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3TR4 Lab 4: AM Radio

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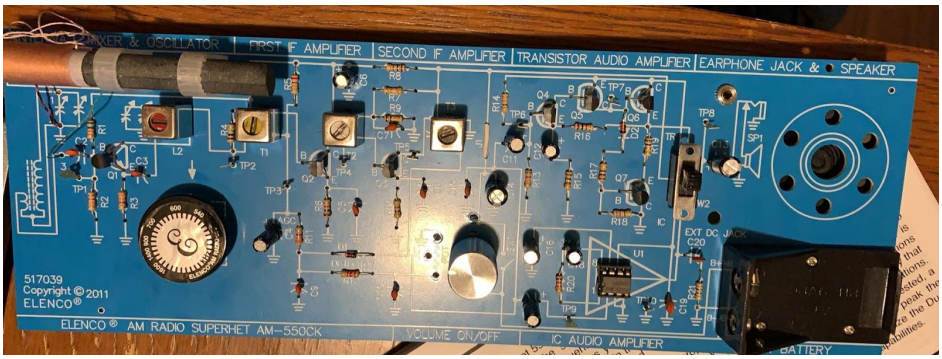
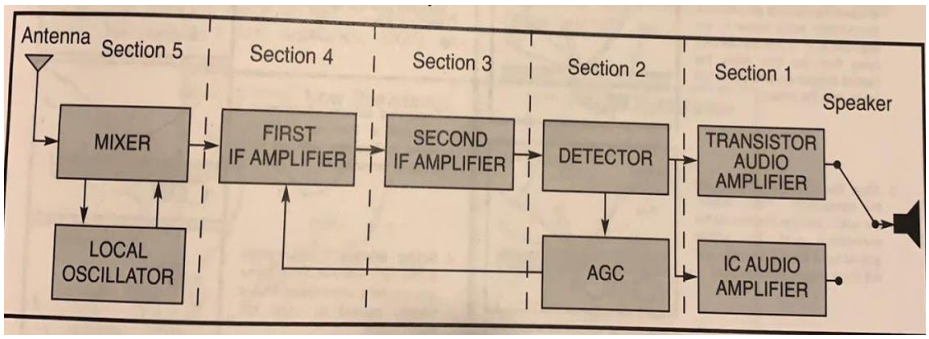
Introduction:

This lab helps apply the knowledge learned throughout the course in making an AM radio through a series of different applications or stages, such as an antenna, mixer and oscillator, first IF amplifier, second IF amplifier, and transistor audio amplifier. The radio is a "superheterodyne" receiver of the standard AM (amplitude magnitude) broadcast frequencies.

Hardware Configuration and Assembly:



Circuit Diagram:



Transistor Audio Amplifier:

The purpose of this section is to increase the power of the audio signal received from the detector to a power of the audio signal received from the detector to a power level capable of driving the speaker. The amplifier helps convert the current from the battery to AC in the speaker. The maximum efficiency, being the ratio of power delivered to the speaker and taken from the battery depends on the class in question, being either class A or B. The efficiency rates for these classes are 50% and 78.5% respectively. The transistor is used to help determine what class it is, with very small levels of power representing class A and a higher power changing the operation to class B. The integrated circuit audio amplifier helps in amplifying the signal through the use of the IC chip, as the gain is set to 50. This is done through the transistor, capacitor and resistor components connected.

AM Detector and Automatic Gain Control (AGC):
The function of the detector is to vary the amplitude of the intermediate frequency signal back to an audio signal. This process is completed by demodulation. The amplitude modulated intermediate frequency signal is passed through a diode so that only the negative portion of the signal is remaining. The discharging time constant in this circuit has to be small enough so so the it can follow the audio signal and prevent high frequency audio distortion from occurring, but also must be big enough to remove the IF. The AGC circuit maintains a constant audio level regardless of the incoming signal. Without this, volume would have to be adjusted for each station, preventing distortion. The AGC is achieved by varying the the bias of the first IF amplifier to lower the gain as the signal increases in strength.

Second IF Amplifier:
The purpose of this section is to increase the amplitude of the intermediate frequency and at the same time provide selectivity. Selectivity refers to the ability to "pick out" one radio station while rejecting all others. The IF transformer acts as a bandpass filter with a 3dB bandwidth of approximately 6kHz. Both IF amplifiers are tuned to frequency of 455kHz, and provide the majority of the gain and selectivity needed to separate the radio stations. The signal is coupled from the first IF amplifier to the second. The IF transformers help provide an impedance to match between the collector of one stage and the base of the next stage which allows maximum power transfer from one stage to the next.

First IF Amplifier:
The operation of the first IF amplifier is the same as the second IF amplifier with the difference that the gain decreases after the AGC threshold is passed. This is done to keep the audio output constant at the detector and prevent overload of the second IF amplifier. This is done by making the voltage on the base of transistor Q2, lower as the signal strength increases.

Mixer and Oscillator:
In a superheterodyne type receiver, the radio wave at the antenna is amplified and then mixed with the local oscillator to produce the intermediate frequency. In this process, there are 4 frequencies present at Q1, being: the local oscillator frequency, the RF carrier or radio station frequency, the sum of these two frequencies, and the difference of these two frequencies. The difference frequency is used as the intermediate frequency in AM radios. The antenna helps reject certain stations and selects stations below the oscillation frequency by 455kHz. The frequency of the undesired stations above the oscillator frequency is called the image frequency. This fine tuning process helps us achieve the desired frequency of our station.

Conclusion:
In conclusion, the steps taken to create this radio helped with learning the different components needed to have an efficient amplifier that can help select our desired channel.