70 MHz - The Forgotten Band

A beginners band or a low cost chat channel? Either way Chris Lorek, G4HCL, shows us how to have fun on Four.

Six metres is the current talking point with its far reaching possibilities and it is certainly easy to get going on the band with the abundance of commercial equipment available. Many amateurs, especially class Bs, are keen to get going on the 'new' frequencies, but quickly stumble against the cost of getting set up again on another band at a later date.

Many amateurs would like a low cost set, portable, mobile or fixed, to use on a local 4m natter channel. In my area many of us have been doing this for some time using surplus two-way radio gear on 70.260MHz, the national mobile and calling frequency and an ordinary car radio aerial will often resonate perfectly as a mobile quarter wave on 4m. A tiny single-channel Pye Reporter, which is smaller than many current 2m rigs, offers a welcome alternative to 2m on car journeys and with sets available from 50p-£45, with no modification whatsoever required (apart from re-crystalling and tuning), is it any wonder that surplus dealers are doing a roaring trade!

In this article, I aim to show what to look out for to set yourself up on 4m, giving simple retuning instructions for popular equipment. It is clearly not possible to provide full circuit diagrams and fault-finding information as well as detailing every type of equipment found, but I hope it will feed a currently needed information gap.

AM vs FM

The majority of voice activity on 4m using carrier modes (ie. not SSB) is currently AM and not FM. This is simply due to the vast majority of ex-commercial equipment available being AM, so don't turn your nose up at in the rally stall. You might find you'll pay three times the price for an FM set and then find you'll have no-one to talk to! My advice would be to ask any active 4m operators what's used in your area if you're not sure, as there are 'pockets' of both AM and FM usage, the explosion is just beginning to start and will inevitably be led by what is abundantly available in your area on the surplus market.

Table 1 shows the current 4m bandplan and as you can see 70.260MHz is a good frequency to get crystalled on using either AM or FM, with 70.450MHz a possibility for FM users with 70.425MHz and 70.475MHz as simplex working channels. Crystals for the more popuar frequencies such as 70.26 are normally available ex-stock from suppliers such as Quartslab. If a 12.5kHz channel plan is eventually adopted, as common sense suggests, then one's crystals should easily pull to 70.2625MHz.

The first step of acquiring a set is to know what you're looking for. The majority of sets on the surplus market have been of Pye Telecom manufacture, and the magic letters to look for on the serial number plate are 'E' or 'EO' in the equipment code space. This means it has been manufactured to operate in any segment of 68-88MHz, which of course covers 4m quite nicely. Some sets, notably portables, have sub-divided ranges of E1 (68-79MHz) and E2 (77-88MHz), so obviously avoid anything marked 'E2'!

UK 4M BANDPLAN		
70.000		
	BEACONS	
70.75		
	CW	
70.150		
	SSB/CW	
70.260		70.260 National mobile and calling
		70.300 Raynet calling
	ALL MODES	
		70.350
		Raynet use
		70.400
70.400		
	FM SIMPLEX	70.450 FM calling
70.500		

Table 1 Recommended band plan for the 4m band

The Pye Europa FM tranceiver

Westminsters and Reporters

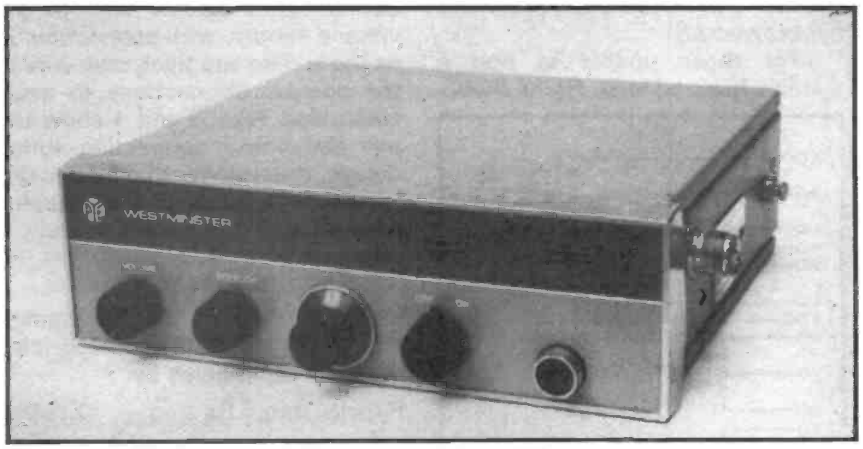
Westminsters are currently the most commonly available and have proved themselves to be both popular and reliable. These come in AM and FM versions, remote and dash mount, with 'W15***' marked on the serial plate. Following the W15 comes either 'AM' or 'FM', followed by 'D' or 'B' for Dash or Boot mount versions respectively. A variant to this is the W30AMB, a high-power boot mount, identified by a long case (similar to the W15U UHF set) but with small ventilation slots at the rear. This is also suitable for use on 4m.

Reporters (MF6AM) are now also coming onto the market — these are small low cost sets either single or six channel, dash mounted AM units which are reliable and pack a good performance for their size, the photograph shows a surplus model with a built-in speaker microphone.

Europas, Bantams and Pocketphone

Europas in both low (MF5FM) and high (MF25FM) power versions are available, operating purely on FM. These are reasonably compact dash mount sets with a black padded front panel housing a built in speaker. Easy to tune, these are becoming increasingly popular. For those of us who get around on our feet a lot, a portable set may be very useful. The old Bantams are rapidly being taken over by the Pocketphone 70 range on the amateur market; 4m is covered by the PF2FMH hand-held and PF2FMB bodyworn FM sets, and higher power version, the PF3FMH/B is also found. A rare beast you may happen across is the PF2AMB AM bodyworn set.

Occasionally seen is the MF5AM Motafone, this is a compact AM set but not featured here due to its relative scarcity in working condition. Also found is the more modern Olympic range, in AM and FM variants. These are normally higher priced and tend to be far more fiddly to tune up and keep working reliably, hence these are not featured either. However, do remember that the surplus 'EO' band A200 linear amplifier will also perform well at 4m (on both AM and FM) and this was featured in the September 86 issue of *Ham Radio Today*.



Pye Westminsters are available in either AM or AM form

Tuning Up

Those familiar with aligning their own surplus gear will already have their own ideas on suitable methods, however, for the uninitiated one certainly doesn't need a shack full of expensive test gear such as signal generators or frequency counters to get going, though of course they do help. What is important is common sense. For a weak signal source on receive, those not endowed with a signal generator can enlist the help of fellow amateurs in radiating a test signal, or may use a harmonic of an HF rig, eg. the 7th harmonic of a 10MHz transmitter. If you have a scanner receiver, then its local oscillator may be used. Dial up a frequency separated by the scanner's first IF (for instance if this is 10.7MHz then try dialling up 80.960MHz) and hold it near the set receiving 70.260MHz.

On transmit, some form of RF power indication must be used, such as a wavemeter (which we all have to comply with our licence conditions — don't we!) or any form of diode detector coupled to your multimeter. Don't leave a transmitter running too long in an unaligned state, drawing a high current but not producing full power and make sure you use non-metallic tools on the fine ferrite cores and capacitors. Take a look at the shape of the slots in these and file a knitting needle or even a matchstick down to suit. Don't be tempted to use a jeweller's screwdriver, apart from altering the resonance you'll most likely irrecoverably damage the adjusters. I still get letters and phone calls from people who should know better, asking me where they can get new coils after they've damaged theirs.

The Westminster Range

For details on the **FM** range of equipment and their tuning details, may I refer readers to the March 1986 edition of *HRT* where full details are given (article reprints are available from *HRT*). For the more commonly available **AM** sets, read on.

The W15AM is the most popular, this gives around 8W output and there have recently also been a large number of W30AMB sets released onto the market. These are almost identical but with the addition of a quick heat QQZ0640 single valve amplifier in the PA — these sets make an excellent starter, but the

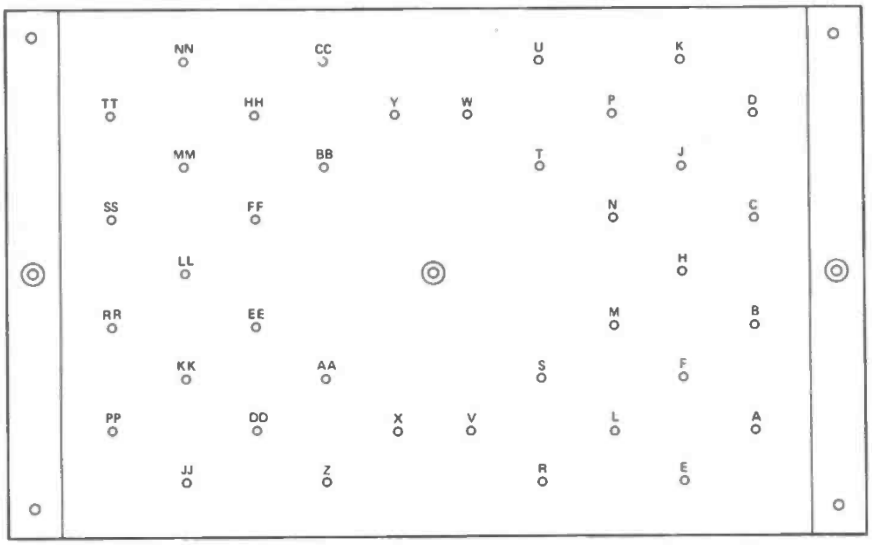


Fig.1 Connections for the Westminster remote socket (viewed from wiring side

snag is that they are remote mounts and often come without the control box and lead! This is because it is easy to simply remove the set itself, but quite a different matter to lift up carpets etc. to remove the control box and lead so this is often left in the car with maybe each cable end hacksawed off!

For those unable to find a suitable box and lead, **Fig. 1** shows the set multiway plug connections, with **Fig. 2** indicating the required control box wiring. As you can see, a simple rewiring job is all that's needed and the required controls may in fact be fitted to the set itself. If making up your own remote lead, use screened double wire to the volume control, with connection 'Z' as the screen and thick core wire to the speaker connections to avoid audio loss. **Figs. 3** and **4** show the mic and power connection wiring details, these items also tend to get lost before reaching the surplus market!

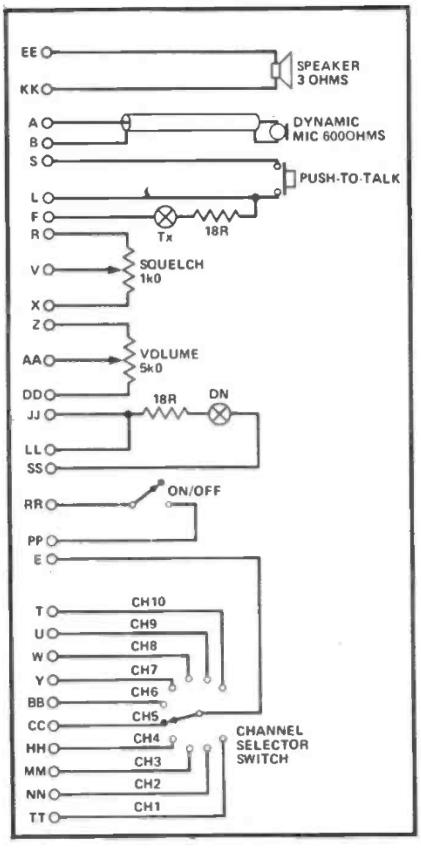


Fig.2 Westminster control box wiring

Alignment

First, plug in the appropriate HC6u crystals, the frequencies required being given by:

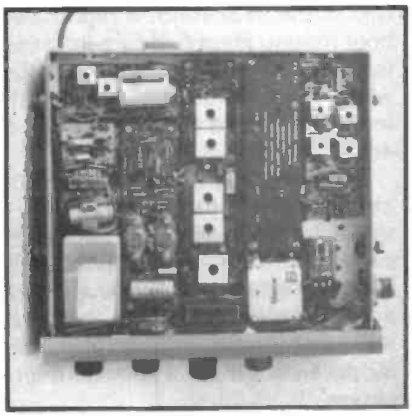
$$\text{Rx xtal freq} = \frac{\text{Rx freq} - 10.7\text{MHz}}{2}$$

$$\text{Tx xtal freq} = \frac{\text{Tx freq}}{2}$$

Connect your set up to DC power and switch on. Connect some form of RF power detection in the aerial line and the negative lead of your multimeter to the negative voltage supply, *not* the set chassis, as this isn't negative. Set your multimeter to the 2.5V DC scale and connect the positive test lead to TP1 on the Rx Mult board, referring to **Figs. 5** and **6.** With a suitable non-metallic trimming tool tune L1 for maximum reading, then L3 for minimum. Transfer the positive test lead to TP2 and tune L4, then L3, then L1 all for maximum.

Disconnect the meter positive lead, set the meter to a sensitive current range such as 50uA and connect the positive lead to TP3 on the 455kHz IF board. While receiving your off-air signal. tune T2, L3, T1, L2 and L1 on the Rx front end for best signal, indicated by maximum meter reading, whilst keeping this below 30uA by reducing the level of signal received accordingly. Retune as required for the absolute best sensitivity, checking and adjusting as required the appropriate crystal trimmer to ensure co-channel reception. The coils on the 10.7MHz and 455kHz IF boards should not need retuning, so leave well alone.

If you have a W30AM, then prior to keying the transmitter, set the 'Tune/Tx' switch to 'Tune', this avoids over-dissipation in the valve amplifier on tune-up. Set your multimeter again to the 2.5V DC range, connect the positive test lead to TP2 on the Tx driver board. Keeping the mic keyed, or the Tx button pressed on the front of a remote mount set, tune L1 and L2 for maximum reading. Transfer the positive test lead to TP3, and tune L3 and L4 again for maximum, repeating as required for absolute maximum. The following now applies to the W15AM — W30AM owners skip to the next paragraph.



Top view of an AM Westminster

W15AM Tx Alignment

Connect your multimeter lead to TP1 on the PA board, and tune L5 on the driver board and C2 on the PA for maximum. Transfer to TP2, tuning C7 and C10 on the PA board for maximum reading, then transfer to TP3 and tune C15 and C17 again for maximum. By now, you should start

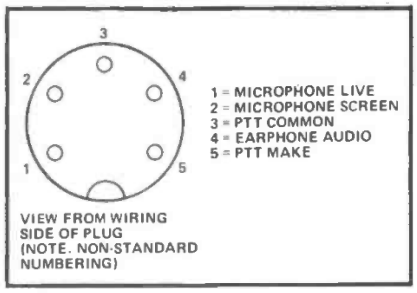


Fig.3 Mic connections for the Westminster, Europa and Reporter

to see a bit of RF power indicated so tune C23 and C24 for maximum. Then go back and retune C2, C7, C10, C15, C17, C23 and C24 in that order for absolute maximum, then check the crystal trimmer for accurate frequency netting.

W30AM Tx Alignment

For W30AM users, the tune-up is a little more tricky, but you will get around 30W output for your trouble. Switch to the 2.5V DC range on your multimeter and referring to Fig. 7 connect the positive test lead to TP1 on the Tx PA board. Tune C1 and C2 for maximum, then transfer to TP2 and tune C6 and C7 — also for maximum. Now disconnect your multimeter leads, set to the 250uA range and connect the positive lead to chassis and the negative lead to TP3 on the valve PA unit. Tune C11 and then C13 (both on the Tx PA board) for maximum reading, repeating as required to gain the absolute maximum. Now disconnect your multimeter leads, switch to the 50uA range and connect the positive lead to TP1 and the negative lead to TP2 — both on the valve PA unit. Initially set the vanes of C17 fully apart (minimum capacity) and tune C16 for minimum deflection on the meter. By now your RF power meter should be indicating nicely, so tune C17 for maximum indicated power.

In the higher power PF3FMH/B, J and K (which are low pass filter stages) are not fitted so don't worry if you find nothing to tune! Expect

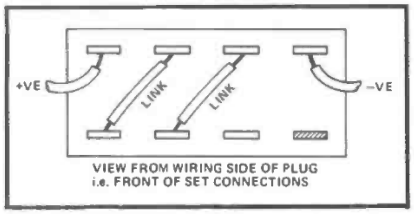


Fig.4 Westminster & Europa power plug details

around 1.8W output for the PF2 and around 2.5W output for the PF3 model. If you need to reset the transmitter deviation, this is performed by changing the value of a small resistor on Board 2 of the transmitter modulator, as shown in **Fig. 10**, increasing its value reduces the peak deviation. Access to this board entails melting the solder on the screening cover and temporarily bending this back with a pair of pliers.

Now it is safe to switch the 'Tx/Tune' switch back to Tx, so do this and you'll find your RF power increases nicely. Replace the set's bottom cover and readjust C16 slightly as required to give a minimum reading on your multimeter (this should be around 12-20uA) then retune C17 for maximum RF power. If you're a perfectionist, you might like to repeat the Tx alignment procedure again to make sure you're getting the last ounce of RF out, also you'll find that varying the positioning of L8 to L7 on the PA, coupled with realignment of C17, will give varying maximum output, but be careful not to go above 30W output or you'll run out of modulation power. Finally, check your crystal trimmer for co-channel accuracy and that's it — you're finished.

The transmit modulation level on both versions is set by RV1 on the Tx AF board, this should already be set at around the appropriate level but may be adjusted either way as required from off-reports, being careful to ensure over-modulation doesn't occur.

MF6AM Reporter

This set is becoming very popular now on the secondhand market due to its small size and high performance and is in fact the type I use myself on 70.26. Expect around 7W output on 4m, with good receive sensitivity limited mainly by external noise. The single channel version is most commonly found, but there is a plug-in crystal oscillator board which extends this to six channels where required. Some versions are found with external mic and speaker connectors, some with a wired-in speaker mic. If you don't obtain a mic, the required connections are as shown in **Fig. 3.** You may find, apart from the normal red and black power

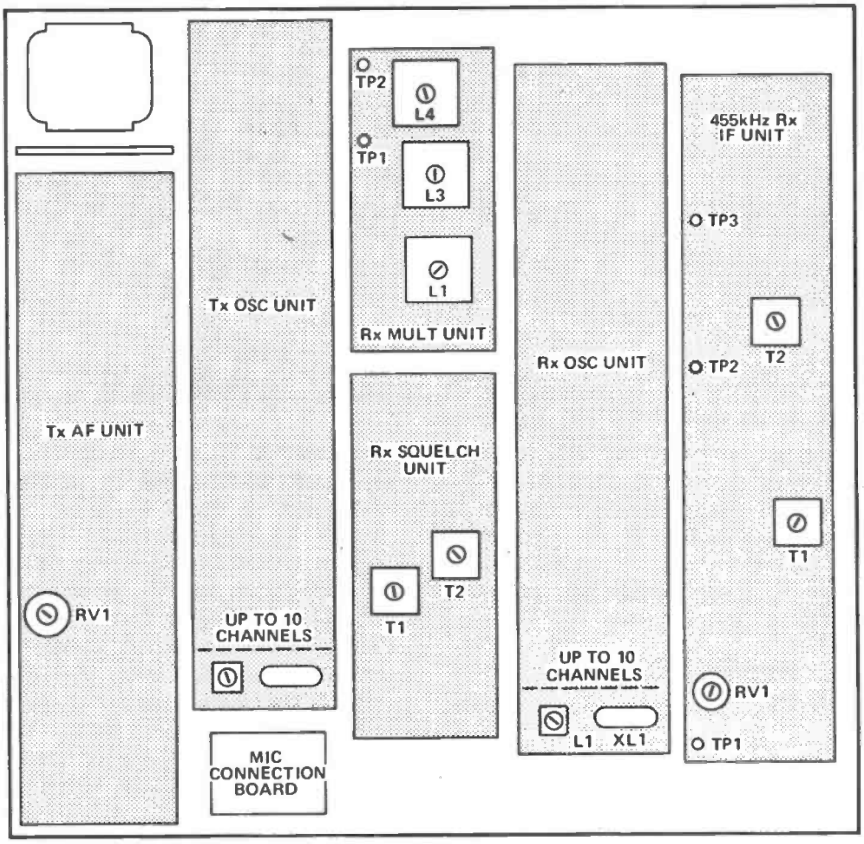


Fig.5 W15AM Westminster — bottom view

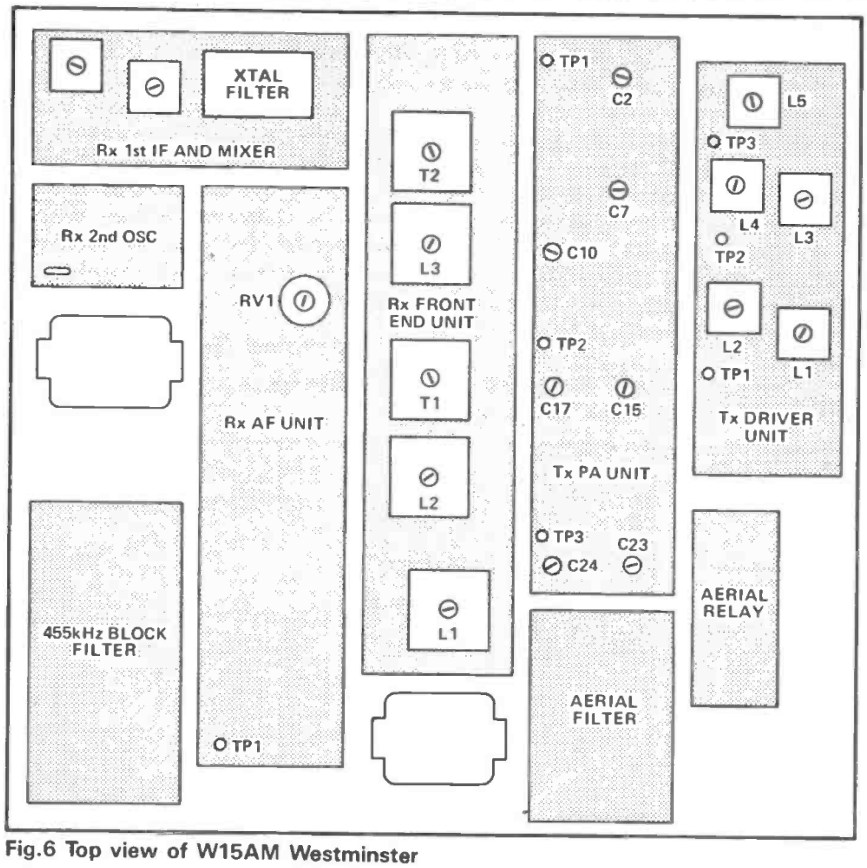


Fig.6 Top view of W15AM Westminster

leads, a pair of white leads emanating from the rear of the set. These are shorted internally on switch-on and can be used to control external options — I use them to control the automatic car radio aerial which I use for 4m.

Reporter Alignment

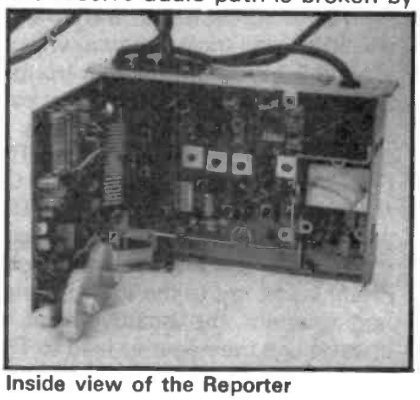
The crystals used are HC25u, with frequencies given by the formula:

$$\text{Rx xtal} = \frac{\text{Rx freq} + 10.7\text{MHz}}{2}$$

$$\text{Tx xtal} = \frac{\text{Tx freq}}{2}$$

Referring to **Fig. 8**, plug your crystals into the appropriate sockets and connect DC power and aerial coax connections. With your multimeter set to the 2.5V DC range, connect the negative lead to the set chassis and the positive lead to TP1 (a small gold plated vertical pin). Tune L12, L13 and L14 in that order for maximum reading, readjusting as required for absolute maximum. Now transfer the multimeter positive lead to TP3 and while receiving an off-air signal adjust the adjacent crystal trimmer first for best reception and then tune L1, L2, L3, L4 and L6 in that order for maximum, keeping the level of signal down to achieve around 0.5V at TP3. Finally retune these again for absolute maximum on a weak signal to ensure the best sensitivity. You should not need to readjust any of the IF coils as these will already be correctly aligned in a working set. However you may find it useful to slightly readjust RV1 (the IF gain setting potentiometer) to suit your operating needs. Note this will also shift the position of the squelch opening point; with no aerial connected all you will hear on no-signal is a very slight 'thump' from the speaker at maximum volume when this occurs, so be warned!

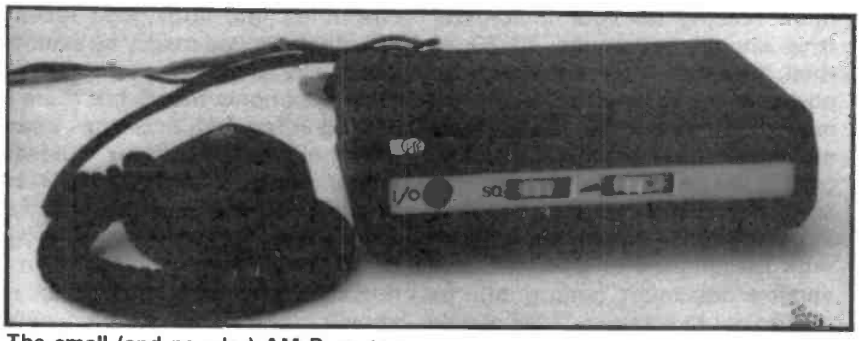
If you do find that you have no receive audio and a 15-way D-type socket is fitted to the rear panel of the set, check that pins 8 and 7 are linked on this, alternatively that pins 8 and 12 are linked on the vertical pin array at the rear of the set main board which connects to this socket. These connections are used for external selective calling options and the receive audio path is broken by these pins. You may have bought the surplus radio without the accompanying tone unit.



Inside view of the Reporter

Now onto the transmitter. Connect your multimeter positive lead to TP2, and keeping the PTT keyed tune L17 for maximum, then L18 for minimum reading. Now use a diode probe if you have one connected to TP4 and tune L20 and C76 for maximum, alternatively tune both these until you start to see a trace of RF power from the aerial connection. Now tune C82 with C85, and C89 with C92, in pairs for maximum RF power output. Retune from L20 onwards as required for absolute maximum, checking the crystal trimmer for correct frequency netting.

The transmit modulation should be reasonably set already, however should you find the need to adjust these RV4 sets the peak modulation, and RV3 sets the modulation gain.



The small (and popular) AM Reporter

The FM Europa

The VHF set is identified by

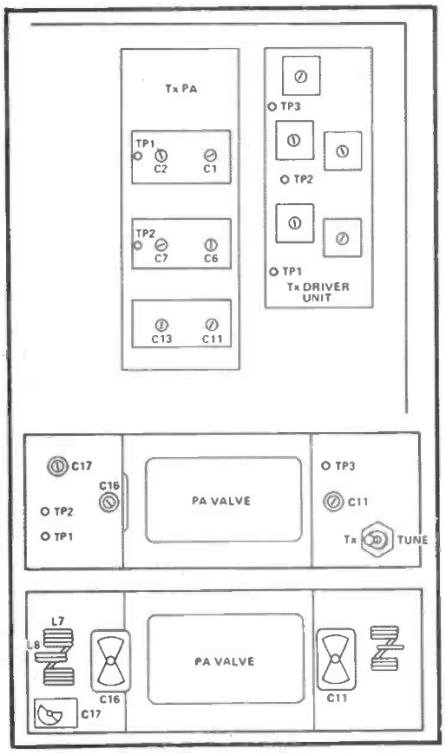


Fig.7 W30AM Tx alignment points

MF5FM or MF25FM on its rear serial number plate, having 9W or 25W output powers respectively, together with 'E0' signifying 4m suitability. They come in 3 or 6 channel versions, the 3 channel version uses HC6u crystals while the 6 channel version uses the smaller HC25u crystals. It is possible to remove the HC6u sockets and fit ones for the HC25u crystals if required but not vice versa, so watch out when ordering crystals. Often the sets come without mic or power leads, Figs. 3 and 4 show the required connections. An internal speaker is used and a socket for an external speaker is fitted to the rear. Beware of shorting these speaker connections together or connecting any to chassis, as you will easily destroy the hard-to-obtain audio IC used in the set. This is the most common cause of failure to my knowledge in the sets, so beware when purchasing.

A plug-in tone option facility is fitted to the left of the set, normally a blank panel is fitted but if a gaping hole is in its place then don't worry, a simple receiver audio link is all that's required to restore normal operation. The channel spacing is identified by 'V' or 'S' marked after the equipment code on the serial number plate, 'V' signifying 25kHz and 'S' for 12.5kHz. You may find distortion evident with 12.5kHz sets on receive when listening to 5kHz deviated signals from other stations, but due to the lack of available FM bandwidth it would seem to make sense that 12.5kHz spacing with 2.5kHz deviation be adopted by amateurs from the outset to utilise the 4m FM section to its fullest extent.

Alignment

Remove the top lid, undo the three screws at the rear of the upper PCB and hinge the board up, making sure it doesn't short along the front of the set.

The crystal frequencies required are given by:

$$\text{Rx xtal} = \frac{\text{Rx freq} - 10.7\text{MHz}}{8}$$

$$\text{Tx xtal} = \frac{\text{Tx freq}}{16}$$

Plug in your crytals, switch on and select the appropriate channel. Open the receiver squelch by adjusting RV1, checking you are getting audio from the speaker. If not, check that Pins 8 and 12 are linked on the facility socket on the Tx board (pin 1 is at the left looking from the front of the set), either by a PCB link on a blanking board or by a wire link at the rear of the socket. If a tone option board is fitted, I would recommend removing it and fitting the appropriate link in its place. If the large circular audio IC is getting hot with still no audio, even into an external 8 ohm speaker, suspect the IC.

Referring to **Fig. 8**, connect the negative lead of your multimeter to the set's chassis, set the range to 10V DC and connect the positive lead to TP7. Tune L10 for a 'dip' in reading, ie. a minimum, then transfer to TP8 and tune L11 and then L10 for maximum, then L12 for minimum. Transfer to TP10, and tune L13 and then L12 for maximum, then L16 for minimum. Now connect to TP6 and tune L17 and then L16 for maximum.

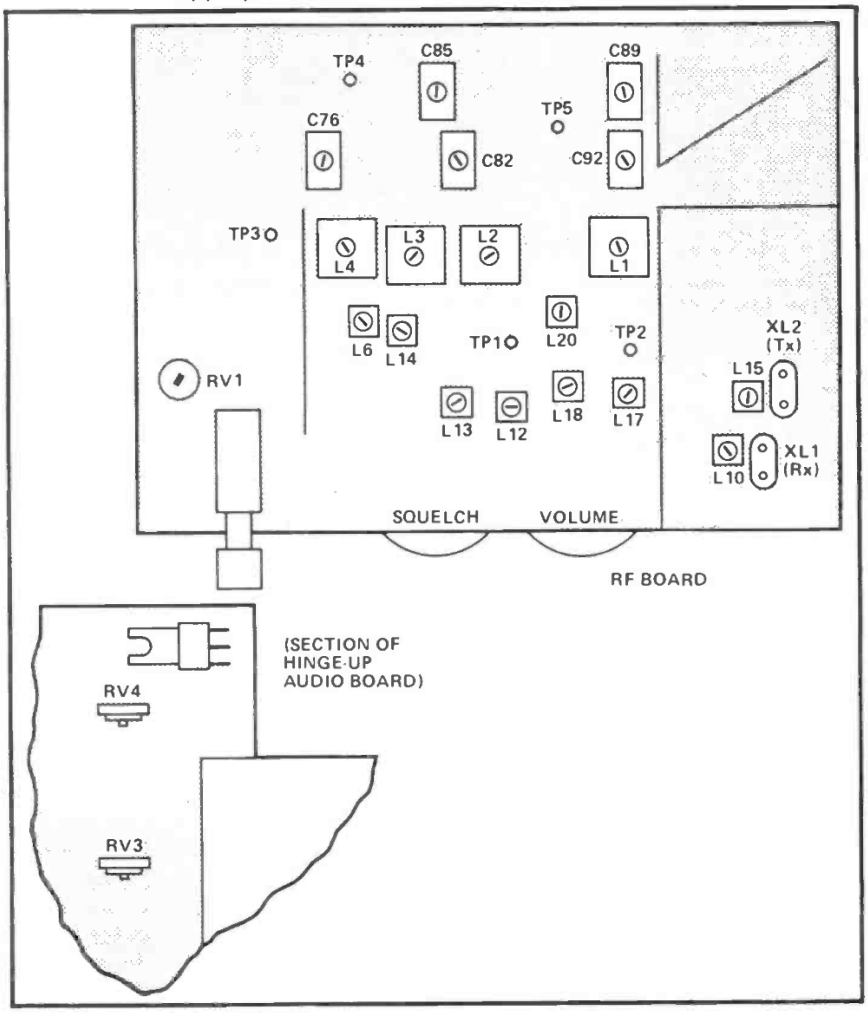


Fig.8 Reporter internal layout

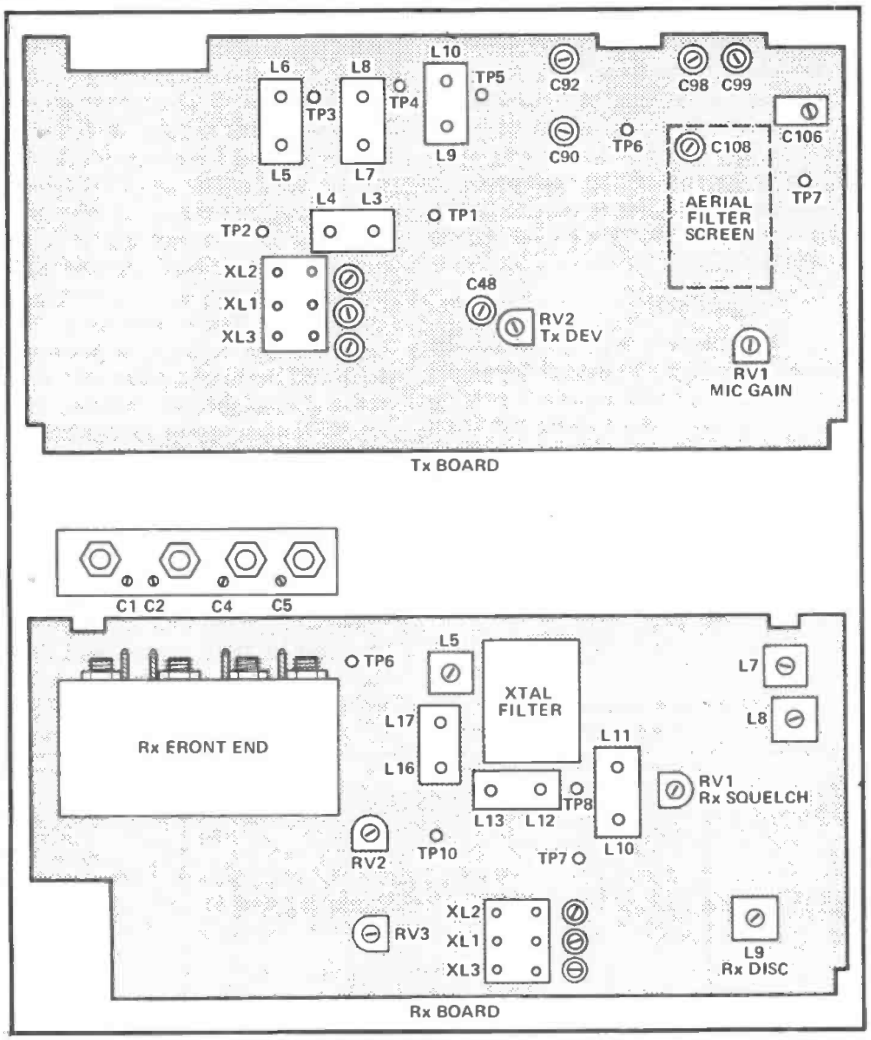


Fig.9 Internal layout for the VHF Europa

That's the multiplier stages tuned, now on to the front end.

With a slot filed out of any suitable metallic or strong non-metallic tool, tune C1, C2, C4 and C5 on the metal front end section for best quieting from an off-air signal, reducing the level as required and make sure the appropriate crystal trimmer has been adjusted first for best (least distorted) reception. Readjust the front end again as required to get the absolute best sensitivity. Don't be tempted to try and 'lock' the front end metal adjusters with any locking compound, you'll instantly detune the front end and then find you can't adjust it any more. I speak from bitter experience! Finally readjust the squelch as required to open up on weak signals, or you may if you wish bring the connections out to a front panel mounted 5k potentiometer in the options space for greater operating convenience.

If you wish to change the crystal filter, marked FC03233 (12.5kHz) and FC03234 (25kHz), then you will also need to slightly readjust L5 to achieve the correct filter matching given by least distortion on received signals. These filters are commonly available from surplus dealers such as Garex.

To align the transmitter, connect a suitable RF load and key the PTT. Connect your multimeter positive lead to TP1 on the transmitter board, keeping the range at 10V DC. Initially tune C48 for maximum, then tune L3 for minimum. Transfer to TP2 and tune L4, then L3 for maximum, then L5 for minimum. Transfer the positive test lead to TP3 and change the multimeter range to 2.5V DC. Tune L6 and then L5 for maximum, then L7 for minimum. Transfer to TP4, tuning L8 and then L7 for maximum, then L9 for minimum. On to TP5 and tune L10 and then L9 both for maximum. Remove the positive multimeter lead, change range to 250uA DC and connect to TP7. Tune C98 and C99 for maximum. By now you'll be seeing some RF output, so tune C106 and C108 (accessible from beneath the PCB — remove the lower case lid) for maximum RF, going back along the PA capacitors to tune for absolute maximum. Note that these capacitor designations are for the lower power MF5FM, the MF25FM is slightly different. It has for instance a diagonal row of four trimmers in place of C106, but in any event simply tune all variable capacitors, including those under the aerial filter screen, for maximum RF output, repeating several times as required. Set the relevant crystal trimmer for the correct transmit frequency.

RV1 which sets the mic gain will already be set fairly accurately, but RV2, the Tx deviation control, may need slight adjustment to give 2.5kHz peak deviation. Slight readjustment of C48 for maximum deviation (which coincides closely with minimum transmit distortion) should be performed first. Finally, note that hinging the boards down often has a slight effect on the operating frequency of both Tx and Rx, so check this and readjust as necessary before screwing the lids down.

The Pocketphone 70 Range

Often incorrectly described as a 'PF70' (by someone who doesn't have a clue what they're selling you!), this is a range of equipment covering 68-470MHz that look identical from the outside. Take a look at the rear serial number label and look for the magic letters 'E1' in the equipment code, 'E2' sets require tiny capacitor modifications to the equally tiny front end board to achieve the best performance, which is a tricky operation at best and is beyond the scope of this brief guide.

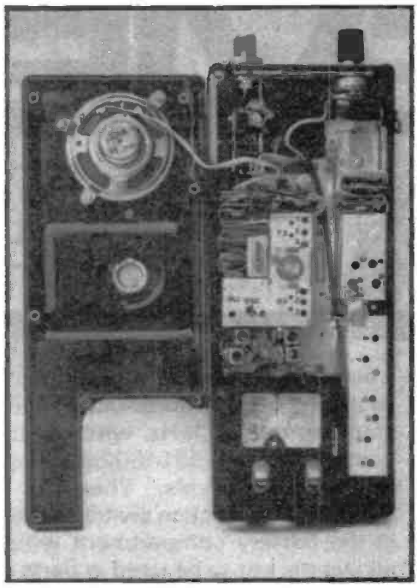
The VHF sets operate on three channels and are available in hand-held and body-worn versions, the former having a clearly evident speaker grille whilst the latter uses an external speaker microphone clipped onto one's lapel. Make sure you get one of these included in the sale of a body-worn set, it's rather useless without one! Also look for a

screw-on helical aerial, these are also difficult to come by separately, but may be purchased new if required from companies such as Antenna Products Ltd in Aylesbury. Alternatively the rather long 4m quarter wave (1m long in practice) may usefully be fitted as a wire taped to a carrying strap for the set. The set uses a 200mAh 15V nicad pack, spare nicads are a useful purchase but are often expensive. You'll find the set works quite well when operated from a 13.8V power supply though for home or mobile use.

Alignment

The set uses HC18u wire-ended crystals, with the leads cut short and plugged into small sockets in the set. The required crystal frequencies are:

The Pocketphone 70 — make sure it's the correct version for the band



Pocketphone 70 internal view

$$\text{Rx xtal} = \frac{\text{Rx freq} + 23.455\text{MHz}}{3}$$

$$\text{Tx xtal} = \frac{\text{Tx freq}}{12}$$

Remove the case front and undo the large flat hexagon nut securing the channel knob locating tab. Remove these and now using a pair of fine nosed pliers unscrew the nut securing the crystal compartment screen. Remove these also and fit your crystals, reassembling the screen. Remember to switch back to the appropriate channel after refitting. The channel spacing of the set, if not identified from the rear serial plate, may be found from the crystal filter marking, this being FC03262 or FC03246 for 12.5kHz spacing, and FC03260 or FC03244 for 25kHz spacing. The alignment diagram is shown in **Fig. 10.**

Switch on, and connect your multimeter negative lead to the set chassis. Switch to the 2.5V DC range and connect your positive multimeter lead to the exposed solder connection on the insulated wire lead accessible beneath the hole marked 'OSC'. Tune L3 and L2 on the 'Inj. Osc' board for maximum dip in meter reading. Now while receiving an off air signal, initially tune the respective crystal trimmer for least distorted reception, then tune T1, L1, L2 and T2 in that order on the front end board for best quieting, repeating as required for the absolute best sensitivity. After checking the crystal trimmer alignment again for co-channel reception, you may also slightly re-tune L3 on the 'Inj. Osc' board also for best quieting. That completes the receiver alignment.

Now disconnect your multimeter, set it to a current range of around 200mA and connect in line with the voltage supply to the set, be this the battery (pull off the plug-in power lead on the board), or from an external 13.8V power supply. Key the PTT and tune the coils marked A, B, C, D, E and F in that order for maximum indicated current, this may require you to select a higher current range towards the end. Now, monitoring the RF power output, tune the coils marked G, H, J and K for maximum RF, repeating as required for absolute maximum. Simple, eh?

Rally Hunting

I am often asked for cheap sources of supply of equipment for conversion, the best choice normally being found at the large radio rallies where dealers often buy up quantities of gear prior to these for economic sale. Mail order is also a possibility although prices of course tend to be a little higher, you may however care to try the following:

A J H Electronics (0788 76473)
Anchor Surplus (0602 864902)
B Bamber (0353 860185)
H Collins, Amateur Sales Office (0223 69108)
Garex Electronics (0296 668684)

With that, I'll wish you good hunting, and see you on 4m!

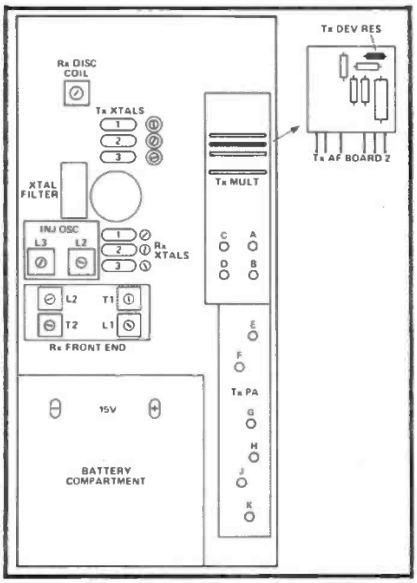


Fig.10 PF2/3 Internal layout — VHF