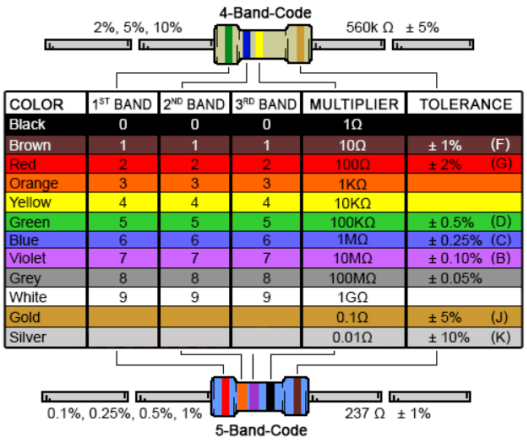
# JOTA – JOTA Bug

| Part | Qty | Check |
|---|---|---|
| Battery holder 2 x AAA Switch | 1 | |
| Printed Circuit Board | 1 | |
| Cap 100n (104) | 1 | |
| Cap 1n (102) | 1 | |
| Cap 22n (223) | 2 | |
| Cap 27 pF (27 | 1 | |
| Cap 5.6 pF (5p6) | 1 | |
| Electret Microphone 2 lead | 1 | |
| Resistor 1M | 1 | |
| Resistor 120R | 1 | |
| Resistor 10k | 1 | |
| Resistor 22k | 1 | |
| Resistor 470R | 1 | |
| Resistor 47k | 1 | |
| Transistor BC457 | 2 | |
| LED | 1 | |
| Trim Cap 6-47pF | 1 | |
| Coil (5 turns of copper wire wound around a 3.5 mm drill bit) | 1 | |
| Antenna (Approximately 20cm hookup wire) | 1 | |



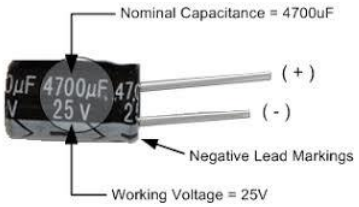

| COLOR | 1ST BAND | 2ND BAND | 3RD BAND | MULTIPLIER | TOLERANCE |
|---|---|---|---|---|---|
| Black | 0 | 0 | 0 | 1Ω | |
| Brown | 1 | 1 | 1 | 10Ω | ± 1% (F) |
| Red | 2 | 2 | 2 | 100Ω | ± 2% (G) |
| Orange | 3 | 3 | 3 | 1KΩ | |
| Yellow | 4 | 4 | 4 | 10KΩ | |
| Green | 5 | 5 | 5 | 100KΩ | ± 0.5% (D) |
| Blue | 6 | 6 | 6 | 1MΩ | ± 0.25% (C) |
| Violet | 7 | 7 | 7 | 10MΩ | ± 0.10% (B) |
| Grey | 8 | 8 | 8 | 100MΩ | ± 0.05% |
| White | 9 | 9 | 9 | 1GΩ | |
| Gold | | | | 0.1Ω | ± 5% (J) |
| Silver | | | | 0.01Ω | ± 10% (K) |

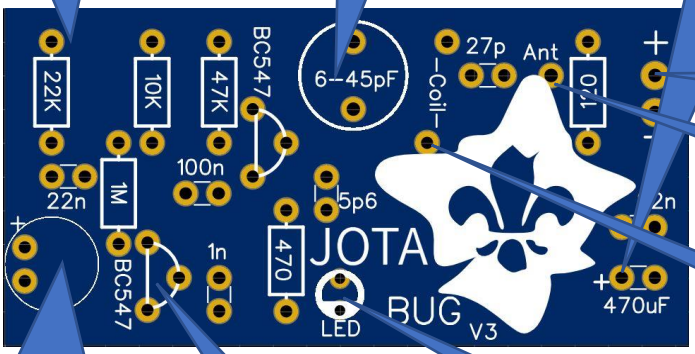
[Step 1] Solder in the resistors first, as these are low profile and less sensitive to heat.

Good to practise on…

[Step 2] Solder in the TRIM Capacitor . *This is used with the coil to tune your circuit*

[Step 3] Solder in all the capacitors. Note the 470uf is the only one with a polarity. Put it in the correct way around




[Step 10] Solder the leads from the battery pack. Positive and Negative to the right terminals

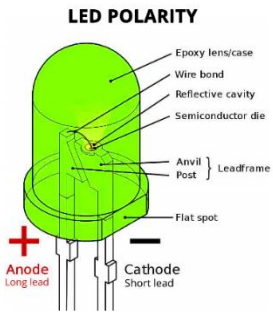
Hot glue the battery pack to the board, leaving room for the on/ off switch to operate.

[Step 9] Make an antenna out of about 30cm of wire. Solder it in here . Then hot glue the joint to the board

[Step 8] Make the coil and solder it in

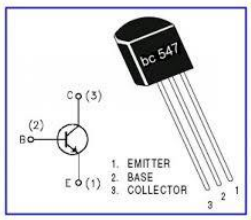
[Step 4] Solder in the Microphone. Note the have a polarity and should not be soldered in reverse.

[Step 7] Solder in the Power LED , Take care the it is soldered in right way around with the flat spot down




[Step 6] Solder in the 2 Transistors ,

- *take care they are the correct way round*
- *minimise the heat to them by mounting them higher and giving them time to cool between soldering each leg*



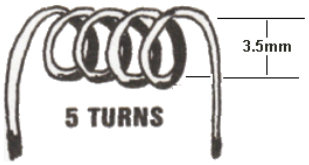

Warning a 5 band 120 Ohm Resistor looks very Similar to a 10k. Use a multi meter if you are unsure what they are.

Top Tips

- Don’t Rush
- Read through the soldering tips document
- Remember your iron is hot. It could burn you, your neighbour or the power cord. Give yourself lots of room.
- Sticky tape a clothes peg to a block of wood to make a simple holder.
- Ask an adult if you have the components the right way round BEFORE you solder them in.
- Make sure your solder joints are nice “volcanos”
- Cut the legs off the component with side cutters, after you solder them
- Check you have not joined any solder pads together by accident BEFORE you power it up

## Making the oscillator coil

The oscillator coil is made out of tinned copper wire and does not need any insulation as the coils are unable to touch each other and short-out. The coil is made by winding the tinned copper wire over a 3.5mm drill bit. The gauge of wire, the diameter of the coil and the spacing between turns is not extremely important and it will be can be adjusted when tuning.




## Setting up the transmitter

When the FM BUG is complete, checked and ready for insertion into its case, there is one slight adjustment which must be made to align it to the correct frequency.

Since we are working with a very high frequency, the proximity of your hand or even a metal screw-driver will tend to de-tune the oscillator appreciably.

For this reason you must use a plastic aligning stick to make the adjustment to the coil or the trim cap.

Place the bug about a metre from the FM radio and switch both units on. Tune the radio to an unused portion of the band and use the alignment stick to push the turns of the coil together or to turn the cap. Make sure none of the turns touch each other as this will short out the operation of the oscillator.

All of a sudden you will hear the background noise diminish and you may even get feedback. This amount of adjustment is sufficient.

The fine tuning between radio and transmitter is done on the radio . Peak the reception and move the BUG further away. Peak the fine tune again and move the BUG into another part of the house and see how far it will transmit.

## If the bug fails

The frequency at which the BUG operates is too high for most digital tests or ordinary audio test procedures.

Compare a unit which works, with the faulty unit.

The first fact you have to establish is the correct operation of the FM receiver.

If you have another BUG and it is capable of transmitting through the radio you know the radio is tuned to the correct frequency. Otherwise you will have to double-check the tuning of the dial and make sure the radio is switched to the correct setting.

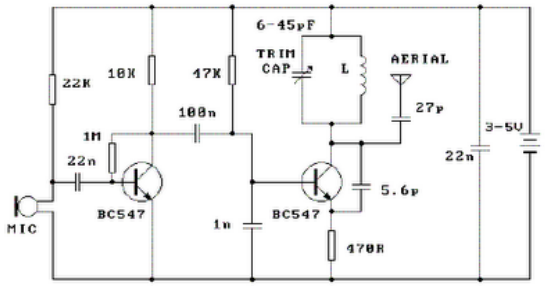
The next stage is to determine if the BUG is functioning AT ALL. The only voltage measurements you can make are across the collector-emitter terminals of the first transistor (1 v to 1.5v) and across the collector-emitter terminals of the second transistor (1.3v to 1.5v) These values won't tell you much, except that the battery voltage is reaching the component.

Tune the radio to about 90MHz and lay the radio antenna very close to the antenna of the BUG. Switch the BUG on and off via the slide switch or slide your thumb over the microphone. You should hear a click or scratching in the radio if the BUG is on a frequency NEAR 90MHz. Move the turns of the aerial coil together or apart with a plastic stick as you switch the unit ON and OFF.

If a click is heard but no feed-back, the oscillator will be operating but not the pre-amp stage. This could be due to the electret microphone being around the wrong way, the transistor around the wrong way, a missing component or an open 2.2u capacitor.

If the fault cannot be located, compare your unit with a friend's. You may have made a solder bridge, connected the batteries around the wrong way, made the coil too big or used the wrong value capacitor for one of the values.

## How it all works




The circuit consists of two separate stages. The first is an audio pre-amplifier and the second is a 90MHz oscillator.

The first stage is an amplifier capable of amplifying minute signals picked up by the microphone. The amplification of the first stage is about 70 and it only operates at audio frequencies. The 22n capacitor isolates the microphone from the base voltage of the transistor and allows only AC signals to pass through. The output from the transistor passes through a 100n capacitor.

The critical components are the coil and trim capacitor. These determine the frequency at which the bug will transmit.

This stage is basically a free-running 90MHz oscillator in which the feedback path is the 5p6 capacitor.

When the circuit is turned on, a pulse of electricity passes through the collector-emitter circuit and this also includes the parallel tuned circuit made up of the oscillator coil and the 47p capacitor. This pulse of electricity is due to the transistor being turned on via the 47k resistor in the base circuit.

Whenever energy is injected into a tuned circuit, the energy is firstly absorbed by the capacitor. The electricity will then flow out to the coil where it is converted to magnetic flux. The magnetic flux will cut the turns of wire in the coil and produce current and voltage which will be passed to the capacitor.

In theory, this current will flow back and forth indefinitely, however in practice, there are a number of losses which will cause the oscillations to die down fairly quickly.

If a feedback circuit is provided for the stage, the natural RESONANT frequency of the coil/capacitor combination will be maintained. The 5p6 provides this feedback path and keeps the transistor oscillating.

The 5p6 feeds a small sample of the voltage appearing at the collector, to the emitter and modifies the emitter voltage. The transistor sees its base-to-emitter voltage altering in harmony with the resonant frequency of the tuned circuit and turns the collector on and off at the same frequency.

Thus there is a degree of stability in the oscillator frequency.

The actual frequency of the stage is dependent upon the total capacitance of the circuit and this includes all the other components to a minor extent.

Once the basic frequency of 90MHz is set, the variations in frequency are produced by the changes in effective capacitance of the transistor. This occurs when its base voltage is increased and reduced. The electret microphone picks up the sound waves which are amplified by the first transistor and the resulting frequency is passed to the base of Q2 via the 100n cap.

This alters the gain of the transistor and changes its internal capacitance. This junction capacitance modifies the oscillator with a frequency equal to the sound entering the microphone thus FREQUENCY MODULATING the circuit. A short length of antenna wire is connected to the collector of the oscillator via a coupling capacitor and some of the energy of the circuit will be radiated to the surroundings.

Any FM receiver will pick up this energy and decode the audio portion of the signal.