 2.7 - 5.5V, 0 - 20 MHz @ 4.5 - 5.5V

8-bit AVR® Microcontroller with 4/8/16/32K Bytes In-System Programmable Flash

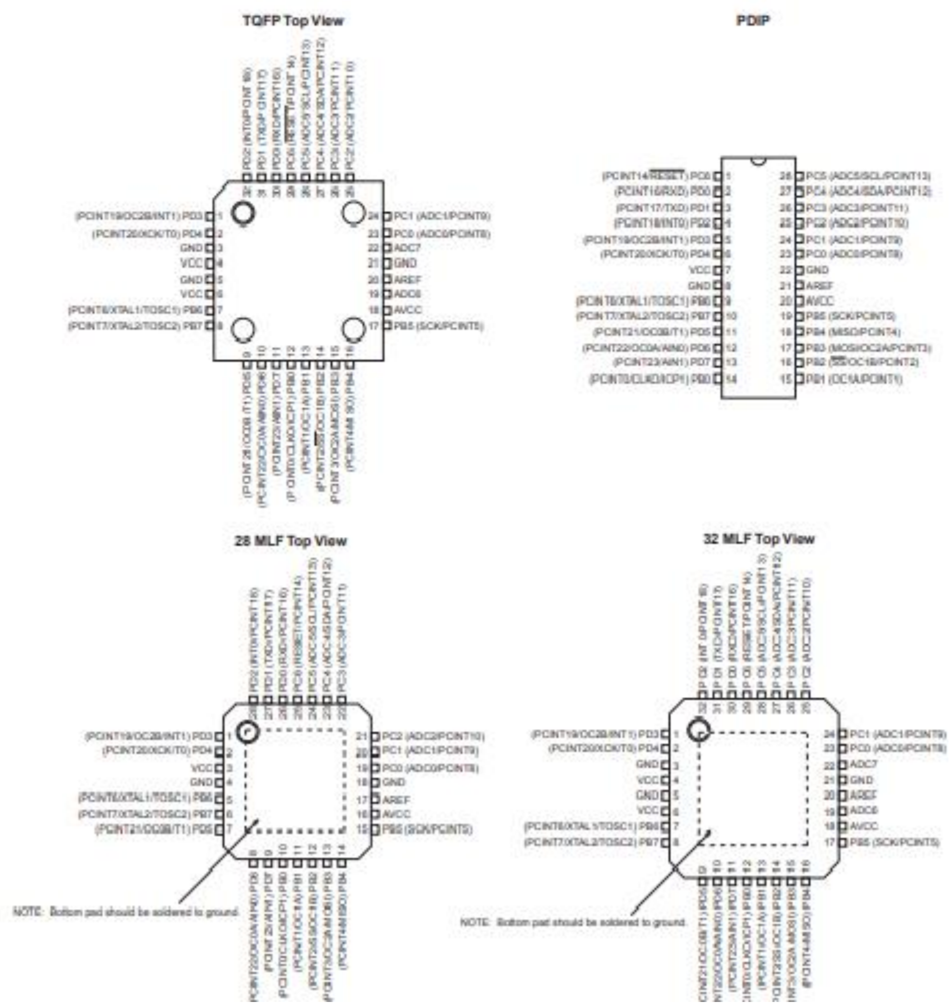
ATmega48P/V*
ATmega88P/V*
ATmega168P/V
ATmega328P**

****Preliminary**

* Not recommended for new designs.

1. Pin Configurations

Figure 1-1. Pinout ATmega48P/88P/168P/328P



1.1 Pin Descriptions

1.1.1 VCC

Digital supply voltage.

1.1.2 GND

Ground.

1.1.3 Port B (PB7:0) XTAL1/XTAL2/TOSC1/TOSC2

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Depending on the clock selection fuse settings, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

Depending on the clock selection fuse settings, PB7 can be used as output from the inverting Oscillator amplifier.

If the Internal Calibrated RC Oscillator is used as chip clock source, PB7..6 is used as TOSC2..1 input for the Asynchronous Timer/Counter2 if the AS2 bit in ASSR is set.

The various special features of Port B are elaborated in "Alternate Functions of Port B" on page 82 and "System Clock and Clock Options" on page 26.

1.1.4 Port C (PC5:0)

Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC5..0 output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

1.1.5 PC6/$\overline{\text{RESET}}$

If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C.

If the RSTDISBL Fuse is unprogrammed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running. The minimum pulse length is given in Table 26-3 on page 320. Shorter pulses are not guaranteed to generate a Reset.

The various special features of Port C are elaborated in "Alternate Functions of Port C" on page 85.

1.1.6 Port D (PD7:0)

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

The various special features of Port D are elaborated in "Alternate Functions of Port D" on page 88.

1.1.7 AV_{CC}

AV_{CC} is the supply voltage pin for the A/D Converter, PC3:0, and ADC7:6. It should be externally connected to V_{CC}, even if the ADC is not used. If the ADC is used, it should be connected to V_{CC} through a low-pass filter. Note that PC6..4 use digital supply voltage, V_{CC}.

1.1.8 AREF

AREF is the analog reference pin for the A/D Converter.

1.1.9 ADC7:6 (TQFP and QFN/MLF Package Only)

In the TQFP and QFN/MLF package, ADC7:6 serve as analog inputs to the A/D converter. These pins are powered from the analog supply and serve as 10-bit ADC channels.

2. Overview

The ATmega48P/88P/168P/328P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega48P/88P/168P/328P achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

"AUTOMATIC UNDERGROUND CABLE FAULT DETECTION"

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