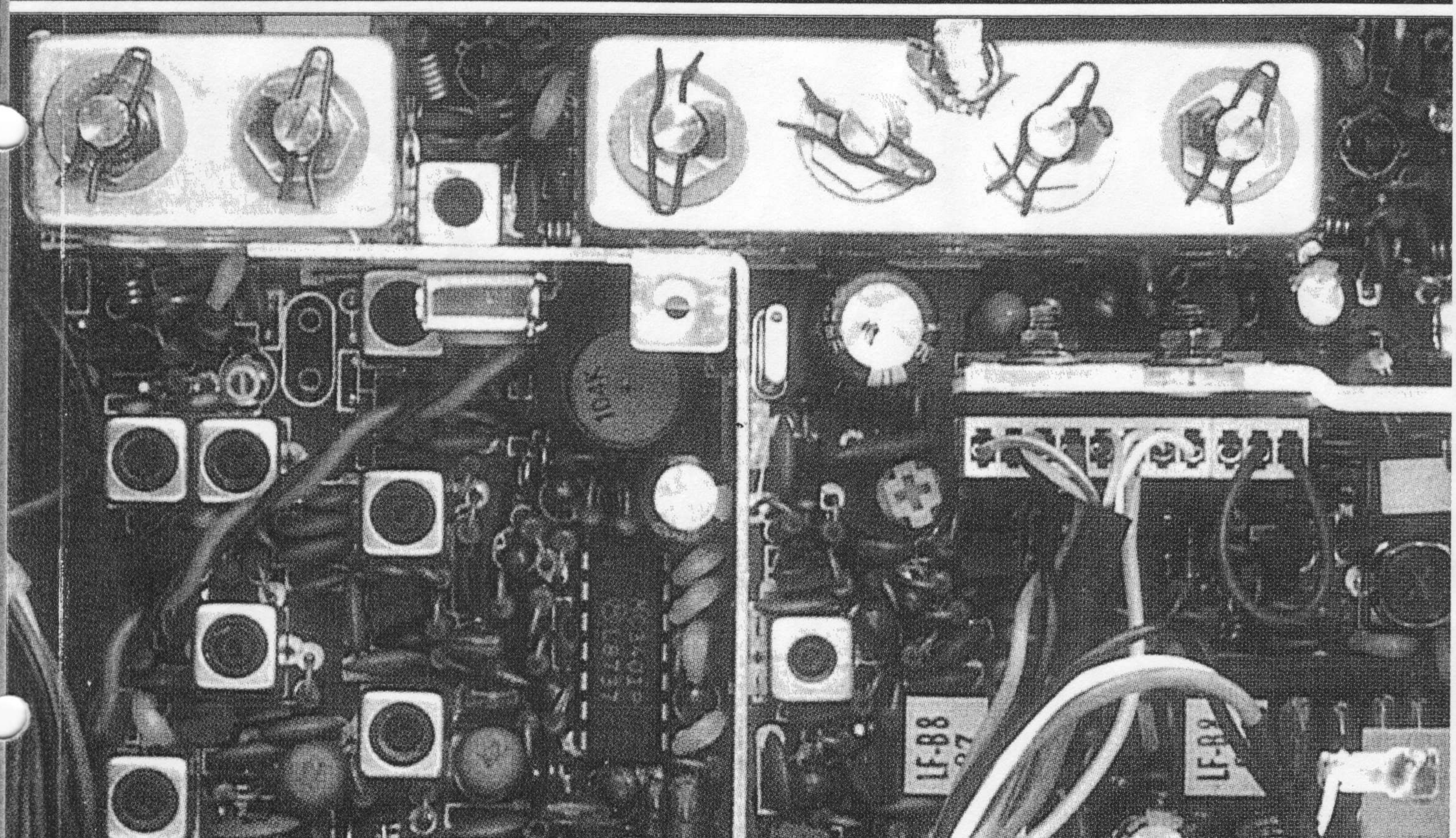
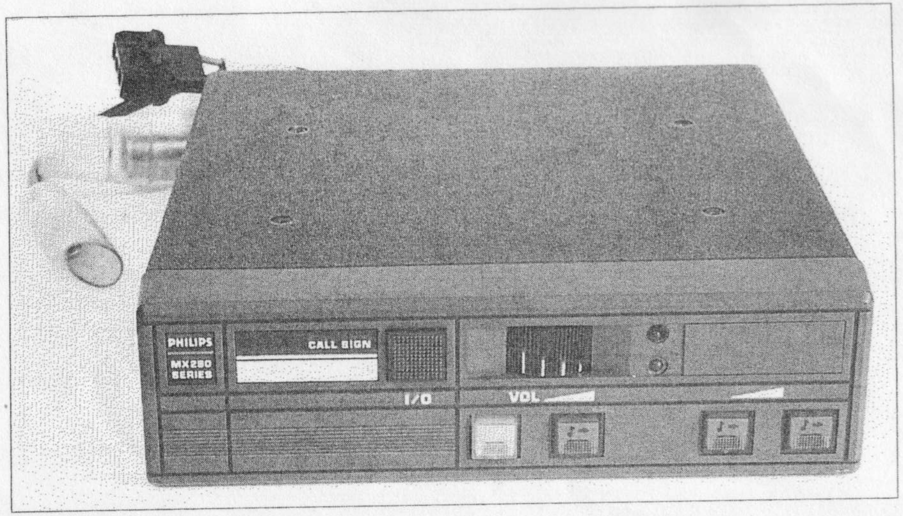
PMR CONVERSION HANDBOOK



BY CHRIS LOREK, G4HCL

RSGB

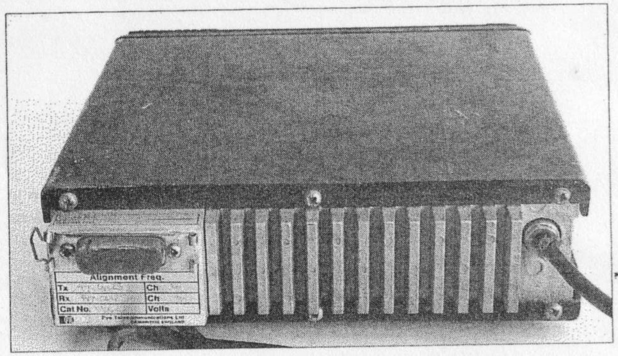


The MX290 series, fitted with a trunking controller in this case

control mounted on the set's front panel. Alternatively, you may wish to add a 'squelch open', ie 'busy', indicator. For this, connect an LED in series with a 1kΩ resistor between the set's positive supply and pin P2, which switches to 0V when the squelch lifts. P2 is often linked to pin M1, which in turn is connected to pin M on the main board.

MX290 SERIES

The MX290 series of sets outwardly look physically similar to the M290 series at first glance. As they can share the same front-panel options, you could easily be excused for mistaking them! A closer look, however, shows that the set is built on a die-cast alloy frame, with top and bottom lids screwed on using two screws on either end of each lid. Also, rather than a 'smooth' rear panel, a small finned die-cast heatsink, which is part of the cast frame, is used, together with a smaller serial number panel. The sets come in four types:

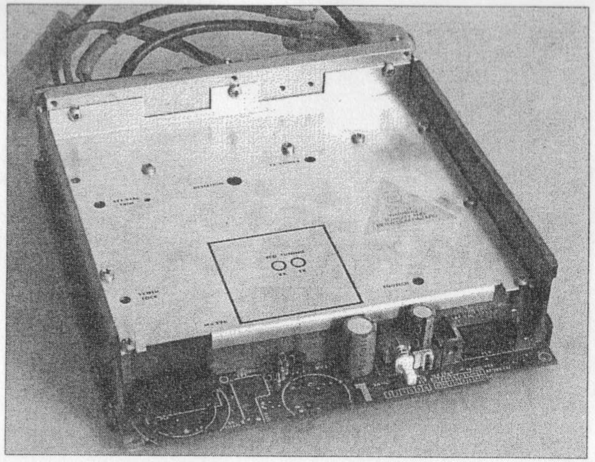


The MX290 series can be identified by a finned rear-panel heatsink

MX293: VHF AM
MX294: VHF FM
MX295: Band III (174–225MHz) FM
MX296: UHF FM

You'll often (but not always) find a trunking front panel on the MX295, although I've also seen other sets, particularly the MX296, also with trunking plug-ins for MPT1327 and other signalling formats.

The MX293, being AM, isn't detailed here, neither is the MX295 as this requires a substantial amount of RF circuitry changes to 'get it going' onto the amateur bands. The MX294 and MX296 are, however, often ideal for use on 4m, 2m, or 70cm. Although you'll need to expend a little effort in adding suitable frequency control, the end result is a high-performance, multichannel set. I've used an E band (68–88MHz) and an A band (148–174MHz) MX294 continuously for several years at my local hilltop-sited packet radio node for 4m and 2m respectively – indeed, the 70cm port of this node uses an M296.



You'll usually find the RF circuitry is fitted with a large metal screen

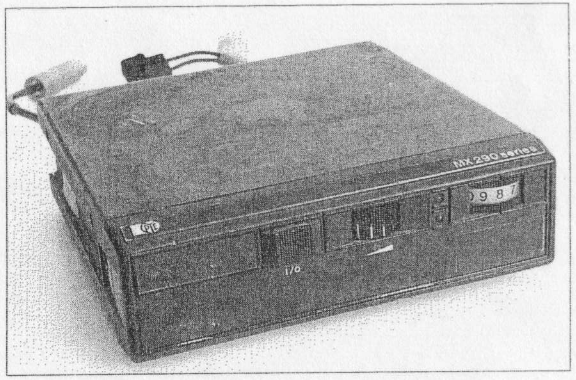
Identification codes

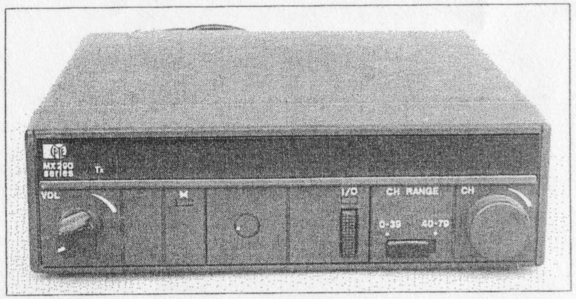
The rear panel information label will give you the serial, code and catalogue numbers, together with the transmitter and receiver alignment frequencies. The typically found alphanumeric codes are in the order given in Table 4.5.

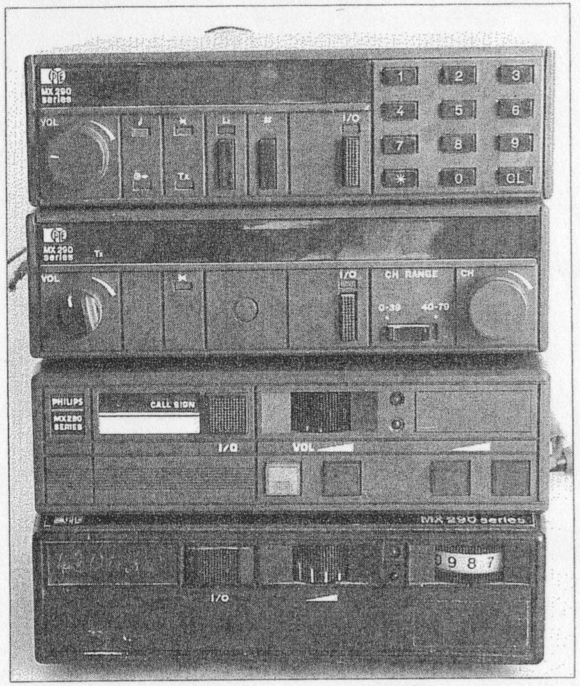
The MX294 and MX296 come in a variety of forms, the main difference being the front-panel channel control arrangement. You'll usually find this is a edgewise mechanical 16-way channel switch, which appears virtually identical to the M294/M296 type apart from the greater number of switch positions. This switch is occasionally mechanically limited to the programmed number of channels – lift off the outer knob from the switch and remove the small metal ring from the switch itself. This ring will have a

Table 4.5. MX290 series identification codes

Equipment type:	MX294, MX296 etc
Market code:	01 (standard production)
Mobile type:	1 (standard), 2 (with fitted rear facility socket), 3 (for cassette mounting)
Installation items:	A, 1–4 (speaker, mounting brackets etc)
Number of channels:	1–9, X (10), A–F (11–16), Q (up to 256 with special front panel)
Brand label:	0–2 (front panel label)
Internal options:	0 (none), 1 (carrier level detector, eg for trunking sets)
Channel spacing:	S (12.5kHz), V (25kHz), R (20kHz)
TX/RX freq band:	A0, E0 etc.
Channel capacity:	F (up to 16), G (all others)
Freq programming:	T, 1–6 (various programmed options)
Transmit power:	1 (25W), 2 (15W), 3 (10W), or 4 (6W)
Primary options:	1A ('New' front panel), 1B (TEDX), 1C (TED3), 14 (TE1), 15 (TED1), 16 (TED6), 41 (40-chan), 45 (40-chan, TED1), 46 (40-chan, TED6), 81 (80-chan), 85 (80-chan, TED1), 86 (80-chan, TED6), S1 (CX290 trunking)
Secondary options:	00–30 (various mics), 90 (mic with internal TX timer).







Top: **The MX290 series is usually fitted with a 16-channel switch**

Middle: **If you find an MX294 or MX296 with a 40/80-channel front panel like this, you're in luck**

Bottom: **All these sets are from the MX290 series**

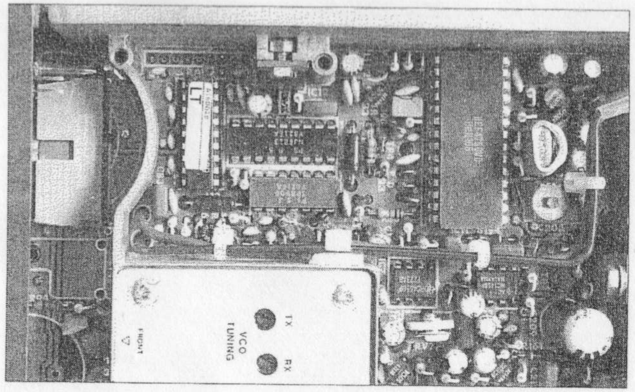
detented 'stop' in it which fits into the appropriate channel position on the rotary switch to act as a mechanical stop. Alternatively, you might find an electronic channel control with a dual seven-segment LED readout giving either 40 channels or 80 channels. In the latter case, an edgewise plug is fitted to the front left of the set's main board to interface with the front panel's channel control. The latter form of front panel of course is ideal for amateur radio use, although you can if you wish add your own BCD switches to give channel control.

Don't be mislead if you see an LCD readout on the front panel along with the 16-way switch – this is a TEDX microprocessor controlled selective calling unit, which has nothing to do with the RF channel control of the set.

You may sometimes find a trunking front panel is used, with a LED readout and keypad but no click-step channel knob. In this case, you'll need to replace this with an added channel switch of your own.

Synthesiser

This uses an NJ8813 synthesiser divider IC and a HEF4750 reference divider IC, the latter in the case of the MX294 plugging into a socket on the main



The MX294 synthesiser section – the TTL PROM has a white label attached

board. Note that this isn't an EPROM, even if it looks like one. The frequency control information is stored in a fusible-link TTL PROM. Now, most amateurs don't have programming facilities for these, although EPROM programming facilities for the commonly available 27 series EPROMs are usually readily available. As common 5V logic levels are used for both, with suitable pin-swapping a suitably programmed EPROM can be used as an effective replacement. I've helped supply over 200 such programmed EPROMs to amateurs in the UK for this very purpose.

You'll find that, for 16 channels, a 16-pin 82S129 PROM is used. For 40/80 or more channels, an 18-pin 82S185 PROM is used. The PROM plugs into an IC socket on the MX294 PCB, and this has facilities for either 16-pin or 18-pin IC sockets. Even if a 16-pin socket is used, the 'holes' are there in the PCB for 18 pins – pins 9 and 10 aren't used. To prevent confusion, the pin numbers I've given here always refer to those for an 18-pin socket – for a 16-pin socket simply subtract 2 from pin numbers 11–18 inclusive.

Channel switch

The 16-way channel switch used is a reverse-logic type, which pulls the output lines to 0V rather than connects positive voltage as needed to the PROM address lines. A thin-film resistor array of eight 4.7kΩ resistors is used to 'pull up' to 5V the address lines to the PROM. You'll see a 7805 regulator next to the latter – this is used to supply the stabilised 5V line. You may also see a plug-in link LK1 next to the regulator. This is the 5V line link and should be left connected. You may also see link LK2 next to the PROM. This is used to pull the A7 binary address line (PROM pin 17) down to 0V. This is because the 82S129 has a capacity to store 32 channels, and this facility is used to provide an alignment channel for the set, which is the frequency marked on its serial number plate. By using the LK2 facility, either with a suitably programmed PROM or a replacement EPROM and the A7 line connected appropriately, with the 16-channel switch you can get access to 32 channels, ie all 2m FM 'S' and 'R' channels plus reverse repeater channels. To do this, use the 16-channel switch and add a toggle switch on the front panel, wired to the two pins on LK2 or to short PROM address line A7 (pin 17) to 0V if LK2 isn't present.

You must make the appropriate pin 'crossovers' when using a substitution EPROM. For this you can simply use several wires

Table 4.6. EPROM Substitution for 82S129 PROM

EPROM function	EPROM pin number (18-pin) conn 2716	2732	2764	27128	27256	MX294 PROM socket
A0	8	8	10	10	10	Pin 5
A1	7	7	9	9	9	Pin 6
A2	6	6	8	8	8	Pin 7
A3	5	5	7	7	7	Pin 4
A4	4	4	6	6	6	Pin 3
A5	3	3	5	5	5	Pin 2
A6	2	2	4	4	4	Pin 1
A7	1	1	3	3	3	Pin 17
A8	23	23	25	25	25	0V
A9	22	22	24	24	24	0V
A10	19	19	21	21	21	0V
A11	–	21	23	23	23	0V
A12	–	–	2	2	2	0V
A13	–	–	–	26	26	0V
A14	–	–	–	–	27	0V
O0	9	9	11	11	11	Pin 14
O1	10	10	12	12	12	Pin 13
O2	11	11	13	13	13	Pin 12
O3	13	13	15	15	15	Pin 11
O4	14	14	16	16	16	o/c
O5	15	15	17	17	17	o/c
O6	16	16	18	18	18	o/c
O7	17	17	19	19	19	o/c
Gnd	12	12	14	14	14	0V
Vpp	21	20	1	1	1	Pin 18 (+5V)
OE	20	20	22	22	22	0V
CE	18	18	20	20	20	0V
Vcc	24	24	28	28	28	Pin 18 (+5V)
PGM	–	–	27	27	–	Pin 18 (+5V)

appropriately soldered between the main PCB (with the PROM socket removed) and an EPROM socket mounted on a piece of Veroboard or similar.

Programming codes

The MX290 series synthesiser requires four sequential binary 'words', of 4 bits each, for each TX or RX frequency (Fig 4.8). On the TTL PROM, it sequentially addresses in binary the A0 (pin 5) and A1 (pin 6) lines to obtain these, and the A2 line (pin 7) is used to switch between RX (binary 0) and TX (binary 1). The address lines, A3 (pin 1), A4 (pin 2), A5 (pin 3) and A6 (pin 4) are the 16-channel binary address from the channel switch, and A7 is the 'LK2' address for 'moving up' 16 channels. The first four hexadecimal 'words' programmed in your PROM/EPROM contain the channel 1 receive division code, the next four contain the channel 1 transmit code, the next four channel 2 receive code, the next four channel 2 transmit code etc. For transmit, this is the division code for the transmit VCO frequency, on receive it's the code for the local oscillator injection frequency, which for both 2m and 4m is 10.7MHz above the required receiver frequency, and for 70cm is 21.4MHz away from the receive frequency.

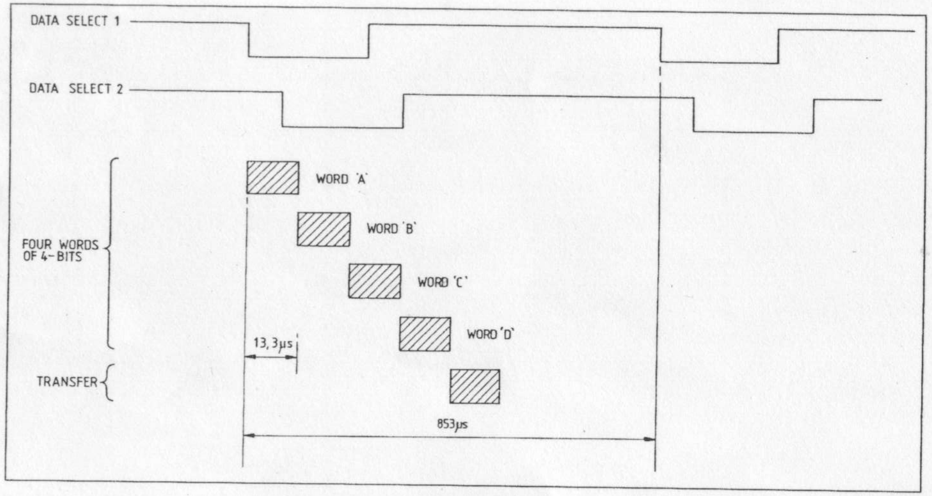


Fig 4.8. MX290 series PROM addressing

If your set is a (rare) 'AW' band (148–174MHz wide-band) or EW band (68–88MHz wide-band) set, identified by a 21.4MHz crystal filter (marked '21xxxx' on the top), then use an injection frequency of 21.4MHz removed from the receive frequency.

The MX296 uses a synthesiser reference frequency of 12.5kHz, and the MX294 uses either a 5kHz or 6.25kHz synthesiser reference. To check on the latter, look at the colour of the thin PCB between the large HEF4750 IC and its socket. If it's blue or red, the synthesiser reference frequency (ie the minimum channel step) is 6.25kHz, as found on virtually all sets in the UK. If it's green (rare in the UK), it's 5kHz. This is important when you work out the codes – a 5kHz reference means you won't be able to program 12.5kHz channel steps, only multiples of 5kHz. The reference frequency is present as a square wave on pin 25 of the HEF4750 if you're in doubt. All codes given in the tables in this section for the MX294 are for the commonly found 10.7MHz receiver IF and reference frequency of 6.25kHz – those for the MX296 are for a 12.5kHz reference and positive-side receiver injection.

Code calculation

To calculate the division code for any required frequency (remember, this is the VCO injection frequency in receive mode), first divide your TX or RX injection frequency by the reference frequency, making sure you keep to the same frequency exponential, ie hertz, kilohertz or megahertz. For example, divide the final VCO frequency in megahertz by 0.00625 (6.25kHz – substitute 0.005 if yours is a 5kHz reference set, or 0.0125 if it's an MX296). Then, subtract 3840 from this number – this is a fixed synthesiser divider offset. Convert the number you now have into a four-digit hexadecimal word, *DCBA*, with *D* as the MSD (most significant bit) and *A* as the LSB (least significant bit). Now change this hexadecimal combination

Table 4.7. Suggested 2m channels

Chan	LK1 in	LK1 out
16	R0	Rev R0
1	R1	Rev R1
2	R2	Rev R2
3	R3	Rev R3
4	R4	Rev R4
5	R5	Rev R5
6	R6	Rev R6
7	R7	Rev R7
8	S8	S16
9	S9	S17
10	S10	S18
11	S11	S19
12	S12	S20
13	S13	S21
14	S14	S22
15	S15	S23

Table 4.8. 2m PROM codes

Frequency (MHz)	RX BCAD	TX BCAD	Frequency (MHz)	RX BCAD	TX BCAD
144.500	0205	5B04	145.275	72C5	CBC4
144.525	0245	5B44	145.300	8205	DB04
144.550	0285	5B84	145.325	8245	DB44
144.575	02C5	5BC4	145.350	8285	DB84
144.600	1205	6B04	145.375	82C5	DBC4
144.625	1245	6B44	145.400	9205	EB04
144.650	1285	6B84	145.425	9245	EB44
144.675	12C5	6BC4	145.450	9285	EB84
144.700	2205	7B04	145.475	92C5	EBC4
144.725	2245	7B44	145.500	A205	FB04
144.750	2285	7B84	145.525	A245	FB44
144.775	22C5	7BC4	145.550	A285	FB84
144.800	3205	8B04	145.575	A2C5	FBC4
144.825	3245	8B44	145.600	B205	0C04
144.850	3285	8B84	145.625	B245	0C44
144.875	32C5	8BC4	145.650	B285	0C84
144.900	4205	9B04	145.675	B2C5	0CC4
144.925	4245	9B44	145.700	C205	1C04
144.950	4285	9B84	145.725	C245	1C44
144.975	42C5	9BC4	145.750	C285	1C84
145.000	5205	AB04	145.775	C2C5	1CC4
145.025	5245	AB44	145.800	D205	2C04
145.050	5285	AB84	145.825	D245	2C44
145.075	52C5	ABC4	145.850	D285	2C84
145.100	6205	BB04	145.875	D2C5	2CC4
145.125	6245	BB44	145.900	E205	3C04
145.150	6285	BB84	145.925	E245	3C44
145.175	62C5	BBC4	145.950	E285	3C84
145.200	7205	CB04	145.975	E2C5	3CC4
145.225	7245	CB44	146.000	F205	4C04
145.250	7285	CB84			

Table 4.9. 4m PROM codes

Frequency (MHz)	RX BCAD	TX BCAD	Frequency (MHz)	RX BCAD	TX BCAD
70.2500	9382	EC81	70.3875	A3E2	FCE1
70.2625	93A2	ECA1	70.4000	B302	0D01
70.2750	93C2	ECC1	70.4125	B322	0D21
70.2875	93E2	ECE1	70.4250	B342	0D41
70.3000	A302	FC01	70.4375	B362	0D61
70.3125	A322	FC21	70.4500	B382	0D81
70.3250	A342	FC41	70.4625	B3A2	0DA1
70.3375	A362	FC61	70.4750	B3C2	0DC1
70.3500	A382	FC81	70.4875	B3E2	0DE1
70.3625	A3A2	FCA1	70.5000	C302	1D01
70.3750	A3C2	FCC1			

from *DCBA* to *BCAD*, because this is the order in which the synthesiser reads the information, *B* first, then *C*, then *A*, then *D*, and this is the order you need to program each frequency into your EPROM or PROM.

I've given typical codes in Tables 4.8, 4.9 and 4.10 for popular amateur FM channels.

Substitution diode matrix

For single-channel use, maybe for packet, you can substitute a low-cost CMOS IC together with a few diodes and resistors for the PROM. I developed the circuit shown here for my 4m MX294 to be used on a hilltop packet node site. See Fig 4.9 and Table 4.11. To program this, fit the diodes needed to give you the correct binary 'words' for each address, in the same *BCAD* order. A diode present in any position provides a logic '1' while the absence of a diode in any position provides a logic '0'. You may wish to produce a PCB, although for the sake of simplicity a stripboard layout is preferred for 'one-off' boards.

Table 4.10. Typical 70cm EPROM codes

Frequency (MHz)	RX BCAD	TX BCAD	Frequency (MHz)	RX BCAD	TX BCAD
433.000	5807	0F07	433.300	6887	1F87
433.025	5827	0F27	433.325	68A7	1FA7
433.050	5847	0F47	433.350	68C7	1FC7
433.075	5867	0F67	433.375	68E7	1FE7
433.100	5887	0F87	433.400	7807	2F07
433.125	58A7	0FA7	433.425	7827	2F27
433.150	58C7	0FC7	433.450	7847	2F47
433.175	58E7	0FE7	433.475	7867	2F67
433.200	6807	1F07	433.500	7887	2F87
433.225	6827	1F27	433.525	78A7	2FA7
433.250	6847	1F47	433.550	78C7	2FC7
433.275	6867	1F67	433.575	78E7	2FE7

Links

If your set was fitted with a selective calling module, than at the front right of the set you'll see a set of links. For 'normal' operation (ie without any front-panel selective calling limitations of TX and / or

Fig 4.9. MX290 series diode matrix PROM replacement

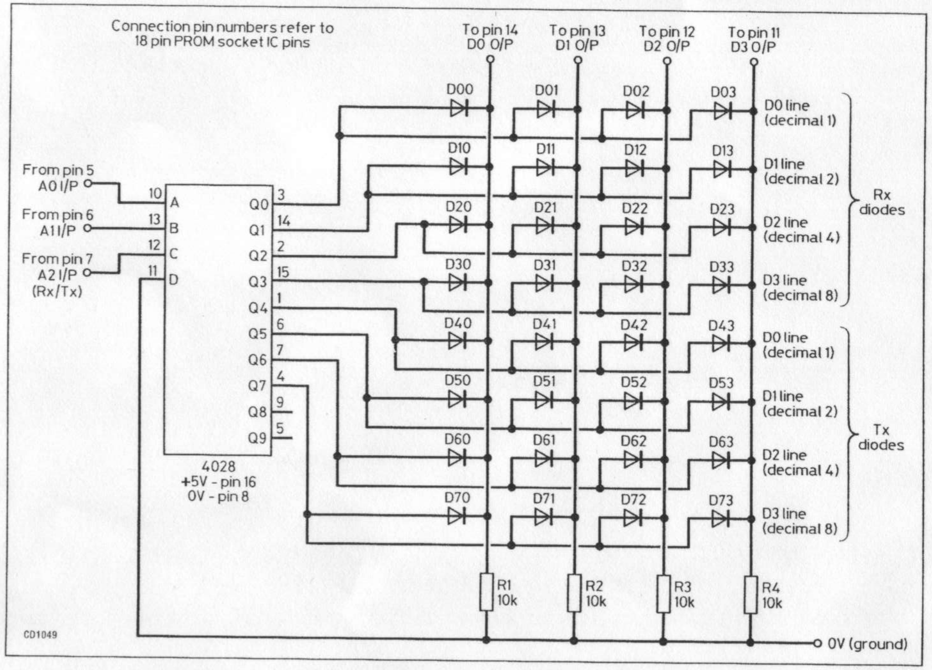


Table 4.11. Binary/hexadecimal codes

Hex	Binary MSB D3x	D2x	D1x	LSB D0x
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
A	1	0	1	0
B	1	0	1	1
C	1	1	0	0
D	1	1	0	1
E	1	1	1	0
F	1	1	1	1

RX capability) you need to link F to S and K1 to L, and remove any other links. If your front panel does have some signalling electronics present, just remove the electronics of this, or at least the plug which mates with the radio itself next to these links, before refitting it after conversion.

Preliminaries

The MX290 series uses the same microphone, speaker, and facility connections as the M290 series to provide interchangeability between plug-in modules. Thus, simply refer to the information I've given earlier in this chapter for these connections.

Opening the set up by removing the covers will usually reveal a large metal screen secured to the chassis with a multitude of screws. This is for screening purposes between the RF section and any added selective calling modules, and for amateur purposes without a Selcall unit fitted it can safely be left off if you need the room for an added EPROM board. Don't at this stage remove the lid above the square VCO unit. For tuning purposes I'd advise leaving the lid on which is next to the track side of the main PCB (this is either the top or the bottom lid, depending upon which front-panel control arrangement is used) to ensure the set doesn't short out on any stray metal on your bench. Before doing this, however, quickly make sure the four VCO unit screws on the track side of the main PCB are tight – you'll find if these are loose you'll get superimposed 'scratchy' noises on both transmit and receive due to vibration if you use the rig on the move.

Connect a 3–8Ω speaker to the rear blue/brown speaker lead, and for transmit alignment a microphone to the five-pin 270° DIN mic connector. Now connect your 13.8V DC supply. If you have a channel switch fitted then, with the controls towards you, check there's a red 'lock' LED glowing at the left of the set – this may occur on only a few channels as you rotate the channel knob. This shows the synthesiser is working OK. If it doesn't, then check whether the small black plug-in PROM is missing – it will usually have a white label on it identifying the stored information.

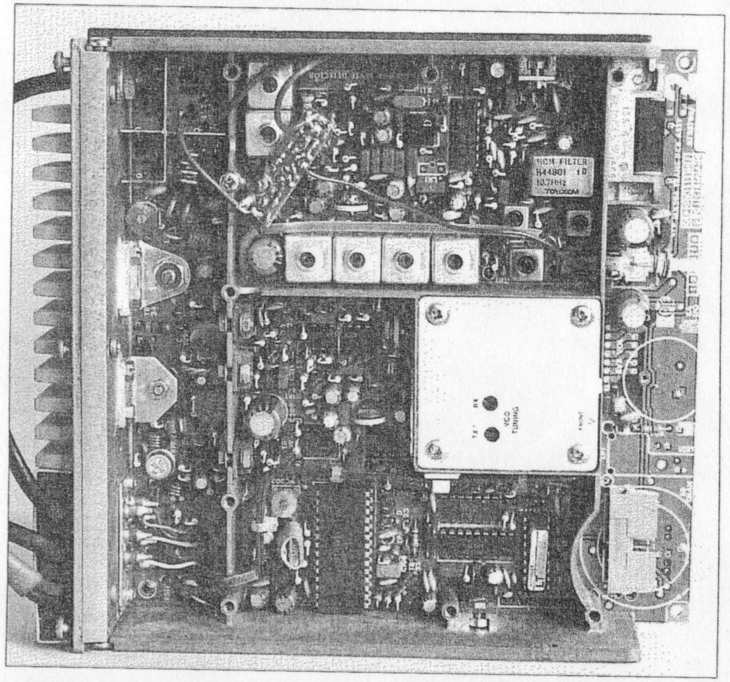
MX294

Two slightly different versions of the MX294 receiver circuitry have been made – one is marked 'AT28790' on the main PCB and is fitted with a bipolar BFQ51 receiver front-end transistor, while the later model is marked 'AT28873' and is fitted with a BF981 which gives slightly better sensitivity. These transistors aren't interchangeable (don't try it!) but the receiver tuning details are identical between the models.

Alignment

Details of the synthesiser layout and circuitry are given in Figs 4.10–4.14. Fit your programmed PROM or EPROM, and initially adjust the multi-turn RX VCO trimmer until the red 'lock' LED lights – then with the radio switched to the centre channel of your programmed frequency range, tune for a voltage of around 6.5V on TP3. You can also check with an oscilloscope or frequency counter that a pulse waveform is present on pin 1 of the HEF4750 reference divider IC – this is the divided VCO signal (a square-wave 6.25/5.0kHz reference derived from the crystal source is present on pin 25 for a comparison). As you adjust the VCO trimmer, the frequency of the waveform on pin 1 should vary in sympathy with the VCO frequency. Rotate RV1, the RX squelch control, until you hear noise from the speaker – if the VCO is out of lock you'll find the receive audio is muted. On receiving an off-air signal, adjust all six front-end coils L1–L7 for best signal, reducing the level of the signal as needed. Reset the squelch as needed.

For the transmitter alignment, key the PTT and adjust the TX VCO trimmer until the 'lock' LED lights, then with your set on the centre channel of your programmed frequency range, readjust for 6.5V on TP3. Set the transmit power control RV4 fully clockwise and adjust the three transmitter PA trimmer capacitors C126, C129 and C138 all for maximum transmit power (you'll usually find you can achieve 35–45W output). Readjust RV4 to the power output you wish, typically 25W for normal operation to prevent overheating of the PA



Inside the MX294 – this set has had a BF981 preamplifier added by the author

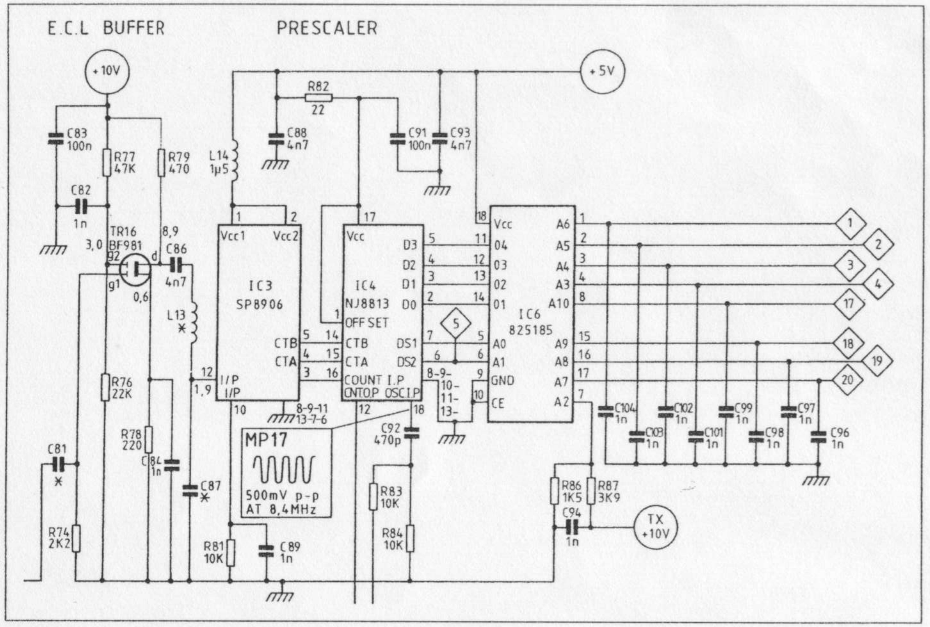
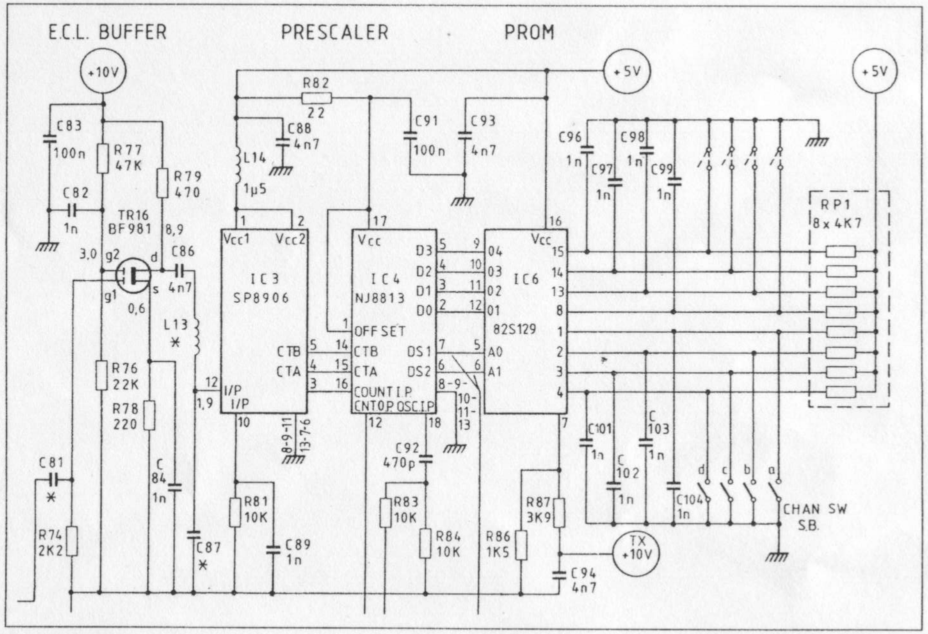
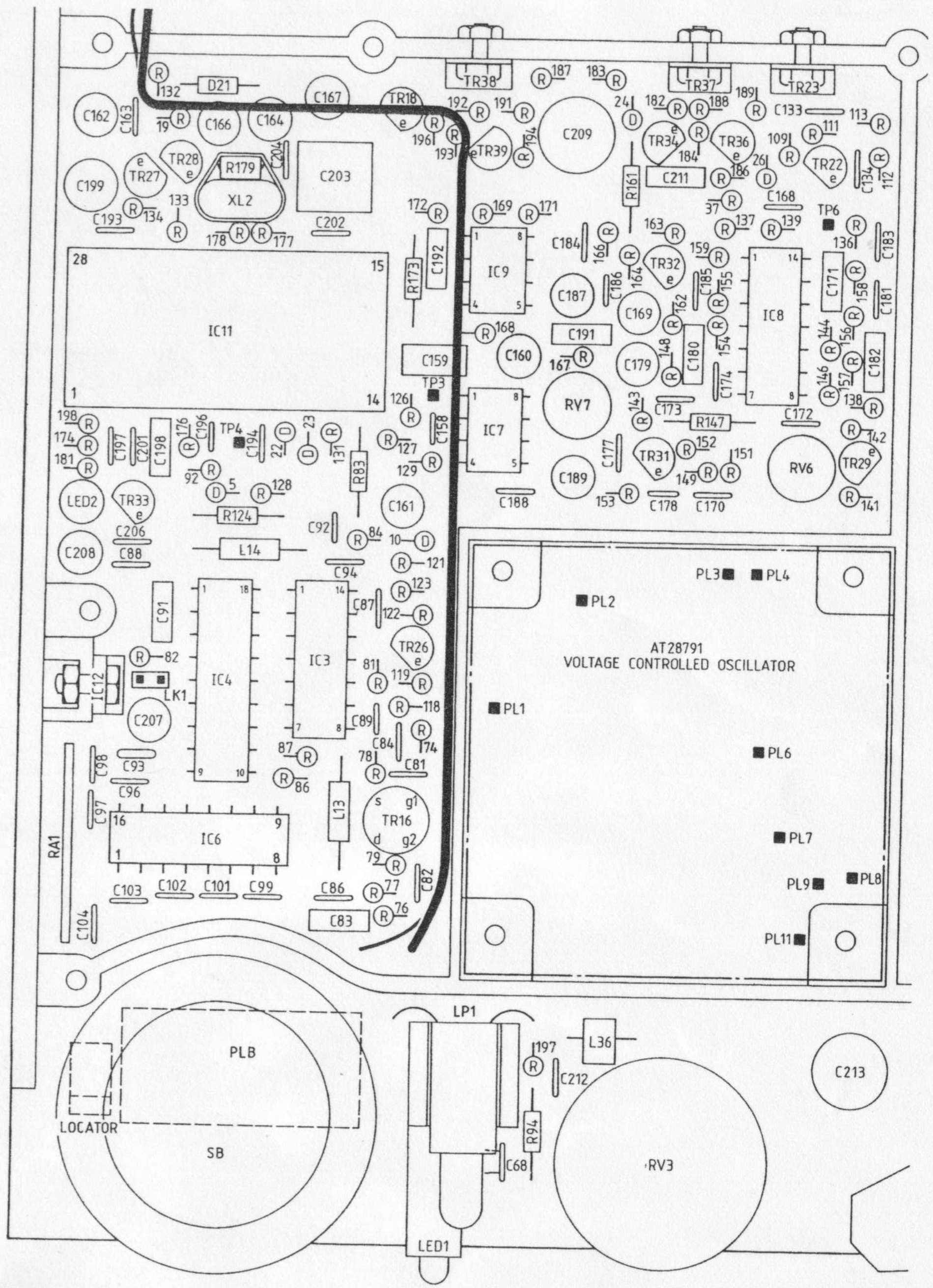


Fig 4.10. MX294 remote channel control and synthesiser circuitry

Fig 4.11. MX294 16-channel PROM and synthesiser circuitry

heatsink. RV6 sets the transmitter deviation but you'll first need to adjust RV7, which is the modulation balance control. Using either a high-impedance AC millivoltmeter or preferably an oscilloscope connected





to TP7, adjust RV7 for minimum reading (ie to 'null' the 'stepped' AC waveform to zero at this test point), at the same time as you're providing a modulation input at the microphone. You will normally

Fig 4.12. Synthesiser component layout, MX294

Fig 4.13. MX294 alignment diagram

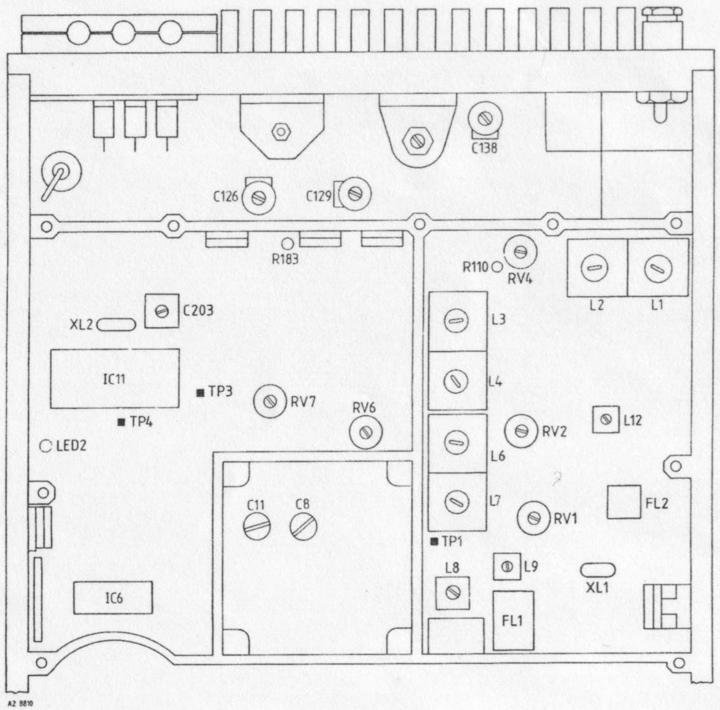
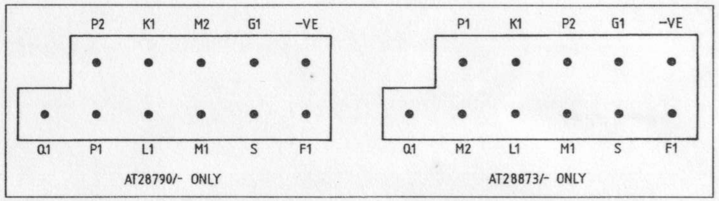


Fig 4.14. MX294 circuit links



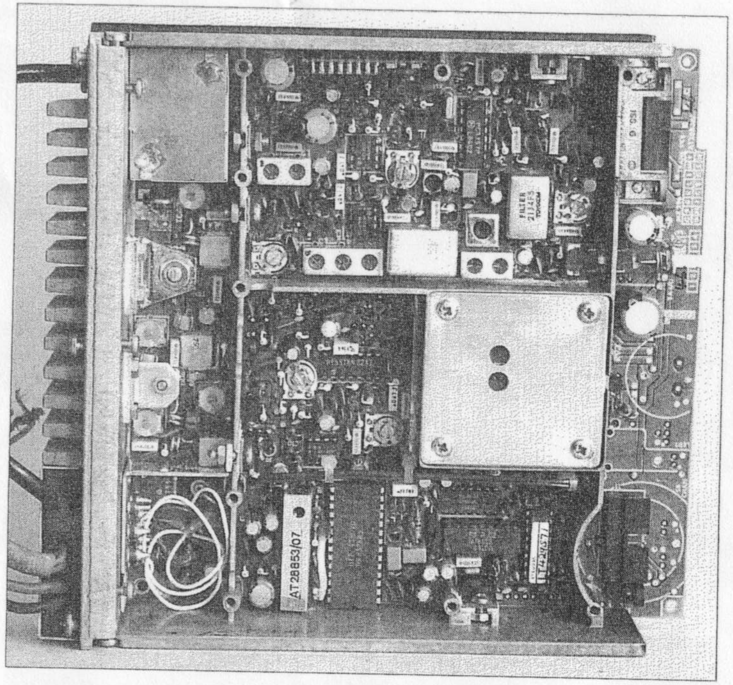
not need to make any further adjustments but C203 is the reference frequency crystal trimmer, which sets the frequency of both transmit and receive on all channels.

MX296

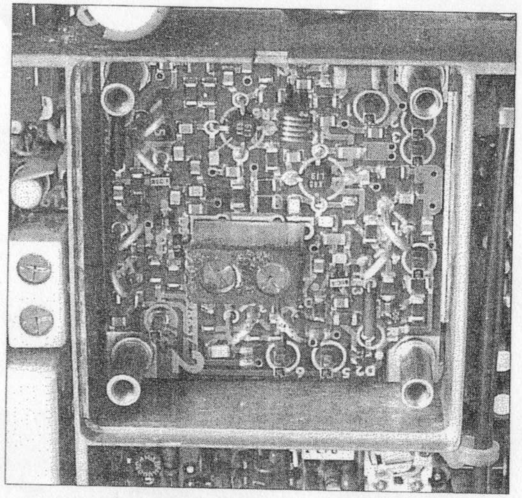
The MX296 is outwardly physically similar to the MX294, and provides around 11W on transmit. After removing the lid and any selective calling module, make links to join pins S to F (RX audio), and pins K1 to L (TX PTT) on the small link header array at the front right hand side of the set's main board. Remove any other links.

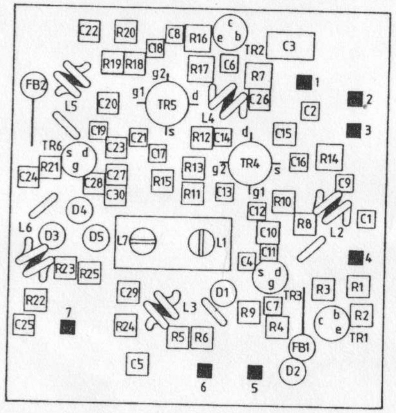
Alignment

Details of the MX296 layouts are given in Figs 4.15–4.18. After plugging in your suitably programmed PROM, or wiring in a replacement EPROM having thoroughly checked the connections, connect



Inside the MX296



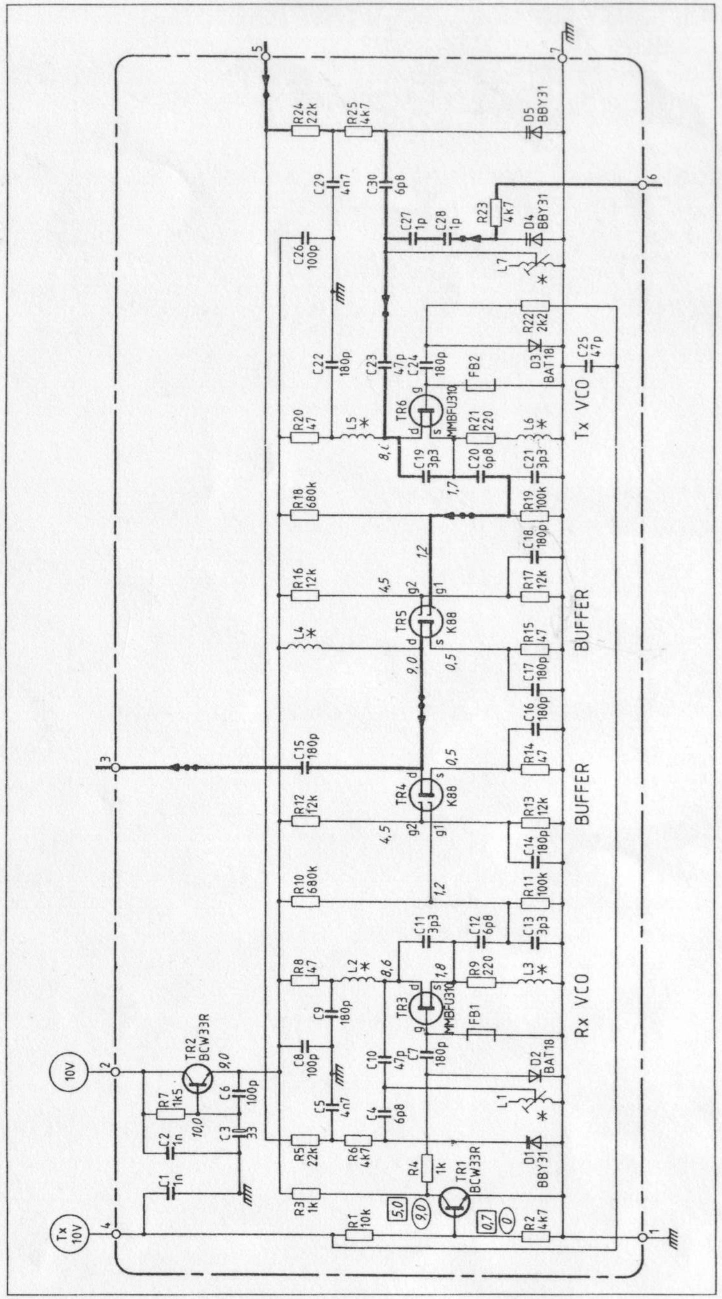


Left: The MX296 VCO unit

Above: Fig 4.15. The MX296 VCO component layout

your DC power supply and switch the set on. Carefully adjust L1 on the VCO board until the red 'lock' LED illuminates. This L1 adjuster may have some flexible rubbery sealant on it – just remove this if needed. If you find the LED doesn't light, then check your EPROM connections. You can also check with an oscilloscope or frequency counter that a pulse waveform is present on pin 1 of the HEF4750 reference divider IC – this is the divided VCO signal (a square-wave 12.5kHz reference

Fig 4.16. The MX296 VCO circuit



derived from the crystal source is present on pin 25 for a comparison). As you adjust the VCO trimmer, the frequency of the waveform on pin 1 should vary in sympathy with the VCO frequency.

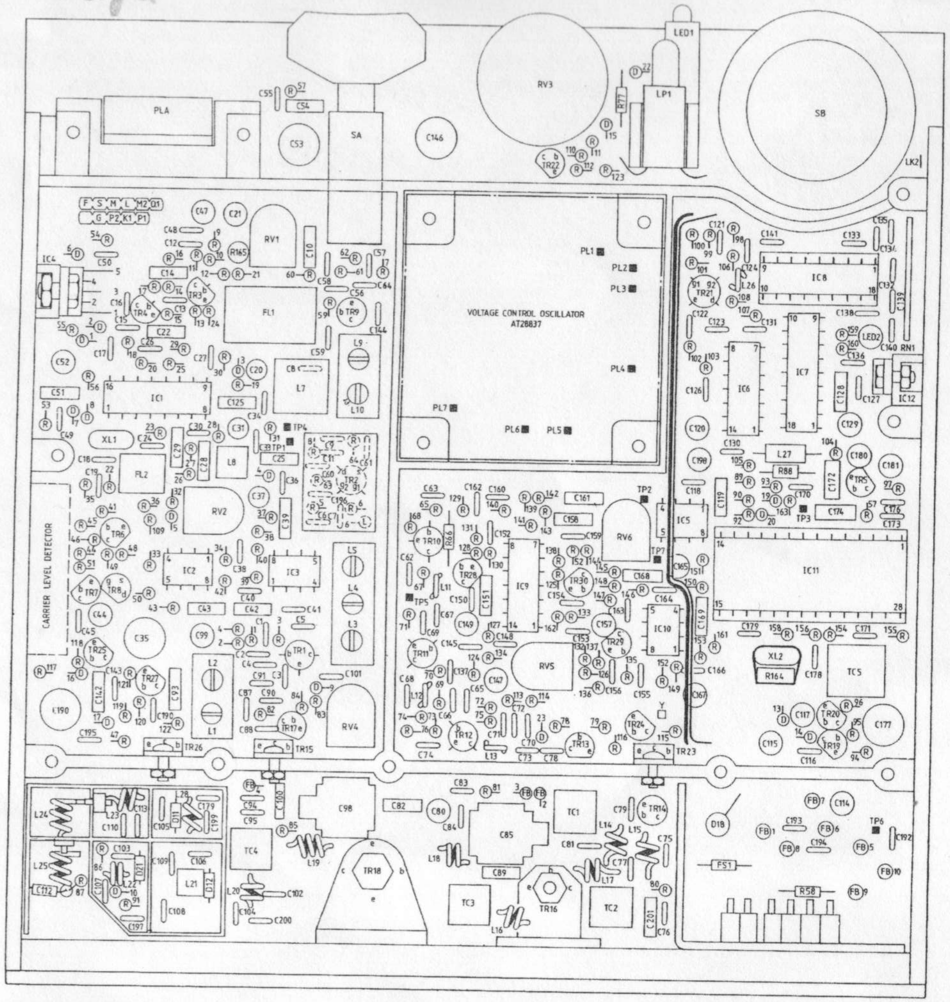
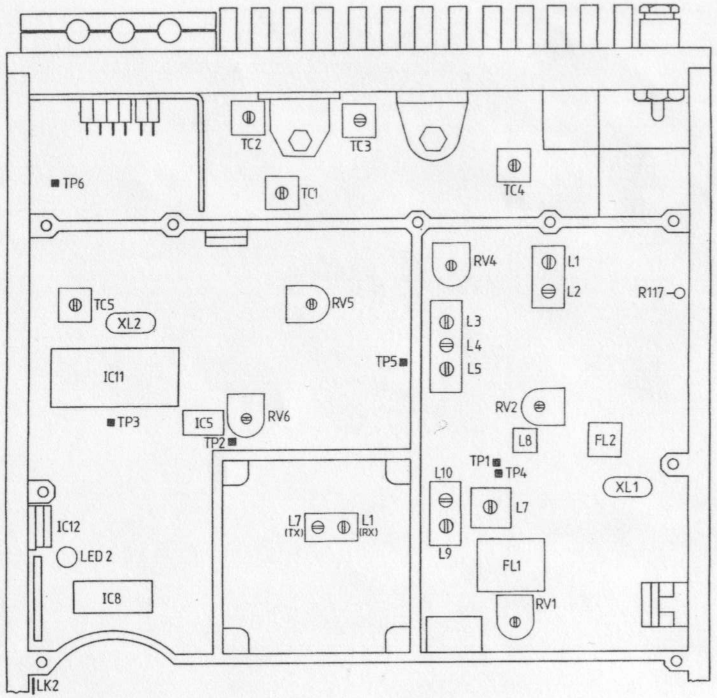


Fig 4.17. MX296 component layout

Assuming you obtain lock, adjust L1 until you get a reading of around 6.5V on test point TP2 – this voltage will vary in sympathy with your tuning when the synthesiser is in lock.

If you find that your VCO will not 'pull' enough for use on 70cm on receive, then you can slightly modify the hairpin coils, L2 and L3, on the receive section of the VCO. First remove the VCO board by removing the four screws securing the lid, followed by the four screws on the track side of the main PCB, and unplug the VCO board by carefully pulling the board-mounted pillars to lift the VCO board out. Unsolder L2 and L3, replacing these with slightly larger hairpin loops so that when the VCO is inserted the tops are just below the nearby metal can. Don't attempt to modify the turns on the coils inside the metal cans – you'll just end up with a mess of melted coil former!

Fig 4.18. MX296 alignment diagram



Initially adjust the squelch preset RV1 so that you can hear receiver noise from the speaker with the volume control suitably adjusted. Whilst receiving an off-air signal, adjust L9 and L10, then L1, L2, L3, L4 and L5 for best reception, reducing the level of signal as needed, and finally retuning these for best sensitivity on a weak signal – then reset the squelch preset as needed.

Signal mad pin 16 ·IC1

Now key the transmitter and adjust L7 on the VCO board again until the 'lock' LED lights, then again adjust this for around 6.5V on TP2. RV4 is the RF power preset control, which you should initially set to give maximum output power. Now adjust the transmitter driver and power amplifier trimmers TC1, TC2, TC3 and TC4 for maximum RF output power, repeating the sequence until absolute maximum output is obtained. If you don't get any RF initially, adjust these first for maximum current drawn by the rig from your power supply, then carry on adjusting for maximum RF power.

TC5, which sometimes forms part of a metal TCXO (temperature compensated xtal oscillator) block, is the reference frequency adjustment. If the unit came out of service, this should be accurately set, but may be adjusted if needed – it sets the frequency of all receive and transmit channels.

RV5 is the peak deviation control and, using an AC millivoltmeter or preferably an oscilloscope, adjust RV6 for minimum AC 'stepped' waveform voltage on TP3 while you're applying audio to the set's microphone.

Packet use for the M290 and MX290 series

Low-level receiver audio is present on pin 4 of the microphone connector – note that the front-panel volume control varies the level of this. You may wish to relink this to the top of the volume control for 1200 baud packet use.

Most packet terminal node controllers use a 'ground to transmit' line for PTT, so to interface with the set you'll need to add a suitable interface, like the one-transistor circuit of Fig 4.19. You'll find +10V on pin 5, and you'll need to switch +10V to pin 3 for transmit.

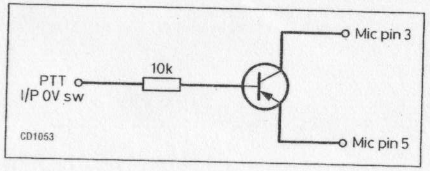


Fig 4.19. M/MX290 series TNC PTT interface

For 9600 baud packet, on receive you can take the receive discriminator audio out from pin 9 of the MC3357 IC in the receiver section on each set, using a series isolating capacitor. On the M294/6, the transmitter uses phase modulation rather than direct frequency modulation, but you can try injecting transmit audio to pin D of the facility connector. On the MX294 remove C187 (2.2μF, next to IC9) and inject your transmit audio to the pad previously connected to the positive lead of C187 via an isolating capacitor of at least 10μF (possibly using the capacitor you removed), with the positive lead to the MX294 connection. On the MX296, remove C165 (10μF, next to IC10, a 1458) and inject TX audio to the pad previously connected to the positive lead of C165, again with an isolating capacitor with the positive lead going to the MX296 connection.

MOTOROLA MC80 ON 70cm

Although Motorola mobiles have in the past been a rarity, there have been a large number of Motorola MC80 transceivers for UHF seen on the surplus market. My thanks go to Colin, G3PSM, for his help in providing me with valuable assistance including a copy of the technical service manual; to Steve, G1FIP, for modification information; to Steve, G3VMW, for his comprehensive information on packet on the MC80; and the notes by G4OAA on 9600 baud packet modifications and connections.

The MC80 is a two-channel set, with simple controls using two knobs for channel and volume adjustment on the left-hand side of the front panel, together with three push switches on the upper right of the front for signalling. The set may be fitted with 'Select 1' ('PL', or CTCSS to the rest of us), or 'Select 5' (five-tone sequential signalling), each of which use an internally fitted board which you'll probably remove for amateur use. The type number of the set is clearly visible below these. The UHF set comes in two band versions, 403–430MHz and 440–470MHz, either of which are suitable for retuning to 70cm. The sets commonly found are 25kHz channel spacing, and use a single IF of 10.7MHz with two crystal filters (Y31 and Y32 on the RX board). The transmitter uses PIN diode changeover (good for packet radio operation) and two transmit power versions are available, nominally 6W and 10W RF output – you'll typically get

82S126A
82S129A
1K-Bit TTL Bipolar PROM

Product Specification

Bipolar Memory Products

DESCRIPTION

The 82S126A and 82S129A are field programmable, which means that custom patterns are immediately available by following the Signetics Generic I fusing procedure. The 82S126A and 82S129A devices are supplied with all outputs at logical Low. Outputs are programmed to a logic High level at any specified address by fusing the Ni-Cr link matrix.

These devices include on-chip decoding and 2 Chip Enable inputs for ease of memory expansion. They feature either Open Collector or 3-State outputs for optimization of word expansion in bused organizations.

Ordering information can be found on the following page.

The 82S126A and 82S129A devices are also processed to military requirements for operation over the military temperature range. For specifications and ordering information consult the Signetics Military Data Book.

FEATURES

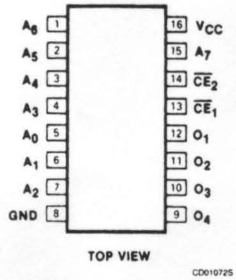
- **Address access time:**
  - **N82S126A: 30ns max**
  - **N82S129A: 27ns max**
- **Power dissipation: 0.5mW/bit typ**
- **Input loading: −100μA max**
- **On-chip address decoding**
- **Two Chip Enable inputs**
- **Output options:**
  - **82S126A: Open-Collector**
  - **82S129A: 3-State**
- **No separate fusing pins**
- **Unprogrammed outputs are Low level**
- **Fully TTL compatible**

APPLICATIONS

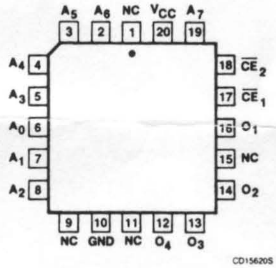
- **Prototyping/volume production**
- **Sequential controllers**
- **Microprogramming**
- **Hardwired algorithms**
- **Control store**
- **Random logic**
- **Code conversion**

PIN CONFIGURATIONS

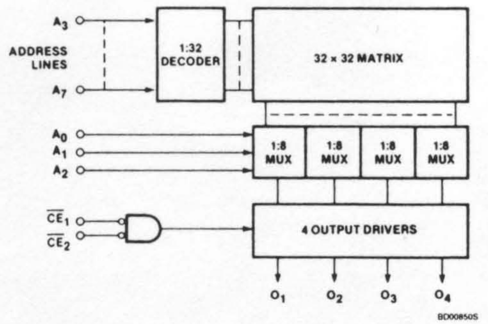
D, N Package



A Package



BLOCK DIAGRAM



1K-Bit TTL Bipolar PROM (256 × 4)

82S126A, 82S129A

ORDERING INFORMATION

DESCRIPTION	ORDER CODE
16-pin Plastic DIP 300mil-wide	N82S126A N • N82S129A N
16-pin Plastic SO 300mil-wide	N82S126A D • N82S129A D
20-pin Plastic Leaded Chip Carrier 350mil-square	N82S126A A • N82S129A A

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V_{CC}	Supply voltage	+7	V_{DC}
V_{IN}	Input voltage	+5.5	V_{DC}
 V_{OH} V_O	Output voltage High (82S126) Off-state (82S129)	 +5.5 +5.5	V_{DC}
T_A	Operating temperature range	0 to +75	°C
T_{STG}	Storage temperature range	-65 to +150	°C

DC ELECTRICAL CHARACTERISTICS $0°C \leq T_A \leq +75°C$, $4.75V \leq V_{CC} \leq 5.25V$

SYMBOL	PARAMETER	TEST CONDITIONS[1,2]	LIMITS			UNIT
			Min	Typ[5]	Max	
Input voltage						
V_{IL}	Low	$V_{CC} = 4.75V$			0.8	V
V_{IH}	High	$V_{CC} = 5.25V$	2.0			V
V_{IC}	Clamp	$V_{CC} = 4.75V$, $I_{IN} = -12mA$			-1.2	V
Output voltage						
		$\overline{CE}_{1,2}$ = Low				
V_{OL}	Low	$I_{OUT} = 16mA$			0.45	V
V_{OH}	High (82S129A)	$I_{OUT} = -2.0mA$	2.4			V
Input current						
I_{IL}	Low	$V_{IN} = 0.45V$			-100	μA
I_{IH}	High	$V_{IN} = 5.5V$			40	μA
Output current						
I_{OLK}	Leakage (82S126A)	$\overline{CE}_1$ or $\overline{CE}_2$ = High, $V_{OUT} = 5.5V$			40	μA
I_{OZ}	Hi-Z State (82S129A)	$\overline{CE}_1$ or $\overline{CE}_2$ = High, $V_{OUT} = 5.5V$			40	
		$\overline{CE}_1$ or $\overline{CE}_2$ = High, $V_{OUT} = 0.5V$			-40	
I_{OS}	Short circuit (82S129A)[3]	$\overline{CE}_{1,2}$ = Low, $V_{OUT} = 0V$, High stored	-15		-70	mA
Supply current[7]						
I_{CC}		$V_{CC} = 5.25V$			120	mA
Capacitance						
		$\overline{CE}_1$ or $\overline{CE}_2$ = High, $V_{CC} = 5.0V$				
C_{IN}	Input	$V_{IN} = 2.0V$		5		pF
C_{OUT}	Output	$V_{OUT} = 2.0V$		8		pF

Notes on following page.

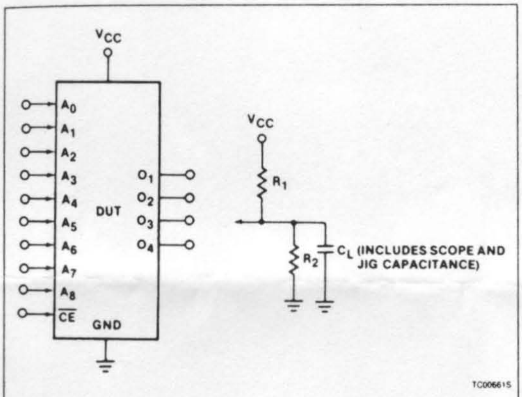
1K-Bit TTL Bipolar PROM (256 × 4) 82S126A, 82S129A

AC ELECTRICAL CHARACTERISTICS $R_1 = 270\Omega$, $R_2 = 600\Omega$, $C_L = 30pF$, $0°C \leq T_A \leq +75°C$, $4.75V \leq V_{CC} \leq 5.25V$

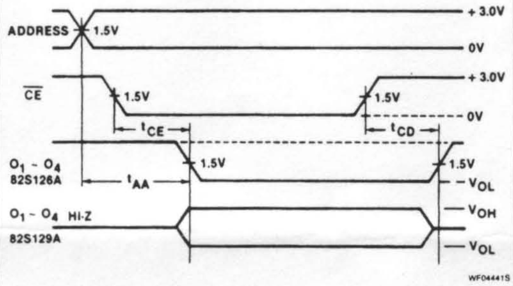
SYMBOL	PARAMETER	TO	FROM	N82S129A			N82S126A			UNIT
				Min	Typ[5]	Max	Min	Typ[5]	Max	
Access time[4]										
t_{AA}		Output	Address		17	27		17	30	ns
t_{CE}		Output	Chip Enable		10	20		10	20	ns
Disable time[6]										
t_{CD}		Output	Chip Enable		6	15		6	15	ns

NOTES:
1. Positive current is defined as into the terminal referenced.
2. All voltages with respect to network ground.
3. Duration of short circuit should not exceed 1 second.
4. Tested at an address cycle time of 1μs.
5. Typical values are at $V_{CC} = 5V$, $T_A = +25°C$.
6. Measured at a delta of 0.5V from Logic Level with $R_1 = 750\Omega$, $R_2 = 750\Omega$ and $C_L = 5pF$.
7. Measured with all inputs grounded and all outputs open.

TEST LOAD CIRCUIT



VOLTAGE WAVEFORMS



NOTE:
All AC parameters are measured at 1.5V unless otherwise specified.