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Construction of a Mobile Frequency Modulation Transmitter

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Abstract. A Frequency Modulation (FM) transmitter is an electronic device that produces radio waves with the aid of an antenna. The transmitter generates radio frequency alternating current, that is applied to the antenna. When the antenna is excited by the alternating current, the antenna begins to radiate radio waves by varying the frequency of the radio signal. The transmitter is a Very High Frequency (VHF) Colpitts oscillator capable of transmitting sound to standard FM receiver fitted with a capacitor microphone which picks weak sound signals. This design was achieved using: transistors, resistors, inductors and capacitors. A transmission frequency of $\pm 5\%$ 100 MHz was used and transmitted up to a distance of 5 metres. The testing of the transmitter was carried out by powering it using a 9 V DC battery and tuning a suitable FM receiver to the transmission frequency of the constructed transmitter. A transmission distance of 5 metres was achieved therefore making it possible to use the transmitter as a portable cordless microphone used for public address (P.A.) systems. The achieved fixed frequency of transmission 56.4 MHz, away from all other radio stations transmission frequencies. This gives the best range and with the least of interferences. With increased power, the range can easily be extended.

Keywords: Transmitter, Antenna, Frequency, Modulation, Receiver, Radio-waves

1. Introduction

FM is a technique used for wireless transmission of data where the frequency of a carrier signal is changed in proportion to the audio signal [1]. Both the carrier amplitude and the associated power of the modulated wave are kept constant. Radio technology is always needed to meet the needs of man as it is readily deployed in: communication, surveillance, aviation, and transportation, just to mention a few. [2]. This article describes the construction of a FM transmitter for quality audio transmission. The first radio transmitter (Hertzian Oscillator) was made by Heinrich Hertz in 1887, and Edwin Armstrong invented practical FM transmission in 1933 [2]. Radio transmission is accomplished with the aid of electrical resonance when the frequency of the receiver is equal to the frequency emanating from the transmitter. FM band is subjected to less distortion compared to those of Amplitude Modulation (AM) band, (where the amplitude of the carrier signal is varied in proportion to the instantaneous amplitude of the data signal) and Short Wave (SW) bands [3]. FM technology plays a vital role in preserving the quality of the audio signal from the source to the receiver since it has more excellent Signal-to-Noise Ratio (SNR) compared to an equal power AM.

Modulation is the process of superimposing data contained in a lower frequency signal into higher frequency carrier signal. The basic parameters of a signal, i.e., amplitude, frequency, and phase can be varied to give rise to a modulated signal of the said parameter. For this construction, the frequency of the signal was varied. Hence frequency modulation was used. The modulation of signal is necessary for efficient radiation and reception of radio signals which enhances comprehensive coverage or broader operating range [4, 5]. The AM was not considered due to its limitations which include: noisy



reception, low efficiency, small operating range, and lack of audio quality occasioned by constraints on the allocated frequency spectrum of about 10 kHz [5]. In order to receive the broadcast, the process of demodulation helps to recover (separate) the data signal from the modulated wave at the receiver end. The recovered data signal is then amplified and fed to a speaker for conversion to sound wherein the initial quality at the production stage is essentially preserved.

2. Methodology

Audio (pre-amplifier) was used for the amplification of the weak audio signal from the microphone, Colpitts Oscillator was used for the generation of the sinusoidal carrier signal, and a Direct Current (DC) 9 V_{dc} battery was used to provide DC power [6 – 8]. The principle of operation involved noise rejection via FM, pre-emphasis (special boosting of high frequencies) at the transmitter stage and de-emphasis at the receiver end [2]. The output at a receiver can only be affected by a noise signal frequency only if it is within the receiver's bandpass. Noise rejection is achieved by ensuring that that peak amplitude is twice as great as the signal. The provided guard band in FM makes it possible to reduce adjacent channel interference. Applying amplitude limiters in the FM receiver creates an effective co-channel interference-capture effect as the relatively weak interfering signal from another transmitter is effectively attenuated. At the transmitter's end, special equalization process and pre-emphasis are used to minimize the level of frequency noise (i.e., hiss) during transmission. At the receiver end, an equal but opposite equalization process, de-emphasis is used to reduce high frequency noise. This second process is called "compensate for the limited dynamic range of radio transmission" [9, 10]. The circuit diagram of a low-cost mobile FM transmitter is shown in Figure 1.

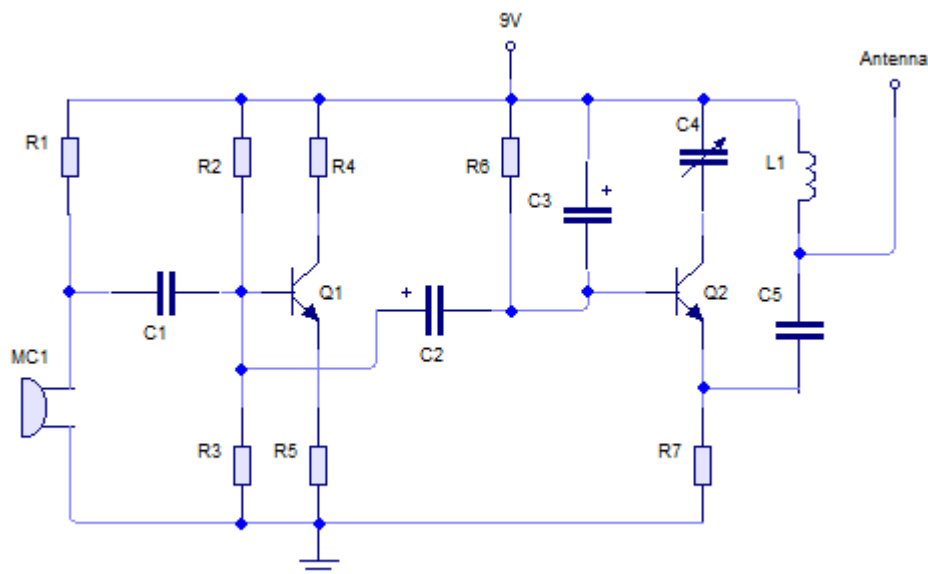


Figure 1: The circuit diagram of a low cost mobile FM transmitter.

The various component values were carefully determined in order to achieve a functional device at 98.1 MHz frequency of operation. The transmitter construction consists of the power supply unit, powered by a 9 V_{dc} battery, the audio pre-amplifier unit constructed with a NPN transistor of common-emitter (CE) configuration, the power amplifier unit to amplify the carrier signal built with a NPN transistor of CE configuration. The RF oscillator unit for the production of the carrier wave was fabricated using a Colpitts Oscillator followed by the antenna unit. A single pole antenna was employed is for transmission of FM signal through space.

The microphone picks the audio signal and feeds it into the pre-amplifier, which then amplifies the weak audio signal and feeds same to the power amplifier. The power amplifier output is fed to the RF oscillator where the carrier signal is generated and frequency modulation is performed. Afterwards, the RF oscillator feeds the antenna for the propagation of the FM signal into space. The electret microphone was used because of its high sensitivity due to its stable dielectric material in conjunction with the embedded electric dipole moment that is static as a result of the in built high resistance. In Figure 1, the 100 K Ω resistor limits the current flow. For the pre-amplifier, the power amplifier and oscillator stages, NPN transistors 2N3904 were used due to its general-purpose amplifying and switching characteristics [11]. A single-pole antenna was incorporated because of the intended portability of the device. A 9 Vdc battery powered the circuit to supply steady current. As soon as the circuit was tested working properly on a breadboard, a printed circuit was made using a Vero board and all components affixed and packaged in an improvised polyvinyl casing. The complete constructed device is shown in Figure 2.



Figure 2: Showing image of the complete work

3. Results and Discussion

The waveform in Figure 3 shows the result before the oscillation and modulation process with a frequency value of 3.343 MHz. While Figure 4 shows the frequency after the amplification process. The attained frequency at this point was 56.39 MHz, though less than the theoretically expected value of 87.5 MHz. A number of factors may have caused this reduced frequency level, notably the source of power and the variation in the value of capacitor C_4 and inductor L_1 used for the construction. The resulting waveform of the output of the pre-amplifier circuit (Figure 5) is in accordance with what a typical Frequency Modulation waveform should look like. It was found that the carrier frequency varies with the magnitude variations of the modulating signal. The carrier frequency was made to fluctuate according to the modulating signal. Based on the result, the output frequency of the pre-amplifier circuit was found to be low. The output is measured at inductor L_1 , where it acts as an antenna for this FM telephone transmitter circuit.

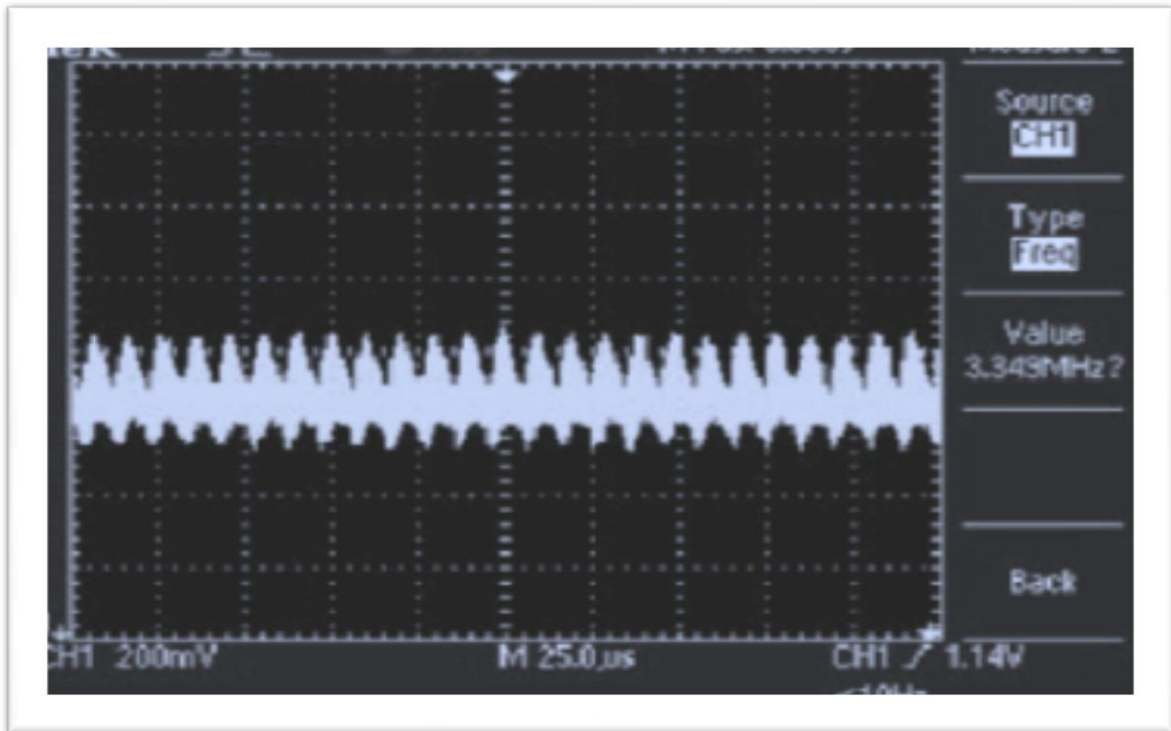


Figure 3: Waveform before pre-amplification

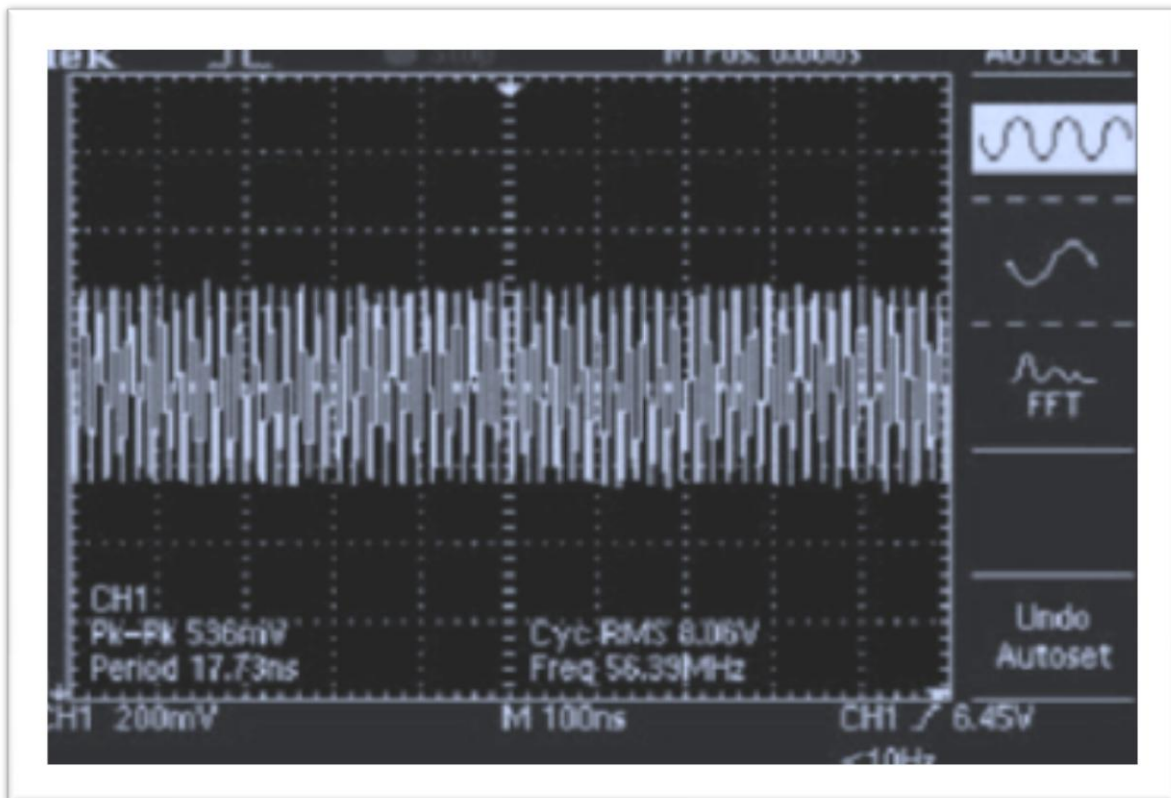


Figure 4: Waveform at the output of pre-amplifier

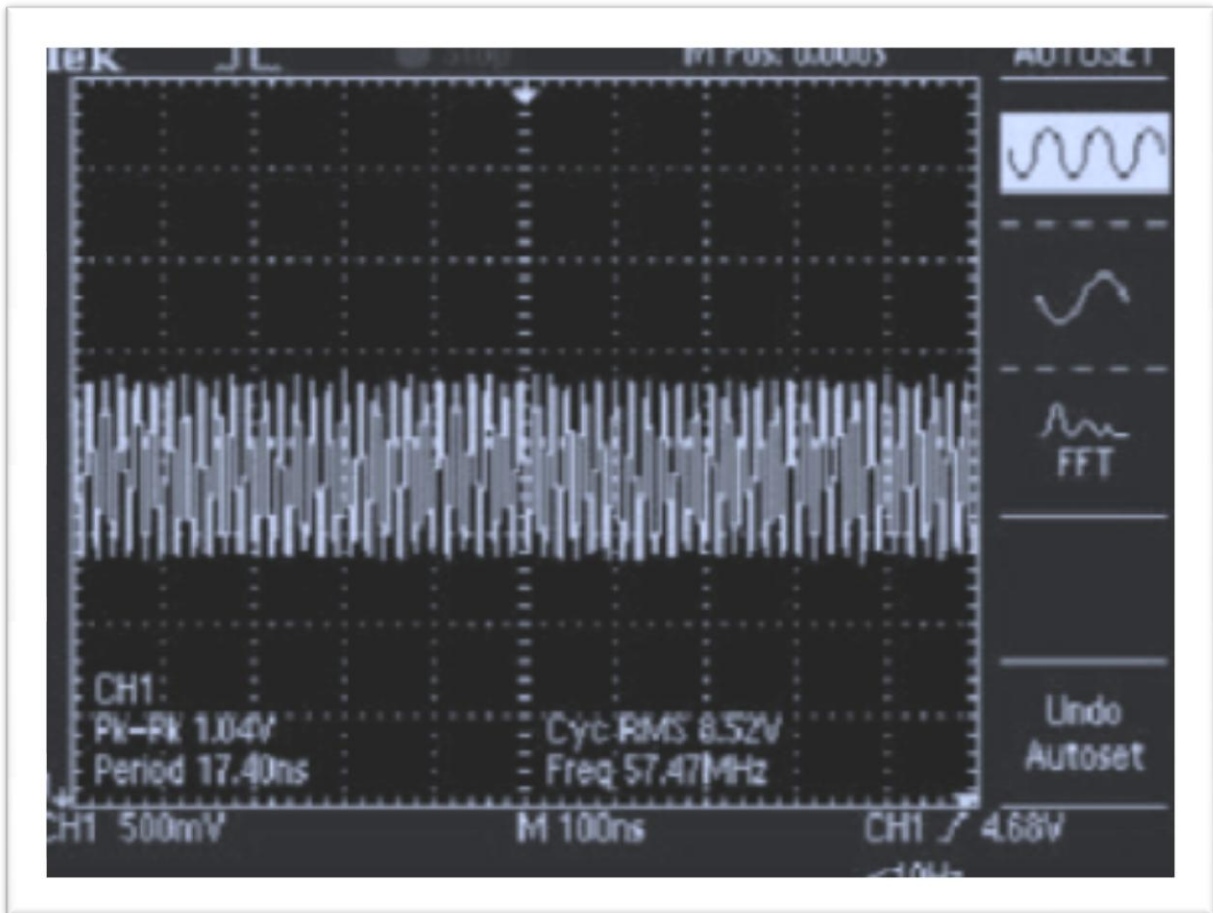


Figure 5: Waveform at output of oscillator circuit

4. Conclusion

The constructed FM transmitter was tested and found to work within 5 metre distance with a frequency range between 55.0 and 56.4 MHz. A greater amount of stability in the reception with a minimal distortion was observed at 56.4 MHz frequency. Observation further revealed that the transmitter performed better at the same frequency when power from a step-down transformer assisted DC regulated power supply. Therefore, for optimal performance a regulated DC operated from the mains will be preferable.

Acknowledgments

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References

1. Chen, D. (2002). Design and Construction of FM Transmitter and Receiver. *Dissertation Abstract International: Science and Engineering*, 1:45-49.
2. Horowitz, L., and Hill, W. (1989) *The Art of Electronics* (2nd edition). London: Cambridge University Press. 297-300.
3. Louis, E. (2008). *Principles of Electronic communication systems*. London: McGraw-Hill Education, 787.

4. Ackermann, J. (2013). TARR: Tomorrow's Ham radio technology today. *British Journal for History of Science* **2**(1): 100-120.
5. Atti, L. (2007). *Audio Signal Processing and Coding*. U.S.A: John Wiley Interscience, 464p.
6. Usikalu M. R, Isaac E. G, Olawole C. O, Abodunrin T. J and Kayode O. T (2019) Design and construction of solar powered fabric dryer, *International Journal of Mechanical and Production Engineering Research and Development*, **9(6)**: 139-148
7. Ayara W. A, Omotosho T. V, Usikalu M. R, Singh M. S, Suparta W. 2017. Development of a solar charged laboratory bench power supply, *Journal of Physics: Conference Series* **852** (1), 012044
8. Usikalu M. R, Shittu A. H and Obafemi L. N (2018) Construction of an intelligent and efficient light control system, *International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)*, **8(4)**: 1057-1066
9. Ezeorah, C. (2009). Wireless system operation. *Selection and operation of wireless Microphone Systems* 23-26.
10. Floyd, T. (2004). *Electronic Devices: conventional current version*. (9th edition). London: Pearson Educational Publications, 976p.
11. Kleitz, W. (2005). *Digital Electronics: A Practical Approach*. (7th edition). London: Cambridge University Press 500-512.