QUASAR PROJECT KIT # 3018v2KT
'MRTX' Miniature 9V FM Room TX
INFORMATION & INSTRUCTIONS

This is an improved version of our 3018 bug. At first sight it looks similar to the original 3018 (especially the inductor etched onto the PCB) but it has been completely redesigned to give the best distance and stability for its size. The new design also enables you to choose from two output powers (see below for full details).

NOTE: *It is against the law to transmit a radio signal in the UK without an appropriate license or with equipment not approved for use in the UK by the Radio Communications Agency (RCA). This kit has NOT been approved by the RCA (they will NOT grant licenses for this type of equipment). Check local laws if you live outside the UK.*

ASSEMBLY INSTRUCTIONS

When assembling this board, take care to fit even the resistor orientation as shown on the component overlay. Although resistors are symmetrical and non- polarised, vertical mounting makes them become asymmetrical: one lead is longer than the other. This can alter VHF circuits by adding greater capacitance to other components. All component leads should be kept as short as possible. The LINK wire on the PCB should lay flat on the PCB. Use the cut-off from a resistor. Components may be added to the PCB in any order but it is easiest to start with the lowest components and work up. The electret microphone should be inserted so the pin connected to the metal case goes 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. See below for antenna connection details. Adding and removing the battery acts as a switch for this TX.

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.

In this new design the battery supply rails have been well tied together with respect to radio frequencies (C1, C2 and C7.) The tracks are also thicker. This makes the circuit a single 'solid' block eliminating RF currents in different parts of the circuit. This also means the battery no longer has RF on it which makes the whole unit a lot more frequency stable. Here is what else we have done:

C6 – new component. The trimmer capacitor is 2pF – 30pF and is much to high a capacitance range to cover just 98MHz +/- 10%.

C5 – 2p7. Reduced from the old 10pF. The old component had to much capacitance preventing the transmitter from operating above 100MHz. If you find the upper frequency is too high (like 112MHz) then increase the value to 3p3.

C1 & C2 – new components for supply decoupling. To force the supply rails to become an RF ground/ earth there should be more than one decoupling capacitor. Electrolytic caps have resonances in the VHF region. The physical position of the ecaps on the PCB is very important.

C3 - Changed from 4n7 to 10nf. The LF response "filled out" a little more and sounds better on the air. C2 is also probably operating to damp the HF response, but for general microphone use this is not a problem. It probably adds to the overall RF stability.

C4 - Changed from 4n7 to 3n3 - it allows the upper frequency response to become over 12KHz.

R4 - R3 - Biasing changes to the AF amplifier transistor. This now gives a more stable bias arrangement that is less dependant upon transistor characteristics. It is important that TR1 is stable - changes in bias affect the frequency range and modulation depth.

R2 - 100K - New component - This works together with R3 to form a voltage divider to prevent over modulation. With 100K (supplied) the bug is sensitive to a normal conversation at about 1 to 4 metres distance. Here are some suggested line level input levels and resistor values:

R2 = 47K - Conversational voices at 5m to 15m (3m minimum).
R2 = 100K - Conversational voices at 0.5m to 4m
R2 = 470K - Conversational voices at 0.2m to 0.5m
R2 = 2M2 - Line input level (computer LINE OUT, also remove R1. Open circuit).
R2 = 100K - Conversational voices at 300mm using low-level dynamic mic (also remove R1. Open Circuit.)
R2 = 470K - Magnetic guitar pickup (also remove R1.)

ANTENNA

The frequency determining elements (L1, C5 and C6) form a simple LC tuned oscillator. The inherent problem with this type of circuit is that any external load (antenna) will change the operating frequency. This is normal. If the antenna load is heavy then the transmitter could be moved off frequency by 1MHz, or perhaps even more.

The tuned coil, L1, has two output tapings for the antenna connection, marked "A" and "B". These are both low-level outputs and you choose which tapping you want to use. Most other kits of this type have fixed output tapings, so you must accept either unstable frequency or low range, whichever the designer has chosen for you.

Tap A (2.5%) takes just a very small portion of signal from the oscillator circuit and therefore gives a very frequency stable transmitter. The output level and range are therefore somewhat reduced.

Tap B (10%) delivers very much more power to the antenna load. This gives you a greater range, but at the expense of frequency stability. Touching the antenna wire will therefore have a noticeable effect on the transmitter frequency.

Antenna length. This varies with frequency for optimum distance. 90MHz 80 cm, 95MHz 75cm, 100MHz 70 cm, 105 MHz 68 cm.

Supply Voltage. This is limited by the voltage rating of the ceramic capacitors to 16VDC. If you use an external supply a regulated one is best but please note that some power supplies might introduce mains hum to the output signal.

SETTING UP

Calibration should be done with the Tx at least 10 metres from an FM radio so as not to pick up harmonics. The Tx should be near some source of soft sound, like a TV, stereo or just people talking. The frequency range of the fundamental signal is between about 90MHz to 109MHz. The metal plates of the trim cap are normally supplied in the lowest frequency position (the gold coloured plates nearest the silver part of the trim caps body i.e. 6 o'clock). Connect a fresh battery (do NOT power from a mains adapter!). Slowly move the radio dial from 88 to 94Mhz until you pick up the signal. You can use a small plastic screwdriver to move the trim cap to a different transmitting frequency of your choice (a 180 degree turn from 6 o'clock to 12 o'clock covers the full tuning range of the Tx). Choose a place where no other stations are transmitting and tune the Tx to that frequency. Note that you must not hold the TX when doing this calibration. Your own body capacitance is more than enough to change the tank frequency of oscillation and shift the transmitting frequency.

The output power is about 9mW at 9V with antenna tapping A. Tapping the antenna at point B should approximately triple the range.

COMPONENTS		
Resistors (carbon, 0.25W, 5%)		QTY
100R (brown, black, brown)	R7	1
1K (brown, black, red)	R5	1
12K (brown, red, orange)	R1 R6	2
22K (red, red, orange)	R3	1
100K (brown, black, yellow)	R2 R4	2
Ceramic Capacitors		
2p7 (marked 2.7 or 2p7)	C5	1
22p (marked 22)	C6	1
3n3 (marked 332)	C4	1
10n (marked 103)	C3	1
22n (marked 223)	C2	1
Electrolytic Capacitors		
10uF/25V Electrolytic	C1	1
100uF/16V Electrolytic	C7	1
Miscellaneous Items		
0-30pF tuning capacitor		1
BC548B transistor	Q1	1
BC338 transistor	Q2	1
MIC - Electret Microphone		MIC
9V Battery snap		1
Aerial Wire		1
3018v2 PCB		1

NOTHING HAPPENS?

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.

For a **DETAILED** technical description of the operation of two stage FM TX like this one see:
www.quasarelectronics.com/ds/fmtx.htm

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