VISVESVARAYA TECHNOLOGICAL UNIVERSITY

MINI PROJECT REPORT ON

“FM WIRELESS MICROPHONE”

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CERTIFICATE

Certified that the mini project work entitled "**FM Wireless Microphone**" carried out by **Nandankumar K (1NH18EC073), Navodit Tiwari (1NH18EC074), Neetha Nataraj (1NH18EC077), Sneha N.S (1NH18EC106),** bonafide students of Electronics and Communication Department, New Horizon College of Engineering, Bangalore.

The mini project report has been approved as it satisfies the academic requirements in respect of mini project work prescribed for the said degree.

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PROJECT ABSTRACT

INTRODUCTION:

A wireless microphone is a mobile electronic audio recording device which allows the user to transmit their recording to a frequency modulated amplifier without any connections by wire, which is why the name wireless microphone.

Wireless microphone and amplifier modules are predominantly used during public broadcast programs, stage entertainment programs or in all instances of occasions where audio signals are to be amplified so as to widen their radius of audibility and improve range of clarity.

However, since the user holds the microphone unit in their hand, the module needs to be easy to use and hassle-free so that the person holding it has the ability to move around a reasonable distance and not be restricted to one spot to speak from. This document, we enunciate about constructing a simple wireless frequency modulated microphone module and use exactly for the above intended purpose.

Advantages:

- The biggest advantage of a wireless microphone module is the freedom it equips the speaker with of movement. Owing to the fact that a wireless microphone is not connected by any cords to any other electronic equipment, the user does not go through any sort of hassle that might occur due to cables. Cables pose a dangerous threat to the speaker as they're lying right on the ground where the speaker is talking. Wireless microphone transmits audio signals over the air instead of transmitting them through cables.

Application:

- This simple frequency modulated wireless microphone transmitter can transmit audio waves over a short range. It can be used as a simple wireless microphone.

CIRCUIT DIAGRAM

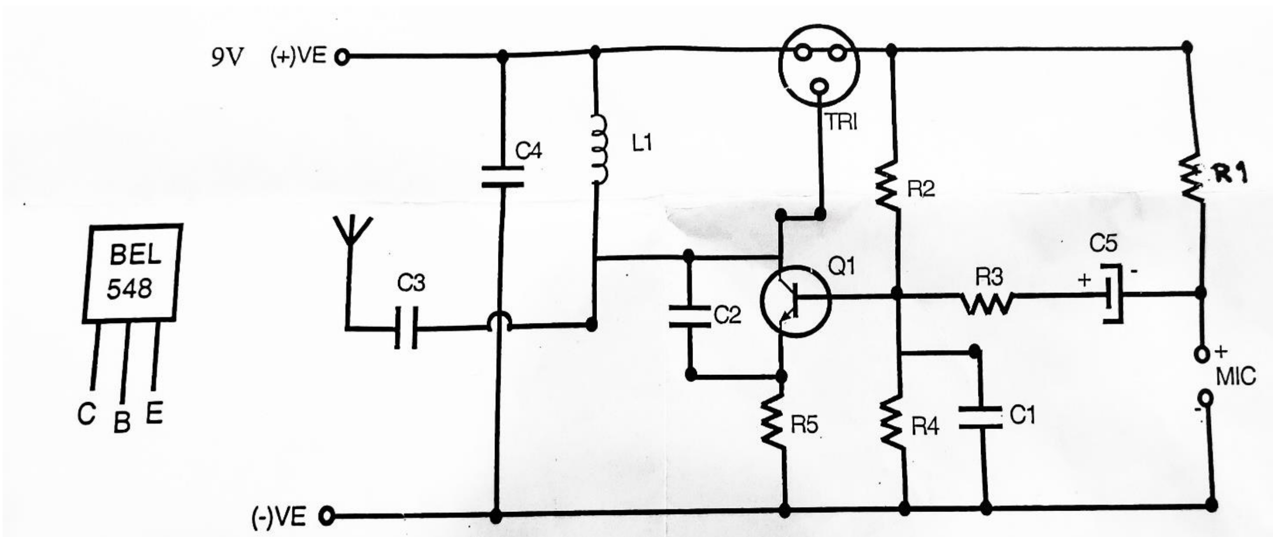

Fig (a): A Circuit diagram showing the construction Of an FM Transmitter

CHAPTER 1

INTRODUCTION

An FM wireless microphone, in its core, works on the principle of Frequency Modulation.

Frequency Modulation involves changing the frequency of the wave that has to be transmitted. The message wave is the wave that has the information impressed upon it that has to be transmitted. Frequency Modulation involves encoding the crucial information by altering the frequency of the message in accordance with a high frequency carrier wave. A carrier signal is used for the reasons as stated below:

1. Since the frequency of the carrier signal is very high and wavelength and frequency are inversely related, using a carrier signal reduces the wavelength requirement of the signal in order to be transmitted. It also reduces the size of the antenna required to receive the signal, as the length requirement of receiver antenna states that it should be a quarter of the wavelength of the transmitted signal. For example, consider a wave of a frequency of 3KHz, which would cause the signal to have a wavelength of 100km, which would set the antenna length requirement at 25km, which is not physically attainable. Consider a carrier wave of frequency 100MHz. This would have a wavelength of 3m and would require an antenna receiver of length 25cm only.
2. Use of carrier signal facilitates multiplexing, which is concurrent use of the same channel by multiple signals, without getting convolved into each other. Each signal can have a different carrier frequency and can use the same channel to be transmitted. This concept was invented by phone companies to accommodate multiple phone conversations on same channels.

These transmissions facilitate high fidelity of audio, which translates to, the signal has very low distortion and noise disturbance. Frequency Modulation presents us with various advantages that it offers, namely:

1. Makes no changes in the amplitude of the transmission signal
2. More tolerant towards noise
3. More noise toleration and ergo, better sound quality.
4. Owing to the increase in frequency, it is less susceptible to attenuation.

However, Frequency Modulation also has a few drawbacks, which are:

1. Broadens the bandwidth requirement
2. Limits area of coverage
3. Requires more complex circuitry as compared to other forms of modulation.

The FM Transmitter works on a single transistor. The circuit works on less power and provides an excellent range, considering the power it draws. The circuit uses radio frequencies of VHF in a range of 87.5MHz to 108MHz for transmission and reception of the signal. Its performance depends upon its induction coil and its capacitance.

1.1 DERIVATION OF THE VOLTAGE WAVEFORM OF A FREQUENCY MODULATED WAVE:

In frequency modulation, the frequency of the carrier voltage is changed according to the instantaneous value of the modulating voltage. It is different from amplitude modulation as the, amplitude of the modulated carrier wave does not change on frequency modulation. This makes an advantage over amplitude modulation modules since any disturbance in the atmosphere or electrical nose that is man-made essentially appears in the form of change of amplitude of the carrier voltage and may be removed in frequency in frequency modulation (FM) receiver as it is made insensitive to amplitude variations.

Let the carrier voltage V_C have amplitude V_C Radian/Second and let it be given by,

$v_C = V_C sin\omega_C t$ ……. (1)

Figure 1(a) shows the carrier voltage V_C. For the reason of keeping it simple, we assume the modulating voltage to be sinusoidal and let it be given by,

$v_m = V_{,} cos\omega_m t$ (2)

Figure 1(b) represents a modulating voltage V_m. Figure 1(c) represents the resultant frequency modulated carrier voltage whereas figure 1(d) represents the variation of instantaneous carrier frequency with respect to time. It can be noted that this frequency variation or frequency derivation is similar in form with the variation of the modulation voltage. Thus, the frequency derivation is proportional to the instantaneously changing value of the modulating voltage. The rate with which frequency variation takes place is equal to the modulating frequency. In frequency modulation, all modulating signals having equal amplitude but different frequencies will cause the same frequency deviation. Similarly, all the modulating signals of the same frequency, say 2000 Hz, will deviate the carrier at the same rate of 2000 timer per seconds, without any relation with their amplitudes. The amplitude of the frequency modulated carrier remains the same at all instants of time during frequency modulation.

Let the following expression denote the modulating sinusoidal voltage:

$v_m = V_m = cos\omega_m t$ …….(3)

ω_m denotes the angular frequency of the modulating sinusoidal voltage in Radians per second and Vm denotes the amplitude of the modulating voltage, in volts. Let the following be the expression for carrier voltage:

$c_m = V_c sin\omega_c t + \theta)$ …..(4)

ω_c donates the angular frequency of the carrier voltage wave in Radian per second, VC denotes the amplitude of the carrier voltage wave in volts and θ denotes the phase angle in Radian.

Let, $\phi = \omega_c t + \theta$ …….(5)

In equation (5), ϕ denotes the total instantaneous phase angle of the carrier voltage. Then equation (4) may be expressed as,

$v_c = V_c sin\phi$ ……(6)

The angular frequency ω_c is in relation with the phase angle ϕ by the following relation,

$\omega_c = \frac{d\phi}{dt}$ ………(7)

On modulating the frequency, the frequency of the carrier wave is no more a constant but it changes with instants of time according to the instantaneous value of the modulating voltage. Thus, the frequency of carrier voltage after frequency modulation is given by,

$\omega = \omega_c + k_f \times v_m$ ………(8)

$= \omega_c + k_f \times V_m cos\omega_m t$ ……(9)

k_f is the constant of proportionality.

After performing integration, Equation (7) provides the phase angle of the carrier voltage that has been modulated. Ergo, we get,

$\phi \int \omega dt = \int [\omega_c + k_f \times V_m cos\omega_m t] dt$ …..(10)

Or $\phi = \omega_c t + k_f \times V_m \frac{1}{\omega_m} sin\omega_m t + \theta_1$ …….(11)

Where θ_1 is the constant of integration and it represents a constant phase angle.

Angle θ_1 may be neglected as non-significant in the upcoming analysis owing to to the fact that it is insignificant in the process of modulation. Hence, the frequency modulated carrier voltage wave is given by,

$$v = V_c sin[\omega_c t + k_f \times \frac{V_m}{\omega_m} sin\omega_m t] \quad \text{........(12)}$$

From equation (9), we get the instantaneous frequency of frequency modulated carrier voltage in Hz, which is given by,

$$f = \frac{\omega}{2\pi} = f_c + k_f \times \frac{V_m}{2\pi} cos\omega_m t \quad \text{......(13)}$$

From equation (13), we can obtain the minimum and maximum value of frequency, which can be given by:

$$f_{max} = f_c + k_f \times \frac{V_m}{2\pi} \quad \text{........(14)}$$

$$f_{min} = f_c - k_f \times \frac{V_m}{2\pi} \quad \text{........(15)}$$

Thus, the derivation of the modulated frequency, that is, the maximum variation of frequency from the mean value is given by the equation,

$$f_d = f_{max} - f_c = f_c - f_{min} = k_f \times \frac{V_m}{2\pi} \quad \text{......(15)}$$

Modulation index mf is the ratio of frequency deviation fd to modulation frequency fm and is also indicated by δ(deviation ratio).

Thus, $\delta = m_f = \frac{f_d}{f_m} = \frac{\omega_d}{\omega_m} = \frac{k_f \times V_m}{\omega_m}$ ......(16)

Thus, the expression for the frequency modulated voltage is given by,

$$v_c = V_c sin(\omega_c t + m_f \times sin\omega_m t) \quad \text{.......(17)}$$

From equation (16) we find that for a constant amplitude of modulating voltage, as the modulating frequency ω_m decreases, the modulation index mf increases.

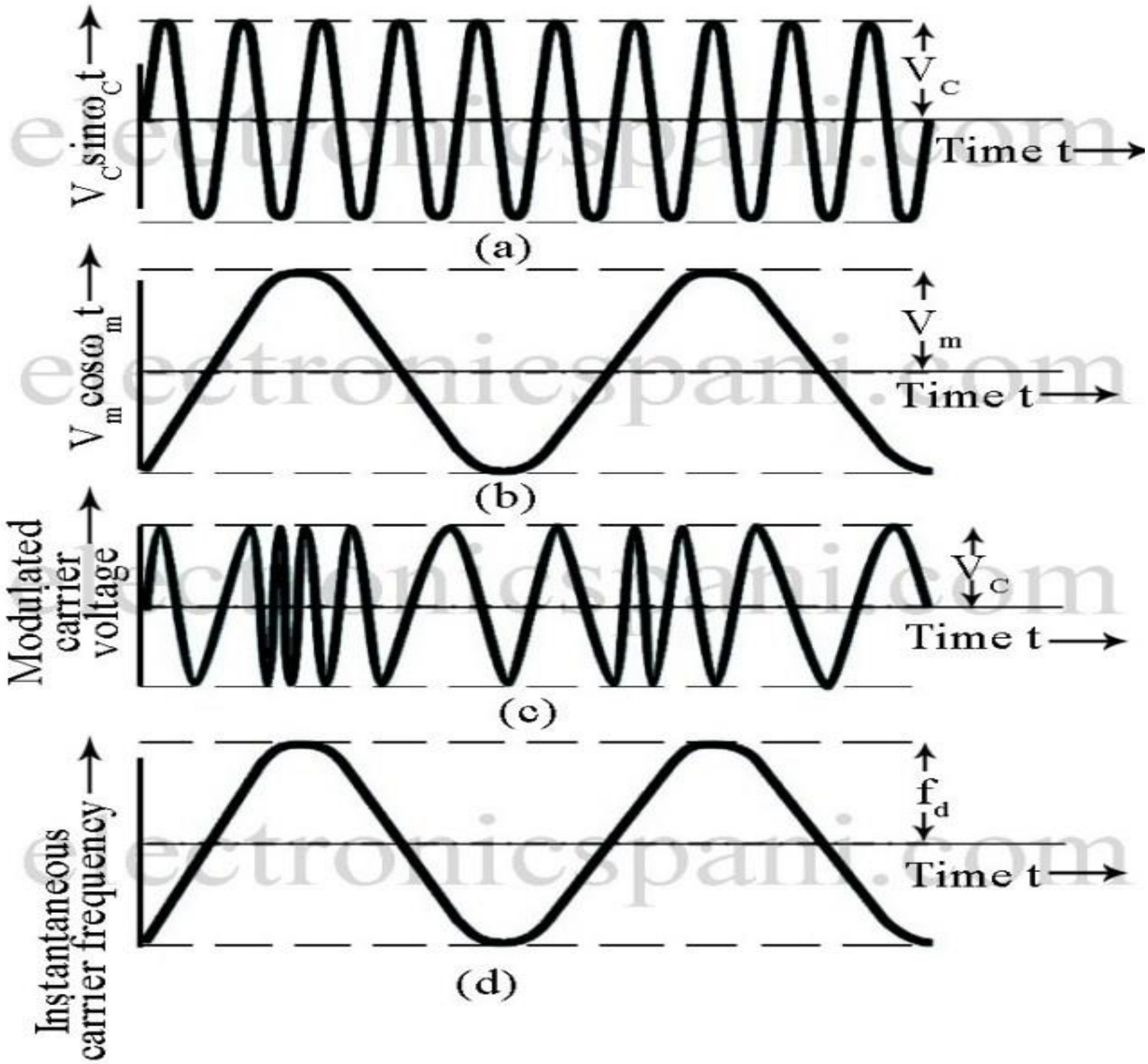

Fig 1.1 : Waveform of a frequency modulated carrier voltage

1.2 APPLICATION OF FM TRANSMITTERS:

1. They are widely used in households, like in sound systems.
2. Form a part of car music equipment and fitness centers.

   1They are used widely in broadcasting systems.

3. The correctional facilities offered by FM transmitters have led them to be used in prisons to reduce noise in common areas.

1.3 ADVANTAGES OF FM TRANSMITTERS:

1. User-friendly and cheap.
2. Have a good efficiency
3. Has a very wide operating range, when the low power it draws is considered.
4. If exists a noise signal with amplitude variation, it will be eliminated.
5. The FM transmitter is a circuit that uses a very low power to operate.

1.4 DISADVANTAGES OF FM TRANSMITTERS:

1. FM Transmission requires a wider channel for communication.
2. The circuitry of the transmitter and receiver tends to be more complex when compared to other forms of modulation.
3. Quality deteriorates a tad bit due to some interference.

CHAPTER 2

LITERATURE SURVEY

In this new era of technology, FM transmission has been a prominent and welcome addition to the world of media communications in mainstream. The use of FM will only continue to broaden, owing to the need of the audience for a variety of broadcasting services. However, one can argue that the lifespan of the FM spectrum is not infinite. The development, effects and management of FM has been researched and it has been pointed out and stressed upon by various researchers that the spectrum policy be reconsidered. Major studies and research conducted on FM transmission by scholars internationally have been furnished below:

2.1 INTERNATIONAL STUDIES ON FM TRANSMISSION

Cohen, in 1996, studied the requirement for mustering communities for the empowerment and participation in the society that calls for modernity and found that rural press, FM radio, low power TV and other micro-media of the likes were being benefited off in a development perspective. He, ergo, suggested that micro-media be used for educational and development purposes, rather than for financially beneficial reasons, like by broadcasting entertainment programs.

Leentvar and Flint, in 1996, studied the power of capturing FM transmitters possess, in the modern society. This led to point out that FM transmitters captured young audiences and women across the globe, in areas of development. It also suggested that the role FM transmitters played in public instruction and development was rather limited. They moved on to suggest that the technology be used for reaching out to the deprived and less advantageous regions of the society, as it has a good power of capturing.

Franck, in 1998, studied the hustling for micro-radio centers in today's world and discovered that due to privatization of the FM radio, a new epoch of broadcasting services as mercenaries had been brought about. The scholar observed that the means of communication was quick in educating and muster the multitudes for developmental endeavors of various sorts. He suggested that the structure of FM transmission be ameliorated make broadcasting services that are more people-friendly.

Skinner, in 1998, studied the low power FM radio and stated that his attempts to privatize its FM channels took heavy tolls when the private payers wagered highly and a large number of them could not reach their commitments to pay what they owed to the government. The researcher made a suggestion to make effective regulations to bring FM radio stations along the right path to be able to safeguard public interests in the current society.

Rudin, in 1999, put the Eureka 147 under the magnifying glass through the lens of digital diversity and has also observed that the government did not put in place any restrictions on the FM radio stations. He also proceeded to state that radio stations were put under regulation on the basis of economics instead of the obligation they have towards social development. He suggested that this should not be the case and that broadcasters should carry out functions based on humanitarian considerations.

CHAPTER 3

PROPOSED METHODOLOGY

To elucidate further upon the title “FM wireless microphone”, it is a hand-sized amateur transmitter-receiver which will carry out operations in the Radio FM range. The operating frequency of the transmitter is fixed to a certain frequency while the receiver, in this case, a mobile phone, is tuned to receive the amplified audio signal.

The circuitry and theory is studied before advancing to the hard-wiring of the project. Analysis, testing and simulation are done to reduce error margins and optimization. The circuit also leaves room for further development and improvement.

Primarily, this project aims at the betterment of our understanding of wireless telecommunication. As we go through this project, theoretical knowledge is transcribed into practice. Also, as a result of this project, certain skills of paramount importance can be enhanced, like using a bread-board comfortably, circuit analysis and testing, troubleshooting of circuits, soldering and more of the likes.

3.`1 OBJECTIVES OF THE PROJECT:

1. To facilitate better understanding of Frequency Modulated wireless transmission among ourselves.
2. To form a good foundation for learning Communications.
3. To hard-wire and test a Frequency Modulated wireless microphone and test it.
4. To simulate the circuit on computer software for a better understanding of the results and error debugging.

3.2 SCOPE OF THE PROJECT

1. The project consists of making a simple single-stage frequency modulated audio amplifier.
2. The project module is tested to be able to tune the frequency to receive the audio on a cellphone with frequency tuning.

CHAPTER 4

PROJECT DESCRIPTION

4.1 HARDWARE DESCRIPTION

FM transmitter is a low power device which used frequency modulated signals for broadcasting of sound by means of a carrier signal, due to a difference in frequency. The carrier wave frequency and the audio signal of the amplitude maintain equivalency and the transmitter produces a VHF band of 88MHz-110MHz.

Amplifier circuits form the fundamentals of a broad variety of electronic systems. They are used are driver circuits to drive systems that require high power.

4.1.1 THE DESIGN AND WORKING OF POWER AMPLIFIERS:

Amplifier circuits can be designed for various power ratings with specified RMS values. The most fundamental requirement of the amplifier is that it should produce an output in the desired range that is capable of transmission or capable of driving the preferred load, in this case, being the transmitter. An audio power amplifying network can encompass various stages to produce gains in current or voltage. It can encompass within itself multiple stages as shown in the block diagram shown:

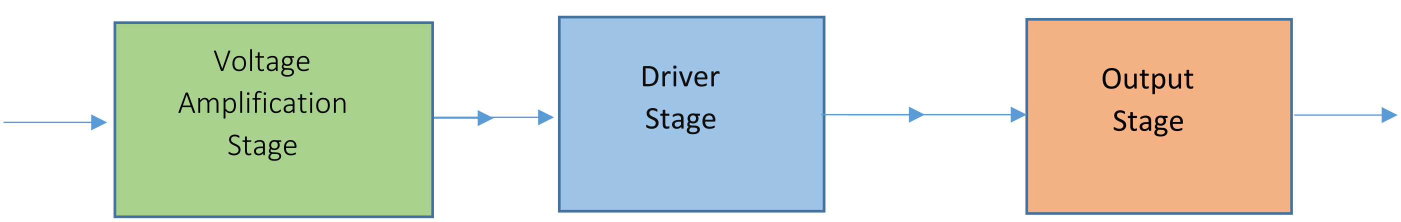

Fig 4.1.1: Stages of a Power Amplifier

4.1.1.1 Stage one- Amplifying of Voltage:

In this stage, signal from the input is forced into the electronic amplifier and the range of the signal is in millivolts in order for it to drive the stages that are upcoming. Ergo, in this stage, the voltage is amplified to make it strong enough to drive the successor stages. This purpose can be fulfilled using a Class A amplifier. For higher gain, more amplifiers can be cascaded.

4.1.1.2 Stage two- Driving

This stage is the middle stage and it views between output stage and the amplification of voltage stage. The driver stage exists because it is not possible for the voltage amplification stage alone to produce desired amplification, owing to its low input impedance. Hence, this stage is to produce gain too.

4.1.1.3 Stage three- Output

This stage is connected to a speaker or to a transmitter to be transmitted across to a speaker, wirelessly. This stage, if required, can provide an additional power gain. This stage can be built using either of the two: push-pull configuration or one transistor. The push pull configuration is preferred over the single transistor for certain reasons, namely, better efficiency, higher power gain, cancellation of DC current and even-harmonics. However, in this project, a single transistor has been used, to maintain simplicity.

4.1.2 BLOCK DIAGRAM OF AN FM TRANSMITTER:

Succeeding this passage is a block diagram of an FM transmitter. An FM transmitter primarily requires the following components: a microphone, a BJT amplifier, a modulator, a transmitter, a receiver and finally, a device that can play the transmitted amplified output. An oscillator may be used to produce an RF signal.

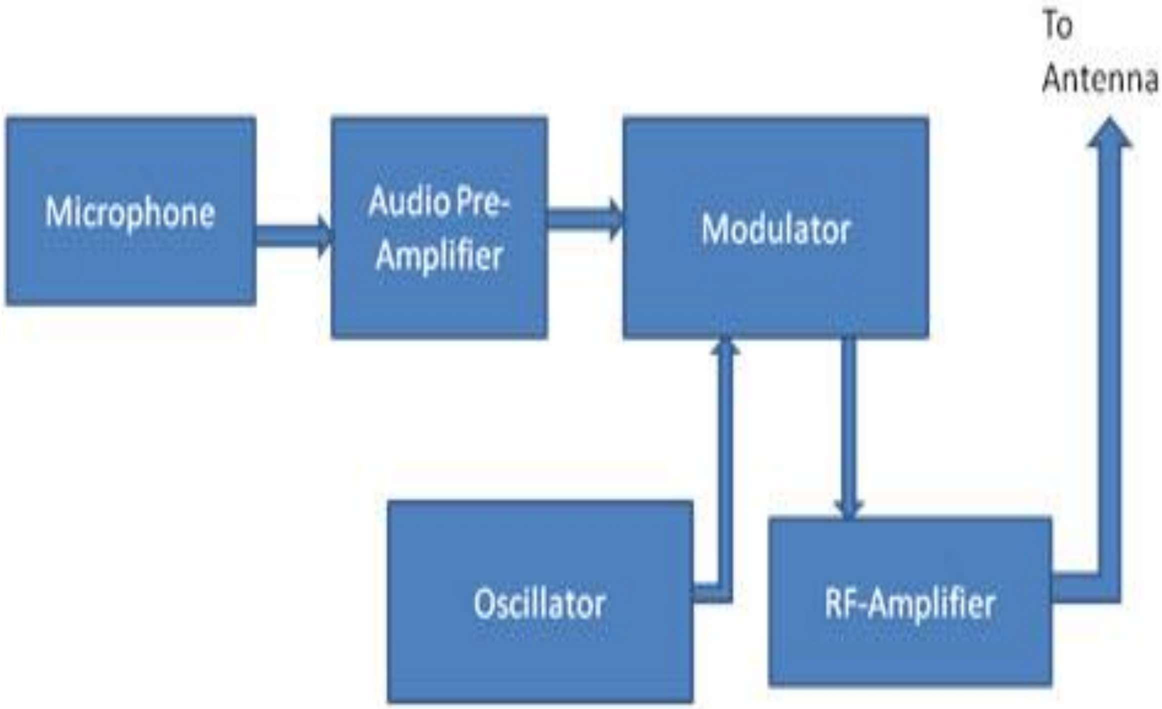

Fig 4.1.2: Block Diagram of an FM Transmitter

4.1.3 WORKING OF AN FM MODULATED WIRESS AMPLIFIER:

4.1.3.1 COMPONENTS REQUIRED

The FM modulated wireless amplifier in this project requires the following components:

1. Resistors (20K, 15K, 4.7k, 47E)

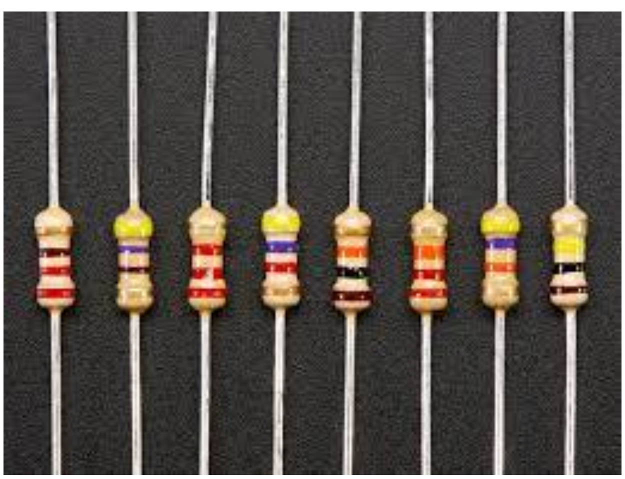

Fig 4.1.3.1.1 Resistors

2. Capacitors (0.01 F (103), 10PF, 0.001KPF, 2.2/50V)

Fig 4.1.3.1.2 Capacitors

3. Inductor coil (0.00062H)

Fig 4.1.3.1.3 Inductor Coil

4. Variable capacitor

Fig 4.1.3.1.4 Variable Capacitor

5. 2-pin condenser microphone

Fig 4.1.3.1.5 2-pin condenser microphone

6. DC voltage source- 9V

Fig 4.1.3.1.5: 9V Battery

7. A BJT transistor (Bel548)

Fig 4.1.3.1.6: Bel548 Transistor

8. Bread Board

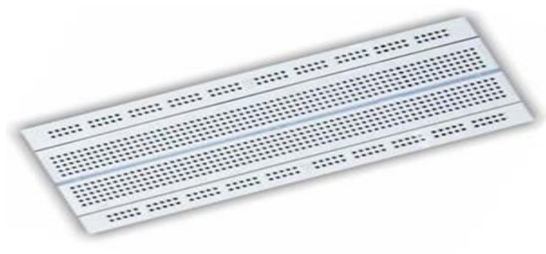

Fig 4.1.3.1.7 Bread Board

9. Antenna

Fig 4.1.3.1.8 Antenna

4.1.4 WORKING OF THE FREQUENCY MODULATED WIRELESS MICROPHONE

Let us consider an input signal falling across the condenser microphone. Inside the microphone, there exists a capacitive sensor. Based on the vibration due to the changes in air pressure, an AC signal is produced by the microphone. An oscillating tank circuit can be formed through the transistor 2N3904 using the variable capacitor and the copper coil inductor. The project makes use of an npn transistor in order to create a general purpose amplified signal.

In reference to the circuit diagram below, when a current passes through inductor L1 and the variable capacitor, the tank circuit starts to oscillate with carrier frequency at resonance of the

FM Modulation. Capacitor C2 acts as negative feedback to the tank circuit that is oscillating.

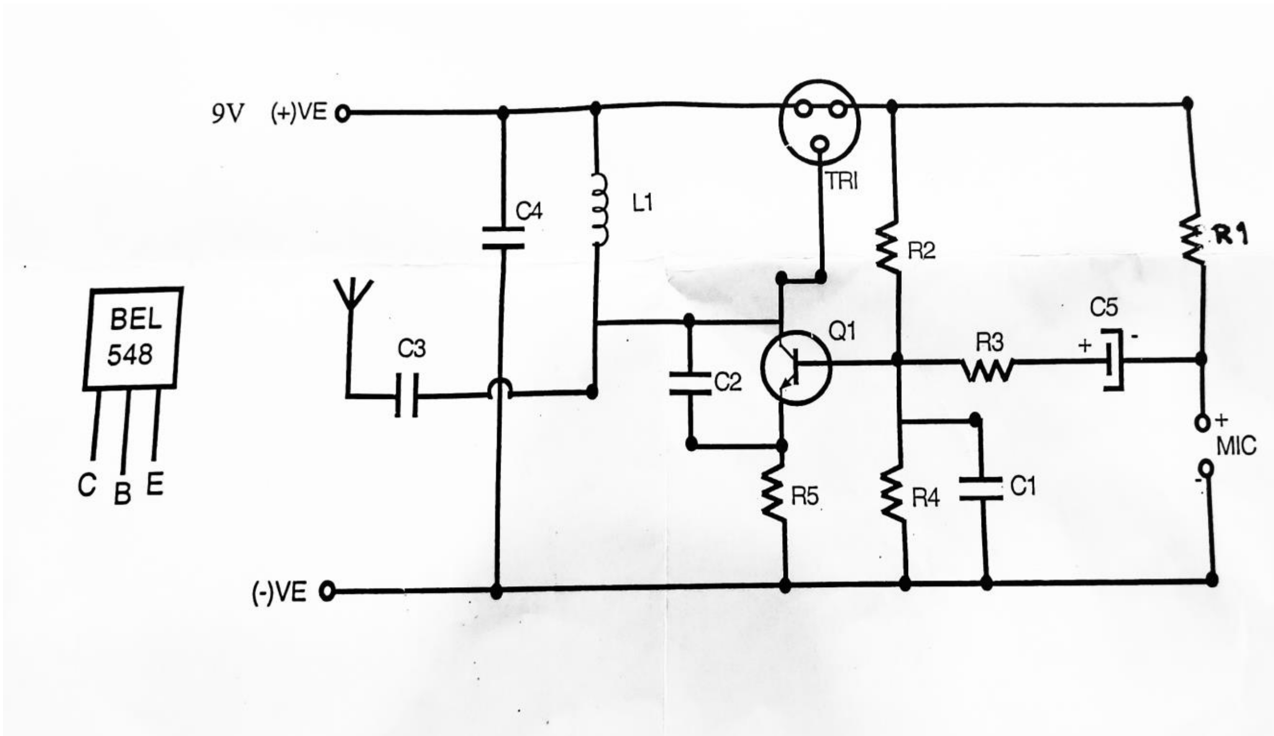

Fig 4.1.4.1: Circuit Diagram of FM wireless microphone

Radio frequency carrier waves are generated in transmitters by means of an oscillator. The tank circuit is derived in this circuit from the LC network to store required energy to create oscillations. Input audio signal from the microphone penetrates the base of the transistor and this action modulates the tank LC circuit carrier frequency in Frequency Modulated format. Resonant frequency can be changed for fine tuning into the Frequency Modulation band by tuning the variable capacitor. The signal, which is now modulated, is radiated from the antenna as radio waves in the frequency band of FM, which consists of a 20cm long wire made of copper. Length of the antenna plays a significant role and hence, can be kept a few inches longer, to accommodate a wider error margin.

4.2 SOFTWARE REQUIREMENT

Owing to the fact that the project is completely hardwired on a bread-board and encompasses no pre-programmable components, the project is void of any software requirement.

However, since the circuitry is simulated on a computer in order to facilitate a better understanding of the project and debugging, it requires the software **OrCAD PSPICE Version 9.2.**

OrCAD PSPICE is a software developed by the company OrCAD Systems Corporation which is a proprietary software tool used to simulate Electronic Design Automation (EDA). It can perform mixed-simulation and electronic prints for manufacturing printed circuit boards.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 RESULTS

The circuit was hardwired on a bread-board and was checked for output. Frequency modulated, amplified signal was to be transmitted wirelessly and the output was to be obtained on a cellphone. This objective was successfully carried out and results obtained had acceptable fidelity and clarity.

Following are the pictures of the hard-wired circuit:

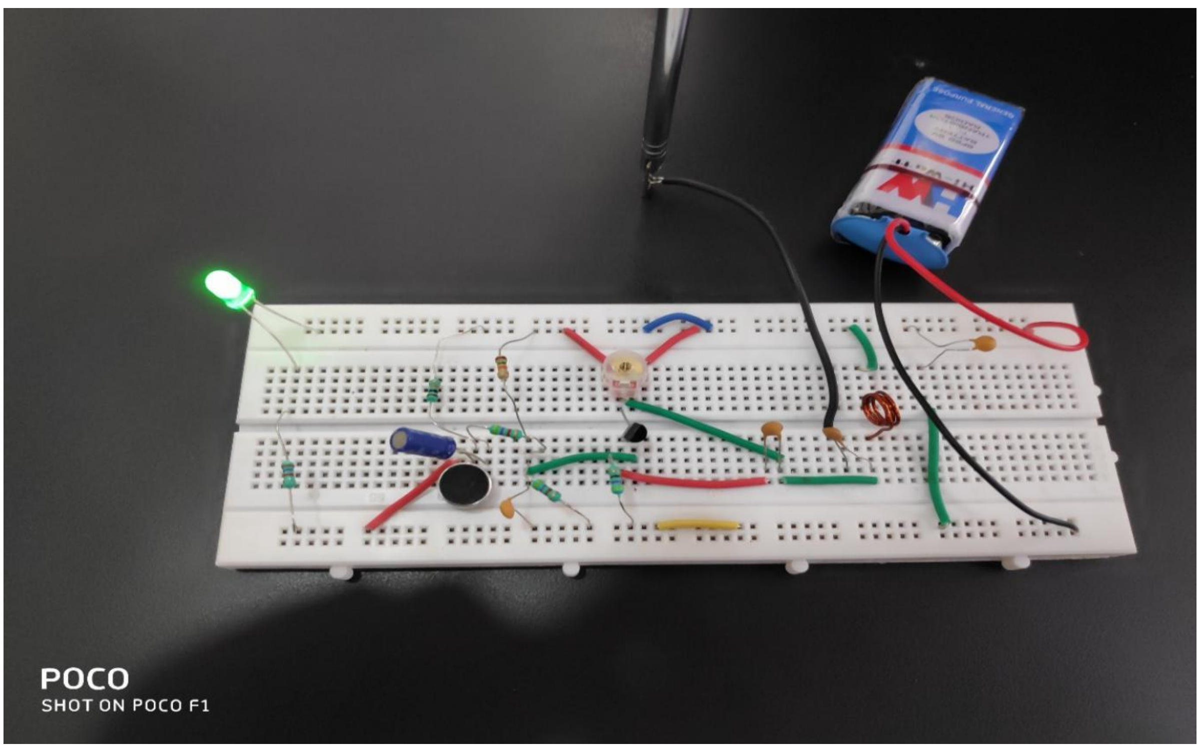

Fig 5.1: Working of the project model

Fig 5.2: An FM Receiver

5.2 DISCUSSION

While wiring the components, we found to have a problem with the capacitors and proper tuning values of capacitance. After much trying and trial-and-error, we were able to obtain proper tuning of the FM Amplifier circuit.

We also faced difficulties while trying to understand the working of the FM Amplifier circuit to a satisfactory degree. The processes by which a single BJT accomplished oscillation,

modulation and amplification was a complicated concept to grapple. After continuous reading and looking up on the internet, we could grasp the concept decently.

We had to pay attention to the components and their values since they could affect the amplification and transmission of the message signal. We simulated the circuit and analyzed wave forms in order to get a better understanding of the transmission in order to equip ourselves with enough knowledge to rectify any errors in the circuit.

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

The circuit for FM Modulated Wireless Transmitter was hard-wired and output was obtained successfully. The circuit employed in the project is rather simple and easy to understand, which can be up scaled to meet larger requirements, in the event that it is required. BJT amplifiers can be more than one and can be cascaded in order to achieve a higher power gain, to drive larger loads. Separate oscillator and modulation blocks can be made to increase transparency of working and efficiency.

6.2 FUTURE SCOPE

Broadcasting is a perpetually broadening service, owing to the fact that audiences always need a plethora of broadcasting services. Micro-media telecommunications will only expand in the near future is what is our hypotheses and prediction.

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