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FM Transmitter Circuit

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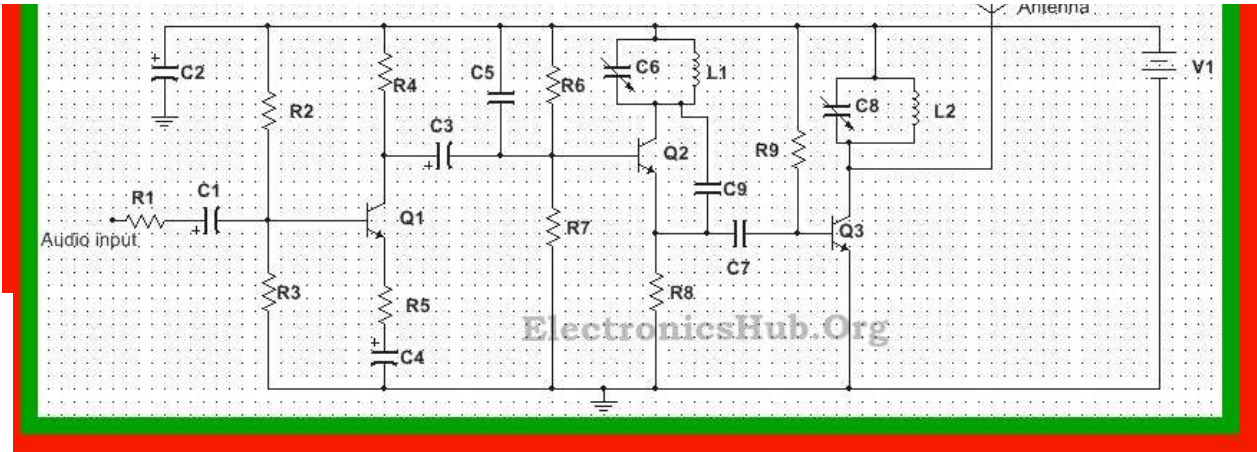
Here we are building a wireless FM transmitter which uses RF communication to transmit the medium or low power FM signal. The maximum range of transmission is around 2 km.

FM Transmitter Circuit Principle:

FM transmission is done by the process of audio pre amplification, modulation and then transmission. Here we have adapted the same formula by first amplifying the audio signal, generating a carrier signal using an oscillating and then modulating the carrier signal with the amplified audio signal. The amplification is done by an amplifier, whereas the modulation and carrier signal generation is done by a variable frequency oscillator circuit. The frequency is set at anywhere between the FM frequency range from 88MHz to 108MHz. The power of the FM signal from the oscillator is then amplified using a power amplifier to produce a low impedance output, matching that with the antenna.

“ Related Post: [How TV Transmitter Circuit Works?](#)

Circuit Diagram of 2 km FM Transmitter Circuit:



FM Transmitter Circuit Diagram – [ElectronicsHub.Org](#)

Circuit Components:

COMPONENT NAME	VALUE
R1	18K
R2	22K
R3	90K
R4	5K
R5	540 Ohms
R6	9K
R7	40K
R8	1K
R9	20K
C1	5uF, Electrolyte
C2	47uF, Electrolyte
C3	0.01uF, Electrolyte
C4	15uF, Electrolyte
C5	0.01uF, Ceramic



C6	20pF, Variable Capacitor
C7	10pF, Ceramic
C8	20pF, Variable Capacitor
L1, L2	0.2uH
Antenna	30 Inches Long Wire or Telescopic Antenna
V1	9V Battery
Audio Input	Microphone

FM Transmitter Circuit Design:

Design of Audio Pre-amplifier:

Here we are designing a simple single stage common emitter amplifier as the pre-amplifier.

a) Selection of Vcc: Here we have selected the NPN Bipolar Junction Transistor, BC109. Since V_{CE0} for this transistor is around 40V, we choose a much lesser Vcc, of about 9V.

b) Selection of Load Resistor, R4: To calculate the value of load resistor, we first need to calculate the quiescent collector current. Let us assume this value to be about 1mA. The collector voltage needs to be about half of Vcc. This gives the value of load resistor, R4 as : $V_c/I_q = 4.5K$. We select a 5K resistor for better operation.

c) Selection of Voltage Divider Resistors R2 and R3: To calculate the value of the voltage divider resistors, we need to calculate the bias current as well the voltage across the resistors. The bias current is approximated to be 10 times the base current. Now base current, I_b is equal to the collector current divided by the current gain, h_{fe} . This gives the value of I_b to be 0.008mA. The bias current is thus 0.08mA.

The voltage across the base, V_b is assumed to be 0.7V more than the emitter voltage V_e . Now assume the emitter voltage to be 12% of Vcc, i.e. 1.08V. This gives V_b to be 1.78V.

Thus, $R_2 = V_b/I_{bias} = 22.25K$. Here we select a 22K resistor.

$R_3 = (V_{cc} - V_b)/I_{bias} = 90.1K$. Here we select a 90K resistor.



current and is approximately equal to the collector current. This gives $R_5 = (V_e/I_e) = 540 \text{ Ohms}$. Here we select a 500 Ohms resistor. It serves the purpose of bypassing the emitter current.

e) Selection of coupling capacitor, C1: Here this capacitor serves the purpose of modulating the current going through the transistor. A large value indicates low frequency (bass), whereas a lesser value increases treble (higher frequency). Here we select a value of 5 μF .

) Selection of Microphone Resistor R1: The purpose of this resistor is to limit the current through the microphone, which should be less than the maximum current a microphone can handle. Let us assume the current through microphone to be 0.4mA. This gives the value of $R_1 = (V_{cc} - V_b)/0.4 = 18.05\text{K}$. Here we select a 18K resistor.

) Selection of Bypass Capacitor, C4: Here we select an electrolyte capacitor of 15 μF , which bypasses the DC signal.

[Also Read: [How to build Adjustable Timer](#)]

Design of Oscillator Circuit:

) Selection of tank circuit components – L1 and C6: We know the frequency of oscillations is given by

$$f = 1/(2\pi\sqrt{LC})$$

Here we require a frequency between 88 MHz to 100 MHz. Let us select a 0.2 μH inductor. This gives value of C6 to be around 12pF. Here we select a variable capacitor in the range 5 to 20pF.

b) Selection of Tank Capacitor, C9: This capacitor serves the purpose of keeping the tank circuit to vibrate. Since here we are using BJT 2N222, we prefer the value of C9 between 4 to 10 pF. Let us select a 5 pF capacitor.

c) Selection of bias resistors R6 and R7: Using the same method for calculation of bias resistors, as in the preamplifier design, we select the values of bias resistors R6 and R7 to be 9 K and 40 K respectively.

d) Selection of coupling capacitor, C3: Here we select electrolyte capacitors of about 0.01 μF as the coupling capacitor.

e) Selection of emitter resistor, R8: Using the same calculations as for the amplifier circuit, we get the value of emitter resistor to be around 1K.

Design of Power Amplifier Circuit:



circuit at the output. The values of the tank circuit components are same as that in oscillator circuit. Here we select the biasing resistor to be about 20 K and coupling capacitor of about 10 pF.

Selection of Antenna:

Since the range is about 2 km, we can prepare an antenna using a stick antenna or a wire of 30 inches approximately which would be about $1/4^{\text{th}}$ of the transmitting wavelength.

Theory Behind FM Transmitter Circuit:

Audio signal from the microphone is very low level signal, of the order of mill volts. This extremely small voltage needs to be first amplified. A common emitter configuration of a bipolar transistor, biased to operate in class A region, produces an amplified inverted signal.

Another important aspect of this circuit is the colpitt oscillator circuit. This is a LC oscillator where energy moves back and forth between the inductor and capacitor forming oscillations. It is mainly used for RF application.

When this oscillator is given a voltage input, the output signal is a mixture of the input signal and the oscillating output signal, producing a modulated signal. In other words, the frequency of the oscillator generated circuit varies with the application of an input signal, producing a frequency modulated signal.

How to Operate FM Transmitter Circuit?

Audio input from the microphone or any other device is first amplified using the common emitter configuration of BC109. This amplified signal is then given to the oscillator circuit through the coupling capacitor. The oscillator circuit generates a signal with a frequency determined by the value of the variable capacitor. The output signal from the emitter of the transistor is coupled to the input of the power amplifier transistor using the coupling capacitor. As this signal is amplified, the variable capacitor in the power amplifier section tends to maintain an output matching with that of the oscillator. The amplified RF signal is then transmitted using antenna.

Applications of FM Transmitter Circuit:

This circuit can be used at any place to transmit audio signals using FM transmission, especially at institutions and organizations.

Limitations:

This circuit is for educational purposes and may require more practical approach.