UNIVERSITY OF GHANA

DEPARTEMENT OF COMPUTER ENGINEERING

SCHOOL OF ENGINEERING SCIENCES

COLLEGE OF BASIC AND APPLIED SCIENCES

SECOND SEMESTER 2022/2023 ACADEMIC YEAR

COURSE CODE AND TITLE: CPEN 206, LINEAR CIRCUITS.

COURSE INSTRUCTOR: DR. GODFREY MILLS

COURSE PROJECT

TITLE: AMPLITUDE MODULATION(AM) RADIO COMMUNICATION SYSTEM.

GROUP 8

DOE AGUDEY DANIEL – 10956661

SAANI MUSTAPHA DEISHINI – 10978425

BONIFACE DELALI DAKEY – 10969344

AHETO OBED EYRAM – 10987509

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ABSTRACT

This lab report presents the design, simulation, and analysis of an AM (Amplitude Modulation) radio communication system using Proteus simulation software. The project aims to understand the fundamental principles of AM modulation, demodulation, and signal processing in a simulated environment. The simulation involves the creation of an AM transmitter and receiver, followed by the examination of the transmitted and received signals.

The report begins with an introduction to the project's objectives and the importance of AM radio communication systems. The problem statement addresses the need to transmit and receive audio signals using the AM modulation technique. The desired functionality of the system involves encoding audio signals onto a carrier wave and subsequently recovering the original audio content through demodulation.

The objectives of the project encompass the design and simulation of an AM transmitter and receiver, the analysis of modulation and demodulation processes, and the examination of received signal. The design methodology details the components of the transmitter and receiver, including the carrier and modulating signals, modulation circuitry, and demodulation circuitry.

Simulations are carried out in Proteus to demonstrate the modulation and demodulation processes. Graphs of the carrier, modulating, modulated, and demodulated signals are analyzed to understand their characteristics. The report also includes an overview of the hardware integration required to create the complete system.

Key findings from the simulations reveal the successful encoding of audio signals onto the carrier wave through modulation and the accurate recovery of the original audio content through demodulation. The amplified audio signal closely resembles the demodulated message signal, indicating effective amplification.

In conclusion, the project offers valuable insights into the principles of AM radio communication systems, modulation, and demodulation. The simulation-based approach allows for a comprehensive understanding of the signal processing steps involved in AM transmission and reception. This lab report serves as a foundational reference for students and enthusiasts exploring radio communication systems.

INTRODUCTION

In an era dominated by digital advancements, the importance of understanding and simulating analog communication systems remains indispensable. This project delves into the realm of Amplitude Modulation (AM) radio, a foundational communication technology that has withstood the test of time. In a collaborative effort to bridge the gap between theoretical knowledge and practical implementation, this report presents an in-depth exploration of the simulation of an AM radio communication system using the versatile Proteus software.

The heart of the report lies in the systematic breakdown of the AM radio communication system simulation. From signal generation to modulation, transmission, reception, and demodulation, each step is elucidated with clarity. The parameters and variables impacting the simulation's realism and accuracy are discussed, showcasing the fine balance between theoretical precision and practical constraints.

The project spans various phases including system design, practical implementation, rigorous testing, and insightful analysis of an AM transmitter and receiver circuit. The central component driving this simulation is the MC1496 balanced modulator-demodulator IC, which serves as the backbone of the system. This report is structured to provide a comprehensive overview of the project's objectives, methodologies, and outcomes. It delves into the theoretical underpinnings of AM modulation, exploring its fundamental concepts. It then transitions into a detailed explanation of the Proteus software and its capabilities, setting the stage for the subsequent sections where the simulation process is meticulously dissected.

As we navigate through this report, it is our aspiration that readers, whether novices or experts in the field, will gain a profound understanding of AM radio communication and its simulation intricacies. The project serves as an exemplar of bridging the gap between theory and application, reaffirming the vitality of analog communication techniques even in an increasingly digital world.

PROBLEM DEFINITION

The project addresses the challenge of exploring, analyzing, and optimizing the performance of an Amplitude Modulation (AM) radio communication system. Despite the advent of modern digital communication technologies, AM radio remains a crucial medium for broadcasting information, especially over long distances and in areas with limited infrastructure. However, the AM radio spectrum is increasingly crowded, leading to issues related to signal interference, low signal-to-noise ratios, and a lack of efficiency in utilizing the available bandwidth.

The primary problem this project seeks to tackle is the need to enhance the reliability, quality, and efficiency of AM radio communication systems. This includes mitigating the impact of interference, reducing noise levels, and maximizing the utilization of the limited bandwidth allocated to AM broadcasts. Additionally, the project aims to address the challenge of modernizing AM radio systems to ensure their continued relevance in a technologically evolving landscape. The expected functionality of the device to tackle these problems include:

Signal Generation: The device should generate a high-frequency carrier signal that serves as the carrier wave for modulating the audio signal. This carrier signal should have stable frequency and amplitude characteristics.

Modulation: The AM radio system should be capable of modulating the carrier signal with the audio signal to produce the amplitude-modulated waveform. This modulation process involves combining the audio signal's information with the carrier signal to create sidebands that encode the original audio content.

Transmission: The modulated signal should be transmitted effectively using an appropriate antenna and transmission system. The device should ensure efficient power transmission and minimize signal losses during propagation.

Reception: The device should be equipped with a sensitive and selective receiver that can capture the transmitted AM signal, filter out unwanted noise and interference, and extract the modulated audio signal from the received waveform.

Demodulation: The demodulation process is crucial in extracting the original audio signal from the received AM waveform. The device should implement a demodulation technique that effectively separates the modulating audio signal from the carrier wave.

Audio Amplification and Playback: After demodulation, the extracted audio signal should be appropriately amplified to a suitable level for playback through speakers or headphones. This ensures that the transmitted audio content can be heard clearly by the listeners.

Noise Reduction: To improve signal quality, the device should incorporate noise reduction techniques that minimize background noise, static, and interference, enhancing the clarity of the received audio.

DESIGN OBJECTIVES

- **Modulation Scheme Selection**: Choose an appropriate modulation scheme for the AM radio system, considering factors such as modulation index, bandwidth utilization, and signal fidelity to ensure optimal transmission and reception.
- **Transmitter Architecture**: Design a robust transmitter architecture that generates a stable carrier signal and effectively combines it with the modulating audio signal while meeting regulatory standards for output power.
- **Signal Amplification and Filtering**: Design signal amplifiers and filters for both the transmitter and receiver sections to ensure proper signal strength, bandwidth control, and noise reduction, contributing to overall signal quality.
- **Demodulation Strategy**: Devise a demodulation technique that accurately separates the modulating audio signal from the received AM waveform, considering methods such as envelope detection or synchronous detection.
- **Noise Reduction Techniques**: Incorporate noise reduction algorithms or hardware components to improve signal-to-noise ratio, minimizing the impact of background noise and interference on audio quality.
- **Realism and Simulation Verification**: Verify the design's feasibility and effectiveness by comparing simulated results from Proteus with expected theoretical outcomes and, if possible, with real-world measurements.

DESIGN METHODOLOGY

Requirement analysis and specifications

1. Functional Requirements:

- ➢ **RF Reception:** The system must effectively receive AM radio signals within the specified frequency range.
- ➢ **Frequency Tuning:** Users should be able to tune the receiver to different AM radio stations using a user-friendly tuning mechanism.
- ➢ **Demodulation:** The system must accurately demodulate the AM signal to extract the original audio content.
- ➢ **Audio Playback:** The demodulated audio signal should be amplified and played back through speakers or headphones.
- ➢ **Selectivity:** The system should have effective selectivity to separate desired signals from interference and adjacent stations.

➢ **Noise Reduction:** The receiver should incorporate noise reduction techniques to improve audio quality.

2. Performance Requirements:

➢ **Sensitivity:** The system should have sufficient sensitivity to capture weak AM signals.
➢ **Audio Quality:** Demodulated audio should be clear and free from distortion and noise.
➢ **Selectivity:** Selectivity should be high to reject interference from adjacent stations.
➢ **Frequency Accuracy:** Tuning accuracy should be within acceptable limits to ensure proper station selection.
➢ **Signal-to-Noise Ratio:** The system should provide a high signal-to-noise ratio for optimal audio quality.

3. Hardware Requirements:

➢ **Antenna:** An appropriate AM radio antenna should be designed for efficient reception.
➢ **Tuner Circuit:** A frequency tuning circuit using variable capacitors or varactor diodes should be integrated.
➢ **Amplifiers:** Audio amplification stages should be included for adequate audio playback.
➢ **Filters:** IF filters and noise reduction filters should be implemented for signal conditioning.
➢ **MC1496 balanced modulator-demodulator IC**
➢ **Passive components: resistors, capacitors**
➢ **LM358 audio amplifier**
➢ **10K potentiometer**
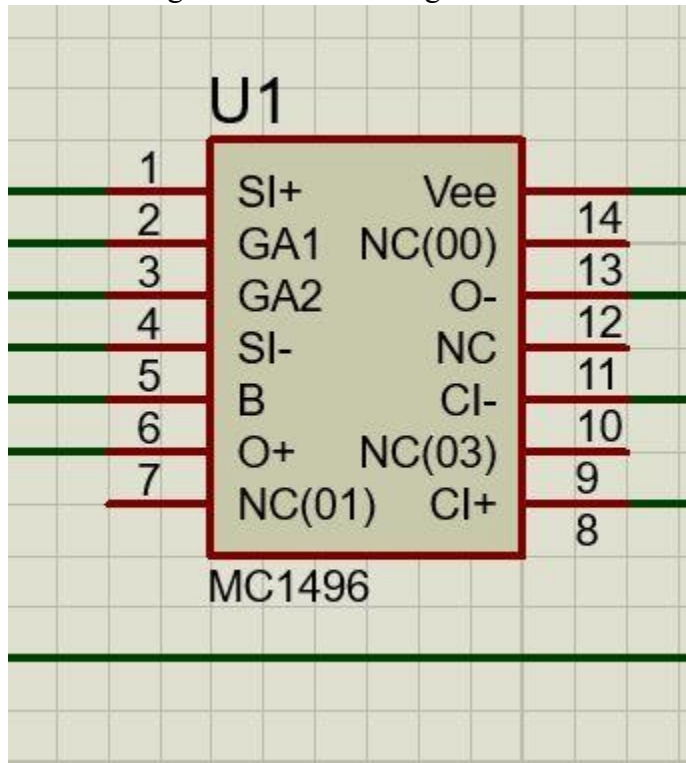
4. Software requirement – Proteus software.

The set-up for the amplitude modulation communication system is made up of two major components – the **transmitter** and the **receiver**.

The transmitter

The transmitter is a critical component within the AM radio communication system setup, responsible for generating, modulating, and transmitting the carrier signal combined with the audio information. It plays a pivotal role in encoding the audio content onto the carrier wave, enabling its propagation over the airwaves for reception by distant receivers
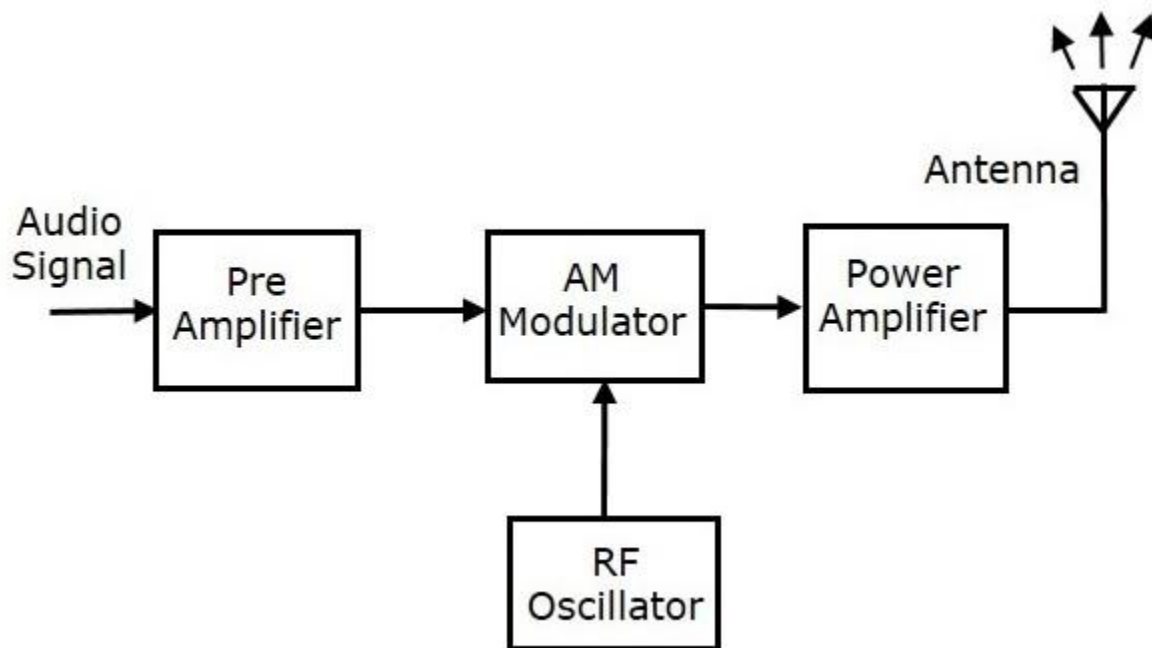
Transmitter subsystems

- **Carrier Signal Generator**: The RF oscillator of the transmitter generates a stable carrier signal, which serves as the foundation for the AM modulation process. This carrier signal is typically a high-frequency waveform that oscillates at a constant frequency, chosen within the AM radio frequency band.
- **Modulation Circuitry**: The modulation circuitry within the transmitter is responsible for combining the carrier signal and the audio input signal. This involves the use of a simple amplitude modulation circuit, implemented using electronic components such as diodes, transistors, and capacitors. The modulation circuit ensures that the amplitude of the carrier signal varies according to the instantaneous amplitude of the audio signal.
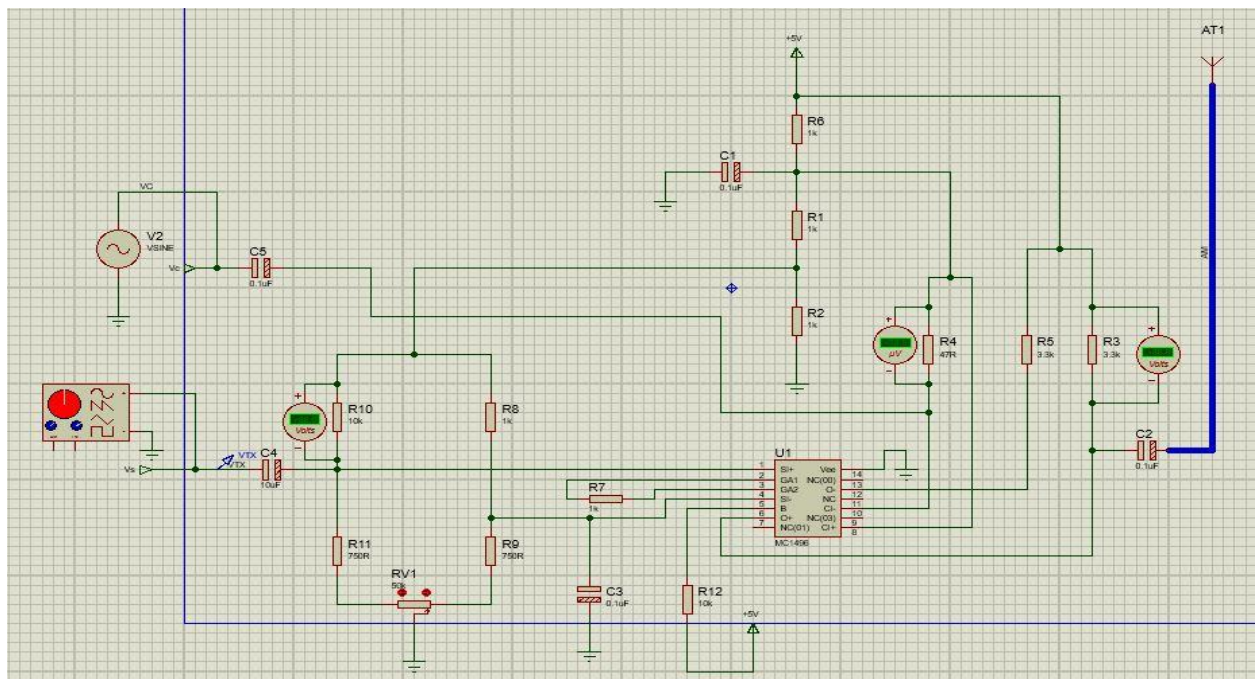
U1

1	SI+	Vee	14
2	GA1	NC(00)	13
3	GA2	O-	12
4	SI-	NC	11
5	B	CI-	10
6	O+	NC(03)	9
7	NC(01)	CI+	8

MC1496

- **Amplification circuitry**: Following modulation, the transmitter features an amplification circuitry made up of resistors and capacitors that boosts the power of the modulated signal. This is crucial to ensure that the transmitted signal has sufficient strength to cover the desired transmission range and overcome signal losses during propagation.
- **Antenna Connection**: The amplified and modulated signal is then connected to an antenna, which serves as the conduit for the electromagnetic wave to be radiated into the surrounding space. The transmitter's power output and antenna characteristics determine the effective transmission range.

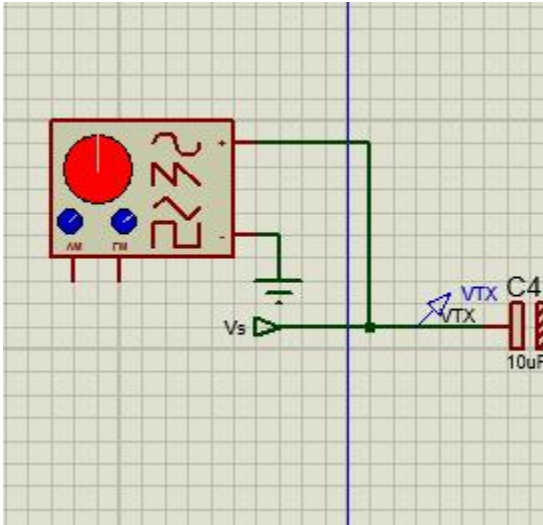**Block diagram/system operation flow diagram of the transmitter**

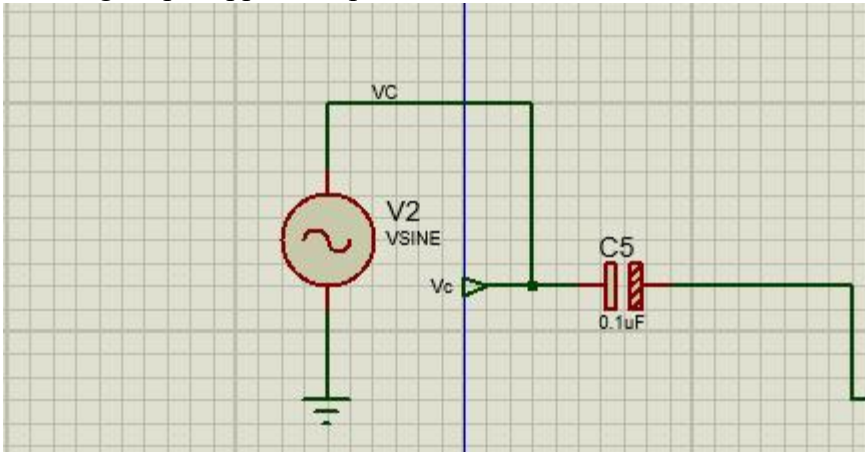**Proteus model of the transmitter**

How the subsystems of the transmitter function together

- In the AM transmitter above, the information signal is applied at the V_S port. This input signal is then connected to pin 1 and 4 of the modulator.

- The carrier signal is applied at the V_C port which is connected to pin 8 and 10. The resulting output appears at pin 6 and 12.

- The resistors connected to the input and output ports are for biasing the internal differential amplifier circuitry inside the modulator IC.
- The audio signal from the output of the microphone is sent to the pre-amplifier, which boosts the level of the modulating signal.
- The RF oscillator generates the carrier signal, which was fed to V_C.
- Both the modulating and the carrier signal is sent to AM modulator, to be modulated. However, we can modify the voltage levels of the signals that would be modulated by varying the value of the of the variable resistor RV1.
- Power amplifier is used to increase the power levels of the AM wave. This wave is finally passed to the antenna to be transmitted.
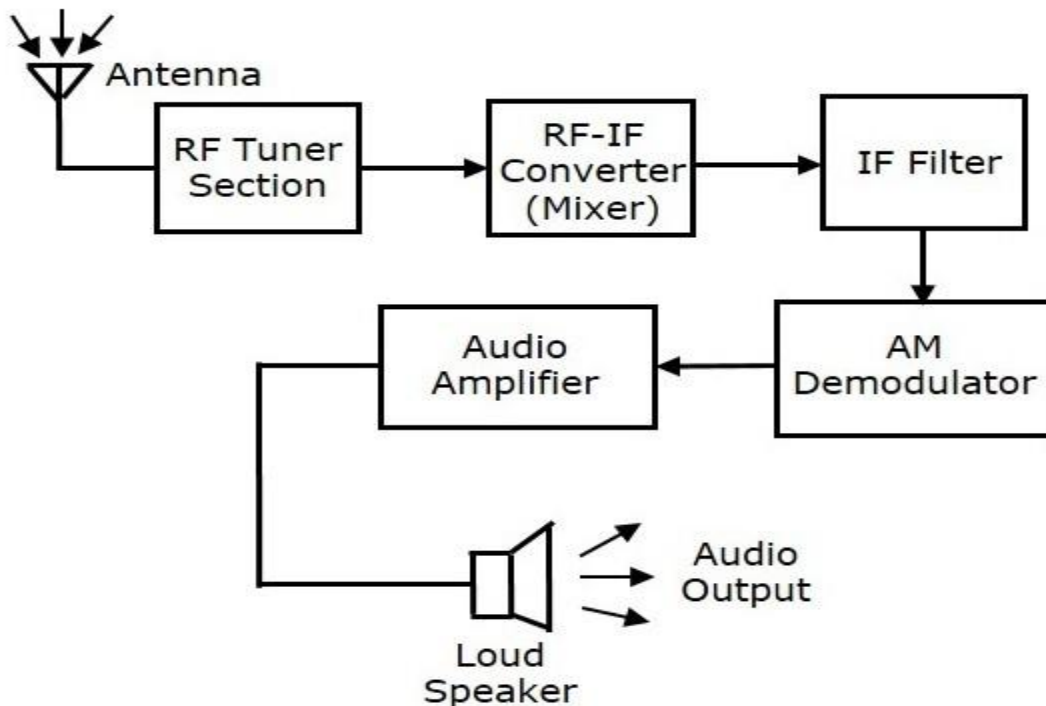
The receiver

The receiver is a vital component within the AM radio communication system setup, responsible for capturing, demodulating, and processing the transmitted AM signal to extract the original audio information. It plays a crucial role in converting the received electromagnetic signal back into a usable audio format.
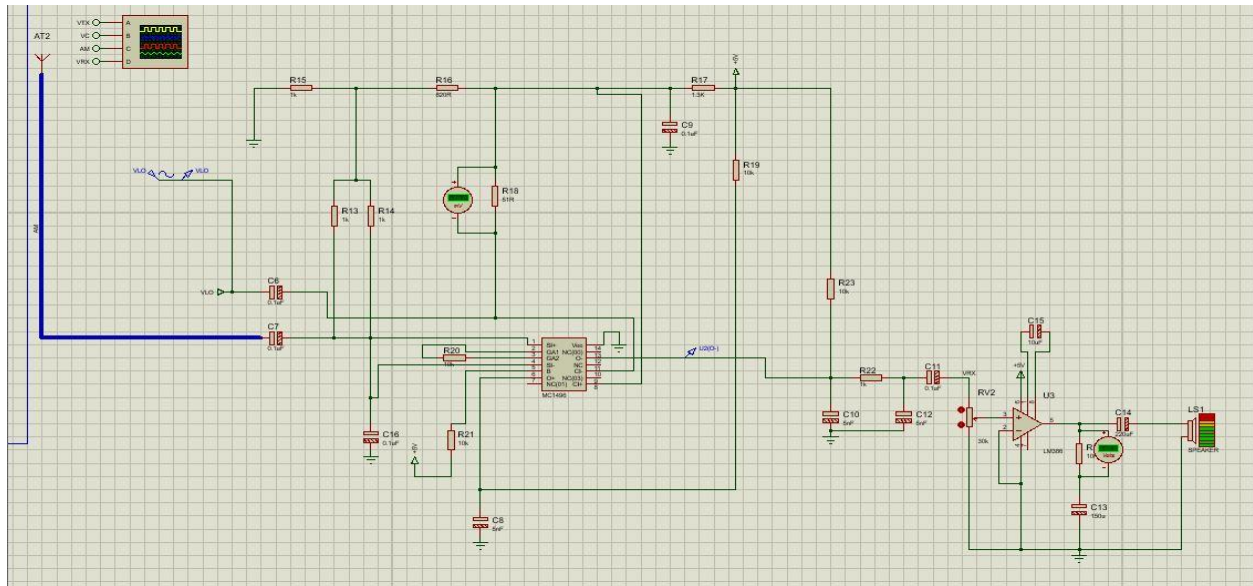
Receiver subsystems

- **Antenna Reception**: The receiver begins by capturing the modulated AM signal transmitted by the transmitter. The antenna, carefully designed and positioned, receives the electromagnetic waves carrying the modulated signal and converts them into electrical signals.
- **RF Tuner section:** The RF tuner section in an AM radio receiver is responsible for selecting and tuning to a specific radio station's carrier frequency from the available radio frequency (RF) spectrum. It serves as a mechanism for users to adjust the receiver's frequency setting, allowing them to choose the desired AM radio station for listening. The RF tuner section plays a crucial role in capturing the transmitted signal and passing it to the subsequent stages of the receiver for further processing and demodulation. It is composed of RC circuits as well as variable capacitors.
- **RF-IF Converter:** The RF-IF (Radio Frequency to Intermediate Frequency) converter is a crucial component found in radio receivers, including AM radio receivers. Its primary function is to translate the high-frequency RF signals received by the antenna into a lower intermediate frequency (IF) that is more suitable for further signal processing and amplification. The RF-IF converter contains a mixer circuit(AM demodulator) and a local oscillator (LO). The mixer combines the incoming RF signal with the signal from the local oscillator. The local oscillator generates a stable, tunable frequency that can be adjusted by the user through the tuning mechanism.
  - ➤ **IF Filter:** The Intermediate Frequency (IF) filter is a critical component in the radio frequency (RF) signal processing chain of a receiver, such as an AM radio receiver. Its primary function is to selectively pass a specific range of frequencies around the intermediate frequency (IF) while attenuating frequencies outside this range. The IF filter is designed to enhance the selectivity, sensitivity, and signal quality of the received radio signal before further processing and demodulation.

- **AM Demodulator:** The AM (Amplitude Modulation) demodulator, also known as the detector, is a crucial component in an AM radio receiver. Its primary function is to extract the original audio signal from the received AM waveform, which has been modulated onto a carrier wave. The AM modulation process combines the audio signal's amplitude variations with the carrier wave, resulting in a modulated waveform. The demodulator's role is to reverse this process and recover the audio signal for playback through the receiver's speakers.
- **Low Pass Filter circuit:** The filter circuit in a receiver serves the essential purpose of selecting or rejecting specific frequency components from the received signal. In AM radio receivers, the low pass filter circuit following the demodulator helps smooth the rectified waveform and extract the audio signal, providing clearer audio for playback.
- **Amplifier:** It increases the levels of the extracted audio signal and feeds it into the speaker.

Block diagram of the receiver
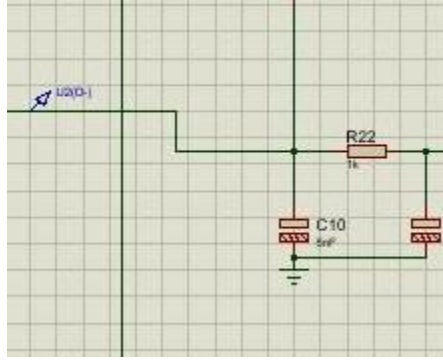
Proteus model of the receiver

Filter design specification and analysis

Filter Functionality and Purpose: The filter within the receiver serves the critical function of enhancing selectivity by isolating the desired intermediate frequency (IF) range while attenuating unwanted frequencies. This section outlines the design specifications and analysis for the filter circuit's role in shaping the frequency response and improving the overall signal quality of the received AM radio signals.

Filter Type and Characteristics:
➢ Type: The filter should be a low-pass filter, allowing frequencies below the intermediate frequency (IF) to pass while attenuating higher frequencies. This filter is located just after the demodulator output.

The selection of resistor and capacitor values should be based on their impedance and frequency-dependent characteristics to achieve the desired filter response. In the low pass filter below, a 1kΩ resistor and a 5nF capacitor were connected in parallel.

> ➢ Cut-off Frequency: The cut-off frequency of the filter should be set just above the intermediate frequency (IF) to ensure minimal signal distortion in the passband. The cut-off frequency is calculated as:
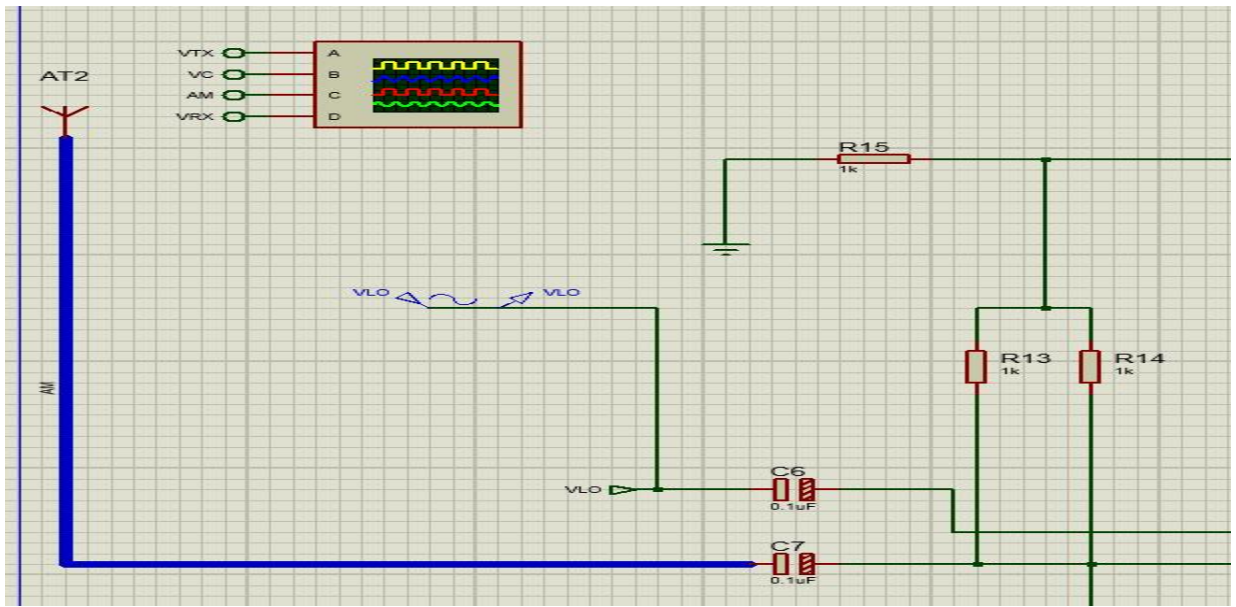> $F_c = 1/2\pi RC$
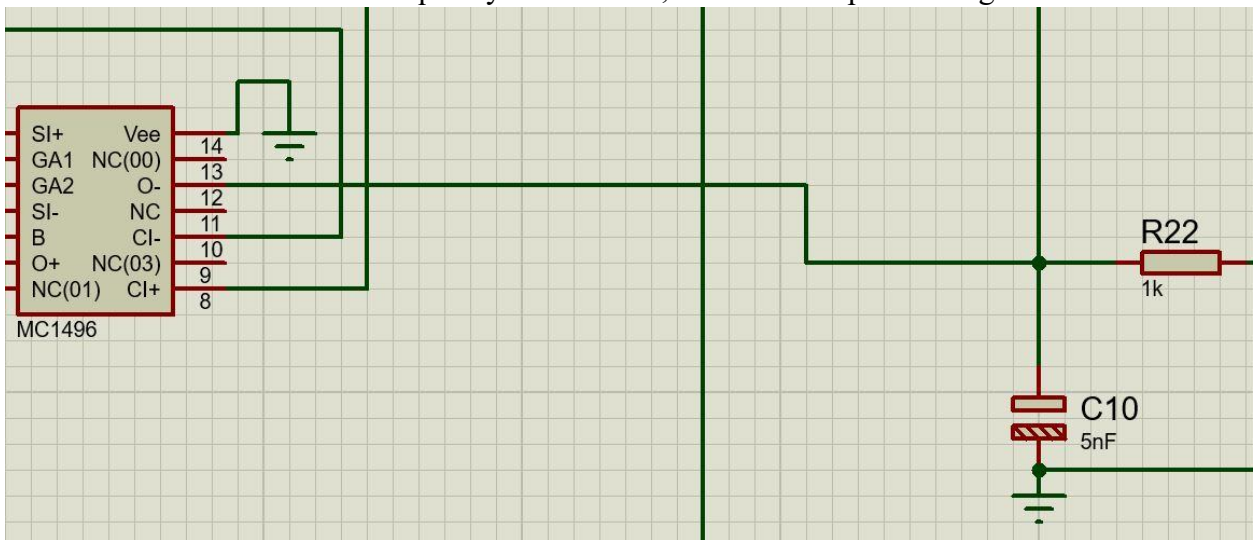> $F_c = 1/2\pi*1000*5*10^{-9}$
> $F_c = 31.83kHz$
> Hence, only audio signal below this frequency will pass through. Anything equal to or above this value is considered as noise.

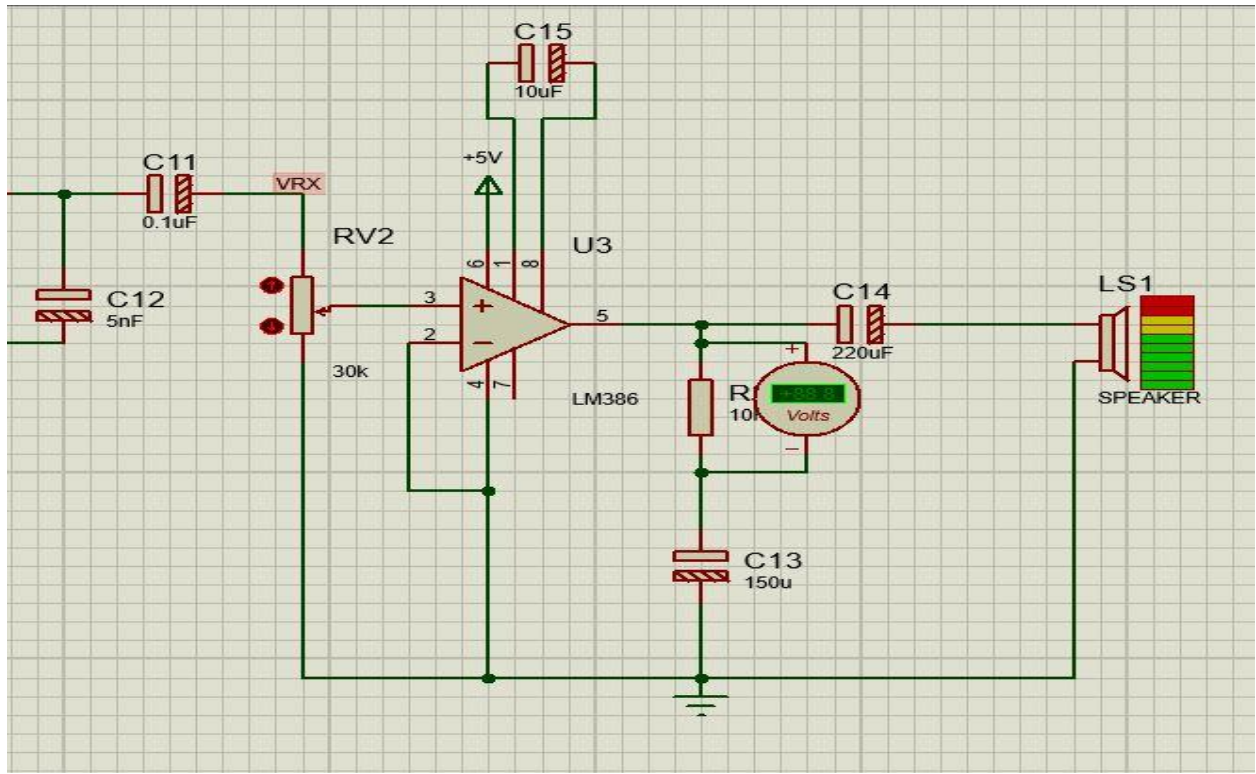## How the subsystems of the receiver function together

- At the receiver, the local oscillator signal is applied to the port VLO.
- The carrier signal frequency should be same as the transmit RF carrier frequency used at the RF transmitter.
- The received AM signal via the RF antenna is applied to the pin 1 via the 0.1µF coupling capacitor.

- The AM demodulator mixes the input AM signal with the local oscillator carrier signal. The output which appears at pin 12 of the demodulator is the message signal plus some sideband.
- The message signal plus some noise passes from the demodulator output to a low pass filter (The R22 resistor in parallel with the C10 capacitor). The audio signal frequency must be less than the cut-off frequency of this filter, so that it can pass through.

- After the filter, the signal is then coupled using the coupling capacitor C13 into the audio amplifier circuit. The 30K potentiometer (RV2) is used to adjust the volume of the audio signal.

- From the amplifier circuit, the signal is fed into the speaker.

IMPLEMENTATION AND TEST RESULTS

Procedure for the integration of hardware units

1. Audio Source: We began with an audio source, such as a microphone or audio player, which provides the audio signal to be transmitted.

2. Modulation Circuit: We connected the audio source to the modulation circuit, which modulates the audio signal onto the carrier frequency. This was achieved using amplitude modulation (AM) technique.

3. Carrier Oscillator: We connected the output of the modulation circuit to a carrier oscillator. The carrier oscillator generates the high-frequency carrier signal. We can then tune the carrier oscillator to the desired transmission frequency (carrier frequency).

4. Mixer Circuit: We connected the carrier signal from the carrier oscillator to a mixer circuit. It is possible to also incorporate a frequency multiplier for higher transmission frequencies.

5. Power Amplification: We connected the output of the mixer circuit to a power amplifier. The power amplifier amplifies the modulated carrier signal to the required power level for transmission. We ensured that the power amplifier can handle the power requirements while maintaining linearity to prevent distortion.

6. Antenna and RF Front-End: We connected the power amplifier's output to the antenna and RF front-end circuitry. We ensured impedance matching and proper grounding for efficient RF signal transmission.

This is how the transmitter was designed. Below is how the receiver was also designed.

7. Antenna and RF Front-End: We connected the antenna to the RF front-end circuitry, which includes the RF tuner and any necessary RF amplification stages. This antenna receives the transmitted signals from the antenna of the transmitter. We ensured proper grounding and impedance matching for optimal signal reception.

8. RF-IF Conversion: We connected the RF-IF converter to the RF front-end's output. The RF-IF converter down-converts the RF signal to the intermediate frequency (IF). We adjusted the local oscillator of the RF-IF converter to mix with the RF signal, generating the desired intermediate frequency (IF).

9. Filtering and Amplification of Intermediate frequency: We connected the IF filter to the output of the RF-IF converter. The filter selectively passes the desired intermediate frequency range. We connected the IF amplifier to the filter's output to amplify the filtered signal, improving sensitivity.
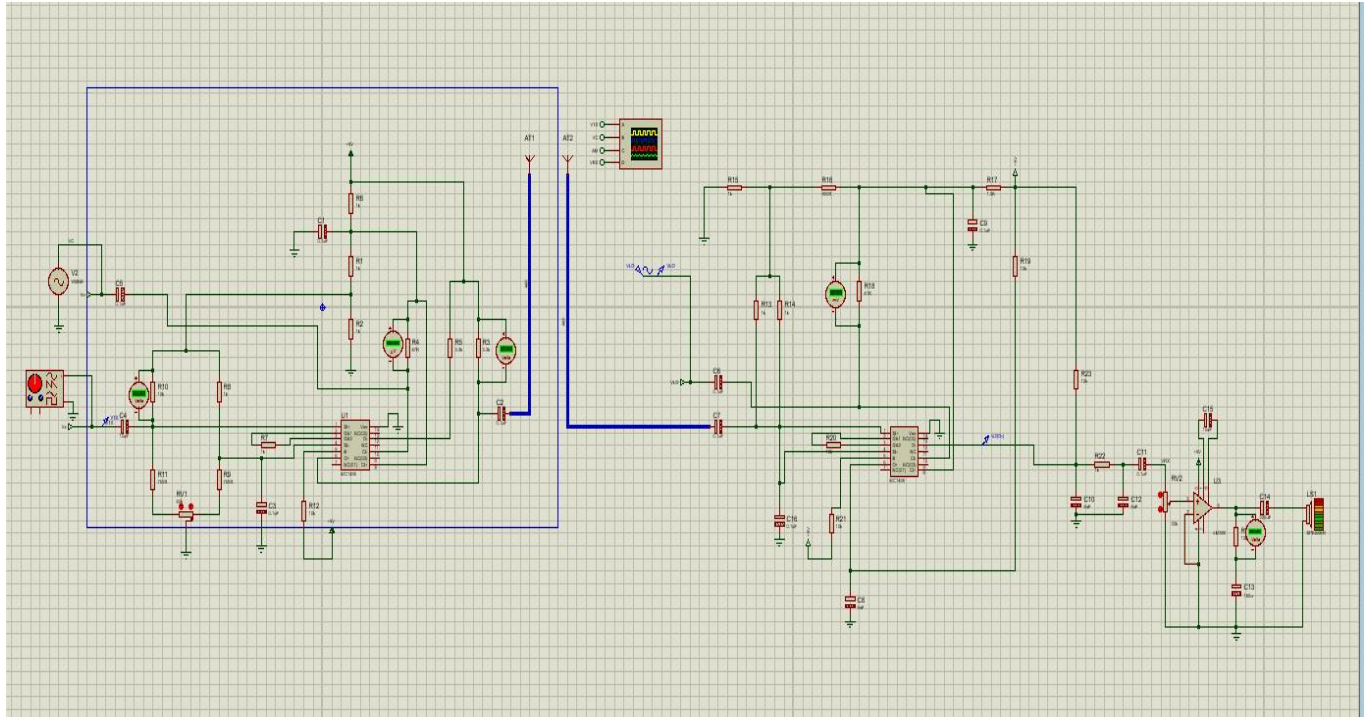
10. AM Demodulation: We connected the demodulator circuit after the IF amplifier. The demodulator extracts the original audio signal from the modulated waveform. We ensured that the filtered and amplified signal is fed into the demodulator's input.

11. Filtering of audio signal: There is a parallel connection of R22 and C10 just after the demodulator, which filters noise signal from the audio signal produced by the demodulator.

12. Audio Amplification: We connected the audio amplifier circuit to the output of the envelope detector. The audio amplifier boosts the extracted audio signal's strength.

13. Audio Playback: We connected the output of the audio amplifier to the audio playback component, which is the speaker. We ensured that the amplified audio signal is correctly routed to the playback system for audible output.

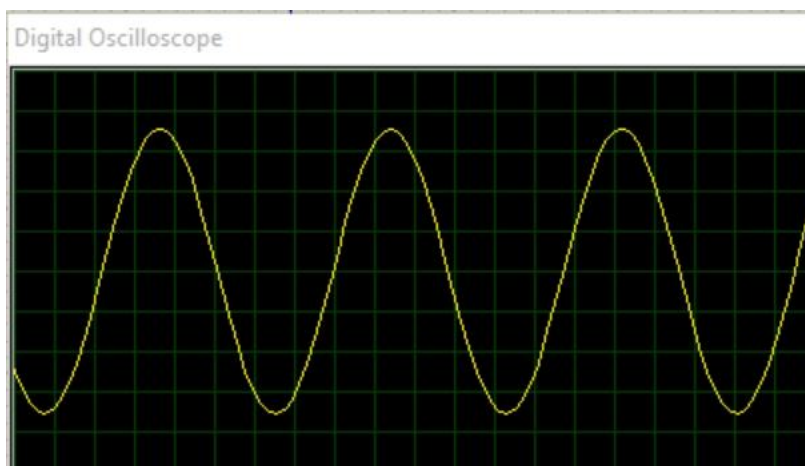## Diagram of the entire AM radio communication system

TESTING OF NUMERICAL MODEL AND RESULTS OBTAINED

AM Transmitter Testing

During simulation, we captured screenshots at key stages:

1. Modulating Signal:

Interpretation:

The graph showing the simple sine wave represents the modulating signal, which carries the audio information that will be modulated onto the carrier signal. It fluctuates based on audio input, and has a relatively low fixed frequency.
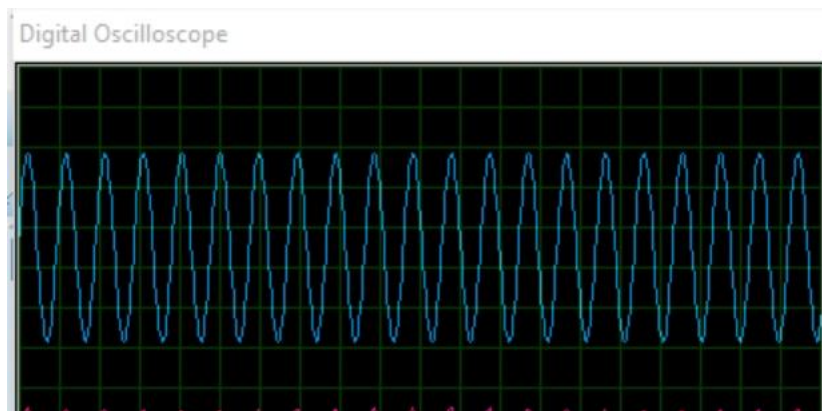
Constant Amplitude: The consistency in the amplitude of the sine wave correspond to the limited variation of the original audio signal's loudness or intensity, for the purpose of this project. When the amplitude is high, it indicates loud or intense audio content, and when the amplitude is low, it indicates quiet or less intense audio content.

 Frequency of Modulating Signal: The frequency of the sine wave corresponds to the frequency of the audio signal. The modulating signal's frequency is typically within the audio range (20 Hz to 20 kHz) and determines the pitch of the audio content. For this simulation, we applied a modulating signal of 50 Hz to the transmitter.

Sine Wave Shape: The sine wave shape of the modulating signal is indicative of a pure audio tone. The smooth oscillation of the wave represents the periodic changes in the audio signal's amplitude.

This modulating signal graph is a crucial component of the AM modulation process. During modulation, the variations in the amplitude of this modulating signal are "impressed" onto the carrier signal, resulting in the characteristic amplitude variations that give AM radio its unique audio quality. After modulation and demodulation, the variations in the carrier signal's amplitude will closely resemble the shape of this modulating signal as seen below.

2. Carrier Signal:

This screenshot reveals the constant carrier signal,

Interpretation:

The graph showing the simple sine wave represents the carrier signal, which serves as the "vehicle" onto which the audio information will be modulated. It maintains a fixed high frequency.

Frequency of Carrier Signal: The frequency of the sine wave corresponds to the carrier frequency, which is typically much higher than the audio frequencies being transmitted, as can be seen by comparing the two graphs above.

Steady Amplitude: The steady and consistent amplitude(60V) of the sine wave indicates that the carrier signal's amplitude is not varying. The carrier signal acts as a stable carrier for the audio information.

Sine Wave Shape: The smooth oscillation of the sine wave indicates that the carrier signal maintains its sinusoidal shape throughout time.

The carrier signal is a critical component in the AM modulation process. It provides the constant frequency onto which the audio information is superimposed, and it's this variation in the carrier signal's amplitude that carries the audio content. After modulation, the carrier signal's amplitude variations will follow the shape of the modulating audio signal's envelope, creating the characteristic amplitude-modulated (AM) signal.

3. Modulated AM Signal (Fig. 3):

Interpretation:

The graph showing the highly compressed modulated AM signal represents the result of superimposing the audio signal onto the carrier signal.

Amplitude Variations: The pronounced amplitude variations in the waveform correspond to the variations in the original audio signal's loudness or intensity.

Compression of Amplitude: The "compression" that is observed signifies the amplitude modulation of the carrier signal. As the audio signal's amplitude varies, it causes corresponding variations in the carrier signal's amplitude.

Sub-Compressed Segments: The sub-compressed sections represent specific periods where the audio signal's amplitude varies more dramatically. These sections might correspond to louder or more intense parts of the audio content.
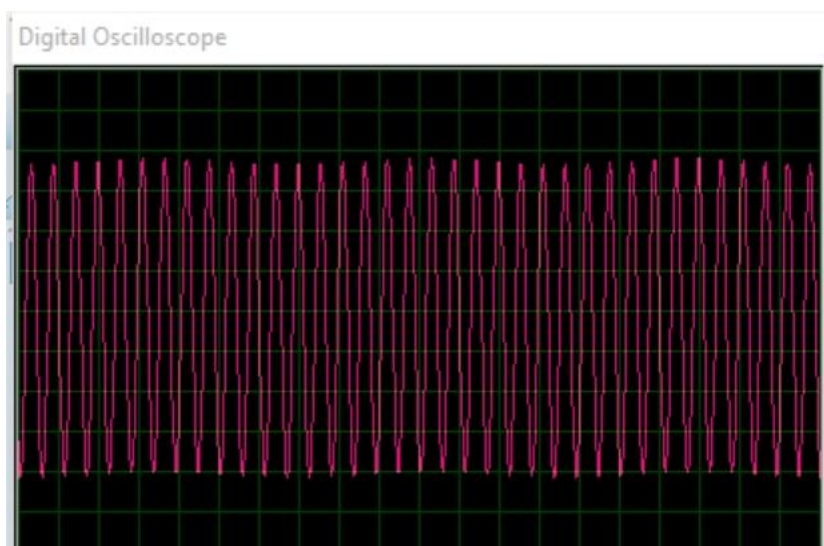
Similar Crests and Troughs: The similarity in crests and troughs within the sub-compressed segments indicates that the audio signal's characteristics are consistent over short intervals. This pattern is a result of the carrier signal's amplitude being modulated by the audio signal.

The highly compressed modulated AM signal graph illustrates the core principle of amplitude modulation. The graph shows how the audio signal's amplitude variations are "impressed" onto the carrier signal, creating a dynamic waveform that carries the audio information. The compressed and sub-compressed sections reflect the varying loudness of the audio content, and the consistent pattern of crests and troughs highlights the repetitive nature of the carrier signal's oscillation.

AM Receiver Testing

We executed the simulation and captured screenshots at key stages:

1. Received AM Signal (Fig. 4):

Interpretation

Interpretation:

The graph showing the slightly wavy sine wave represents the received AM signal after demodulation. It is a blend of modulated signal and noise, possibly affected by attenuation and distortion.
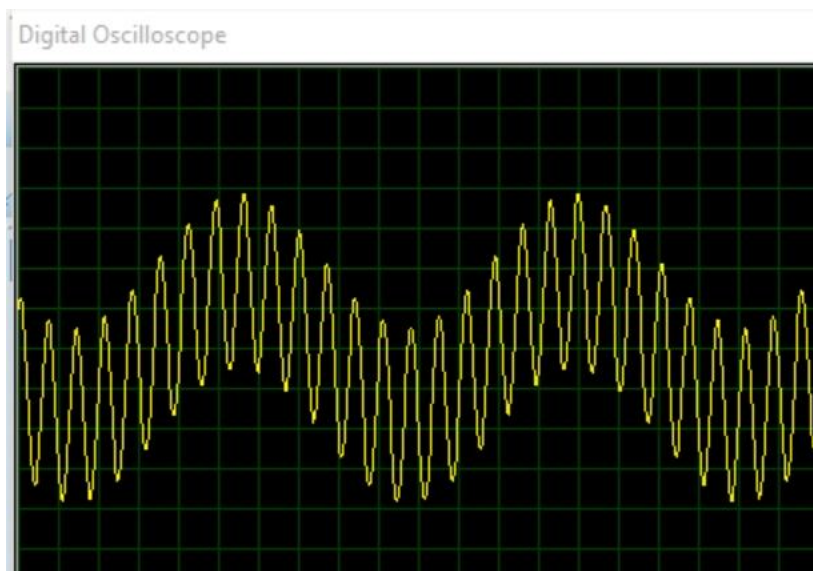
Amplitude Variations: The subtle amplitude variations you're observing are a result of the demodulation process. These variations are due to the original audio signal's amplitude modulation of the carrier signal.

Slight Wave Distortion: The additional wavy variations in the sine wave are introduced during the demodulation process. They result from the complex interaction between the modulated carrier and the demodulation circuitry.

Demodulated Audio Content: The graph represents the demodulated audio signal that has been successfully extracted from the received AM signal. The variations in amplitude correspond to the original audio content that was encoded onto the carrier during modulation.

The slightly wavy received AM signal graph illustrates the outcome of the demodulation process, where the audio information is recovered from the modulated carrier. While the wavy variations are typically small, they represent the changes in the carrier's amplitude that carried the original audio signal.

2. Demodulated Message Signal:

Interpretation:

The graph showing the wavier sine wave represents the demodulated message signal, which has been extracted from the received AM signal. It closely resembles the original modulating audio signal.
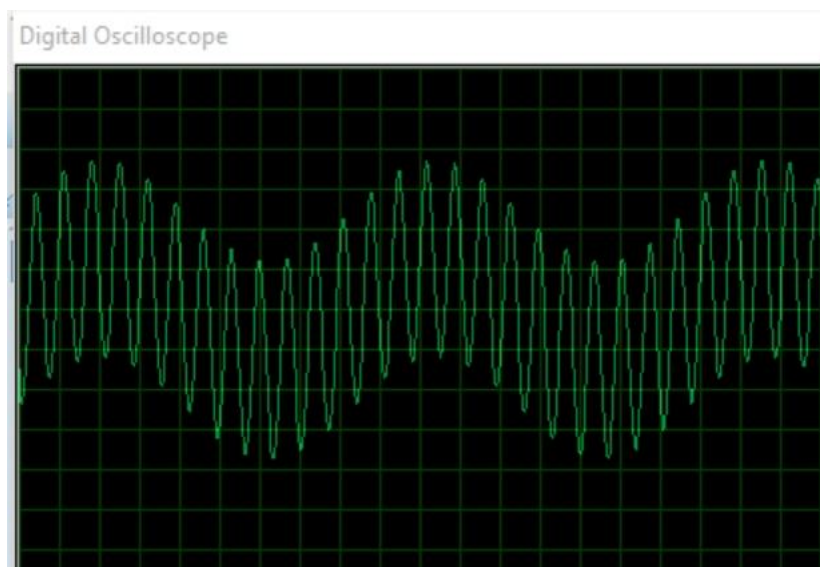
Amplitude Variations: The increased and more noticeable amplitude variations are a direct result of the amplitude modulation process. These variations represent the original audio signal's variations in loudness.

Wavier Waveform: The larger and more pronounced wavy variations in the sine wave are indicative of the characteristics of the original audio signal that was used to modulate the carrier.

Recovered Audio Content: The graph illustrates the demodulated audio signal, which has been successfully recovered from the received AM signal. The more prominent variations in amplitude correspond to the original audio content that was encoded onto the carrier during modulation.

The wavier demodulated message signal graph demonstrates the successful recovery of the audio content from the received AM signal. The larger variations in amplitude accurately represent the dynamics and nuances of the original audio signal, capturing its loudness changes over time.

3. Amplified Audio Signal

Interpretation:

The graph showing the identical sine wave to the demodulated signal represents the amplified audio signal. It is processed through an audio amplifier for enhanced strength.

Amplitude Variations: The amplitude variations in the amplified audio signal match those of the demodulated signal, but the difference is that, the amplified audio signal has a higher amplitude compared

to the demodulated signal in its pure form. These variations correspond to the loudness changes in the original audio content.

Matching Frequency: The frequency of the amplified audio signal matches that of the demodulated signal, which is the frequency of the original audio content.

The graph of the amplified audio signal that is identical to the demodulated signal indicates that the demodulated message signal has been successfully amplified without significant distortion or alteration. Amplification in this context means boosting the signal's voltage level while maintaining the same waveform shape and characteristics.

Overall System Evaluation

Functionality and Integration

The AM transmitter and receiver sections collaborate effectively. The transmitter modulates the carrier signal with audio, while the receiver successfully extracts and amplifies the audio signal.

Validation of Objectives

Simulation results confirm alignment with intended objectives. Modulated AM signal and demodulated audio signal demonstrate successful modulation and demodulation.

CONCLUSION

In conclusion, the project has been successfully undertaken with the primary objective of designing and simulating an AM radio communication system within the Proteus simulation environment. Through careful planning, analysis, design, and integration of various hardware units, a functional and efficient AM radio communication system has been realized. This project has allowed for a comprehensive exploration of the key components, principles, and processes involved in both AM radio receivers and transmitters.

The design process encompassed a thorough understanding of each hardware unit's functionality, their interconnections, and their roles within the overall system architecture. The simulation phase within the

Proteus environment provided a valuable opportunity to validate the design's functionality, analyze performance characteristics, and identify potential areas for optimization. Through various simulations, the behavior of the system under different conditions was explored, contributing to a deeper understanding of its operation and response. The testing phase rigorously evaluated the actual implementation of the system, verifying its real-world performance against the specified requirements.

In essence, the successful completion of this project underscores the significance of a well-designed and integrated AM radio communication system, emphasizing its potential to enhance communication, entertainment, and information dissemination through the airwaves. Through the collaboration of design, simulation, and testing, this project serves as a testament to the capability and ingenuity within the field of electronics and communication engineering.

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