Electronic Workshop - 2
Project Report

Home Automation (Power Line Communication)

INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY

HYDERABAD

Department of Electronics And Communication Engineering

Submitted By

Aditya Aggarwal (20161129)
Unni Krishnan R Nair (20171405)

Abstract

With the increasing number of wirelessly connected devices around us and limited frequency bands available there is a need for an alternative which transmits data without wiring. Then comes into the picture Power Line Communication(PLC).The system uses power lines that are already installed in our houses thus being the best solution for Home Automation Wiring.

In our system we use the method of Frequency Shift Keying (FSK) to send the data over power lines. For this a transmitter circuit is a fsk modulator and receiver circuit is a fsk demodulator. Then the receiver circuit is connected to an arduino which then controls the PWM input to the motor.

Acknowledgement

The success and final outcome of this project required a lot of guidance and assistance from many people and we are extremely privileged to have got this all along the completion of my project. All that we have done is only due to such supervision and assistance and we would not forget to thank them.

We would like to express our special thanks of gratitude to our teachers Dr. Syed Azeemuddin and Dr. Zia Abbas for providing us this golden opportunity to do the project work. We would also like to thank Dr. Madhava Krishna for being our project mentor and giving us all support and guidance which made us complete the project duly.

We owe our deep gratitude to the TA's, who took keen interest on our project work and guided us all along, till the completion of our project work by providing all the necessary information for developing a good system. We would also thank our lab assistants for providing us with the required assistance and resources for this project.

ADITYA AGGARWAL
UNNI KRISHNAN R NAIR

Contents

Introduction

The number of wirelessly connected devices are increasing day by day at a rapid rate. An average household has at least 24 electronic and electrical appliances and assuming a range of 46 m at least 2 houses falling in that range we are up to 48 appliances in a given bandwidth which can potentially slow down networks...

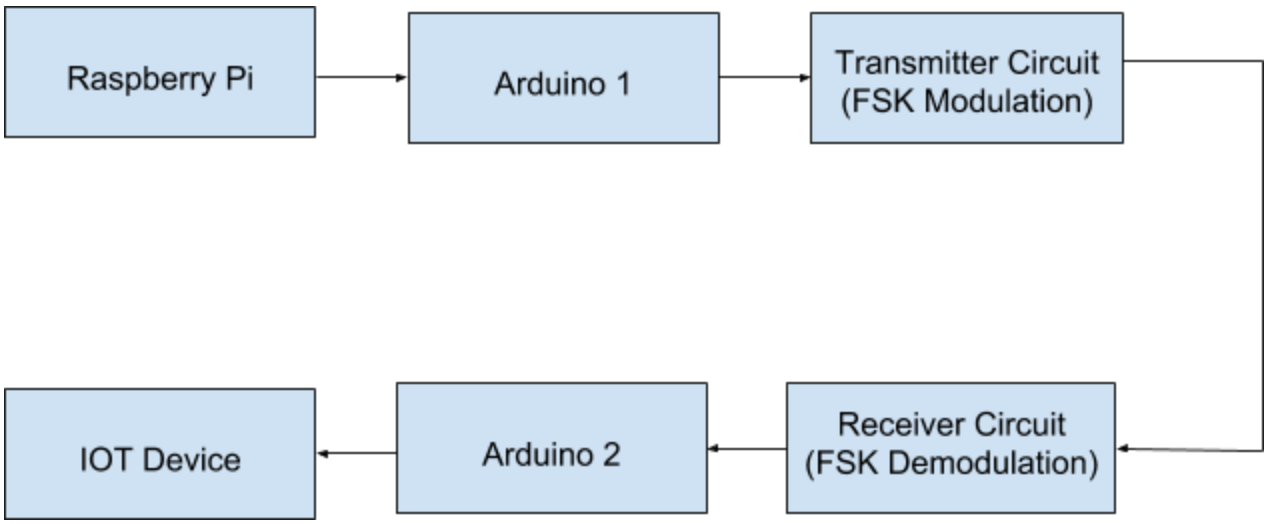
Thus too many wirelessly connected devices can hog too much of wireless frequency bands and ultimately slow down the network. So how do we enable data communication then. One possible solution is to wire them up. But too many wires will create cluster and the advantages of wireless communication will be lost. So Power Line Communication is the best alternative for this problem in IOT domain. In PLC, data is transmitted over the existing power lines thus removing the problem of laying new wires. All devices are connected to the same line and standards can be maintained to avoid interference within communication.

The objectives of the project are:

- To implement Power Line Communication in the field of IOT.
- To control the speed of motor using the PLC communication over transmitter and receiver circuit.

Implementation

So here is the block diagram of how the various subsystems are connected in our system.



Raspberry Pi

Wirelessly collects data from the user and then transmits it to the Arduino 1. It just acts as a wireless channel which takes data from user (through laptop in our case) and then without any modification passes it onto the arduino.

Arduino 1

After receiving the data from pi arduino converts it into a message signal which is a square wave of coded frequency. Next this message signal along with its inverted form is fed to the transmitter circuit.

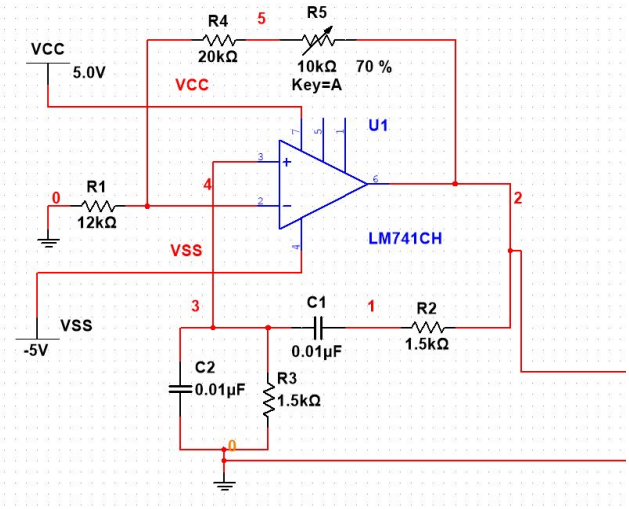
Transmitter Circuit

It is a FSK Modulator which converts the message signal into a modulated wave of frequencies 1.4Khz and 9Khz. FSK Modulation is preferred over Amplitude Modulation because amplitude of wave is not stable and changes over time thus resulting in unstable transmission. In our case logic ‘0’is coded as 1.4Khz signal

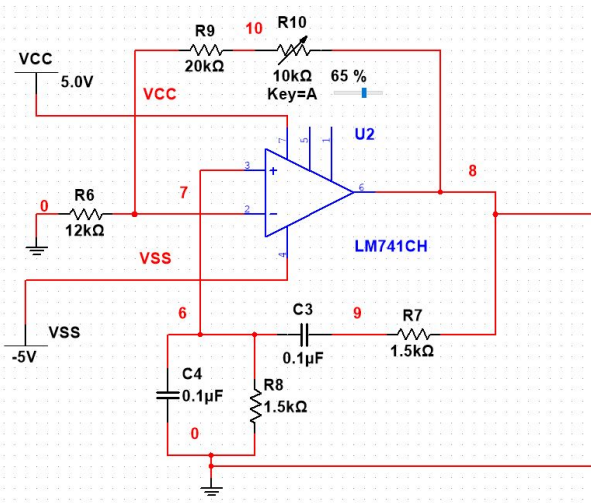
and logic ‘1’ is coded as a sinusoidal wave of frequency 9 Khz. So here is the detailed explanation for FSK Modulation.

Wein Bridge Oscillator : It is is an electronic oscillator and produces the sine waves. It is a two stage RC circuit amplifier circuit with high quality of resonant frequency, low distortion. It is used to generate the required frequencies of 1.4 Khz and 9 Khz.

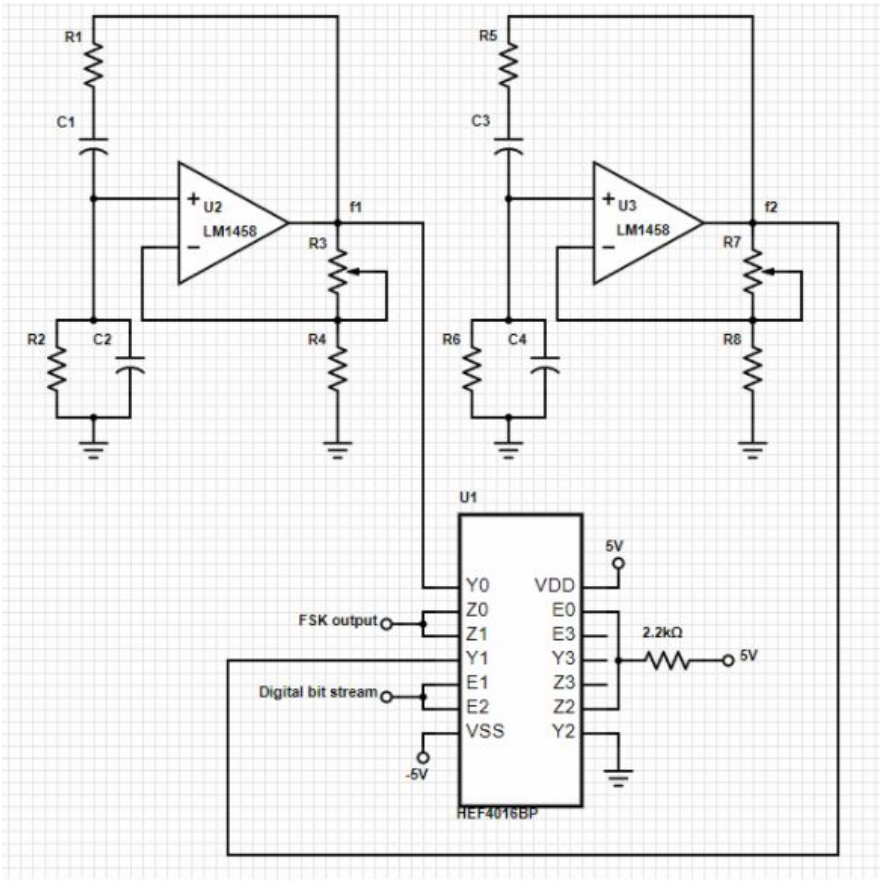
CD4016 : The 4016 contains 4 analogue bilateral switches, each with an active-high enable input (A) and two input/outputs (X and Y). When the enable input is asserted (high), the X and Y terminals are connected by a low impedance; this is the on condition. When the enable is low, there is a high impedance path between X and Y, and the switch is off. It is used to switch between the 2 signals based on the message signal.



Wein Bridge Oscillator for 9 Khz



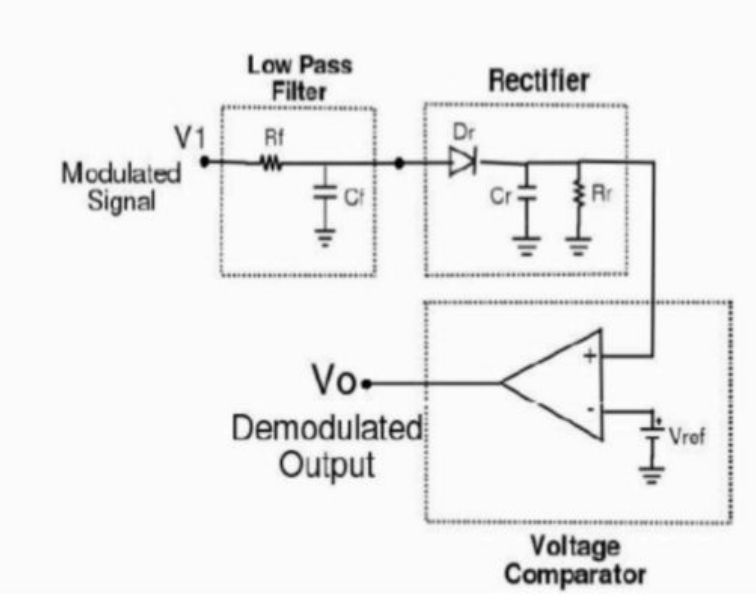
Wein Bridge Oscillator for 1.4 Khz



Complete Transmitter Circuit

Receiver Circuit

Receiver circuit is a frequency demodulator circuit which converts the modulated signal back into the original signal. It comprises of a low pass filter of frequency 1.4 Khz followed by a rectifier and then a voltage comparator which converts the rectified signal back to square waves. It is then again passed through an Op-Amp to convert this signal into a proper amplified signal that can be decoded to find the frequency.



Complete Receiver Circuit

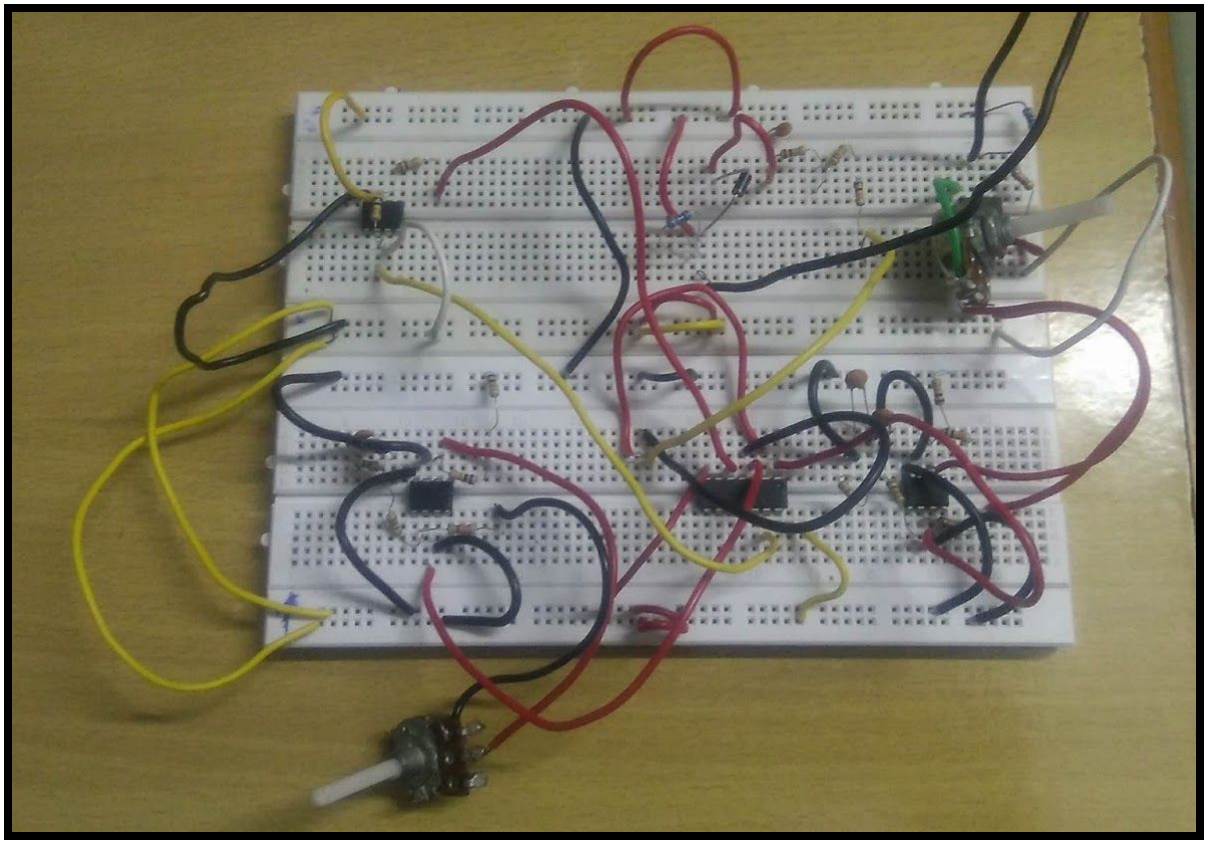
Arduino 2

This arduino takes the demodulated amplified signal to find the frequency of the signal. After finding the required frequency the same schema is used to decode the message signal as was used while transmitting it out. In our case after the signal is retrieved the pwm input is sent to the motor through a motor driver to control the speed of motor.

IOT Device

Customized input is then fed to the IOT device through the Arduino signal. In our case we are controlling the motor speed and hence a PWM signal is used to change the rpm of motor.

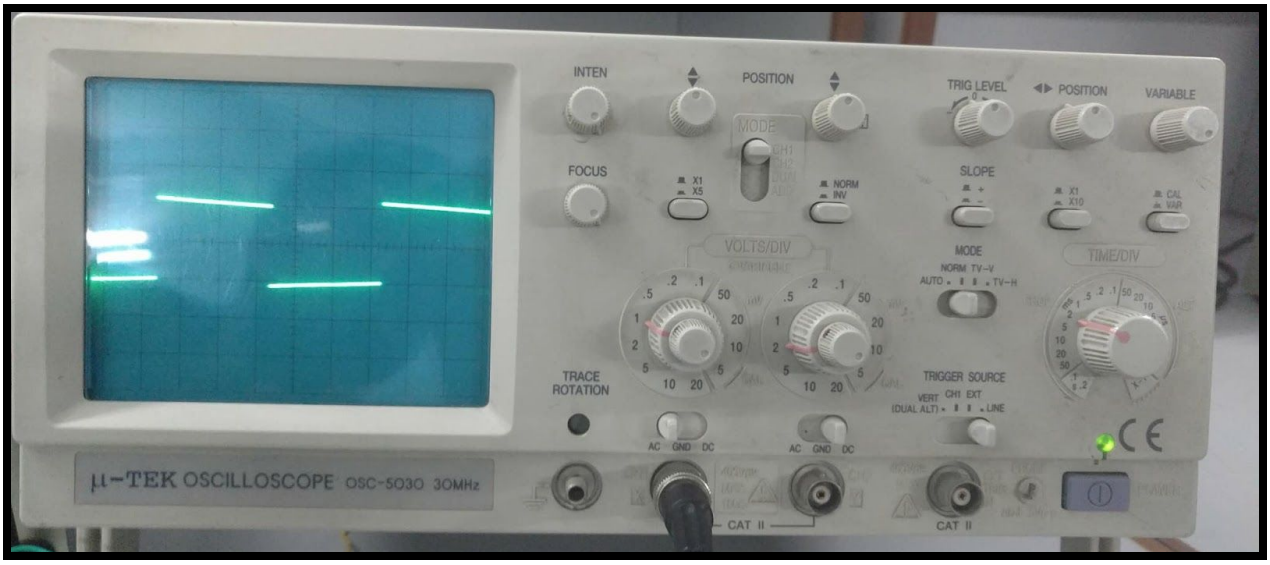
This is our practical realization of the transmitter and receiver circuit. They are further connected to the arduinos and raspberry pi accordingly for processing the input and output.



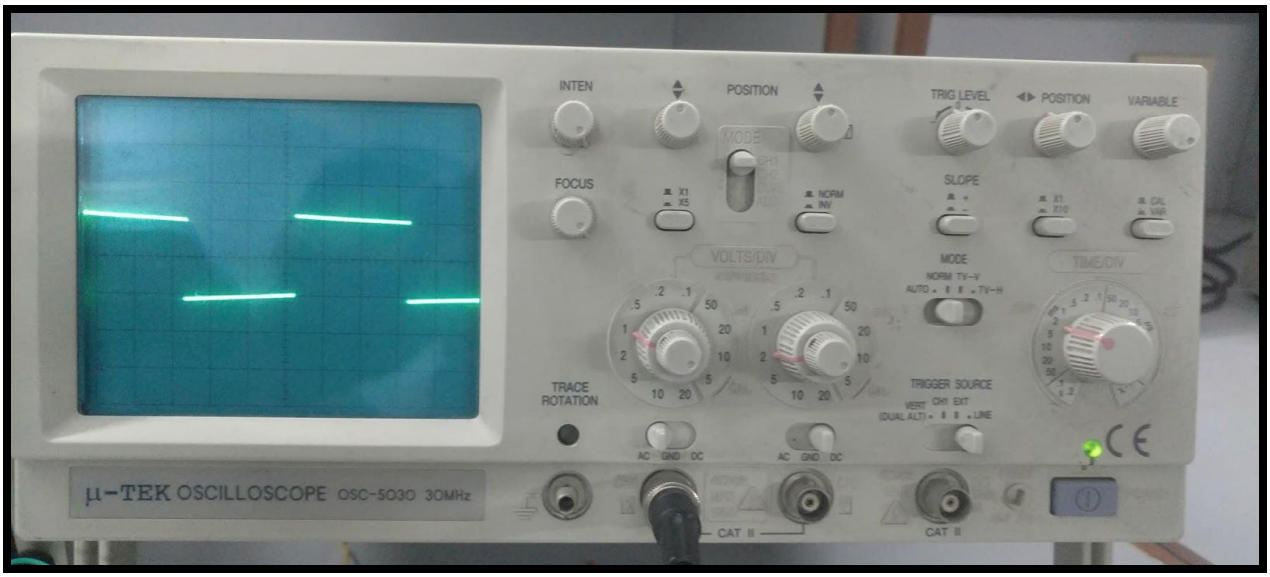
Transmitter and Receiver Circuit

Results

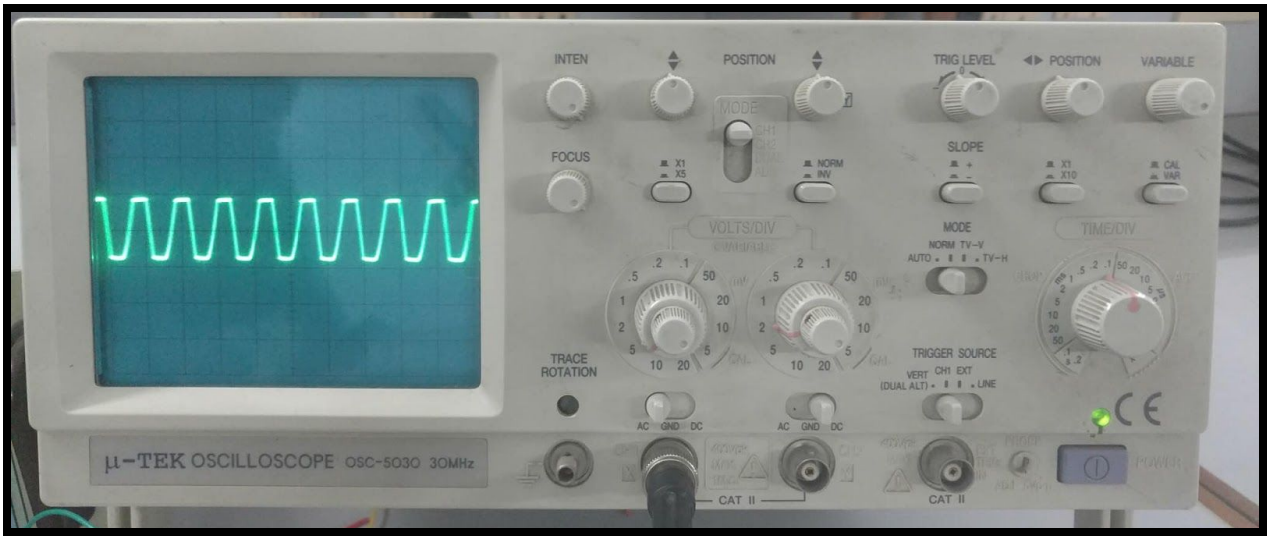
Following are the observed waveforms on the oscilloscope after each subsystem.



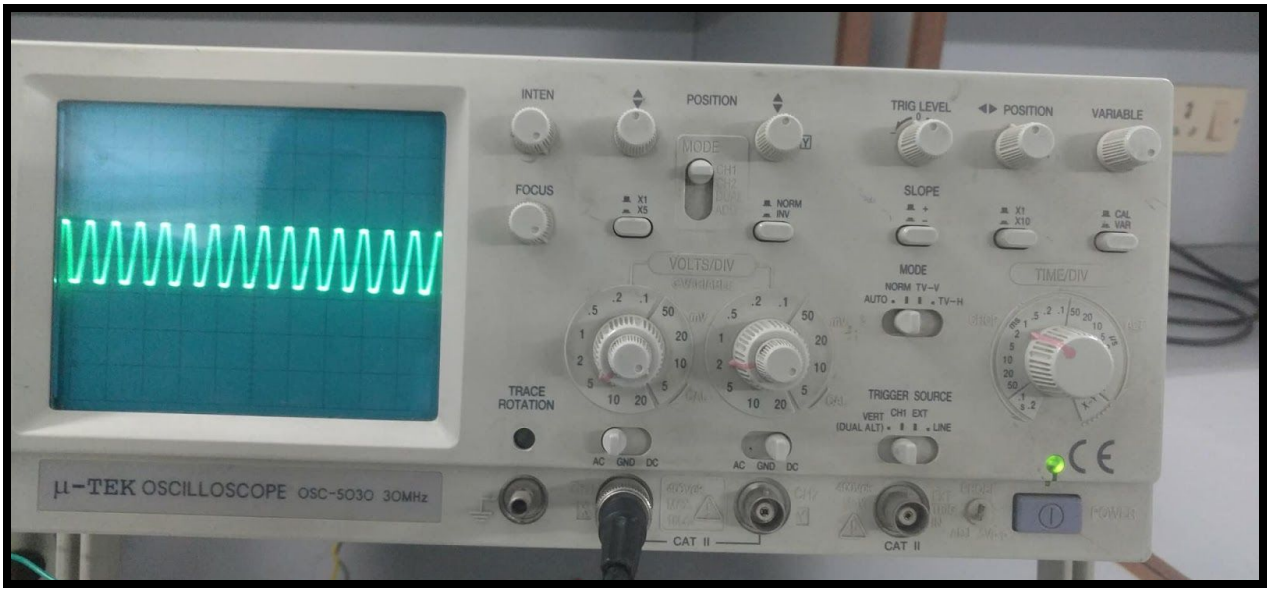
Input message signal



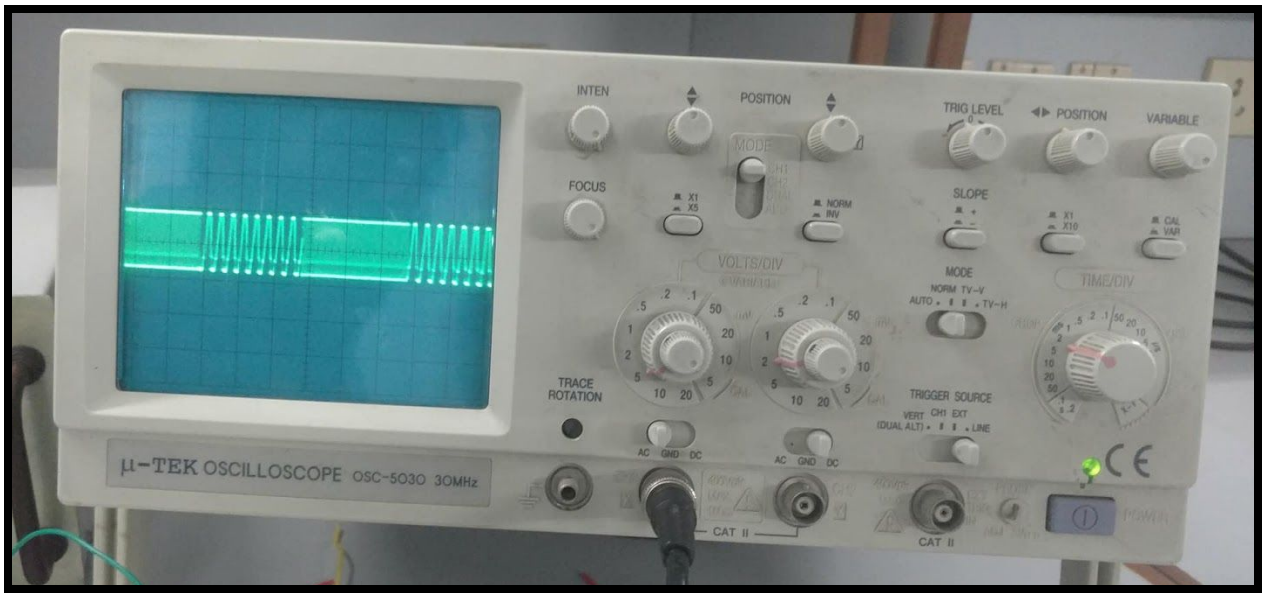
Inverse of the input message signal



Wein Bridge Oscillator for 1.4 Khz

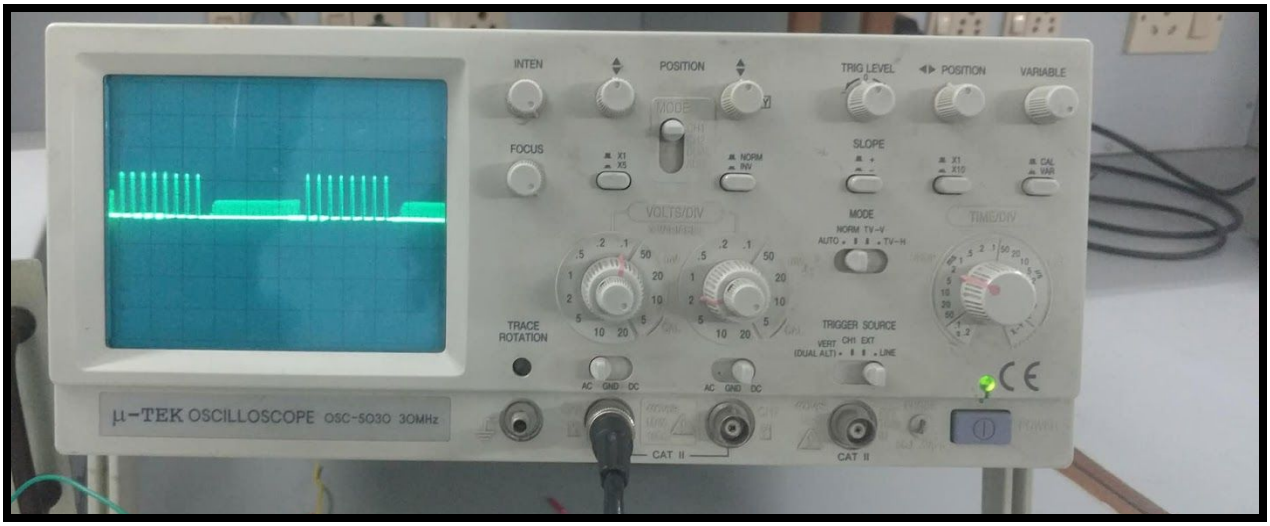


Wein Bridge Oscillator for 9 Khz

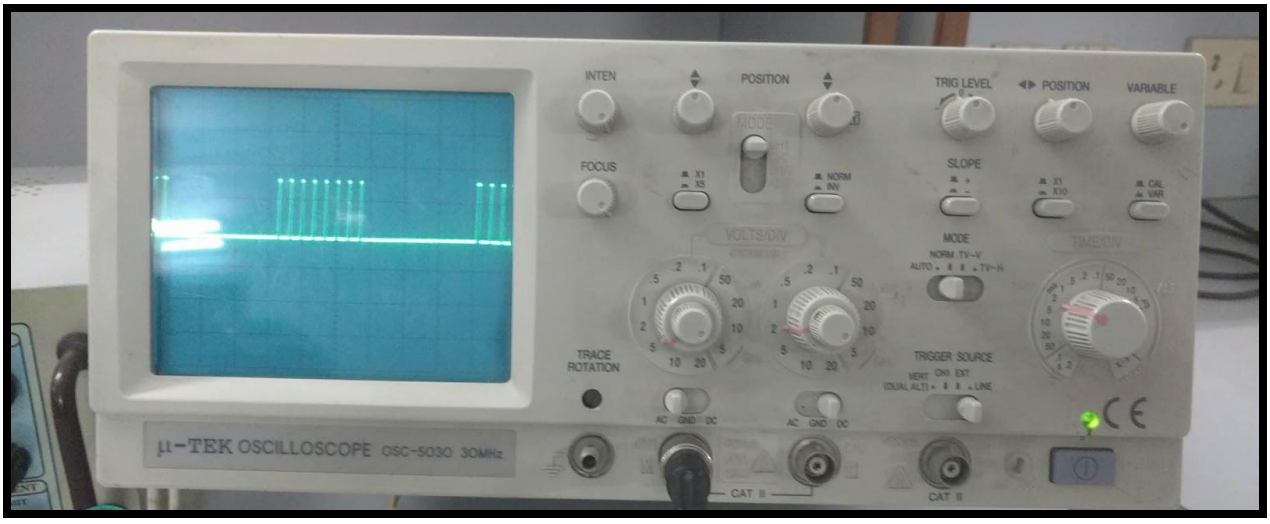


FSK modulated message signal

Low pass filter output



Rectifier output



Comparator output

Conclusion

So as we saw that the data was sent wirelessly to the Raspberry Pi followed by coding the data and then frequency modulation. Now this data is sent over the Power Lines modulated with power signals. At the receiver circuit signal was demodulated and then passed on to Arduino which decoded the signal and then controlled the IOT device accordingly. So this was the implementation of PLC to control the speed of fan.

As the number of devices increase PLC dominates over the wireless transmission as there is no restriction of the bandwidth. Further it avoids cable clustering and it can be incorporated with the existing power supply system without much overhead cost.

Future Scope

There is definitely a scope of improvement and future development in this project. It was limited to controlling one device which was the motor, however its true purpose is satisfied when multiple devices are connected to it. Also it can be interfaced directly with 220V power supply, but considering the scope of project and resources available it was not possible to complete it.

Another thing that can be improved here is trying alternate methods of transmission such as through Phase Shift Keying. Further there is a great scope of reducing the circuit size by properly soldering it. This circuit is very large and thus cumbersome to use.Soldering the circuit will remove this problem.

References

- **Wikipedia**
- **All About Circuits**
- **Electronic Design**
- **Introduction to Communication Systems (By Upamanyu Madhow)**