*University of Moratuwa*

*Department of Electronic & Telecommunication Engineering*


*EN-2110 – ELECTRONICS III*

# *AM TRANSMITTER*

## *PROJECT REPORT*

| | |
|---|---|
| *1. I.G.R.M Kulathunga* | *170318X* |
| *2. T.D Wanigathunga* | *170664D* |
| *3. W.M.T.D Wijesindara* | *170714H* |

*Project Supervisor – MR. Thilina Ambagahawaththa*

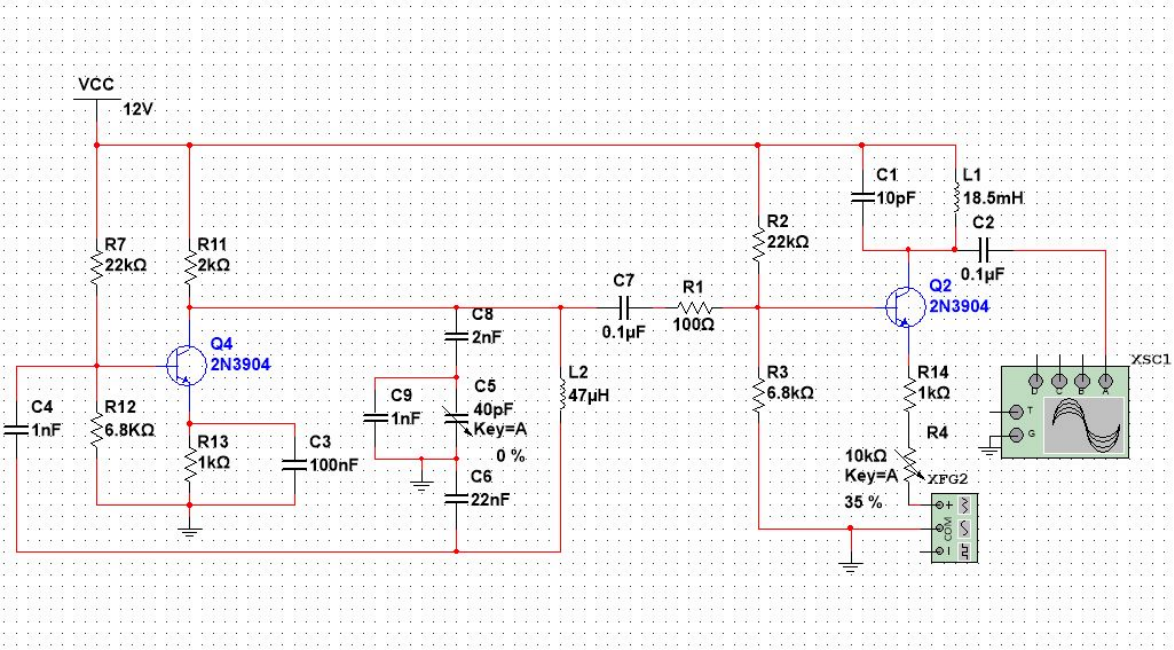
*19th February 2019*

## *Introduction*

*Transmitters are devices that are capable of transmitting audio as radio waves from an audio device. There are two types of transmitters, FM and AM. We have many posts on FM transmitters, so we decided to make one on AM transmitter.*

*AM transmitters create radio waves using Amplitude Modulation. That means only the amplitude of the waves gets changed but the frequency remains the same. In this case, the frequency of career frequencies falls within a predefined range called Carrier Frequency and we can generate the carrier using oscillators, Colpitts or Hartley.*

## *Circuit design*




*In our design, The AM Transmitter circuit contains 3 main parts. They are Colpitts oscillator, AM modulator and class C power amplifier.*

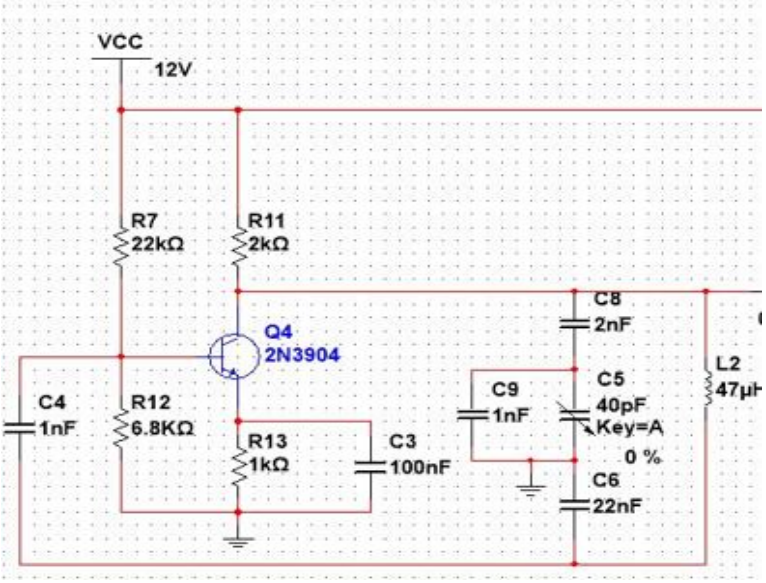
*Also we use another small circuit to get the input signal to this circuit using a small microphone. In order to get undistorted modulated output, input signal amplitude should be around 4V. So in that circuit we use an op-amp to get that amplification.*

- Colpitts oscillator

*We can use oscillators to produce the carrier signal. There are many types of oscillator designs. Op-amp oscillators, crystal oscillator designs, Hartley oscillator, Wien bridge oscillator etc.*

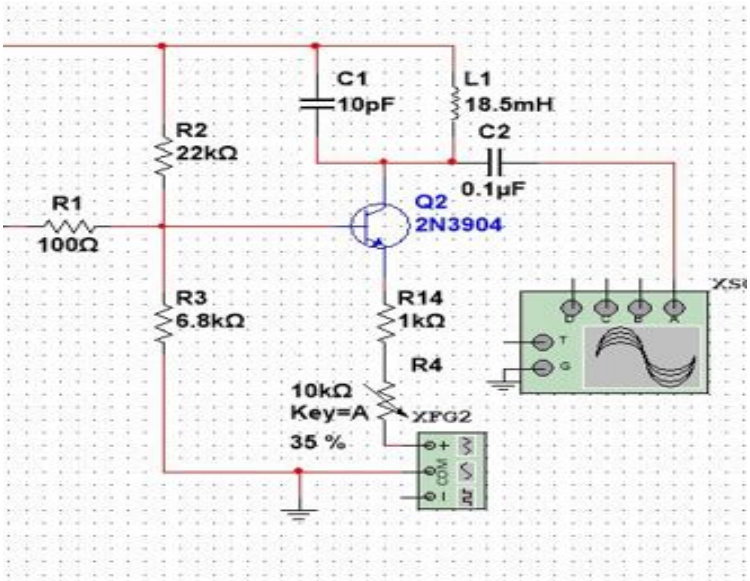
*Oscillators are amplifiers with positive feedback. They generate AC signals using DC signals.*

*To get the desired carrier signal we use a colpitts oscillator. By using a 10nF variable capacitor, we can vary the carrier signal frequency between 600 KHz to 1.2 MHz In this application we use 960 KHz as our operation frequency for the carrier wave.*



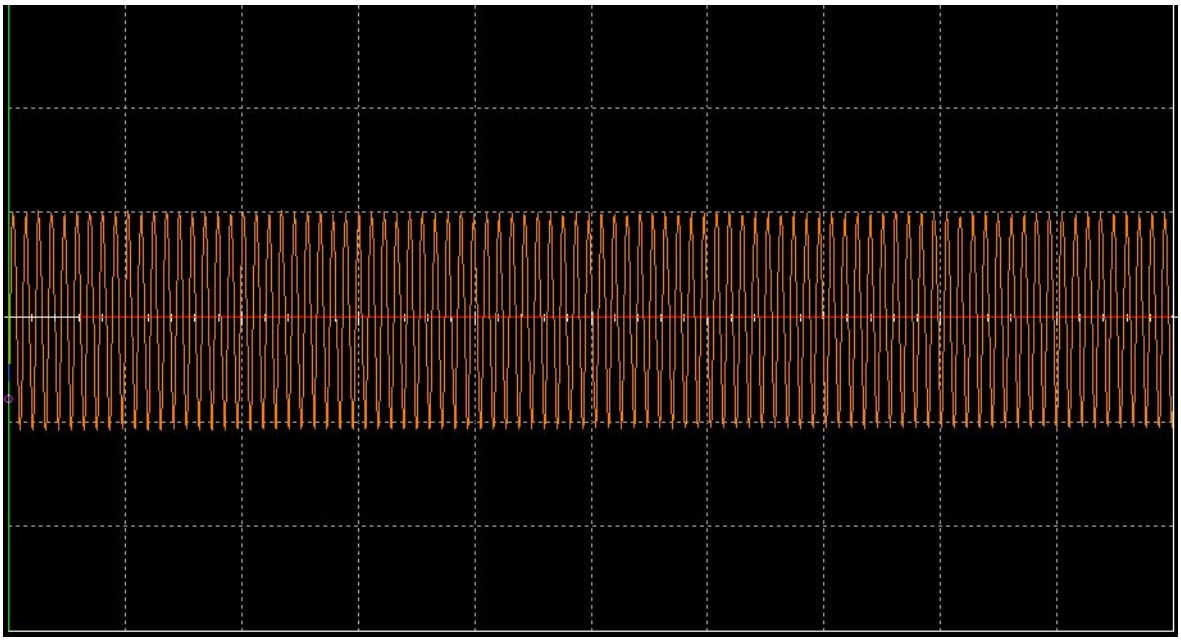

- Modulator and class C power amplifier

*Output of our circuit is an AM modulated signal which is connect to the antenna for transmission. To give the ability to transfer long distances we have to improve the transmitting power. In our project we have to consider about the transmitting range. So we design our circuit to change the output voltage and the output current as well. So we use class C power amplifier to give the current handling ability to our circuit. Also we can improve the efficiency of the circuit by using class C amplifiers.*




## *Simulation results*

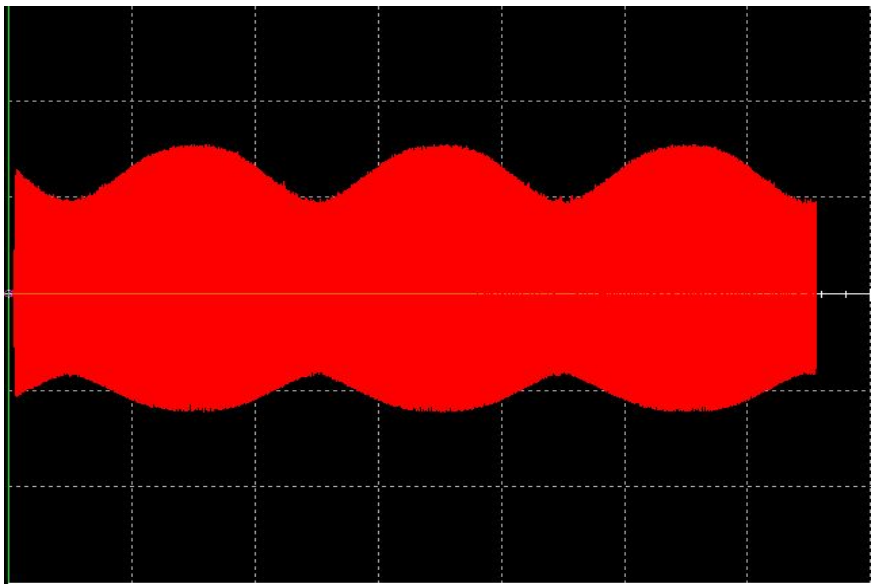
- Carrier signal



*Desired carrier signal amplitude is 10V Vpp and the frequency is 960 KHz.*

*We can change LC values of the LC tank to change those output values. Also we can use a variable capacitor to tune to a radio station easily.*

- Modulated Signal

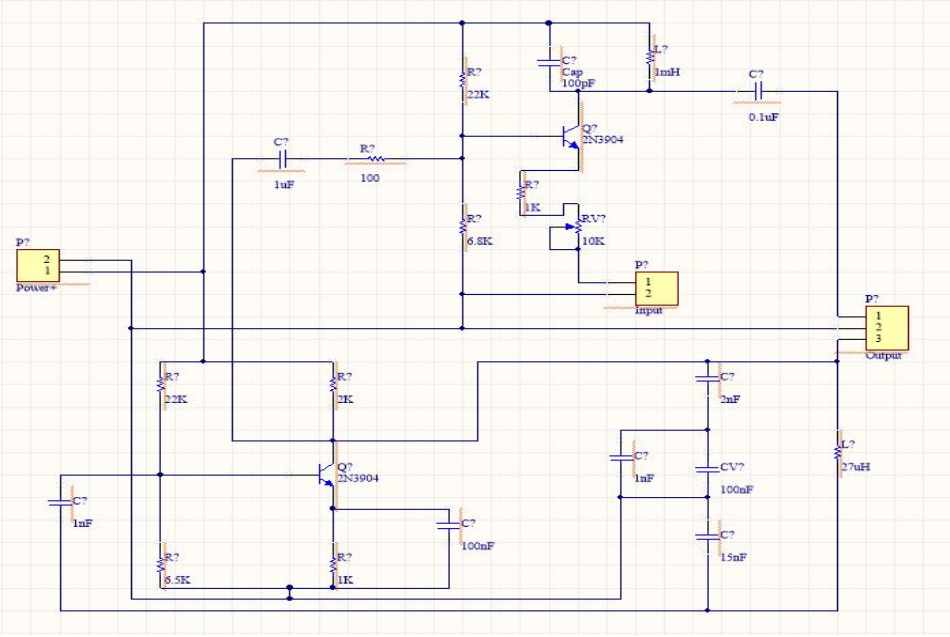


*In order to get undistorted output we have to consider the modulation factor as well as to remove the DC components of the carrier signal by using coupling capacitors. Also to remove the noise we ground a part of the output signal through a resistor.*

## *PCB Design*

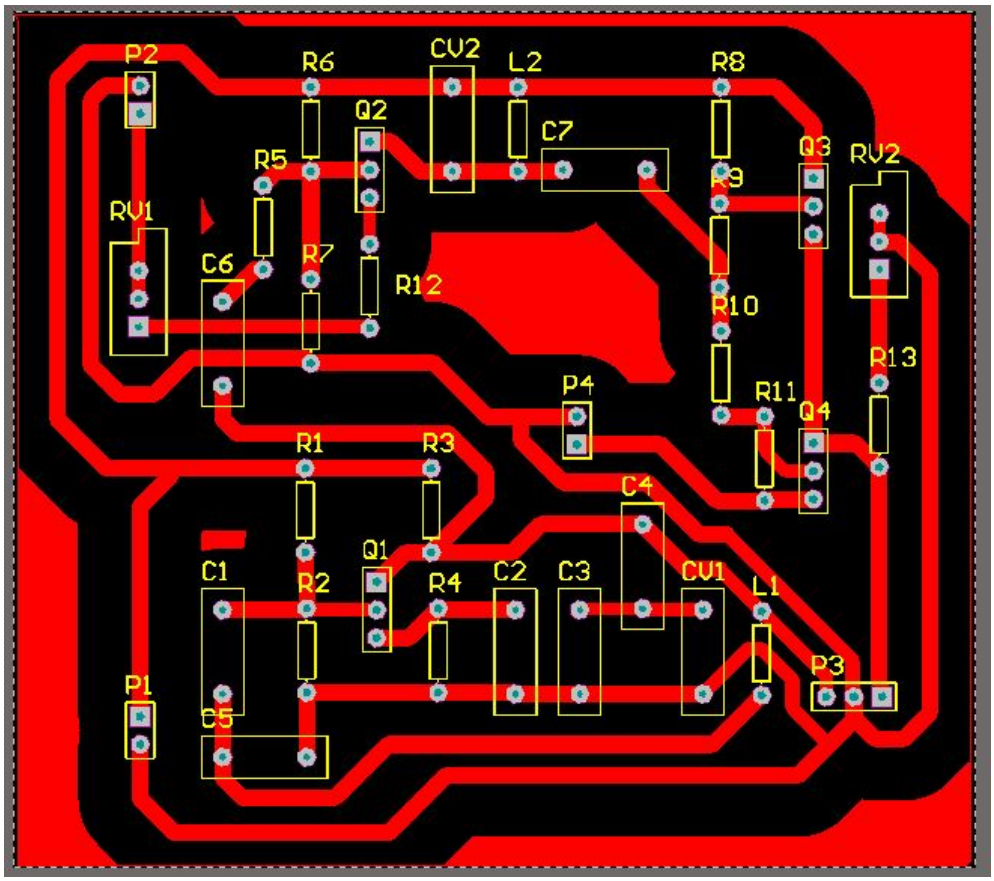
*We use altium to design the PCB.*

- Schematic design



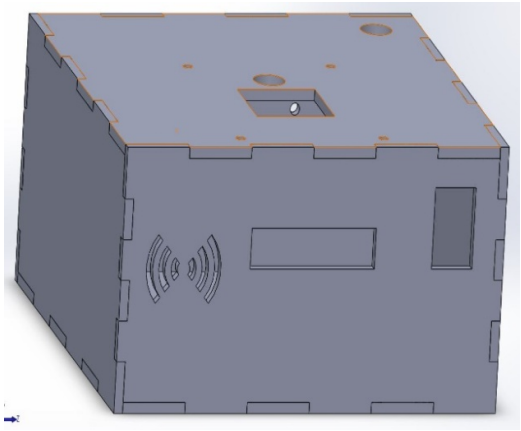
- PCB Layout

*We use screen printing method to create the PCB.*




*In this design our PCB includes a class AB power amplifier as well. We include that part to change the output current accordingly as well as to give great current handling capability. But finally we decided to remove that part and only use the class C amplifier with a voltage controller to change the output power.*

## *Enclosure Design*



## *Raised problems*

*First problem that we got when designing this circuit is generating the carrier frequency in the range of AM transmission. That is because some oscillating circuits used mutual inductance method to generate the signal. Since we are not mature in producing mutual inductors, we came up with a solution which uses normal inductors other than mutual inductors. That is Colpitts oscillator. Then we faced another problem when getting the frequency of the generated signal in to the AM range. Because when a sudden change of a capacitance of one of the capacitors, the signal become to a noisy one which varies between -0.5v to 0.5v and when the frequency gets higher the output signal is not a pure sinusoidal one. As a method to resolve that we used a grounded capacitor between the series connected two capacitors because it guarantees that the resultant capacitance value will not be zero anyway.*

*Since we designed three parts (modulator, Oscillator, amplifier) as separated circuits, when we combine them we got another problem which is the carrier signal not generated. The identified issue for that is follows. Previously we designed the oscillator to get the output when we haven't connected any circuit with it and we used 9v as our power supply. But when we connect them together some current will be delivered to the circuits which we connected later on. As a solution for that which means to generate higher current we decided to increase the input voltage to 12v.*

*After resolving everything mentioned above the final part is to generate an amplified version of the modulated signal by delivering the signal through a power amplifier because to transmit the signal we need to use a signal with high power. For that we used a class AB power amplifier. We used 2N3904 and 2N3906 as NPN, PNP transistors respectively. In AM transmitting we need to obey the rules introduced by TRCSL. So there is a limit of power that can be used to be in between the rules. That's because we had to avoid power transistors. Because of the transistors that we*

*used, we had to face many problems. When the circuit runs (more than one minute) the actual output signal gets vanished. Because after some time the transistors were destroyed because of the higher generated power exceeds the power limit of the transistors. We used a copper coil as a heat sink for the transistors but the problem is not solved. Two small resistors (100Ohm) were used in between the emitter connections of the amplifier as a solution to the higher power dissipation in transistors. The problem was not solved but we could run the circuit more than one minute.*

*Finally we got to know that the power of the modulated signal (before feed in to AB amplifier) has enough power to transmit it as an AM signal. Then we removed the class AB part and got a finely working output which has a transmitting range of 5m.*

## *Conclusion*

*This project presented a very interesting spin on a very old topic. AM transmitters are a mature technology but are still in widespread use.*

- *Standard AM broadcast stations*
- *CB radio*
- *VHF aircraft radio*

*Our implementation is not only addressing the challenges of a proper AM transmitter, but also offering a novel solution to the ability to visualize the stations on the spectrum of interest. Rather than being a fully functional system, we could be able to develop a prototype that is a single signal source. In amplitude modulation, the carrier frequency is constant; on the other hand, the value of the carrier amplitude varies depending on the amplitude the modulating signal. The voltage of each side frequency depends on carrier voltage and the modulation index. Modulation index is the ratio of the peak voltage of the modulating signal and the peak voltage of the unmodulated carrier. From the modulated carrier displayed on an oscilloscope, the percent modulation can be measured through the maximum and the minimum values of the modulating signal. We can conclude pros and cons below for AM transmitting,*

*Pros:*

- *Easy to implement*
- *Less complex*
- *Low Bandwidth*
- *Easy to demodulate*
- *Low voltage used*

*Cons:*

- *Not efficient in terms of its power usage*
- *Not efficient in terms of its use of bandwidth*
- *Prone to high levels of noise*
- *Limited range of transmission*