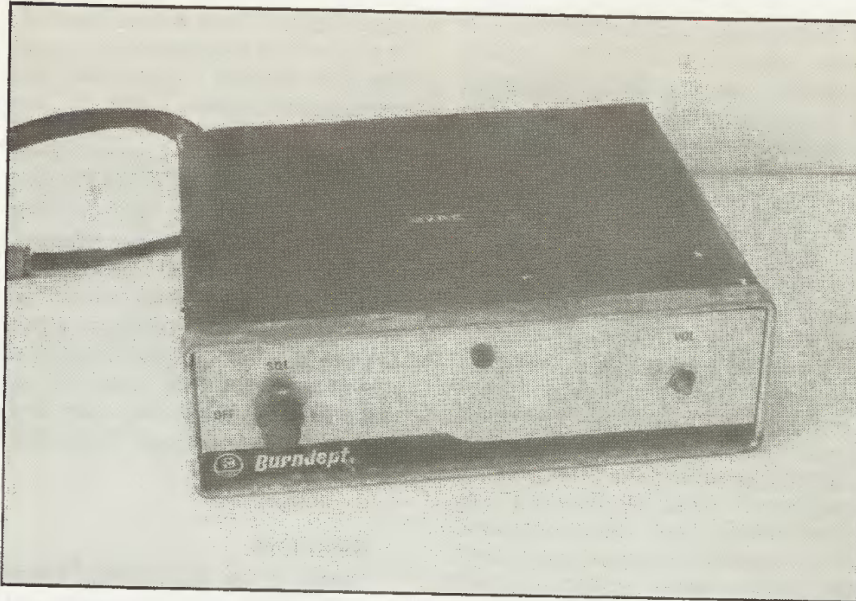


Converting the Burnde



Chris Lorek G4HCL finds another unemployed ex-PMR rig and gets it a job on 2m.

A couple of years ago, the pioneering HRT series on the conversion of ex-pmr (private mobile radio) gear onto amateur bands was a resounding success. We promised you more of the same, and true to our word here we go again. (We confess — our resident conversion expert did take a short break to write up a book based on the series).

Low Cost, High Performance

PMR rigs are designed to extremely high specifications. Before a model can go on commercial sale in the UK it must pass a stringent DTI type-approval test, to make sure the sets don't suffer from adjacent channel reception and other unwanted signals, and that transmitters put out very low levels of harmonics. As technology advances and pmr specifications get more stringent, so the earlier sets that can no longer be legally used in the pmr service find their way onto the second-hand market at a fraction of their original cost, even though many of them are brand-new.

OK, so you see a pile of scruffy-looking sets on the radio rally stand, but if you know what to look for you could end up with a useful 2m FM rig. This could be used either as a dedicated packet, or as a permanent 'stick it in the car' rig on your local natter channel.

Beginner's Rig

We hear too often that amateur radio is a cheque-book hobby, and that some amateurs have never used a soldering iron in their lives. This may be true in some cases, but it need not be. What better for a club project than to convert a number of low-cost ex-pmr sets onto a given natter-net frequency, and what a good way to keep new licensees in touch with their club members.

One of my very first transmitters was a converted Pye Vanguard complete with valves, that I bought as a student for a few pounds to get on the air. With help from a local amateur (thanks Greg, I still remember) it was converted to 2m and gave me many pleasant QSOs, as well as an eventual career in radio communication. We certainly need more radio engineers, with nearly every radio communications company bemoaning the

lack. We also need more young amateurs, who need to get on the air without spending a fortune. Couple an ex-pmr rig to a packet radio tnc and terminal (see next month's HRT for a low-cost system using Digicom), and you have worldwide error-free communication. What more could a keen youngster want?

The Burndept BE448

A recent 'newcomer' to the ex-pmr rigs on sale is the BE448, a small FM transceiver which, depending on the PA circuitry fitted, gives either 5W or 25W transmitter output. The types available on the market cover 'Low' band version is fine for 4m, the 'Mid' band version is, in my strong opinion, best avoided, and the 'High' band version will tune to 2m, albeit with a slightly 'deaf' receiver. However, with a few additional capacitors which I have detailed it will give a good receive performance. The sets are crystal controlled on both transmit and receive, and come in either single or multi channel versions.

The receivers are normally fitted with a crystal filter for 12.5kHz channel spacing, giving a receive bandwidth of ± 3.75 kHz. This is quite OK for club nets and the like using similar rigs, and for packet use providing the distant station's deviation has been correctly set to below the level of its transmit clipper, that is, typically 3kHz. If the other station is producing a full 5kHz deviation, you will find your receive audio is distorted on speech/data peaks unless you replace the set's filter with a 25kHz spacing type, ie ± 7.5 kHz, available from suppliers such as Garex Electronics.

Identification

On the side panel of the transceiver will be a serial number plate, which is duplicated on the inner chassis, and gives details of the transceiver type. If you're offered one with these removed, avoid it! Following the 'Type' designation, a single channel High band 5W unit for UK use will show the following:

BE448/5/GB/1/12/H

Common sense suggests that the 'BE448' is of course the equipment type number, '5' is the power, ie 5W, GB is the market variant, ie the UK version, '1' is the number of channels provided, '12' is the dc supply voltage, and 'H' indicates High band coverage. By using a bit of deduction, you can be your own expert when you search through the pile at the rally.

If you can obtain a set with the

Dept BE-448 for 2m

mating speaker/microphone unit then all well and good, but if not then don't worry as I'll show you how to interface your own speaker, microphone, and power lead to the multi-way connection lead coming from the set.

Before Buying

Before parting with your cash, open the set up by removing the two fixings at the rear of the case, and slide the outer metal sleeve back. Make sure none of the circuitry is obviously missing, as sometimes old sets are 'robbed' of bits for spares. Likewise ensure that extensive repairs haven't obviously been carried out, as such a set may work but there's a high chance of it not doing so. And this article only contains the conversion, not a complete workshop manual on how to fix dead sets! Don't worry if you find the plug-in channel crystals are missing from their sockets — you won't need them, and these are often removed as standard practice prior to disposing of the sets. Then, making sure the set is of the correct band and so on by looking at the serial number plate, the haggling can begin!

Crystals

You'll need one transmit and one receive crystal for each operational frequency, but be careful with your sums as a multi-channel set may often prove expensive to crystal-up fully. I'd advise using one as a low-cost single channel set, on 144.650 or 144.675 for example for packet radio, or on your dedicated

natter channel. The formulae for the crystal frequencies are given in Fig.1.

Suitable crystals may be obtained from supplies such as Quartslab Ltd, PO Box 19, Erith, Kent (Tel. 0322 330830). The commercial specification of the crystals are the Burndep spec. No. X857-1210/14, but whichever crystal supplier you choose ensure that you state they are for use with the BE448, other-

wise you'll find you're off your intended frequency.

Fig.1 Crystal Frequencies

145MHz:

$$\text{Tx Xtal (MHz)} = \frac{\text{Transmit freq. (MHz)}}{16}$$

$$\text{Rx Xtal (MHz)} = \frac{\text{Receive freq. (MHz)} - 10.7}{4}$$

70MHz:

$$\text{Tx Xtal (MHz)} = \frac{\text{Transmit freq. (MHz)}}{8}$$

$$\text{Rx Xtal (MHz)} = \frac{\text{Receive freq. (MHz)} - 10.7}{2}$$

Connections

The coaxial aerial lead coming from the rear of the set is normally terminated in a BNC socket. This may be left in place or changed to suit. The other thick lead coming out of the rear carries all the other functions. If you have the suitable interface with its mating socket then well and good, but if not then remove the attached plug on this lead by unscrewing the two cable clamp screws, then the four plug screws, and carefully pull the lead out through the plug body.

The connections you need for normal amateur use are given in Table 1, note that not all the connections are listed, and you may simply insulate the remaining leads that are present on the connector. The required speaker impedance is a nominal

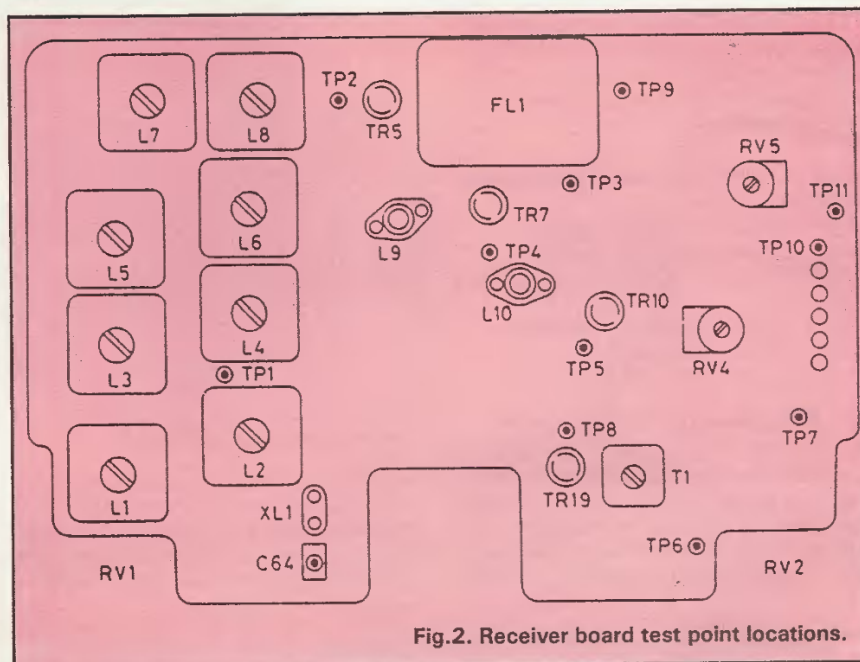
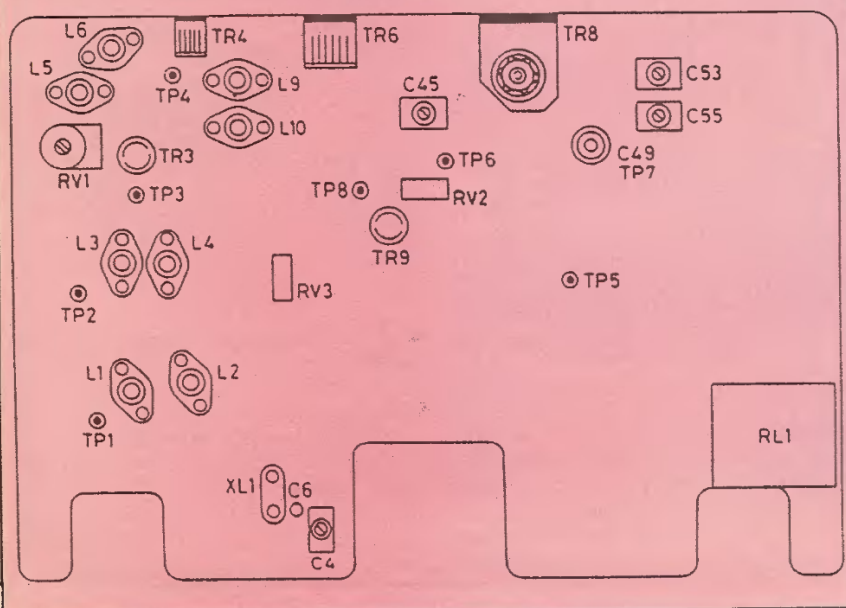


Fig.2. Receiver board test point locations.

Fig.4. Transmitter board test point locations.



3 ohms, the set providing 2W rms output to this connection. The microphone input requires a few millivolts rms at a nominal impedance of 300 ohms. A simple low-cost dynamic microphone will be perfect here, or an electret condenser microphone with suitable bias arrangements. The dc power leads should be suitably fused, the set typically drawing 1.5A (5W version) or 4.5A (25W version), and the front panel squelch control doubles as the set's power On/Off switch.

Table 1. Multi-Way Lead Connections Required

Red	— 13.8V dc Positive supply
Black	— 13.8V Negative supply
Clear	Insulated screen — Common Ground
Yellow insulated inner	— Microphone
Grey	— Receiver Speaker
Pink	— Tx ptt, Ground for Tx

Alignment Preliminaries

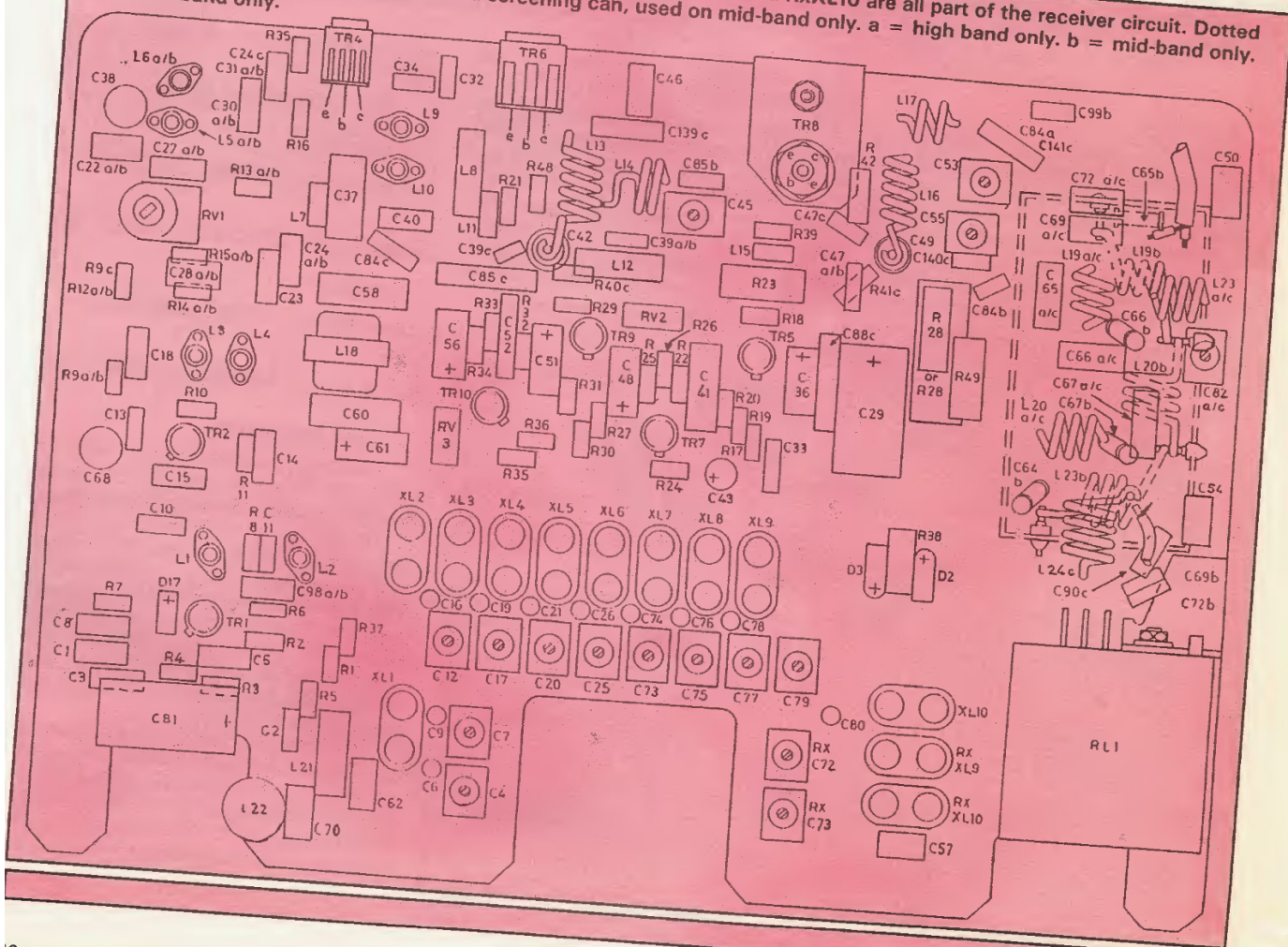
First of all take a look at the trimmer capacitors in the transmitter power amplifier, and the ferrite adjusters in the coils, the latter which have slotted and hexagonal holes in them for adjustment. You'll need to obtain suitable non-metallic

The transmitter circuit board.

trimming tools for these, and don't, under any circumstances, be tempted to use metallic jeweller's screwdrivers and Allen keys for these. Apart from upsetting the set's tuning in the first place, you'll be

likely to crack the brittle ferrite cores, and I've lost count of the number of times I've said 'I told you so' to amateurs asking me where they can obtain replacement cores, along with how they can remove the

Fig. 4. The layout of the transmitter board. Rx C72, Rx C73, Rx XL9 and Rx XL10 are all part of the receiver circuit. Dotted items form an aerial filter contained in a screening can, used on mid-band only. a = high band only. b = mid-band only. c = low band only.



jammed cores without destroying the coils. Don't try it, it just isn't worth it. If you haven't got access to suitable adjusting tools, a filed down matchstick or plastic knitting needle will work very well as a temporary tool for a one off job. You'll also need a multimeter to give a dc voltage reading, and some form of RF power indication to allow you to tune the transmitter for maximum power output.

Receiver Alignment

Connect up your dc power lead and speaker, plug our receiver crystal in, and select the appropriate channel if you have a multi-channel set. Connect the negative lead of your multimeter to the dc supply negative, and with the 2.5V range selected connect the positive lead to TP1, referring to the Receiver Test Point location diagram. Switch on, and check that the front panel volume and squelch knobs operate as expected. If you get an intermittent response then a quick spray of a proprietary switch cleaner into the control's carbon track often works wonders. If you only require a unit to operate into your local, and hence strong, repeater then just perform the normal alignment. However if you need good sensitivity, follow the receiver modifications detailed. It's up to you whether you do this before or after the 'first' alignment, as it is often useful to check the radio works as you'd expect before diving in with your soldering iron, possibly causing a fault in the process which may be difficult to trace.

For the initial alignment, with your hexagonal non-metlic trimming tool, turn the core of L2 until you see the meter needle rise, then carefully tune for maximum reading, ensuring it doesn't suddenly 'drop' if you tune too far. For the next adjustment you need to connect your meter lead to TP2, and carefully tune the cores of L4 and L6 for minimum reading. In practice I have found that this is a difficult job as the voltage difference is very small, and the tuning is fairly broad. You could be better off tuning these for best reception of a received signal as detailed below.

For the remainder of the alignment, you'll need an off-air signal to tune to, reducing the level of this as your tuning progresses. As a first measure, you'll find it useful to tune the cores of L1, L3, L4, L5, L6, L7 and L8, two complete turns clockwise each, ie lowering the tuning cores into their formers. This will place the receiver very roughly in the 145MHz range, the remainder of the tuning adjustments of these cores being performed for best reception of a received signal. Remember to initially tune the appropriate crystal trimmer capacitor for best, ie least distorted, reception of a received signal on the correct frequency. You'll often find that you can perform the final 'spot on' tuning by a suitable choice of a relatively

weak off-air signal, either by using different aerials or by a helpful amateur varying his transmit power for you during an on-air test. Even the local oscillator of a scanner receiver can be used as a weak signal source (key in a frequency separated from your BE448 receive frequency by the scanner's if).

You shouldn't need to touch any of the other receiver adjustments, such as those on the if and audio circuits, as these should already be at their optimum settings.

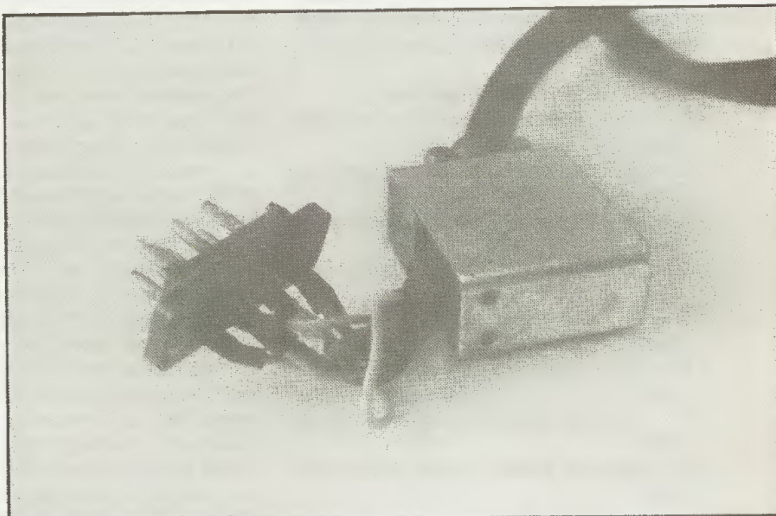
Receiver Modifications

By now you'll typically have a working receiver, but with a sensitivity of the order of 2-3 μ V pd for 12dB sinad, ie around 15-20dB 'deaf'. If this is sufficient for your needs then fine, but if not you'll have to get your soldering iron out. You'll need a number of ceramic plate capacitors, the actual type is irrelevant for our purposes as long as they are physically small. Table 2 gives the capacitor values

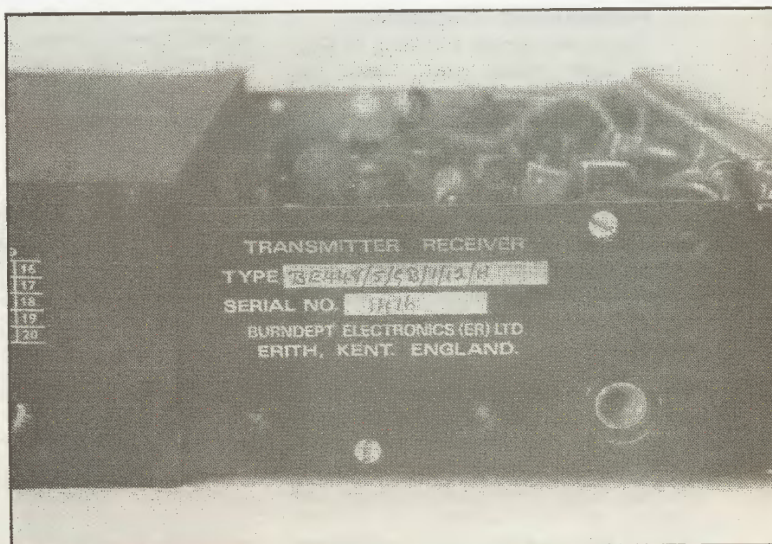
and the required modifications, derived by yours truly after initial calculations followed by many hours of testing with an RF signal generator. They are a compromise, but to get the last half dB out of the receiver you'd need to modify around three times the number of components together with a coil re-winding effort.

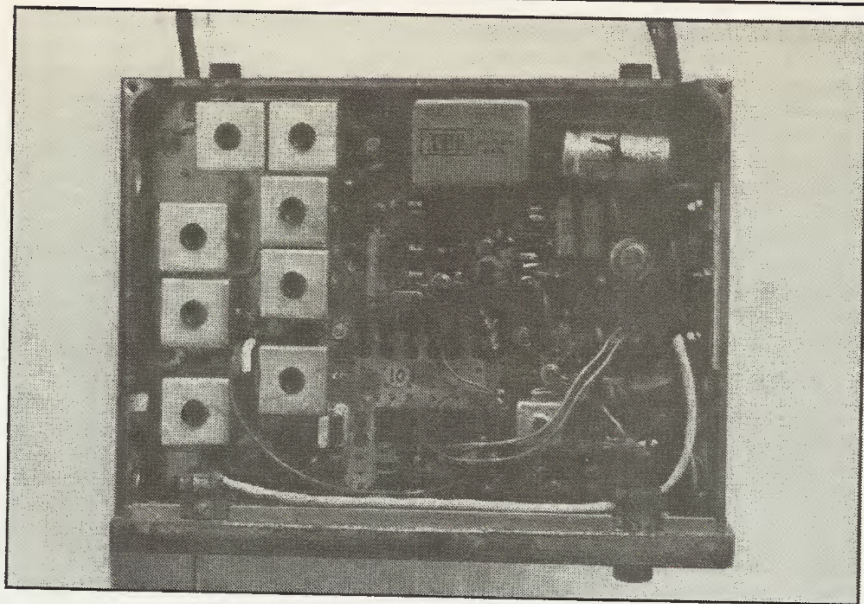
To get at the required locations, you'll first need to remove the seven outer slot-headed screws securing the receiver pcb to the chassis, together with the two central nuts. Then remove the nut/bolt arrangement securing the side heatsink panel to the chassis, and carefully hinge the pcb up as far as it will go. De-solder the folded-over tags securing the coil cans to the pcb and carefully bend these straight, so that the cans can be lifted vertically away from the pcb. Solder the required extra capacitors to the coil former pins, then replace the cans and solder their tags back in place. Finally replace the fixing screws, not forgetting the side heatsink fixings. Following a

Multi-way plug to interface speaker, microphone and power.



The Serial Number Plate — check before buying!





The receiver circuit board.

quick re-tune a detailed above you should achieve better than $0.5\mu\text{V}$ pd for 12dB sinad from the receiver, typically $0.35\mu\text{V}$.

Table 2. Receiver Modifications

- L1 — 3p3 cap added across existing 3p cap.
- L2 — 2p2 cap added across existing 4p cap.
- L3 — 3p3 cap added across existing 3p cap.
- L4 — 3p3 cap added across existing 5p6 cap.
- L5 — 2p2 cap added across existing 3p cap.
- L6 — 1p8 cap added across existing 4p cap.
- L7 — 1p8 cap added across existing 2p cap.
- L8 — 1p8 cap added across existing 2p cap.

Transmitter Alignment

This is the simple bit! Plug in your crystal, again taking care to select the right channel if yours is a multi-channel set. Connect a suitable 50 ohm load to the aerial termination, with some form of RF power indication to show how you're doing. This doesn't need to be an accurate power meter; a simple wavemeter or a diode probe coupled to your multimeter will do. Connect your multimeter negative lead to the dc supply negative, switch to the 10V dc range and connect the positive lead to TP2.

Key the ptt (making sure the internal Tx/Rx relay clicks over) and tune the cores of L1 and L2 with your non-metallic trimming tool for minimum (not maximum) dc reading. Remove the meter positive lead, switch to the 2.5V dc range, and connect to TP3 (145MHz Tx) or TP4 (70MHz Tx). Note that TP4 is the emitter

of the heatsinked transistor, the lead with the violet insulation. Now tune the cores of L3 and L4 for maximum reading with the ptt keyed. For 145MHz rigs, transfer the positive meter lead now to TP4 (the transistor lead) and tune L5 and L6 for maximum reading again.

Note that potentiometer RV1 acts as an RF output power control, and with this fully clockwise maximum power is given. By now you may be getting a sniff of RF power indicated with the ptt keyed, in which case tune the cores of L9 and L10 for maximum RF. If not, then connect the positive lead of your multimeter, set to the 15V dc range, to the dc supply positive, with the negative lead connected to TP6, tuning the two cores for minimum (not maximum) reading, which should coincide with maximum RF power. You can now transfer the negative lead to TP7, this is the centre connection of the chassis mounted feedthrough capacitor, and tune C45 for minimum reading again coinciding with maximum RF power. Now it's a simple case of tuning the remaining

trimmers in the power amplifier, C53 and C55 for the 5W pa, plus C127, 128, 121 and 122 for the 25W pa, for maximum RF output, together with a final adjustment of C82 in the aerial filter (at the extreme right of the pcb) for maximum.

You'll now need to adjust the relevant crystal trimmer capacitor for the correct transmit frequency, either by tuning with the aid of a receiver fitted with a centre-zero meter, or by 'zero beating' your transmitter against another of a known frequency while monitoring on a receiver. Some amateurs may have access to a frequency counter which is the ideal. The transmit deviation will probably be set fairly low if the unit was originally adjusted for 12.5kHz channel spacing. RV3 is the deviation potentiometer to adjust. Watch out for the large wirewound resistor next to your fingers while you're doing this — it gets hot. If you have access to an oscilloscope, either coupled to a deviation meter or a monitor receiver, you can also adjust RV2 for equal clipping of a well-modulate signal, together with a final tweak to L1 and L2 for minimum distortion. Otherwise, leave these well alone.

That's It

That completes the RF alignment as far as amateur service is concerned. If you're a perfectionist with access to a laboratory full of test equipment, then by all means feel free to complete the manufacturer's full 37 page alignment instructions!

I hope this article prompts a few amateurs to have a go, as it really is not all that difficult to get an ex-pmr rig going on the amateur bands, saving yourself a fair bit of cash in the process.

My thanks go to Kanga Products for the loan of the transceiver used in this conversion, and Quartslab for the kind provision of the 144.650MHz crystals used.

