CTU150 Instructions

The HOWES CTU150 is an antenna matching unit for use with shortwave transmitters and receivers. A novel constructional method is used - all parts being mounted on a Printed Circuit Board (PCB). This makes assembly easier than the normal practice of mounting matching unit parts in a case and then wiring them up in situ. The HOWES CTU150 can be assembled on the bench, and then installed in a suitable enclosure. A "hardware pack" (case, knobs, sockets nuts and bolts etc.) is available as an optional extra, or you can fit your CTU150 into a case of your own choosing.

Brief Technical Details

Circuit Configuration:	Twin capacitor "T" matching network for matching unbalanced wire or coax fed antennas to 50 or 75R impedance equipment.
RF Power Handling:	150W peak, rated for SSB and CW operation. Suits all the popular 100W HF transceivers.
Frequency Range:	1.8 to 50MHz with 12 switched inductance ranges.
Case Size Required:	(minimum internal dimensions) : 6.6" (167mm) wide, by 2.3" (58mm) high, by 6.5" (165mm) deep.

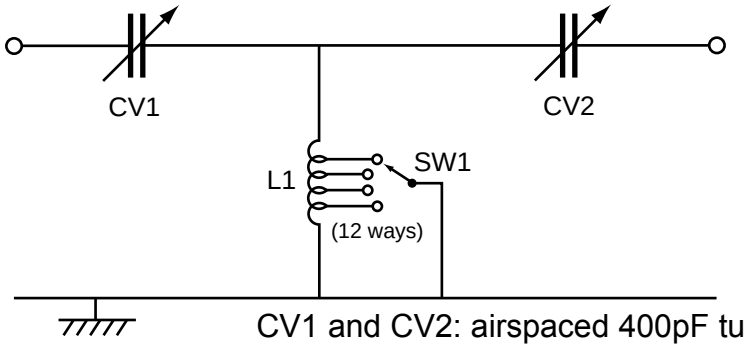
WARNING – When in use, the spindles of the tuning capacitors and the tuning capacitor mounting bracket are at RF potential. The finished CTU150 module must be fully enclosed in a case, and insulated spindle extensions (material supplied in kit) must be used, to prevent contact with RF voltages.

Tools Required:
Fine tipped soldering iron of about 30W. Screwdriver for the various fixing screws. Long-nosed pliers. Sidecutters. Small hacksaw for cutting spindle extension rod.

PLEASE READ ALL THE PAPERWORK THROUGH BEFORE COMMENCING CONSTRUCTION.

CIRCUIT DIAGRAM

PARTS LIST



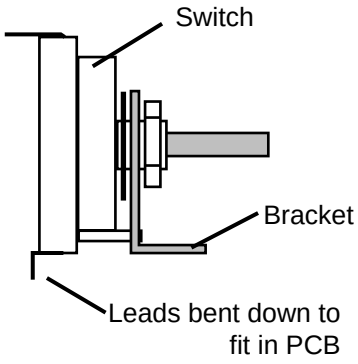
CV1 and CV2: airspaced 400pF tuning capacitors.
L1: 1 off 30 way ribbon jumper cable.
SW1: 1 pole, 12 way rotary switch. Rated 5A.
Switch wiring cable: 1 off 7 way ribbon.
Switch mounting bracket: 1 off.
Switch mounting bracket screws: 2 off self tapping.
Capacitor mounting bracket.
Capacitor bracket fixing bolts (6mm M3) and nuts: 2 off each
3 off spindle couplers.
220mm insulated spindle extension.

Construction.
Mount the ribbon cable that forms L1 first. Straighten any wires that are out of line with a pair of long-nosed pliers. Insert one end of the ribbon first and ease the other wires in one at a time, one end at a time, into the holes marked on the PCB. The ribbon is inserted from the screen printed side of the board, so that the wire ends project from the PCB wiring side, ready for soldering. Only leave just enough wire sticking out of the board to enable it to be soldered, about 1mm, say. You will find that it pays to insert one end of the ribbon, and then solder it, before inserting the other end. When the ribbon cable is in place, check that all the joints have been soldered properly. If you are new to soldering, read the notes on soldering BEFORE you start! (continued)

CTU150 Instructions 2

Construction (continued).

When you have fitted the L1 ribbon cable and soldered all its connections, then the next job is to fit the 12 way switch (SW1). This must be fitted the right way up. Fit the switch to its mounting bracket as shown in the diagram. The locating pip fits into the hole provided. Do not tighten the fixing nut as yet, leave it a little bit loose, so that the final position can be adjusted later. Bend the switch's lower set of leads downwards as shown. These have to be fitted down into the PCB in a moment. Leave the top set of leads as they are. The leads are bent at the point where they narrow down - they will naturally bend here - use long-nosed pliers to carefully bend each lead in turn.

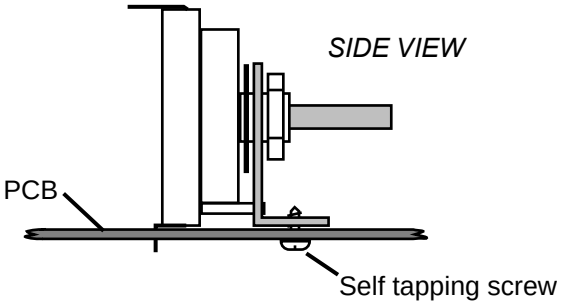


Inserting the switch in the PCB

Now fit the switch's lower set of connecting leads into the PCB and push them down carefully as far as they will go. Make sure the switch is sitting as close to the board as possible. The self tapping screws should now be used to fasten the bracket to the PCB, but first fit the switch's washer either in front or behind the bracket for the best alignment between the fixing holes in the bracket and those in the PCB. Make sure the switch spindle is parallel to the circuit board.

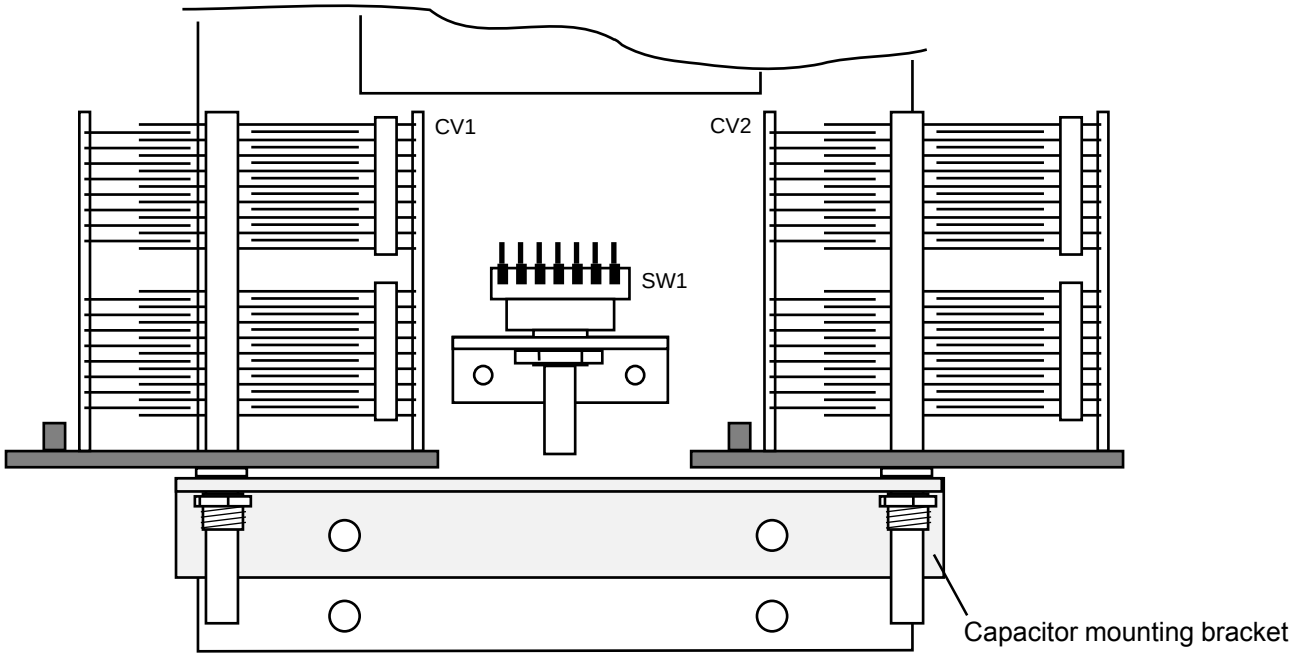
Fastening the switch bracket

The self-tapping screws should be inserted through the holes in the board and then screwed into the switch bracket. Do not over tighten them - the bracket supplied is either made of aluminium or plastic, and the self-tapped thread could be stripped if too much force is applied. When the switch is in position, its mounting nut can be tightened, and its lower set of leads soldered to the PCB tracks.



7 way ribbon cable

The next job is to wire up the top set of switch terminals that are not inserted in the board. These have to be connected to the board with the short seven way ribbon cable. Fit one end of this cable into the PCB and solder the two end wires to the tracks, then turn the board over and solder the other end of the ribbon cable to the switch leads. If needs be, reposition the ribbon to align neatly with the switch terminals (this is the reason for only soldering the end two wires of the ribbon to start with). Once the ribbon is aligned, solder the remaining wires to the tracks and switch.



View from above showing location of tuning capacitors and their mounting bracket

CTU150 Instructions 3

Construction (continued)

Tuning capacitor fixing bracket

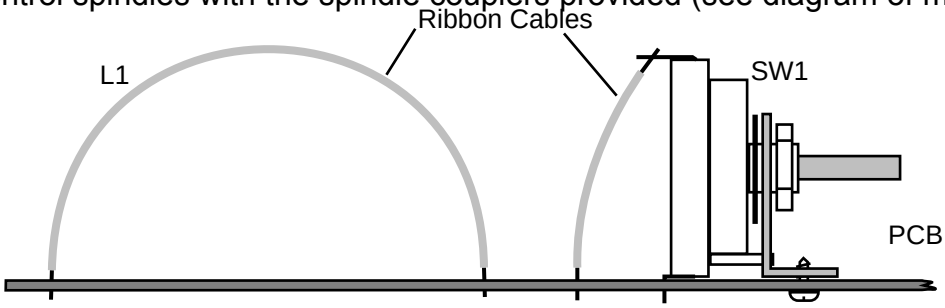
This should be fitted to the PCB as shown in the diagram on the previous page. Fit the 6mm fixing bolts with their heads on the track side of the PCB and the nuts on the bracket side above. The fixing holes allow some slack for adjusting the alignment of the bracket – make sure it sits straight and square on the board.

Tuning capacitors

Next fit the tuning capacitors to the bracket. The positions are shown in the diagram. Make sure they sit squarely on the PCB. Use long nosed pliers or a spanner to tighten the fixing nuts. Remember these are brass threads, so if you are using a spanner, do not overtighten the nuts. The bracket provides the electrical connection between the capacitors and also the PCB track via its fixing bolts. There is no soldered connection to the PCB for these components.

Housing your CTU150

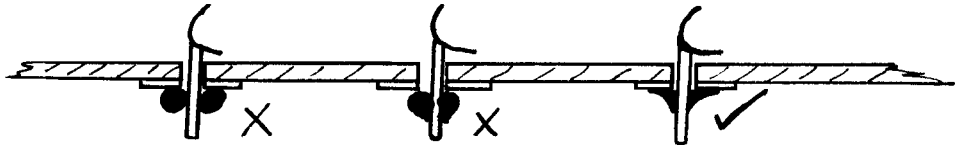
The CTU150, like any piece of RF equipment, should be installed in a screened case. It is also important to house the unit so that no one will come into contact with the high RF voltages that will be present on the module when it is used with a transmitter. In particular, the spindles of the tuning capacitors and the capacitor mounting bracket are at RF potential, so these must not touch the case, or your fingers! It is very important that you fit the insulated spindle extensions, and do not fit the knobs directly to the controls. The insulated spindle extension rod should be cut into three lengths to suit your installation in the case, and fitted to the control spindles with the spindle couplers provided (see diagram of module in case)



Side View of CTU150 Module showing mounting of ribbon cables.

Notes on soldering

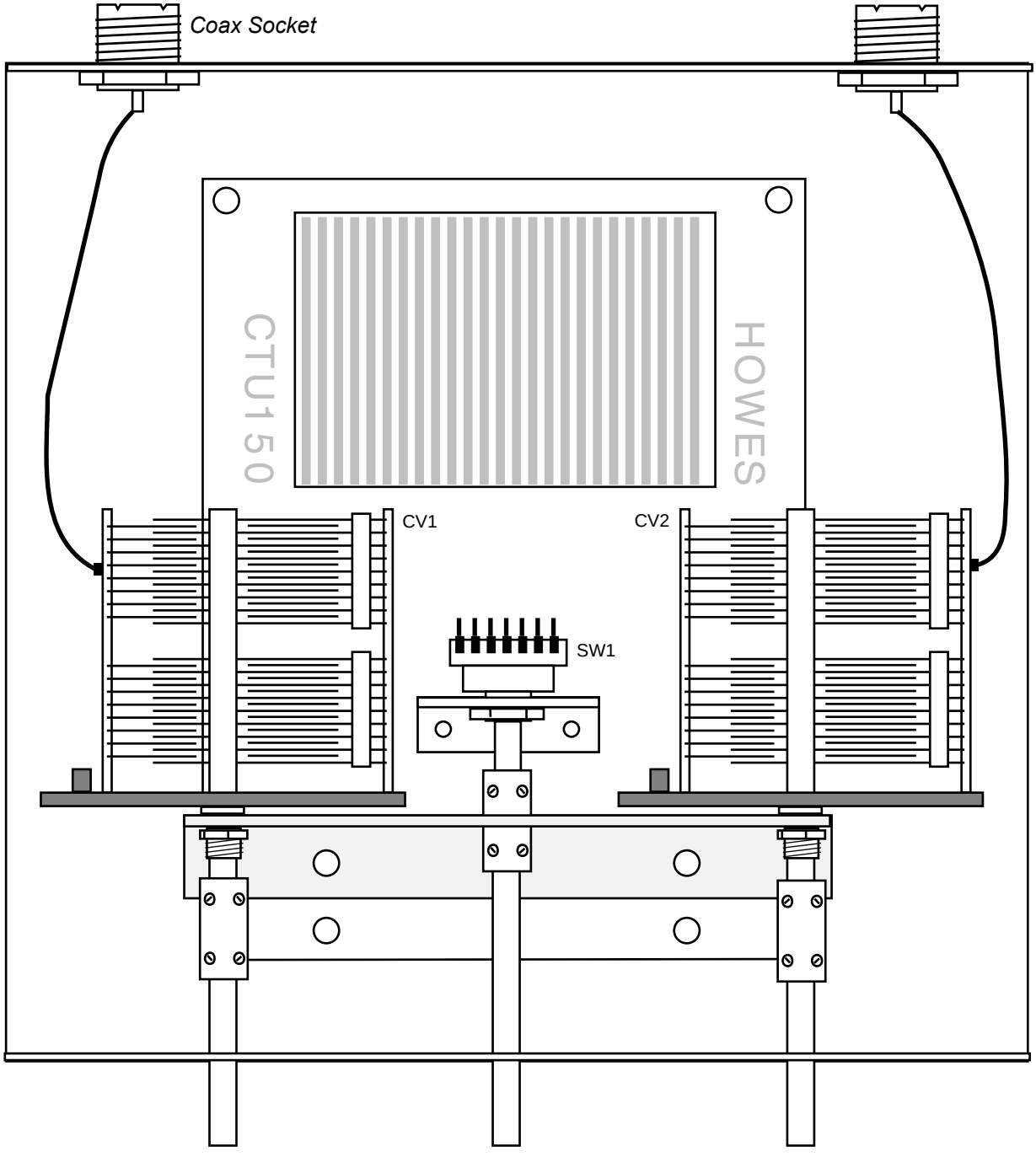
To solder properly, you must use the correct type of iron and the right type of solder. Use a small tipped iron which has a bit that is short and almost pointed at the end. The iron should be of about 30W, unless it is of the thermostatically controlled type, in which case it can have a much higher rating. Thermostatic irons are the best types to use, but they do tend to be expensive. Only use electronic type multicored solder. NEVER use any extra flux.



You should hold the hot iron in contact with both the wire and PCB track for about a second or so to heat them up. Then, keeping the iron in place, touch the solder onto the junction of lead and track and wait a further second or so for the solder to flow along them to form a good joint. Now remove the iron. The iron should have been in contact with the work-piece for a total time of about 4 seconds in all. Most beginners' solder problems are caused by too much, not too little solder, it is not the case of "the more the merrier"! If the result looks like a large spherical blob, it's a disaster! Joints should look shiny and smooth, and the solder should have run a short way along the track and lead.

CTU150 Module Wiring

Connections of input and output sockets.
Install the CTU150 module in a suitable case, and then wire up the connectors as shown in the diagram. The module should be mounted by four M3 bolts passing through the four 4mm diameter holes in the circuit board. The board should be spaced away from the case by M3 nuts under the fixing holes. The earth track at the rear of the PCB is connected to the case via these spacer nuts, so make sure these make good connection to the case (scrape away paint at these points if using a painted box).



The input and output connections are wired to the tags on the side of the tuning capacitors. Do not use an under powered soldering iron to make connections to the capacitors and sockets or you may have problems making good solder joints. Use connecting wire that is substantial enough to take several amps of RF current.

The earth connections to the sockets and CTU150 PCB module are made via the metal case. If you are using an insulated case, then you must wire the earth connections of the two coax sockets together and wire these earth connections to the earth track that runs across the rear edge of the circuit board (linking the two rear mounting holes).

Sockets: Either socket can be used for the antenna or radio connection.

C.M.HOWES COMMUNICATIONS

CTU150 User Information

Use with a Receiver

Set CV1 and CV2 to the centre of their travel. Rotate SW1 for maximum signal strength. On the higher frequencies the signal level may be much the same on several settings of SWI, simply select the most anticlockwise position consistent with good signal strength. Now adjust CV1 and CV2 for best results. The two capacitors are interactive to a certain extent, so peaking one first, then the other, then retuning the first one etc. is the best method. After two or three tweaks of each capacitor in turn, you should have just about optimised things.

Use with a Transmitter

An SWR meter (HOWES SWB30 etc.) should be connected between the rig and the CTU150. The CTU150 is first tuned for maximum signal strength on receive as detailed above, and then given a final adjustment for minimum SWR on transmit.

Again note that CV1 and CV2 are interactive, so peak one, then the other, then the other and carry on until the SWR is reasonable. Sometimes it is necessary to off-tune one capacitor a little, and then retune the other to get the SWR to drop. The three controls are all interactive, so it can take a bit of experimentation to get the best setting. Make a note of the settings when you are happy, so that you can return to them quickly in future. It is a good idea to provide a scale for the knobs, marked 1 to 10 to make this easy. You can then make up a table of settings for the various bands that you normally use, and so save time tuning up in future. NOTE - ALWAYS switch back to receive before moving the switch.

Use with a Valve Transmitter

If you are using a valve rig, or other type that has output tuning controls, then the rig should first be tuned up into a dummy load before connecting the CTU150 into line. The transmitter output controls should not then be reset unless a drastic change in frequency is undertaken. You may like to consider adding an extra switch to your ATU to switch in a load for tuning purposes.

Random Wire Antenna

If you are using a random length of wire, or other general purpose antenna, then the impedance may be outside the matching range at some frequencies. This is quite a rare occurrence with the CTU150 because of its wider matching range than many designs. If you do find an antenna that simply will not match properly, then a modification to the antenna (change of length for example) may be needed to bring the impedance within a manageable range. Remember that the impedance of an antenna goes from maximum to minimum along a quarter wavelength, so a change of about a tenth of a wavelength or so should get you away from any extreme impedance problem.

> NEVER rotate SW1 whilst transmitting, and always tune up with a minimum of RF output power to prevent interference, and any possibility of damage to the transmitter's output devices.

Extending the low frequency range

At the lowest shortwave frequencies (160M amateur band etc.) the matching range of the CTU150 will be reduced somewhat compared with the higher frequency bands. This is because the tuning capacitors capacitive reactance increases as the frequency reduces (in simple terms, the lower the frequency, the larger the capacitors needed). You can extend the low frequency matching by switching high voltage capacitors (220pF would be a typical value at1500V rating or greater) in parallel with the tuning capacitors, when required. You will need to use high voltage rated switches (2500V or greater) as well as high voltage capacitors if you do this. These extra capacitors will only prove of occasional use at the lowest frequency end of the CTU150's range. The unit will match to antennas over a reasonable impedance range at these frequencies without any additional parts, so this is only worth considering if you operate on the 1.8MHz band with an antenna that proves difficult to match. A change to the antenna length or feeder can often to be used to bring it within the impedance range of the unmodified CTU150.

We hope that you will be pleased with your HOWES CTU150. It should make a very worthwhile addition to your radio shack.