K. J. Somaiya College of Engineering, Mumbai-77
(Autonomous College Affiliated to University of Mumbai)

FM RECEIVER

by

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1.Aim

- To learn more about Telecommunication Field.
- To use different software's.
- To learn and fabricate PCB.
- To develop team work.
- To test and debug electronic circuits.
- To learn more about devices involved in the communication field.
- To gain knowledge by doing projects.

2.ABSTRACT

Frequency modulation is the encoding of information in a carrier wave by varying the instantaneous frequency of the wave. The term and technology are used in computing, signal processing and telecommunications.

One should learn about FM modulation as it has many advantages like in FM receivers the noise can be reduced by increasing the frequency deviation and hence FM reception is immune to noise.FM transmitters are highly efficient. FM transmission can be used for the stereo sound transmission due to a large number of sidebands.

The project aims to enhance the learning of students. The circuit shows the working of FM receiver circuits. The project was built so that students can see the working of FM receiver and transmitter circuits without wasting time to build it on a breadboard. The project aims to reduce the hardships faced by students who do not know how to build circuits and for students who are not in the electronics field. The project aims to build a readymade FM receiver circuit for students.

The project takes into consideration all the required components and merges them to create a circuit board which can be used directly by students to enhance their learning.

3.INTRODUCTION

This project was started with a goal to make a FM transmitter which was to be used with a FM receiver in our auditorium which receives signal from a mic, which would have made it easy for testing. Its carrier frequency range is from 460-970 MHZ. To work well with the receiver, the transmitter had to be of frequency in the middle of that range which is about 715 MHZ. Circuit diagrams for this transmitter was made, all components were available in the market, except for the oscillator for such high frequency, combined with the fact that receiver for such a high frequency is more susceptible to external noise when components would have been connected with wires and through hole components. While looking for lower frequency FM transmission in range 250-400 MHZ it was found that this range is used by police and other security in India, and creating such a transmitter would have interrupted with their signal and hence would have been safe.

The project was scaled down to making a FM receiver tuned to the frequency of a local FM music radio station. A circuit was designed, PCB was fabricated in the lab, while testing the results were not very clear due to connecting wires and other components picking up noise, which could have been improved further with the use of surface mounted components. We also created a FM modulation circuit which will make it easy for students to learn how FM modulation works without assembling the whole circuit themselves on a breadboard. This PCB is submitted in the Communication lab which will help as teaching aid for Frequency modulation.

4. FM RECEIVER

A radio or FM receiver is an electronic device that receives radio waves and converts the information carried by them to a usable form. An antenna is used to catch the desired frequency waves. The receiver uses electronic filters to separate the desired radio frequency signal from all the other signals picked up by the antenna, an electronic amplifier to increase the power of the signal for further processing, and finally recovers the desired information through demodulation.

Of the radio waves, FM is the most popular one. Frequency modulation is widely used for FM radio broadcasting. It is also used in telemetry, radar, seismic prospecting, and monitoring newborns for seizures via EEG, two-way radio systems, music synthesis, magnetic tape-recording systems and some video-transmission systems. An advantage of frequency modulation is that it has a larger signal-to-noise ratio and therefore rejects radio frequency interference better than an equal power amplitude modulation (AM) signal.

5.Literature Survey

5.1.Brief description of different parts :-

1. IC LM-386:-

Figure 1 IC LM386

The IC LM386 is a low-power audio amplifier, and it utilizes low power supply like batteries in electrical and electronic circuits. This IC is available in the package of mini 8-pin DIP. The voltage gain of this amplifier can be adjusted to 20, and the voltage gain will be enhanced to 200 by employing external components like resistors as well as capacitors among the pins 1 & 8.

2. BJT BF494,495:-

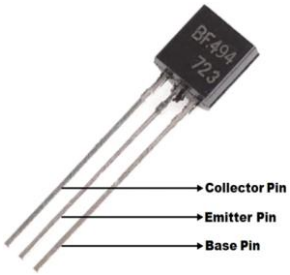

Figure 2 BJT BF494

General purpose radio frequency transistors BF 494,495 are used for obtaining FM modulation.

3.Capacitors:-

Figure 3 Capacitor

A capacitor is a device that stores electrical energy in an electric field. It is a passive electronic component with two terminals. The effect of a capacitor is known as capacitance.

4.Resistors:-

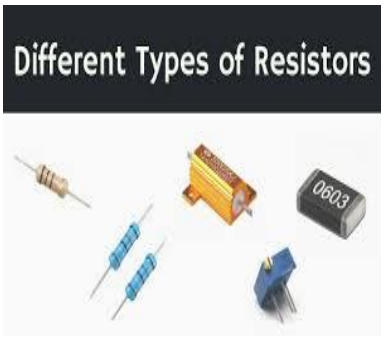

Figure 4 Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses.

5.Variable Resistance:-

Figure 5 Variable Resistance

A resistor of which the ohmic resistance value can be adjusted. Either mechanically (potentiometer, rheostat) or electronically (digital potentiometer).

6.Variable Capacitor:-

Figure 6 Variable Capacitance

A variable capacitor is a capacitor whose capacitance may be intentionally and repeatedly changed mechanically or electronically. Variable capacitors are often used in L/C circuits to set the resonance frequency, e.g. to tune a radio (therefore it is sometimes called a tuning capacitor or tuning condenser), or as a variable reactance, e.g. for impedance matching in antenna tuners.

7.Speaker:-

Figure 7 Speaker

Speakers are transducers that convert electromagnetic waves into sound waves. The speakers receive audio input from a device such as a computer or an audio receiver. This input may be either in analog or digital form. Analog speakers simply amplify the analog electromagnetic waves into sound waves. Since sound waves are produced in analog form, digital speakers must first convert the digital input to an analog signal, then generate the sound waves.

5.2.List of Components

- IC- LM386
- T1 BF494
- T2 BF495
- 4 turn 22SWG 4mm dia air core
- C1 220nF
- C2 2.2nF
- C 100nF * 2
- C4 10uF
- C5 10uF (25 V)
- C7 47nF
- C8 220 uF(25 V)
- C9 100 uF (25 V) * 2
- R 10KΩ * 2
- R3 1KΩ
- R4 10Ω
- Variable resistance
- Variable capacitance
- Speaker
- Switch
- Antenna
- Battery

6.PROJECT DESIGN

6.1:FM Receiver Circuit Explanation

Here's a simple FM receiver with minimum components for local FM reception. Transistor BF495 (T2), together with a 10k resistor (R1), coil L, 22pF variable capacitor (VC), and internal capacitances of transistor BF494 (T1), comprises the Colpitts oscillator. The resonance frequency of this oscillator is set by trimmer VC to the frequency of the transmitting station that we wish to listen to. That is, it has to be tuned between 88 and 108 MHz The information signal used in the transmitter to perform the modulation is extracted on resistor R1 and fed to the audio amplifier over a 220nF coupling capacitor (C1).

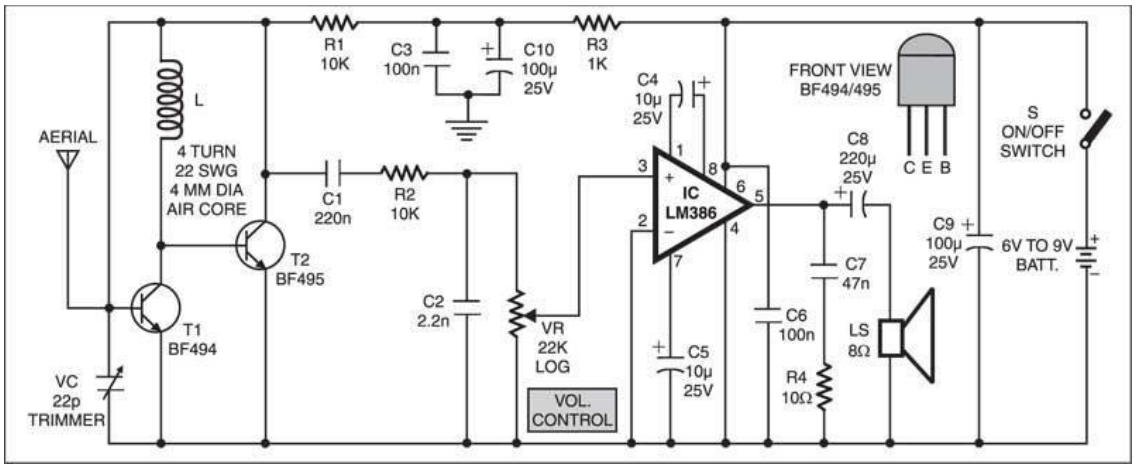

Figure 8 FM Receiver Circuit Diagram .*https://www.electroschematics.com/small-fm-receiver/*

You should be able to change the capacitance of the variable capacitor from a couple of picofarads to about 20 pF. So, a 22pF trimmer is a good choice to be used as VC in the circuit. It is readily available in the market. If you are using some other capacitor that has a larger capacitance and are unable to receive the

full FM bandwidth (88-108 MHz), try changing the value of VC. Its capacitance is to be determined experimentally.

The self-supporting coil L has four turns of 22 SWG enameled copper wire, with air core having a 4mm internal diameter. It can be constructed on any cylindrical object, such as a pencil or pen, having a diameter of 4 mm. When the required number of turns of the coil has reached, the coil is taken off the cylinder and stretched a little so that the turns don't touch each other.

Capacitors C3 (100nF) and C10 (100µF, 25V), together with R3 (1k), comprise a band-pass filter for very low frequencies, which is used to separate the low-frequency signal from the high-frequency signal in the receiver.

6.2 RECEIVER CIRCUIT SNIPPETS

Figure 9 PCB Layout of FM Receiver

Figure 10 Front Side of PCb

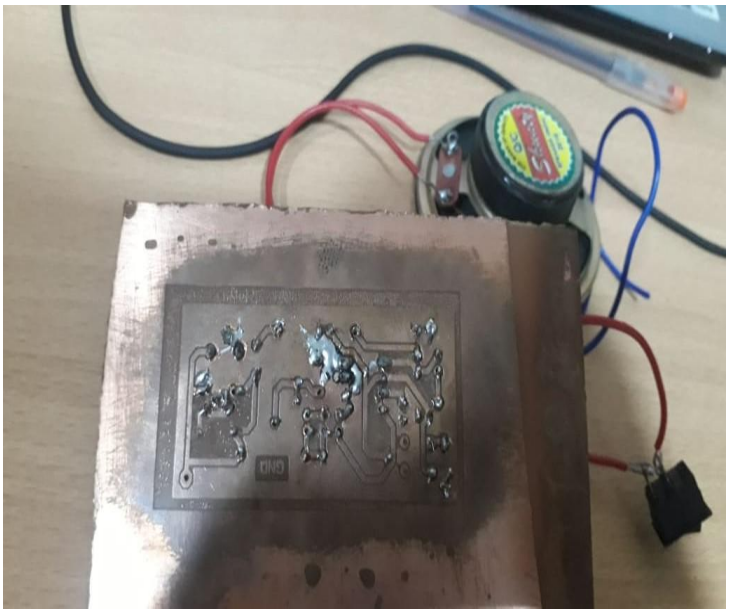

Figure 11 Tracks (Backside of PCB)

6.3.FM Modulation

The above circuit was not able to receive the FM signals. We were unable to identify the problem as the circuit was a bit tricky and complex to build. So instead we decided to build the sub part of FM Receiver i.e. Frequency modulation using IC 8038.

The process, in which the frequency of the carrier is varied in accordance with the instantaneous amplitude of the modulating signal, is called 'Frequency Modulation'. The FM signal is expressed as:

$$S(t) = A_C \cos(2\pi f_C t + \beta \sin(2\pi f_m t))$$

Where Ac is amplitude the carrier signal, fc is the carrier frequency fm is the modulation index of the FM wave.

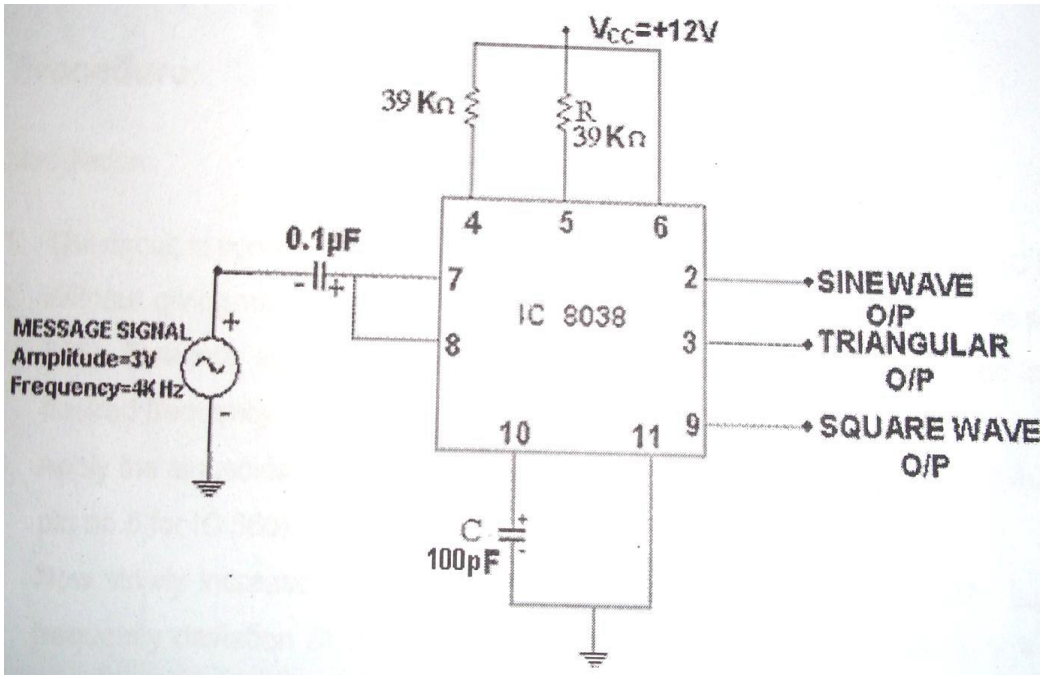

Figure 12 Frequency Modulator

6.4.Working of circuit

1. The circuit is connected as per the circuit diagram shown in Fig.2

2. Without giving modulating signals observe the carrier signal at pin no.2 . Measure amplitude and frequency of the carrier signal. To obtain a carrier signal of desired frequency, find the value of R from f=1/ (2πRC) taking C=100pF.

3. Apply the sinusoidal modulating signal of frequency 4 KHz and amplitude 3Vp-p at pin no. 7. (pin no. 5 for IC566)

4.Now slowly increase the amplitude of modulating signal and measure fmin and maximum frequency deviation Δf at each step. Evaluate the modulating index (mf=β) using Δf/fm where Δf=|fc-fmin|. Calculate Band width. BW=2(β+1) fm=2(Δf+ fm)

5. Repeat step 4 by varying the frequency of the modulating signal.

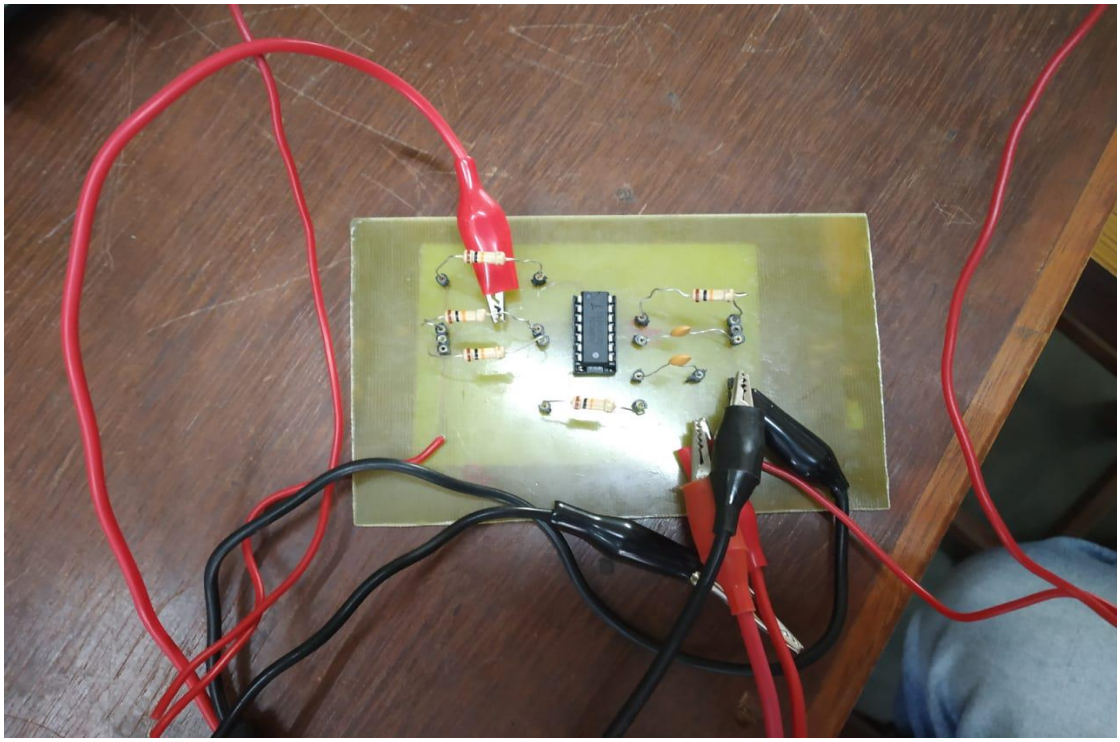

Figure 13 Frequency Modulator Circuit

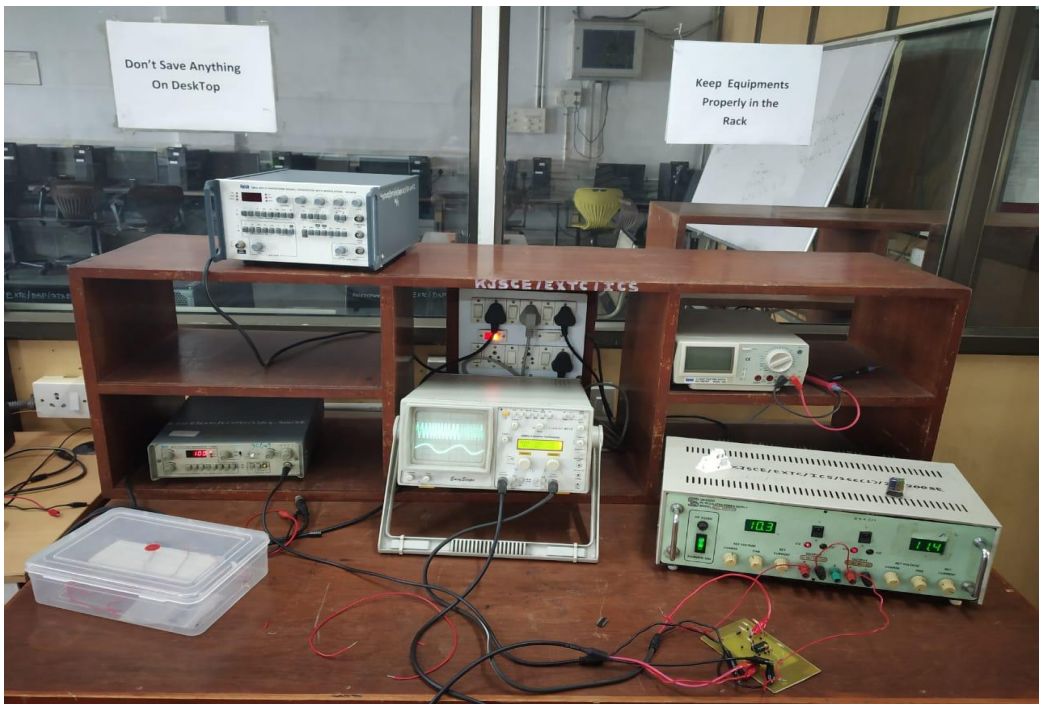

Figure 14 Setup of Testing

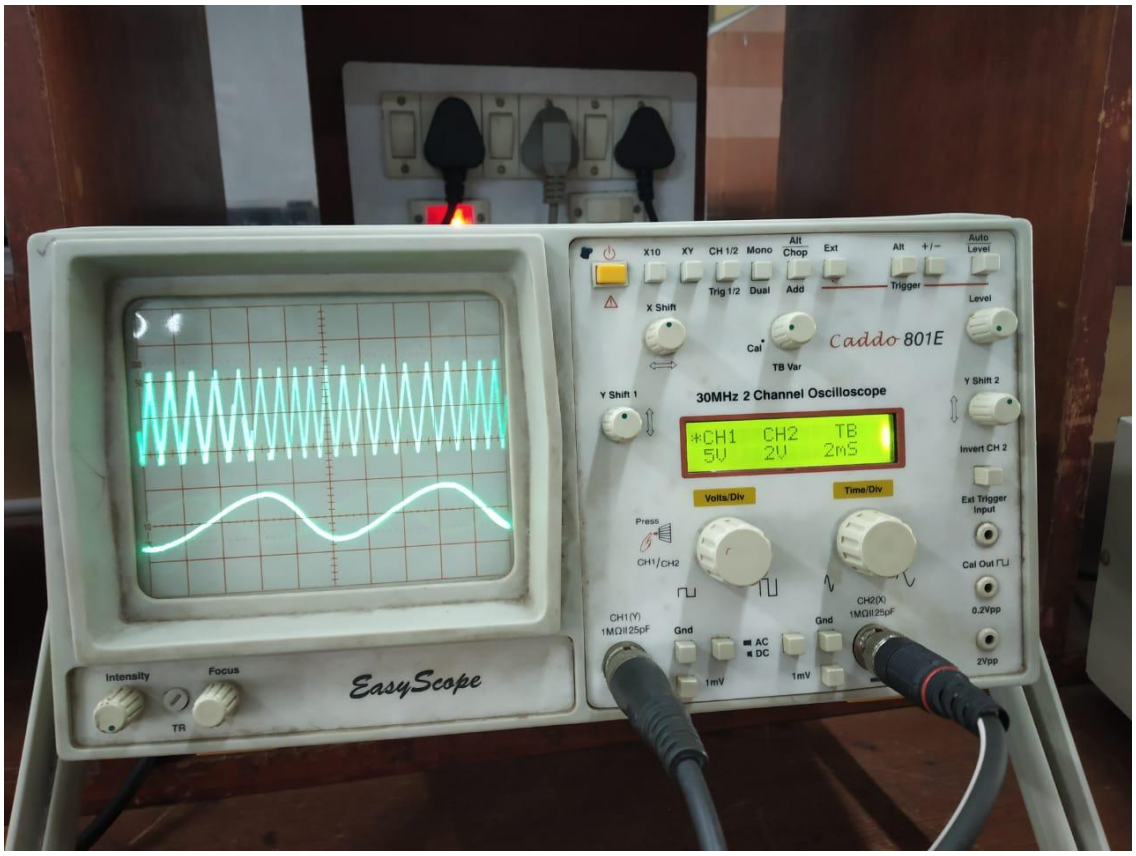

Figure 15 Output

7.Conclusion

From this project we learned to divide the project on smaller parts and work on it as a team. We learned the functioning of FM receivers. In this project we reviewed the whole pipeline, like how we must move to build a small functioning circuit board. The pipeline is as follows:-i. Understanding the concept, ii. Simulating the circuit, iii. Designing the circuit, iv. Testing the circuit. We learned the working of FM receivers along with its circuit and learned about various kinds of parts needed to build it. We learned how frequency-based circuits require more ground on board to avoid noise. We learned how SMD (surface mounted devices) can be used instead of regular devices to avoid noise in frequency-based circuits. We learned the designing of circuits on LTSPICE. We learned how to simulate the circuit before building it. We learned the required procedure required for building a good circuit board. From this project we learned building PCB of circuits. We learned how to overcome the difficulties faced during PCB building. At last we learned a lot from this project.

8.References

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