C.M.HOWES COMMUNICATIONS issue 1

HOWES DC2000 Instructions

Caution

The DC2000 receiver and the band module(s) supplied with it are separate kits. Please take care not to mix them up! The part numbering starts at R1, C1 etc. in each kit, so be sure not to start putting the parts from one kit into another kit's board by mistake!

Overview of the DC2000 project

The **HOWES DC2000** is an amateur radio receiver in kit form. It can cover all the shortwave (HF) bands by means of plug-in band modules. One band module kit is supplied with the DC2000 (80M band as standard, others to special order). Any frequency between 1.8 to 30MHz can also be received with the appropriate additional module. The DC2000 is a "direct conversion" type receiver suitable for SSB, CW and related modes, and is compatible with many other HOWES KITS including ATUs, "S meter", audio filters, digital frequency displays and transmitters.

Brief Technical Details

Frequency Coverage: Determined by the band module in use. A nominal 50pF tuning capacitor is required to tune the receiver (supplied in HA22R hardware pack and available separately)

Semiconductors: One transistor, two diodes and three integrated circuits on main PCB.

Sensitivity: –118dBm (about 0.3µV) for 10dB Signal/Noise in audio bandwidth (–6dB) of 2.6kHz.

Audio output: Up to 1.2W into 8 Ohms (for loudspeaker or headphones).

Power required: 10 to 15 Volts DC, supply rated at 200mA or more. Approx. 22 mA quiescent, about 180mA at 1W output at 13.5V DC.

Tools Required

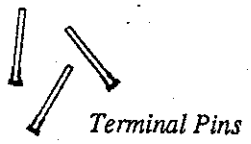
Small tipped soldering iron of about 25W rating, small side cutters, wire strippers, long nosed pliers and a trimming tool for the oscillator coils.

Building The Kit

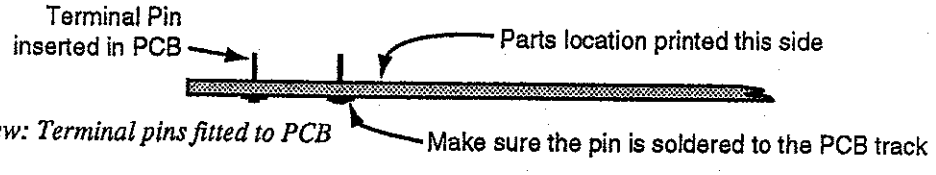
Please read all the paperwork through at least once *before* starting work.

Make sure you have all the parts and tools to hand - if you don't have a small tipped iron suitable for modern electronic circuitry, then buy one, or borrow one from someone at the local radio club!

Terminal Pins

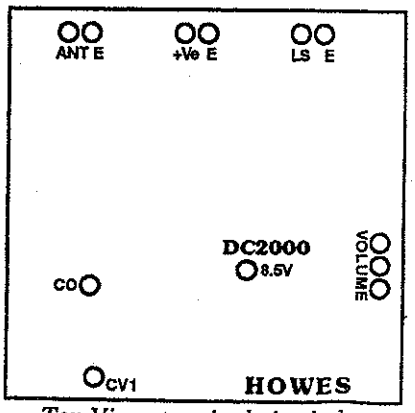


Terminal Pins



Side View: Terminal pins fitted to PCB

Terminal Pins need to be fitted to some of the Printed Circuit Board (PCB) holes to make it easier to wire the external connections. These are inserted into the holes shown in the diagram on the right. They have circles printed around them, so they are quite easy to find. The pins are inserted from the track (foil) side of the board and after fitting should project from the component side (the side with the printed parts locations). Push the pins into the holes by hand, and then resting the board over the edge of the bench, use a hot soldering iron and a little solder to push the pins fully home, flush into the board. ***Be careful*** not to slip with the hot iron as you do this. When all the terminal pins have been fitted check that they are all soldered to their PCB tracks (see soldering notes for guidance) and then move on to fitting the resistors.

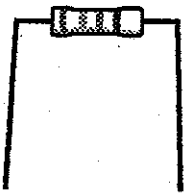


Top View: terminal pins holes

DC2000 Instructions, continued

Resistors

Refer to the Parts List, and select the first resistor from the top of the list. Bend its leads as shown in the diagram, and fit them into the holes marked for them on the circuit board. Be careful that you do not confuse the slightly larger axial inductor with the resistors. All the resistors have a light straw coloured background body colour with a gold band at one end.



Resistor with leads bent ready for insertion into PCB

Resistor inserted into PCB ready for soldering

When you have inserted the resistor's leads into their holes, push the body of the component down onto the circuit board, and then bend the ends of the leads out slightly to hold the resistor in place. Then turn the PCB over and solder the leads to the printed circuit tracks. Make sure the resistor's body is flat against the board so that its leads are kept as short as possible. Please read the notes on soldering on page 4. Poor soldering is the most common cause of a kit failing to work first time, so please take the soldering advice to heart!

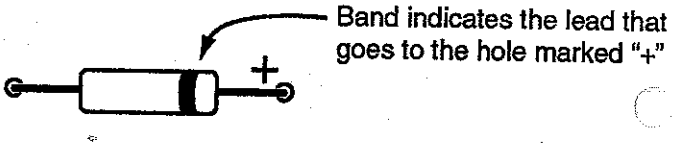
Cut the excess length of component lead off as close to the joint as possible *after* you have soldered it. Now fit the next resistor from the parts list in a similar manner, and then carry on down the parts list until all the resistors are fitted.

Axial Inductor (L2)

This component looks just like a fat resistor, but it has a blue or green background colour to its body. Inside the device is a small coil wound on ferrite material. In the band modules, the axial inductors form part of the band-pass RF filters. On the receiver board, L2 acts as an RF "choke". Fit this to its designated place on the board in the same way you fitted the resistors.

Diodes

Fit the diodes next, these must go the right way round. There is a band at one end of each diode's body - this indicates the lead that must go to the hole marked "+" on the board. D1 is the larger of the two diodes.



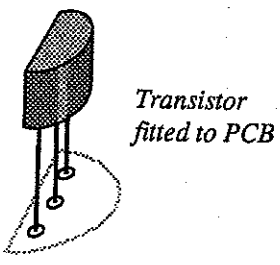
Capacitors

When the diodes are in soldered in place, move on to the capacitors. When fitting these, be sure to keep their leads as short as possible.

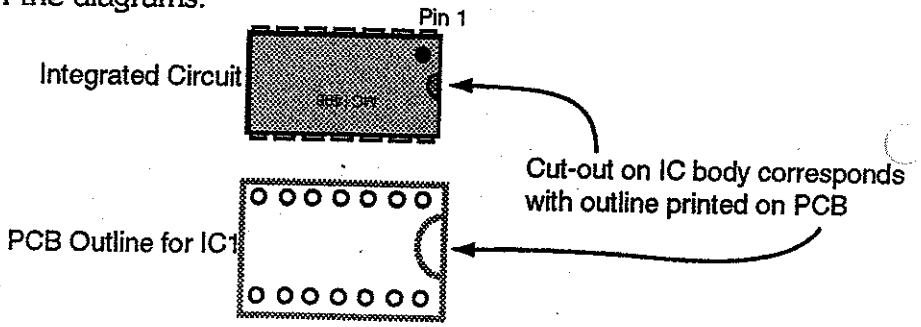
Notes: the "electrolytic" type capacitors must be fitted the right way round – see note on the Parts List 2 page. There are two different types of .1µF capacitor in this kit (brown disc shape and rectangular green ones). Please be careful to select the correct part.

Transistor and Integrated Circuits

Select and fit the transistor, TR1, followed by the integrated circuits, IC1, IC2 & IC3 – again these must be fitted the right way round as shown on the diagrams.



Transistor fitted to PCB



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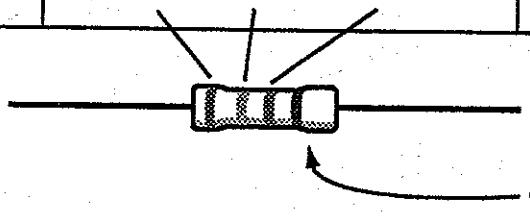
DC2000 Parts List 1

Resistors

Value	Colour Code			Part Numbers
2R2	Red	Red	Gold	R20
56R	Green	Blue	Black	R3 R21 R22
390R	Orange	White	Brown	R5 R6
820R	Grey	Red	Brown	R8
1k0	Brown	Black	Red	R7 R15 R23
1k2	Brown	Red	Red	R10
2k2	Red	Red	Red	R9 R12
2k7	Red	Violet	Red	R2 R11
4k7	Yellow	Violet	Red	R17 R18
8k2	Grey	Red	Red	R4
10k	Brown	Black	Orange	R1 R19
33k	Orange	Orange	Orange	R13 R14
100k	Brown	Black	Yellow	R16



Axial Inductor, L2

220µH colour coded: Red, Red, Brown, Silver. This looks like a fatter resistor.

Diodes - *take care to put these in the right way round.*

D1 - This is a 1N4004 and has its type number marked on it. **D2** - This is a BZX55 zener diode. It is a little smaller than D1 and has BZX and its voltage (9V1) marked on it.

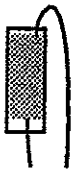
The body colour of the 1N4004 and BZX55 diodes is usually black with a grey or silver coloured band.

Capacitors

Plate Capacitor

Disc Capacitor

Mylar Capacitor



Polystyrene Capacitor mounted vertically

Value	Marking	Part Numbers
1nF	Disc marked 102	C13 C22
.01µF	Disc marked 103	C1 C2 C3 C6 C9 C17
.1µF	Disc marked 104	C7 C25 C26
.047µF	Multi-layer plate marked 473	C5
4.7nF	Mylar, green marked 472	C4 C8 C11 C19
.1µF	Mylar, green marked 104	C10 C14 C16 C18
1µF*	Electrolytic marked 1µF	C12
100µF*	Electrolytic marked 100µF	C15 C20 C21 C23 C24

* Electrolytic capacitors must be fitted the right way round. The longer lead goes to the hole marked "+", the other lead goes to the "–" hole and is indicated by a band containing "–" signs on the side of the capacitor.

DC2000 Parts List 2

Transistor, TR1

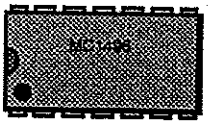
This is a BC547B device. It has its type number marked on it. Insert it into the PCB the right way round as the outline printed on the board indicates.

Integrated circuits (chips).

IC1 is an MC1496 double balanced mixer.

IC2 is a TL071 "operational amplifier (op-amp)"

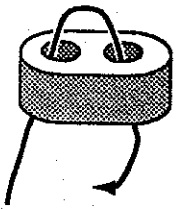
IC3 is an audio output amplifier, type TBA820M.



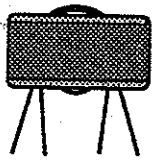
Mixer "Chip"

Make sure you fit the "chips" the right way round - as indicated by the outlines printed on the PCB.

Mixer Input Transformer: L1



Taking the wire in one hole and out the other counts as one turn.

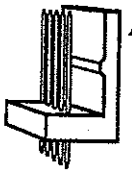


The finished transformer

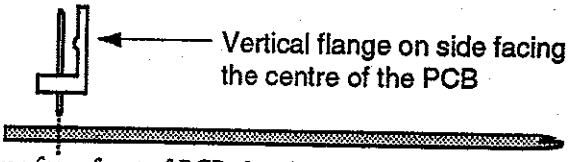
Wind eight turns of the thin yellow wire supplied neatly and tightly onto the two hole balun core. Passing the wire through one hole and then back out of the other counts as one turn. Do this eight times for eight turns. Both ends of the wire should project from the same side of the balun core (see diagram). When this is done, wind two turns of the red wire on top. The ends of the red wire should project from the same side of the balun core as the yellow wires. After the windings are complete, strip the insulation from the ends of the wires and insert them into the PCB holes marked for L1. The yellow wires go to the centre two holes, and the red wires to the outer two holes. When L1 is neatly in place, solder its wires to their PCB tracks.

Plug-in Band Module Connectors

PL1 and PL2 are PCB mounting 6 pin plugs and form the connectors for the plug-in band module. These are fitted with the plastic flange that runs along side the contacts facing towards the centre of the circuit board as shown in the diagram.



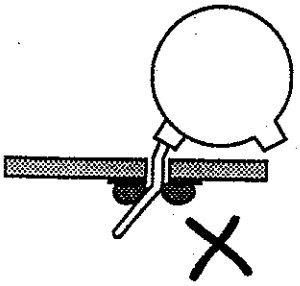
Module Plug



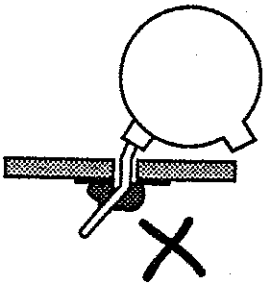
View from front of PCB showing connector orientation

Notes On Soldering

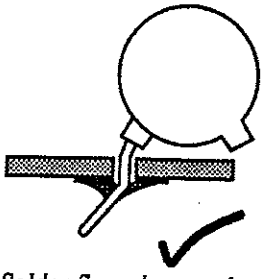
To solder properly, you must use the correct type of iron and the right quality of solder. Use a small tipped soldering iron which has a bit that is short and almost pointed at the end. The iron should be about 25 Watts (if it is not thermostatically controlled). Only use electronic type multicored solder. NEVER use any extra flux.



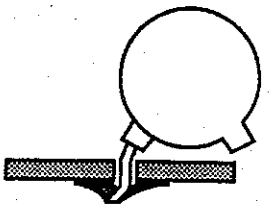
Lead not heated enough



Track not heated enough



Solder flowed properly on lead and track



Lead cut close to joint after soldering

You should hold the hot iron in contact with both the board and component lead 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 the lead and track 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. It is a good idea to drag the tip of the iron up the component lead as you remove it from the joint, this helps to pull any excess solder up with it and ensures [illegible]

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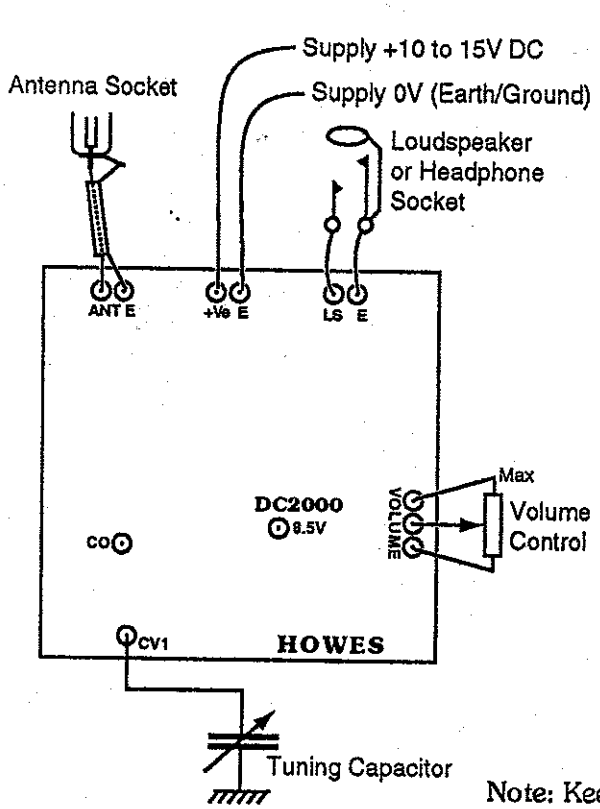
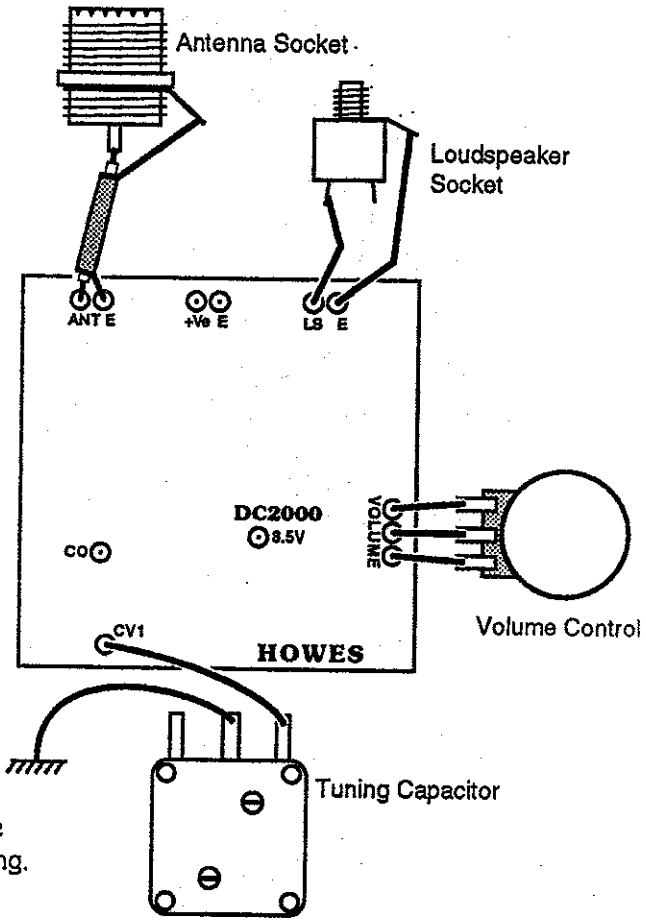
DC2000 Module Wiring

When your DC2000 module if fully assembled you can install it in the case and wire it up. The diagrams on this page show the connections required by the module. The diagram on the left shows theoretical symbols for the connections, whilst the diagram on the right shows the appearance of typical real components. However, your own items may vary from these. If you are using one of our hardware packs to house your project, then refer to the hardware instructions for details of the actual parts supplied with it.

Wire the flexible wire connections first (everything except the tuning capacitor). Then wire up the tuning capacitor connections to the PCB in tinned copper wire (22 SWG recommended).





Note: Keep all other wiring away from the tuning capacitor wiring.

Module Wiring and Connection Notes

Important – you must have some means of limiting the current to the receiver in case of a fault condition. Either a current limited power supply should be used (set to between .5 and 1A), or fit a 1A fuse in the positive supply lead going to the receiver. This fusing is of the utmost importance if you are using a car battery or other source of potentially high currents. For correct protection, the fuse should be fitted at the battery connection end of the wire, not at the receiver end.

If you are going to use accessory kits with your DC2000 ("S Meter", transmitter etc.), we would recommend you wire up the DC2000 on its own first for testing, and then add the additional wiring/changes for the accessories once you know your receiver is correctly constructed and installed.

"CO" Terminal

The "CO" (counter output) terminal is for connecting a HOWES CBA2 buffer to drive a digital read-out (HOWES DFD5 etc.). Fit the following component values (supplied with CBA2) for this application.

For CBA2 part number R2 use 100R, for CBA2 part number C1 use 3p3.

Connect CBA2 input ("IP") to "CO" terminal on the DC2000 PCB. These component values and input connection should give consistent buffer output on all bands.

"8.5V" Terminal

This connection provides stabilised +8.5V to power a DT1 fine tune control or other accessory. Only a small

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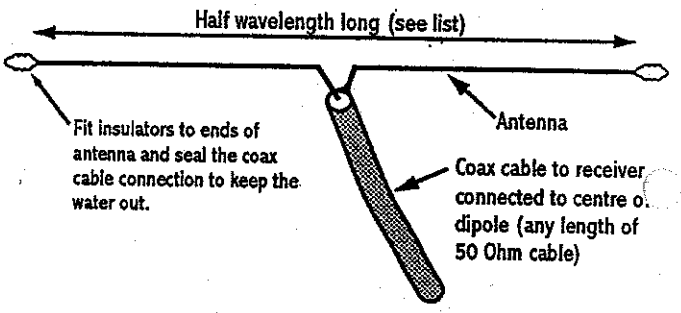
Power Supply

The DC2000 requires a power source providing between 10 to 15V DC. It should be capable of providing at least 200mA and should be of the regulated type, or a battery. If you wish to purchase a power unit to enable you to run the receiver from the mains, then we recommend you buy a good quality supply giving a regulated 13.8 Volt DC output with a current rating of 4 or 5 Amps. This will be powerful enough to run most equipment, and is a good investment, ready for future additions to your station.

Antenna Requirements

The DC2000 is quite a sensitive receiver and you will normally be able to hear some signals with a few meters of wire connected. However, you will get much better results if you use a decent antenna. The dimensions for a simple wire dipole antenna are shown in the band module instructions. A dipole will give good results without the need for an ATU (antenna tuning unit). If space is limited, then using the longest wire you can connected through an ATU (Howes CTU8 for example) should be quite effective. An active antenna (Howes AA2) is the alternative for locations where other types of antennas are impractical or not desired.



Always keep antennas away from other wiring, especially high voltage power lines, and always disconnect them from the equipment when they are not in use, or in weather conditions that may cause high static voltage discharges (thunder storms etc.).

Loudspeaker or Headphones

Use an 8 Ohm or higher impedance loudspeaker or headphones. Adjust the volume control for a comfortable listening level as you tune in the stations. There is no automatic gain control in this receiver, so if you wish to use headphones, use ones that are intrinsically incapable of delivering high volume. Exposure to high sound pressure levels can lead to hearing damage over time and should be avoided.

Tuning the Receiver

The DC2000 is a communications receiver for reception of SSB (speech) and CW (Morse) signals. It does not work in the same way, or sound at all like, an AM or FM broadcast receiver. As you tune the main tuning control you will hear a lot of whistles as you tune through stations. Morse signals are quite easy to tune. As you adjust the main tuning control (slowly!) the pitch of the signals changes – simply adjust for a comfortable pitch of the Morse "note" (using the fine tune control if your hardware includes this).

The pitch of SSB speech varies in the same way. As you tune through the signal the pitch varies, but with speech you need to be very accurate in your tuning to get anything like a human sounding voice. This applies to all SSB receivers, it is not peculiar to the DC2000. Learning to tune in SSB signals quickly and easily will take a little practice, if you are new to this. Don't forget that it may be a foreign language or a very poor quality transmission (or both) you are trying to "resolve"! There is some skill required to "drive" a shortwave radio effectively – it will come with practice.

Alignment

If you have bought an assembled band module, it will have been aligned in our test jig. If you have built the module from a kit, you will need to adjust the oscillator coil to set the exact frequency coverage of the radio. You must use a proper insulated trimming tool to adjust the coil. In the band module instructions there is an approximate mechanical setting for the coil's core. Calibrate the end of a matchstick to measure this distance easily. The mechanical setting will get you near to the nominal frequency.

If you use a digital frequency display (Howes DFD5 etc.) you can read the receiver frequency directly. Alternatively a crystal calibrator (Howes XM1) can be used to determine the dial readings, or you can use an already calibrated receiver to set up the DC2000. To do this, link the antenna sockets of the two receivers together and listen for the DC2000's local oscillator signal with the other set (strong!). The local oscillator signal (sounds like a carrier with no modulation) is on the frequency the DC2000 is tuned to. Adjust the band module core for the desired frequency coverage.

DC2000 User Information - 2

Fault finding checklist – try these suggestions if your kit doesn't work.

1. Is the battery or power supply you are using OK? Test it on another piece of equipment.
2. Is the loudspeaker or headphone properly connected. Can you hear a click when you connect the power to the DC2000? If not recheck these connections again.
3. Are all the parts in the right places, are all the diodes etc. the right way round?
4. Is anything loose that should not be? Try wiggling everything very gently. If a wire comes away, or a component moves on the PCB, then you have found a poor connection. There may be others, so check all parts.
5. When you have done the above and the problem persists or you have found a loose or incorrect part on the PCB, disconnect the power supply and then the wires from the terminal pins on the PCB, take the board out of the case. Recheck all the soldering. All the joints should look bright and shiny, and no light should be visible through any holes when you hold the board up to a bright light. Don't heap extra solder onto everything out of desperation! Only add solder if a joint really needs it. Too much solder will tend to "bridge" across to other tracks, so don't overdo it.
6. Reinstall the module but without any additional wiring for optional accessories etc. so that faults in other associated boards or wiring will not affect the receiver.
7. We can give telephone advice during office hours, and usually on Saturday too. Please carry out the above checks before 'phoning, because these are the most effective "first aid" suggestions and they should get you up and running in most cases.

Operational Problems

Hum

A steady hum coming from the receiver's loudspeaker is likely to be due to one of two causes. If the hum remains the same when the antenna is disconnected, then the hum is almost certainly coming from the power supply running the receiver. Try a battery instead of the power supply, to prove this is the case. The only answer to this problem is a better power supply with a lower output "ripple" (or use a battery!).

If the hum goes away when you unplug the antenna, then you almost certainly have a case of "modulation hum". This is when the signal from the receiver's VFO is somehow carried into the power supply or mains wiring where it is modulated by the mains frequency. The modulated "hummy" signal is then picked up by the antenna and fed back into the receiver where it is received just like any other signal, except that as it is the receivers own signal, it is always perfectly tuned in at "zero beat" – you just hear the superimposed hum. Ensuring that the receiver's antenna is kept away from mains wiring will help to avoid this problem. This is why, when you are wiring the receiver into its case, you should also make sure you keep the leads that go to the power supply well away from the signal circuits and especially the tuning capacitor and its wiring.

Winding the leads from the power supply around a ferrite rod or ring is a good way to prevent the VFO signal getting back to the power supply, and is the thing to try if the problem persists after correcting the receiver's wiring and the antenna siting. Due to its low VFO radiation, the DC2000, when correctly installed in a screened case, will be less susceptible to modulation hum than many "straight" receiver designs.

AM Demodulation

All receivers will "overload" at signal strengths above a certain threshold. In direct conversion type receivers overload tends to manifest itself as "AM breakthrough" when strong broadcasting stations can be heard in the background. The range of signal levels that a receiver can cope with is known as its "dynamic range". There are various technical ways to specify this performance, we won't go into the details here, but the DC2000 is good for this class of receiver. For a given dynamic range, the more sensitive a direct conversion receiver is, the lower the signal level that will produce AM breakthrough. We have made the DC2000 a very sensitive little receiver, so that it will work well with very modest antennas. However, this does mean that it will overload more easily on a good antenna than a less sensitive receiver with the same dynamic range. Adding an attenuator in the antenna feed will reduce the sensitivity and raise the overload threshold if you find you need this. The HOWES RA30 is an attenuator kit designed for this type of application.

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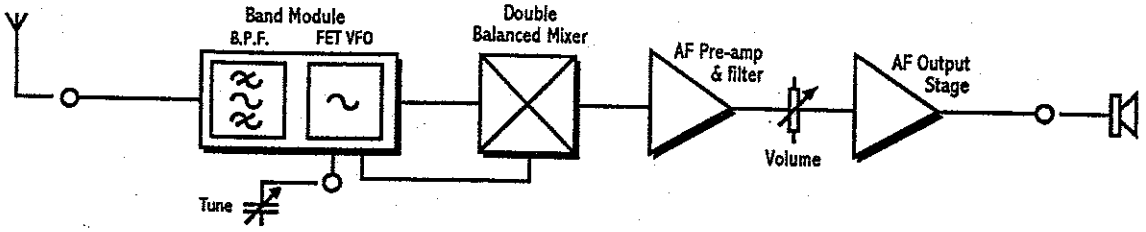
DC2000 User Information - 3

Circuit Description

The DC2000 circuit is quite simple in concept and the block diagram shows the basic circuit functions in outline.



RF stages

The signal from the antenna is fed to the band module where it passes through a bandpass filter to reduce the level of unwanted out-of-band signals. It is then returned to the receiver mother board (via PL1) and fed to the MC1496 mixer (IC1) through an impedance matching transformer, L1. The transformer has a turns ratio of 1:4 (2 turns on the input, 8 on the output winding) this increases the impedance by a factor of 16 (the square of the turns ratio). The mixer is also fed with the signal from the variable frequency oscillator (VFO) on the band module (via PL2).

This oscillator, along with the mixer and audio pre-amplifier (IC2) is supplied with a stabilised voltage of about 8.5V from TR1. The stabilised voltage ensures that the circuit performance will not vary, even if the supply voltage does (within the rated range).

Mixer Stage

The output from the mixer is the result of the interaction between its two inputs, the VFO and the incoming signals. This produces an audio frequency signal, the frequency being equal to the difference between the VFO and signal frequencies. In other words, if the VFO is tuned 1kHz away from the incoming frequency, then a note of 1kHz will be heard. The pitch of the note will alter as the VFO is tuned. This conversion of the incoming signal straight to audio and not via any other (intermediate) frequency gives this type of receiver its name: Direct Conversion.

Audio Stages

The audio frequency (AF) signal from the mixer is amplified by IC2 and then fed to the volume control. After the volume control the signal is further amplified by the audio output stage, IC3. This provides enough signal level to drive a loudspeaker at a decent volume.

Passive Components – resistors and capacitors

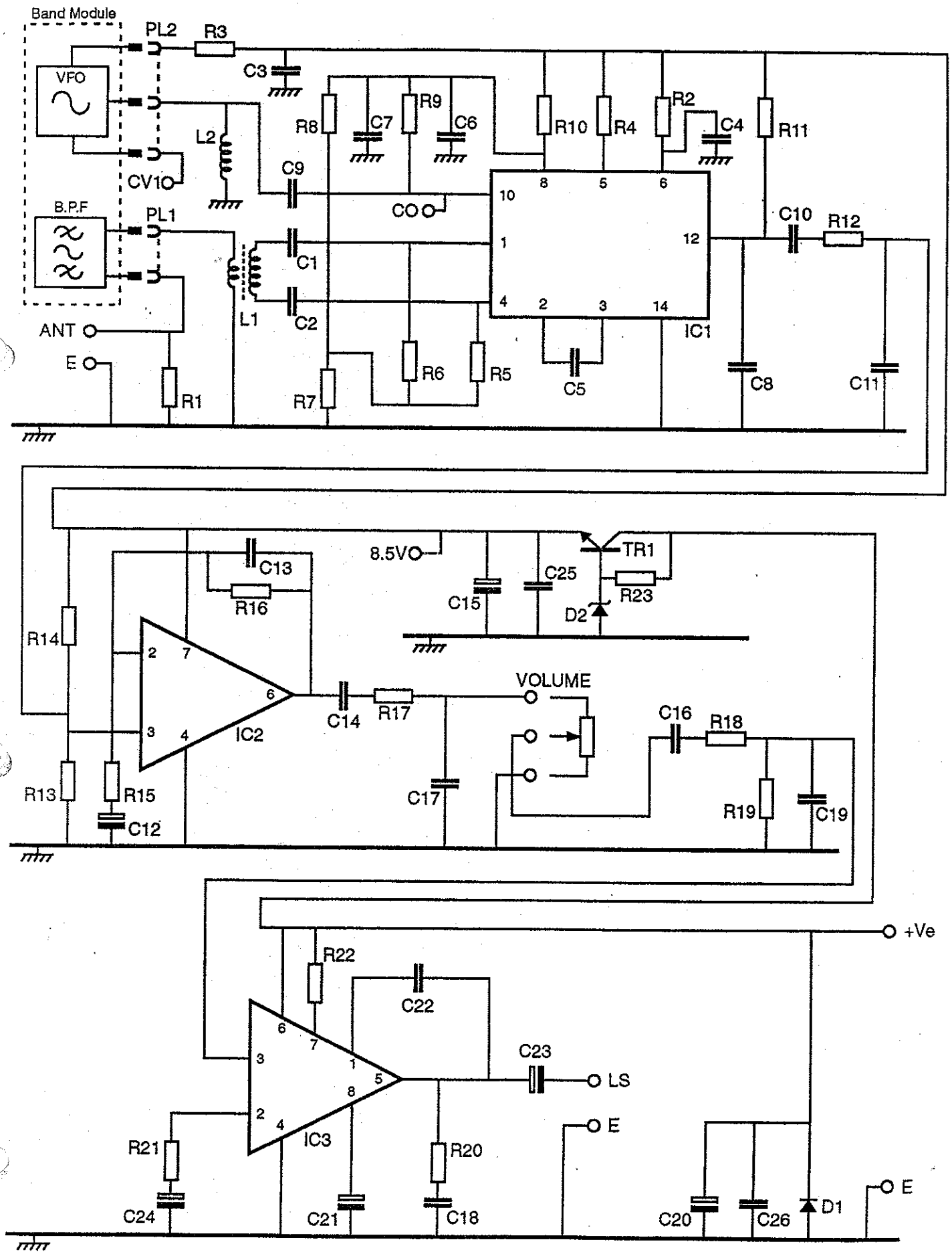
Most of the resistors in the circuit are used to set up the correct operating voltages around the ICs. The calculation of the values of these resistors is very important in determining the performance and function of each stage.

The capacitors in the signal path are to pass on the signal to the next stage without letting the DC voltages of one stage affect the operation of the next one. They provide DC isolation. Most of the other capacitors (usually with one connection to earth or chassis) are for "decoupling" purposes. That is, conducting signals to earth (ground) rather than allowing them to pass on to other parts of the circuit where they could cause undesired effects. Sometimes a combination of resistors and capacitors is used (as in the DC voltage feed to the band module) to give extra decoupling efficiency. The resistor makes it harder for the signals to travel along the supply "rail" and the capacitors offering them an easier route (to earth).

Design

The design of good kit equipment is not just about electronic components and circuitry, but also about ease of construction, alignment, test equipment requirements, clarity of instructions, tidy board layout etc. We hope you will find your DC2000 to be just as effective in these departments, as well as being a great little receiver!

DC2000 Circuit Diagram



C.M.HOWES COMMUNICATIONS

HA22R Hardware Pack Instructions

Hardware pack for use with ***HOWES DC2000*** *Receiver kit*

Parts List

1 off HA22R chassis
1 off DT1 Fine Tune Kit
4 off M3 12mm pan head bolts
1 off M2.5 12mm pan head bolt
1 off solder tag
1 off SO239 antenna sockets
4 off self adhesive feet
2 off push-on knobs
1 off multicoloured ribbon cable
1 off 22swg tinned copper wire

1 off HA22R cover
4 off No.4 self tapping screws
15 off M3 nuts
2 off M2.5 6mm pan head bolt
1 off small grommet
1 off 3.5mm jack socket
1 off tuning capacitor with spindle extension
1 off large screw fitting knob
1 off RG174 miniature coax

WARNING: Do not try to fit the tuning capacitor's fixing screws to this component before reading th structions. This component can be irreparably damaged by screwing these bolts in too far.

Tools Required

Medium cut flat file for rounding corners of case. Screwdriver and spanner for M3 nuts and bolts. Centre punch. Small hacksaw. Drill for drilling chassis with the following size drill bits: 2, 2.5, 4 & 7mm.

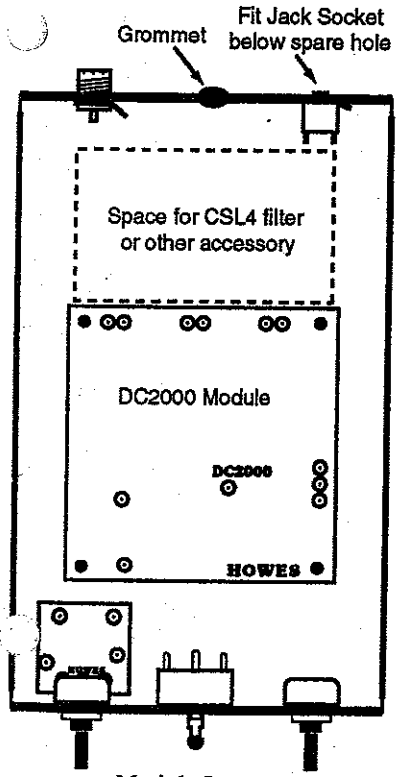
Pre-assembly Preparation

Before your hardware can be bolted together, there are a few jobs to do first. There is the small DT1 kit to assemble for the Fine Tune control circuit and some pre-assembly metalwork as follows:–

Use a file to round off the corners of the rear panel and the cover. Round them to match the front panel corners which have already been done for you.

Cover Fixings

Position the cover in place on the chassis, and decide how much overlap you like at the front. Equal overlap of the front and rear panels looks quite good. Hold the cover in position, and mark the chassis through the four fixing holes. Centre punch the marks and drill the four positions with a 2.5mm drill bit (to take the No.4 self tap screws).



Module Layout

A Battery Power Option to Consider

As supplied, the HA22R hardware with the DT1 Fine Tune control assumes the use of an external power source that can be disconnected when the receiver is not in use. However, there is room behind the DC2000 module to fit an internal battery pack, if you wish to do this for portable operation. If this idea appeals, then it is suggested that you might like to consider replacing the "ON" indicator LED fitted to the front panel (which takes about 3mA) with an on/off toggle switch. If you intend to do this, then you will need to carefully drill out the LED hole to a suitable size. The position of the toggle switch can then indicate when the receiver is on, rather than the LED, which consumes current.

Rear Panel

We have already punched the SO239 socket hole for you (plus a spare hole to take a 5 pin DIN socket for linking to a transmitter). You need to drill two 7mm holes, one for the power cables' grommet (if you are going to use an external power source), and one for the loudspeaker/headphone socket. Dr the jack sochet hole below the one for the optional DIN socket. If you are going to add a linking module or audio filter to your receiver, then you may need to add holes for extra switches on this panel as well.

HOWES

HA22R Instructions 2

Drilling the Chassis to take the PCB Module

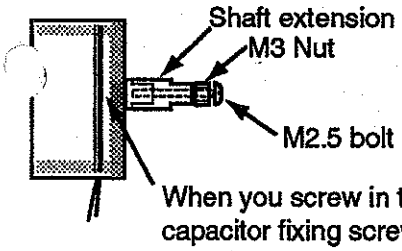
Arrange the DC2000 PCB module in place on the chassis as shown in the diagram on page 1. The front edge of the DC2000 should be approx. 38 mm (1.5") behind the rear of the front panel to allow for mounting the controls. The edge of the module should be about 20mm in from the left hand side of the chassis. Mark the chassis through the PCB fixing holes using a felt tip pen. Remove the module, centre punch the chassis where you have marked it and then drill with 2mm pilot holes first, then enlarge the holes to 4mm. If you are going to add an accessory kits, such as the CSL4 audio filter, then this should be fitted behind the DC2000 in a similar manner. Peel off the thin protective plastic from the chassis when the drilling is complete.

Feet

Stick the self-adhesive feet neatly in position on the base of the chassis, one near each corner of the case.

Tuning Capacitor

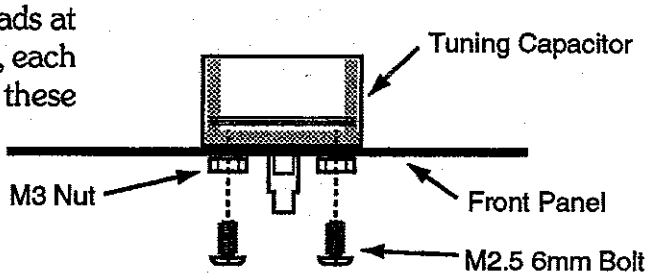
The tuning capacitor needs to have its spindle extension fitted, and to then be mounted behind the front panel.



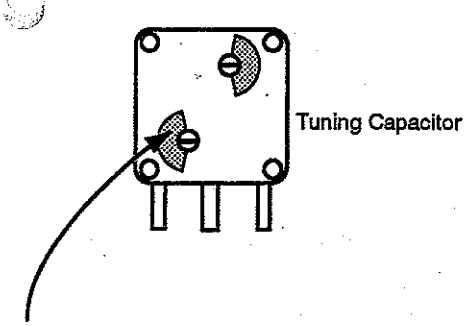
Important:- *you must only fit the fixing screws to the capacitor once it is in place behind the panel, and the M3 nuts are on the fixing bolts to act as spacers. Without the panel and spacers, the screws could enter too far into the body of the capacitor and damage its internal workings.*

Fit the brass spindle extension to the capacitor using the 12mm length M2.5 bolt with one M3 nut on the bolt to act as a spacer (see diagram on left).

Fit the capacitor in its position behind the panel with its leads at the bottom. Use the 6mm length M2.5 bolts to fix it in place, each bolt being fitted with one M3 nut as a spacer. Do not tighten these bolts more than just enough to hold the capacitor in place. The diagram on the right shows the assembly.



When the tuning capacitor is fitted to the front panel, rotate the trimmers on its rear to the positions as shown in the diagram below. This sets them to minimum capacitance, as they are not needed in this application.



Rotate the two trimmers on the capacitor to the positions shown (use a screwdriver)

Rotate the capacitor fully anticlockwise, and fit the large knob to it with the indicator spot aligned with the base line on the left. If the knob sits at an odd angle on the capacitor shaft, you may need to reposition the spindle extension spacer nut to straighten it (slacken the M2.5 12mm bolt slightly, move the nut round a fraction, and retighten the bolt). Check the knob turns without scraping on the panel, and the white spot follows the scale from end to end.

Fine Tune and Volume pots

Cut the spindles of these two controls down to a length of about 10mm. To do this hold the end of the spindle in a vice, or over the edge of the bench and cut the spindle with a small hacksaw.

DT1 Fine Tune Control PCB

Before fitting the Fine Tune pot, you will need to assemble the DT1 PCB module from the kit provided (the DT1 PCB module needs to be soldered to the pot before the pot is fitted to the front panel).

Mounting the Pots

Fit the Volume pot to the panel with its solder tags at the bottom and the crinkle washer behind the panel. Do not overtighten the fixing nut. When the DT1 PCB has been assembled, checked and soldered to the pot's solder tags, fit the Fine Tune control behind the panel in the same manner as the Volume control.

HA22R Instructions 3

Push-on Knobs

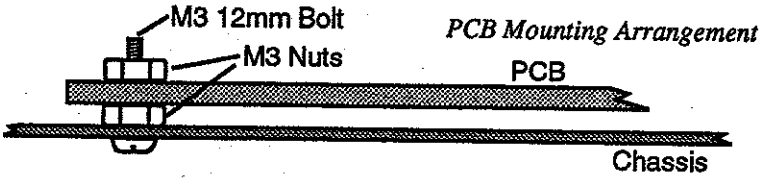
The push-on knobs should be fitted to the two control pots. Remove the knob caps, if these are already in the knobs (use your finger nails or a thin tool), and position them so that they line up with the panel markings by turning the controls fully anticlockwise and then pushing the caps in so that their white lines align with the most anticlockwise line printed on the panel.

Volume at minimum

Mounting the DC2000 Module

The DC2000 PCB module is spaced off the chassis on M3 nuts as shown in the diagram. Make sure you have trimmed the leads of all the components short enough so that they are not going to touch the chassis. Neat soldering and trimming of component leads should ensure that one spacer nut is sufficient. If you feel that you may need a second spacer nut to ensure clearance, then fit additional ones, we have included enough to do this.

Fit the small solder tag to the front left hand PCB fixing bolt, above the PCB.



Sockets

Fit the sockets in place on the rear panel. The SO239 coax socket is inserted from the outside of the chassis with the fixing nut screwed on from behind the panel. The socket's solder tag is fitted under the fixing nut. Once the nut is tightened, the solder tag should be bent slightly away from the panel so that you can solder to it. The 3.5mm jack socket is inserted from inside the chassis and the nut screwed on from the outside. If you are fitting the LM2000 linking module, then also fit the 5 pin DIN socket.

Wiring

You can now wire up the DC2000 module as shown in the diagrams (kit instruction "module wiring" page and on page 4 of these instructions).

The PCB fixings connect the module to chassis. All four corner mountings must be used, and tightened up, to connect the module properly to the case.

To avoid some wires getting in the way of soldering other connections, it is suggested that you wire up the unit in the order set out below.

Wire the tuning capacitor centre lead and the DT1 "E" terminal pin to the solder tag using a length of the 22swg tinned copper wire supplied. Use another length of this wire to connect the capacitors right hand tag to the "CV1" terminal on the DC2000 and to "CV1" on the DT1 PCB.

Wiring the Coax Socket.

Use the short length of miniature coax supplied to connect the antenna socket to the DC2000's "ANT" and adjacent "E" connections as shown in the diagrams, but please read the paragraphs below first!

SO239 coax sockets are not the easiest of things to solder properly. We supply this type of connector because they are the standard on most amateur radio equipment, not for their ease of soldering! The best way to solder to this is to make sure the connection points are clean by scraping them with a sharp knife, and then tin them using a soldering iron with a reasonable amount of power behind it. Anything less that 25W is unlikely to make a good connection — a higher powered device is useful if you have one. After tinning the connection points well, offer up the coax cable (also pre-tinned) and then reflow the solder to make the joints.

Note: Do not attempt to solder the coax to the connector without first tinning the socket, otherwise the length of time it will take to get the solder to flow on the socket in the first instance, will almost certainly melt the insulation on the coax, and probably lead to a short circuit in the cable.

HA22R Overall Wiring Diagram

Ribbon Cable

Multicoloured ribbon cable is provided for wiring the other connections. Peel off a strip of three wires from the ribbon (e.g. black, white and grey). Separate the ends of the wires for about 15mm and then strip the insulation from the last 3mm at the ends ready for soldering. Tin the ends of the wires (apply some solder to them) and then use them to connect the "Volume" pot to its PCB terminals (see wiring diagrams for details).

Peel a pair of wires from the ribbon (e.g. violet and blue), prepare the cable ends as before, and use them to connect the "LS" and adjacent "E" terminal to the jack socket as shown in the diagram.

Peel off two separate wires from the ribbon, (e.g. red and brown). Use one (red) to connect the "8.5V" terminals on the DT1 and the DC2000 PCBs together.

LED Mounting

Tin a spot on top of the Volume pot's case, then trim and solder the shorter of the two LED's leads to the spot you have tinned (see diagram). Use the remaining single wire (brown) to link "L" on the DT1 PCB to LED's longer lead (which should be trimmed short before soldering). This completes the internal wiring of the basic receiver. You now need to connect up some power supply leads and test your handiwork! Don't forget to plug in the band module!

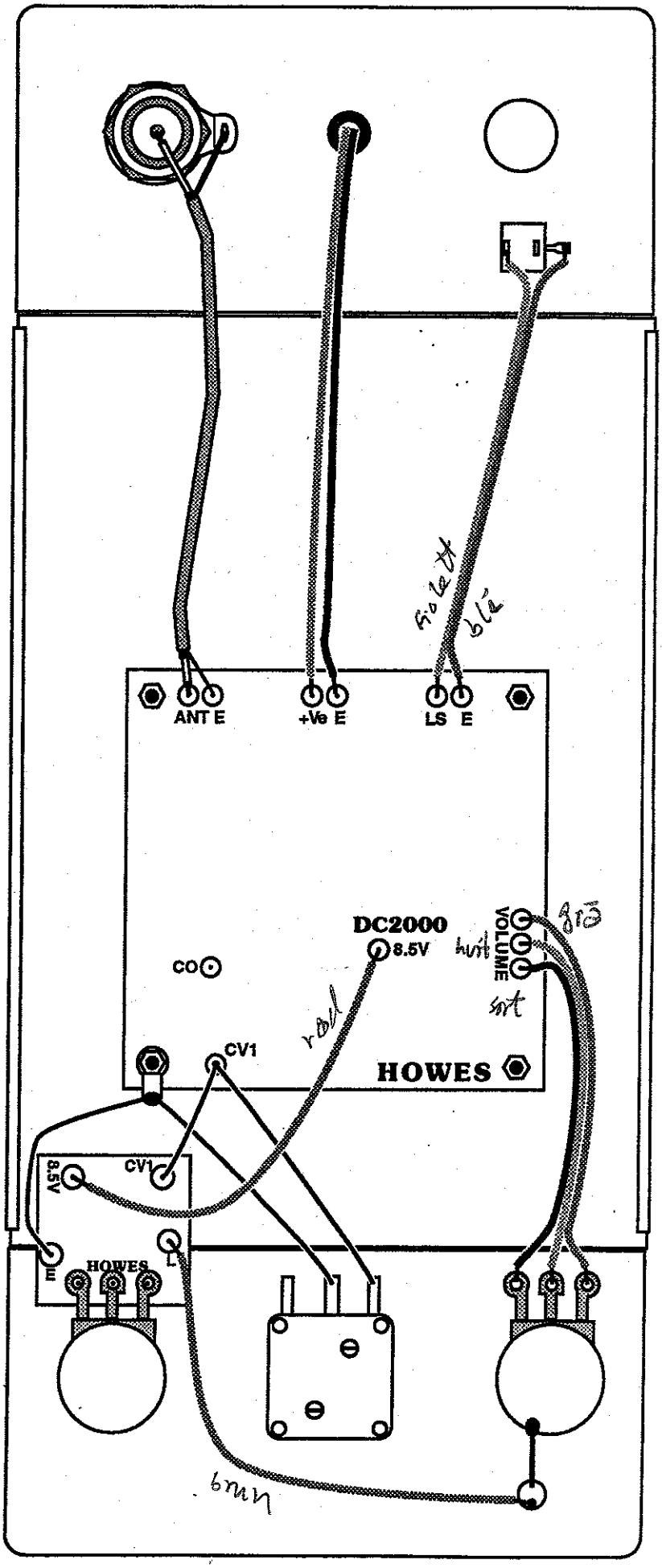
Checking your Wiring

The diagram on the right shows the overall wiring connections for the DC2000 when installed in the HA22R hardware.

Note: The diagram shows the module viewed from above, and the rear view of the front and back panels, as though they had not been folded into their normal vertical position. The drawing is not done to an exact scale.

Finishing your Project

To complete the good looks of your project, you can paint the cover to match your other equipment, or any colour you choose. A satin finish tends to look better than gloss or matt, and does not show the finger marks so much! Satin black acrylic car paint is used on our demonstration equipment (over a coat of primer). If you don't like using spray paints,



HA22R User Notes

en a very effective finish can be obtained by covering the cover with "Fablon" or other thin self-adhesive plastic decorative material obtainable from DIY shops.

Operating the Finished Unit

Refer to the DC2000 instructions for more information about using the receiver. These notes give a quick recap of the basic operation.

Volume Control

Adjust the Volume control for a comfortable listening level. There is no automatic gain control in this receiver, you will need to adjust the volume manually for different stations. If you wish to use headphones, only use ones that are intrinsically incapable of high sound pressure levels. Hearing damage can result from exposure to high sound levels over time.

Main and Fine Tune Controls

Use the central Main Tuning control to find stations on the band. First, set the Fine Tune to midway and then tune slowly across the band with the Main Tune. When you are roughly tuned to a signal, use the Fine Tune control to tune it in accurately.

ote: If the receiver is tuned to the "wrong side" of an SSB signal it will not "resolve" (be intelligible), so you may need to tune through to the other side of an SSB signal to make out what is being said. SSB signals are normally lower sideband on the 160, 80 and 40 meter amateur bands, and upper sideband on everything else. You need to adjust your tuning technique to take this into account when you swap band modules to a band using the "inverted" mode.

Dial Scale

The HA22R front panel is scaled for 160, 80 and 20M bands (1.8 to 2.0, 3.5 to 3.8 and 14.0 to 14.35MHz respectively). A logging scale (effectively 0 to 10, but not numbered) is closest to the knob for guidance on other bands. Frequency / logging scale relationships for some popular bands are set out below. The logging scale counts from 0 to 10 clockwise. The 10 and 40M bands are shown for two settings of their band module adjustment, one starting at the bottom of the band for CW and one for the main SSB section.

Module: **BM10**	
Frequency	Scale
28.0	0
28.1	3
28.2	5
28.3	7
28.4	8.5

Module: **BM10**	
Frequency	Scale
28.4	0
28.5	3
28.6	5
28.7	6.8
28.8	8.3

Module: **BM15**	
Frequency	Scale
21.0	0
21.1	3
21.2	5
21.3	6.5
21.4	7.8
21.5	9

Module: **BM30**	
Frequency	Scale
10.10	0
10.11	1.9
10.12	3.4
10.13	4.7
10.14	5.7
10.15	6.8

Module: **BM40**	
Frequency	Scale
7.00	0
7.01	3.1
7.02	5.4
7.03	7
7.04	8.6

Module: **BM40**	
Frequency	Scale
7.05	0
7.06	3.2
7.07	5.4
7.08	7
7.09	8.8

DT1 Instructions

The **HOWES DT1** is a fine tune control for use in parallel with the normal 50pF tuning capacitor as used in many of our kits. It enables the frequency to be adjusted by a small amount, to make exact tuning easier. It is supplied as standard with the HA22R hardware pack.

Caution: Please be careful not to mix up the parts in this kit with the parts from other kits you may have.

Brief Technical Details

Frequency Coverage: Dependent on the range being tuned by the main tuning capacitor. The DT1 will give approximately 2.3% variation of the tuning range provided by a nominal 50pF tuning capacitor. The tuning rate is roughly equivalent to having a 60:1 ratio reduction drive on the main tuning control.

Power Required: the DT1 is designed to operate from a nominal +8.5V stabilised supply taken from the associated receiver/VFO etc. A light emitting diode (LED) is provided for "power on" indication. Total current consumption of DT1 with LED connected is approx. 4mA.

Building The Kit

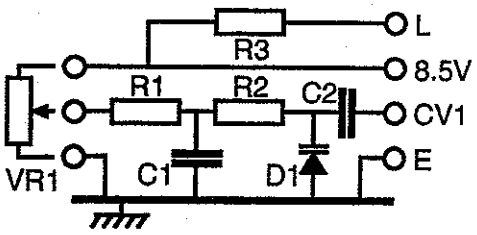
These are very brief instructions simply giving the details of which parts go where on the DT1 PCB. Please refer to your main kit instructions for more details on soldering, drawings to help identify component types, and general assembly techniques.

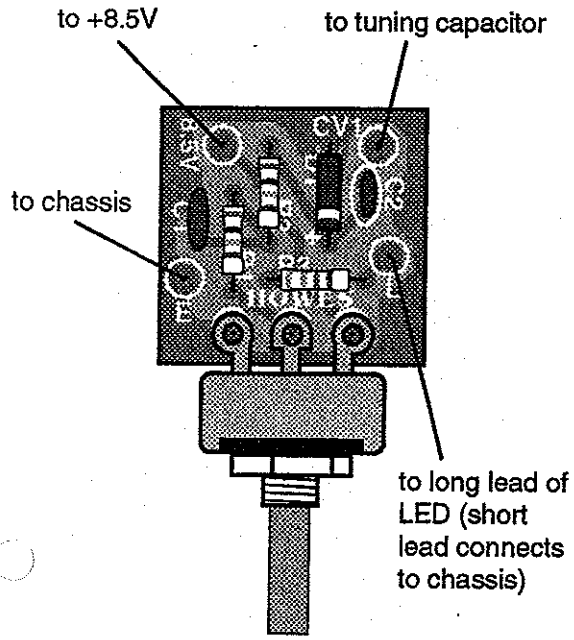
The suggested assembly order is to fit the terminal pins (to holes with circles around them), followed by the fixed resistors, the diode and the capacitors. Make sure you fit the diode the right way round – see diagram below. Finally the PCB is connected to the control pot ready for installation. Take care to connect the LED correctly when you wire it up. It won't light if the connections are reversed.

Parts List

Part	Marking/Colour Code
Resistors **R1 & R2** (100kΩ)	Brown, Black, Yellow, Gold
R3 (3k3)	Orange, Orange, Red, Gold
Capacitor **C1** (.1μF)	104 (disc type)
C2 (5.6pF)	5p6 (plate type)
Diode **D1**	1N4004, black with grey band

Circuit Diagram





Control pot fitted to DT1 PCB viewed from above

Fitting the Control Pot

Very carefully bend the solder tags of the pot backwards so that they are at right angles to the body of the component. Take care that their crimped connections to the pot itself are not loosened as you do this. When this is done, fit the solder tags over the terminal pins on the PCB as shown in the diagram. Cut down the length of the centre terminal pin to ensure it won't touch the back of the pot. Then solder the tags to the terminal pins. These electrical connections also provide the mechanical mounting for the module, so make sure the joints are well made.

The fine tune control can now be installed in the equipment's case and wired up. The connections are quite straightforward and are shown in the diagram. Make sure that the DT1 board is spaced off the chassis sufficiently so that it won't "short" to the metalwork. Don't forget that when you make the connection to the main tuning capacitor, you still have to connect the capacitor to its connection point on the main PCB (receiver/VFO etc.).

C.M.HOWES COMMUNICATIONS

issue 1

BM80 Instructions

The **HOWES BM80** is a plug-in tunable band module for use with a **HOWES DC2000 and DXR20** direct conversion receivers to give coverage of the 80M amateur band or other frequencies between 2.4 and 3.9MHz.

Brief Technical Details

Frequency Coverage: Approx. 3.5 to 3.8MHz with a 50pF tuning capacitor. This module can also be set to cover other frequencies between 2.4 & 3.9MHz.

PCB type BMV with 8 pole RF band-pass filter & FET VFO.

Building The Kit

These are very brief instructions simply giving the details of which parts go where on the band module PCB. Please refer to your receiver kit instructions for more details on soldering, drawings to help identify component types, and general assembly techniques.

The suggested assembly order is to fit the resistor, followed by the axial inductors (these look like fatter resistors), the diode, capacitors, the wire link (*note* – only fit *one* link), variable inductor, the sockets and finally the transistor. The diode and transistor must be fitted the right way round. Keep all component leads as short as possible. Mark the band on the module with a spirit based felt tip pen, so you know which it is!

Parts List

Part	Marking/Colour Code
Resistor **R1** (100kΩ)	Brown, Black, Yellow, Gold
Axial Inductors, **L1, L2, L3 & L4**	Red, Violet, Gold, Silver
Diode **D1**	1N4148 (usually orange with black band)
Capacitors **C1 & C3** (1.2nF)	1n2 (plate type)
C2 (1.8nF)	1n8 (plate type)
C4 (680pF)	n68 (plate type)
C5 (.1µF)	104 (disc type)
C6 (22pF)	22 (disc type)
C7 (330pF)	330 (silver coloured) – mount this vertically
C8 (1nF)	1n (silver coloured) – mount this vertically

Link LKA. Use an offcut capacitor lead to link the two PCB holes indicated. Only fit one link to the board. Fitting LKB and not LKA would give much reduced frequency coverage.

Variable Inductor L5 (VFO coil).
This is marked K4921 on its side (amongst other numbers).

Sockets SK1 & SK2. These have little plastic mouldings that wrap around the edge of the board, the terminals then slide into their holes for soldering.

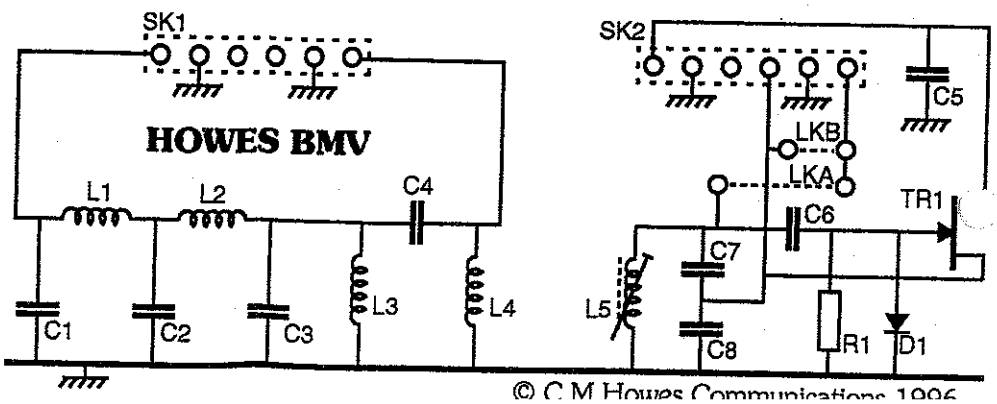
Transistor TR1. Marked BF245A. Fit this the right way round as indicated by the outline on the PCB.

Alignment for 3.5 to 3.8MHz

Adjust the core of L5 using an insulted trimming tool so that the top of the core is about 4mm below the top of the screening can. Then, plug the module into your receiver (with the power off), and make a final VFO alignment in the manner described in the receiver kit instructions.

Antenna Information:

The total length of a wire half-wave dipole antenna for 3.6MHz is approx. 39.58M. If a dipole is too big for your location, use as long a wire as you can in conjunction with an antenna tuning unit (HOWES ATU8 etc.). A tuned antenna will help reject spurious signals. 40M signals are often very strong at night, and can sometimes be tuned by the harmonic of the oscillator.



C.M.HOWES COMMUNICATIONS issue 1

BM20 Instructions

The **HOWES BM20** is a plug-in tunable band module for use with the **HOWES DC2000** and **DXR20** receivers to give coverage of the 20M amateur band or other frequencies between 12.4 and 17.5MHz.

Brief Technical Details

Frequency Coverage: Approx. 14.0 to 14.33MHz with a 50pF tuning capacitor in DXR20, 14.0 to 14.36 in DC2000/HA22R. This module can also be set to cover other frequencies between 12.4 & 17.5MHz.

PCB type BMV with 8 pole RF band-pass filter & FET VFO.

Building The Kit

These are very brief instructions simply giving the details of which parts go where on the band module PCB. Please refer to your receiver kit instructions for more details on soldering, drawings to help identify component types, and general assembly techniques.

The suggested assembly order is to fit the resistor, followed by the axial inductors (these look like fatter resistors), the diode, capacitors, the wire link (*note* – only fit *one* link), variable inductor, the sockets and finally the transistor. The diode and transistor must be fitted the right way round. Keep all component leads as short as possible. Mark the band on the module with a spirit based felt tip pen, so you know which it is!

Parts List

Part	Marking/Colour Code
Resistor **R1** (100kΩ)	Brown, Black, Yellow, Gold
Axial Inductors, **L1, L2, L3 & L4**	Yellow, Violet, Silver, Silver
Diode **D1**	1N4148 (usually orange with black band)
Capacitors **C1 & C3** (270pF)	n27 (plate type)
C2 (680pF)	n68 (plate type)
C4 (180pF)	181 (disc type)
C5 (.1µF)	104 (disc type)
C6 (22pF)	22 (disc type)
C7 (220pF)	220 (silver coloured) – mount this vertically
C8 (330pF)	330 (silver coloured) – mount this vertically

Link LKB. Use an offcut capacitor lead to link the two PCB holes indicated. Only fit one link to the board. Fitting LKA and not LKB would give much wider frequency coverage, and lose bandspread.

Variable Inductor L5 (VFO coil). This is marked K1731 on its side (amongst other numbers)

Sockets SK1 & SK2. These have little plastic mouldings that wrap around the edge of the board, the terminals then slide into their holes for soldering.

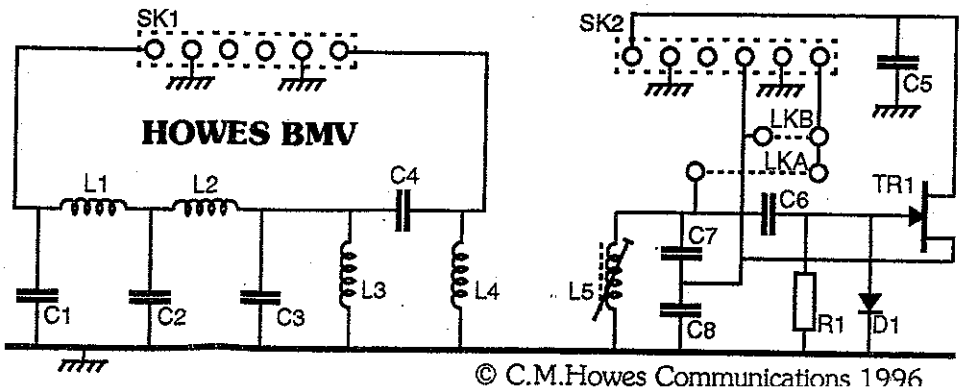
Transistor TR1. Marked BF245A. Fit this the right way round as indicated by the outline on the PCB.

Alignment.

Adjust the core of L5 using an insulted trimming tool so that the top of the core is approximately 3mm below the top of the screening can. Then, plug the module into your receiver (with the power off), and make a final VFO alignment in the manner described in the receiver kit instructions.

Antenna Information:

The total length of a wire half-wave dipole antenna for this band is approx. 10.0M.



C.M.HOWES COMMUNICATIONS

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Eydon, Daventry,
Northants NN11 3PT

2nd May 1997

Dear DC2000 Customer,

Our quality control checks have shown that some DC2000 kits appear to have been shipped with the wrong connectors during this past week. The kits in question have had two six-way PCB sockets packed in place of two six-pin plugs. We are enclosing two six-pin plugs to ensure that you have the right parts for your project.

When you come to assemble the PCB, please make sure you fit the plugs to the main DC2000 board, and the sockets to the band module. Please accept our apologies if your kit was one of the ones with the wrong connectors.

I hope you are pleased with your kit and that it gives you many hours of pleasure,

73

Dave Howes, G4KQH

Technical Manager

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issue 1

HOWES LM2000 Instructions

The **HOWES LM2000** is a linking module for connecting a direct conversion receiver to a transmitter for transceive operation. In particular, it is designed for use with the HOWES DC2000 and TX2000. Facilities include additional audio filtering for the receiver and a side-tone oscillator for Morse operation, in addition to the buffering and muting facilities that transceive operation requires.

Brief Technical Details

VFO Buffer: Dual gate MOSFET input buffer with adjustable amplifier gain of nominally –4dB to +10dB. Output signal level nominally 0dBm (1mW). Test figures at 7MHz.

Side-tone oscillator: Side tone injection into receiver audio amplifier stage from key operated oscillator (earth/ground for oscillation) with adjustable pitch, volume and attack.

Audio Filter: A special low pass filter gives a nominal 6dB peak at 800Hz (standard CW pitch), –6dB points nominally 450 and 1100Hz (650Hz bandwidth). This filter is also quite effective for narrow bandwidth SSB reception.

Receiver Muting: Relay operated muting, switches the receiver audio output stage over to side-tone input on transmit, and switches the receiver antenna input connection to earth (ground).

Incremental Receiver Tuning: The variable resistor ("pot") controlled IRT function, allows the receiver's VFO to be frequency shifted from the transmit frequency by a small amount, to give a "beat note" for CW reception. A "dead spot" circuit ensures the control has no effect over a few degrees of rotation either side of the transmit frequency, to make accurate netting easy, and avoid the need for a receiver IRT on/off switch.

Power Required: 12 to 14V DC at about 95 mA maximum (transmit), 38 mA in receive mode. Onboard voltage stabiliser for VFO buffer and side-tone oscillator stages.

Tools Required

Small tipped soldering iron of 25W rating (or greater if thermostatic type), small side cutters, long nosed pliers and a trimming tool for the preset resistors.

Building The Kit

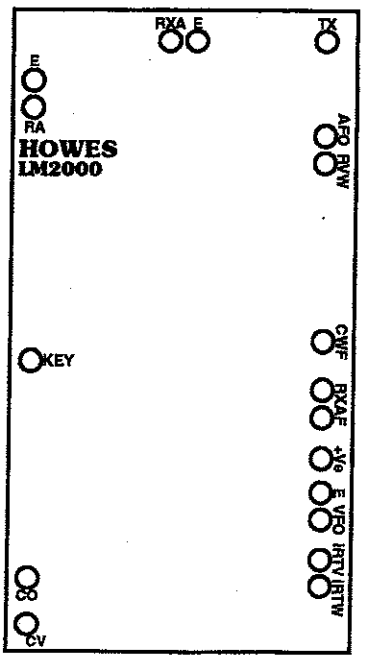
Please read all the paper work through at least once *before* starting work.

Make sure you have all the correct tools and parts to hand. A decent soldering iron appropriate to this type of work is essential for good soldered joints. Please do not use an underpowered iron (not less than 25W). The large copper area on the ground plane (the top, green side of board) will soak up almost all the heat output from a 10 or 15W iron, and the ground plane solder joints will tend to be "dry" as a result.

Terminal Pins

Terminal Pins need to be fitted to some of the Printed Circuit Board (PCB) holes for wiring to the external connections. These are inserted into the holes shown in the diagram on the right. They have circles printed around them, so they are quite easy to find. The pins are inserted from the "wiring" side of the board and after fitting should project from the "ground plane" side (the green side with the printed parts locations). Push the pins into the holes by hand, and then resting the board over the edge of the bench, use a hot soldering iron and a little solder to push the pins fully home, flush into the board. ***Be careful*** not to slip with the hot iron as you do this. When all the terminal pins have been fitted, check that they are all soldered to their PCB tracks, and also the ground plane, if there is a "silver spot" around the pin to solder to. The next job is to fit the resistors.

Terminal Pins



Holes Requiring Terminal Pins

HOWES

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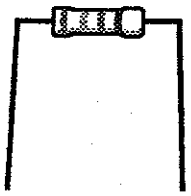
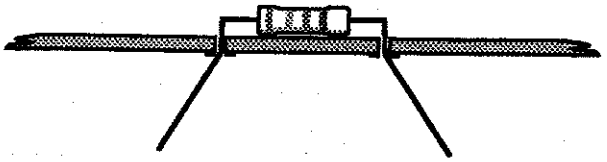
Resistor with leads bent ready for insertion into PCB





Cutaway Side View: Resistor inserted into PCB with leads bent out slightly, to hold it in place for soldering

Fixed Resistors

Select the first resistor from the list on the Parts List 1 page, by using the colour code shown. Bend its leads as shown in the diagram above, and fit it to the holes marked for it on the PCB. Push the resistor fully home, so that its body is resting on the board. Then, holding the resistor in place, turn the board over and bend its leads outwards a little, so that the component is held firmly in position. Now solder the resistor to its PCB tracks. Some resistor's leads also have "silver spots" around them on the ground plane side of the board, and these need to be soldered to the leads, in addition to the track connections under the board. Please refer to the soldering notes on page 8 for soldering advice.

When the resistor is soldered in place, use side-cutters to trim off the excess lead length, as close to the joint as possible. Move on to fit the next resistor from the parts list, and carry on down the list, until they are all soldered in place. The preset resistors are the next parts to fit.

Preset Resistors

There are four preset resistors in this kit, all having different resistance values! Please be careful to select the correct parts. Refer to the Parts List for the details. If you bend the leads outwards just a little, before pushing then into the board, they should stay in place as you solder them. The diodes are the next parts to fit.

Diodes

These must be fitted the right way round. There is a band at one end of each diode's body - this indicates the lead that goes to the hole marked "+" on the board. D1 is the largest of the six diodes. One of its leads should be soldered to the ground plane, in the same way that some of the resistors' leads were. When the diodes are all soldered in position, move on to fitting the relays.

Relays

The two relays are simple to install, they will only fit one way round. But, be careful that all their pins go through their PCB holes, and that one doesn't get bent over as you push it in.

Capacitors

When the relays are in soldered in place, move on to the capacitors. When fitting these, be sure to keep their leads as short as possible.

Notes: the "electrolytic" type capacitors must be fitted the right way round – see note on the Parts List 2 page. There are two different types of .01µF (10nF) and .1µF (100nF) capacitor in this kit (brown disc shape and rectangular green ones). Please be careful to select the correct part. We have described the capacitance of the disc capacitors in µF (micro Farads) and the Mylar ones in nF (nano Farads) to help distinguish them (1000nF = 1µF).

Transistors

The last parts to select and fit are the transistors. TR1 must have its leads bent for insertion into the PCB. The details are on the Parts List 2 page. The outlines printed on the PCB should show the orientation of the other transistors quite clearly. Keep these transistors' leads quite short by sliding them down into t board, so that the body of the device is about 3 or 4 mm above the PCB. Once these are all soldered in place and their leads are trimmed, make a thorough inspection of the module to make sure that everything is correctly assembled.

LM2000 Checking and Alignment

Checking the Assembly

Make especially sure that all the ground plane "silver spots" have been soldered to the terminal pins or leads passing through them. It is very easy to miss one of these. There is one spot without any connection (near "CO"). This is for soldering a lead to when you instal the module, and will have no connection at the moment.

Hold the board up to a bright light and check that there is no light coming through any of the holes where a solder joint should be. Resolder any connections that are in any way suspect with a little fresh solder, but do not build the joints up into a "blob"! Good soldering is bright and shiny.

When you are happy everything is correct, you can move on to installing and testing the module. Information about this is on the Module Wiring pages.

Alignment

Alignment is very straightforward. The initial mechanical positions of the preset resistors are as follows:

VR1 & VR4: Set to one third clockwise rotation.

VR2 & VR3: Set to half rotation.

Testing the Module

With the LM2000 wired to the receiver as per the Module Wiring information, you can test the basic functions of the unit. You do not need to connect up the transmitter to carry out these basic tests.

Connecting the "TX" terminal to chassis (earth/ground) will mute the receiver and bring the side-tone oscillator into use. Connect the "KEY" terminal to chassis to cause the side-tone oscillator to sound (with "TX" still earthed). Adjust the side-tone preset controls as set out below to suit your preferences.

Remove the "TX" chassis connection and the receiver should return to normal operation, with just a short delay between removing the "TX" earth and the receiver audio returning. This short delay is to ensure the transmission is completely finished before the receiver unmutes.

You can now connect up the transmitter and see how the units work together. Do not forget to fit the same frequency band modules in both the transmitter and the receiver!

Final Preset Adjustments

VR1 adjusts the VFO buffer gain. Turning the control clockwise increases the VFO output level. The nominal output level is 0dBm (1mW), but this is not critical, and the mechanical adjustment above will be quite adequate in most instances. The TX2000 transmitter also has gain adjustment, and output power can be set for the desired level by the transmitter's band filter preset power control.

VR2 is side-tone bias adjustment. This alters the attack and purity of the note and will also have some interaction with the pitch control. If you are using a transistorised keyer with this equipment, the bias control will need to be turned more clockwise than if you are using a "straight" key. If the bias is set too low, the side-tone oscillator will not oscillate. Turn it up (clockwise) to "kick" the oscillator harder.

VR3 adjusts the side tone pitch. The normal 800Hz frequency occurs with it set about half way, but simply adjust this to your taste (in conjunction with VR2).

VR4 is the side-tone volume control. Set the level to suit your monitoring requirements. It operates independently of the receiver's volume control setting.

Receiver Alignment

The "CO" and "CV" connections from the LM2000 to the receiver's oscillator circuit have a small capacitance effect, and will lower the frequency of the oscillator. The oscillator coil (L5 on the BM band module) will need to be adjusted to compensate for this.

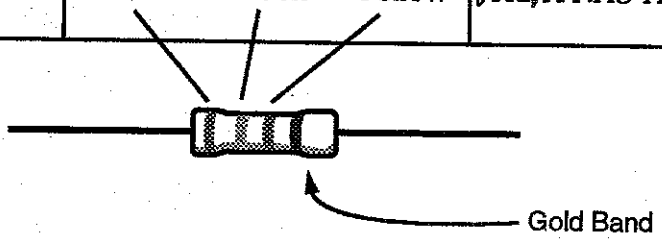
IRT Knob Alignment

There is a "dead spot" at about the centre of the IRT pot's rotation, where it has no effect on the frequency for a few degrees of rotation. This corresponds to the transmit frequency, and is provided to make "netting" easier. Ensure that the IRT pot's knob pointer is vertical in the centre of this "dead spot".

LM2000 Parts List 1

Resistors

Value	Colour Code			Part Numbers
10R	Brown	Black	Black	R9 R29
100R	Brown	Black	Brown	R2 R3
330R	Orange	Orange	Brown	R7 R11
680R	Blue	Grey	Brown	R6
1k0	Brown	Black	Red	R24 (+ one extra for IRT pot wiring)
2k2	Red	Red	Red	R15 R19 R21
4k7	Yellow	Violet	Red	R27
5k6	Green	Blue	Red	R16
6k8	Blue	Grey	Red	R17
8k2	Grey	Red	Red	R25
10k	Brown	Black	Orange	R26 R30 R32
22k	Red	Red	Orange	R8 R10 R12 R18 R22
47k	Yellow	Violet	Orange	R13 R14 R20
100k	Brown	Black	Yellow	R1 R4 R5 R23 R28 R31



Note: There should be two fixed resistors left over after the PCB mounted ones are in place. These are for wiring to the IRT pot (also supplied in this kit), when you come to install it later. The 1k0 resistor's colour code is shown above, the 3k3 one is Orange, Orange, Red.

Preset Resistors

These all look similar, but are of different values. The resistance is printed on them.

VR1 is 4k7, **VR2** is 100k, **VR3** is 22k and **VR4** is 470R.

Preset Resistor

Diodes – *make sure these are fitted the right way round.*

D1 is a 1N4004 and has its type number marked on it. It is black with a silver/grey band.

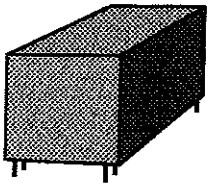
D4 is a BZX55C 9V1 zener diode it is marked with its type number. It is orange with a white band.

D2, D3, D5, D6 & D7 are all 1N4148. These are small orange coloured diodes with a black band.

Band indicates the lead that goes to the hole marked "+"

Relays, RL1 & RL2

These are easy to identify and fit. Solder just one "leg" first and check that the relay is flat against the PCB before soldering the rest of the pins.

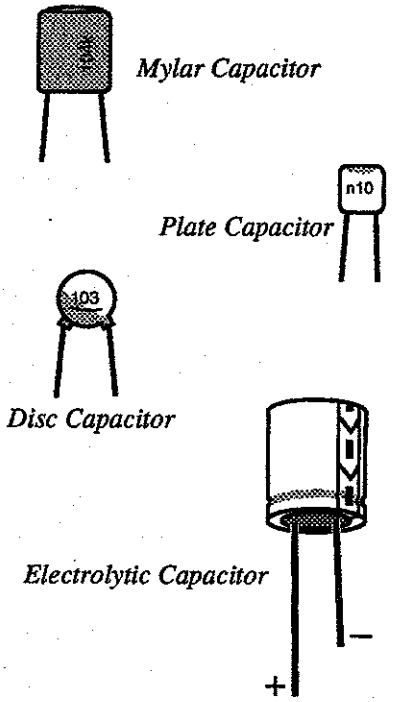


Relay

LM2000 Parts List 2

Capacitors

Value	Identification Details	Part Numbers
5p6F	Plate marked 5p6	C1 C2
1nF	Disc marked 102	C4 C11
.01µF	Disc marked 103	C5 C6 C7 C21
.1µF	Disc marked 104	C3 C8 C9
4n7F	Green Mylar marked 472	C12 C18
10nF	Green Mylar marked 103	C16 C17 C19
100nF	Green Mylar marked 104	C10 C14
220nF	Green Mylar marked 224	C13
1µF*	Electrolytic marked 1µF	C15
4µ7F*	Electrolytic marked 4.7µF	C22
470µF*	Electrolytic marked 470µF	C20



* **Electrolytic capacitors** are polarised devices and must be fitted the right way round. The longer lead goes to the hole marked "+", and the other lead, which is indicated by "–" signs on the side of the capacitor, goes to the hole marked "–" on the board.

Transistors

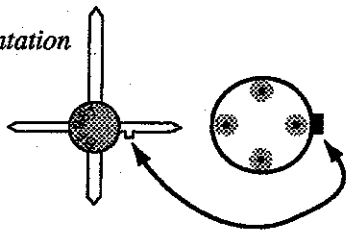
TR1: This is a BF961 dual gate MOSFET. The part number can be quite hard to read on these. The shape is distinctive though. Refer to the diagram below for fitting details. Make sure the body of the transistor is flat against the PCB after installation, and trim off the excess lead lengths after soldering.

TR2 to TR7. These are all similar shaped "bipolar" transistors (and a couple of similar numbers), but there are several different types with some very different electrical characteristics, so please be careful not to mix them up. They have their type numbers marked on them. The BC547A is marked "C547A".

TR2: MPSH10.
TR3: BC547*B*
TR4 & TR5: BC550C
TR6: BC547*A*
TR7: BC307B

Bipolar Transistor mounted in PCB

TR1 Orientation



"Pip" on lead indicates the lead that goes to the hole indicated by the pip on the PCB outline. Bend the transitor's leads down at right angles to its body so that they fit into the PCB holes. The part number on the transistor should face upwards as shown. The transistor's body should sit flat on the PCB.

PCB Pillars

Two plated brass PCB mounting pillars are included in this kit. They enable the LM2000 to be mounted 10mm above the DC2000 receiver. The right hand side fixing nuts of the DC2000 module are removed and replaced with the pillars, the LM2000 is placed on top of the pillars, and the removed nuts used to fix it in place. If you are using the LM2000 with a different receiver, the fixing holes of the two boards are unlikely to align. In this case, fit a small aluminium plate on top of the pillars and mount the module on this.

LM2000 Module Wiring 1

Outline of Connections

The diagram on this page shows the connections to the LM2000 module in general terms. The diagram on the next page shows the actual practical wiring layout when the module is used with the DC2000 receiver in the HA22R hardware pack. Refer to whichever diagram you find more appropriate for your project. The notes about the modules connections are intended as additional guidance.

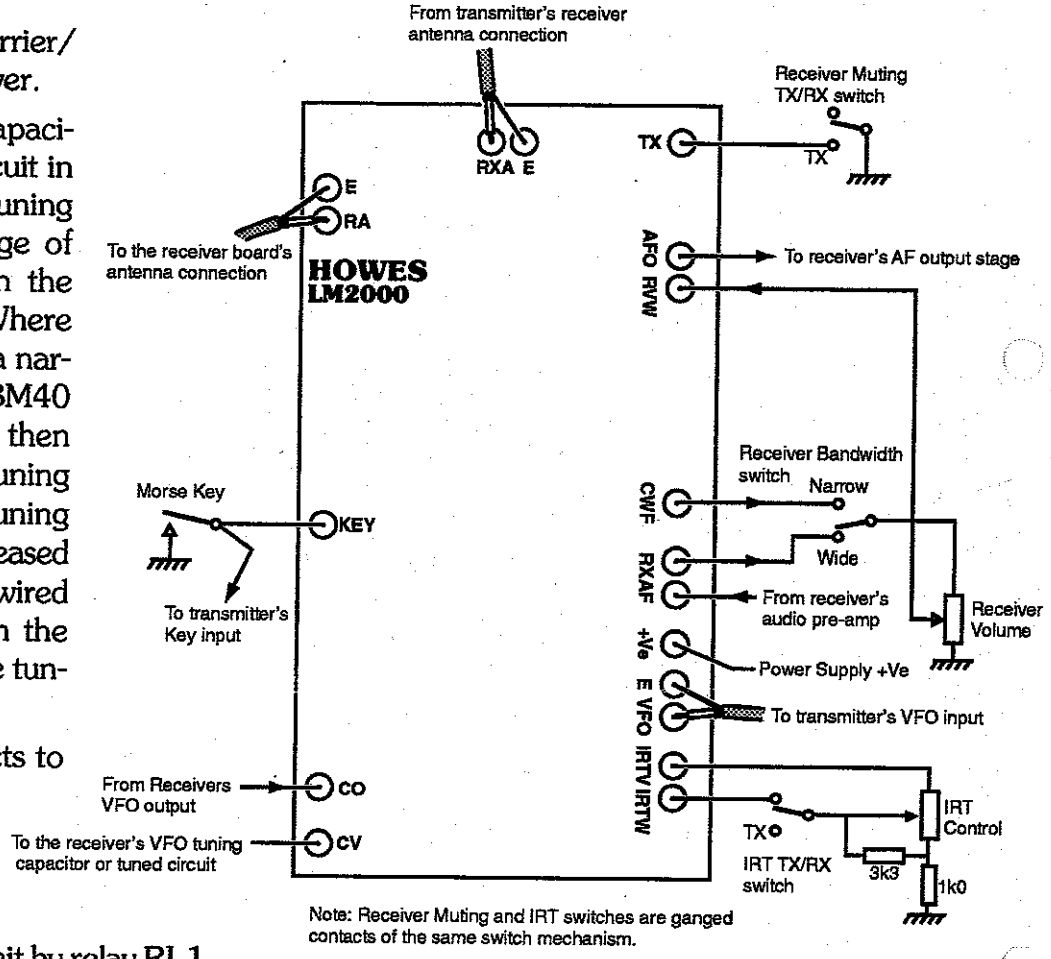
Module Terminals

CO: Connects to "CO" (*C*arrier/ counter *O*utput) of the receiver.

CV: Connects to the tuning capacitor ("CV") or VFO tuned circuit in the receiver. This is the IRT tuning connection. The tuning range of the IRT diode will vary with the receiver band module used. Where the band module only tunes a narrow frequency range (e.g. the BM40 with bandspread link option), then the IRT will give only a small tuning range when wired to the tuning capacitor. Its range can be increased if the LM2000 CV terminal is wired to the L5/C7 connection on the band module instead of to the tuning capacitor.

KEY: The Morse key connects to this terminal.

RA & E: The coax output to the receiver board's antenna connection. This connection is shorted to ground on transmit by relay RL1.



RXA & E: The coax connection for the antenna input to the module. Usually taken from the receiver antenna connection of the transmitter ("RXA" on TX2000).

TX: This terminal is connected to earth (ground) to switch the LM2000 to transmit mode.

AFO: *A*udio *F*requency *O*utput, the audio signal leaving the LM2000 to go to the receivers audio output stage.

RVW: *R*eceiver's *V*olume control *W*iper. Takes in the audio signal from the receiver's volume control.

CWF: *CW F*ilter terminal, the output of the LM2000's audio filter stage.

RXAF: ***Receiver A***udio ***F***requency terminals, the connection points for the output of the receiver's audio pre-amp stages and the "wide" connection to the optional audio bandwidth switch.

+Ve: The terminal for the positive power supply input. This needs 12 to 14V DC. The power supply 0V (earth/ground) connection should be made via the module's mounting arrangement, and does not need to be wired separately.

VFO & E: Terminals for the coax cable taking the buffered VFO signal to the transmitter. A parallel hi impedance frequency counter feed can also be taken from here.

IRTV: The stabilised *V*oltage feed to the ***IRT*** pot.

IRTW: The ***IRT*** pot's *W*iper connection.

LM2000 Module Wiring 2

HA22R Installation

The diagram on the right shows the basic connections needed to install the LM2000 above the DC2000 receiver module in the HA22R hardware pack.

The optional audio filter bandwidth switching is omitted for clarity. The feed to the volume control is shown coming from the CW Filter ("CWF") terminal on the linking module (filter in circuit). If you prefer to have a wider bandwidth, then the wire to the volume control should come from the spare receiver audio terminal ("RXAF") instead. You can of course add a switch, to switch between the two bandwidths, as shown on the previous page.

Wire the "CO" and "CV" terminals, plus the VFO signal return (see below), in 20 or 22 SWG tinned copper wire. The other, non coax, connections are best wired in flexible insulated wire.

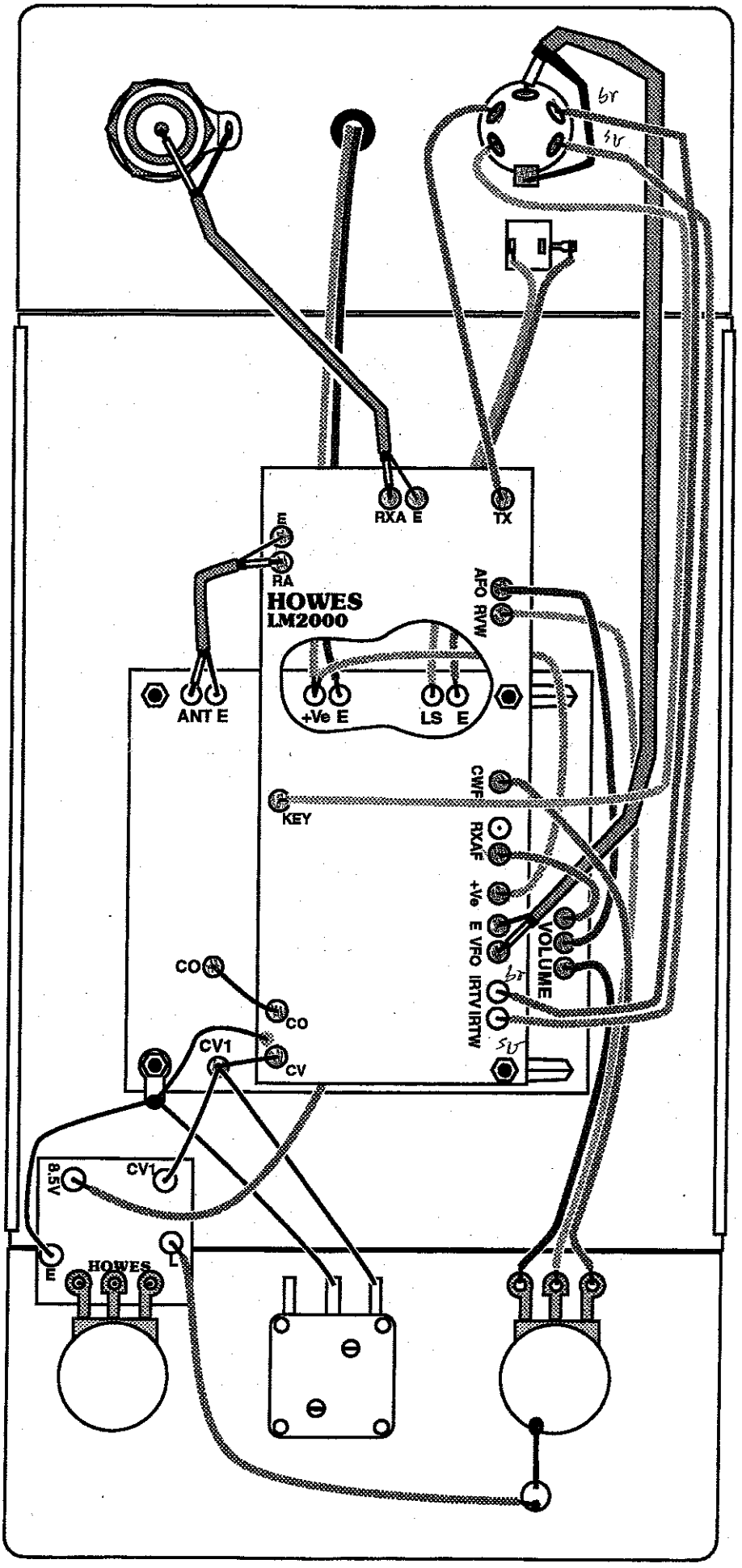
Notes

The diagram is not to scale. Some items shown have been moved slightly from their real relative positions for clarity. The front and rear panels of the hardware are shown as if they have been hinged outwards, this is to allow a view of the back of their components, so that the wiring can be seen.

The wire coming from the receiver's "+Ve" terminal to the linking module's "+Ve" terminal (seen through the diagrammatic cutaway in the top board) must be soldered to the receiver terminal, before the linking module is installed.

Signal Earth Return

The return path for the receiver's VFO signal should be provided by a piece of tinned copper wire linking the "silver spot" near the "CO" terminal on the LM2000, to the solder tag on the front left hand fixing screw of the DC2000 module. This is the only connection shown in the diagram on the right, that does not wire to a terminal pin.



LM2000 User Information

Netting

This is the term used to describe the action of tuning a transmitter to operate on the same frequency as another transmission. A number of stations in communication with each other on the same frequency, are described as being in a "net". The term can also be used to describe the action of tuning a receiver to match the transmitter frequency when using a separate transmitter and receiver.

With the LM2000 linking a transmitter and receiver together for transceive operation, the receiver main tuning (and the fine tune control, if fitted) also tunes the transmitter's frequency. The IRT control tunes the receiver *only*, by just a small amount, either side of the transmitting frequency.

To net your transmitter frequency to a received signal, you need to turn the IRT control to its centre position (knob pointer at the "dead spot" – see alignment information), and then tune the receiver's main tune (and fine tune if fitted) for "zero beat" with the incoming CW signal. "Zero beat" means the receiver is tuned so that the pitch (the "beat" note) of the received signal, reduces to zero frequency (hence "zero beat"). Once the receiver's tuning controls (main and fine) have been used to obtain zero beat, the receive and transmit frequencies are the same. To listen to the incoming signal, you need to restore a beat note by using the IRT control. This can be tuned to either side of the incoming signal frequency by the IRT pot. Adjust this for b reception. Do not touch the receiver's main or fine tune controls again, until you wish to repeat the netting procedure.

When searching for signals, it is a good idea to keep the IRT control in its centre position, so that netting is speeded up, if you decide to give the station a call.

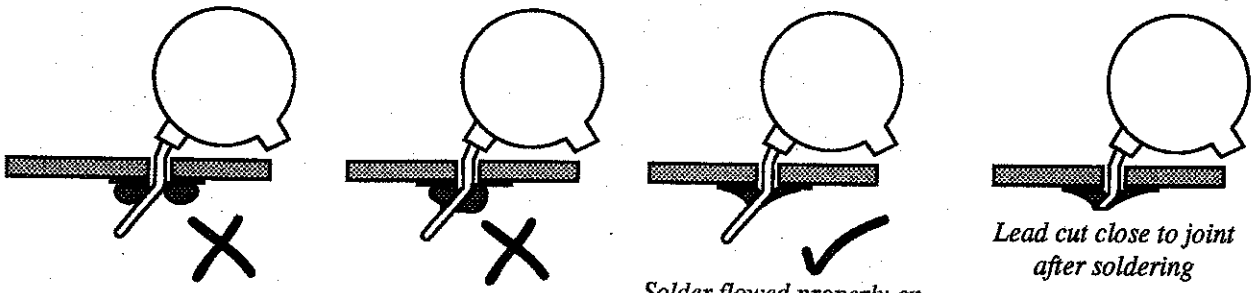
If you wish to call CQ, remember to tune the IRT either side of the frequency, to check that you won't be about to interfere with a QSO already in progress. Remember, some QRP operators may not be very skilled at netting, and you may need to use your IRT control to tune around the frequency for replies to your CQ call. Do not touch the main or fine tune controls when listening for replies, as this will shift your transmitting frequency, and you will probably lose any station trying to call you.

Using a Frequency Counter

If you have a DFD5 or other counter connected to the VFO output of the LM2000, remember that it displays the actual VFO frequency of the receiver. This is only the same as the transmit frequency, when the IRT control is centred. On receive, the exact frequency of an incoming signal is displayed at zero beat.

Notes On Soldering

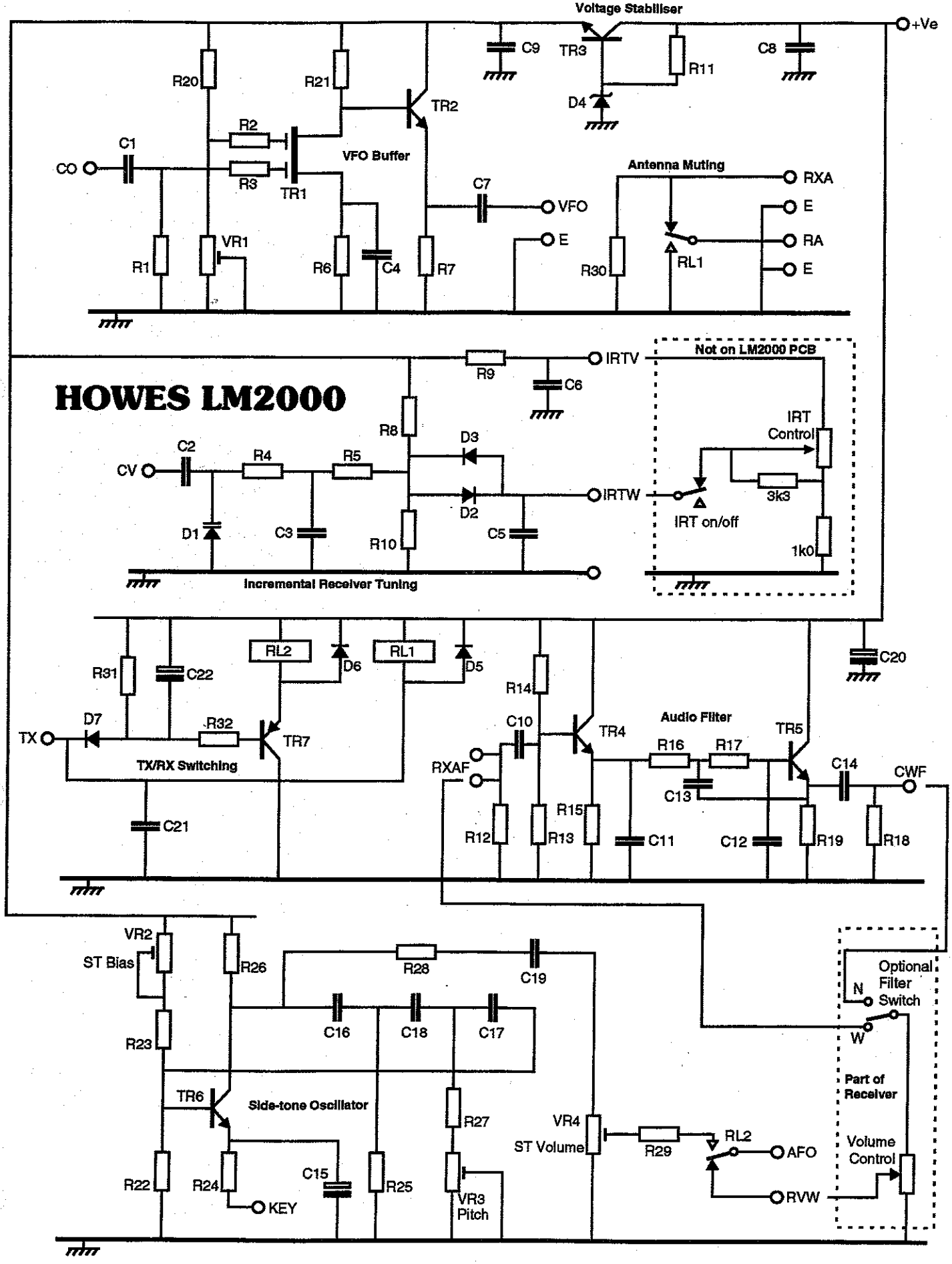
To solder properly, you must use the correct type of iron and the right quality of solder. Use a small tipped soldering iron which has a bit that is short and almost pointed at the end. The iron should be about 25 Watts (if it is not thermostatically controlled). Only use electronic type multicored solder. *Never* use any extra flux.



Lead not heated enough *Track not heated enough* *Solder flowed properly on lead and track* *Lead cut close to joint after soldering*

You should hold the hot iron in contact with both the board and component lead 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 a wait a further second or so for the solder to flow along the lead and track, 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. It is a good idea to drag the tip of the iron up the component lead as you remove it from the joint, this helps to pull any excess solder up with it, and encourages good flow along the component lead.

LM2000 Circuit Diagram



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HOWES TX2000 Instructions

Caution

The TX2000 transmitter and the band filter module(s) supplied with it are separate kits. Please take care not to mix them up! The part numbering starts at C1, L1 etc. in each kit, so be sure not to start putting the parts from one kit into another kit's board by mistake!

Note: A relevant amateur radio licence is required to install or operate this transmitting equipment.

Overview of the TX2000 project

The **HOWES TX2000** is an amateur radio CW (Morse) transmitter in kit form. It can cover all the shortwave (HF) bands by means of plug-in output filter modules. The transmitter will produce up to its full output on bands from 1.8 to 14MHz, with the power reducing to about 1W at 30MHz. One band filter kit is supplied with the TX2000 (80M band as standard, others to special order). The TX2000 is compatible with many other HOWES KITS including ATUs, SWR indicator, digital frequency displays and receivers. It can be combined with a receiver for transceive operation, by adding the relevant linking module (LM2000 linking module for use with DC2000 or DXR20 receivers).

Brief Technical Details

Frequency Coverage: 1.8 to 30MHz, operating frequency is determined by the input signal frequency applied to the module. The relevant plug-in low-pass filter must be fitted to correspond with the drive frequency.

Power: Up to a nominal 5W RF (adjustable) on 160 to 20M bands (1.8 to 14MHz) reducing to about 1W at 30MHz. Maximum power for each band is set by a preset resistor on the low-pass filter module. This enables the transmitter output to be compensated for drive level and transmitter gain changes from band to band. TX2000 is rated for continuous service at full rated output at 20°C.

VFO Input: nominal 50Ω input impedance, recommended input level: 0dBm (1mW) ±6dB.

Harmonics: Typically better than –50dBc with relevant "LF" filter module fitted.

Power required: Nominal 13.8 Volts DC, supply rated at 1.5A or more. Approx. 150 mA with "key up", about 900mA with key down at 5W output (at 7MHz).

Tools Required

Small tipped soldering iron of about 25W rating, small side cutters, wire strippers, long nosed pliers, a sharp knife, a screw driver for the M3 bolt, a drill with 2 mm and 4mm bits, and trimming tool for the power level preset on the band filter.

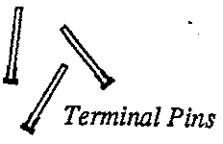
Building The Kit

Please read all the paperwork through at least once *before* starting work.

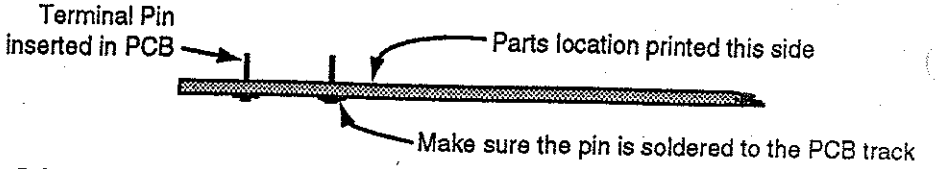
Make sure you have all the parts and tools to hand - if you don't have a small tipped iron suitable for modern electronic circuitry, then buy one, or borrow one from someone at the local radio club!

Important Note: If you intend to fit your TX2000 into the slimline HA23R hardware case, you must make a neat job of the soldering and lead trimming. There is only enough height in this case to space the PCB off the chassis by the thickness of one M3 nut. Please bear this in mind when building this kit and don't leave long lead ends, or "blobby" soldering, to short out to the case.

Fitting the Terminal Pins



Terminal Pins



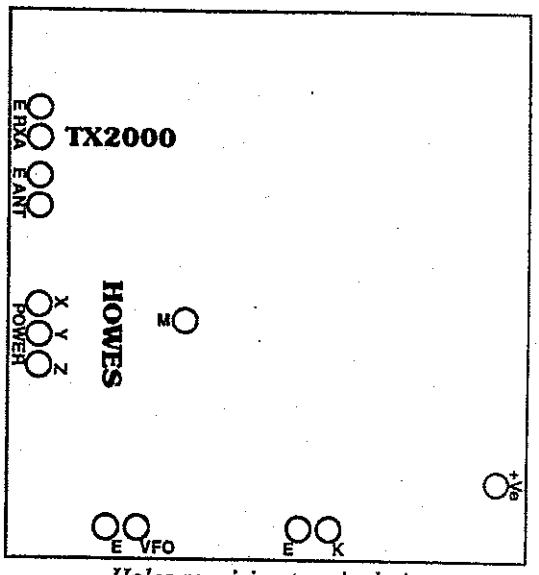
Side View: Terminal pins fitted to PCB

(continued)

TX2000 Instructions – page 2

Terminal Pins – continued

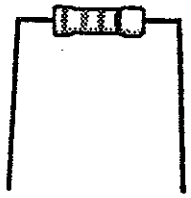
Terminal Pins need to be fitted to some of the Printed Circuit Board (PCB) holes to make it easier to wire the external connections. These are inserted into the holes shown in the diagram on the right. They have circles printed around them, so they are quite easy to find. The pins are inserted from the wiring side of the board and after fitting should project from the component/ground plane side (the green side with the printed parts locations). Push the pins into the holes by hand, and then resting the board over the edge of the bench, use a hot soldering iron and a little solder to push the pins fully home, flush into the board. ***Be careful*** not to slip with the hot iron as you do this. When all the terminal pins have been fitted, check that they are all soldered to their PCB tracks (see soldering notes for guidance)l, and that the "E" pins are also soldered to the "silver spots" around them on the ground plane side of the board. When this is done, move on to fitting the resistors.



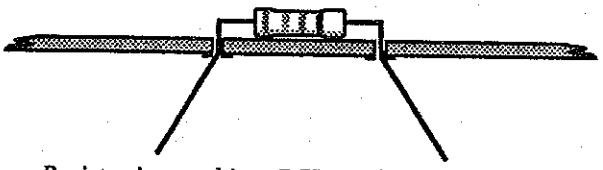
Holes requiring terminal pins

Resistors

Refer to the Parts List, and select the first resistor from the top of the list of quarter watt resistors. Bend its leads as shown in the diagram, and fit them into the holes marked for them on the circuit board. Be careful that you do not confuse the slightly larger axial inductors or the big 2 watt resistor with the quarter watt resistors. All the resistors have a light straw coloured background body colour with a gold band at one end.



Resistor with leads bent ready for insertion into PCB



Resistor inserted into PCB ready for soldering

When you have inserted the resistor's leads into their holes, push the body of the component down onto the circuit board, and then bend the ends of the leads out slightly to hold the resistor in place. Then turn the PCB over and solder the leads to the printed circuit tracks. Make sure the resistor's body is flat against the board so that its leads are kept as short as possible. If you are not an experienced hand with a soldering iron, please make yourself familiar with the "Notes on Soldering" at the bottom of page 8.

Cut the excess length of component lead off as close to the joint as possible, *after* you have soldered it. Now fit the next resistor from the parts list in a similar manner.

Note: Some resistors need to be soldered to the ground plane (component side) of the board as well as to the tracks under the board. The leads that require soldering to the ground plane are easily identified because they have a "silver spot" around them to solder to. If there is no "silver spot" around the lead's hole on the ground plane, then the component only needs to be soldered to the tracks under the board.

Carry on down the parts list until all the resistors are fitted, including the larger 2W resistor.

ial Inductors

These components look just like fat resistors, but usually have a blue or green background colour to their bodies. Inside these devices is a small coil wound on ferrite material. Fit these to the PCB in the same manner as the resistors by referring to the Parts List for the inductor's colour code information.

TX2000 Instructions, continued – page 3

Diodes

Fit the diodes next, these must go the right way round. There is a band at one end of each diode's body, this indicates the lead that must go to the hole marked "+" on the board. The parts list shows the part identification information.

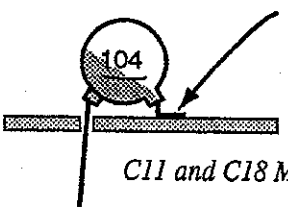
Capacitors

When the diodes are in soldered in place, move on to the capacitors. Fit all the capacitors *except C17 and C19* (the two green Mylar ones) at this point. It is best not to fit C17 and C19 until all the other components are in place (this is because C17 can get in the way of soldering TR5 to the ground plane, and as C19 is the tallest component on the board, it tends to get bent about somewhat, unless it is fitted last).

When fitting the capacitors, be sure to keep their leads as short as possible. C26's leads will need to be bent carefully before fitting to the PCB, as its holes are spaced a little wider apart than the leads coming out of the component. Be careful not to break the capacitor's body when you bend its leads.

Notes: The "electrolytic" type capacitors must be fitted the right way round – see note on the Parts List 2 page. There are two different types of .1µF capacitor in this kit (brown disc shape and a rectangular green one). Please be careful to select the correct part.

C11 and C18 have one lead soldered directly to the ground plane. There is a PCB hole for only one lead of these two components. Please *do not* drill a hole in their "silver spots" thinking we have forgotten to do this!



C11 and C18 Mounting Arrangement

Relay, RL1 and Filter Connector, PL1

Fit the relay, RL1 next. It will only fit in one way. The filter module plug, PL1 must be fitted the right way round. The plastic tab running alongside the pins must be closest to the centre of the PCB (see diagram on Parts List 2 page). Make sure the connector is pushed fully home into the PCB before soldering it in place.

Transistors

Select and fit the transistors, again these must be fitted the right way round, as indicated by the outline printed on the PCB. The power amplifier (PA) transistor, TR5, is mounted on the aluminium heatsink with the mica washer fitted between the transistor and the heatsink. There are also two fixing holes to drill in the heatsink. The Parts List 3 page has the assembly details. Make sure you remove any burrs around the edge of the holes when you drill these. TR5's emitter lead must be soldered to the ground plane "spot" in addition to its track connection on the "wiring" side of the board.

Coil Winding

The correct winding of the two transformers L5 and L8 is crucial to obtaining the specified performance of the transmitter, so please pay particular attention to the instruction on the Parts List 3 page. L7 also needs to be wound carefully if it is to fit neatly into its holes on the PCB.

Finishing the Module

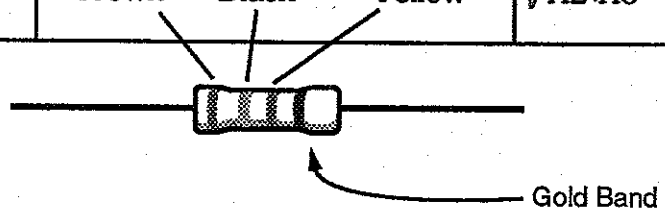
The only components left to fit now should be C17 and C19. When these are soldered in place make a very careful check that all the parts are in the right places, and the right way round. Make sure all the "silver spots" around component leads on the ground plane are soldered to the leads. It is very easy to miss one or two of these when fitting the parts, so this check is very important for even the most experienced constructor. When you have assembled a band filter module to plug in to your main transmitter board, you can start to think about testing your handiwork!

The Module Wiring page shows the normal external connections required by the TX2000. If you are using one of our hardware packs to house your project, then you should refer to the hardware pack instructions for the definitive guide to wiring the unit with that specific hardware.

TX2000 Parts List 1

.25W Resistors

Value	Colour Code			Part Numbers
10R	Brown	Black	Black	R16 R21
47R	Yellow	Violet	Black	R20 R23
56R	Green	Blue	Black	R1
100R	Brown	Black	Brown	R7 R8 R13
220R	Red	Red	Brown	R19
270R	Red	Violet	Brown	R12 R26
470R	Yellow	Violet	Brown	R14
680R	Blue	Grey	Brown	R5 R10
1k2	Brown	Red	Red	R17 R22
2k2	Red	Red	Red	R11 R18
4k7	Yellow	Violet	Red	R15 + one spare (see page 7 for usage)
10k	Brown	Black	Orange	R3 R9
18k	Brown	Grey	Orange	R25
22k	Red	Red	Orange	R4
100k	Brown	Black	Yellow	R2 R6



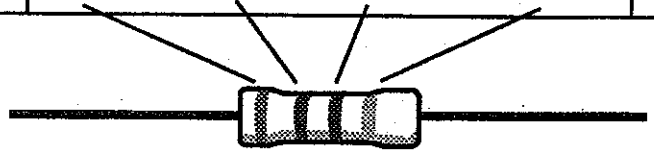
2W Resistor – R24

This is the large resistor colour coded Brown, Black, Brown, Gold and is 100R (Ω) in value.

Axial Inductors, L1 to L4 & L6

These look rather like fat resistors.

Value	Colour Code				Part Numbers
0.82µH	Grey	Red	Silver	Black	L1 L3
2.7µH	Red	Violet	Gold	Silver	L6
180µH	Brown	Grey	Brown	Silver	L4
220µH	Red	Red	Brown	Silver	L2



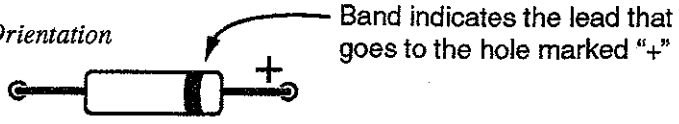
Diodes - *take care to put these in the right way round.*

The band on the diodes indicates the lead that must go to the hole marked "+" on the PCB.

D1 - This is a BZX55 Zener diode (black body with grey band) – it has BZX and its voltage (10V) marked on it.

D2 and **D3**, these are 1N4148s are orange coloured with a black band and have their type numbers marked on them.

Diode Orientation

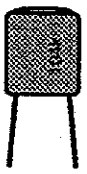


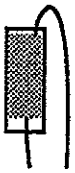
TX2000 Parts List 2

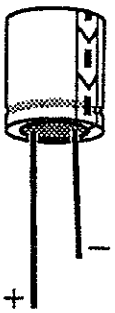
Capacitors

Plate Capacitor

Disc Capacitor


Mylar Capacitor


Polystyrene Capacitor mounted vertically (as used in some band modules)


Electrolytic Capacitor

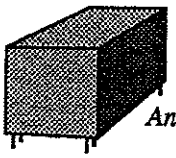
Value	Marking	Part Numbers
2p2	Plate marked 2p2	C26
1nF	Disc marked 102	C2, C4, C5
.01µF	Disc marked 103	C1, C3, C7, C9, C10, C12, C13, C14, C20, C21, C25
.1µF	Disc marked 104	C6, C11, C15, C16, C18
1µF*	Electrolytic marked 1µF	C23
22µF*	Electrolytic marked 22µF	C8
100µF*	Electrolytic marked 100µF	C22
470µF*	Electrolytic marked 470µF	C24
.1µF	Mylar, green marked 104	C19
.22µF	Mylar, green marked 224	C17

Fit C17 and C19 after all the other components are soldered in place

* Electrolytic capacitors must be fitted the right way round. The longer lead goes to the hole marked "+", the other lead goes to the "–" hole and is indicated by a band containing "–" signs on the side of the capacitor.

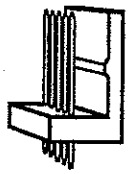
Relay, RL1

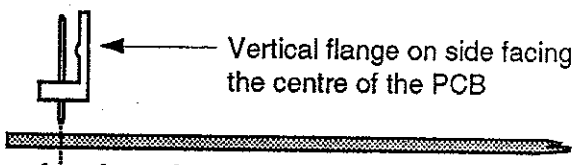
The antenna switching relay will only fit one way round.


Antenna Relay

Plug-in Band Filter Connector

PL1 is a PCB mounting 6 pin plug and is the connector for the plug-in low-pass filter module. This is fitted with the plastic flange that runs along side the contacts facing towards the centre of the circuit board as indicated by the PCB part's outline.


Module Plug

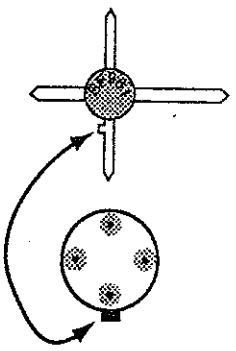


View from front of PCB showing connector orientation

BF961 Dual Gate MOSFET, TR1

Bend the leads of this transistor down at right angles to the transistor's body with its part number facing upwards. The hole for the lead with the "pip" on it is indicated on the PCB outline as shown in the diagram. Fit this carefully to the PCB and solder it in place. Trim the excess lead length off after soldering.

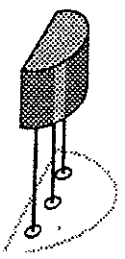
"Pip" on lead indicates the lead that goes to the hole indicated by the pip on the PCB outline. Bend the transitor's leads down at right angles to its body so that they fit into the PCB holes. The part number on the transistor should face upwards as shown. The transistor's body should sit flat on the PCB.



Transistors, TR2, TR3, TR4 & TR6

These have their type numbers marked on them. Insert them into the PCB the right way round, as the outline printed on the board indicates.

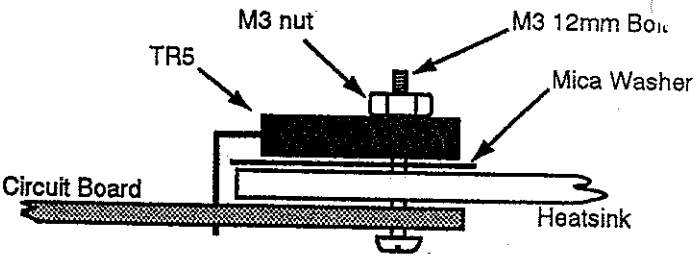
TR2 and TR3 are type MPSH10.
TR4 is the taller device marked C2500, its full title is 2SC2500.
TR6 is a BC547B.


Transistor fitted to PCB

TX2000 Parts List 3

PA Transistor, TR5

TR5 is a BUP41. Bend its leads backwards at right angles, 3 to 4 mm from its plastic body, so that they will align with their PCB holes when the transistor is bolted in place on its heatsink. **Note:** the face of the transistor with its type number on it, faces upwards away from the board and heatsink.



Fitting the PA transistor to its heatsink – side view

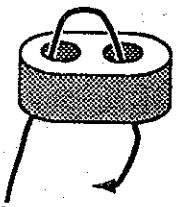
Make a temporary installation of the PA transistor without soldering it, or removing the protective plastic coating from the aluminium heatsink (see diagram for assembly order). The transistor's fixing hole is pre-drilled. You need to drill the two corner holes. Make sure the heatsink is parallel with the PCB and then mark the heatsink through the PCB fixing holes ready for drilling. Remove the heatsink, centre punch the two fixing hole positions and drill with 2 mm pilot holes. Then enlarge the holes to 4 mm and de-burr them.

Peel off the protective plastic film from the heatsink and mount TR5 on the heatsink with the mica washer between the transistor and the heatsink (you may need trim the washer to length). Make sure the heatsink and PCB corner fixing holes are aligned. Tighten TR5's fixing bolt just a little more than finger tight.

When the transistor is bolted correctly in place, solder the transistor to its PCB wiring tracks under the board, and also solder its emitter lead to its "silver spot" on the ground plane.

Matching Transformers

These are wound on the two hole balun transformer cores and provide impedance matching for the PA stage. The PA output transformer has an additional winding that provides drive for a transmitter output monitoring circuit.



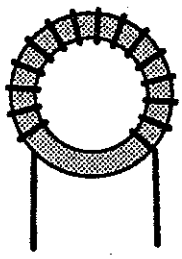
Taking the wire in one hole and out the other counts as one turn.

The finished transformer

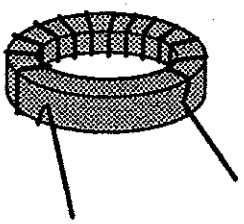
L5: Take 100 mm (4") of each of the red and yellow plastic insulated silver plated wire, and twist the wires together along their full length. Wind three turns of the twisted pair onto one of the two hole balun cores. Passing the wire in one hole and then back out of the other hole counts as one turn, as defined in these instructions. Doing this three times gives a three turn winding. The diagrams should help make this clear.

Once this transformer is wound, carefully remove the insulation from the lead ends projecting from the transformer using suitable wire strippers or a sharp knife. Please be careful not to cut or nick the wire if using a knife for this job. Then insert the leads into the PCB holes marked for L5 in the correct order. The holes are marked "y" for yellow leads and "r" for the red leads. Solder the leads and trim off the excess length.

L8 is wound in a similar manner to L5, except that this needs 100 mm lengths of red, yellow and blue wires to be twisted together. Three turns of the twisted wires should be wound on the remaining two hole balun core. Remove the insulation from the wires ends as before, and then insert the leads into their correct holes for soldering. The colours of the leads are indicated by "y" = yellow, "r" = red, and "b" = blue.



L7 Side View



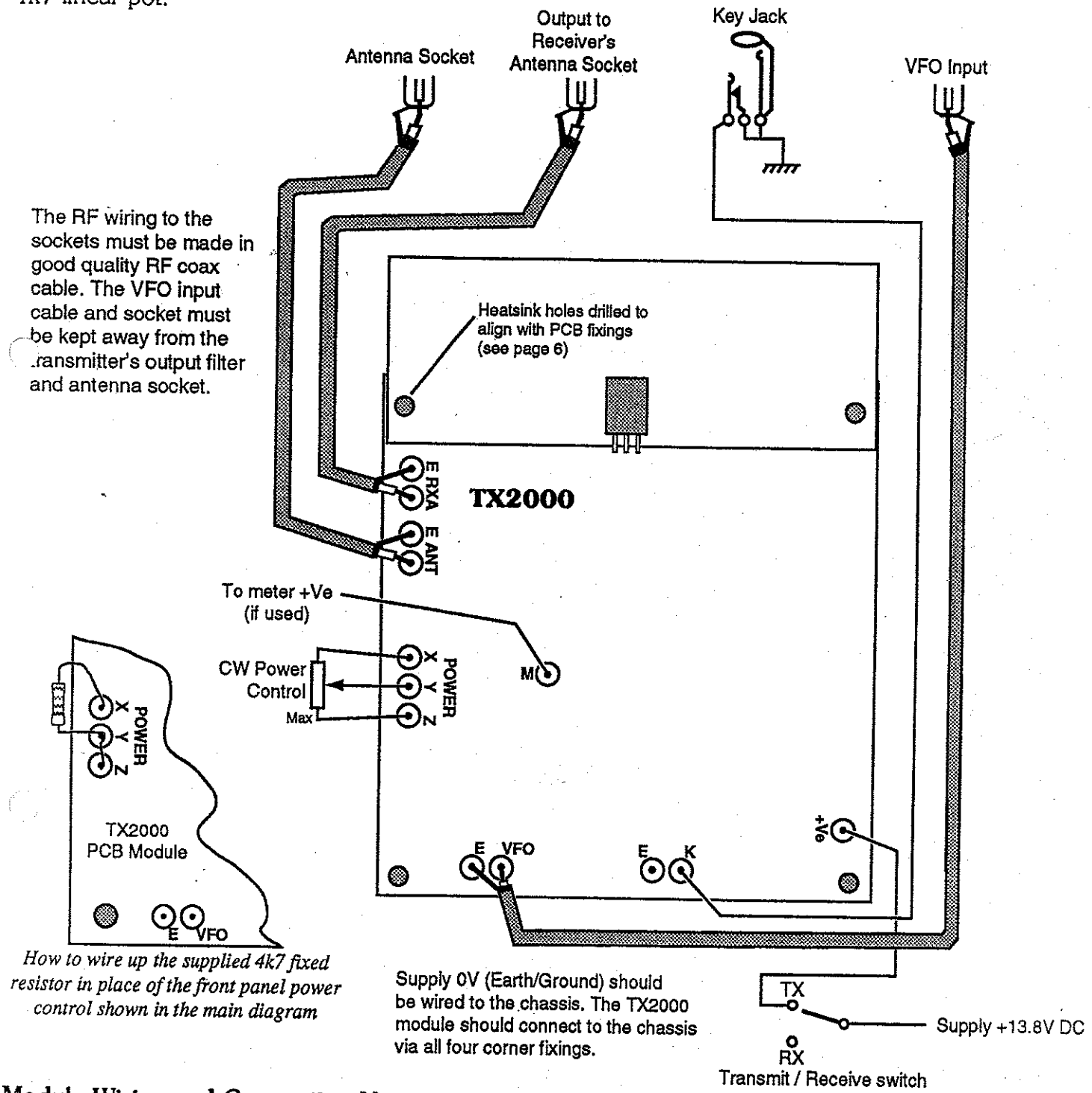
L7 showing how the leads should be bent

RF Choke – L7

Take 300 mm (12") of the enamelled copper wire, and wind 15 turns on the grey toroid core. Space the turns evenly around the core, and wind the wire tightly so that it follows the contours of the core, without any air gaps between the wire and the toroid. Bend the leads at the end of the winding as shown in the diagram, so that the coil will sit neatly in its PCB holes between the other components (the end leads need to be bent out at right angles from a point half way across the outside of the core). Use a sharp knife to scrape the insulation off the coil's end leads before inserting them into their PCB holes and soldering them to their tracks.

TX2000 Module Wiring

When your TX2000 module is fully assembled, you can install it in a metal case and wire it up, as shown in the diagram. If you are using one of our hardware packs to house your project, then refer to the hardware instructions for details of how to wire up the actual parts supplied. The optional power control shown is a 4k7 linear pot.



How to wire up the supplied 4k7 fixed resistor in place of the front panel power control shown in the main diagram

Module Wiring and Connection Notes

Important – you must have some means of limiting the current to the transmitter in case of a fault condition. Either a current limited power supply should be used (set to between 1 and 2A), or fit a 2A fuse in the positive supply lead going to the transmitter. This fusing is of the utmost importance if you are using a car battery or other source of potentially high currents. For correct protection, the fuse should be fitted at the battery connection end of the wire, not at the transmitter end.

"M" Terminal

The "M" (meter output) terminal is for connecting to a moving coil meter (use 250µA or a slightly higher rating) to indicate transmitter output. The HOWES DCS2 "S meter" kit has a suitable connection point (marked "M") so that it can indicate transmitter output, as well as receiver signal strength.

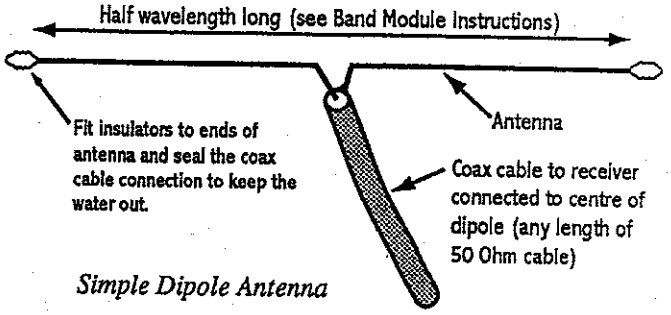
TX2000 User Information – 1

Power Supply

The TX2000 requires a power source providing a nominal 13.8V DC. It should be capable of providing at least 1.5 Amps, and should be of the regulated type, or a vehicle type battery.

Antenna Requirements

The TX2000 is designed to work with a nominal 50Ω antenna impedance. It is recommended that an SWR indicator is used to check that the antenna provides a good impedance "match". If the antenna provides an SWR of greater than 1.5 : 1, then an antenna tuning unit (ATU) should be used to improve the match. A half-wave dipole antenna should provide a reasonable match (usually about 1.5:1) without an ATU.



Simple Dipole Antenna

Always keep antennas away from other wiring, especially high voltage power lines, and always disconnect them from the equipment when they are not in use, or in weather conditions that may cause high static voltage discharges (thunder storms etc.).

Testing the Module and Alignment.

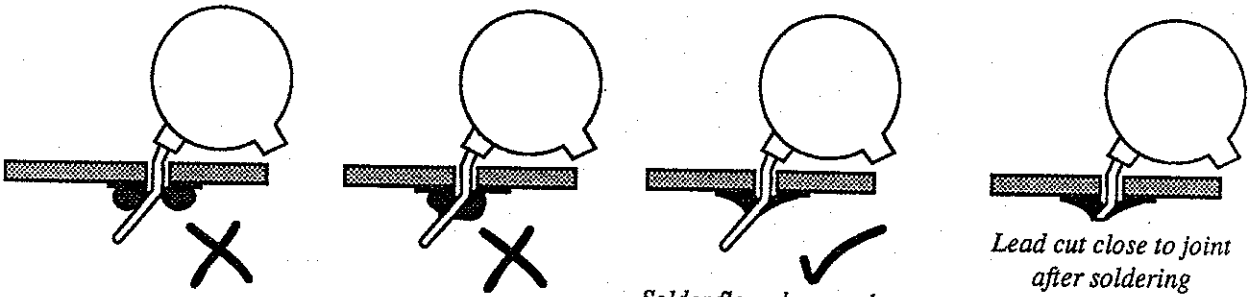
Wire the output of the TX2000 to a suitable RF power indicator with a 50Ω dummy load on its output. Connect the TX2000 VFO input to a suitable VFO/signal generator/LM2000 Linking Module, to drive the TX. Make sure the frequency is correct for the plug-in low pass band filter you are using. Set the preset power control on the filter module to half travel. If you have a front panel power control, turn this to maximum. Plug in a Morse key and connect up the power supply, being very careful to get the polarity correct.

Switch the TX/RX switch to transmit and press the key. You should obtain a reading on the power indicator. Adjust the power level preset resistor on the plug-in filter module for the desired output power, but keep the power to 5W or less. If the unit appears to be non functional, try turning the power control the other way! If there is still no output, recheck all your connections. Refer to the fault finding list on page 10 for additional help.

When all is well, fit the lid onto the transmitter's case and use your station receiver and test gear to check that the signal is "clean". You should now be able to connect up the receiver, antenna, SWR bridge etc. and set about making your first contact with your new rig! Good DX!

Notes On Soldering

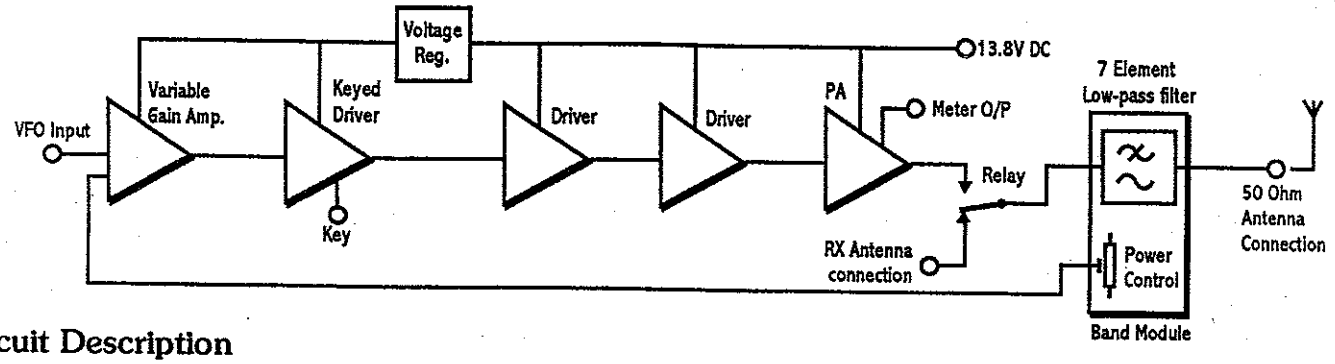
To solder properly, you must use the correct type of iron and the right quality of solder. Use a small tipped soldering iron which has a bit that is short and almost pointed at the end. The iron should be about 25 Watts (if it is not thermostatically controlled). Only use electronic type multicored solder. NEVER use any extra flux.



Lead not heated enough | *Track not heated enough* | *Solder flowed properly on lead and track* | *Lead cut close to joint after soldering*

You should hold the hot iron in contact with both the board and component lead for about a second or s 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 the lead and track 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. It is a good idea to drag the tip of the iron up the component lead as you remove it from the joint, this helps to pull any excess solder up with it and encourages good flow along the component lead.

TX2000 User Information - 2



Circuit Description

The TX2000 circuit is quite simple in concept, and the block diagram above shows the basic circuit functions in outline. The circuit diagram on the next page gives the more detailed picture. The signal from the external VFO or receiver linking module is fed into the TX2000, where a series of amplifier stages boost the signal up to a suitable level for transmission (nominally about 5W). This is in essence the main function of the TX2000. Morse "keying" is achieved by TR2 being turned on and off by the action of the Morse key. The power amplifier stage (PA), TR5, produces the transmitter's output power, and operates in a slightly different way from the other driver stages, due to its higher power operation. The transmitter output is then filtered by a plug-in low-pass filter, to reduce the harmonics of the transmitter frequency to a low level.

Variable Gain Input Stage

TR1 is a dual gate MOSFET transistor whose gain is controlled by the DC voltage applied to its second gate. The signal input is applied to gate 1 of the transistor. The gate 2 voltage is adjusted on the band filter module by the preset resistor, and also by a front panel control pot, if you chose to connect one to the terminals marked "POWER" on the PCB. A fixed resistor must be fitted to these terminals, if a front panel power control is not being used. As each band filter module has its own power control, the power output can be equalised across the bands, or set to different levels, as desired.

Driver Stages

TR2 is an "emitter follower" stage to convert the highish impedance of TR1's output to the lower impedance input of TR3. It also doubles as the keyed stage, with the current flowing through it via the Morse key, connected to the "K" and "E" terminal pins. Current only flows through TR2 when the key is pressed.

TR3 and TR4 operate in "class A" linear mode with negative feedback (some of the output signal returned to the input in opposition to the input signal) to give less distortion, and a more even frequency response, than more basic amplifier circuits can achieve. The negative feedback is reduced at the higher frequency end of the range by the action of the RF chokes, L1 and L3. This helps to keep the frequency response from tailing off as the frequency rises.

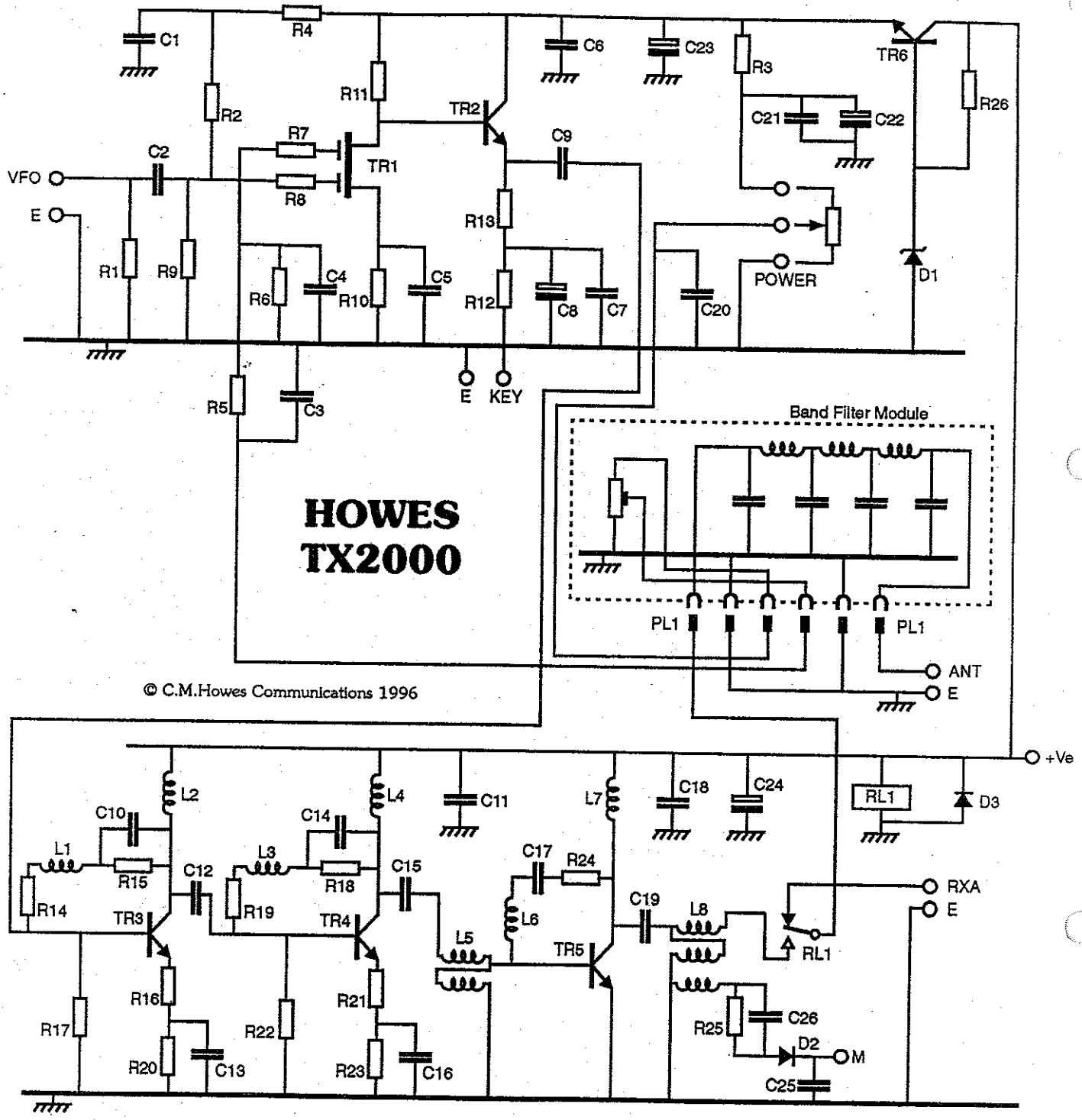
TR5 is the transmitter's Power Amplifier stage. Again some RF negative feedback is employed by means of R24, C17 and L6 to smooth the performance of the amplifier. As the power levels are higher in this stage, the currents flowing are greater, and this means that the input and output impedances of the amplifier are lower. To provide matching to the required 50Ω impedance, transformers L5 and L6 are used on the input and output of the stage. The output transformer, L8, also has an additional winding to drive a simple RF detector circuit, that can be used to drive a meter for output indication.

The output of the PA stage (which operates in class C for good power efficiency), is rich in harmonic energy, and needs to be filtered before it can be fed to an antenna. The plug-in low-pass filter module provides a good degree of harmonic suppression, and gives the TX2000 a level of harmonic performance rarely seen in simple QRP equipment. In fact, many expensive QRO linear amplifiers do not have their harmonics nearly as well suppressed!

Design

The design of good kit equipment is not just about the electronic circuitry, but also about ease of construction, minimising alignment problems and test equipment requirements, clarity of instructions, tidy board layout etc. We hope you will find your TX2000 pleasing in all these respects, as well as being a great little transmitter capable of providing you with many contacts!

TX2000 Circuit Diagram



Fault finding checklist – try these suggestions if your kit doesn't work.

1. Is the battery or power supply you are using OK? Do not try reversing the polarity under any circumstances – the unit will be damaged if you do.
2. Are your external connections correct? Pay particular attention to the key jack and antenna socket wiring. Is the SWR/Power meter you are using suitable for the power level and frequency you are using? Note: CB power meters will often under read on all frequencies below the CB band, and not register any reading at all on the 160 or 80M bands with a 5W input. Have you remembered to wire up a resistor to the "power" control terminals?
3. Are all the parts in the right places, are all the diodes etc. the right way round? Is the band filter the correct one for the frequency, is it plugged in properly?
4. Is anything loose that should not be? Try wiggling everything very gently. If a wire comes away, or a component moves on the PCB, then you have found a poor connection. There may be others, so check all parts.
5. When you have done the above and the problem persists or you have found a loose or incorrect part on the PCB, disconnect the power supply and then the wires from the terminal pins on the PCB, take the board out of the case. Recheck all the soldering. All the joints should look bright and shiny, and no light should be visible through any holes when you hold the board up to a bright light. Don't heap extra solder onto everything out of desperation! Only add solder if a joint really needs it. Too much solder will tend to "bridge" across to other tracks, so don't overdo it.
6. Reinstall the module with just the essential connections made (power, VFO input, output load) link the key terminal pin, "K" to "E" with a short wire and retest the unit. If it now works, the fault may be in the external wiring rather than on the PCB itself.
7. We can give telephone advice during office hours, and usually on Saturday too. Please carry out the above checks before 'phoning, because these are the most effective "first aid" suggestions and they should get you up and running in most cases.

C.M.HOWES COMMUNICATIONS

issue 1

LF20 Instructions

The **HOWES LF20** is a plug-in band filter module for use with a **HOWES TX2000** transmitter. It provides harmonic suppression for transmissions on the 20M amateur band.

Brief Technical Details

Frequency Coverage: For use with transmissions between 14.0 and 14.35MHz.

PCB type "LF" with 7 pole RF low-pass filter, and preset power control for the adjustment of transmitter drive levels in conjunction with the TX2000 module.

Building The Kit

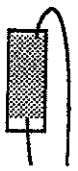
These are brief instructions giving the basic outline of building the band filter module. Please refer to your transmitter kit instructions for more information on soldering, components, and assembly techniques.

The suggested assembly order is to fit the preset resistor, followed by the socket, the capacitors, and finally the inductors (coils). When the module is finished, mark the band on it with a spirit based felt-tip pen, so that you will be able to tell which band it is! **Tip:** Grip the PCB module by the ends of the board when you plug it in.

Assembly Notes

The polystyrene capacitors are mounted "on end" in this module, as shown in the diagram.

Socket SK1: This has little plastic mouldings that wrap around the edge of the board, the terminals then slide into their holes for soldering.

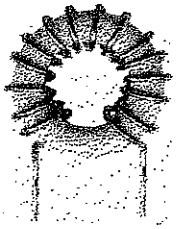


Polystyrene Capacitor

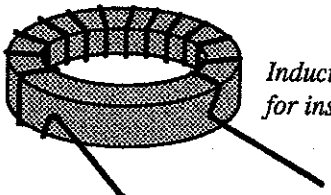
Parts List

Part	Value	Identification information
VR1	22k	Preset resistor marked 22K
C1 & C4	270pF	Plate marked n27
C2 & C3	470pF	Polystyrene marked 470

L1 15t
L2 13t
L3 15t



15 turn inductor – side view



Inductor's leads bent ready for insertion in PCB

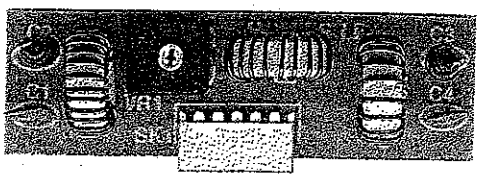
Coil Winding

Two of the inductors, L1 and L3, are identical. L2 has two less turns than the others. It is very important to wind these correctly, your transmitter's output power depends on it! Loose winding of the coils will lead to reduced transmitter output. It is essential that the wire follows the contour of the toroid to obtain the correct inductance values. Take 300mm (12") lengths of the .56mm diameter enamelled copper wire supplied, and wind 15 turns on two of the green and white toroids. Keep the wire as tight to the core as you can. When you have wound the 15 turns, bend the end wires of the coil out at right angles to the core at a point half way across the width of the toroid, as shown in the diagram. The ends of the windings should drop straight down through their PCB holes, so carefully adjust the spacing of winding on the core, so that this happens.

Use a sharp knife to scrape the insulation from the inductor's lead ends where they will be soldered. Make a thorough job of this, and then tin the leads. Insert L1 and L3 into their PCB holes and solder them in place. Then wind L2 with 13 turns and fit it to the module in a similar manner to the other inductors.

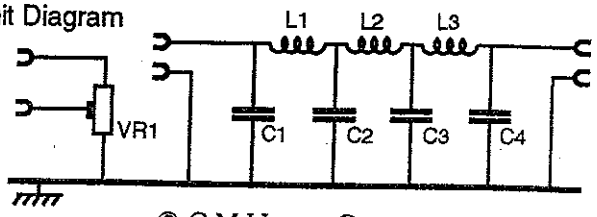
Antenna Information:

The total length of a wire half-wave dipole antenna for the 14MHz band is approx. 10.0M (32.8').



LF20 after assembly

Circuit Diagram



HA23R Hardware Pack Instructions

*Hardware pack for use with **HOWES TX2000** CW transmitter kit*

Parts List

1 off HA23R chassis
4 off M3 12mm pan head bolts
2 off M3 6mm pan head bolts
4 off self adhesive feet
2 off push-on knob
2 off SO239 antenna sockets
1 off 5 pin DIN socket
1 off red LED
1 off RG174 miniature coax
1 off HA23R cover
10 off M3 nuts
4 off No.4 self tapping screws
1 off small grommet
1 off 4 pole, 3 way switch
1 off 3.5mm jack socket
1 off green LED
1 off 2.2kΩ resistor
1 off multicoloured ribbon cable

Mechanical Tools Required

Medium cut flat file for rounding corners of case. Screwdriver and spanner for M3 nuts and bolts. Screwdriver for self-tap screws. Centre punch. Drill with the following size drill bits:– 2, 2.5, 4 & 6.5 (or 7) mm.

Pre-assembly Preparation

Before your hardware can be bolted together, there are a few jobs to do first.

Start by using a file to round off the corners of the rear panel and the cover. Round them to match the front panel corners which have already been done for you.

Cover Fixings

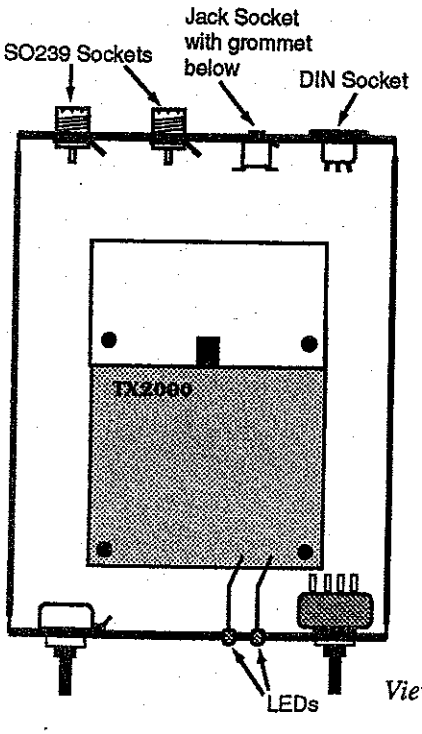
Position the cover in place on the chassis, and decide how much overlap you like at the front. Equal overlap of the front and rear panels looks quite good. Hold the cover in position, and mark the chassis through the four fixing holes. Drill the four positions where you marked the chassis with a 2.5mm drill bit (to take the No.4 self tap screws).

Rear Panel Holes

We have already punched the antenna socket holes for you, along with the DIN socket's main hole. You need to drill 6.5 or 7mm holes for the key socket and the grommet (for the power supply leads) These should be drilled one above the other. You will also need to drill the two 4mm fixing holes for the DIN socket. These should be drilled with a 2mm pilot hole first to ensure accuracy, and then enlarged to the correct size.

Drilling the Chassis to take the module.

Position the TX2000 PCB module in place on the chassis, as shown in the diagram. The front edge of the module should be approx. 25mm (1") behind the rear of the front panel to allow for the rotary switch and LED mounting. Mark the chassis through the PCB fixing holes using a felt tip pen or centre punch. Then remove the module and drill the chassis where you have marked it with 2mm pilot holes, these should then be enlarged to 4mm.



View from top showing layout

Sockets

Fit the sockets in place on the rear panel. The SO239 antenna sockets are inserted from the outside of the chassis and the fixing nut screwed on from behind. Their solder tags should be bent away from the panel so that you can solder to them later. The 3.5mm Morse key socket should be fitted in the upper 6.5/7mm hole. The DIN socket should be fixed in place with M3 6mm bolts and nuts. This connector carries the interconnections to the receiver (apart from the antenna).

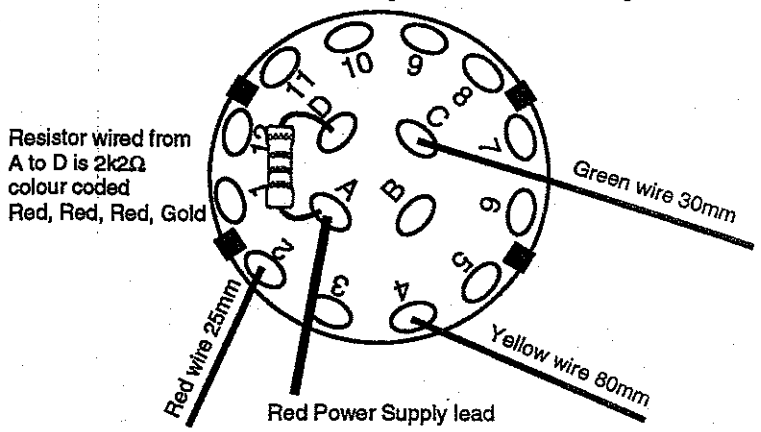
Controls

The spindles of the IRT pot (supplied in LM2000 kit) and the rotary switch should be cut down to a length of approx. 11mm. The pot can then be bolted in place on the panel. Fit the crinkle washer behind the panel.

HOWES

HA23R Instructions page 2

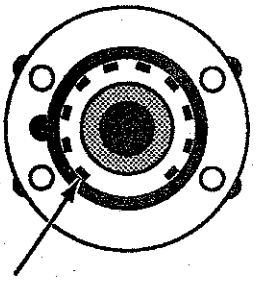
Switch with pre-installation wiring



Pre-Wiring the Switch

It is best to pre-wire the switch, as shown on the right, before fitting it into the case, as this makes the wiring easier. The recommended wire colours and lengths are shown for guidance. Peel these wires from the length of ribbon cable provided, as required. Once these wires are attached, fit the switch in the case.

The switch fits in the same way as the IRT pot, with the crinkle washer behind the panel, but before you fix it in position, you need to restrict its rotation to convert it to a two way switch. This is done by ensuring the switch is rotated fully anticlockwise, removing the "stop collar" and relocating its spigot in the two way position hole. The diagram should help make this clear. The stop collar is the silver coloured metal ring found under the crinkle washer.

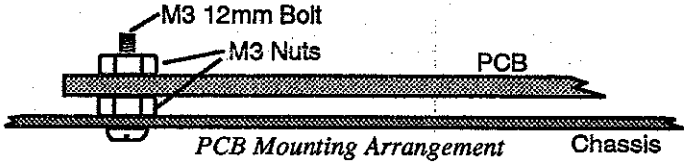


With the controls in place, the push-on knobs should be fitted. Remove the knob caps, if these are already in the knobs (use your finger nails or a thin tool), and position them so that they line up neatly with the panel markings.

Feet

Stick the self-adhesive feet neatly in position on the base of the chassis, one near each corner of the case.

Mounting the Module



PCB Mounting Arrangement

The PCB module is spaced off the chassis on M3 nuts as shown in the diagram. Make sure you have trimmed the leads of all the components short enough, so that they are not going to touch the chassis. There is only enough room in the case to mount the module one nut height above the chassis, so any "blobby" soldering on the PCB may need to be reworked, so that the leads can be trimmed more neatly.

Wiring

With the mechanical work complete, wire up the module as shown in the diagrams. You can also refer to the kit instructions (module wiring page).

The miniature coax provided, should be used to connect the SO239 sockets to the transmitter module, and also the VFO input from the DIN socket to the PCB.

The other connections are made with the multicoloured ribbon cable. Peel off the white / grey / violet / blue section from the rest of the ribbon to make the connections from the DIN socket to the front panel controls.

Note - run all the control wires around the right hand side of the transmitter module (not under or over the module). Only the SO239 coax cable connections should run along the left hand edge of the PCB.

Finishing your Transmitter

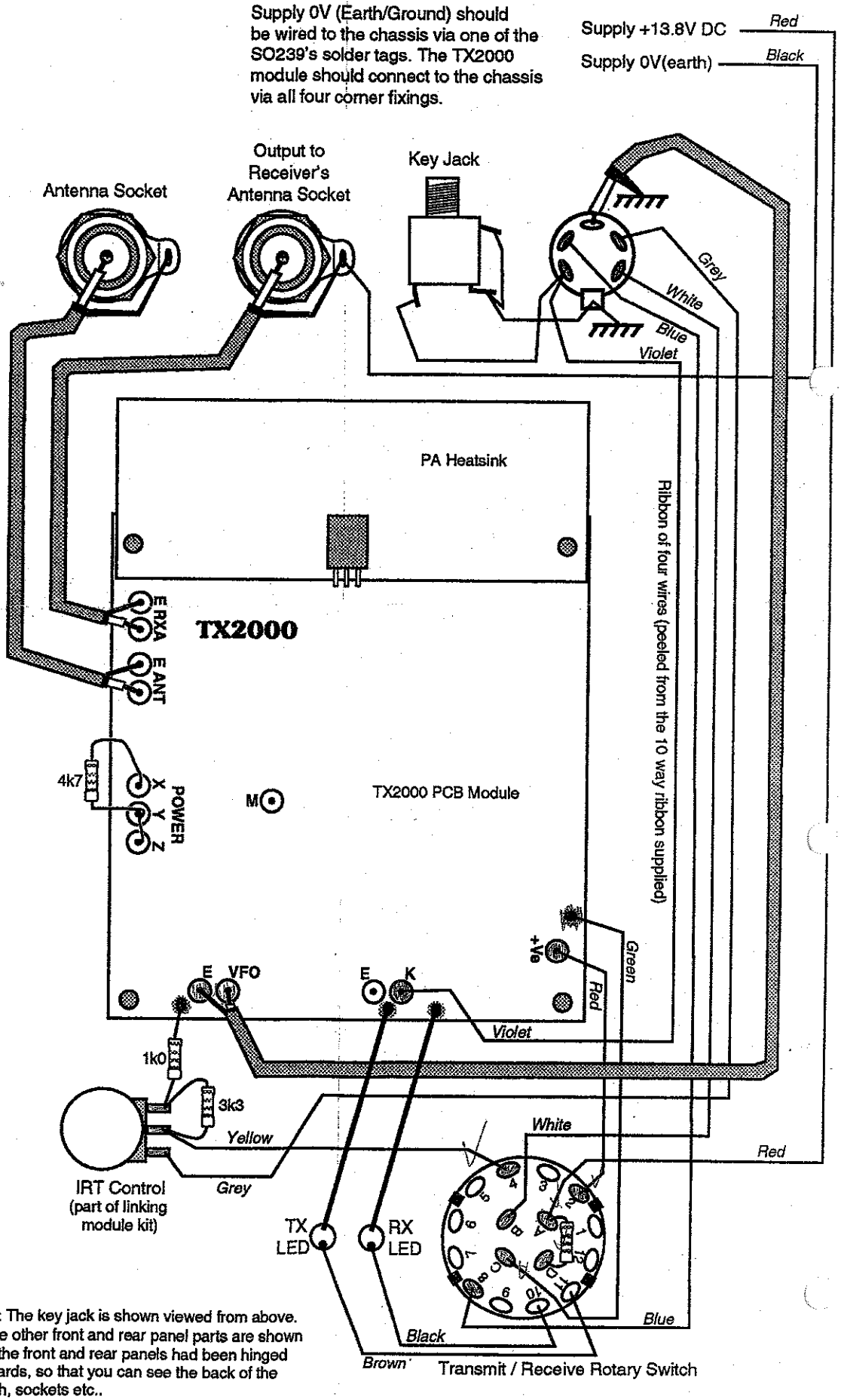
Trim and fit the self adhesive label to the rear panel to indicate which antenna socket is which.

To complete your project, you can paint the cover to match your other equipment, or any colour you choose. A satin black finish is used on our demonstration units, and is recommended. If you don't like using spray paints, then a very effective finish can be obtained by covering the cover with "Fablon" or other thin self-adhesive plastic decorative material obtainable from DIY shops. Ensure that the case's top cover can make good electrical contact with the chassis along the length of both sides by masking these areas when you paint them, or trim the covering to avoid these areas, if you are using this method to finish the case.

HA23R Instructions page 3

Wiring Diagram

The diagram below shows the connections for the TX2000 transmitter module when connected to t... DC2000 receiver via the LM2000 linking module installed in the receiver. The IRT pot and resistors are part of the LM2000 kit. If you are going to use your transmitter with a separate VFO, then you may like to fit a pot to control the transmitter's output power in place of the IRT control.



LED Wiring

The shorter lead of the LEDs is the one that connects to the silver coloured earth "spots" on the front edge of the TX2000 PCB. Push the LEDs bodies into their front panel holes (red for TX and green for RX) and solder their short leads to the PCB. After the short leads are soldered, the longer leads should then be cut down to about 5mm ready for the switch connections to be soldered to them. Solder to the cut down leads as quickly as possible, as LEDs seem to be more prone to failure due to overheating than most other components.

Note: The key jack is shown viewed from above. All the other front and rear panel parts are shown as if the front and rear panels had been hinged outwards, so that you can see the back of the switch, sockets etc..