ISSN: 2582-7219

International Journal of Multidisciplinary Research in Science, Engineering and Technology

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Impact Factor: 8.206

Volume 8, Issue 5, May 2025

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© 2025 IJMRSET | Volume 8, Issue 5, May 2025| DOI:10.15680/IJMRSET.2025.0805127

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

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FM Transmitter

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ABSTRACT: Transistor-based circuits are used to generate frequency-modulated signals in FM transmitters. This circuit, which assists the antenna and amplifies the electromagnetic signal, essentially functions as a radio system. A high voltage spark between two metals was used to create radio waves (conductors). The purpose of this project is to develop a small FM transmitter with low power consumption that can be used in a variety of situations.

For example, listening to music for entertainment, hearing in distance, or as a tour guide. FM transmitters are superior to AM (amplitude modulation) in many ways. Shields signals from unwanted signals, noise, and interference. Provides a higher S/N ratio than AM (Amplitude Modulation). An electronic circuit called an FM transmitter converts the electrical energy from the battery into high-frequency alternating current (AC).

Such a rapidly reversing current causes him to emit EM waves (electromagnetic waves) from the antenna. FM transmitter is a device which generates frequency modulated signal. It is one element of a radio system which, with the aid of an antenna, propagates an electromagnetic signal. Standard FM broadcasts are based in the 88- 108 MHz range.

The signal (from the microphone) is fed into the audio frequency (AF) for amplification then to the modulator which combines the modulating signal with the carrier wave transports the modulated signal through (RF) for final amplification to the antenna.

FM receivers can be operated in the very high frequency bands at which AM interference is frequently severe, commercial FM radio stations are assigned frequencies between 88 and 108 MHz and is the intended frequency range of transmission.

The project enhances one's practical skill and it involves both the electronics and telecommunication engineering fields. Theoretical knowledge such as circuit theory, electronic circuit and principles of telecommunication learned through several courses offered by the electrical and telecommunication program is applied in the project.

I. INTRODUCTION

This chapter provides an overview of the project by giving a description of the problem. Chapter one discusses the background of the project, problem description, aims, and objectives. Introduction provides a comprehensive overview of the project by outlining the nature and relevance of the FM Transmitter system. The purpose of this project is to explore the development and practical application of a low-power FM transmitter, a device that plays a vital role in the field of wireless communication. The chapter discusses the background of the project, clearly defines the problem statement, and elaborates on the aims and objectives of the work undertaken.

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1.1 BACKGROUND

FM transmitter is an electronic device, which produces frequency-modulated waves with the help of an antenna. The FM transmitter is a low-power transmitter and it uses FM waves for transmitting the sound, this transmitter transmits the audio signals through the carrier wave by the differ

1.2 PROBLEM DESCRIPTION

Audio signals have an inherently low frequency. Transmission of low-frequency signals requires large antenna sizes due to high signal attenuation. Modulation of audio signals is typically achieved using amplitude modulation (AM) and frequency modulation (FM). Frequency modulation is achieved by varying the carrier frequency with changes in the amplitude of the audio signal (i.e. the modulating signal). AM is the variation in carrier amplitude relative to the audio signal.

1.3 AIM OF THE PROJECT

The primary aim of this project is to design, construct, and test a working prototype of an FM transmitter that can broadcast audio signals over a defined frequency range. The project aims to simplify the concept of FM modulation for educational purposes and offer a practical solution for short-range audio broadcasting.

II. LITERTURE REVIEW

2.1 Edwin Armstrong – "Invention of FM Radio"

Edwin Howard Armstrong is widely credited with the invention of Frequency Modulation (FM) in the early 1930s. His work resolved major drawbacks in Amplitude Modulation (AM), particularly its susceptibility to noise and static interference. Armstrong introduced a wideband FM system that significantly improved audio fidelity. His contribution laid the foundation for commercial FM radio and influenced modern wireless communication systems, including portable and miniaturized FM transmitters used today for short-range broadcasting, education, and experimentation.

2.2 European Academic Research (2013) – "FM Bug for Baby Monitoring"

This publication explores a practical application of FM transmitters in surveillance and baby monitoring. It outlines a compact transmitter circuit capable of broadcasting over a small distance using frequency modulation. The study emphasizes noise immunity, ease of deployment, and the circuit's simplicity. The FM transmitter's design included basic components like a condenser mic, transistors, and a tuned LC circuit, demonstrating how small devices can be used in real-life audio transmission scenarios, especially in domestic settings.

2.3 F. McSwiggan – "Multichannel Portable FM Transmitter" (1998)

This project focused on building a multichannel, miniaturized FM transmitter using discrete components. The design included a two-stage transistor setup where the first stage acted as an audio pre-amplifier and the second as an oscillator and modulator. A 6 MHz tuning range was achieved, and it could transmit up to 80 feet. The study discussed frequency stability, antenna design, and modulation techniques, making it one of the more technically complete student-level transmitter projects.

2.4 D. Mohankumar – "Single Transistor FM Transmitter"

D. Mohankumar developed a simplified FM transmitter circuit using a single general-purpose transistor (BC547 or 2N3904). The circuit operated on the transistor reactance modulation principle. Despite its simplicity, the design could transmit audio signals over short ranges (9–15 meters). However, it suffered from frequency drift and lacked amplification stages, limiting its usability. The study highlights the trade-offs between circuit complexity and performance, making it a common reference for beginners in RF circuit

III. EVOLUTION OF FM RADIO TRANSMITTE

3.1 BASIC HISTORY OF FM RADIO TRANSMITTER

The development of radar before and during World War 2 was a great stimulus to the evolution of high-frequency transmitters in the UHF and microwave ranges, using new devices such as the magnetron and traveling wave tube. In recent years, the need to conserve crowded radio spectrum bandwidth has driven the development of new types of transmitters such as spread spectrum (European Academic Research, 2013).

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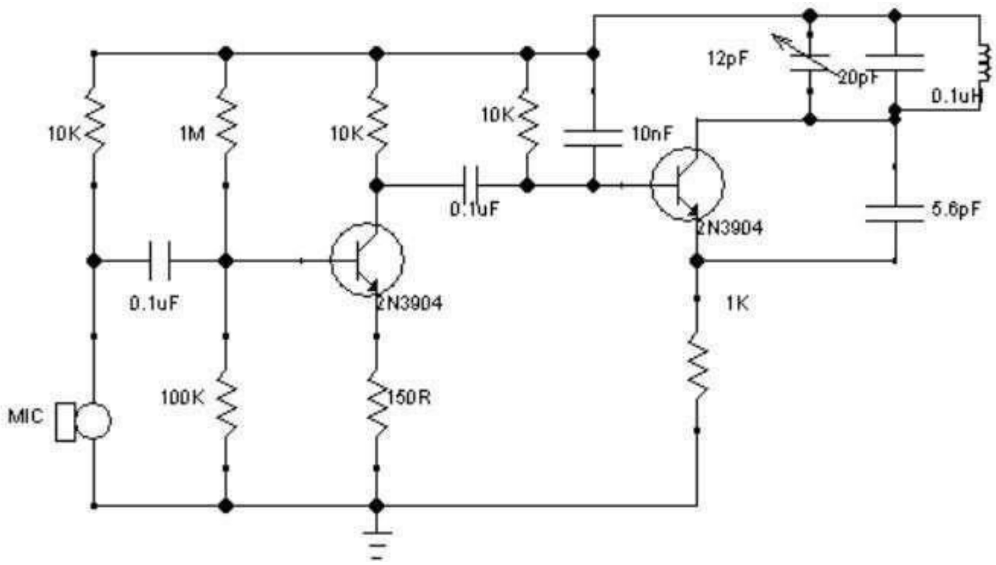
Frequency Modulation (FM) is the method of varying a carrier wave's frequency proportionally to the frequency of another signal, in our case the human voice. This compares to the other most common transmission method, Amplitude Modulation (AM). AM broadcasts vary the amplitude of the carrier wave according to an input signal. Standard FM broadcasts are based in the 88 - 108 MHz range; otherwise known as the RF or Radio Frequency range. However, they can be in any range, as long as a receiver has been tuned to demodulate them. Thus the RF carrier wave and the input signal can't do much by themselves they must be modulated. 5 An FM bug is a device that generates frequency modulated signal. It is one element of a radio system that, with the aid of an antenna, propagates an electromagnetic signal.

FM transmitters work on the principle of frequency modulation which compares to the other most common transmission method, Amplitude Modulation (AM). That is the basis of a transmitter. Nikola Tesla experimentally demonstrated the transmission and radiation of radio frequency energy in 1892 and 1893 proposing that it might be used for the telecommunication of information. The Tesla method was described in New York in 1897. In 1900, Reginald Fessenden made a weak transmission of voice over the airwaves. In 1901, Marconi conducted the first successful transatlantic experimental radio communications. In 1907, Marconi established the first commercial transatlantic radio communications service, between Clifden, Ireland and Glace Bay, Newfoundland.

IV. PREVIOUS RESEARCH

4.1 THEORETICAL BACKGROUND

German physicist Heinrich Hertz developed the first crude radio transmitters (also known as spark gap transmitters) in 1887 while conducting ground-breaking research on radio waves. A high voltage spark between two conductors produced the radio waves. These transmitters were used by Guglielmo Marconi to create the first effective radio communication systems starting in 1895, and radio started to be used commercially around 1900. The operator tapped a telegraph key to turn on and off the transmitter, which produced radio wave pulses that represented text messages in Morse code since audio (sound) could not be transmitted by spark transmitters. Instead, information was transmitted by radiotelegraphy. These pulses were audible in the receiver's loudspeaker as "beeps" and were converted back to text by an operator who understood Morse code. The wireless telegraphy or "spark" era, also known as the first three decades of radio (1887–1917), saw the use of these spark-gap transmitters. Spark transmitters were electrically "noisy" because they produced damped waves. They produced radio noise that interfered with other transmitters because they dispersed their energy over a wide range of frequencies. In 1934, damped wave emissions were made illegal by international law. Practical Frequency Modulation (FM) transmission was invented by Edwin Armstrong in 1933, who showed that it was less vulnerable to noise and static than AM. The first FM radio station was licensed in 1937.



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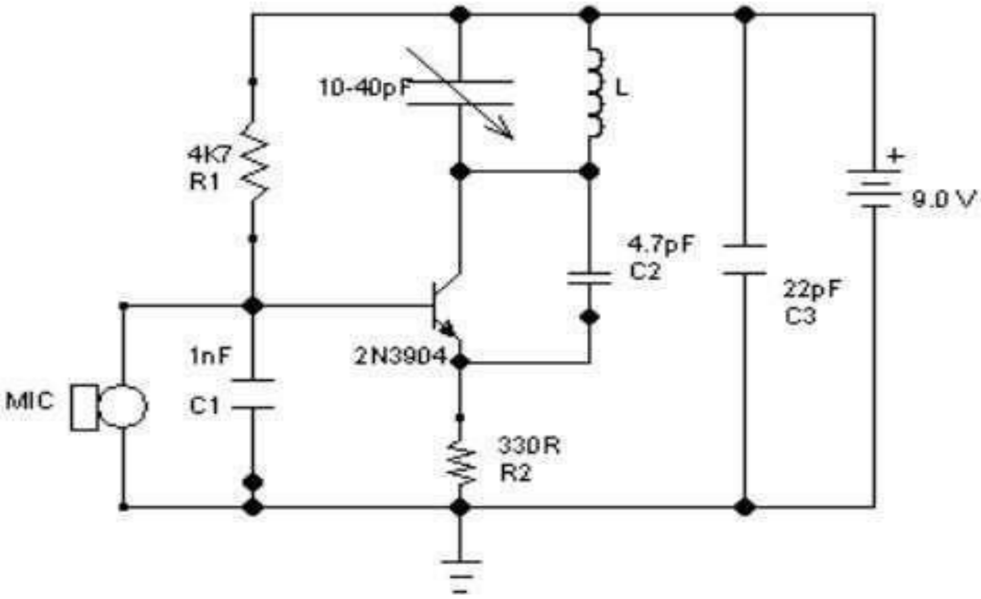

Fig 4.2 SINGLE TRANSISTOR FM TRANSMITTER BY D. MOHANKUMAR

The single transistor FM transmitter is based on the transistor reactance modulator model. The circuit is simplified by excluding a pre-amplifier stage, while the modulator and carrier oscillator stage are implemented on a single 2N3904 or BC547 general purpose transistors. The modulating effect is achieved by the specific arrangement of the input resistor R1 = 4k7 and C1= 1nF capacitor. The single transistor FM Transmitter had a very poor range of about 9 - 15 meters, and also the stability of the circuit was a bit poor, as the frequency often drifted o

V. METHODOLOGY

5.1 SIGNIFICANCE OF THE PROJECT

Wireless transmission of voice messages enables the exchange of information in real-time. It also allows the transmission of audio signals from one point to another without the use of wired electrical connections. It has a wide range of uses, including: Bring sound to corner speakers in large halls, stadiums, and large open-air events without running long cables. Communication between people in a building or office.

5.2 BLOCK DIAGRAM

When creating a system for transmitting frequency-modulated waves, several building blocks should be considered. The following diagram gives a very broad overview. Impressions of transmitters and their individual parts.

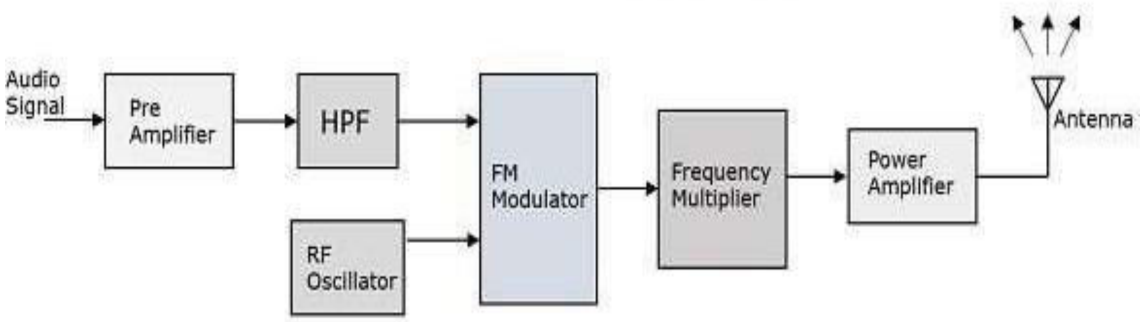

Fig 5.1 : FM Transmitter Block Diagram

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5.3 CIRCUIT DIAGRAM

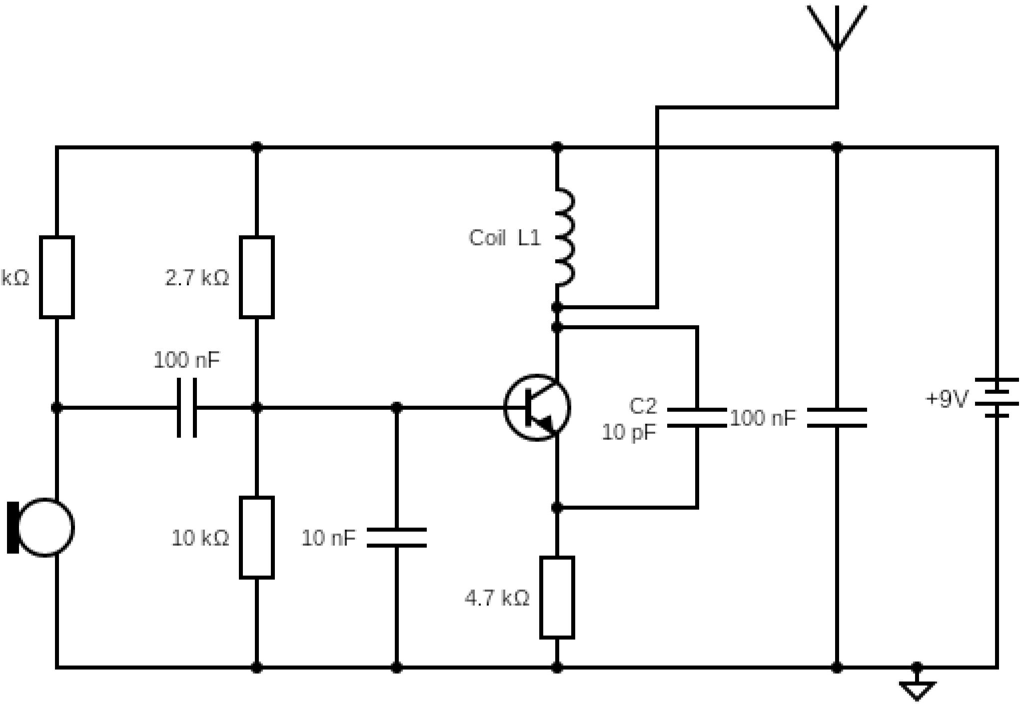

Fig 5.2 : Circuit Design

VI. TEST AND RESULTS

6.1 INTRODUCTION

This section will discuss tests carried out on the final circuit and the results obtained. Measured waveforms from the oscilloscope will be used to illustrate the performance at each stage of the circuit and the method used to evaluate the obtained result will be described. Test equipment at various stages of the circuit different tests was required to confirm the performance of the stages. The following test tools were used:

a) Digital Multimeter:
This is an electronic device used to measure continuity, voltage, and current. The multimeter was particularly useful for measuring the base-emitter voltage of each transistor in order to verify if it was within the voltage range (i.e 0.6V to 0.7V) of the transistor active region.

b) Oscilloscope:
This is a type of electronic test instrument that allows observation of constantly varying signal voltages with respect to time. It allows the observation of signal amplitude and the period of the signal

VII. RESULT

Both the FM transmitter and FM radio are switched on with the bug sited at one spot and the FM radio moved within the maximum specified distance of 50 meters. Then the FM radio is tuned to the specified frequency 97MHz of the transmitter and a voice message is then received.

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VIII. CONCLUSION

1.1 Conclusion

In conclusion, the FM bug transmitter & inductor coil design was a success. The human voice transmission was received at the output on 97.1 MHz frequency, provided conditions are favorable for wireless transmission. For extending the range and power of the FM transmitter, one can apply another level of Amplification after the Second stage, which would in turn further amplify the signal, and then it can be transmitted, the more the power of a signal transmitted, the greater is its range and more noise immune it becomes. Also, to improve efficiency one may check the voltage of the source applied and assure it is 9V for the above circuit. Furthermore, one should implement the design on a PCB board as breadboard is not preferred for high-frequency circuits The development and testing of the FM bug transmitter and inductor coil design proved to be a successful endeavor. The project achieved its primary objective—transmitting the human voice wirelessly over a frequency of 97.1 MHz, with the output being received clearly under favorable transmission conditions. The successful reception of audio signals demonstrates the viability of the circuit design and its effectiveness in real-world applications, especially for short-range

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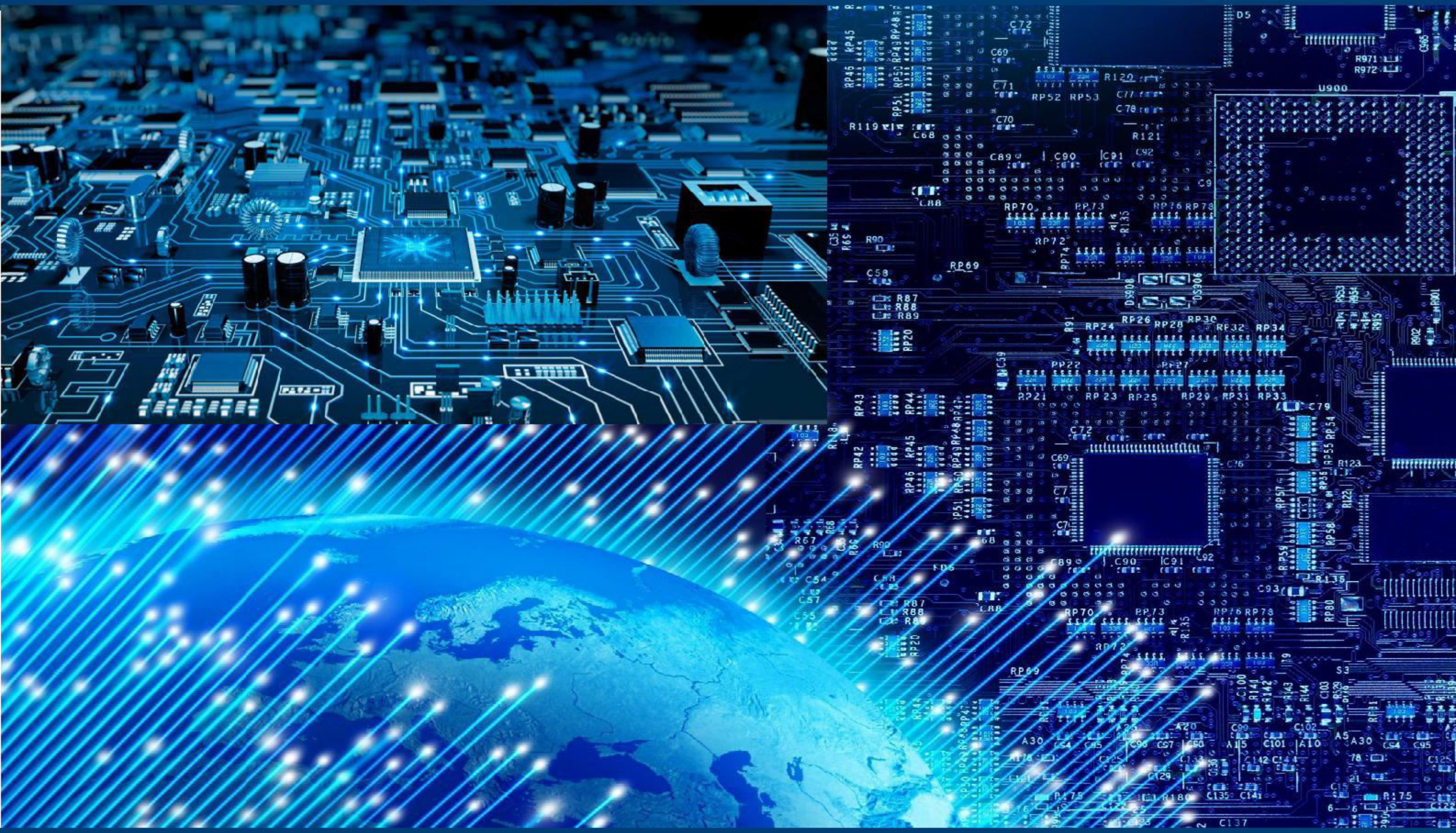

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