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Design and Development of Stethoscope Amplifier Circuit

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ABSTRACT The stethoscope is an indispensable medical device used for auscultation, enabling healthcare professionals to listen to internal body sounds, such as heartbeats and lung sounds. Traditionally, stethoscopes have been purely mechanical devices. However, in recent years, advancements in electronics and circuitry have paved the way for innovative electronic stethoscopes that offer improved functionality and sound amplification. This report outlines the design and outcome of an electronic stethoscope amplifier circuit, aiming to create a cutting-edge stethoscope that delivers heartbeat sounds with superior clarity and precision. The primary objective of this project is to develop an electronic stethoscope that utilizes state-of-the-art electronics and several circuits to provide accurate and well-amplified heartbeat sounds. Our aim is to explore a novel approach to amplifying the sounds of the heartbeat and demonstrate the benefits of using modern technology to enhance the performance of a stethoscope. To achieve our objective, we employed an innovative approach in the design of the electronic stethoscope amplifier circuit. The core concept involves the integration of an RF transmitter that broadcasts the signals of the heartbeat wave sounds. These signals are then detected using the VHF (Very High Frequency) method, optimizing the transmission and reception of the sound data. The electronic stethoscope's circuitry is carefully calibrated to ensure precise signal processing and accurate amplification. The electronic stethoscope's amplifier circuit is carefully engineered to accommodate the RF transmitter and VHF detection system seamlessly. The circuitry incorporates high-quality components to minimize noise and interference, ensuring faithful reproduction of heartbeat sounds. The use of advanced electronics enables us to achieve finer control over the amplification process, resulting in clearer and more distinct audio output. Furthermore, we implemented robust safety measures to guarantee the device's compliance with medical standards. The electronic stethoscope is designed with patient safety in mind, employing non-invasive technology and adhering to electromagnetic compatibility regulations. To assess the performance of our innovative electronic stethoscope, we conducted extensive testing and comparison studies against traditional physical stethoscopes. A team of skilled healthcare professionals participated in the evaluation, analyzing the quality and accuracy of the heartbeat sounds captured by both the electronic stethoscope and conventional stethoscopes. The results of our performance evaluation showcased significant advantages of the electronic stethoscope over its traditional counterparts. The heartbeat sounds captured and amplified by the electronic stethoscope were consistently clearer and more defined. The RF transmitter and VHF detection method effectively minimized signal distortion, resulting in a more faithful representation of the heart's sounds. This innovative approach allowed for enhanced amplification, making it easier for healthcare professionals to detect subtle abnormalities and anomalies in heart sounds.In conclusion, the design and outcome of the electronic stethoscope amplifier circuit have proven successful in creating an innovative and high-performance stethoscope. By combining advanced electronics, the RF transmitter, and the VHF detection method, we have achieved superior sound amplification of heartbeat sounds compared to traditional physical stethoscopes. This breakthrough offers promising opportunities for the advancement of auscultation technology, leading to more accurate and efficient diagnoses in medical practice. As we move forward, further refinements and enhancements in electronic stethoscope design could revolutionize the way we listen to the body's internal sounds and improve patient care.

KEYWORDS VHF, heartbeat sounds, electronic stethoscope.

I. INTRODUCTION

The stethoscope amplifier circuit represents a remarkable electronic advancement in the realm of auscultation, serving to magnify the sounds of our heartbeat and delve deeper into the realm of medical diagnostics. While conventional stethoscopes have served as indispensable tools for healthcare professionals, electronic stethoscopes, with their amplified capabilities, hold the potential to revolutionize the way we perceive and interpret bodily sounds [1].

However, even as electronic stethoscopes bring newfound benefits, they too are not without their drawbacks. One of the significant challenges faced by electronic stethoscopes is the potential for unintended noise pollution to be amplified along with the crucial cardio sounds. This arises from the inherent design of electronic stethoscopes, which involve sound amplification and signal detection through the utilization of a sensitive microphone. As a result, ambient noises or interference from the surroundings may inadvertently be picked up, impacting the overall accuracy and clarity of the auscultated sounds.

In order to overcome these limitations and enhance the electronic stethoscope's performance, the present project embarks on the development of specialized circuits tailored to optimize the antenna range for amplifying heartbeat sounds. By fine-tuning the circuit configurations, it is possible to refine the electronic stethoscope's sensitivity, ensuring that it primarily captures the essential cardiovascular sounds while minimizing the influence of extraneous noises.

Throughout the centuries, the stethoscope has undergone an incredible journey of evolution. From its earliest recorded mention in ancient Egypt to the modern-day acoustic and electronic stethoscopes utilized in medical practice, this quintessential medical instrument has continuously adapted to meet the demands of advancing healthcare technologies. Through this project, we aim to propel the stethoscope's evolution even further, harnessing the power of electronics and innovative circuitry to augment its diagnostic capabilities [2].

The culmination of this project lies in the creation of an FM Transmitter circuit, a feat that amplifies the sound of the heartbeat to unparalleled levels. Employing several integrated circuits, this transmitter circuit transforms the auscultated cardiovascular sounds into radio signals, allowing them to be received by a compatible radio receiver within a practical range of a few meters. By implementing this FM Transmitter circuit, we ensure that the amplified heartbeat sounds can be effectively transmitted without encroaching upon or interfering with any licensed communication channels' bandwidth [3].

The implications of this project are significant, with the potential to elevate stethoscope technology to new heights. The precise amplification and transmission of heartbeat sounds open doors to improved medical diagnostics and remote patient monitoring. Healthcare professionals gain access to enhanced auscultation capabilities, empowering them to detect subtle irregularities and anomalies in patients' cardiac functions, respiratory health, and circulatory system.

As we embark on this technological journey, we remain cognizant of the historical significance of the stethoscope and its invaluable role in medical examinations. This project serves as a testament to the ingenuity and innovation that continues to shape the field of healthcare. By blending the ancient wisdom of auscultation with cutting-edge electronics, we pave the way for a future where electronic stethoscopes redefine precision diagnostics and contribute to a healthier world.

II. MEDICAL WORKING METHODS OF A STETHOSCOPE

A. APPLICATION OF ELECTRONIC STETHOSCOPE

Signal processing plays a pivotal role in advancing the analysis of body sounds once they have been amplified using an electronic stethoscope. Healthcare professionals rely on auscultation to detect potential health issues by listening to bodily sounds. By comparing these body sounds with pre-defined acoustic patterns of diseases, recorded previously, it becomes feasible to create a machine capable of automatically determining the likelihood of an illness. One of the primary advantages of electronic stethoscopes lies in their versatility, as they can be comfortably worn over clothing. Unlike conventional stethoscopes, which necessitate placing the diaphragm directly on an exposed heart or chest, electronic stethoscopes can effectively capture sounds through clothing. This feature enhances patient comfort during examinations and addresses a significant concern in some conservative communities and locations where individuals, particularly women, might feel uncomfortable seeking medical attention due to cultural norms associated with physical exposure. In conclusion, the application of signal processing enhances the potential of electronic stethoscopes in analyzing body sounds, aiding medical professionals in diagnosing health issues. By comparing these sounds with established disease patterns, it is possible to develop automated diagnostic tools. Furthermore, the non-invasive nature of electronic stethoscopes, allowing them to be worn over clothing, promotes patient comfort and facilitates healthcare access in various cultural contexts.

B. BASICS OF HEART AUSCULATION

Auscultation, a fundamental medical practice, involves the act of listening to the internal sounds of the body, typically facilitated by using a stethoscope. This essential diagnostic technique is primarily employed by physicians, nurses, and other healthcare professionals to evaluate a patient's health status comprehensively. By auscultating specific body regions, clinicians can diagnose and monitor a wide range of conditions, spanning from heart and lung diseases to gastrointestinal and vascular disorders. During auscultation, the healthcare professional places the stethoscope on various body areas, such as the chest, abdomen, or back, to listen attentively to the sounds produced by internal organs and structures. This auditory examination enables them to gain valuable insights into the patient's health condition. For instance, by listening to the heart sounds, the healthcare provider can discern the heart's rate and rhythm, detecting irregularities that may indicate potential cardiac issues. Similarly, auscultating the lungs allows them to detect abnormal sounds like crackles or wheezes, indicating the presence of fluid or airway constriction, respectively. Auscultation also provides critical information about vascular health. By listening to blood flow through arteries and veins, clinicians can identify potential blockages or abnormalities that may impair circulation and require further investigation or intervention. The art of auscultation is a skill honed through experience and training, as different conditions may manifest distinct sounds that require careful interpretation. Subtle nuances in sound quality, pitch, and duration can hold valuable diagnostic clues, making auscultation an indispensable tool in a healthcare professional's arsenal [4].

C. HEARTBEAT WAVEFORM PATTERN

The heartbeat waveform pattern, also known as an electrocardiogram (ECG or EKG) is a representation of the electrical activity of the heart. The ECG waveform is produced by the electrical activity of the heart as it contracts and relaxes. The ECG waveform is typically composed of three main waves: the P wave, the QRS complex, and the T wave.

- The P wave represents the electrical activity of the atria as they contract.
- The QRS complex represents the electrical activity of the ventricles as they contract.
- The T wave represents the electrical activity of the ventricles as they relax.

The P wave is typically a small, upward deflection and the QRS complex is usually a larger, downward deflection. The T wave is typically a small, upward deflection. The duration of the ECG waveform is usually measured in milliseconds.

f	λ	Band	Description
30-300Hz	$10^4 - 10^3$ km	ELF	Extremely Low Frequency
300-3000Hz	$10^3 - 10^2$ km	VF	Voice Frequency
3-30 kHz	100 – 10 km	VLF	Very Low Frequency
30-300 kHz	10 – 1 km	LF	Low Frequency
0.3-3 MHz	1 – 0.1 km	MF	Medium Frequency
3-30 MHz	100 – 10 m	HF	High Frequency
30-300 MHz	10 – 1 m	VHF	Very High Frequency
300-3000 MHz	100 – 10 cm	UHF	Ultra-High Frequency
3-30 GHz	10 – 1 cm	SHF	Superhigh Frequency
30-300 GHz	10 – 1 mm	EHF	Extremely High Frequency (millimetre Waves)

Table 1 Frequency Band Designations [7]

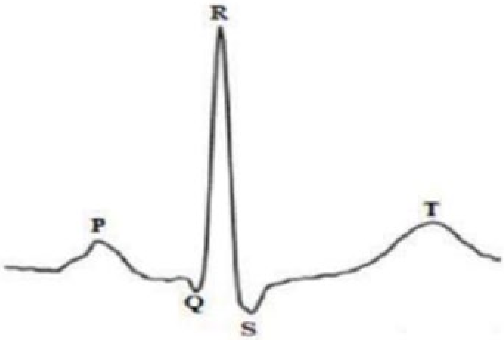


Figure 1 ECG Waveform [7]

II. RF BASICS

In the realm of electrical energy transmission, two primary modes of travel exist: through the air as invisible waves and along conductors as flowing current, represented by a group of electrons moving along a metal wire. In the context of a wireless system, electrical energy initially takes the form of current flowing over a conductor before transitioning into airborne waves. Subsequently, it undergoes another transformation, reverting back into current traveling along a conductor. The abbreviation RF stands for radio frequency, encompassing a broad spectrum of wireless and high-frequency signals. These signals span a wide range, ranging from 2.4 GHz computer local area networks (LANs) to AM radio frequencies between 535 kHz and 1605 kHz. However, RF is typically associated with frequencies ranging from a few kHz up to approximately 1 GHz. If we consider microwave frequencies as part of the RF spectrum, it extends up to 300 GHz.

In essence, RF technology plays a pivotal role in wireless communications, enabling the transmission and reception of signals over different frequency bands. Its diverse applications encompass everything from wireless networks to radio broadcasting, providing a versatile means of information exchange in the modern world. As technology continues to evolve, RF innovations hold the potential to shape the future of wireless communication, enhancing connectivity and accessibility across various industries and domains[8].

III. DEVELOPMENT OF CIRCUITS

A. STETHOSCOPE USING RF TRANSMITTER CIRCUIT

A stethoscope that uses an antenna and RF transmitter circuit would likely be a wireless stethoscope as well. The antenna would be used to transmit the audio signal picked up by the stethoscope's diaphragm to a receiver via a radio frequency (RF) signal. The RF transmitter circuit would be responsible for converting the audio signal into a wireless signal that can be transmitted by the antenna.

This design would allow for greater flexibility in use, as the sound can be transmitted over a greater distance than traditional stethoscopes and the sound can be easily shared with others or stored for future reference. It can also be connected to various software for analysis.

This type of stethoscope would have the same advantages and disadvantages as wireless stethoscopes mentioned earlier. It may not be as widely available or as well-established as traditional stethoscopes and may also be more expensive.

B. FM TRANSMITTER CIRCUIT

An electrical circuit known as an FM (frequency modulated) circuit is used to create or demodulate FM signals. FM signals, which are frequently used in radio broadcasting and two-way communication systems, are distinguished by the manner that their frequency changes in response to changes in the original signal's amplitude.

An FM circuit modifies the carrier wave's frequency using the original signal to produce a modulated output signal. As the original signal's amplitude changes, so does the frequency of the carrier wave, larger amplitudes produce higher frequency deviations, and vice versa. This makes it possible to encode the original signal into the output signal's frequency, which may then be transmitted and received by an FM receiver.

FM circuits come in a variety of forms, such as frequency synthesizers, FM modulators, and FM demodulators. While frequency modulators are used to change the frequency of a carrier wave with an input signal, frequency synthesizers are used to produce a variety of frequencies from a single source. By demodulating the frequency variations and transforming them back into the original amplitude variations, FM demodulators are used to retrieve the original signal from an FM modulated transmission.

C. APPLICATION OF FM TRANSMITTER

FM transmitters are frequently used in radio broadcasting, which involves sending audio signals from a radio station to receivers in the neighborhood. To allow users to speak with each other across a large distance, FM transmitters are also employed in two-way communication devices like walkie-talkies and other handheld radios. FM transmitters can also be used to transmit data signals for wireless networking, audio and video signals for home entertainment systems, and signals from sensors and other remote equipment for industrial and scientific applications. For usage in sound reinforcement systems, public address systems, and other audio applications, FM transmitters can also be used to broadcast audio signals from microphones and other audio sources.

On the other hand, an FM transmitter is a specific type of RF transmitter that modulates the signal using frequency modulation (FM) techniques. In FM, the frequency of the carrier signal is changed in proportion to the amplitude of the modulating signal, in this case the audio signal, this is done to transmit the audio information [4].

The main difference between RF transmitter and FM transmitter is that FM transmitter modulates the signal using FM techniques and RF transmitter can be used for various types of modulation techniques [8]. In this project, FM transmitter is being constructed to result in the output waveform of the of the sound of the heartbeat that would be amplified afterwards by the circuit implemented, which the audio signal would be received and transmitted through the FM transmitter [9].

IV. METHODOLOGY

A. BLOCK DIAGRAM OF FM TRANSMITTER CIRCUIT

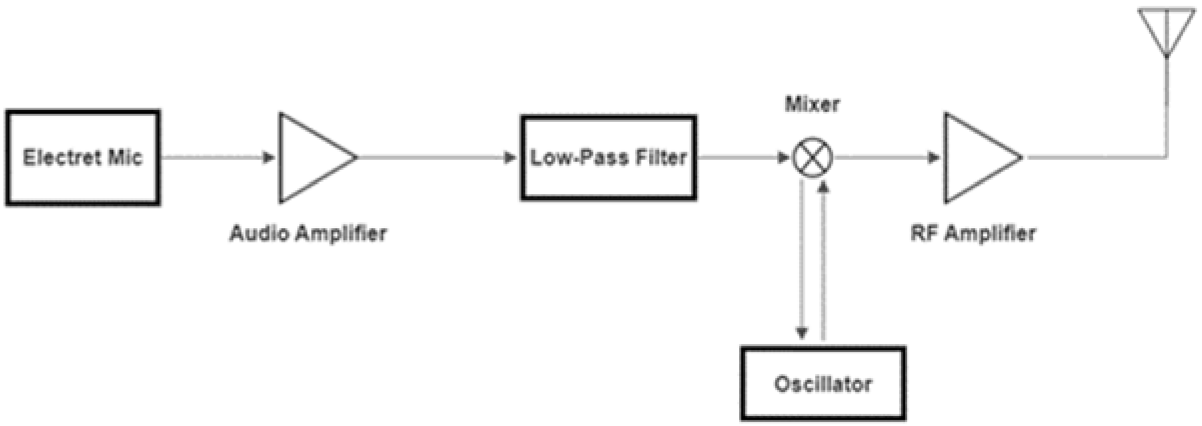


Figure 2 Block Diagram of FM Transmitter Circuit

B. FM TRANSMITTER CIRCUIT DESIGN 1 AND 2

Prior to the construction of both FM transmitter circuit designs, extensive calculations were conducted through DC and AC analysis to ensure their feasibility and performance. The goal was to optimize the efficiency and effectiveness of the FM transmitter circuits in transmitting signals. Both FM transmitter circuit designs serve the purpose of transmitting frequency modulated signals, with the modulator circuit playing a crucial role in manipulating the carrier signal based on the modulating signal. By altering certain attributes of the carrier signal, such as amplitude, frequency, or phase, the modulator circuit allows the transmission of information contained within the modulating signal.

However, during the experimentation phase, it was observed that FM transmitter circuit design 1 encountered instability in the transmission of the modulator signal when the values of certain components were modified. This instability could lead to undesired effects on the transmitted signal and compromise the quality of communication. To better understand the importance of the modulator circuit, it is vital to comprehend its application within a communication system. Modulator circuits are predominantly utilized at the transmitting terminal of communication systems to encode the information to be transmitted onto the carrier signal. This encoding process enables the communication of data over the transmission medium effectively.

Considering the comparison between both FM transmitter circuit designs, it is evident that one of them may exhibit superior performance in terms of signal output and stability. The selection of the more efficient design will depend on factors such as signal clarity, bandwidth efficiency, and resistance to interference. To further improve the FM transmitter circuit design and achieve stable modulator signal transmission, additional analysis, simulations, and practical testing may be required. Iterative adjustments to the component values and careful consideration of the circuit's overall configuration can contribute to achieving a much better output and enhanced performance.

In conclusion, the success of FM transmitter circuits heavily relies on the proper functioning and stability of the modulator circuit. This crucial component ensures that the carrier signal accurately carries the information from the modulating signal, enabling effective communication. By addressing the issues with FM transmitter circuit design 1, we can pave the way for more reliable and efficient communication systems in the future.

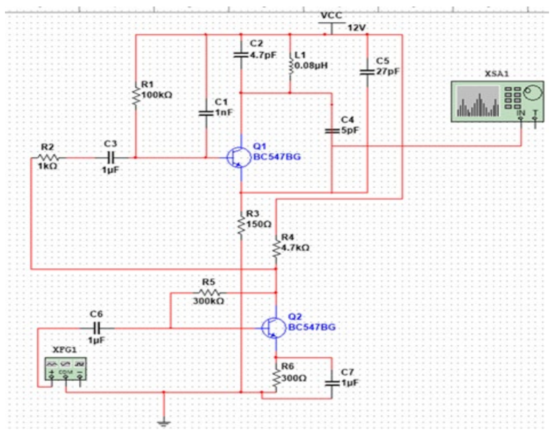


Figure 3 FM Transmitter Circuit Design 1

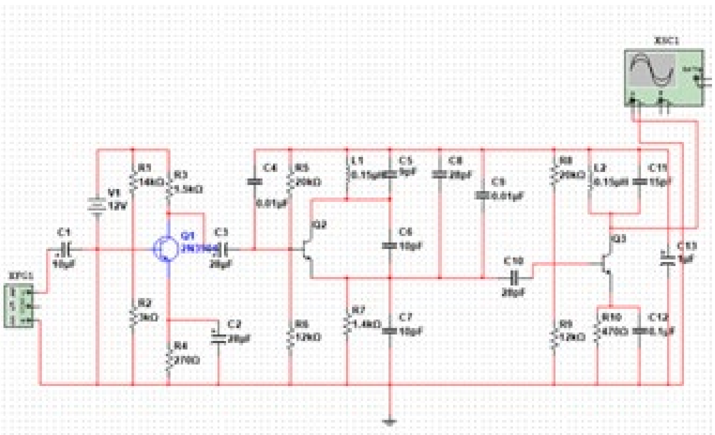


Figure 4 FM Transmitter Circuit Design 2

V. RESULTS AND DISCUSSION

A. AUDIO AMPLIFIER OF FM TRANSMITTER CIRCUIT DESIGN 1

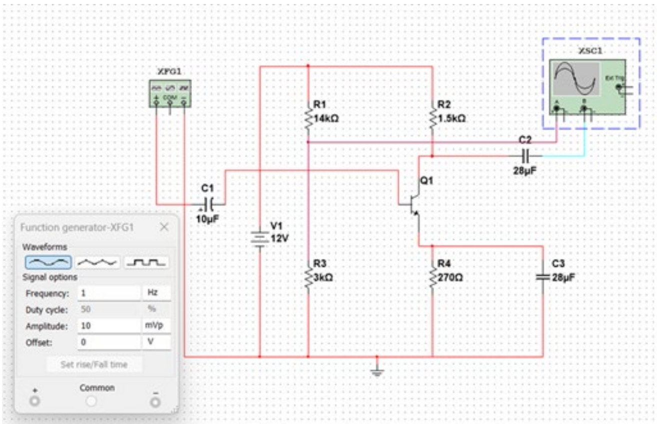


Figure 5 Audio Amplifier Circuit for FM Transmitter Design 1

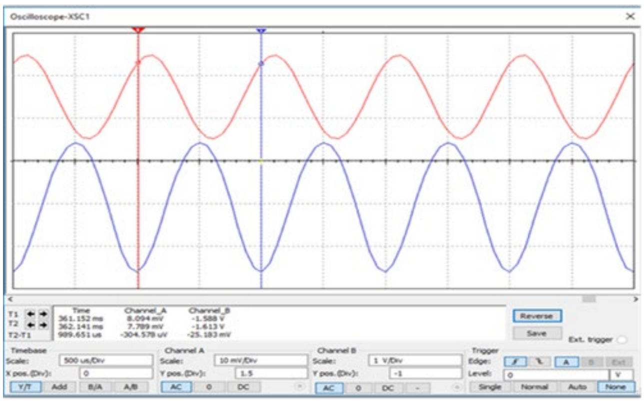


Figure 6 Audio Amplifier FM Transmitter Circuit Design 1 Output

The simulation's output results are visually depicted in Figure 6, wherein data was captured using an oscilloscope. Channel A in the figure represents the original signal waveform, highlighted in red, while Channel B represents the output of the preamplifier circuit, highlighted in blue. The analysis of the observed results, as illustrated in Figure 6, reveals essential characteristics of the signals. Each oscillation in the waveform takes approximately 989.651µs, which strongly suggests an input frequency close to 1kHz. The input waveform, denoted earlier in Channel A, exhibits an amplitude of approximately 18mVpp in the red waveform.

Upon scrutinizing the amplified output waveform in the blue waveform of Channel B, a significant change becomes apparent. The amplified output displays an amplitude of roughly 3Vpp, signifying a remarkable gain of 160 from the initial signal. This substantial amplification showcases the efficiency and effectiveness of the preamplifier circuit in boosting the signal's strength. Moreover, the waveform's modulation characteristics are notable. The successful modulation of a 1kHz signal at an impressive frequency of 100MHz further validates the circuit's functionality and capacity to handle high-frequency signals. The results presented in Figure 6 attest to the successful operation of the preamplifier circuit, demonstrating its ability to amplify the input signal significantly. With an observed gain of 160 and successful modulation of a 1kHz signal at 100MHz, the preamplifier circuit showcases its proficiency in signal amplification and modulation, holding promising potential for various applications in electronic systems and communication technologies.

B. AUDIO AMPLIFIER OF FM TRANSMITTER CIRCUIT DESIGN 2

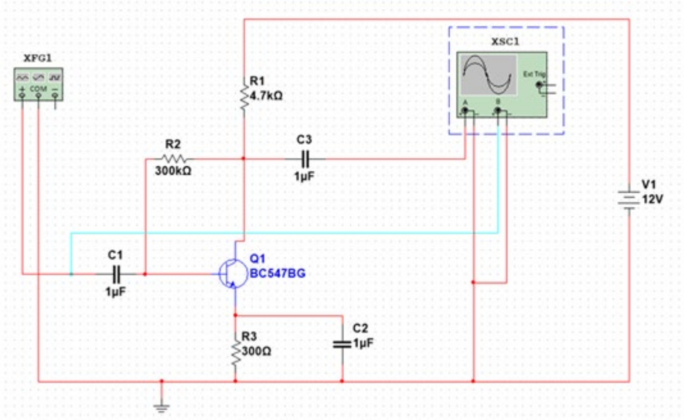


Figure 7 Audio Amplifier of FM Transmitter Circuit Design 2

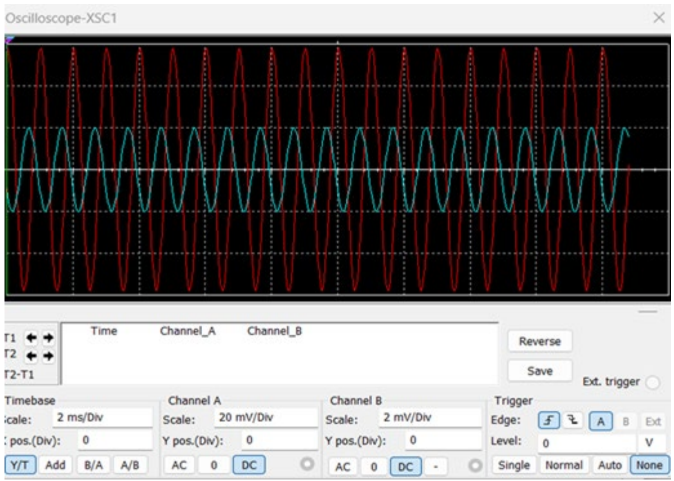


Figure 8 Audio Amplifier of FM Transmitter Circuit Design 2 Output

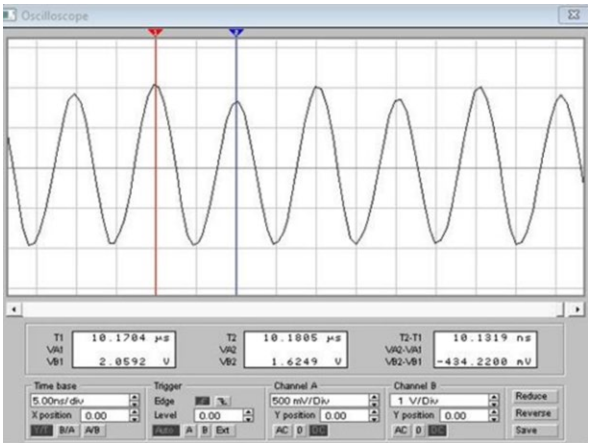
Figure 7 shows the audio amplifier of FM transmitter circuit design. Based on the data presented in Figure 8, it is evident that the audio has undergone successful amplification, resulting in the achievement of a smooth waveform. The amplification is quite substantial, with the audio being magnified twice as large as the original signal, as indicated by the scale change from 2ms/Div to 20 ms/Div (peak to peak). This significant amplification demonstrates the improved performance of the audio amplifier circuit, effectively enhancing the audio output. Furthermore, the application of a modulator in the circuit design proves to be highly beneficial. The modulator plays a crucial role in refining the signal, leading to a much clearer audio output compared to a circuit design lacking a modulator. FM transmitter circuit design 2, incorporating a superior modulator signal transmission, outperforms FM transmitter circuit design 1 in this aspect. The presence of a stable modulator signal transmission in circuit design 2 contributes to the higher clarity and fidelity of the audio transmission.

These findings underscore the importance of using an appropriate modulator in electronic circuit design, especially when dealing with audio transmission. The successful modulation of the audio signal in circuit design 2 showcases its potential to deliver improved audio quality and performance. In contrast, the instability observed in the modulator signal transmission of FM transmitter circuit design 1 may result in compromised audio transmission and lower signal fidelity. The data presented in Figure 8 highlights the effectiveness of the audio amplifier circuit, achieving significant audio amplification and a smooth waveform. The inclusion of a modulator in FM transmitter circuit design 2 proves to be a critical factor in achieving clearer and more stable audio signal transmission. This demonstrates the importance of careful circuit design considerations, ensuring the optimal performance of electronic systems, and delivering enhanced audio experiences.

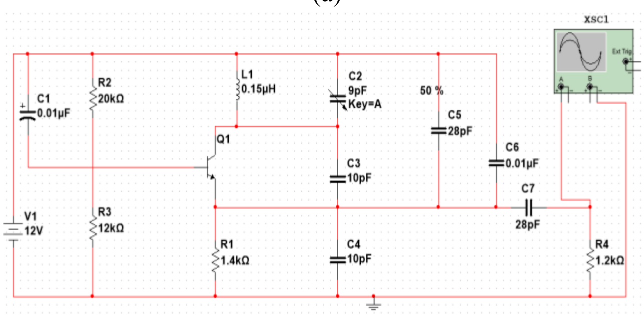
C. FM TRANSMITTER CIRCUIT DESIGN 1 OSCILLATOR AND RF CIRCUIT

Based on the analysis of Figure 9, the period required for a complete oscillation was measured at 10.1319ns, leading to a calculated frequency of approximately 99MHz. This value closely aligns with the previously determined frequency of 100MHz, validating the accuracy of the simulation. However, during the simulation, it was observed that the waveform did not achieve complete stabilization. This phenomenon was attributed to inherent limitations in the software components, such as inadequate losses and resistance models, which may have affected the overall behavior of the circuit in the simulation environment.

Despite the successful simulation results, it is essential to acknowledge the challenges encountered when attempting to implement the circuit in the real world. The practical implementation of the circuit was hindered by the unavailability of components with extremely small values in the market. As a result, assembling the actual circuit became impractical. Additionally, the simulation results revealed that the voltage levels in the circuit were excessively high. This raised concerns regarding the feasibility of powering up the real circuit, as such high voltages could potentially lead to complications and undesirable consequences. The simulation results showcased promising performance, the real-world implementation of the circuit encountered significant challenges. Issues with component availability and voltage levels posed obstacles in creating a functional prototype. These observations underscore the importance of realistic component selection and careful consideration of practical constraints when moving from simulation to real-world implementation in electronic circuit design.



(a)



(b)

Figure 9: (a) Oscillator circuit FM Transmitter Circuit Design 1 Output, (b) Oscillator circuit FM Transmitter Circuit Design 1

In Figure 10, the RF amplifier circuit is depicted, where a function generator supplies a 100MHz frequency signal originating from the oscillator. The RF amplifier is initially configured for 100MHz but can be adjusted to different frequencies by tuning the variable capacitor, allowing for frequency channel variations. The waveform in this circuit, specifically designed for the 100MHz frequency channel, demonstrates complete stability. However, if the input frequency differs from 100MHz, the RF amplifier will generate an unstable output waveform, indicating the presence of noise in the signal. Confirming the 100MHz frequency the period for each oscillation measures approximately 9.921ns, corresponding to a frequency of approximately 100.8MHz for the modulated channel. The output results show that the design works as an FM Transmitter circuit but due to the value in differences, it is not stable enough to make it work as a physical project as once the values were modified, a significant waveform could not be provided. The stated values could also not be found as a physical component as the values are too small to be found in the market.

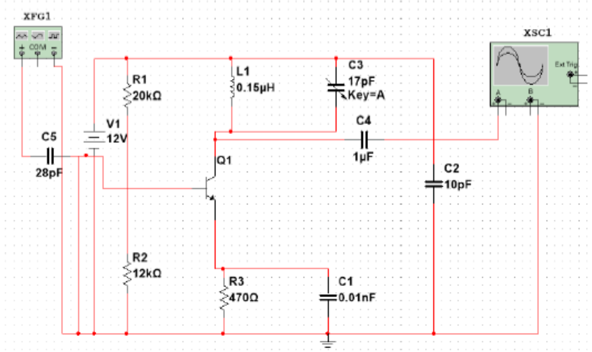


Figure 10 RF Amplifier Circuit

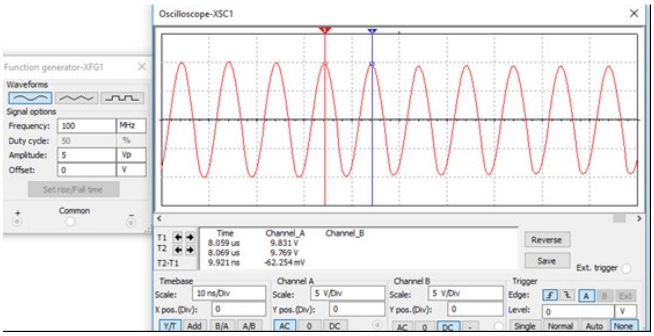


Figure 11 RF Amplifier Circuit Output

D. FM TRANSMITTER CIRCUIT DESIGN 2 MODULATOR CIRCUIT

I. FREQUENCY SPECTRUM OF MODULATOR CIRCUIT AFTER CAPACITOR (C2) VALUE ARE MODIFIED

Based on the analysis of Figures 12 and 13, it is evident that modifying the capacitor value (C2) has a significant impact on the output spectrum of the frequency signal. The frequency values change notably with the alteration of the capacitor values. For instance, with a capacitor value of 10 pF, the frequency spectrum measures 7.329MHz, whereas with a capacitor value of 0.1 pF, the frequency spectrum measures 82.517MHz. This demonstrates a substantial difference in frequency response corresponding to the changes in the capacitor value. The observations from the figures lead to a crucial conclusion: as the capacitor value decreases, the frequency spectrum increases. In other words, lower capacitor values lead to higher frequencies in the output signal. Consequently, this allows for a wider transmission range of signals.

A higher frequency spectrum implies that the signals can be transmitted over a more extensive range. For example, when sounds are collected through an electret microphone and then transmitted to the radio receiver using the FM Transmitter circuit, they can be heard across a radius of more than 50 meters. This increased transmission range allows for enhanced signal coverage and reception, potentially benefiting various applications, including wireless audio communication and remote monitoring systems. In summary, the relationship between capacitor values and frequency spectrum is well-established through the figures presented. Lower capacitor values result in higher frequencies, enabling wider signal transmission ranges, which can be advantageous in various electronic communication applications.

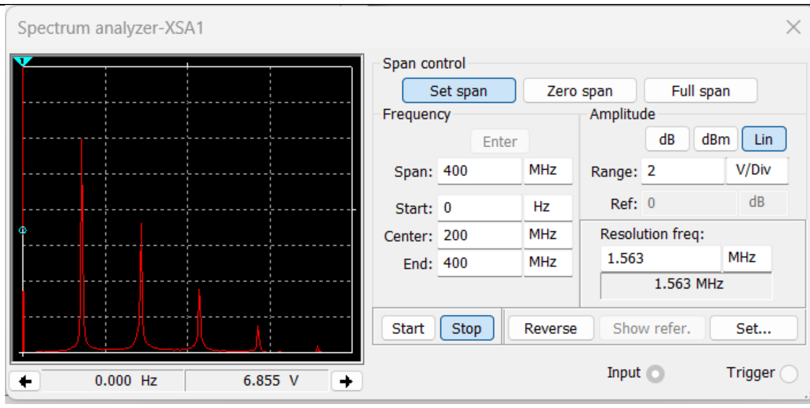


Figure 12 Frequency Output result when capacitor (C2) value modified to 10 pF

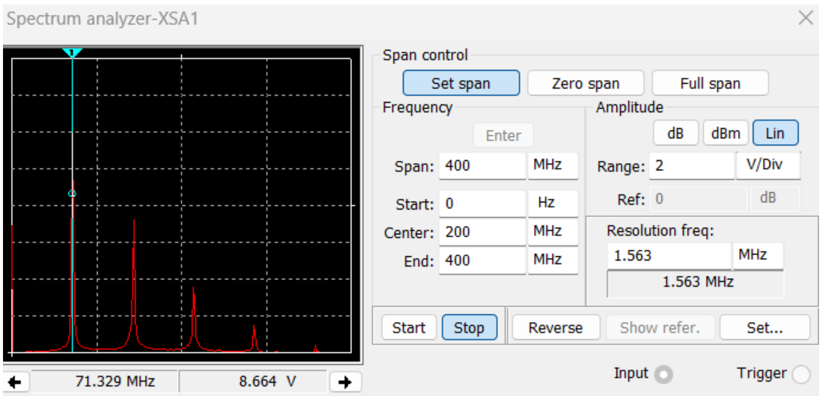


Figure 13 Frequency Output result when capacitor (C2) value modified to 0.1 pF

II. FM TRANSMITTER CIRCUIT DESIGN 2 FREQUENCY SPECTRUM OUTPUT AFTER CAPACITOR VALUE MODIFICIATION

It is said to be that when the capacitor (C2) value is 4.7pF,the frequency that was obtained is 99.301 MHz which is close too 100MHz for figure 14 and it is said to be that when the capacitor (C2) value is 1.7pF, the frequency that was obtained is 106.294 MHz for figure 15. it is shown that as the values were being modified, the frequency spectrum changes, the smaller the capacitor value is the higher the frequency spectrum gets. When values were modified, the FM transmitter circuit design still resulted in a stable waveform output compared to FM transmitter circuit design 1. When the frequency is higher, the range of transmission will also widen which also means that sounds can be amplified and transmitted to a range higher than 50 meters.

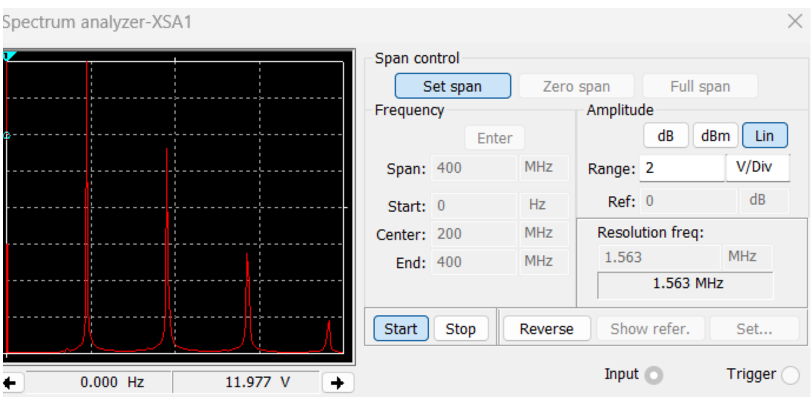


Figure 14 Frequency Spectrum output results of C2 value 4.7pF

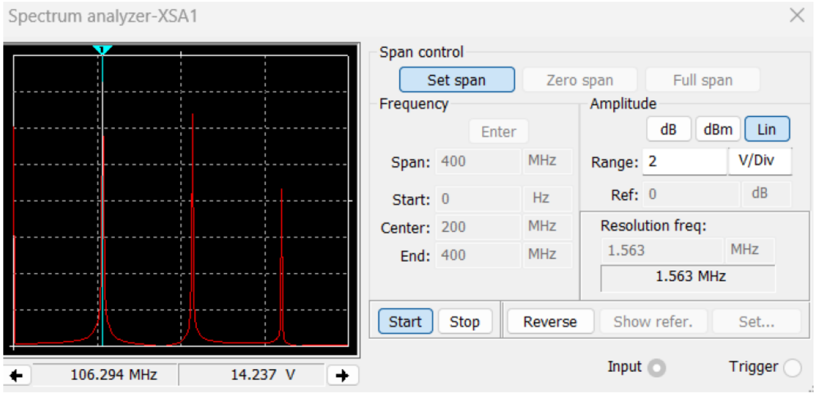


Figure 15 Frequency Spectrum output results of C2 value 1.7pF

Based on the evaluation of the two FM Transmitter Circuit Designs, it is evident that they yielded different outcomes in terms of stability, clarity of output results, and frequency transmission range. The first design encountered challenges with the stability of the modulator signal transmission, leading to unclear output results when component values were modified. Additionally, the spectrum diagram did not clearly depict changes in frequency, and achieving higher frequencies proved to be problematic. Consequently, the transmission range of frequencies was limited, resulting in a constrained range of transmission.

In contrast, the second FM Transmitter Circuit Design showcased a stable modulator signal transmission, allowing for clear and discernible output results when component values were adjusted. The design effectively demonstrated variations in the frequency spectrum as component values changed. Moreover, this improved design succeeded in achieving higher frequencies, significantly broadening the range of transmission frequencies. The ability to transmit over a wider range of frequencies enhances the circuit's versatility and potential applications.

Considering these findings, it is evident that FM Transmitter Circuit Design 2 surpasses the first design in various aspects. Its stability, clarity in output results, and extended frequency transmission range make it the superior choice for creating a more effective Stethoscope Amplifier Circuit. In conclusion, FM Transmitter Circuit Design 2 stands out as the best approach for developing an enhanced Stethoscope Amplifier Circuit. The analysis and clear results obtained from this design provide strong evidence of its superiority and suitability for various applications in electronic signal amplification and transmission.

VII. CONCLUSION

The construction of the 1st FM Transmitter Circuit was successful in achieving the desired waveform through Multisim Software, a powerful simulation tool. However, when attempting to implement the circuit in the real world, certain challenges were encountered. The values of the components used in the simulated design were too small and not readily available in hardware shops, rendering it difficult to realize the circuit physically. As a result, the waveform results could only be validated digitally through Multisim. To address this limitation and ensure the feasibility of the FM Transmitter as a Stethoscope Amplifier Circuit, a 2nd FM Transmitter design was introduced. The main objective of this design was to validate the working theory of the FM Transmitter concept while using components readily available in the market. By selecting more practical component values, the 2nd FM Transmitter aimed to overcome the obstacles faced with the 1st design, potentially leading to a functional real-world prototype.

Indeed, the availability of components with appropriate values is crucial in electronic circuitry projects. In some cases, certain pre-designed circuitry projects may not work due to the unavailability of specific components or the impracticality of utilizing extremely small-value components in real-world applications. The performance of circuits heavily relies on selecting suitable components that match the intended purpose and operating range. An important consideration in FM Transmitter circuits, specifically for stethoscope applications, is the frequency range. The signal transmitted by an FM Radio typically operates at around 100 MHz. Therefore, to ensure that the heartbeat sound is effectively transmitted and audible through the FM Radio, the frequency must fall within this specific range. Choosing the right frequency is crucial for achieving the desired results.

In conclusion, the challenges faced during the construction of the 1st FM Transmitter Circuit highlighted the significance of practical component availability. The 2nd FM Transmitter design aimed to address this issue and validate the functionality of the FM Transmitter concept. The selection of appropriate component values and adherence to relevant frequency ranges are critical factors in the successful implementation of electronic circuit prototypes. Being mindful of these considerations is essential in bridging the gap between simulation and real-world applications, ensuring the efficient operation of electronic systems and achieving the desired outcomes.

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