M294 Ex-PMR Conversion

G4HCL converts a car-radio sized transceiver to 2m and 4m

The M290 series

The last few rallies seem to have brought about a sudden 'surge' in M290 series mobiles. Likewise with requests for information on the packet network. Why? Maybe now is 'the time' for M290 series radio users to 'upgrade' to a newer generation of sets? But the fact remains that we've been getting calls asking 'have you got anything for the M290 in the pipeline?'. Here's the first.....

The Series

The M290 series, as the label on the front of the case states, is a *series* of sets. There is *no such thing* as an M290, remember that, it's important! The series is split up into three basic types, the M293, M294, and M296. They're crystal controlled sets which come in either single channel or six channel versions, the six channel ones have a channel change switch on the front, the single ones don't. A later range, the *MX290* series which are synthesized transceivers, look virtually identical from the outside apart from the channel change switch which has 16 positions instead of 6 or more rarely an electronic front panel with a digital display (not to be confused with some selective calling modules – check the channel switch). You'll see a conversion project on these synthesized rigs soon, it's here, waiting to be published. But this article deals with the crystalled version, by far the most commonly available at the time of writing.

Identification

As usual, look at the serial number plate on the rear panel. Here you'll see the equipment type number, *M293* signifying VHF AM, *M294* signifying VHF FM, and *M296* UHF FM. This plate is riveted on, if it's missing then don't touch the set with a barge pole! I once saw such a number-less rig selling at £5 at a rally, with an attached label saying 'M296 70cm FM'. I looked inside the case before parting with my money and found an M293 VHF AM rig. Trust *only* the serial number plate! The M293, unless you want an AM set, frankly isn't worth trying to convert to FM, and this article deals with the M294 – the M296 will be covered in a forthcoming HRT conversion.

Frequencies

The M294 is available in a number of frequency ranges, such as 68-88MHz (E band) which is OK for 4m, plus 132-156MHz (B band) and 148-174MHz (A band) which are both OK for 2m. Two further bands are available, M band which covers 105-108MHz TX with 138-141MHz RX, and P band which covers 96-106MHz RX with 79-88MHz TX. These will require a large degree of modification work to get going, and although a conversion may be possible with an amount of work (this will be covered in the future if demand exists) I'd advise you obtain the correct type of set for the band you're interested in. To do this, simply look at the frequency label at the rear, if 'A', or 'B' is shown on the equipment code or the frequency engraved is something like 167MHz/172MHz then you're OK for 2m, likewise 'E' or 72MHz/85MHz and you've got a 4m set. You'll find most sets to be 12.5kHz channel spacing which is OK for packet and/or 4m. You'll probably find some distortion on receive on 2m FM speech, if this gets too much you can replace the standard 10.7MHz crystal filter and 455kHz ceramic filter directly with +/-7.5kHz types, these are available from firms such as Cirkit.

Crystals

You'll need a pair of crystals for each channel, one for transmit, the other for receive. The crystal frequencies you'll need are given by;

A & B Bands

$$\text{RX xtal} = \frac{\text{RX Freq} + 10.7\text{MHz}}{3}$$

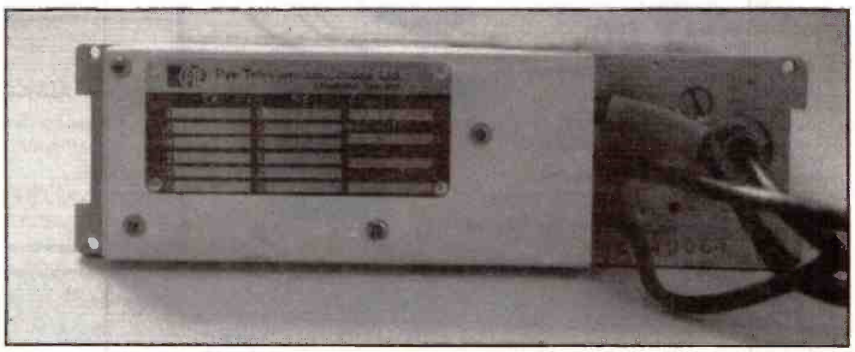
$$\text{Tx xtal} = \frac{\text{TX Freq}}{16}$$

E Band;

$$\text{RX xtal} = \frac{\text{RX Freq} + 10.7\text{MHz}}{2}$$

$$\text{TX xtal} = \frac{\text{TX Freq}}{16}$$

Look at the rear serial number plate for identification



The crystals are plug-in HC25u types, and when ordering state they're for the M294. It may be worth giving the crystal supplier the commercial specifications for these which are T71 for the receiver, and T93Rx for the transmitter, requesting 'amateur spec' versions to keep the cost down. Note that positive side receiver injection as shown should be used for 2m on both A and B bands, not negative side injection as indicated for A band sets in the 'official manual' as this applies only to frequencies above 148MHz.

Opening Up

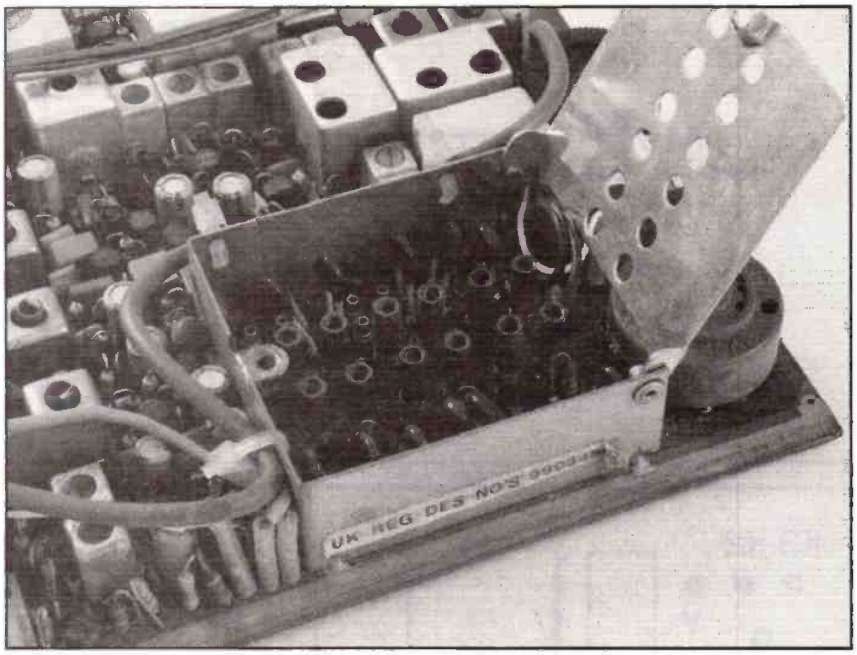
The transceiver is a single PCB which fits in an extruded alloy case. You may also find a built-in selective calling module, with buttons and/or LEDs built onto the front panel in addition to the transceiver controls shown in the photograph here, but don't worry about that at the moment. To remove the transceiver innards you don't need to take the front panel off, instead remove the four screws at each corner of the rear panel and slide the transceiver assembly out. This shouldn't leave any electronics inside – look into the case as a 'double check' for any selective call circuitry built onto the front panel.

Receiver Alignment

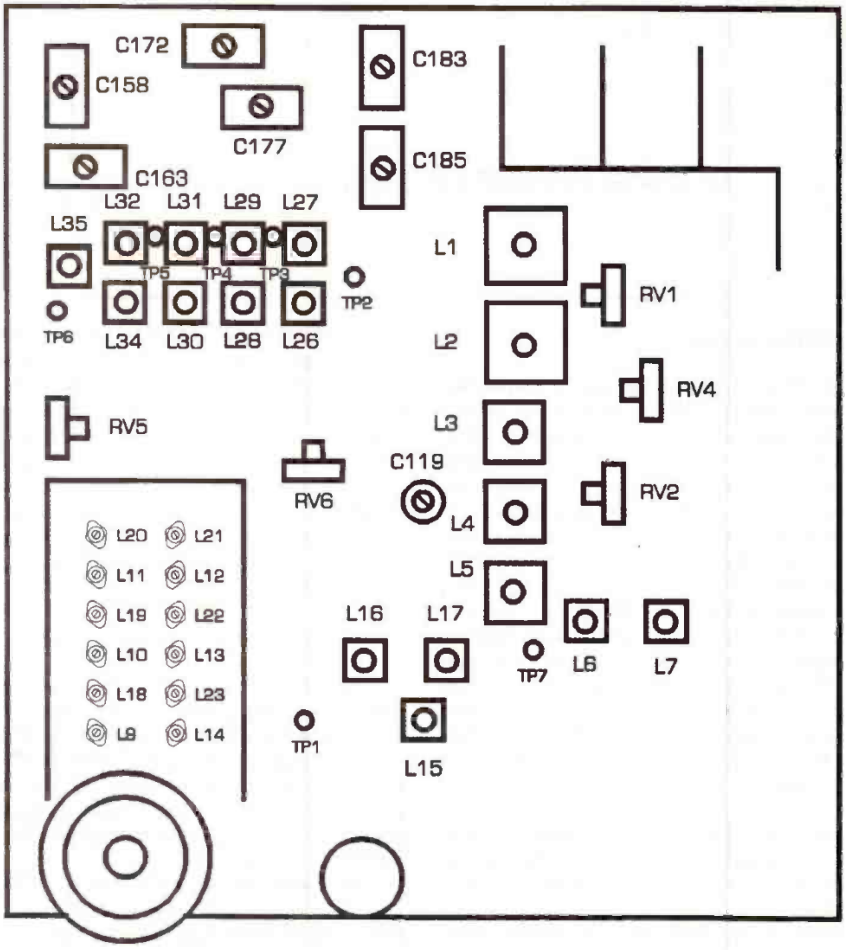
You'll need a 13.8V supply, connected to the red and black power leads coming from the rear of the set (normally terminated in a black connector), and an external speaker of 3-8 ohms impedance connected to the blue and brown speaker leads (normally terminated in a smaller white connector). The aerial lead is the flying coax lead, and finally the five-way socket is the microphone plug, leave this plug disconnected for now. You'll need a multimeter and suitable non-metallic trimming tool to fit the ferrite cores for adjustment. Don't, ever, use a metallic tool like a jeweller's screwdriver, you'll break and thus jam the fragile cores very easily. Towards the end you'll also need an off-air signal on the receive frequency for the front end and crystal adjustments.

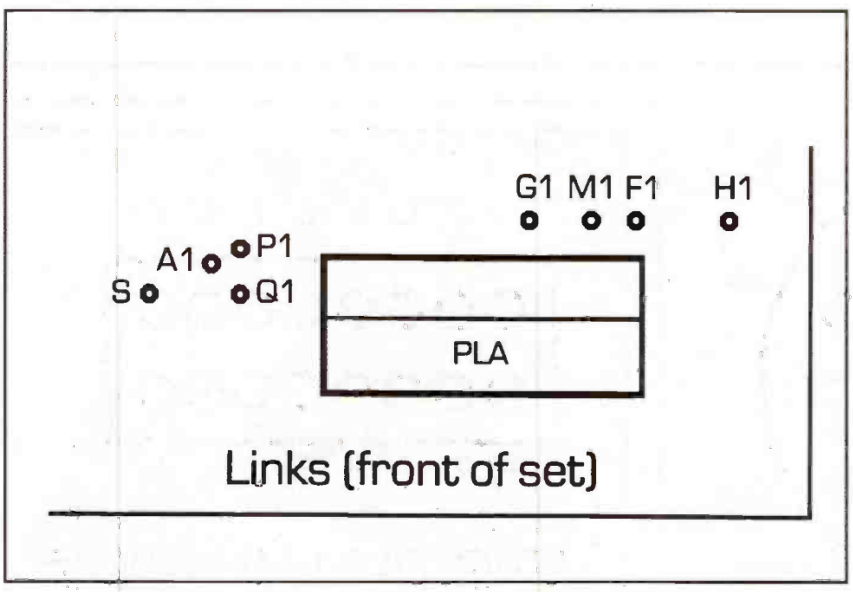
Plug your crystals into the compartment beneath the hinge-up lid (this is normally screwed down), the crystal positions for each channel are clearly marked. Switch on, and check smoke doesn't appear! If the set doesn't draw any current, check your connections and the plug-in fuse at the front of the set. With the volume control set midway, adjust the squelch preset RV4 to 'open' the squelch, then reset the volume control to a suitable level.

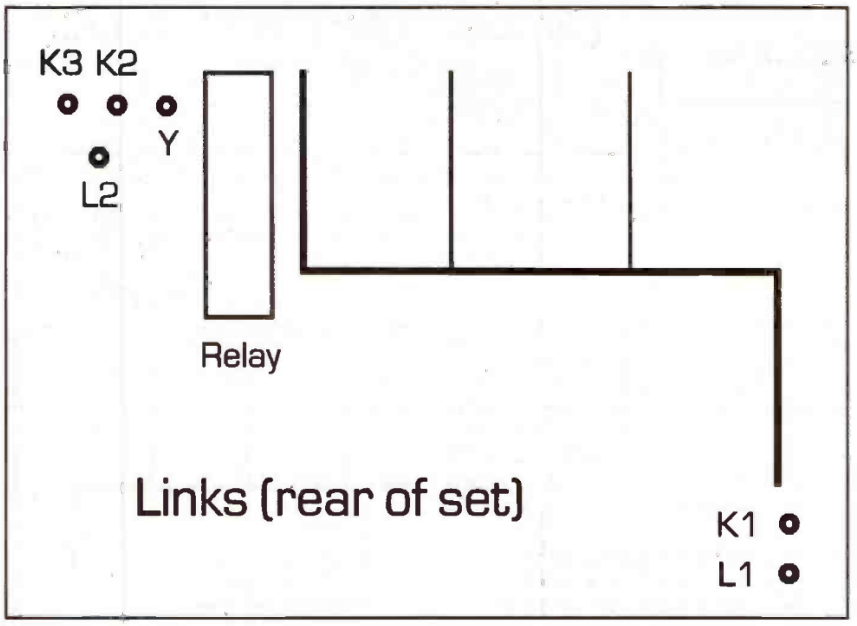
If you don't hear any squelch noise, your set may have been 'linked' for receiver audio switching for use with a selective calling module. Refer to the linking point diagrams, and check that



Alignment Diagram







Linking points

pin F1 is connected to pin G (some sets may have pin G1 connected to S, which disables the direct receive audio path). Start by connecting your multimeter negative lead to the supply negative, which is also the transceiver ground. With the meter set to the 2.5V DC range or thereabouts, connect the positive lead to TP1 and tune L15 with your adjusting tool for maximum voltage reading, then tune L16 for a 'dip' in voltage. Switch your multimeter to read 10V and transfer the positive lead to TP7. Tune L16 and then L17 for maximum, then L15, L16 and L17 in that order again for absolute maximum voltage.

Now connect your aerial (or signal generator if you're fortunate enough to have one). To get the front end 'somewhere near', start by tuning the cores of L1-L5 downwards about three full turns each. If you can hear a signal, then adjust the core of the receiver crystal coil for best reception, i.e. least distortion of a modulated signal. Then tune L1, L2, L3., L4 and L5 in that order for best reception, readjusting the crystal trimmer if a signal eventually appears. You shouldn't need to touch the IF coils L6 and L7 if the set came out of service, these should be already correctly tuned. Reset the squelch preset, and that's it, now for the transmitter.

Transmitter Alignment

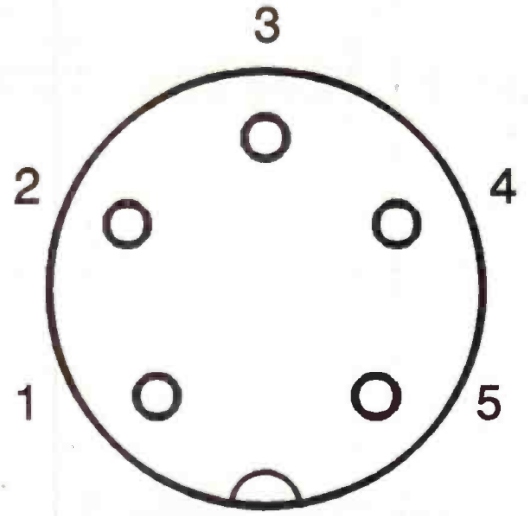
For the transmitter tune-up you'll need a suitable 'dummy load' capable of dissipating 25W connected to the aerial socket, with some form of RF power level indicator in line such as a power/SWR meter. You'll also need a 13.8V power supply capable of providing 6A or more.

To keep the TX PTT keyed while you're tuning the set up, externally connect pins 3 and 5 together on the mic plug – refer to the connection diagram. This is a standard 270 degree DIN socket, plugs are readily available. Note that the PTT switching is 'positive voltage' rather than 'ground for transmit', so don't short the PTT line to 0V. During the final stages of tuning, when transmit power is produced, keep the PTT switched only for the time needed for each individual tuning step, to prevent damage to the PA.

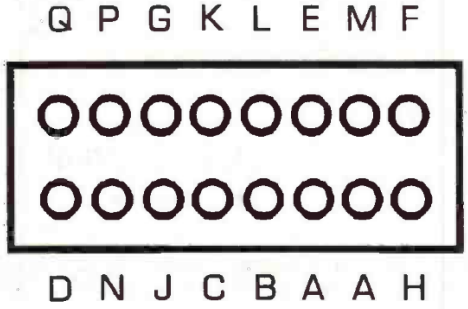
Firstly, check that the large TX/RX relay clicks over when the PTT is keyed, if not then check the links as these may have been set to give external 'TX inhibit' under some selective calling arrangements if such a module was fitted. The lead from mic socket pin 3 should go to pin L2 for 'normal' operation (it's connected to pin K3 for 'transmit lockout), and links are needed from pin K1 to pin K2 and from pin L1 to pin L2.

Now for the alignment. First turn RV7, which is the transmitter power control adjustment, fully clockwise to give maximum power. Connect your multimeter negative lead to the negative voltage supply, and with the meter set to a 10V DC range or thereabouts connect the positive meter lead to TP2. With the set's PTT keyed, adjust C119 for a slight peak, then tune L26 for minimum voltage. Transfer your multimeter positive lead to TP3, adjust L27 for maximum and then L28 for minimum. Transfer to TP4 and adjust L29 for maximum, then L30 for minimum. On to TP5, adjusting L31 for maximum, then L32 for minimum, then L34 for maximum. By now you may be seeing a slight 'sniff' of RF power, or an increase in DC current drawn as you tune. Otherwise, connect a simple diode probe to your multimeter and detect the RF drive present on the metal adjuster of C163 (you may need to turn RV7 clockwise to take a reading), in either case retune L26-L32, L34 and L35, in that order, for maximum reading of power or current.

From now on, keep the PTT only for as long as needed to take a measurement. First adjust C185 to minimum capacity, i.e. plates fully apart, and then adjust C158 and C163 for maximum RF output (or initially for maximum supply current if there's no RF, then for maximum RF output). You'll probably need to use a different trimming tool for these capacitors, don't use a metal screwdriver – it may be tempting but some of the slots are 'hot' with RF, and you'll soon know about it! Now adjust C172 together with C177, then C183 together with C185, in 'pairs' (one hand on each trimming tool) for maximum power output. Retune the six capacitors, in pairs, until you can't get any more RF output, then de-key the PTT to give the PA a rest!



Microphone Connections



Facility plug connections (viewed from front of set)

Table 1 – Mic Connections	
1	Mic live
2	Ground
3	10V PTT line
4	RX low level audio
5	10V output

Table 2 – Facility Module Connections			
A	-ve	H	Undedicated
B	-ve	J	TX 10V
C	Mic preamp gating	K	10V via TX PTT
D	In band TX encode	L	TX relay coil
E	Sub audio TX encode	M	Undedicated
F	RX audio for decoders	P	Undedicated
G	RX squelched audio	Q	Undedicated

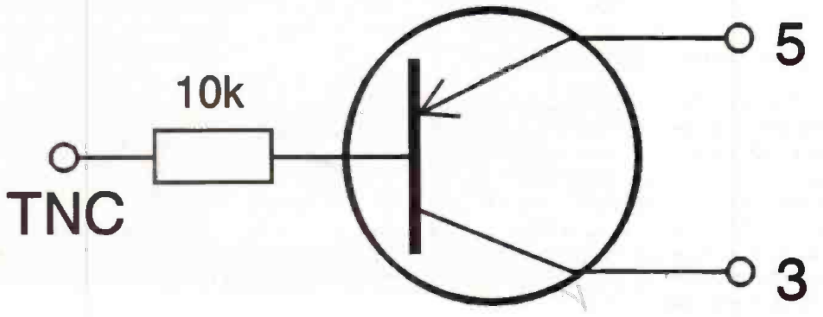
You should get around 25W output, which you can reduce if you wish with RV7. Adjust your crystal trimmer to get you accurately on frequency, and RV6 is the peak deviation control which may need altering to give you 5kHz deviation. The mic gain preset is RV5 which should already be set to a suitable level for a normal 600 ohm dynamic microphone, but you can adjust this to suit your particular microphone or operating conditions after having set RV6 correctly. That's it, you now have a fully working rig!

Selective Calling Module Fitted?

Before putting the set back in its case, if such a module is fitted then (unless you want to use it of course) I'd recommend you remove the circuitry completely. The PCB(s) simply unscrew from the case front – you'll see two spigots next to the facility connector which partly secure the front PCB. The buttons stay as part of the case front, so you shouldn't be left with any unsightly holes.

External Interfacing

If you plan to use your rig for packet, remember the set needs +10V for PTT switching, and not a 0V ground line for TX keying which most TNCs give. The accompanying diagram gives a simple one-transistor switch interface which you can use if needed. At the front of the set you'll see the multi-way connector used for interfacing the selective calling modules, this should enable you to add home-made options if you so wish. **Table 2** shows the pin connections for these, note the non-sequential pin layout as shown in the diagram. If you'd like to connect a 'busy' LED, you'll find that pin P2 on the main PCB goes low when the receiver squelch raises, and this may already be linked to the interface connector pin M via board pin M1.



PTT modification for 0V TX TNC switching

Problems?

You'll find the most common fault giving poor operation is the crimped-on BNC aerial connector, sometimes having an open-circuit braid at the end of the crimp; it's worthwhile checking for this in any case. Otherwise the sets are very reliable, and most faults are caused through jammed ferrite cores by not following the instructions of 'no metallic trimming tools'. If you really get stuck and need a circuit or whatever, I can be reached with an SAE c/o the HRT Editorial Office, P. O. Box 73, Eastleigh, Hants, SO5 5WG. With that, have fun, and watch out for the forthcoming M296 UHF article in HRT.