

Ultimate LPF kit: Relay-switched LPF kit

1. Introduction

Thank you for purchasing my relay-switched low-pass filter (LPF) kit.

This kit is designed to compliment the Ultimate3 QRSS/WSPR kit but could also be used on its own at the output of a homebrew QRP transmitter. The kit consists of a PCB that switches one of five LPF's between the transmitter output and the antenna (the kit's "RF output"). This kit does not include the LPF's, it is designed to accept the plug-in LPF filter kit, which is available separately (for bands 2200m, 600m, and ten HF bands 160m – 10m).

Note that when used with the Ultimate3 QRSS/WSPR kit, the relay-switched LPF kit provides up to six bands, each with its own relay-switched LPF. This is because the Ultimate3 kit contains space on its PCB for fitting Relay 0 (band 0). Combined with the 5 LPF's on the relay-switched LPF kit PCB (band 1 to 5) this allows for six LPF's.

2. Design

The circuit diagram of one of the LPF switching sections is shown to the right (band 1). This circuit is simply repeated five times over, on the relay-switched LPF kit PCB (bands 1 to 5). The same circuit also exists once on the Ultimate3 QRSS/WSPR kit board (band 0). Together, they provide six selectable bands for the Ultimate3 QRSS/WSPR kit.

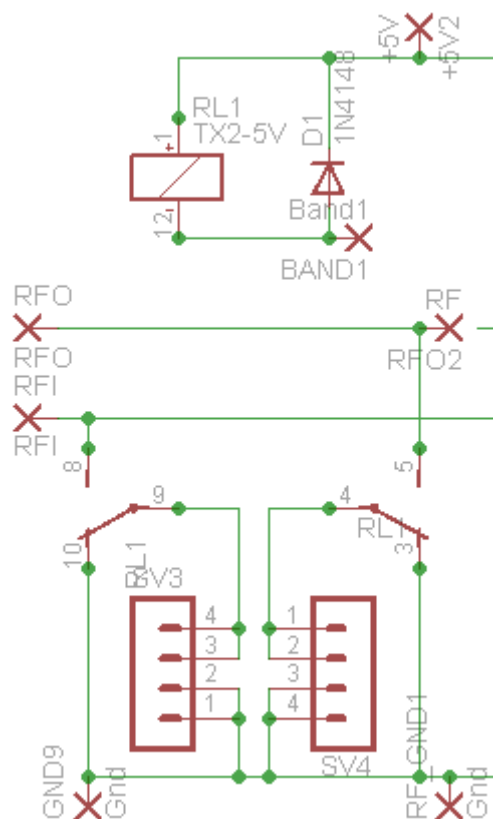
The relay is a DPDT type (dual pole, dual throw). When the relay is un-energised, the resting position is for both input and output of the corresponding LPF to be shorted to ground. An LPF kit is plugged in to the two 4-way sockets, shown here as SV3 and SV4.

When the relay is energised, the corresponding LPF is switched into the circuit, connected between RF In and RF Out. In use, only one relay should be energised at once time, to switch in the desired LPF.

The relays are miniature Panasonic RX2-5V types. With a height of only 8.5mm, they are small enough to fit underneath the plug-in LPF boards. The coil current is only 28mA and it can therefore be driven directly by an AVR microcontroller output pin. A 1N4148 diode is installed across the coil of each relay, to prevent high switching voltages from damaging the microcontroller output.

The relay-switched LPF kit can be used in your homebrew QRP transceiver project too. One side of the relay coils are connected to +5V. So to switch a relay, the appropriate band 1 to 5 input should be driven to a low voltage to energise the relay coil. A transistor could also be used to switch each relay coil.

When used with the Ultimate3 QRSS/WSPR kit, you can either take the RF output from the original connections on the Ultimate3 PCB, or from connections provided on the relay-switched LPF board.

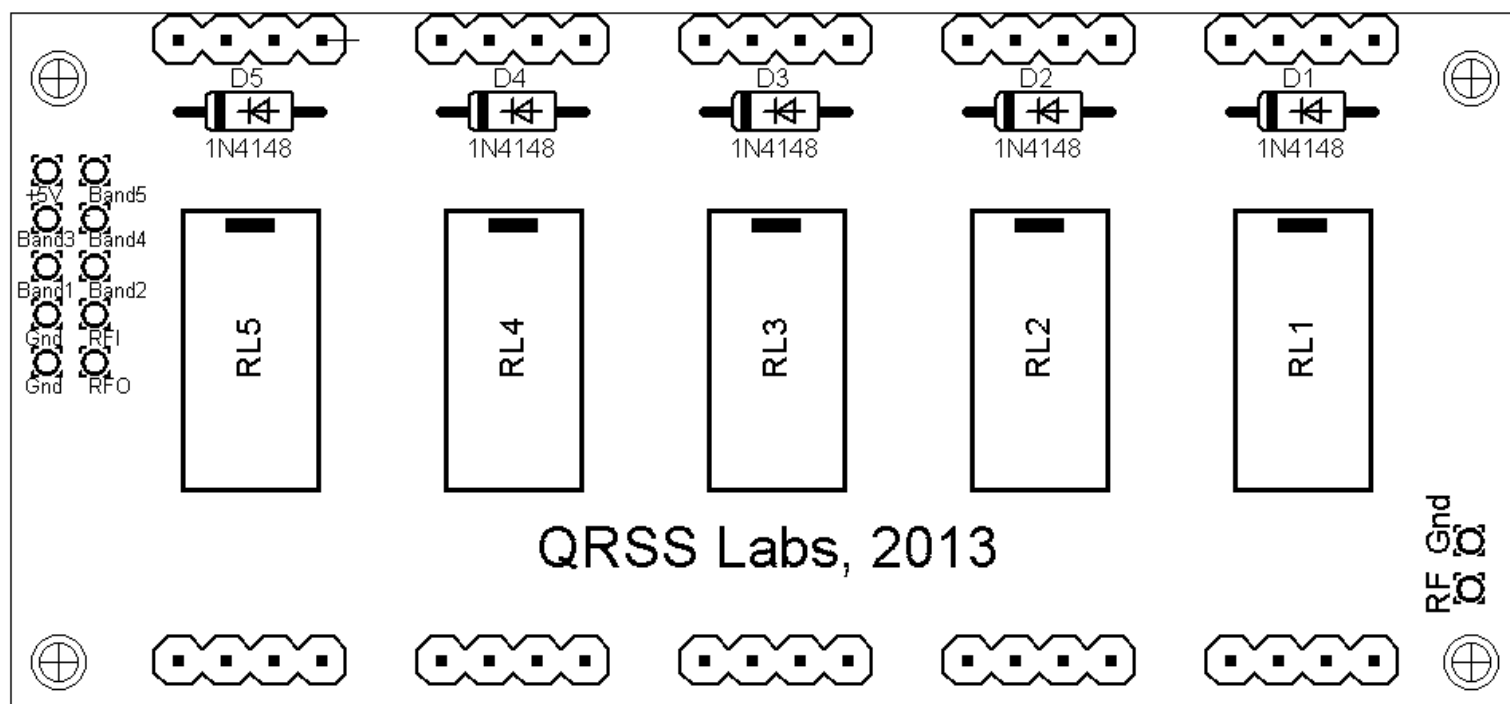


3. Parts List

RL1-RL5	Panasonic TX2-5V relays. Six are supplied (five are installed on the LPF kit PCB, one is provided for the installation on the Ultimate3 kit PCB)
D1-D5	1N4148 diode. Six are supplied (five are installed on the LPF kit PCB, one is provided for the installation on the Ultimate3 kit PCB)
10 of	4-way female header sockets
2 of	10-way (2 x 5) female header sockets
2 of	10-way (2 x 5) male header plugs
4 of	25mm nylon hex spacers
1 of	Printed circuit board, 80 x 37mm size

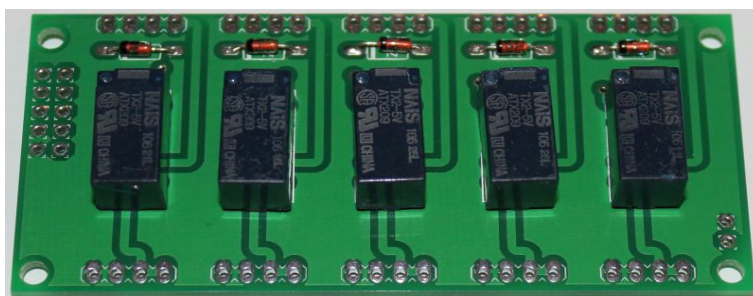
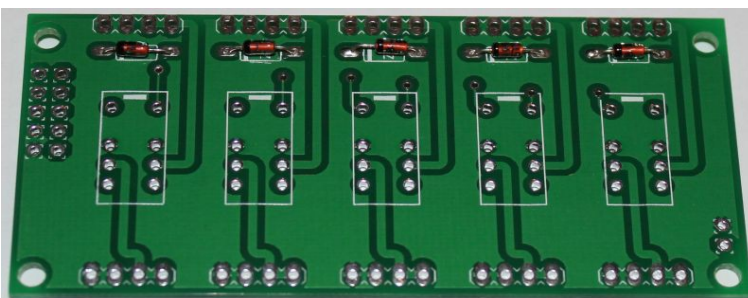
4. Construction

Please refer to the parts placement diagram below.



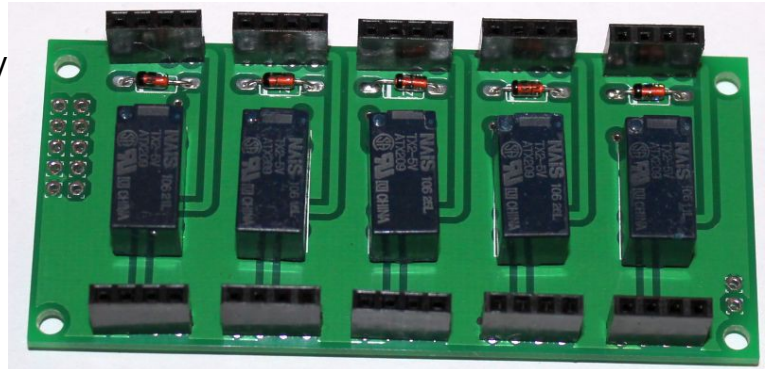
The order of construction is not important but a good principle to follow is to install the smaller components first, so that the larger ones do not prevent easy access. One suggested order of construction is:

- 1) Solder in the five diodes D1-D5. Pay attention to align the diodes correctly, according to the stripe on the diode and the silk-screen of the PCB.
- 2) Fit and solder the five relays. Ensure that the relay pins are straightened before inserting into the PCB, as some may have become slightly bent.

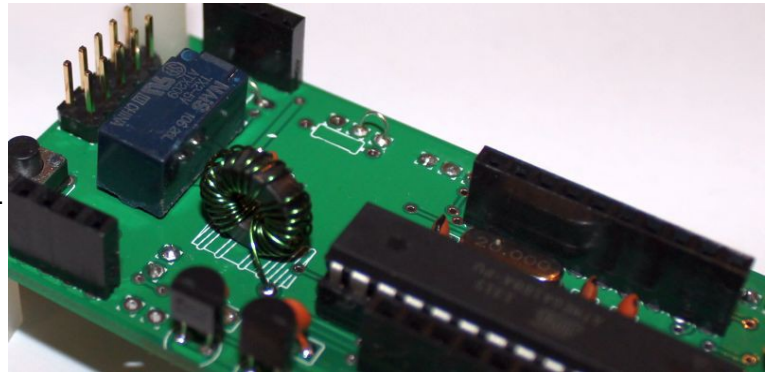


- 3) Fit and solder the ten 4-way sockets for the LPF's. Ensure that they are pushed in properly into the PCB, and at right-angles to the PCB. One way to do this, is to plug in a constructed LPF to ensure correct orientation of the sockets, then solder them to the PCB.

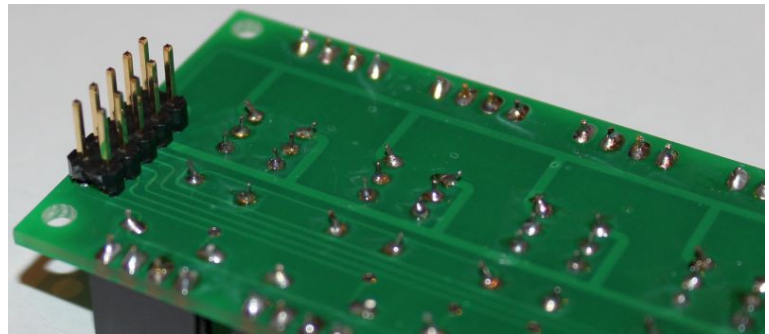
Note that you should aim for more careful and straight alignment than the slightly crooked result shown here. It works, but is not pretty.



- 4) If using the LPF board with the Ultimate3 QRSS/WSPR kit, solder the 6'th diode and relay (for band 0) in place under the plug-in LPF on the main Ultimate3 PCB. Note that if you have previously fitted wire jumpers at W0-W1 and W2-W3 on the main Ultimate3 PCB (for standalone use WITHOUT the relay-switched LPF board), then you need to remove these wire jumpers now.



- 5) Fit and solder the 10-way (5 x 2) pin plugs to the bottom side of the relay-switched LPF PCB and the top side (component side) of the Ultimate3 PCB.



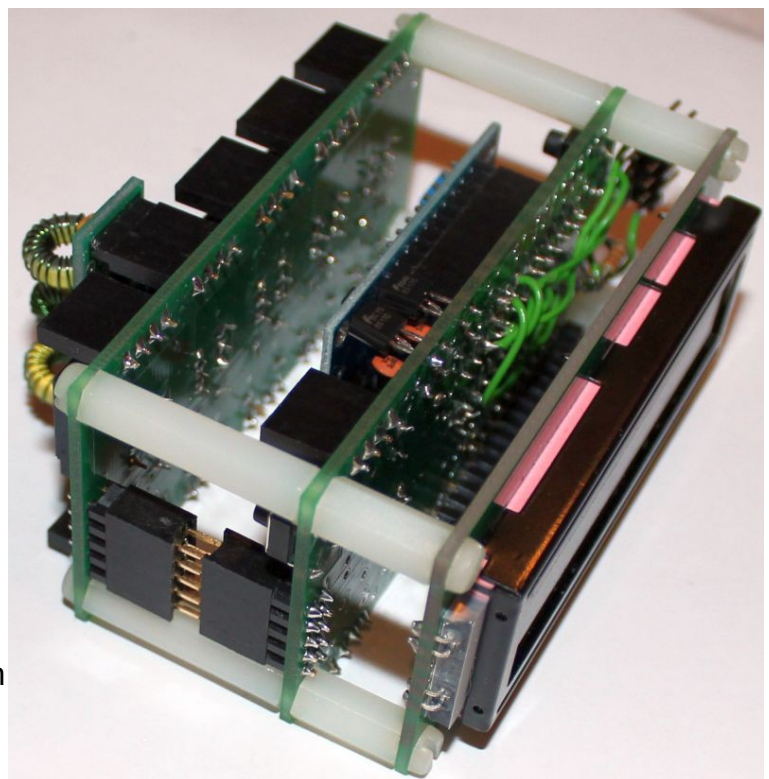
- 6) The two 10-way (5 x 2) sockets should be back-to-back and soldered together. They will cover the 25-mm gap between the two PCB's (Ultimate3 and LPF board). The resulting board-to-board connector will look like the (rather bad, sorry) photograph above left. The two 10-way sockets back-to-back form a bridge between the two PCB's.

Making this connecting bridge is the only tricky part of the kit construction. You should tin (solder coat) all the pins of the 10-way sockets, to make the job of soldering them together properly easier.

Then bolt the PCB's together using the 25-mm hex spacers, but WITHOUT soldering yet.

This will ensure correct orientation of all the connectors. The 25-mm hex spacers are a rather tight fit with some of the components on the U3 PCB. I suggest temporarily removing the

LCD from the U3, then hold the 25-mm hex spacers fixed in place, while turning the shorter 12-mm



hex spacers to tighten them into the 25-mm spacer screw thread. This way you avoid trying to turn the 25-mm spacers which are very close-fitting against the components on the U3 PCB (revision 1).

NOTE: in the photograph, I failed to tin the pins before soldering. I learnt the hard way: please save yourself lots of trouble, tin the pins first!

When everything is in place, you can solder the outside row of 5 pins of the 10-way sockets back-to-back, to each other. Then take apart the assembly, turn around the back-to-back socket “bridge” so that the unsoldered row of 5-pins are on the outside edge, and solder this row of 5 pins, to complete the bridge.

I recommend careful inspection of the inter-board connecting bridge, to ensure all pins are properly soldered. It is tricky to get this right. You should use a DVM to check for short-circuits between adjacent pins, and to check for continuity between each of the 10 tracks on the two connected circuit boards.

5. Operation

When used with the Ultimate3 kit, firmware version v3.02 or above is required. Please refer to the appropriate operation manual for your firmware version, for details.

6. Resources

Please see the kit page <http://www.hanssummers.com/ultimatelpf> for information on latest updates and issues.

Please join the Yahoo forum <http://groups.yahoo.com/neo/groups/QRPLabs/info> for discussion and updates on all the kits!

7. Version History

1 **14-Jan-2014**

- Initial version