



# ***Four State QRP Group***



## **"Ham Can"**

**A 40M Minimalist Transceiver  
Designed by David Cripe, NMØS**

### **Construction and User's Manual**

Congratulations on your purchase of the HAM CAN transceiver, the latest offering in minimalist amateur radio from the Four State QRP Group! The HAM CAN is a crystal-controlled CW transceiver, delivering 1/2 to 1W transmit power, with enough sensitivity and selectivity to receive plenty of signals. It does all this with only TWO transistors!

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# ***"Ham Can" a 40M Minimalist Transceiver***

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### **Construction and User's Manual**

## ***Specifications and Description***

### ***General Description***

The "Ham Can" is a minimalist transceiver designed to be very simple and inexpensive, yet provide good performance. The low cost kit sacrifices nothing in the way of quality. It features a high quality printed circuit board, low parts count and fast and easy building. It makes an excellent first kit for first time builder, and for this reason it was chosen as the Build Session kit for OzarkCon 2011.

This NMØS design features an innovative power switch. Your straight key plug also serves as the on and off switch, i.e. Just plugging int the hey powers up the rig automatically

Designed to be as small as possible and still use through hole parts, it will fit on top of a 3 oz ham snack can, while a 9 volt battery resides inside the can, thus making self contained portable rig. Brand names with cans this size are Armour, Bryan, Fancy Feast and probably many others. The builder can enjoy a snack while obtaining the enclosure :o)

### ***Receiver***

Crystal-oscillator-filter design - Smooth and easy regeneration control due to 25 turn pot - Direct conversion - Crystal controlled on 7122 kc - Adequate sensitivity for 40M - Audio stage drives earpones

### ***Transmitter***

Keyed oscillator operating in class C - .5 to 1 watt output into 50 ohms - VCC keying - pleasing bell like signal -

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#### ***Part List***

Let's begin construction by taking an inventory of components:

C1	( )	680p	681J
C2	( )	220p	221J
C3	( )	10p	100J
C4	( )	1000p	102J
C5	( )	Not Used - Jumper Out	
C6	( )	0.047 u	473j
C7	( )	0.47u	0.47uF Electrolytic
C8	( )	1000p	102J
C9	( )	470u	470uF Electrolytic
C10		Not Used - Leave Open	
D1	( )	1N4148	
D2	( )	1N4148	
D3	( )	1N4148	
D4	( )	1N4148	
L1	( )	T50-2	
L2	( )	T50-2	
L3		Not Used - Leave Open	
Q1	( )	2N3866	
Q2	( )	2N3904	
R1	( )	1.0k	brown-black-red
R2	( )	27k	red-violet-orange
R3	( )	10k	10-turn pot
R4	( )	220k	red-red-yellow
T1	( )	T50-2	
T2	( )	1k:8 ohm audio	
X1	( )	7.122 MHz	
J1	( )	1/8 Stereo Jack (Key)	
J2	( )	1/8 Stereo Jack (Phone)	
J3	( )	RCA Jack (Ant)	
J4	( )	9v Battery Clip	
HS	( )	Heat Sink	
26 AWG	( )	3'	
22 AWG	( )	2'	
PC Board	( )		

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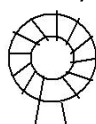
## Construction and User's Manual

### ***Component Installation***

#### **WINDING THE COILS**

Let's begin construction! Start off by winding the toroids. Yeah, those are the least fun part of the whole project, and take the most attention to detail, but once they are wound, it is all downhill from there.

There are three toroids to wind. Starting with L1, this is wound with 22 turns of 26 gauge magnet wire. This is the thinner of the two pieces of magnet wire included in the kit. Cut off about two feet from the piece, and wind it in the direction shown in the diagram above. Make sure the wire is pulled snug against the toroid coil form, without any kinks, and that the turns are evenly distributed around the core. Turns are counted as the number of times the wire passes through the center of the core.



Next, cut the 22 gauge wire in half, and wind L2 with 11 turns, in the same manner as L1.

Finally, we need to wind T1, the RF transformer. The core is wound with two windings of 11 turns each, one of 22 gauge for the primary, and one of 26 gauge wire for the secondary. Start with the 22 gauge primary, and wind it per the diagram. When finished with this, wind the secondary so that it lies in between turns of the primary, flush to the core without crossing any of the primary windings. Double check when finished to be sure that both primary and secondary have 11 turns each.

Cut the legs of each coil so that there is about ½ inch remaining, and set them aside until later. Now that the hard part is over, let's start soldering!

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### ***Component Installation Cont'd***

The component identification and mounting locations are silk screened on the component side of the PCB. Check off each part as you install them. Install and solder one part at a time, clipping the leads flush with the back of the board.

#### **Capacitors**

We'll start by installing capacitors. Their value is designated by the code printed on them. Locate the capacitors, and insert them into the board, spreading their legs slightly at the bottom to keep them from falling back out when the board is inverted. Solder them in, and trim their leads flush with the board. Mark them off the list as they are installed.

C1	( )	680p	681J
C2	( )	220p	221J
C3	( )	10p	100J
C4	( )	1000p	102J
C5	( )	Not Used - Jumper out using component lead	
C6	( )	0.047u	473j
C7	( )	0.47u	0.47
C8	( )	1000p	102J
C9	( )	470u	470

#### **Diodes**

Next, the diodes are to be installed. They are all the same type, so there is no chance for confusion, but they need to be inserted into the board so that their body stripes line up with the stripe on the silk screen board marking.

D1	<input type="checkbox"/>	1N4148
D2	<input type="checkbox"/>	1N4148
D3	<input type="checkbox"/>	1N4148
D4	<input type="checkbox"/>	1N4148

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### ***Component Installation cont'd***

#### **Resistors**

Next come the resistors. These are installed in a space-saving 'hairpin bend' manner. The value of the resistors is designated by three color coded bands. A fourth gold band at the right side of the resistor indicates 2% tolerance of the resistor value. Install and solder one at a time, clipping the leads flush with the back of the board when finished.

R1	( )	1.0k	brown-black-red
R2	( )	27k	red-violet-orange
R3	( )	10k	10-turn pot
R4	( )	220k	red-red-yellow

#### **Transistors**

Be certain that the body of Q1 is spaced above the board by about 1/16" so that it DOES NOT contact the board surface.

- ( ) Q1 - 2N3866 **Install with tab on transistor oriented to outline on pcb.**
- ( ) Q2 - 2N3904 **Install with flat on transistor oriented to outline on pcb.**

#### **Audio Transformer**

Install the audio transformer, T2. Be certain that the primary-side windings are installed into the correct holes. Solder the mounting tabs into the PCB holes as well.

- ( ) 1K:8 ohms **Install with the side marked P oriented toward Q2.**

#### **Connectors**

Install the three connectors next. Be certain they are snug against the board before soldering. Do not overheat the Key and Phone jacks so that the plastic bodies of the connectors do not soften.

- ( ) J1 Key Install 1/8 STEREO jack in KEY position indicated on PCB
- ( ) J2 Antenna Install RCA jack in ANT position indicated on PCB
- ( ) J3 Install 1/8 STEREO jack in PHONES position indicated on PCB

NOTE: A 1/8 MONO plug (as used with a straight key) inserted in the KEY jack serves as the on and off switch.

#### **Toroids**

We need to install the toroidal coils next. The pigtail wire leads of each coil need to be tinned. The enamel insulation on the magnet wire is solder-strippable, melting clean at the touch of a well-tinned soldering iron. Tin the leads flush to the body of the toroids. If the wires do not strip cleanly, the remaining enamel may be cleaned off by scraping with an X-Acto knife.

Insert the wire pigtails through the holes in the board, and pull them snug before soldering.

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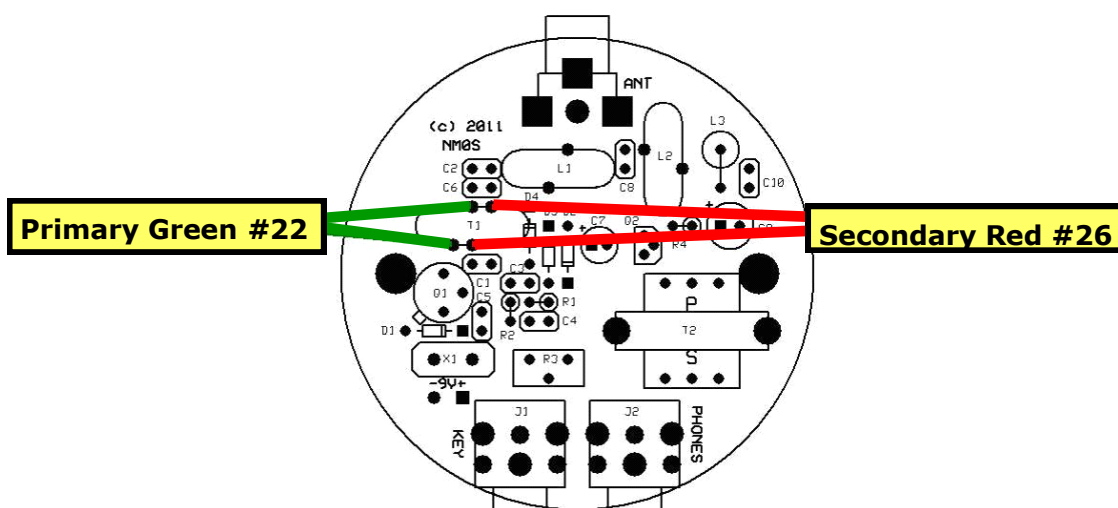
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## Installing Components Cont'd

### Toroids (con't)

RF transformer T1 requires special care in its installation. The 26 gauge secondary winding is to be inserted into the ROUND holes on the board. The 22 gauge primary leads are to be installed in the SQUARE holes on the board. If they don't line up, make sure to place the correct windings in the correct holes. See picture below for clarification..



### Crystal

( ) 7122 HC-46 Install in crystal outline adjacent to the 2N3866  
Some builders may make a socket from an IC machined pin socket.

### 9 Volt Power Leads

( ) install POSITIVE lead into the SQUARE hole close to key jack,

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#### ***Soldering Know How***

Because of the simplicity of this kit, it will have appeal as a first project for beginning kit-builders. For those with little or no experience with soldering, there are a few things to keep in mind before starting.

It is recommended that a low wattage, 25 to 30 watt, pencil-tip soldering iron be used. Only rosin-core solder may be used, as acid core plumbers solder will corrode the board and components. Either lead-free or tin-lead solder may be used, though the builder should be aware of the potential toxicity of lead-based solders.

Soldering is not hard if the proper procedure is followed. The soldering iron is to be used to heat up the bottom side of the board PC pad and component lead, and the solder applied to the pad, where it melts and flows into the hole. Do not melt the solder onto the tip of the iron and then attempt to dab it onto the joint – a defective connection will result! After soldering, check the top (component side) of the board, to be sure the solder has filled the hole completely, and wicked up around the component lead. Re-heat and apply more solder if necessary.

Burned flux and solder residue will accumulate on the soldering iron tip and lead to dirty solder joints if not kept clean. Periodically wipe the soldering iron tip on a dampened sponge to clean it.

The PC board has the reference designators for the component mounting locations in silk-screened lettering on the component side of the PCB.



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#### ***Using the Ham Can***

To begin, turn the regeneration control R3 fully clockwise. **Note: there is no stop, listen for a light click.**

The 1/8" MONO key plug connects 9v battery power to the circuit—unplug when not in use.

Plug in the antenna (matched to 1:1 SWR), earphones, and a straight key, **do not use your electronic keyer.** This rig requires a special keying circuit (described later), or a straight key.

Snap in a 9 volt battery if you used a clip, or hook up leads from a 9 volt power supply (do not use higher voltage ) **OBSERVE POLARITY**, there is no protection diode on the board. Add one in the 9 volt line if you wish, any 1 amp diode will work fine (1N400x).

The Ham Can does not have a sidetone, so all you will hear is keyclicks on TX. The regen is very smooth, and you will not hear any clicks when the RF oscillation commences. If you are connected to an antenna when the band is active, you will hear stations start to come in, and you will also hear the rig's oscillation on a nearby CW receiver.

Adjust the 10K trimpot (R3) regeneration control if needed. Start with pot fully Clockwise, then rotate counter clockwise until receiver regeneration begins. This will be heard as a weak signal on your big rig, or you will hear signals and band noise.

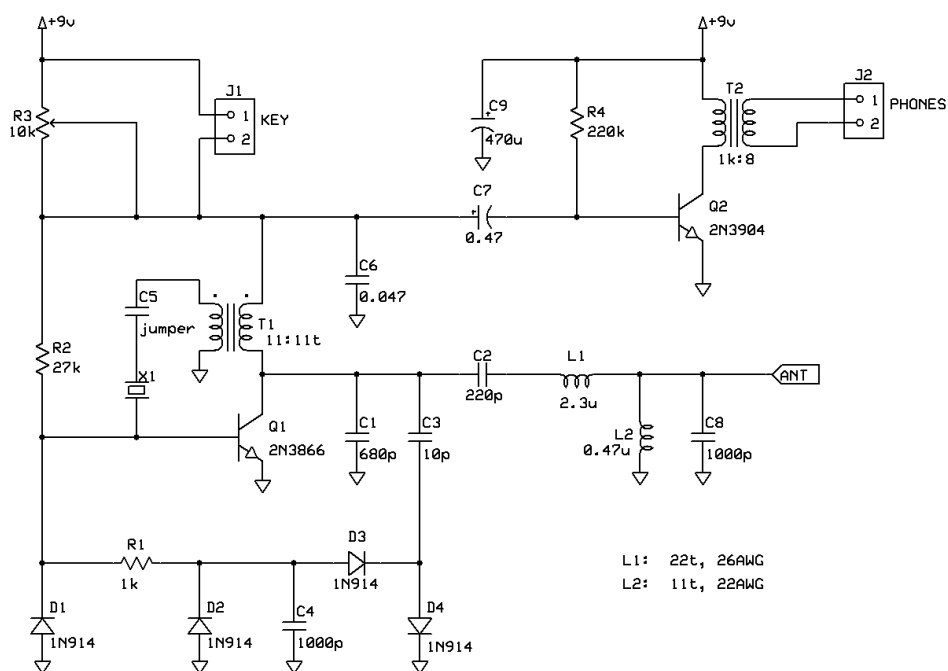
Once oscillation begins, turn the pot one or two more turns counterclockwise to bring receiver volume to max. You should not need to readjust this pot setting unless the battery voltage droops. When it does, then another 1-2 CCW turns will be necessary to again peak the receiver volume.

Press straight key - the xmitter should be making 1/2 to 1 watt of power. You will be able to hear receiver signals while you are transmitting! How's that for full QSK?

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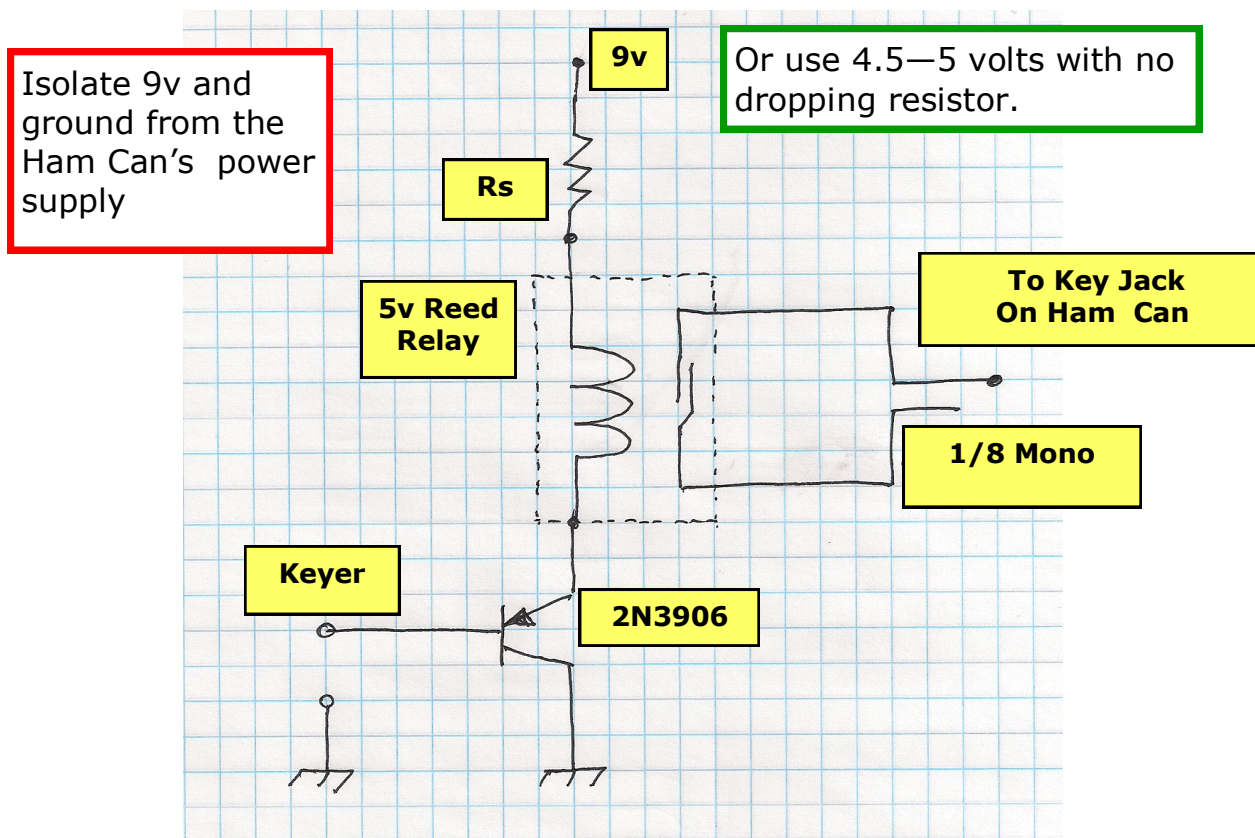


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#### ***Keying Circuit For Electronic Keyers***



A reed relay keys the Ham Can nicely. Almost any reed relay can be used. The first one tried was a Radio Shack #275-232, another suitable one is the Coto 9007, Mouser # 816-9007-05-01. These are 5 volt relays and need the dropping resistor  $R_s$ .  $R_s = 4 \text{ volts} / \text{coil current in amps}$ . Some relays have an internal spike snubbing diode, add an external one if your's doesn't. Double click the link below to hear an on the air recording of the [Ham Can's signal](#).