QRP Labs QRSS Beacon Kit

Thank you for purchasing our QRSS beacon kit. QRSS is a slow morse, weak signal mode capable of worldwide HF propagation using a fraction of a watt of RF output power.

The transmitter is designed to be powered with 5-6V DC, which could come from a mobile phone charger, wall wart, or even four 1.5V batteries connected in series. Do not use more than 6V: this may kill the microcontroller.

The circuit diagram is shown on page 2. It consists of a simple Colpitts oscillator (Q1), a buffer stage (Q2), and a power amplifier (Q3) followed by a 7-element low pass filter. The keyer shifts the oscillator frequency a few Hz via the red LED which behaves as a varactor diode.

The kit comes in three versions (80/40/30m), please follow the instructions for your version. Parts placement is defined by the printed legend on the PCB, so please observe it carefully, paying particular attention to the correct orientation of the semiconductors. Note that the parts values written on the PCB are for 30m. Please refer to the parts list for the correct capacitor and inductor values to use for 80m and 40m versions.

1. The Keyer

The Atmel microcontroller included in the kit is pre-programmed with your callsign, and the kit produces 100-150mW of continuously keyed FSK CW ("key down" is a 5Hz higher frequency than "key up"). Solder in the IC socket and insert IC1, taking care to match the notch on the circuit board layout with the end of the chip containing a dimple (next to pin 1). Fit C12. At this point if power is applied and walkman-headphones briefly connected between the "TONE" output and ground, you should hear your callsign in 12wpm CW. Be careful, in some sensitive headphones it can be very loud!

2. Winding the inductors

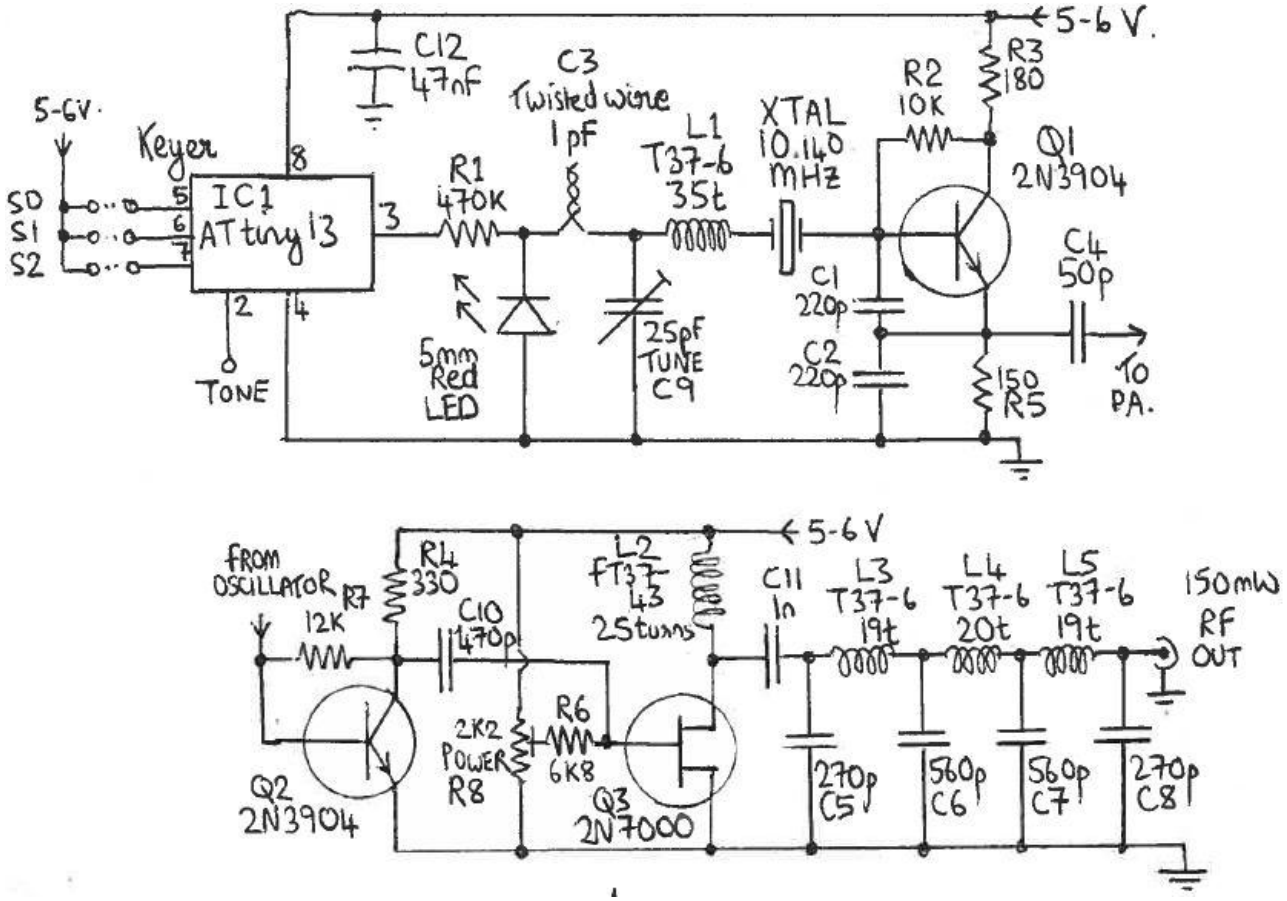
Remember that each time the wire goes through the centre of the toroid counts as one turn. 35cm of wire should be enough for 25 turns. Label the toroids aids identification later!

	80m version	40m version	30m version
L1	27 turns,T37-6 (yellow)	27 turns,T37-6 (yellow)	27 turns,T37-6 (yellow)
L2	25 turns,FT37-43 (black)	25 turns,FT37-43 (black)	25 turns,FT37-43 (black)
L3	25 turns, T37-2 (red)	19 turns, T37-6 (yellow)	19 turns, T37-6 (yellow)
L4	27 turns, T37-2 (red)	21 turns, T37-6 (yellow)	20 turns, T37-6 (yellow)
L5	25 turns, T37-2 (red)	19 turns, T37-6 (yellow)	19 turns, T37-6 (yellow)

Trim the ends of the wire and scrape the enamel off and tin them with solder.

3. The "gimmick" capacitor

C3 is a 1pF capacitor. To make it, cut about 50mm of the magnet wire and solder the ends to the PCB where C3 is marked. Twist the wire in a spiral and cut the tip so we end up with two wires about 15mm long.



Parts List

Resistors

R1 470K (yellow-purple-yellow-gold)
R2 10K (brown-black-black-red-brown)
R3 180 ohm (brown-grey-black-black brown)
R4 330 ohm (orange-orange-black-black-brown)
R5 150 ohm (brown-green-black-black-brown)
R6 6.8K (blue-grey-black-brown-brown)
R7 12K (brown-red-black-red-brown)
R8 2.2K trimmer potentiometer

Inductors See table on page 1

Semiconductors

IC1 ATtiny13 keyer chip
LED 5mm Red LED
Q1,2 2N3904 transistor
Q3 2N7000 transistor

Miscellaneous

Printed Circuit Board
IC Socket for IC1
Quartz crystal: 3.500/7.000/10.140MHz
Wire for winding toroids

Capacitors (observe carefully for your band)

	80m version	40m version	30m version
C1,2	680pF	470pF	220pF
C3	1pF twisted wire	1pF twisted wire	1pF twisted wire
C4	47pF	47pF	47pF
C5,8	470pF	270pF	270pF
C6,7	1200pF (1.2nF)	680pF	560pF
C9	25pF trimmer capacitor	25pF trimmer capacitor	25pF trimmer capacitor
C10	470pF	470pF	470pF
C11	1nF	1nF	1nF
C12	47nF	47nF	47nF

4. Crystal Oscillator and buffer stage

Solder the components on the top half of the board: R1,D1,C1, C2, L1, the 10.140 crystal, R2, C3, C4, Q1, Q2, R3, R4, R5, R6, C9 and C10. When power is applied to the board, you should be able to check that the oscillator works by listening for it at 10.140MHz on a communications receiver, using a frequency counter or oscilloscope connected to C10.

6. The PA and low pass filter

Solder the rest of the components to the board. Note: The two board holes for R8 nearest the left edge of the board are unfortunately slightly too small. The best way to deal with this is cut off 1/4-inch from the two R8 pins in question so that when the remaining pin is inserted in its hole, the two left-hand pins sit on the board. Then pass short pieces of wire, e.g. resistor lead offcuts, through from the opposite side of the board. You should be able to solder wires on the board underside, then solder them to the fore-shortened R8 pins on the component side of the board.

TURN R8 FULLY CLOCKWISE. Connect the output of the LPF to a 50-ohm dummy load (two ¼-Watt 100-ohm resistors in parallel will do). Connect some means of measuring power such as a power meter or an oscilloscope. Apply power to the board. Slowly turn R8 anti-clockwise and monitor the output power. You should be able to achieve more than 100mW before you notice that power starts to dip; then turn R8 back to the peak power point. With a 50-ohm dummy load, 100mW on an oscilloscope is 6.3V peak-to-peak (Watts = peak-to-peak voltage squared, divided by 400). If you turn R8 too far you may destroy Q3. Q3 should not get noticeably warm. If it does, then R8 is too far anti-clockwise.

7. Setting the keyer speed

The PCB contains links at pins 5, 6 and 7 of IC1 which allow the keying speed to be set. By default (no wire links), the keyer speed is 12wpm CW, which is useful for testing but no good at all for QRSS. A good recommended speed for QRSS is 6 second CW dots. To select this speed, just connect a wire between the top pair of holes, which are connected to pin 7 of IC1. These holes are labelled 2 and 5 and are right under the “QRP Labs” label. The full list of speed settings is shown in the table below (“X” means connect the wire link):

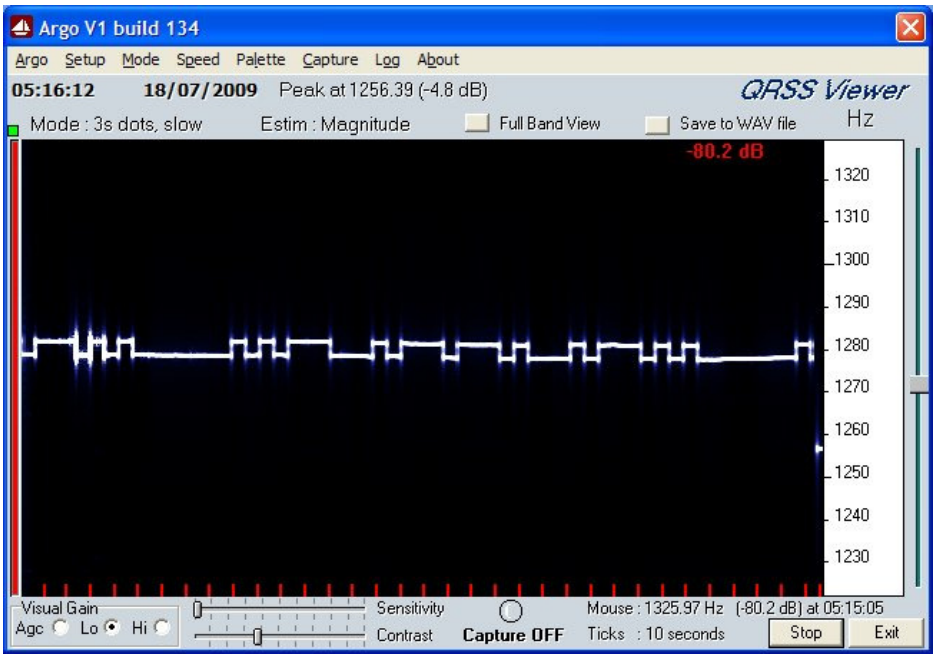
	12wpm	6wpm	1s	3s	6s	10s	15s	20s
S2 (pin 7)					X	X	X	X
S1 (pin 6)			X	X			X	X
S0 (pin 5)		X		X		X		X

8. Tuning

It is very important to realise that by far the hardest part of any successful QRSS beacon operation, is tuning the oscillator to the correct frequency. Most 30m QRSS stations monitor a narrow 100Hz-wide band from 10,140,000 to 10,140,100. If you are much outside this, the chances are that nobody will see your signal. It is therefore essential either to

adjust your output frequency using an accurately calibrated frequency counter, or an accurately calibrated receiver. Adjust the frequency using trimmer C9, aiming at first for 10,140,050. If it is impossible to achieve this frequency, try increasing or decreasing the number of turns on L1.

The easiest way to adjust the frequency and frequency shift of your keying, is to install the Argo software (download: http://www.sdrham.com/argo/index.html) on your PC, and monitor the output frequency on a 30m receiver. A small length of wire may be necessary at the RF output of the transmitter, to ensure it is picked up by your receiver antenna. Use Argo in the horizontal, 3s dots Slow mode. The image should look something like this:



The “gimmick” capacitor C3 will need to be adjusted, to bring the “height” of the FSK to around 4-5Hz. Do not waste spectrum by using more! Less may be sufficient and preferable! Twist C3 tighter to increase the shift, or unwind/snip some wire to decrease it.

Operation

Connect the antenna and remember, QRSS is all about patience! You should join the QRSS news group http://cnts.be/mailman/listinfo/knightsqrss_cnts.be and announce that your beacon is on the air. You should get reception reports by email and see your signals on the various online “grabbers” (see http://digilander.libero.it/i2ndt/grabber/grabber-compendium.htm for a set of links to “grabbers” worldwide). With a reasonable dipole antenna worldwide reception on 30m (and perhaps 40m and 80m!) should be easily achievable with this kit, when the propagation conditions are on your side.

Resources

Please join the Yahoo group http://groups.yahoo.com/group/qrplabs/ to for new kit announcements, to discuss any problems with the kit, enhancements you’ve made, or just to tell everyone how much fun you’re having. For general information and more QRSS projects, links to other QRSS resources etc., see http://www.hanssummers.com.