HW-8-TR PARTS LIST

Qty Ref	Description	Markings
1 C1	Capacitor Disc .2ls .1uF 100V	104 .2" lead spacing
4 C2 C3 C4 C5	Capacitor Disc .1ls .1uF	104 .1" lead spacing
1 D5	LED 3mm Green	
1 D6	LED 3mm Red	
2 D1 D2	Diode 1N4007	
2 D3 D4	Diode 1N4148	
3 L1 L2 L3	Inductor 100uH	Brown-Black-Brown-Silver
1 P1	Terminal Block TE3	
2 Q1 Q2	Transistor 2N7000	
2 Q3 Q4	Transistor 2N3904	
1 R1	Resistor_3W_5% 200	Red-Black-Brown-Gold
		Brown-Red-Red-Gold
1 R3	Resistor 1/4W 5% 1K2	Sub 1% Brown-Red-Black-Brown-Brown
1 R4	Resistor 1/4W 5% 4K7	Yellow-Violet-Red-Gold
3 R2 R5 R6	Resistor 1/4W 5% 220K	Red-Red-Yellow-Gold
0.5	Wire 22ga Stranded (Ft) Red	
1	Header Right Angle 5 pin	
1	Header Right Angle Double row 2 pin	
1	PCB	
1 QSKMOD	Capacitor Mylar .47uF	
1 QSKMOD-C92 Capacitor Electrolytic 1uF 50V		
1 QSKMOD-R27	7 Resistor 1/4W 5% 470K	Yellow-Violet-Yellow-Gold
1 HW-7-QSK	Resistor 1/4W 5% 4.7K	Yellow-Violet-Red-Gold

HW-8-TR V2 Product Update

Sporadic low sensitivity and improved isolation performance

Receive sensitivity may be sporadically low during initial power up and will clear up as transmitting begins. Although the openQRP project design does not apply power to the JFET's, Q1 is particular, we found applying a power through the JFET's, as in the N5ESE version, not only removes the sporadic issue but also greatly improves Tx/Rx isolation by at least 2 or more S-units (>12db).

The solution is to apply a small DC current through Q1 by adding a resistor at the Drain of Q1 to Vcc and another resistor from the Drain of Q2 to ground. We have also found the problem resolves itself greatly with only the resistor to ground but both resistors are preferable. Values of the resistors are not critical as a range between 4.7K and 22K have been tested.

For the inclusion of these resistors on the V2 boards place the following on the bottom side of the board:

10K resistor between C2 (connects to the Drain of Q2) and the Source of Q2 (ground). 10K resistor between C2 (connects to the Drain of Q1) and L2 (at Vcc).



This kit was designed to replace the transmit/receive relay in the Heathkit HW-8 transciever. Benefits include replacement of a worn relay, QSK operations, and quiet operation without the relay clicking sound. The board can also be used as a transmit/receive switch for other equipment or as a T/R switch between seperate transmitters and receivers.

Construction notes:

- Familiarize yourself with components using the included parts list.
 - TIP: Not sure what part is what? We recommend picking up almost any fairly recent copy of the ARRL Handbook published within the last 25 years. The GQRP web site also has several good articles on component identification.
- Some parts in this kit may have been substituted with parts of a better quality. Alternates will be shown in the parts list with "SUB".
- All parts are mounted on the top side of the PCB except resistor R1 and 4 of the relay pins.
- Solder and trim the excess leads after installing each component. Be carefull when trimming leads and use eye protection! Some of the short header leads can fly into your eyes! TIP: Not sure how to solder? There are many excellent videos on the internet. Check out
 - sites such as Sparkfun.com, adafruit.com, and electronics123.com
- In order to fit into the area of the HW-8 relay, components on this board are spaced close together and may be difficult to insert and solder. Pay close attention to the solder pads for shorts.
- Many of the axial parts are placed vertically on the board. See picture below for preparing parts.
- All diodes on this board are inserted with the BAND end UP. Then bend over the banded end lead and insert into the SQUARE solder pads. BAND=UP=SQUARE
- Double check for solder bridges or part leads touching each other. Let's keep those final and front end transistors happy!



Preparing parts for vertical installation

Board Assembly

Install the pin headers – Note the photos and double check your work before soldering.
[] Coil pin

- () Break off 1 pin from the single row right angle header.
- () Push the plastic insulation towards the elbow.
- () Insert the <u>non-insulation end</u> into the hole marked COIL on the <u>**TOP**</u> side of the PCB.

() Solder (top or bottom whichever is easier) and trim the excess.

[] NC, NO, and C pins – Do this for each of these pins

() Break off 1 pin from the single row right angle header

() Push the plastic insulation towards the elbow.

() Insert the <u>non-insulation end</u> into each of the above defined holes on the **<u>BOTTOM</u>** side of the PCB.

() Solder (top or bottom whichever is easier) and trim the excess.

[] GND pin

() Using the dual row right angle header, carefully push the inside pin up until it touches the outside pin. Clip the inside pin just under the elbow. Remove the remaining inside pin piece by sliding it out.

() Insert the <u>non-insulated end</u> into the BOTTOM of the PCB. Note: you may need to slide the insulation up or down slightly to clear the COIL solder area.

() Solder (top or bottom whichever is easier) and trim the excess.



- 2. Insert the 3 pin terminal block at location P1. Make sure the wire entrances are AWAY from the board.
- 3. Insert the following components:
 - [] D3 1N4148 Diode
 - [] D4 1N4148 Diode
 - []C1 .1uF 100V Capacitor
 - [] C3 .1uF 50V Capacitor
 - [] R6 220K Resistor
 - []Q1 2N7000 Transistor
 - []Q2 2N7000 Transistor
 - [] C2 .1uF 50V Capacitor
- 4. Imsert the following components:
 - [] L1 100uH Inductor
 - [] L2 100uH Inductor
 - [] L3 100uH Inductor

Observe Polarity BAND=UP=SQUARE Observe Polarity BAND=UP=SQUARE 104 .2" lead spacing 104 .1" lead spacing Red-Red-Yellow-Gold

104 .1" lead spacing

Brown-Black-Brown-Silver Brown-Black-Brown-Silver Brown-Black-Brown-Silver



- 5. Insert the following components:
 - []D2 1N4007 Diode
 - [] R2 220K Resistor
 - []R5 220K Resistor
 - []C5 .1uF 50V Capacitor
 - []Q4 2N3904 Transistor
- 6. Insert the following components:
 - []D1 1N4007 Diode
 - []R3 1.2K Resistor
 - []C4 .1uF 50V Capacitor
 - []R4 4.7K Resistor
 - []Q3 2N3904 Transistor
- 7. Insert the following components:
 - Green LED []D5
 - []D6

Observe Polarity BAND=UP=SQUARE Red-Red-Yellow-Gold Red-Red-Yellow-Gold 104.1" lead spacing

Observe Polarity BAND=UP=SQUARE Brown-Red-Red-Gold SUB: Brown-Red-Black-Brown-Brown 104 .1" lead spacing Yellow-Violet-Red-Gold

Flat spot to Left, Short Lead = Square pad Red LED Flat spot to Left, Short Lead = Square pad Tip: Instead of soldering the LEDs to the board, mount them on/near the meter and run wires to the board! The LED's MUST be installed (somewhere) for proper operation.



- 8. Install R1 on the BOTTOM side of the board. Keep the resistor spaced off from the pins of P1. Notes:
 - a) You may find it easier to solder the resistor from the bottom side of the board as well.
 - b) This is only needed to emulate the relay load in the HW-8. Other usage may not require this extra load.



This completes the board assembly.

Board Installation (HW-7 and HW-8)

1. Wire Preparation:

[] Cut a piece of 22ga wire 1-1/4" long. Strip 1/4" from each end and tin. Bend each end at a 90 degree angle to form a Z. Place one end into terminal block P1 at the Tx position with the wire facing upward. Secure with the terminal block screw *Note: HW-7 does not need this step.

[] Cut a piece of 22ga wire 4-1/4" long. Strip 1/4" from each end and tin. Place one end into terminal block P1 at the +12V position. Secure with the terminal block screw.

2. Relay removal:

[] Remove the center wire from the RCA antenna connector jack which connects to the relay. *Note: The HW-7 does not need this step.

[] Take care to remove the relay using solder wick and/or solder sucker. These traces and pads on these boards may be fragile with excessive heat. Clean the holes.

[] With the relay removed, clean up the center terminal of the RCA antenna jack if needed. *Note: the HW-7 does not need this step.

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3. HW-8-TR board insertion:

[] Place the HW-8-TR board into position with the "C" pin toward the rear of the transceiver. Solder in place and trim the excess leads.

[] Route the antenna lead (short wire) to the RCA antenna jack center connector and solder. *Note: The HW-7 does not need this step.

[] Route the +12V wire behind the HW-8-TR board, down between the PCB and chassis, then over to the trace which is the +12V side of RFC3 (For HW-7 this is the +12V side of RFC2). Solder and trim excess (pic).



This completes the board installation.

HW-7 QSK Modification (optional but highly recommended!)

Changing R14 (Located left of Q8) from 47K ro 4.7K greatly reduced the relay delay. Additionally you can also reduce C19 from 25uF to 10uF or even 1uF as the circuit is the same as the HW-8.

HW-8 QSK Modifications (optional)

This modification is from the John McNeil, WA2KSM, via the HW-8 Handbook and From QRP ARCI Quarterly to aid in faster audio recovery. We have included these parts in the kit.

[] Change C92 to 1uF – located between the relay and next to the DELAY pot. Observe polarity

[] Change R27 to 470K – located under the audio output jack.

[] Add a .47uF capacitor from base to collector of Q1

[] Adjusting R68 should eliminate some of the popping.



HW-8 Operation, Tips, & Circuit Description

<u>Note:</u> Depending on the LED batch, the transmit (RED) LED may be visible in the receiving mode, from a "dull can only see it in the dark" to a "low red illumination". When transmitting this LED will be fully bright. If you do not see the green LED on along with the dim red LED, <u>DO NOT</u> <u>TRANSMIT!</u>

Tune your transmitter first! Now that the swich connects the antenna straight to the transmitter output, the final tank circuit can affect the received signal. On the loading adjustment there is a large "dip" in receive strength just clockwise of where the transmitter is properly peaked. To avoid the dip, tune your transmitter first (into a dummary load!), then proceed to peaking the preselector.

Trade offs using a solid state switch versus a relay:

The good is the QSK operation possible. Yes you can hear between the dits and dahs! The other good part is the operation no relay clicking.

Of course there are some downfalls to solid state. Extra power is needed for the switch (see power ratings) but this is only a probem for battery uses. The Tx/RX isolation is lower, of course, as a relay has much better continuity and isolation. However, the swith provides around 40dB of isolation which is enough to keep the front end happy. Finally the biggest culprit is received signal loss of around 1.5-6dB or about 1/4 to 1 S-unit. Not a great solution for those weak signal operators but at the same time the loss is minimal for normal QSO operation.

<u>Circuit Description:</u>

Resistor R1 emulates the coil loading of the original relay. Tapping off this connection is R6 to feed the switching transistors. C5 helps remove any debouncing if a source such as a straight key is used in other circuits. Transistor Q4 inverts the keying input for Q3 and Q1 to be

opposite that of Q2. Q4 also plays double duty driving the RED transmit LED.

The N.O. relay connection (going to the transmitter) is connected directly to the antenna eliminating any transmitter side switching circuitry. From the antenna we also feed this signal through C1, a DC blocking capacitor and on to diodes D1 and D2. These 2 diodes act as an RF switch. Q3 is normally switched on in receive mode causing current to flow through diode D1 and D2, allowing the low level RF to pass through. Q3 is also the driver for the GREEN receive LED. In transmit mode the transistor is off, no current passes through the diodes and transmitting RF is blocked. Inductors L1, L2, and L3 act as RF chokes allowing DC to pass through and keep RF off the power lines. Receiving RF is then passed through C2, another DC blocking capacitor. Note: This part of the circuit is adapated and described from John McNeil – WA2KSM via the Hot Water Handbook and QRPARCI QQ articles.

Even with the above circuit some transmitting RF will pass through the diodes via the skin effect. MOSFET Q1 is turned on in receive mode and provides a low resistance path to the receiving circuit. During transmit the transistor is turned off which results in a high resistance "block". Q2 works in the opposite way. By being off during receive the resistance is very high and acts as if it was not in the circuit. However, during transmit it is turned on providing a very low resistance path to ground. Capacitor C3 is an additional DC blocking capacitor. Under an extreme condition if the RF voltage exceeds .7V then diodes D3 and D4 create a limiter circuit. This part of the circuit can be found in circuits from N5ESE, 4SQRP Magic box, and others.

Note: In a minimalist configuration the diode switch portion can be ommitted resulting in less receiver loss. However, under higher power and bad SWR conditions, this may destroy Q1 due to over voltage. It would be advised to use a MOSFET with a higher voltage rating in this situation. In effect, the diode portion is used as a trade off to protect Q1.

This circuit was designed not only for the HW-8 but to handle other transmitters with higher power levels. The board works well at up to 20W of transmitter power.

Power Consumption: Receive: 8mA Transmit W/R1: 63mA Transmit W/O R1: 2.2mA

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