Kit 18. 9V FM Transmitter

This transmitter (Tx) has been developed as a more powerful yet simpler version of Kit 7. Component count has been reduced yet the power has been increased by using a 9V battery. The tank oscillator coil has been incorporated into the PCB trackwork itself. A bigger tuning film capacitor has been used to get more fine tuning anywhere in the FM band.

It has a greater range which is mainly the result of its higher operating voltage. The output power of this FM Tx is below the legal limits of many countries.

The kit is constructed on a single-sided printed circuit board (PCB). A computer aided design program, Protel for DOS, was used to design the board.

ASSEMBLY INSTRUCTIONS

Components may be added to the PCB in any order. The electret microphone should be inserted with the pin connected to the metal case connected to the negative rail (that is, to the ground or zero voltage side of the circuit.) This is marked with a '-' sign at the MIC on the circuit board.

The battery snap must be connected with the Red lead going to the 9V+ pad and the Black lead going to the '-' or ground rail. Adding and removing the batteries acts as a switch for the Tx. Use some of the metal wire cut off the other components to add the **LINK** at the place indicated on the circuit board.

Connect a half or quarter wavelength length of wire to the aerial point. At an FM frequency of 100 MHz these lengths are 150 cm and 75 cm respectively.

CIRCUIT DESCRIPTION

The circuit is basically a radio frequency (RF) oscillator that operates around 100 MHz (100 million cycles per second). Audio picked up and amplified by the electret microphone is fed into the audio amplifier stage built around the first transistor. Output from the collector is fed into the base of the second transistor where it modulates the resonant frequency of the tank circuit (the coil built into the circuit board and the trimcap) by varying the junction capacitance of the transistor. Junction capacitance is a function of the potential difference applied to the base of the transistor. For a review of the theory behind two and three stage FM transmitter circuits download

http://kitsrus.com/zip/fmtx.zip

from my website. It is 1.1MB but has the full theory of operation behind these circuits. Let us look at the building blocks of the circuit:

The electret microphone: an electret is a permanently chargeddielectric. It is made by heating a ceramic material, placing it in a magnetic field then allowing it to cool while still in the magnetic field. It is the electrostatic equivalent of a permanent magnet. In the electret microphone a slice of this material is used as part of the dielectric of a capacitor in which the diaphram of the microphone forms one plate. Sound pressure moves one of its plates. The movement of the plate changes the capacitance. The electret capacitor is connected to an FET amplifier. These microphones are small, have excellent sensitivity, a wide frequency response and a very low cost.

First amplification stage: this is a standard self-biasing common emitter amplifier. The 4n7 capacitor isolates the microphone from the base voltage of the transistor and only allows alternating current (AC) signals to pass.

The tank (LC) circuit: every Tx needs an oscillator to generate the radio Frequency (RF) carrier waves. The tank (LC) circuit, the BC338 and the feedback 10pF capacitor are the (Colpitts). An input signal is not needed to sustain the oscillation. The feedback signal makes the base-emitter current of the transistor vary at the resonant frequency. This causes the emitter-collector current to vary at the same frequency. This signal fed to the aerial and radiated as radio waves. The 10pF coupling capacitor on the aerial is to minimise the effect of the aerial capacitance on the LC circuit.

The name 'tank' circuit comes from the ability of the LC circuit to store energy for oscillations. In a pure LC circuit (one with no resistance) energy cannot be lost. (In an AC network only the resistive elements will dissipate electrical energy. The purely reactive elements, the C and the L simply store energy to be returned to the system later.) Note that the tank circuit does not oscillate just by having a DC potential put across it. Positive feedback must be provided.

CIRCUIT CALIBRATION

Calibration should be done at least 10 feet from an FM radio, preferably in another room. The Tx should be near some source of soft sound, like a TV, ticking clock or just people talking. Plug in the battery. Use a small screw driver or your fingernail to move the movable plates so they are just inside (that is, overlapping) the fixed plates by about 5 degrees. (You can easily see this by looking at the plates as they move.) Go back to the FM radio and move the tuning dial at around 104 - 106 MHz end of the dial. Somewhere there the Tx transmission should be picked up.

By moving the movable plates about one third the distance into the fixed plates you will find that the transmission will drop to about 90MHz on the FM radio. Moving the plates still further will lower the transmission frequency below the commercial band.If you have a scanner or de-tuned FM receiver then you can easily pick up these transmissions and be sure that no-one with an ordinary FM receiver can listen in too!

Note that you must not hold the Tx when doing this calibration. Your own body capicitance is more than

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enough to change the tank frequency of oscillation and shift the transmitting frequency.

WHAT TO DO IF IT DOES NOT WORK

Poor soldering is the most likely reason that the circuit does not work. Check all solder joints carefully under a good light. Next check that all components are in their correct position on the PCB. Thirdly, follow the track with a voltmeter to check the potential differences at various parts of the circuit particularly across the base, collector and emitter of the two transistors.

A check list of other items:

- are the transistors in the correct way and correct places.
- is the battery flat. did you add the LINK
- Check that the following collector-emitter voltages are present; 2V across the 548, 5V across the 338.
- If you hear an oscillation or 'putt-putt' at all frequencies then it is possible the unit is in oscillation due to the load resistor on the microphone being too low. Increase it to say 22K or 47K. This should overcome the problem.

The simple halfwave antennae used in the kit is not the most efficient. Greater efficiency may be gained by connecting a dipole antennae using 50 ohm coaxial cable. Connect one lead to the Antenna point and the other to the earth line. In experiments using this type of aerial and 18V supply we have got transmitting distances of 2 miles in the open. You may experiment with higher voltages to see how this increases the range. Adding a small capacitor in parallel with the trim capacitor (eg, 10pF) will shift the tuning range of the trim cap.

For a review of FM transmitter kits on todays market see:

http://members.tripod.com/~transmitters/

Our Kit 32 is reviewed on the page at /**begin.htm**

COMPONENTS		
Resistors (carbon, 0.25W, 5%):		
100R (brown, black,brown)	R5	1
1K (brown, black, red)	R4	1
12K (brown, red, orange)	R1 R2	2
2M2 (red, red, green)	R3	1
BC338 transistor	T2	1
BC548 transistor	T1	1
Electret Microphone	MIC	1
9V Battery snap		1
10pF ceramic capacitor	C3 C4	2
4n7 ceramic capacitor	C1 C2	2
22n 223 ceramic	C6	1
trimmer capacitor 2-30pF	C5	1
K18 PCB		1
Hookup wire for aerial	160cm	

For other DIY Kits see our website at

http://kitsrus.com