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Additional Technical Support:

Note that additional technical support is available to Q-MAC Dealers under the "Dealer Support" section of the Q-MAC website: www.qmac.com. This site incorporates Technical Bulletins issued by Q-MAC, plus Technical Notes and Instructions in relation to specific products.

TABLE OF CONTENTS

1. WARNINGS & ADVICE

1. On no account should the unit be connected directly to 110volt or 240volt AC mains power. Serious damage or personal injury may result.

2. An approved 12volt or 24volt power supply or battery should be used. The supply should be capable of sourcing peak currents up to 10ampere. Failure to comply with this rating will result in severe distortion on transmissions. Please note that some power supplies labeled as 10ampere peak are not adequate as the voltage collapses towards the peaks.

3. Use only the approved power cable for installation. Use of thinner conductors or extensions will result in severe distortion on transmissions.

4. The system performance is generally only as good as the antenna and ground system will allow. If unbalanced antennas are being used eg. whips, end-fed broadbands etc, then it is vital to obtain a good low impedance ground connection either to a vehicle body, a moist patch of ground or a metal fence with rust removed at the point of connection.

5. The HF-90 is extremely small. When transmitting, the heatsink and extrusion may get very hot. Under some circumstances it may be possible to get burned by touching the heatsink. The radio has been designed and tested to cope with elevated temperatures. However the user should endeavour to allow free circulation of air around the radio.

6. In order to achieve the high output power, an internal power convertor is used to supply +55volt to the final amplifier on transmit. The energy stored by this supply is quite high (2.2joules) and it is wise to WAIT FOR A FULL MINUTE after transmitting prior to doing any service work on the PASW printed circuit board.

7. Radio Frequency Field Exposure: The HF-90 Packages generate high radio frequency fields. Their antennas are marked with a safe working distance in accordance with required Standards. This should be observed. Details are given on the following pages.

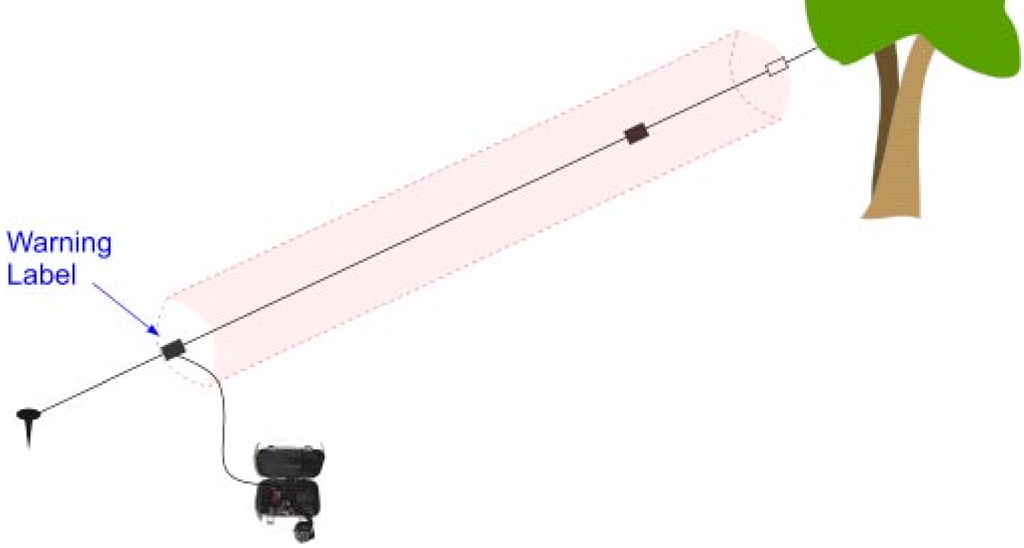
8. This device complies with Part 90 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

Radio Frequency Field Exposure
- Safe working distance information for Q-MAC antennas

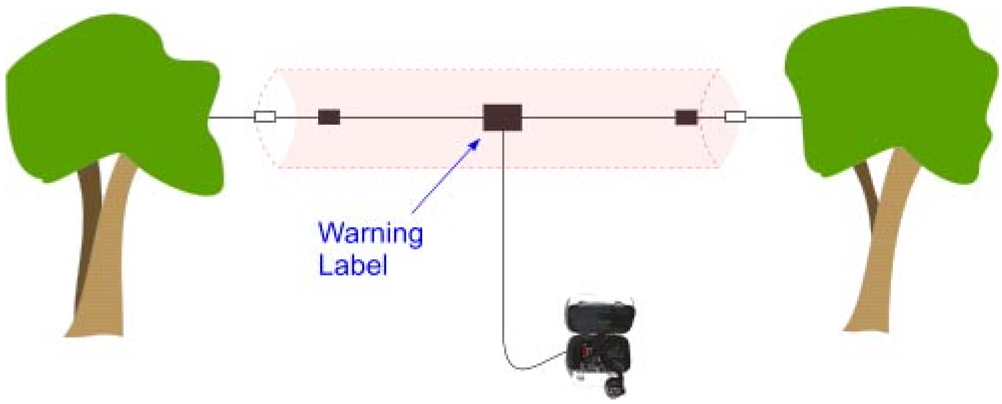
1. HF-90 used with QM7005 Portable End-Fed Broadband Antenna

WARNING LABEL

Safe working distance 0.2m (20cm)
Do not touch antenna wire
No RF burn risk



2. HF-90 used with QM7001 Broadband Dipole Antenna



WARNING LABEL

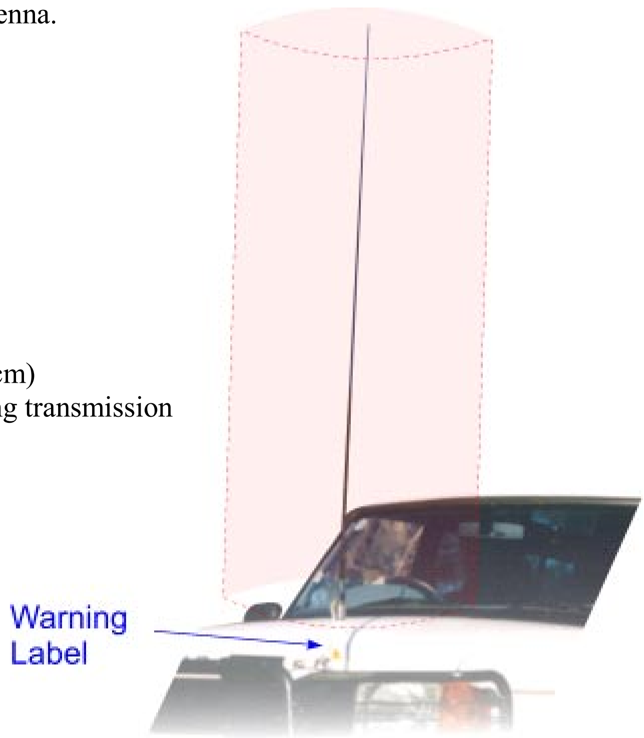
Safe working distance 0.2m (20cm)
Do not touch antenna wire
No RF burn risk

3. HF-90 used with ML-90 Vehicle Loop Antenna

WARNING LABEL

Safe working distance 1.0m (100cm)
Do not touch antenna arm during transmission
RF burn risk

4. HF-90 used with TA-90 Vehicle Tuner and QM7131 or QM7133 continuously loaded whip antenna.

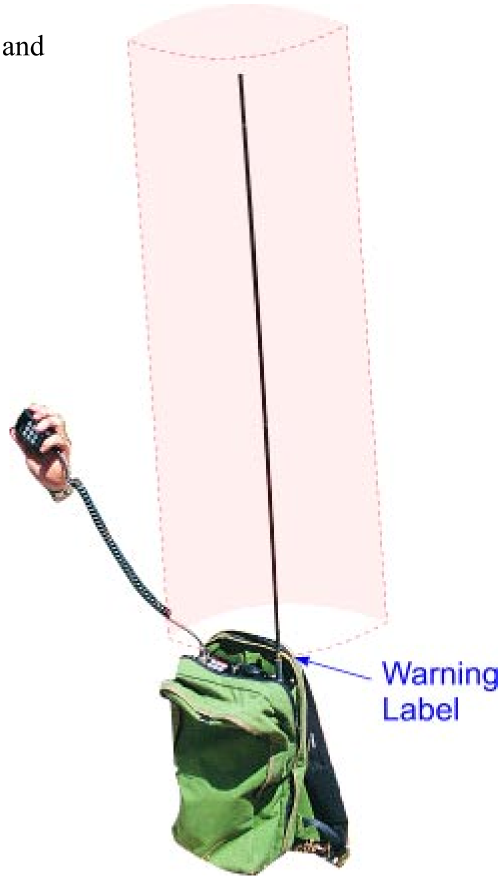


WARNING LABEL

Safe working distance 1.0m (100cm)
Do not touch whip or spring during transmission
RF burn risk

5. HF-90 used with TA-99 or TM-90 whip tuner and

QM7301 3m 6-section whip or
QM7303 3m 8-section whip or
QM7302 1m 2-section whip or
QM7304 1m 4-section whip or
QM7309 1m tape whip



WARNING LABEL

Safe working distance 0.6m (60cm)
Do not touch antenna during transmission
RF burn risk

2. INTRODUCTION

The HF-90 Compact Transceiver breaks new ground in the following areas:

Size: The volume of the transceiver is approximately one litre. This is less than a tenth of comparable products. On initial inspection it is often mistaken for a VHF/UHF set.

Weight: At 1 kilogram, the HF-90 is a quarter of the weight of products with a similar specification.

Ease of use: The HF-90 has quite deliberately been kept simple so that persons unfamiliar with HF communications may immediately pick it up and use it.

Low cost: The transceiver has been designed using state of the art SMD technology. Components from cellular telephony, satellite television, and personal computers have been used wherever possible to keep the cost at a minimum. Also, wherever possible, functionality has been implemented in software rather than hardware.

Ruggedness: Use of a heavily ribbed aluminium extrusion confers great strength to the HF-90. Stainless steel handles protect all front panel controls. A ribbed rear heatsink protects the rear connectors.

Reliability: Use of SMD technology and the delegation of functionality to software has led to simplicity of design which translates to high reliability. Unreliable parts such as potentiometers and wiring looms are avoided. All internal connectors have gold to gold mating surfaces.

Serviceability: The HF-90 was designed with serviceability as a top priority. The radio consists of three PCBs, all of which plug together. Only four screws need be removed to access the main PCBs. These PCBs plug together as a 'sandwich' with all the essential components and nodes easily probeable while the radio is operating, without the use of extenders. All power transistors are easily accessed and use single screw fixing.

Minimised inventory: The design of the HF-90 was implemented with the minimum number of different types of components. Thus spares inventory is reduced.

Versatility: The high performance and small size allows the HF-90 to be used in portable, mobile or fixed configurations. The wide power supply range (12 to 24volt) makes it particularly attractive in multi-role applications.

Receiver performance: Excellent receive sensitivity is combined with a large dynamic range through the use of four GaAs FETs in the front end mixer.

Transmitter performance: A very high power to weight ratio and extreme RF ruggedness is obtained through the use of 500volt MOS FETs in the power amplifier.

Selcall performance: A sophisticated digital signal processing algorithm is capable of extracting very weak calls in the presence of noise. Successful decodes at down to -132dBm have been observed.

3. PRODUCT SPECIFICATION

General

Frequency range:	2 ⇨ 30MHz
Modes of operation:	USB, LSB (J3E) CW (optional) Hopping (optional) AM (Rx only), FSK
Number of channels:	255
Channel resolution:	100Hz
Supply voltage:	12 ⇨ 24V DC nominal
Power consumption:	
- Transmit:	2A⇨ 10A (subject to pre-set power output)
- Receive:	310mA
Frequency stability:	± 1.5ppm
Antenna impedance:	50Ω
Antenna connector:	BNC
Handsets:	Speaker microphone DTMF microphone & telephone handset
Selcall system:	Based on CCIR 493-4 (Australian Standard)
Programming:	IBM PC 4800,8,1,N
BITE:	Micro, Rx, Tx tests

Environmental

Operating temperature:	-30ºC ⇨ 60ºC
Storage temperature:	-30ºC ⇨ 80ºC
Humidity:	95% non-condensing
Environmental rating:	IP54

Physical characteristics

Dimensions (mm):	112(W) x 47(H) x 220(D)
Weight:	1kg (HF-90 only)
Construction:	All metal extruded sleeve with front panel and heatsink
Finish:	Black anodized aluminium

Transmitter

Power output:	50Watt PEP
Duty cycle:	Normal speech or data (with fan option)
Unwanted sideband:	Better than -45dB
Carrier suppression:	Better than -50dB
Harmonic suppression:	Better than –60dB
Spurious emissions:	Better than –60dB
Noise suppression:	Better than -35dB
Distortion:	Less than 5% @ 70% PEP
Audio response:	270Hz ⇨ 2800Hz
Microphone:	Electret insert
Tune:	>20W radiated @ +1000Hz
Load protection:	ALC

Receiver

Sensitivity:	0.25µV for 10dB S+N/N
Selectivity:	2.3 kHz @ -6dB 6kHz @ -60dB
Image rejection:	Better than -50dB
Intermodulation:	Better than -70dB
3rd order intercept:	+20dBm (GaAs FET mixer)
Blocking:	Better than -70dB
Spurious response:	Better than -60dB
IF rejection:	Better than -60dB
Intermediate freq's:	83.16MHz, 455kHz
AGC:	Less than 3dB from 3µV ⇨ 1V
Clarifier range:	± 250Hz
Audio response:	270Hz ⇨ 2800Hz
Audio output:	2Watt
Audio load impedance:	8Ω
Audio distortion:	Less than 5% @ 1W

Specifications are subject to change without notice

4. MECHANICAL ASSEMBLY

Radio construction

The radio shell comprises a 2.5mm aluminium front plate complete with black stainless steel handles, a 160mm long key-ribbed sleeve extrusion and a 10-fin extruded rear heatsink. This provides a simple and strong housing for the radio. Four M3x12 screws are used to secure both front and rear panels. The display PCB is secured to the metal front-plate by the fixing nuts of three front panel parts. This allows for simple removal. The two main PCBs pug into each other as a 'sandwich', and the whole assembly slides into the extruded sleeve on keyways. The rear heatsink is part of the PASW board assembly. Rubber gaskets on the front and rear mating surfaces give some water resistance.

Front panel

The front panel allows manual control of all the radio functions. This is achieved by six elastomer keys, an incremental shaft encoder (volume) and a toggle switch for power activation. A high efficiency 6-digit 7-segment LED display indicates the channel number on receive and frequency on transmit. An 8-pole microphone socket provides all the external interface requirements for microphones, headphones, DTMF keypad, and computer interface.

The front panel can be removed by undoing the four screws on the front of the radio and pulling gently on the handles. It can be further disassembled by simply undoing the two hex grub screws on the volume knob and unscrewing the volume, on/off switch and microphone socket nuts. The elastomer keys and fibreglass key separator should be left in the keyholes. The gold keypads are placed on a small sub-board above the display PCB. Six pins hold this small keypad in place.

RXMP board

This board has no direct connections to the outside world. It mates both mechanically and electrically with the PASW board via four 10-way connectors. It also mates via two of the 10-way connectors with the display PCB. There is one unused 10-way pin field for test use. When mated with the PASW board it slides into the extruded sleeve on keyways.

PASW board

The PASW board incorporates the rear heatsink extrusion as part of its assembly. The heatsink contains the BNC antenna connector and the 4-pole power receptacle. The heatsink is attached to the PCB by virtue of the heavy connections to the power receptacle and the 18 power transistor leads. The PASW board mates with the RXMP board via four 10-way connectors but has no connection to the display PCB.

5. FUNCTIONAL OVERVIEW

Front panel

Refer to the block diagram (FRONT PANEL) in Section 6 of this manual.

The only electronic parts of significance on the display PCB belong to the display register and multiplexor. All other parts merely route signals from the keys, microphone socket, volume encoder etc to the main two PCBs via a pair of 10-way connectors.

RXMP PCB

This board incorporates three distinct functional blocks, the Microprocessor, Receiver/Exciter and Synthesizer.

Microprocessor

Refer to the block diagram (MICROPROCESSOR) in Section 6 of this manual.

This section contains the 8-bit microcontroller along with its address latch, battery backed RAM, data memory and glue logic. For simplicity, communication with peripheral devices is via a serial 3-wire bus. This bus sends data to the display, volume DAC, transmit low pass filters and power control. A separate data line feeds the synthesizer. Computer I/O and Selcall data in, also share the same serial ports. The keypad is read via a 5-wire matrix and the volume encoder has a 2-line quadrature input plus interrupt. A DTMF decoder handles tones from the microphone and utilises a memory mapped interface.

Receiver/Exciter

Refer to the block diagram (RECEIVER/EXCITER) in Section 6 of this manual.

The receiver/exciter section is configured as a double superhet with first IF at 83.160MHz and second IF at 455kHz. The same circuit is used on receive and transmit apart from the second IF processor. Relays re-route the signal on transmit through the first IF. The other circuit elements are bi-directional. LO1 and LO2 are synthesizer derived. The carrier insertion oscillator at 453.6kHz or 456.4kHz is counted down from the LSB or USB crystal.

Synthesizer

Refer to the block diagram (SYNTHESIZER) in Section 6 of this manual.

The first local oscillator uses a high level push-pull circuit. It covers a 30MHz span and is controlled by one half of the frequency synthesizer running at a high comparison frequency to obtain low phase noise. The second local oscillator is a simple single ended unit covering a 20kHz span, controlled by the other half of the frequency synthesizer. The Selcall decoder uses a PLL and data slicer to demodulate the FSK signal.

PASW PCB

Refer to the block diagram (POWER AMP & SWITCHING PSU) in Section 6 of this manual.

The PASW board contains the main power supplies and the transmitter power train. A shielded +5volt switching power supply provides power for most of the RX and logic and a +10volt linear supply is also provided. On transmit a +50volt switching power supply is active. The transmit power train comprises two RF Op-Amps, the first of which is ALC controlled, then a driver stage and final amplifier, both of which use MOS FETs. One out of six harmonic filters is selected by a darlington driver.

6. BLOCK DIAGRAMS

Please refer to the following pages for block diagrams .....

REFER BLOCK DIAGRAM
“HF-90 RADIO BLOCK DIAGRAM - FRONT PANEL”
IN FILE NAMED “HF90BFP.xxx”

REFER BLOCK DIAGRAM
“HF-90 RADIO BLOCK DIAGRAM - MICROPROCESSOR”
IN FILE NAMED “HF90BMCP.xxx”

REFER BLOCK DIAGRAM
"HF-90 RADIO BLOCK DIAGRAM RECEIVER / EXCITER"
IN FILE NAMED "HF90BRXE.xxx"

REFER BLOCK DIAGRAM
“HF-90 RADIO BLOCK DIAGRAM - SYNTHESIZERS”
IN FILE NAMED “QMAPAPS.xxx”

REFER BLOCK DIAGRAM
"HF-90 RADIO BLOCK DIAGRAM POWER AMP & SWITCHING P.S.U."
IN FILE NAMED "HF90BPAP.xxx"

7. CIRCUIT DESCRIPTION

7.1 Front panel PCB

Refer to the schematic diagram (HF-90 DISPLAY 90000) in Section 17 of this manual.

The front panel PCB contains a 6-digit 7-segment LED display, 6-button keypad matrix, on/off switch, volume control and microphone socket. It measures 35mm x 95mm and contains eight integrated circuits.

Display data is contained within a 6-byte serial shift register (U1 - U6) and the display is refreshed at one sixth of the 7kHz clock rate by the multiplex counter (U8 & U25).

The display is updated from the microprocessor via a 3-wire serial interface (TOC, SCK & DIS). A fourth line DSIRO allows the microprocessor to check for serial link integrity.

The 7-segment display sections (U18 - U23) are extremely compact and efficient resulting in excellent readability and endurance.

An incremental shaft encoder (VR1) controls the volume level on the Standard and Advanced Model HF-90 and allows a flexible user interface for possible future options. It gives 24 detents (clicks) per revolution.

The computer programming interface utilises D1 and Q2 to achieve compatibility with IBM PC Clone RS232C ports, operating at 4800N81 (4800 baud, no parity, eight data, one stop).

A simple auxiliary PCB contains the 5-line, 6-button keypad matrix. TR and BR (top and bottom row) carry negative going key scan pulses at 250Hz repetition rate. RCL, MCL and LCL (right, middle and bottom column) are inputs allowing the key presses to be read by the microprocessor.

The microphone socket allows use of an unbalanced electret microphone, telephone style handset with PTT, a DTMF keypad and an RS232C programming link.

A single pole on/off switch activates the power relay on the PASW PCB (power amplifier and switch mode power supply PCB), by switch closure to ground.

7.2 RXMP PCB

Refer to the schematic diagram (HF-90 I.F. STRIP , MICRO SECTION & SYNTH. 90003) in Section 17 of this manual. Applies to RXMP boards of issue U and beyond.

The RXMP PCB is the heart of the radio and condenses a high degree of functionality into a small board area.

The two main functional blocks on this board are the microprocessor and the receiver. Large sections of the receiver are re-used on transmit to generate the drive for the PASW PCB. This minimises unnecessary replication of circuitry. The RXMP PCB measures 100mm x 147mm and contains 30 integrated circuits.

Microprocessor architecture

A minimal number of components are used as a result of the following:

- Delegation of functionality to software, wherever possible.
- Extensive re-use of ports.
- Utilisation of a simple serial interface.
- Use of a microprocessor with embedded code and separate data memory.

The microprocessor core consists of the microprocessor (U1), the non-volatile data memory (U2), and the low address latch (U3). D24 gates the battery backed RAM enabling it during RAM reads and writes.

DTMF detector

The DTMF chip (U9) flags data valid on pin 14 when keys on the DTMF microphone are pushed. The microprocessor activates the DTMFE line when it is ready to read the DTMF code. The DTMF chip is memory mapped at address #8000H and diode D1 disables the battery backed RAM when a DTMF read occurs.

A full table of microprocessor port allocations is shown in Table 1 (Section 8 of this manual).

Serial links

There are two separate serial data paths which share a common data and clock signal (TOC and SCK) but have different enable lines (SYN and DIS).

One of these serial links has been described in Section 7.1 (Front panel PCB), however it services other registers besides the display. It loops back onto the RXMP PCB and controls the miscellaneous register and volume control. It then loops through the PASW PCB where it controls the PA low pass filter selection and power selection. Finally, it loops back to the microprocessor where it can be sampled to check the link.

The second serial data signal is the synthesizer loader. This is fed to U16 setting the frequency of LO1 and LO2.

The display enable and clock are also used to increment the signal strength meter ramp counter, which is active on every display write.

A hardware and software summary of these two serial links is contained in Diagram 1 and Table 2, respectively (Section 8 of this manual).

Interrupts

The microprocessor runs three interrupts:-

1. The incremental shaft encoder interrupt on INT1 (volume set).

2. An internal software interrupt on Timer 0, TICKINT which wakes up the microprocessor from an idle state every 2ms (or 666µs in hop mode). This is the 'heartbeat' of the radio and it ticks at all times except during computer communication.

3. An internal software interrupt on Timer 1, TIMER1INT which provides timing for all tones generated by the radio on receive and transmit.

The RS232 serial I/O programming link is not run as an interrupt driven service. It is operated as a scheduled polled service.

Although PTT input to the microprocessor is fed into pin INT0, the interrupt on this pin is disabled and instead the pin is polled. It is also a PTT output.

Shaft encoder

Quadrature drives to the shaft encoder from QUAD1 and QUAD2 allow the detection of turning direction and velocity, by line INT1. The change in volume is output via the serial link to the shift register (U11) setting the gain DAC (U13).

Clarifier

The clarifier on receive is implemented entirely in software adjusting the synthesizer in 25Hz increments over ±250Hz.

Receiver and synthesizers

The receiver architecture comprises a double conversion superheterodyne with intermediate frequencies of 83.16MHz and 455kHz. Two high-side local oscillators (LO1 and LO2) mix down to 83.16MHz and 455kHz respectively.

The local oscillators are controlled by a dual frequency synthesizer which allow coverage of 2 - 30MHz in 100Hz steps.

Mixing scheme

Diagram 2 (Section 8 of this manual) shows the HF-90 superheterodyne mixing scheme.

Synthesizer Part 1

Synthesizer Part 1 controls LO1. The synthesizer chip (U16) utilises an internal dual modulus prescaler to obtain a high operating frequency (85 - 113MHz), along with a high phase comparison frequency (47 - 202kHz). The synthesizer is designed for low phase noise and the loop filter (R25, C96, C99) is optimized for low phase comparison sideband level. The high comparison rate gives the synthesizer a very rapid lock time of 3ms. The non-linear amplifier (Q10, Q14, Q15, Q16, Q22) linearises the overall system gain to maintain consistent noise performance across the VCO span.

LO1

LO1 is a high level (+13dBm) low phase noise VCO providing the injection source for Mixer 1. It employs push-pull JFETS (Q6, Q7) and an amplitude stabilisation circuit (D7, D8, Y1, Y2, Y7, Y8). Fast inverters (U29 E and F) provide hard switching and load isolation.

Synthesizer Part 2

Synthesizer Part 2 (U16) employs a single chip synthesizer to stabilize the injection frequency of LO2. It has an on-board prescaler and requires only the external loop filter (C85, C77, R83, R4, C46). The frequency of LO2 is controlled in 200 100Hz steps over a 20kHz span.

LO2

LO2 employs a Vackar circuit with a very narrow span. It provides a +7dBm injection level for Mixer 2 using a single JFET (Q8). A fast inverter (U30C) and a 3dB pad provide hard switching and load isolation. Capacitor C212 is a 33p N470 type, to achieve temperature compensation from -30ºC to +60ºC.

Front end

A 5-element elliptic low pass filter band limits the receiver input signal and suppresses leakage from LO1 on transmit and receive.

A high-level GaAs FET mixer (Q1, Q2, Q3, Q4) provides a low loss, high 3IP performance to obtain excellent sensitivity and dynamic range. This mixer incorporates proprietary architecture. Being essentially a passive element, the mixer is reciprocal and operates in the reverse direction in transmit mode. Diodes D14 and D27 provide front end protection.

First IF

The first IF chain comprises F1, Q5 & U21, with associated components. The active components are switched in direction between receive and transmit by a relay pair (RL1 & RL2). This ensures optimum IMD performance on both receive and transmit.

Saw filter

Selectivity with a bandwidth of 30kHz is provided by the first IF filter (F1). Use of a SAW device allows very smooth passband performance with deep transmission zeros on the image frequency of the second IF. The tank circuits associated with L5 and L6 provide impedance matching for the filter which has a Zo of 800Ω.

Active devices (Q5 and U21) provide the AGC controlled gain in the first IF. The Op-Amp (U20) stabilises the bias current in the GaAs FET. The GaAs FET is characterised by excellent linearity and ultra low noise.

Mixer 2

The second mixer uses a diode ring module (M1) to mix to 455 kHz. Because it is passive, it functions as a reciprocal device, operating in the reverse direction on transmit.

Filter 2

The ultimate selectivity of 2.4kHz @ 3dB points is provided by ceramic filter (F2). This device has a Zo of 2kΩ. Matching on transmit and receive is performed by 5mm transformer (T8).

Tx/Rx switch

Bilateral switch (U22) routes the signal through the final IF processor chip (U23) on receive and direct from the double balanced mixer on transmit. It also handles the transmit and receive audio paths ensuring correct audio switching to/from the double balanced mixer (U24).

455 kHz IF processor

The IF processor chip (U23) provides up to 100dB gain at 455kHz and provides 100dB of AGC range. U19C and Q11 along with C131, C22 and C174, implement hang AGC appropriate to SSB signals. Two different decay times, fast and slow, are available by switching MOS FET Q25.

Double balanced mixer

The double balanced mixer (U24) provides greater than 50dB of carrier suppression on transmit and highly linear demodulation on receive. As previously described, bilateral switch (U22) performs the signal routing to enable this to happen.

Carrier insertion oscillator

To generate and receive a single sideband signal a carrier insertion oscillator is required. On USB this operates at 453.6kHz and on LSB the frequency is 456.4kHz. It is derived from oscillator (U6), which has selectable crystals (X3 & X4). The oscillator operates on 7257.6kHz or 7302.4kHz for USB and LSB respectively. The CIO frequency emerges from output Q4 of counter U7, after division by 16. Counter U7 also provides a 7kHz clock to run the charge pump, 25volt & -5volt supplies and the display multiplex clock.

Gain distribution

Diagram 3 (Section 8 of this manual) shows the HF-90 system gain distribution.

Receive audio chain

The recovered audio of pin 6 of the double balanced modulator (U24) is routed through a switch (U22) to the gain stage (U25B). This provides 30dB gain, taking AGC level signals up to 2volt p-p.

The audio path feeds through the volume control DAC onward to the output amplifier (U28). The DIL audio amplifier yields 2watt, or more if the radio is operating from higher than 12volt.

The amplifier (U27:B) provides a limiting signal to the Selcall decoder (U18).

Selcall decoder

The Selcall decoder uses an on-frequency PLL with a VCO centre frequency of 1700 Hz. An XOR phase comparator (PCI) is used for noise rejection. The recovered data signal appears on the loop filter (R32, R128, C127, C129). It is then fed to a data slicer which has an adaptive reference level (pin 6 U19:A). This ensures that off-frequency signals will be satisfactorily recovered since the reference is the mean signal deviation. The data is sent on its way to the microprocessor as SELD.

The switching transistor (Q12) disables the Selcall output (SELD) when SELE is taken high by output PL3/Pin 7 on the PASW PCB. This allows the computer the use of the FROMC line during programming.

Microphone amplifier

The microphone amplifier (U25:A) provides a differential balanced input allowing common mode rejection. Inputs from TR and BR allow tone modulation for the emergency alarm, being added at the virtual earth. Input from the microphone is via a 600Ω transformer (T7) which provides isolation. The microphone amplifier has a feed to DTMF chip U9.

Automatic audio level control

The ALC chip (U26) works on transmit to maintain a near constant output level of 2volt p-p when the audio output is beyond a certain threshold set by R73. In this way the best radiated signal to noise ratio is maintained. The transmit audio signal (TXA) is routed through U22 to pin 4 of the double balanced mixed (U24). A diode clipper (D18,C173) prevents any transient overshoot.

Receiver voltage supplies

The main +5volt supply is switch mode derived on the PASW PCB. The main +10volt supply is from a linear regulator on the PASW PCB.

Low current supplies at +25volt and -5volt are derived from a charge pump circuit (comprising U8, D2, D6, D16, D17 and D19). The charge pump is clocked at 7kHz by the CIO counter (U7).

Low battery detector

The comparator (U4B and A) detects when the 10volt regulator loses regulation and pulls the LOBAT line low, signaling low battery level. At present this signal is not used by the radio.

Signal strength meter

The signal strength meter comprises counter U14, DAC U15 and comparator U4:C. The counter is clocked and enabled by the display serial line. During display write the counter is clocked and when the DAC ramp crosses the AGC level comparator U4:C, output feeding RCL is pulled low. In this way the microprocessor can measure signal level.

7.3 PASW PCB

Refer to the schematic diagram (HF-90 P.A. & POWER SUPPLY 90002) in Section 17 of this manual.

This printed circuit board contains the power stages of the transmitter and all the radio power supplies. It measures 100mm x 147mm and contains nine integrated circuits. Four MOS FETS and two power transistors are mounted on the mechanically connected rear heatsink.

The HF-90 breaks new ground in obtaining excellent transmitter intermodulation distortion, low broadband noise and PA economy, through the use of high voltage MOS FETs in the PA and driver stages. The necessary supply rails are provided by low EMI switch mode power supplies.

Power supplies

Tx supply switches

The darlington driver (U8) inverts the PTT / line to switch series pass transistor (Q11) which keys up the +5 Tx supply.

+5volt supply

A simple switcher chip (U9) along with D10, L2 and C80, provide a high efficiency +5volt output from a wide range of input voltages (10 - 28volt). Chokes (L1 and L3) with associated decoupling capacitors minimise electromagnetic emission. The unit is enclosed by a shield to further reduce interference.

+10volt supply

This relatively low current +10volt supply is obtained by sitting a 5volt regulator (U10) on the +5volt rail. The regulator is a low dropout type requiring only 0.2volt of headroom.

+15volt supply

This supply should be more correctly designated the +11.4volt limiter since its function is to maintain an output voltage in the range 10 - 11.4volt, irrespective of input voltage.

The series pass transistor (Q13) is hard on until U3:A detects that its output has risen to +11.4volt. Thereafter it is held in regulation. It is keyed on only in transmit by using the +5volt supply as a reference. Its function is to limit supply voltage to U4 and MOSFET drivers (Q1 & Q2).

+50volt Tx supply

The +50volt Tx supply is a classic boost convertor utilising energy storage choke (L5), switches (Q5 and Q6), and a rectifier (D5). The switch mode controller chip (U4) monitors the output voltage via voltage divider (R7 & R8) comparing it against a 5volt reference to obtain an error duty cycle on the gates of Q5 and Q6. The chokes (L4 & L6) with their associated decoupling capacitors yield a low EMI design. Some supply droop will occur on speech peaks.

Tx amplifier (pre-driver)

The current mode Op-Amps (U1 & U11) each provide +16dB of gain with low output impedance, wide bandwidth and excellent linearity. They drive the driver MOS FET gates through a balanced transformer (T4). the MOS FET (Q9) in the feedback circuit of U11 controls the stage gain. This permits ALC of the PASW unit.

Bias circuit

Bias for both the driver and PA MOS FETs is derived from a source which is effectively an amplified thermal junction pedestal (Q8 and Q12). VR1 is the driver bias pot and VR2 is the PA bias pot. These references are buffered by Op-Amps (U2:A and U3:B) which have gains of three and five respectively. Device Q12 is in direct thermal contact with PA MOS FET Q3, and device Q8 is in direct thermal contact with Q4 in order to obtain a thermal coefficient of bias which is slightly negative, thus ensuring thermal stability.

PA drivers

The PA driver circuit uses MOS FETs (Q1 and Q2) running from the +15volt limited supply (+11.4volt). Negative feedback networks (C57, R43, R90, C56, R88 & R44) fix the gain of the stage at 20dB. The 10R input resistors (R37 & R55) suppress parasitics. The bifilar feed transformer (T1) provides a DC cancelled supply isolation.

The transmission line transformer (T5) yields a 4:1 impedance step-down to provide final output MOS FETs (Q3 & Q4) with a high current source for gate drive.

PA final output

The final output architecture is similar to that of the drivers, with negative feedback and parasitic stoppers. The difference lies in the supply voltage and output matching. The PA transistors operate from a +50volt rail, achieving isolation from supply by a DC cancelled bifilar choke (T2). An output transmission line transformer (T3) combines the output signals and provides balance-to-unbalance conversion. Impedance conversion is unnecessary since the PA matches directly to 50Ω. Polyswitches (Negative TC Thermistors) in series with the source leads of the output MOS FETs Q3 and Q4, wind back the output power when the temperature on the heatsink exceeds 80°C.

PA low pass filters

Harmonic attenuation of the transmitter output signal is implemented through the six 5-element elliptic low pass filters. Latching relays (RL3 - RL8) select the sub-octave filters according to Table 3 (Section 7 of this manual).

Relay drive circuit

Selection of the set or reset coil for activation is implemented via seven darlington drivers (U6). The address information is loaded down the DIS serial data line into a shift register (U5) and this drives the darlington driver (U6). When a frequency change occurs the common reset line is pulsed, then the specific set line is pulsed. In the static condition no current is consumed by the relays. Latching takes place through application of a 5ms pulse.

Tx RF ALC

The forward and reverse current are sampled by a 16:1 current transformer (L19) and detector diodes (D1 and D2). These provide references for the ALC circuit. Potentiometer VR3 sets the power level by manipulating the fraction of signal fed to U3:B.

Low power select deactivates the +50V supply by grounding pin 2 on U4.

ALC time constants are determined by C34, R95 and R96. A diode (D3) combines the forward and reverse signals and the Op-Amp (U2:B) provides system gain in the ALC feedback loop. The gain controlled RF amplifier (U11) in the first stage of the PASW PCB is fed with the ALC output signal via Q7.

ATU PSU switch

A software keyed +12 - 28volt supply is provided on the rear 4-pin connector to allow the interfacing of a TA-90 automatic antenna tuner, a horn alarm or flashing beacon.

Reverse / over-voltage / under-voltage protection

A tranzorb diode (D7) provides reverse and 33volt clamp protection. An external fuse must be fitted. Diodes D4 and D6, in series with the power on relay activation coil, ensure that the radio will not power up if the supply is accidentally reverse polarised. The relay also guarantees that the radio will switch off completely below 9.5volt, thus protecting the connected battery against over discharge.

8. TABLES & DIAGRAMS

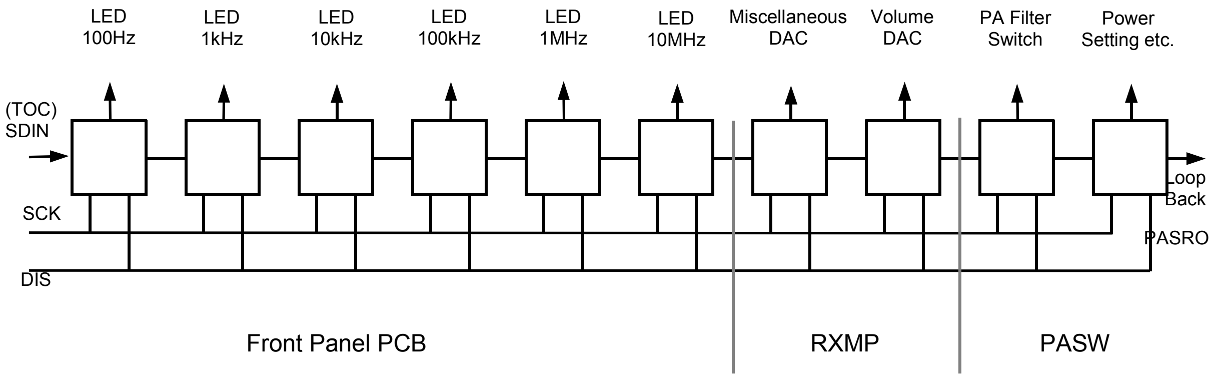
Table 1. HF-90 micro port allocations

Port Number	Micro Pin	Input Function	Output Function
P0.0	43	D0 / DTMF Q0	A/D0
P0.1	42	D1 / DTMF Q1	A/D1
P0.2	41	D2 / DTMF Q2	A/D2
P0.3	40	D3 / DTMF Q3	A/D3
P0.4	39	D4	A/D4
P0.5	38	D5	A/D5
P0.6	37	D6	A/D6
P0.7	36	D7	A/D7
P1.0	2	TOP ROW	TONE 1 OUTPUT
P1.1	3	SIG METER INPUT	RIGHT COLUMN
P1.2	4	DTMF NOT VALID	MIDDLE COLUMN
P1.3	5		LEFT COLUMN
P1.4	6	BOTTOM ROW	TONE 2 OUTPUT
P1.5	7		SYNTH. CLOCK
P1.6	8		SYNTH. ENABLE
P1.7	9		DISPLAY ENABLE
P2.0	24		A8
P2.1	25		A9
P2.2	26		A10
P2.3	27		A11
P2.4	28		A12
P2.5	29		DTMF ENABLE
P2.6	30		(A14)
P2.7	31		(A15)
P3.0	11	RXD SERIAL DATA/ SELCALL IN	
P3.1	13		TXD ALL SERIAL DATA OUT
P3.2	14	$\overline{\text{INT0}}$/PTT IN	PTT OUT
P3.3	15	$\overline{\text{INT1}}$/ENCODER	
P3.4	16	T0 QUAD IN	
P3.5	17	T1 QUAD IN	
P3.6	18		$\overline{\text{WR}}$ EXT DATA
P3.7	19		$\overline{\text{RD}}$ EXT DATA

Note:- ***ALE latches Port 0 address***

Diagram 1./Table 2. Serial link chain

Diagram 1. Physical hardware



The serial link chain comprises 10, 8-bit serial shift registers with common serial clock (SCK), select display (DIS) lines and cascade data (TOC).

Serial data is clocked through the shift registers by SCK and when 80 bits of data have gone through, the enable DIS is pulsed high and the data is parallel loaded to internal latches.

Table 2. Software byte allocation

Byte 0	100 Hz display (last byte)
Byte 1	1 kHz display
Byte 2	10 kHz display
Byte 3	100 kHz display
Byte 4	1 MHz display
Byte 5	10 MHz display
Byte 6	BIT 6: 1 = MIC INHIBIT BIT 1: 1 = AGC SLOW BIT 0: 1 = USB, 0 = LSB
Byte 7	Bits 0 to 7 volume in range 00H - FFH (LOW = LOW VOL)
Byte 8	BIT7 NIL; BIT6 BAND1; BIT5 BAND6; BIT4 BAND2; BIT3 BAND5; BIT2 BAND3; BIT1 BAND4; BIT0 RESET; PA Filter Band Select
Byte 9	Disable loop-back; Disable Selcall; NIL; NIL; +50V OFF; Low power; ATU ON; NIL (1st byte)

Diagram 2. Superhet. mixing scheme

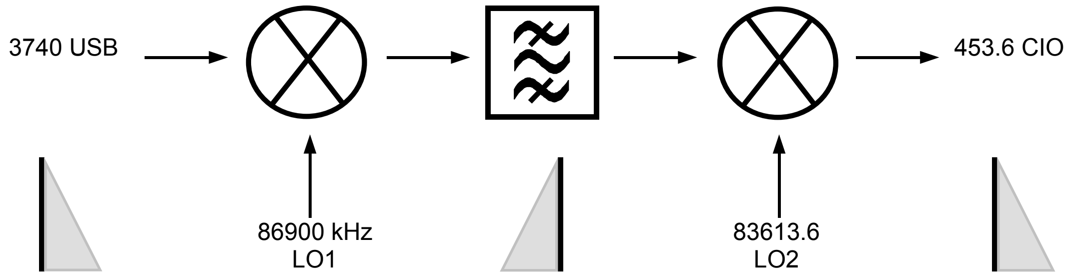
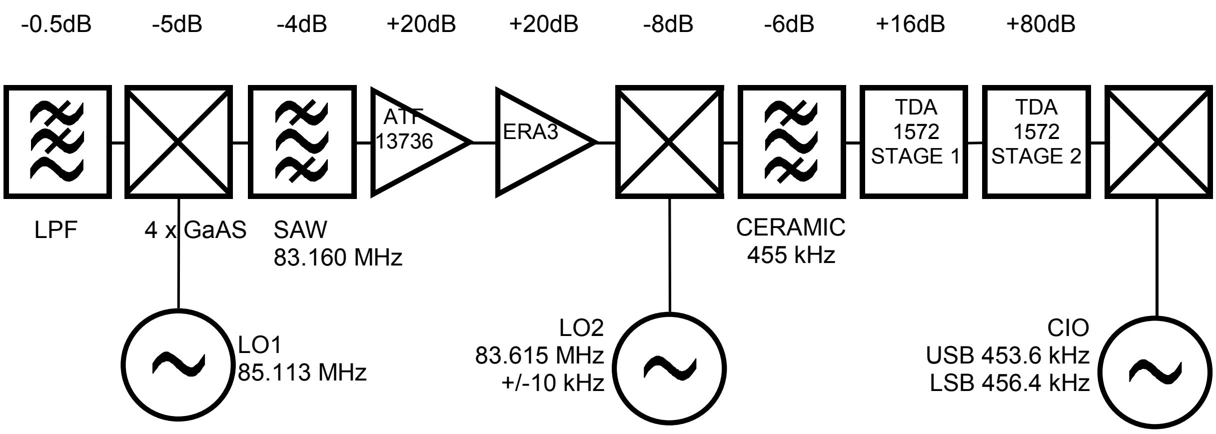


Diagram 3. HF-90 Rx gain distribution



Sensitivity = 0.25uV @ 10dB S+N/N
3I/P = +20dBm
3dB AGC knee = 1uV

Table 3. HF-90 Tx low pass filters

Truth table

Band	HEX Code	Causes 1 U5 Pin	Causes 0 U6 Pin
RESET	01H	15	10
NULL	00H	-	
1	40H	6	16
2	10H	4	14
3	04H	2	12
4	02H	1	11
5	08H	3	13
6	20H	5	15

Note:- *When the PA filter is selected, the high level (+5V) on U5 pin persists for only three seconds. After this time the voltage on all U5 output pins reverts to zero. The latching relays preserve their current state.*

Relays may be selected manually by first resetting (ie. shorting pin 10 of U6 to ground momentarily) then shorting the relevant pin (11-16) on U6 momentarily to ground, to select the desired filter.

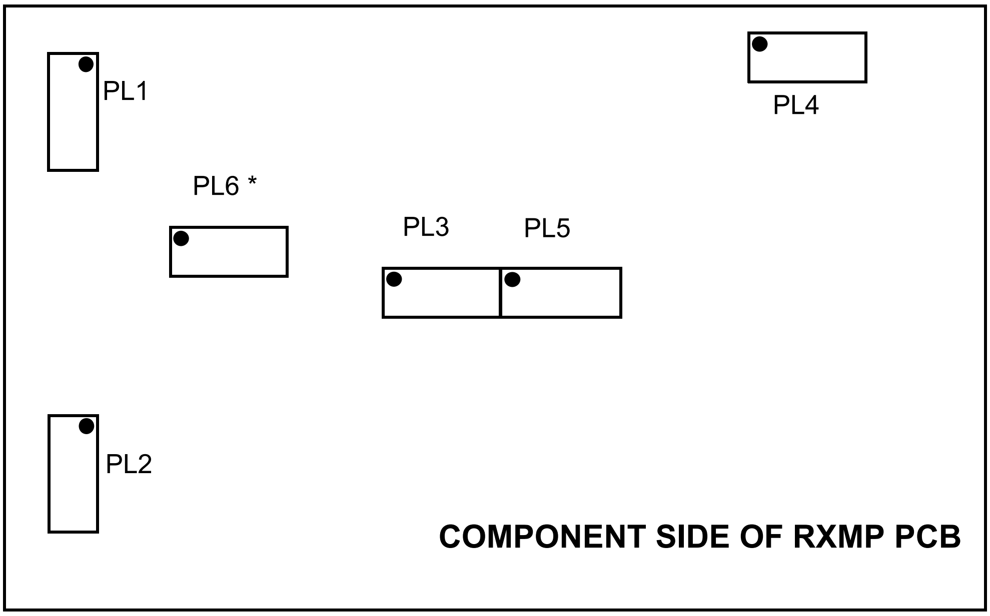
Table 4. HF-90 connector pinouts

Connector	Pin	Code	Function	Used on (source underlined)
Con: PL1 SERIAL QUAD	1	QUAD 1	QUAD ENCODER IN 1	<u>FP</u> / RXMP / PASW
	2	QUAD 2	QUAD ENCODER IN 2	<u>FP</u> / RXMP / PASW
	3	DISRO	DISPLAY SHIFT REG OUT	<u>FP</u> / RXMP / PASW
	4	FROMC	SERIAL DATA IN (FROM COMPUTER)	<u>FP</u> / RXMP / PASW
	5	SCK	SERIAL CLOCK	FP / <u>RXMP</u> / PASW
	6	GND	GROUND	FP / RXMP / PASW
	7	DIS	DISPLAY ENABLE	FP / <u>RXMP</u> / PASW
	8	+5	+5 SUPPLY	FP / RXMP / <u>PASW</u>
	9	TOC	GENERAL SERIAL DATA OUT (TO COMPUTER)	FP / <u>RXMP</u> / PASW
	10	7 kHz	DISPLAY MPX CLOCK	FP / <u>RXMP</u> / PASW
Con: PL2 KEYS MIC LS	1	MCL	MIDDLE COLUMN	FP / <u>RXMP</u> / PASW
	2	LCL	LEFT COLUMN	FP / <u>RXMP</u> / PASW
	3	RCL	RIGHT COLUMN	FP / <u>RXMP</u> / PASW
	4	TR	TOP ROW	<u>FP</u> / <u>RXMP</u> / PASW
	5	BR	BOTTOM ROW	<u>FP</u> / <u>RXMP</u> / PASW
	6	MIC1	MICROPHONE 1	<u>FP</u> / RXMP / PASW
	7	MIC2	MICROPHONE 2	<u>FP</u> / RXMP / PASW
	8	ON/OFF	ON/OFF	<u>FP</u> / RXMP / PASW
	9	PTTU	PTT UNBUFFERED	<u>FP</u> / <u>RXMP</u> / PASW
	10	LS	LOUD SPEAKER	FP / <u>RXMP</u> / PASW
Con: PL3 POWER SIGNALS	1	PASRI	PA SHIFT REG IN	<u>RXMP</u> / PASW
	2	PASR0	PA SHIFT REG OUT (SELD)	RXMP / <u>PASW</u>
	3	SCK	SERIAL CLOCK	<u>RXMP</u> / PASW
	4	DIS	DISPLAY ENABLE	<u>RXMP</u> / PASW
	5	+5	+5 SUPPLY	RXMP / <u>PASW</u>
	6	+10	+10 SUPPLY	RXMP / <u>PASW</u>
	7	SELNE	SELCALL DISABLE	RXMP / <u>PASW</u>
	8	GND	GROUND	FP / RXMP / PASW
	9	GND	GROUND	FP / RXMP / PASW
	10	GND	GROUND	FP / RXMP / PASW

Connector	Pin	Code	Function	Used on (source underlined)
Con: PL4 PA MONITOR	1	GND	GROUND	FP / RXMP / PASW
	2	+24	+24 RELAY SWITCHED	RXMP / PASW
	3	GND	GROUND	FP / RXMP / PASW
	4	+50	+50 TX SUPPLY	RXMP / PASW
	5	+15	+11.4 LIMITED TX SUPPLY	RXMP / PASW
	6	PA BIAS	PA BIAS (3.9V)	RXMP / PASW
	7	RFI0	RF INPUT/OUTPUT	RXMP / PASW
	8	DR BIAS	DR BIAS (2.2V)	RXMP / PASW
	9	GND	GROUND	FP / RXMP / PASW
	10	ALC	ALC MONITOR	RXMP / PASW
Con: PL5 RXMP SIGNAL TEST SOCKET	1		NOT USED	
	2	GND	GROUND	FP / RXMP / PASW
	3		NOT USED	
	4	AGC	RX AGC OUT	RXMP
	5	SELD	(PASRO) SELCALL DATA	RXMP
	6	GND	GROUND	FP / RXMP / PASW
	7	GND	GROUND	FP / RXMP / PASW
	8	RXA	RX AUDIO	RXMP
	9	SELA	SELCALL AUDIO	RXMP
	10	TXA	TX AUDIO	RXMP
Con: PL6 RXMP MICRO TEST SOCKET See below *	1	ROMOE	ROM OUTPUT ENABLE	RXMP
	2	WR	ROM WRITE	RXMP
	3	ROMCE	ROM CHIP ENABLE	RXMP
	4	12 MHz	12 MHz CLOCK	RXMP
	5	ALE	ADDRESS LATCH	RXMP
	6	DTMFE	DTMF ENABLE	RXMP
	7	A0	ADDRESS 0	RXMP
	8	A3	ADDRESS 3	RXMP
	9	A1	ADDRESS 1	RXMP
	10	A2	ADDRESS 2	RXMP

*** PL6 not present on RXMP issue M and beyond (S/No 1400→).**

Diagram 4. Connector positions



*** PL6 not present on RXMP issue M and beyond (S/No 1400→).**

9. MAINTENANCE

9.1 Disassembly and assembly

A. Removal of PCBs

First undo the four M3 screws on the rear heatsink. Take care not to lose the insulating bushes. Slide the heatsink assembly complete with PASW and RXMP boards out of the extruded sleeve.

B. Separation of PCBs

The PASW and RXMP PCBs mate via four 10-way connectors. These hold the boards firmly together. It is best to separate the boards by taking one board in the left hand and the other board in the right and using the fingers as levers to gently prize the boards apart in a controlled manner.

C. Removal of the front panel

Undo the four M3 screws on the front panel. Take care not to lose the three plastic bushes. The display PCB is held on to the front panel by the nuts of the on/off switch, microphone socket and volume encoder.

D. Reassembly of radio

It is advisable to commence reassembly with the RXMP and PASW boards first. Make sure that the boards are firmly together and that the rear rubber gasket is in place. Slide the 2-board ‘sandwich’ into the sleeve making sure that the correct orientation has been selected. The small aluminium heatsink on the PASW board has a keyway which engages in the extruded sleeve. Tighten the screws on the rear heatsink evenly, making sure that the gasket is correctly placed. Finally, replace the front panel making sure that the two 10-way connectors engage properly on the RXMP board. Tighten the four M3 screws taking care to position the gasket correctly.

9.2 Replacement of Microprocessor

In the event of firmware upgrade or in the extremely unlikely event of corruption (leading character of software version display is “E”), the microprocessor chip U1 will require replacement.

A number of precautions should be observed during this procedure.

- The correct PLCC 44 “scissor squeeze” type of extraction tool MUST be used.
- Removal and insertion must take place at an antistatic workstation.
- Orientation of U1 is critical with PIN 1 dot nearest to edge of RXMP board.
- This chip determines whether or not radio has a hopping option fitted.

9.3 Radio alignment

RXMP board

Refer to the test point overlay (HF-90 RECEIVER BOARD ALIGNMENT - POSITION REFERENCE) in Section 12 of this manual, as well as the schematic diagram (HF-90 I.F. STRIP , MICRO SECTION & SYNTH. 90003) in Section 17 of this manual.

1. Set the radio to any channel where its frequency is exactly divisible by 20kHz, ie frequency ending in 00, 20, 40, 60, 80.

2. Using a digital multimeter measure the voltage at TPLO2. Adjust VC5 until this voltage is 2.3volt +/-0.1

3. Set the radio to 30,000kHz

4. Using a digital multimeter measure the voltage at TPLO1. Adjust VC6 until this voltage is 20volt +/-0.5

5. Using a frequency counter with high impedance probe measure the frequency at TP24MHz. Check that the radio has been running for two minutes. Set the frequency to 24MHz +/-7Hz by adjusting the TCXO.

6. Check that a USB channel has been selected. (no indicator point lit next to highest digit).

7. Using a frequency counter with high impedance probe measure the frequency at USB/ LSB TP. Adjust VC3 to obtain 453.6kHz +/-3Hz.

8. If the radio has software for the export market ie HF-90E then select an LSB channel.

9. At the same USB/LSB test point measure the frequency and adjust VC2.
   - On radios with Serial Number below 1200 measure 456.6kHz.
   - On radios with Serial Number of 1200 and above measure 456.4kHz.

10. On PL5 fit a 10-way receptacle which has pin 7 connected to pin 9 via a 100nF capacitor. Using a frequency counter with high impedance probe, measure the frequency at TP1700Hz (U18 pin 3 & 4). Adjust VR1 until the frequency is 1700Hz +/- 8Hz.

11. Using an oscilloscope with 10:1 probe, measure the voltage on USB/LSB TP. Adjust core T10 for maximum. This corresponds to approximately 1.7volt p-p.

12. Select a channel somewhere in the 5 - 8MHz region. Turn up the volume and with no antenna or signal generator connected, adjust the AGC threshold control (VR2) clockwise just beyond the point where there is no increase in noise. RXMP boards beyond issue S do not require this adjustment.

13. Inductors L1 and L2 should be left at the factory setting. The core position will be approximately 2mm below the coil top.

14. Apply a signal at 1kHz above the channel frequency to obtain a 1kHz tone. Set the level to 0.25µv and monitor the loudspeaker recovered audio on an oscilloscope.

15. Adjust L5 and L6 to obtain a peak in the tone. L6 will probably be screwed further in than L5. Neither adjustment is very critical.

16. Adjust L11 to obtain a peak in the tone. This will probably be quite sharp.

17. Adjust L7 to peak the recovered tone. The core may be screwed up until it is starting to emerge from the coil. Do not allow it to protrude more than 1mm above the coil.

18. Adjust T9 to obtain a peak in the tone. The signal to noise may be slightly improved by turning the core slightly clockwise beyond the peak.

It should now be possible to measure 10dB S+N/N on the 0.25µv signal.
The receiver alignment is now concluded.

PASW board

Refer to the test point overlay (HF-90 P.A. BOARD ALIGNMENT - POSITION REFERENCE) in Section 12 of this manual, as well as the schematic diagram (HF-90 P.A. & POWER SUPPLY 90002) in Section 17 of this manual.

1. There are only three adjustable potentiometers on the PASW board and with two of them (VR1 and VR2) the bias settings SHOULD NOT BE TOUCHED unless a driver or final amplifier transistor has been changed.

2. Connect the HF-90 to a power meter and dummy load. The wave form can be monitored by 'eavesdropping' on the coaxial line using an asymmetric Tee pad. This consists of a 1K 1watt resistor connected to the 50Ω line. The other end of the resistor is connected to the oscilloscope input and a 47Ω resistor must be connected across the oscilloscope input. The above network yields approximately 30dB attenuation.

3. Inductor L20 should not be adjusted. It should remain as factory set with core 1mm below the coil top.

4. Potentiometer VR3 is the ALC power level setting pot. It should be set on a channel in the 4 to 6MHz range to give a clean 2-tone signal of the required power level (50-60watt). On Australian models (HF-90A) a 2-tone signal can be obtained by holding down the ALARM key for two seconds. The control VR3 is typically adjusted near to the anti-clockwise end-point. Note that if the power level is backed off, a 'bubbling' effect can occur. This can be alleviated by screwing in core L7 slightly or adjusting VR3 on the RXMP board. It may also be necessary to do this when swapping PCBs.

5. In the event of either driver or final amplifier MOS FETs having been changed, the bias can be set up as follows:
    - First remove the two jumper links on the back of the PASW board.
    - Using a multimeter on the 10volt range, measure the voltage on the positive end of C49 (10µF tant).
    - Push the PTT switch and adjust VR1 to obtain 2.6volt.
    - Measure the voltage on the positive end of C63 (10µF tant).
    - Push the PTT switch and adjust VR2 to obtain 3.7volt.
    - Now replace the jumpers under the PASW board.

Changing a final amplifier transistor

Should either of the final amplifier MOS FETs Q3 or Q4 require changing, the following procedure should be followed:

1. First check the manufacturer of the replacement. IRF830 devices from Motorola (M), Harris (H), International Rectifier (IR) and SGS-Thomson (S or ST) have been used. If the replacement is not the same manufacturer as the original parts, then both devices MUST be replaced.

2. Loosen off the M3 screw securing the power device. Carefully remove the screw and swing away the thermal protection transistor Q8 or Q12 on its flying lead. The SILPAD between the thermal sensor and the output device must be kept. Next desolder all three legs of the defective device. Remove the device taking care to preserve both the SILPAD under the device flange AND THE TINY PLASTIC SLEEVE WHICH SPACES THE FLANGE FROM THE SCREW. Note that a polyswitch disc thermistor may be fitted in series with the source lead of each output transistor Q3 and Q4. These should not be removed. If they are not fitted (two yellow discs) contact Q-MAC Electronics for advice on fitting as per ECN 79 and 80.

3. Having removed the device, simply reverse the process with the new device taking care to fit all the parts correctly (two SILPADs plus plastic sleeve). The M3 screw should be firmly tightened.

IMPORTANT NOTE:
THIS PROCEDURE SHOULD ONLY BE ATTEMPTED BY QUALIFIED SERVICE PERSONNEL. Q-MAC ELECTRONICS WILL CHARGE FOR ANY DAMAGE CAUSED BY INCORRECTLY IMPLEMENTING THIS PROCEDURE.

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10. FAULT FINDING

10.1 No tools fault finding

Fault diagnosis

1. Check that the 4-pole power connector on the rear of the radio is correctly connected to a 12 - 24volt power source (battery or power supply) capable of providing 10ampere peak current. Screw up the locking ring. Ensure correct polarity. Refer to the table below if in doubt.

2. Check that an approved antenna or 50Ω dummy load is connected to the rear BNC coaxial socket.

3. Connect the microphone to the front 8-pole receptacle. Screw up the locking ring.

4. Connect the loudspeaker to the 4-pole spur connector on the rear cable if required. ENSURE THAT THE CORRECT POLARITY IS OBSERVED

5. Switch ON/OFF switch to the ON position and check that the following power on sequence occurs.

Power-on Sequence

Elapsed Time	Display Contents	Loud Speaker	Internal Sounds
Start	Blank	Click	Relay Click
1 second	HF-90A or HF-90E or HF-90H	1kHz Tone	Relay Click
2 seconds	Software Revision eg. 2-407 or if error E2-407	Silence or if error 900Hz Tone	Relay Click
3 seconds	Selcall Number if Advanced Model eg. 1234	Radio Noise	Relay Click
4 seconds	Channel Number eg. CH 2	Radio Noise	Relay Click
5 seconds onward	Frequency display if HF-90E or HF-90H	Radio Noise	Silence

6. If the radio is completely dead, ie. no tones, clicks, loudspeaker noise or display, then suspect that no power is getting through to the rear connector. If this is not the case then possibly the wiring at the rear of the front panel ON/OFF switch is faulty, or the two front panel 10-way connectors may have been mis-engaged during the last re-assembly.

7. If a display is present on turn-on, but the software revision comes up with a program memory checksum error (eg. E2-407), accompanied by a 900Hz tone from the loudspeaker, then some degree of memory corruption has occurred. The radio should be fitted with a new microprocessor available from an authorised dealer or Q-MAC Electronics Pty Ltd. The microprocessor is the only pluggable component on the RXMP PCB. Some radio functionality may be unaffected by the corruption. Corruption is highly unlikely to occur.

8. If the display is normal on turn-on and the sequence of five relay clicks can be heard from inside the radio, but no loudspeaker tones or noise of any sort is heard, then suspect a problem with the external loudspeaker connection. If the loudspeaker and wiring are in good condition then the internal loudspeaker feed wire or tracks on the RXMP or PASW PCBs may be broken or short-circuited. If a speaker microphone produces audio but a loudspeaker does not, then the loudspeaker track on the PASW PCB has been broken. Check that the loud speaker plug has been correctly inserted.

9. If the display is blank or has unintelligible characters, but the turn-on sequence of tones and relay clicks is correct, then the microprocessor is probably operating correctly but the display multiplexor clock (7kHz) is absent. This signal is generated on the RXMP PCB.

10. If no clicks other than the first power relay click are heard, and no tones are audible and either no display or incorrect characters are shown, then the microprocessor is probably not running correctly. Some faint noise from the loudspeaker may be audible in this condition. Replacing the RXMP PCB should fix the problem.

11. If the display comes up normally and tones are heard, but the sequence of relay clicks is absent, then the serial data chain is broken somewhere. Turn the volume control up and down and if this works then the break is between the RXMP and PASW PCBs. If the volume is not working then the break is between the DISPLAY and RXMP boards. Board substitution will confirm this.

12. If switch-on tones and clicks are normal but no radio noise is audible then there may be a receiver fault. With the volume control at maximum a reasonable amount of noise should be heard. The volume control gives clicks when it is being turned up or down. At maximum or minimum, no more clicks will be heard. A high pitched whine may indicate a fault in the -5v supply. If the problem has not been located substitute the RXMP PCB.

13. Pressing the CHAN∧ or CHAN∨ keys should produce an internal click and the display should show the next channel number. Some change in the character of the noise from the loudspeaker may occur. If only UP or DOWN works then suspect a key or matrix fault on the DISPLAY board. If it is a matrix fault then it will affect a whole row or column of keys.

14. Press the PTT switch on the microphone. Listen for an internal relay click. Check that the display changes to exhibit the frequency in kHz with decimal point illuminated. If neither occurs then a fault in the microphone PTT switch should be suspected. If this is not the case then the internal PTT circuit is faulty. If the frequency display is not accompanied by a click, then the microprocessor is responding correctly but the PTT feed to the changeover relays is faulty. If there is no display change but a relay click is audible then the PTT input of the microprocessor has been damaged and a new micro will be required. Replace the RXMP board.

15. Press the TUNE key briefly. The PTT relay clicks should again be heard. This time the microprocessor is activating the PTT.

16. Program the radio with CH9999 (23999kHz USB). A strong 1kHz tone should be audible on this channel. This is the 24MHz microprocessor clock. If it can be heard then:
    - The microprocessor clock is running.
    - The receiver is functioning.

17. If the receiver is working but the transmitter is giving no power, then the internal HV fuse on the rear surface of the PASW board may have ruptured. The fuse is implemented as a meander track on the PCB. It should be replaced with 20mm of 0.16mm enameled copper wire.

18. Hold down the TUNE key for 20 seconds. The rear heatsink should start to get significantly warm compared to the receive condition. If this is not the case then the TX current is abnormally low. Again the HV fuse should be checked.

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11. DIAGNOSTIC TEST SEQUENCE

11.1 Receiver test sequence

Refer to the test point overlay (HF-90 RECEIVER BOARD ALIGNMENT - POSITION REFERENCE) in Section 12 of this manual, as well as the schematic diagram (HF-90 I.F. STRIP , MICRO SECTION & SYNTH. 90003) in Section 17 of this manual.

The checks below should be made with the radio on receive with a USB channel in the range 3 - 6MHz selected.

1. Check the rails on RXMP

+5volt

- If dead, then check inverter on PASW.
- If high, then check for short between middle pin and output on U10 PASW.

+10volt

- If dead, then check that U10 PASW is properly connected.

+5volt output U31 RXMP

- If low, then open R80, R108 and R111 to see which is loading supply.

+5volt output U32 RXMP

- If low, then open R87 to see if it is loading supply.

+3v6 supply R133

- If high, then check for open circuit LED Y3, Y4.

-5volt supply

- If low, then check for loading by opening R150 RXMP. If this makes little difference, then suspect charge pump or CIO.

+25volt supply

- If low, then check for loading by opening R137 RXMP. If this makes little difference, then suspect charge pump or CIO.

2. Check clocks on RXMP

TP24MHz

- If clock is absent or low, then open R101 then R187 to check for loading.
- If the clock is absent after opening R101 and R187 then replace TCXO.

USB/LSBTP

- Using an oscilloscope check that the wave form at this point is approximately 1.7volt p-p at 453.6kHz. It should be approximately sinusoidal.
- If no signal is present, check for a 7257,6kHz square wave at U6 pin8 (74HC00D). If nothing is present then the CIO has stopped. If the wave form is there, then U7 (the 74HC4040) is at fault.

7kHz clock

- Using an oscilloscope, check the wave form at U7 pin14 (74HC4040). This should be a 7kHz square wave and without it the display multiplexor and charge pumps will not run.

U18 pins 3 and 4

- Using an oscilloscope check for the presence of a noisy square wave at an average frequency of 1700Hz.
- In the absence of this, check the supply to the chip and the timing components C28, R30, R127, VR1.

ALE on U4 pin 1

- This wave form is the 'heart beat' of the radio. If it consists of bursts of logic high going pulses every 2ms during normal operation or every 666µs whilst hopping, then the microprocessor is basically healthy. It is executing instructions correctly and responding to the Timer 0 interrupt. It is also idling correctly. This wave form shows how 'busy' the microprocessor is at any point in time.
- If the wave form is incorrect maybe an interrupt is stuck or the one of the buses has a fault.

3. Check the synthesizer control voltages

LO2 TP

- Using a multimeter or oscilloscope, check that the voltage on this point is in the range 2 - 3volt. It should also be clean.
- If it is out of range then check that VC5 has not been damaged. Reset VC5 if necessary as per Section 9.3 (Radio alignment).

LO1 TP

- This control voltage should start off low at 2MHz (2 - 3volt approx) and increase towards 20volt at 13MHz. By 14MHz it should be back low again and increase back up to 20volt at 30MHz.
- If there is noise or a sawtooth on the wave form inspect C96 and C99 for damage. Bad connections to T12, T13 and T5 will also cause problems.
- Above 5MHz check that at least two of the four LO1 LEDs are lit. If not then LO1 is dead or LO1 TP is at a very low value with the loop out of lock.

4. Check for correct DC voltages around the RXMP

GaAs FET gates Q1 and Q2, Q3 and Q4

- Check for approximately -1.8volt at both these points. This voltage is present only if LO1 is running correctly (although not necessarily in lock) AND if all the GaAs FETs are intact.
- If both points are slightly positive and all four LEDs in LO1 are extinguished, then there is a problem with LO1 activity. Check T12, T13 and T5.
- If one point is normal and the other slightly positive, then it may be due to asymmetry in LO1 or one or two defective GaAs FETs. Check also one end of R91 and R104 for 2.5volt bias and check U29 gate E and F levels (approximately 2volt average). U29 runs warm.

Q5 (ATF13736) gate

- This should measure -0.7volt approximately and the drain +2.8volt.
- If this is not so, then either the -5volt charge pump derived rail is not correct, or feedback stabilising amplifier U20:B (LM358D) is faulty. U20 should have +2.8volt on both pins 5 and 6.

Q21 (SST309) source

- This should measure +8.7volt approximately. If this is not the case then Op-Amp U20:A is faulty.

Pin4 of F2 (the 455Khz filter at the end furthest from T8)

- This should have 2.5volt present. If not then R48 or R49 are faulty.

U23 pin 12 (TDA1572T)

- This should have 5.9volt with 0.5volt p-p of noisy 455kHz signal present.
- If not check for 2.2volt on pin 1 of U23 and 2.2volt on pins 3 and 4.

AGC monitoring point (on plus terminal of C22)

- This should be 2volt with no signal and rise to a maximum of 3.8volt with a huge signal.
- If it is stuck high then check that AGC transistor Q11 is functioning.

Bias voltages on U24 (MC1496D)

- Pins 6 and 12, the outputs should be at 7volt.
- Pins 8 and 10, the CIO ports should be at 3.8volt.
- Pins 1 and 4, the signal input ports should be at 1.7volt.
- Significant discrepancies will likely be due to faulty resistors in the biasing chain.
- Injection at 453.6kHz should be visible at pin 8 of U24 (MC1496D) at a level of approximately 0.3volt p-p.

RXA PL5 pin 8

- This should have a DC level of 3.6volt and a very low level recovered audio signal.
- If the DC level is incorrect then the bias pedestal set by R133, Y3 and Y4 is probably faulty.
- If no audio is making it through the TX/RX switch ,U22 (4053D), then possibly it has been damaged or the PTT level reaching pins 9,10 and 11 may be incorrect.
- Finally, damage to R178 or C200 may disable the switch path.

VOLI on pin 7 of U25 (LM358M)

- This should again be at a DC level of 3.6volt with a maximum recovered signal of 1.2volt p-p when a signal at full AGC level is applied.

U13 pin 8 (DAC0800M)

- This should have a DC level varying between 5volt at minimum volume and 3.3volt at maximum.
- Failure of the DC level to correctly follow the encoder may be due to loss of the -5volt bias on pin 7 or a failure of the serial data to correctly reach U11 (74HC595D).

U27

- This Selcall audio amplifier has a gain of 100 and should have clipped noise present on pin 7 of U27 (LM358M).

U28 pin 14 (LM384N)

- This should have full supply voltage typically 14volt, otherwise resistor R172 has failed.

U28 pin 8 (LM384N)

- This should have half supply voltage typically 7volt, with the full audio output present under received signal conditions.

SELA pin 9 PL5

- This should exhibit almost rail to rail noise on an unoccupied channel. The average voltage should be 2.5volt.

5. Serial digital wave forms can be checked

Channel change

- This should provoke activity on SYDA (DOP), SYCK (SCK) and SYEN (SEN) on resistors R17, R13 and R12 respectively. Refer to schematic for wave forms.

Volume control change

- This should provoke activity on DIS (DEN) R14 and on SYCK (SCK) and SYEN (SEN) as the serial data is sent down the chain to the volume control shift register U11 (74HC595D). However after the control reaches the 'software endstop' no further data will be seen.
- Note that SYEN (SEN) pulses are very few and narrow.
- The volume encoder wave forms to the microprocessor can be checked on pins 1 and 2 of PL1. These are normally high but pulse low with shaft rotation.

SELD pin 5 PL5

- On a Selcall channel check for multiple data transitions on incoming noise.
- When receiving a Selcall the data on SELD should display a periodicity of 10ms.

Pin 13 of the micro U1 (89C738)

- All serial data from the microprocessor, for the synthesizer or the serial data chain or for the computer during frequency programming emerges from pin 13 of the micro U1 (89C738).

U1 at pin 11

- All serial data to the micro from the Selcall decoder or from the computer during frequency programming or from the serial chain loopback when enabled enters the micro U1 at pin 11.

Keypad

- Keypad reading strobes emerge on pins 1, 2 and 3 of PL2 MCL, LCL and RCL. These are short negative going pulses at 250Hz repetition rate.
- When keys are pressed in the matrix, either TR or BR pins 4 or 5 PL2 will be strobed low.
- If all seems to be well yet keys are not being read check for shorts between the column lines MCL, LCL and RCL.

DTMF keys

- Pressing keys on the DTMF microphone on an advanced model should produce a high level on DV pin 14 of U9, (MC145436D).
- If this does not happen check that the DTMF tones at level 0.5volt p-p are reaching U9 pin 8.

11.2 Transmitter test sequence

Refer to the test point overlay (HF-90 P.A. BOARD ALIGNMENT - POSITION REFERENCE) in Section 12 of this manual, as well as the schematic diagram (HF-90 P.A. & POWER SUPPLY 90002) in Section 17 of this manual.

For these tests the radio should be connected to a power meter and dummy load via a 30dB asymmetric Tee off to an oscilloscope. A channel in the range 3 - 6MHz should be chosen for measurements.

6. Transmitter Power Supplies

- Press PTT and check that +5voltTX is present on pin 5 of U3 (LM358M). If not check Q11 and D10.
- Press PTT and check that +15voltTX is present in the range 10 - 11.4volt on collector of Q13 (BD136 on heatsink). If not check Q13 and U3:A bias voltages.
- Press PTT and check that +50volt rail comes up to approximately +55volt. Some sag of this rail is normal on speech peaks and Selcalls. If +50volt rail remains at 14volt on transmit, check first that the channel program does not specify low power and then check for 25kHz switching wave forms on R2 and R3.
- A 3-step wave form which varies with duty cycle should be visible on the anode of diode D5 in the centre of large toroid L5.

7. Lowpass filter selection

- The low-going lowpass filter selection pulses to the latching relays are emitted on pins 10 to 16 of U6 (ULN2003L). On a channel change, the common RST line is pulsed and then the band of choice is pulsed. As the driving device is open collector, the lines may be manually pulled low to test for switching by momentarily shorting the relevant pin to ground. Refer to Table 3 (Section 8 of this manual) which details the expected state on pins of U6.
- For the filters to operate correctly the serial data chain must be intact all the way to U7 pin 9 (74HC595D), and serial data should be visible on this pin during a channel change.

8. Bias check

- Check that the bias settings for driver and PA are approximately 2.6volt on C49 positive and 3.7volt on C63 positive with PTT active.
- Check that Op-Amp outputs U11 pin 6 and U1 pin 6 are approximately half rail (6volt) with PTT active and no modulation.

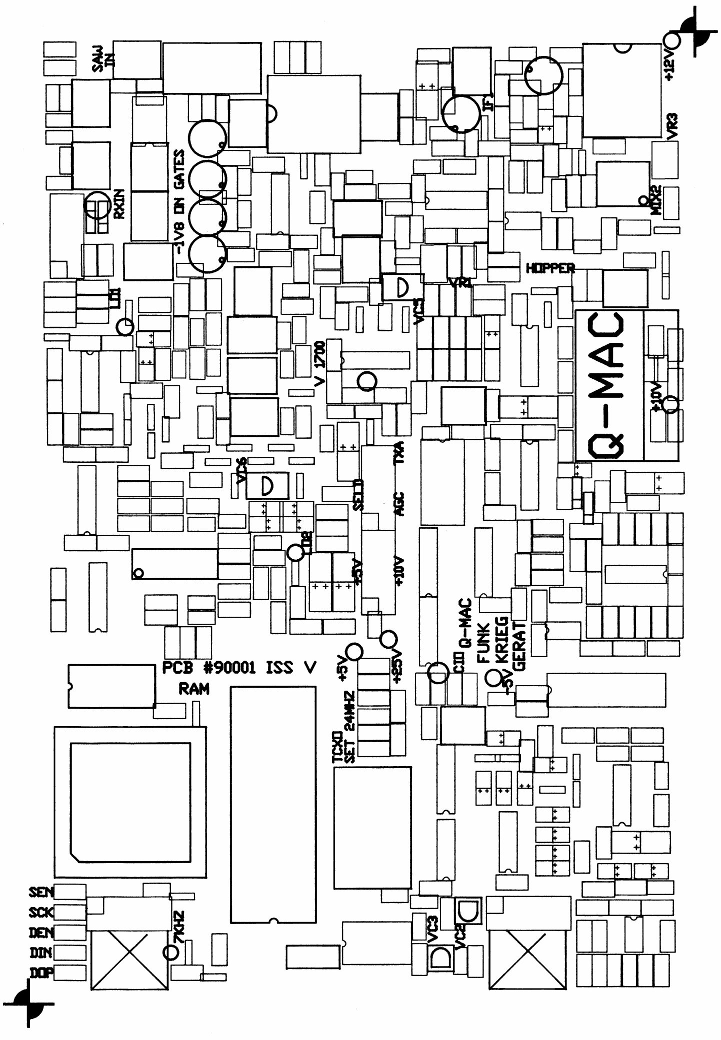
9. Signal check

- Apply a fully modulating 2-tone by external means.
- The 2-tone envelope should reach 0.8volt p-p on U11 pin 6, 6volt p-p on U1 pin 6, 3volt p-p on the gates of Q1 and Q2 (VN88AFDs), 7volt p-p on the gates of Q3 and Q4, 70volt p-p on the drains of Q3 and Q4 (IRF830s) and finally 140volt p-p at the output of T3. Note that these values are approximate and are most accurate in the rage 3 - 6MHz.
- For the above levels, the rectified ALC wave form at U3 pin 7 should be approximately 9volt peak. A similar voltage should be present on the gate of Q9 (BSD22).
- If signals are larger than above up to a stage and then very small thereafter, then the first stage with the small signals is the one to suspect.
- Study the wave forms shown on the schematic carefully.

12. TEST POINT OVERLAYS

Please refer to the following pages for test point overlays .....

12.1 RXMP test point voltages



Test Point Name	Acceptable Voltage Range	Fault Finding Comment
+5v	4.7 ⇨5.1	Main +5v rail, derived in PASW.
+10v	9.7 ⇨ 10.2	Main +10v rail, derived in PASW.
-5v	-2.5 ⇨ 5.2	Bias rail from RXMP charge pump.
+25v	20.5 ⇨ 27	Varactor bias rail from RXMP pump.
LO1	VARIES	2MHz, 3.5v, 13.1MHz. 20v 13.2MHz, 3.5v, 29.9MHz. 20v Set at 20v at 13.1MHz by VC6
LO2	2 ⇨ 2.5	Set at 2.3v by VC5.
Q1,2,3,4 GATES	-1 ⇨ -2	Positive voltage caused by failed GaAS FET or no LO1 drive.
Q5 GATE	-0.5 ⇨ 1	Positive voltage caused by failed GaAS FET or failed auto-bias.
24MHz	4.5 ⇨ 5p-p	Main system clock (logic level) 24MHz TCXO trimmer adjusts to ±7Hz.
C10	1 ⇨ 20p-p	456.4KHz (LSB) 453.6KHz (USB)
AGC	VARIES	2 ⇨ 4v with increasing signal.
TXA	VARIES	2.65 DC RX 2.8 DC TX
7KHz	4.5 ⇨5p-p	Charge pump and display multiplex clock (logic level) 7.143KHz. Failure of this will cause bad bias voltages and no display.
DOP	Sits at 5v	DOP has negative going data bursts on channel change. DATA OUTPUT
DIN	Data	DIN has continuous incoming Selcall data normally on a Selcall channel, DATA INPUT.
DEN	Sits at 5v	DEN has negative going enable pulses on channel charge. DISPLAY ENABLE.
SCK	Sits at 0v	SCK has positive going clock pulse bursts on channel change. SERIAL CLOCK.
SEN	Sits at 5v	SEN has negative going enable pulses on channel change. SYNTHESIZER ENABLE.
ALE	Sits at 5v	ALE has continuous negative going data bursts at 500Hz rate.
1700		Connect 100n capacitor between pins 7 & 9 on PL5, measure frequency at 1700 test point. Adjust to 1700Hz ±8Hz using VR1. Remove capacitor.

REFER LAYOUT DIAGRAM
"HF-90 P.A. BOARD ALIGNMENT POSITION REFERENCE"
IN FILE NAMED "PAHTPNOT.xxx"

13. SOFTWARE OVERVIEW

13.1 Program description

Note:
For details concerning functionality, the HF-90 Operation & Installation Guide should be consulted.
For details of the programming software, the HF-90 Programming Guide (Q-MAC Part No. QM1001/2) should be consulted.

This section simply gives a broad view of how the radio software is structured.

START
INITIALISATION

MAIN LOOP
JUMP IF PTTON
CALL CHECK SELCALL
CALL CHECK KEYPRESS
CALL CHECK VOLUME

PTTON
CALL CHECK PA LOWPASS
CALL CHECK DISP TIMEOUT
CALL CHECK PTT

IDLE UNTIL INTERRUPT
JUMP MAIN LOOP

When the radio is not in computer control, the micro executes the above code every time it is interrupted by one of the following:

1. Another Selcall one fifth bit period elapsing (every 2ms). -You can see this occurring on ALE!

2. If tones are active on receive as a Selcall alert, in transmit as Selcall tone generation or revertive tone generation. (approx every 300µs- depending on tone frequency)

3. If the volume control is being turned. (occasionally).

13.2 Routine description

Volume

Checks if shaft encoder has moved and updates value to be sent to DAC if it has. (Note that incoming Selcall has priority over this)

Keypress

Checks the 6 keys in the matrix:

- If CHAN∧ or CHAN∨, calls routine which updates synthesizer and display.
- If CLAR∧ or CLAR∨, calls routine which updates clarifier DAC and display.
- If TUNE, calls routine which pulls PTT low, updates synthesizer & display and generates 1kHz tone.
- If ALARM/MODE, then USB/LSB bit toggled and synthesizer & display updated.

DTMF keys

The DTMF keys are checked and the values passed to the SELCALL command line interpreter.

Selcall

If the radio is in receive and the channel is a Selcall channel then the Selcall decoder algorithm is active.

This algorithm samples every fifth bit, filters the bit stream, looks for a dot pattern, then goes on to detect sync and countdown, rephasing as necessary, detects the caller ID and attempts to match the destination ID with its own. The following telephone digits are stored for resending as required. The algorithm uses a priori knowledge to effect resynchronization. If an own-ID match is achieved, then PTT is pulled low, the synthesizer and display are updated and a revertive tone sequence is generated. After the revertive sequence is complete, an ALERT tone sounds for one second and the caller ID flashes in the display until cancelled by pushing PTT.

If the radio is in receive, the channel is a Selcall channel and the DTMF keys are being pressed, then the SELCALL command line interpreter handles the incoming key stream and holds the data in an interim buffer.

Permissible key streams are as follows:

1234
SENDs SELCALL to 1234, after final *

******
SENDs SELCALL last ID in send buffer, after final *

1234#0892042444
SENDs TELCALL to 1234 with digits 0892042444, after final *

#
SENDs last TELCALL in send buffer, after final *

##
SENDs TELCALL HANGUP command, after final #

#6101*
Requests TELCALL BEACON from 6101, after final *

#*
Requests TELCALL BEACON from last caller ID in send buffer, after final *

The command line interpreter will respond with ERROR if an invalid keystroke is entered or CLOSED if the channel has Selcall disabled.

Once the final * or # character has been entered the TX SELCALL routine pulls PTT low, updates the synthesizer and display with SEND and calls the TONES routine to generate the FSK tone sequence. Timeouts control the sequencing of counter loading.

PA lowpass

This routine ensures that the correct TX lowpass harmonic filter is selected on a channel change. It is also called on a timeout to de-energize the latching relay set coil thus saving power. On the same timeout the current channel number is stored. This avoids excessive use of the EEPROM while scanning.

DISP timeout

This routine is a series of timeouts which ensure that periodic activities occur at the correct time.

PTT

The PTT routine ensures that the synthesizer and display are correctly updated on transmit and receive. If the channel is a split frequency simplex channel this is critical.

Computer programming

This routine is entered by holding CHAN UP and DOWN keys together for 2 seconds. It can only be exited by using the computer to download or by switching off.

Direct programming (not before V120)

This routine is entered by holding CLAR UP and DOWN keys together for 2 seconds. On radios where direct programming is prohibited, only the Selcall ID can be changed. Otherwise frequency programming is possible.

Erase (not before V300)

Holding CHAN UP and CLAR UP keys together for 12 seconds erases all channel information.

Signal meter (not before V300)

This routine is entered by holding CHAN DOWN and CLAR DOWN Keys together for 2 seconds. Thereafter the signal strength is displayed. To exit this routine press a CLAR or CHAN key.

13.3 Software releases

Version	Description	Radio S/No.	RXMP Issue
102	Original release software	<1030	Issue A to L
103	Improved Selcall decode	<1086	
104	6061 decode problem eliminated	<1200	
105	16 digit Telcall, long preamble LSB=456.6	<1200	
106	16 digit Telcall, long preamble LSB=456.4	>1200	
107	Identical to V104 but LSB=456.4	>1200	
108	As V107 but Selcall band not recentred	>1200	
109	Not issued	NA	
110	New Selcall decode algorithm sampling every 2ms not 2.5ms	>1300	
111	As above but Selcall decode L.U.T improved	>1300	
113	Unused pins on U16 RXMP shut down for improved EMI	>1550	
114	First version allowing fully automatic TA-90 operations	>1678	
115	Not issued	NA	
116	Select pulses to LPF latching relays extended	>1802	
117	As V116 but LSB correction implemented	>1900	
118	As V117 but tune time extended to 10 seconds on this version only	NA	
119	Not issued	NA	
120	New software in 89C52 micro. Fast scan and programmable ID	>1974	Issue M to S (except Q)
121	Full release version of new software in 89C52 micro	>2000	
202	Erase and program enable feature added	>2500	
203	Scan microphone entry bug fixed, timeouts changed, zero trap	>2500	
204	Scan bug fixed, Selcall improved	>3000	
205	No channel lockup problem fixed	>3000	
206	89C738 micro version of V205	>4000	
401	First release of software for new RXMP	>3500	Issue T ⇨ (also Issue Q)
402	As above with software clarifier	>3500	
403	As above with 25Hz resolution clarifier	>3500	
404	Not issued	N/A	
405	Erase, tune, no channel problems fixed.	>3500	
406	Clarifier register reallocated for MICINH, AGC	>4000	
407	Tx inhibited on zero frequency load	>4000	
408	Removes clear scan lock-up problem.	>4300	

14. HINTS & TIPS

The following are a series of useful and anecdotal observations on causes and cures for faults on the HF-90. But first some words of advice on servicing the SMD parts on the HF-90 PCBs

14.1 Device removal

The SMD devices on the PCBs are pretty small and can be tricky to get on and off the PCB without the correct technique. At Q-MAC we generally do not use special tools to get devices off but have evolved a number of effective techniques for device removal during the development of the radio.

The techniques below should be practiced on scrap boards again and again before attempting to service a customer's radio.

1. The loaded PCB is quite valuable and damage to a track can be disastrous so the first rule is KEEP THE SOLDER SUCKER AWAY! The recoil can often push a track off the PCB and it isn't easy to put it back. Most chips on the board are worth a lot less than a dollar so if they have to come off you might as well sacrifice them. To remove a 16 pin SMD device get a very sharp knife of the type with the snap off blades and break off the last blade. Using the knife in a gentle arcing motion with the tip resting on the PCB cut through the pins at the root of the device one by one on a single side only. Now the device can be gently fatigued off by four small back and forward displacements. The pins can be picked up on the end of the soldering iron and the pads carefully cleaned up with solder wick and alcohol.

2. Solder wick is infinitely preferable as an aid to device removal as compared to the sucker.

3. Resistors and capacitors are simply heated at ends alternately and gently flicked off.

4. With large PLCC packages such as the microprocessor, the cutting technique is not advisable as the leads are much thicker and the tracks rip up first. With the 44 pin package a special tool is desirable, however if stuck the best technique is to use two or three fairly large irons and run lots of solder along all 44 pins until the whole surround is molten. AT NO TIME APPLY ANY FORCE WHATSOEVER. It is best to tip the PCB at a slight angle and when the device is ready it will float off. It is necessary to remove a couple of capacitors around the micro prior to getting started. The mess of solder can be cleaned up using solder wick and alcohol. DO NOT USE A HOT AIR GUN TO REMOVE PARTS. There are plenty of parts which will shrivel and die before the part that you want comes off.

5. The X-pack transistors such as the ATF13736 are flush down to the board and not easy to remove. The best technique again is a fairly large hot iron tip and a sea of solder to float it off on. Again apply no force, just patience.

6. If for any reason a 10-way connector is damaged and it is necessary to replace it, ON NO ACCOUNT TRY TO REMOVE IT IN ONE PIECE. Each joint should be gently heated with the tip of the iron while the end of the pin is gripped with tweezers. When the pin is ready it will slide out. Repeat for each pin and clean up as before. With the receptacle style connectors the plastic shroud can be carefully removed prior to starting.

14.2 Servicing warnings

1. When servicing a radio DO NOT 'TWEAK' OR ADJUST ANY OF THE TRIMMING CAPACITORS OR POTENTIOMETERS UNLESS ABSOLUTELY NECESSARY. These devices give trouble free life if left alone but are designed to have an adjustment cycle life of only 100 operations. UNITS RETURNED WITH WORN TRIMMERS WILL NOT BE REGARDED AS VALID WARRANTY CLAIMS.

2. When removing an EEPROM from its socket on earlier radios MAKE SURE THE EXTRACTION TOOL IS ENGAGED ON THE EEPROM AND NOT THE SOCKET. We have had some units returned with tracks ripped up due to extracting the socket along with the chip. PLEASE DON'T DO IT!

3. When reinserting EEPROM into socket, please make sure that all pins engage and that none are bent underneath.

14.3 Servicing case histories

The following case histories are classified by fault symptoms. Where they have limited serial number applicability this is noted. Symptom categories include:

1. Transmit faults
2. Transmit & receive faults
3. Receive faults
4. Audio faults
5. Display faults
6. Microprocessor faults
7. Miscellaneous faults
8. Programming faults

1. Transmit faults

Symptom: No Tx on some frequencies
The PASW harmonic filter is arranged in six latching relay switched bands. If transmit power is absent or diminished on one band then suspect a relay. Refer to Table 3 (Section 8 of this manual) for a suggested manual switching technique to operate each relay. *Note that power is less above 15MHz.*

Symptom: No Tx, but Rx OK
If the PASW +50volt fuse is blown then suspect damage to one of the output MOS FETs. Compare the resistance measurements on both to identify the defective device. After changing the device, as per the passage in Section 9.3 (Radio alignment) check the gate bias voltages with the links removed. It may have been a bias fault which caused the failure. Under these circumstances check that the pots VR1 and VR2 operate normally. Also check that C43 and C51 in the feedback around the output MOS FETs are not shorted. Check the seating of resistors R39, R40, R33, R34 (22Ω 1watt and 220Ω 2watt) as they may short upon components beneath if they have been damaged.

Symptom: No Tx, but Rx OK
On the PASW board, if thermistor TH1 (470Ω red or blue disk) has been knocked, it may short on parts beneath causing a bias failure on transmit.

Symptom: No Tx, but Rx OK
As mentioned in Section 1 (Warnings & advice), the transmit +50volt inverter 'packs a big punch'. If you do not wait for a full minute after transmitting before probing the PASW and happen to short from the +50volt rail to adjacent components then damage will result. We managed to lose U11 (CLC404) and Q9 (BSD22) in a flashover in that corner of the PCB!

Symptom: No Tx, but Rx OK
Low or zero transmit power output can be due to a cracked coupling capacitor C131, C132 (3n3) or C52, C53 (10n) on PASW PCB.

Symptom: No Tx, but Rx OK
Low or zero transmit power output has also occurred due to failure of 100n coupling capacitors C44, C50 or C47, C48. These devices are subject to high voltage and current stress.

Symptom: No Tx, but Rx OK
Low transmit power output may occur if either VN88AFD Q1 and Q2 MOS FET fails. These devices are extremely reliable and failures have only occurred in batch with markings T942AB. As the devices fail open circuit the effect can go unnoticed.

Symptom: Low Tx power
The most common cause of low transmit power is that the radio has been PROGRAMMED for low power. Check that this is not the case before investigating further.

Symptom: Low Tx power
Low transmit power has occasionally occurred due to a dry joint on T4 or T6 on the P A S W board.

Symptom: Low Tx power above 15MHz
On radios with low talk power above 15MHz, changing RXMP R74 from 3K3 to 10K in parallel with 10K (5K) will improve the level. *Note: Applies only to radios pre S/N 1975.*

Symptom: Tx failure
In the event of failure of PASW RF op amp U1, it should be replaced with device type CLC404.

Symptom: Tx failure
The radio is protected against indefinite short circuit or open circuit RF output, however other phases of VSWR in excess of 3:1 have caused the failure of RF power output transistors Q3 and/or Q4 IRF830. These devices fail short-circuit and will blow the series meander fuse on the rear of the PCB. Occasionally an MPF 3055 Q5 or Q6 will be blown in the 50v power inverter. When replacing blown RF power transistors, ECN 79 and 80 should be implemented. This entails the adding of two RXE110 polyswitches each in series with the source of an IRF830 power transistor. The bias circuit requires changing when this modification is done. R80 (3K3) should be removed and R93 (0R) replaced with 100R. All radios post 3650 have this modification fitted as standard. This ensures total immunity to RF device failure. All radios returned for repair are upgraded with this modification.

Symptom: 50volt supply damage
If when probing the PASW board, the gate and drain pins of either MTP3055 are shorted together while the unit is in transmit, the device will be destroyed. As there are two devices in parallel, the unit may continue to function however it will place undue stress on the remaining device.

Symptom: 50volt supply failure
If a 50volt inverter MOS FET Q5 or Q6 (MTP3055E) fails or if D5 (BYV28-200) fails then replace R1 (100R) and C8 (10N) also, as these snubber components may also have been damaged.

2. Transmit & receive faults

Symptom: +5volt rail damage
On the PASW board If the output and middle terminal of the regulator U10 (LM2840CT5) are accidentally shorted together, the regulated +5volt rail will jump to +14volt. This has unfortunate consequences on the RXMP board. Under these circumstances the weakest chips on the +5volt rail snap and in doing so protect everything else. On the occasion where it happened in our lab we lost U8 and U29 on the RXMP board (both 74AC04Ds). Quite why U30 didn’t blow we don't know. Sometimes when devices like this fail you can feel a slight raised portion on the top where the internal chip has overheated. *Note: On boards of issue M and later U8 is a 74HC04D.*

Symptom: Off frequency
If the radio is off frequency significantly then before trimming VC1 on RXMP as per Section 9.3 (Radio alignment), check the PTC heater to ensure it is working and has not become damaged or detached. Extreme thermal shock may cause this. *Note: Radios with S/N >3500 have TCXO instead of PTC thermistor and crystal.*

Symptom: 'Warbling' or intermittent Rx and Tx
If the synthesizer is 'misbehaving' (noisy, jumping erratically) examine the polystyrene capacitors C9 and C15 for damage or mis-location. If these capacitors have been brushed with a soldering iron or misplaced against a noisy line then problems can occur. Also inspect the green polyester capacitor C69 (1µF) to ensure it is properly seated and connected. *Note: On RXMP board of issue M and beyond, C9 and C15 are no longer polystyrene but high-Q 1206 SMD ceramic ports. Also, C69 is now an SMD device and not subject to damage. This overcomes the above problem.*

Symptom: 'Warbling' or intermittent Rx and Tx
Loss of lock on LO1 synthesizer on RXMP boards fitted with black polyester SMD capacitors on the rear side may be due to the 100nF polyester capacitors becoming leaky. WIMA SMD polyester capacitors have proved to be unreliable and were used only on a small number of radios.

Symptom: No Tx with weak Rx
If RF power has been directly applied to the BNC socket in error, you will have a deaf receiver (typically 50dB down) and no transmit power. Look for a 'fried' protection diode D14 near PL4 on RXMP and one or more dead GaAs FETs Q1, Q2, Q3, Q4. Usually that is all the damage caused. You can tell which pair of GaAs FETs are damaged by checking for negative voltage on the gates (-1.8volt). If Q1 and Q4 have plus volts on the gates you had better change them. *Note: ECNs 19 and 22 have improved front end protection on all radios by using more robust protection diodes D14 and D27 (BAV103) and including a DC block on the PASW board.*

Symptom: No Tx with weak Rx
The only single random component failures that we have seen in service so far are an open circuit red LED (Y3 on RXMP) causing the audio paths to die on TX and RX and a SAW filter (F1 RXMP) which had mysteriously increased insertion loss by 20dB (as at 6/6/96).

Symptom: No Tx with weak Rx
A small number of radios have been returned with front end damage. The symptom is low or no Tx power and Rx sensitivity 20dB down (or more). The voltage on the gates of RXMP Q1, Q2 or Q3, Q4 will be slightly positive, not -1.8volt as it should be. To repair and ensure that this does not happen again, you will need to do the following (in accordance with Technical Bulletin 1746/96): *Note: Since ECN19 and 22 the only radio returned with front end damage had been struck by lightning.*

a. Replace pair of GaAs FETs with positive gates.
b. Remove D14 (BAV99) and replace with back to back 1N4148s between PL4 pin 7 and ground.
c. On PASW lift centre of coax feeding 5mm coil L20 and place series 100n cap in line.
d. A series 10K resistor may be placed between signal pin on L20 and ground, to ensure DC leakage path. *Note: Applies only to radios pre S/N 1975.*

3. Receive faults

Symptom: Weak Rx
If the RX is very deaf and the AGC line is up high, (3.8volt or more on C22 on RXMP) then examine T8 on RXMP. There should be an insulating shim beneath this ferrite core. If it has become dislodged, the conductive core may short upon components beneath and cause the AGC to wind on full. Also check that C197 beneath the board (330N) is intact. *Note: On boards of issue M and later, T8 is replaced by a 5mm coil L17, which overcomes this problem.*

Symptom: Intermittent Rx
Intermittent receiver operation when changing between transmit and receive is likely to be due to a TX/RX changeover relay, RL1 or RL2 on RXMP or RL1 or RL2 on PASW. *Note: ECN62 changed these relays from EB2-12 to EB2-9 eliminating this.*

Symptom: Intermittent Rx
If the receiver is dead but can be occasionally activated by knocking the case, then check that the legs of filter F2 are adequately clearing the case. If they have been displaced, then shorting may result.

Symptom: "Whoop whoop" sound
If a radio emits a "whoop whoop" sound out of the loudspeaker then LO2 is unlocked. This can be fixed by monitoring TPLO2 on RXMP C85 and adjusting VC5 (blue trimmer) for 2volt. On all radios S/No 1400 onward, LO2 is temperature compensated over the range -30ºC to +60ºC. Older radios may be upgraded by ordering a new part for C212 (33p N470 0604 SMD) which improves the temperature compensation (in accordance with Technical Bulletin TB33/97).

4. Audio faults

Symptom: No audio
We found that if you short circuit the loudspeaker for a long time and make sure that there is plenty of signal coming in you can burn out R172 SMD 1Ω near PL4 on RXMP. This stops further damage occurring.

Symptom: No audio
No received audio whatsoever, may be due to a failed U28 (LM380N or LM384N) and/or open circuit DC feed resistor(s) R172, R213, R214. The coupling capacitor C89 220µ should be replaced if V28 is defective.

Symptom: No audio or intermittent behaviour
Radios prior to S/No 1400 had rear power connectors with split pins. If intermittent power connection is experienced, this can be eliminated by slightly separating the split pins WITH CARE.

Symptom: No audio or loudspeaker always on
When plugging in the loudspeaker to the 4-pole mini-fit receptacle, care should be taken to ensure correct orientation. There is a positive orientation keyway however a really determined user can ram the plug into the socket the wrong way.

Depending on the misalignment this can result in:
a) Loudspeaker remaining 'on' permanently.
b) Burnt out loudspeaker PCB track on edge of PASW PCB, destroyed R173 feed resistor to LM384N and destroyed C89 220µ output coupling capacitor.

5. Display faults

Symptom: Front panel not mating
On some units, if the PASW and RXMP are slid out for servicing and subsequently slid back in, the RXMP may not engage with the 10-way sockets on the front panel. If resistance is encountered when sliding the boards in, do not force them. It is better to remove the front panel, screw the heatsink in first, then re-engage the front panel and screw it back in place. If the connectors are bent for any reason and mis-engage, the radio will not come on. However it has been designed so that no electrical damage can occur under this circumstance and if the connectors are realigned, no harm will be done. *Note: Radios are now jig aligned in the factory to overcome this.*

Symptom: No display or frozen display

Failure of the display to come up but otherwise operate normally is probably due to a damaged resistor R19 (10M) on the display PCB. It has also been found that if Q1 (BC847) beneath the shaft encoder is physically damaged by over tightening the case screws, the display may fail to show digits. Shorting of the SMD capacitors at the rear of the display PCB may also show that same effect.

Symptom: No display and no Tx

On the PASW board EMC inductors L4 and L6 have strong heatshrink fitted over the windings. This heatshrink protects the windings which have +55volt on them in transmit. The heatshrink should not be damaged or removed as shorting may occur to the LEDs on the display board. This would cause destruction of most of the devices on the display.

Symptom: No display or bad display

One instance of loss of display has been observed where the SMD capacitors C8 and C13 on the back of the display have shorted to a sliver of ground track on the PASW PCB edge. This can be eliminated by removing the ground sliver with a utility knife.

Symptom: Bad display

If the display has weak incorrect characters then probably the 7kHz multiplex clock from the CIO counter is absent. If RX performance is normal then the problem is not in the CIO itself, however if the RX is inactive then the CIO or charge pump is probably defective.

Symptom: Error display on turn-on

If corruption occurs on a radio prior to S/No 1300, using an ATMEL EEPROM will eliminate this. *Note: This part may be ordered from Q-MAC (Part No 77164).*

Symptom: Error display on turn-on

EEPROM corruption is flagged by a leading E on the displayed version number (eg. E2-104). If this occurs the EEPROM should be replaced or reprogrammed as per Section 9.2 (Replacement of EEPROM). *Note: Q22 has been added to the RXMP board to stop corruption. Since radio S/N 1975, the program code has resided in the microprocessor, eliminating the likelihood of corruption.*

Symptom: Display freezes on "HF-90"

If the display freezes on HF-90E then it is possible that the radio has been downloaded with no channels specified. On radios with firmware prior to V405/V355 if a computer download is done with all channels unprogrammed the radio will lock up. This can only be fixed by fitting new firmware V408/V358 or above for radios after S/N 3500 or by replacing the EEPROM for radios before S/N 3500.

Symptom: Display freezes on Selcall ID

If the radio freezes on Selcall number display eg: "5555" then it is probable that the radio has had all scan channels deleted by using front panel programming. If a radio has had scan channels programmed, and then subsequently deleted without setting these channels back to SCANOFF, the radio will lockup when SCAN is entered. The problem does not occur when programming from the computer. Firmware versions V408/V358 and beyond overcome this problem.

6. Microprocessor faults

Symptom: Crashes whilst scrolling

If a radio seems to crash (ie. resets back to start-up routine displaying HF-90A etc.) when fast scrolling channels, then the program dwell time on the EEPROM is incorrect. Try adding a 1n 0805 SMD capacitor in parallel with RXMP C16 and C224. *Note: Applies only to radios pre S/N 1975.*

Symptom: Radio will not Selcall
If a radio comes up as standard (no Selcall) or Australian (HF-90A) instead of Export (HF-90E) then check diodes D31 and D32 on rear of RXMP. These should have blue bands (BAT42). If they have black bands advise Q-MAC and these can be changed. Upgrading software to V408/V358 or beyond may also fix this problem.

7. Miscellaneous faults

Symptom: Radio doesn't turn on
Failure of the HF-90 to turn on may simply be due to a broken wire at the back of the on/off switch on the front panel.

Symptom: Radio doesn't turn on
When disassembling and reassembling several radios at once it is important to use the gaskets supplied with the original radio. Failure to do this can result in failure to turn on due to pins not mating caused by a thick gasket.

Symptom: Radio is dead
If for any reason the main +5volt rail is dead, the radio will be inoperative. There will be no noise or display of any sort.

Symptom: Radio not programming from PC
If the radio operates normally but will not program from the computer AND OTHER RADIOS WILL PROGRAM, then suspect a dry joint on Q13 (BC847 RXMP).

Symptom: Blown supply fuse
Tranzorb over voltage protection diode D7 on the underside of PASW board will cause the fuse to blow on overvoltage. If the fuse is replaced by one of too high current rating (>15A) or is defeated, the tranzorb will be destroyed in the event of overvoltage.

Symptom: Black resistors
If the transmitter is operated at high power for a long time into an open circuit, then PASW resistors R34 and R34 (220Ω, 2watt) will start to discolour. These resistors have been chosen for their stability of value even under extreme overload so check their value with a meter first before assuming they're no good. The same blackening has been noted along with low TX power (4watt at 5MHz) when the braid of transmit output transformer T3 had come adrift at one end. *Note: T3 is now soldered directly to the PASW PCB, thus circumventing this problem.*

Symptom: Microphone keys not working
If some of the keys on the DTMF mic are inoperative (eg. six) then it is likely that the level set pot in the microphone is incorrectly adjusted. This pot should be fully anti-clockwise when viewed from the rear of the mic. *Note: Later model DTMF microphones do not have this pot.*

Symptom: Instability
In the event of U21 (MAR8) on RXMP oscillating, remove R69 (100R) and R161 (100R).

Symptom: RF instability on mobile pack
RF instability which occurs when changing to a mobile pack setup may be cured by the following modification to the DTMF microphone:

a. Add 1n disc ceramic beneath IC from pin 1 to pin 11 (pin 1 is at top left when viewing from the back).
b. Add 100n monolithic ceramic capacitor from PTT input to ground.
c. Add 100K resistor across above capacitor. *Note: Applies only to radios pre S/N 1975.*

Symptom: TA-90 Tuner does not operate (no clicks heard)

If the auxiliary supply pin out the back is shorted to ground for a long time then PASW resistor R62 1Ω 1watt will get fairly black and hot. Check its value and replace it if it has gone high, having first fixed the cause of the problem. *Note: PASW PCB's beyond S/N P0500 are fitted with self resetting Polyswitch instead*.

15. PARTS LIST

15.1 Front panel PCB parts list (ISSUE N)

Description	Qty	Component designators				
100P 0805 SMD NP0 (10101)	3	C15	C16	C17		
3N3 1206 SMD NP0 (10332)	6	C8	C9	C10	C11	C12
		C13				
100N 1206 SMD X7R (10104)	7	C1	C2	C3	C4	C5
		C7	C14			
1U SMD TANT (10105)	2	C18	C19			
BAV99 SMD DIODE (65001)	3	D1	D2	D3		
8PIN MIC SOCKET (50000)	1	P1				
10PIN SOCKET (50010)	2	PL1	PL2			
BC847 SMD NPN (60000)	1	Q1				
BC807 SMD PNP (60100)	1	Q2				
10R 1206 SMD 5% (00100)	1	R18				
100R 1206 SMD 5% (00101)	1	R20				
330R 1206 SMD 5% (00331)	8	R1	R2	R3	R4	R5
		R6	R7	R8		
1K 1206 SMD 5% (00102)	3	R15	R16	R17		
3K3 1206 SMD 5% (00332)	1	R13				
10K 1206 SMD 5% (00103)	4	R9	R11	R12	R14	
100K 1206 SMD 5% (00104)	1	R10				
10M 1206 SMD 5% (00106)	1	R19				
SWITCH SPST (45000)	1	SW1				
74HC595 SHIFT REG (73595)	7	U1	U2	U3	U4	U5
		U6	U8			
74HC30 8 I/P NAND (73030)	1	U25				
HDSP7503 7-SEG LED (68002)	6	U18	U19	U20	U21	U22
		U23				
QUADRATURE ENCODER (07000)	1	VR1				

15.2 RXMP PCB parts list (ISSUE V)

Description	Qty	Component designators				
1P 0805 SMD NP0 (10109)	3	C70	C232	C253		
3P3 0805 SMD NP0 (10339)	4	C134	C168	C177	C211	
10P 0805 SMD NP0 (10100)	15	C62	C63	C64	C65	C66
		C67	C68	C94	C113	C114
		C115	C161	C162	C176	C239
33P 0805 SMD NP0 (10330)	6	C36	C37	C110	C116	C130
		C251				
100P 1206 SMD NP0 (10101)	14	C6	C69	C71	C72	C77
		C86	C97	C100	C108	C112
		C118	C144	C167	C226	
330P 0805 SMD NP0 (10331)	8	C125	C140	C154	C241	C245
		C246	C248	C249		
1N 0805 SMD NP0 (10102)	38	C18	C24	C27	C32	C38
		C44	C57	C60	C76	C79
		C80	C81	C82	C83	C93
		C105	C111	C117	C119	C121
		C122	C124	C127	C129	C133
		C142	C143	C151	C158	C163
		C165	C171	C189	C190	C196
		C227	C243	C244		
2N2 1206 SMD NPO (15222)	2	C85	C136			
3N3 1206 SMD X7R (10332)	5	C34	C104	C145	C247	C250
10N 1206 SMD X7R (10103)	4	C11	C23	C55	C126	
33N 1206 SMD X7R (10333)	1	C39				
100N 1206 SMD X7R (10104)	63	C3	C7	C9	C10	C12
		C13	C14	C15	C17	C19
		C26	C30	C35	C40	C41
		C42	C43	C45	C48	C49

Description	Qty	Component designators				
		C50	C52	C54	C56	C58
		C73	C74	C78	C84	C87
		C88	C95	C98	C103	C106
		C123	C128	C135	C137	C138
		C139	C152	C153	C157	C166
		C170	C179	C182	C183	C184
		C193	C194	C198	C199	C201
		C202	C203	C204	C205	C207
		C208	C217	C220		
330N 1206 SMD X7R (10334)	9	C25	C33	C59	C185	C197
		C214	C215	C216	C221	
1U SIZE A TANT 16V (10105)	7	C2	C4	C8	C120	C156
		C191	C200			
1U SIZE C TANT 35V (12274)	4	C61	C146	C147	C148	
3U3 SIZE B TANT 10V (10335)	4	C51	C132	C149	C150	
10U SIZE C TANT 16V (10106)	7	C47	C53	C141	C164	C173
		C218	C219			
100U SMD ELECTRO (17107)	16	C5	C20	C21	C22	C29
		C31	C91	C101	C159	C172
		C174	C178	C180	C228	C229
		C231				
22U SMD ELECTRO (17226)	4	C234	C235	C236	C237	
33U SMD ELECTRO (17336)	9	C1	C75	C102	C107	C131
		C155	C181	C195	C230	
220U/25V ELECTRO (10227)	1	C89				
P10N POLYESTER CAP (17103)	2	C46	C240			
33P CAP N470 (17330)	1	C212				
100N POLYESTER CAP (17104)	1	C210				
BAV99 SMD DIODE (65001)	13	D2	D5	D6	D7	D8
		D11	D16	D17	D18	D19
		D20	D23	D28		
100U/35V ELECTRO (10107)	1	C90				
470U/16V ELECTRO (11477)	3	C16	C92	C169		
P47N POLYESTER CAP (17473)	1	C99				
P470N POLYESTER CAP (17474)	1	C96				

Description	Qty	Component designators
BAW56 SMD DIODE (65002)	2	D3 D24
BAT42 SMD DIODE (65021)	6	D1 D4 D13 D30 D31 D32
BAV103 SMD DIODE (65019)	2	D14 D27
BBY42 SMD VARICAP (66002)	7	D9 D10 D12 D21 D22 D25 D26
CFJ455K14 FILTER (85000)	1	F2
83FY4F SAW FILTER (85012)	1	F1
100NH 5MM COIL (34001)	1	L3
330NH 5MM COIL (34002)	7	L1 L2 L4 L5 L6 L7 L11
1UH SMD CHOKE (35020)	7	L8 L9 L10 L12 L13 L14 L15
RMS11X MIXER MODULE (69000)	1	M1
10PIN RA HEADER IDC (50015)	2	PL1 PL2
10PIN HEADER IDC (50013)	3	PL3 PL4 PL5
ATF13736 GaASFET (60202)	5	Q1 Q2 Q3 Q4 Q5
BC807 SMD PNP (60100)	3	Q11 Q15 Q16
BC847 SMD NPN (60000)	6	Q9 Q12 Q13 Q17 Q18 Q19
SST309 JFET (60200)	8	Q6 Q7 Q8 Q10 Q14 Q20 Q21 Q22
BSS123 MOSFET (60203)	2	Q23 Q25
78LO5ACD 5V REGULATOR SMD (79005)	2	U31 U32
0R 1206 SMD 5% (00000)	15	R42 R67 R92 R157 R162 R193 R203 R205 R206 R208 R209 R210 R211 R215 R217
1R 1206 SMD 5% (00109)	4	R84 R110 R139 R174
3R3 1206 SMD 5% (00339)	3	R172 R213 R214
10R 1206 SMD 5% (00100)	34	R18 R37 R38 R43 R47 R50 R59 R71 R80 R87 R103 R106 R108 R111 R112 R118 R120 R131 R136 R140 R143 R144 R147 R150 R171 R173 R175 R176 R177 R186 R220 R221 R222 R226

Description	Qty	Component designators				
33R 1206 SMD 5% (00330)	9	R7	R69	R72	R121	R125
		R137	R156	R162	R205	
100R 1206 SMD 5% (00101)	25	R29	R19	R34	R52	R53
		R57	R60	R61	R64	R68
		R69	R77	R90	R101	R109
		R135	R159	R161	R164	R165
		R168	R184	R187	R198	R216
330R 1206 SMD 5% (00331)	6	R15	R56	R88	R89	R100
		R223				
1K 1206 SMD 5% (00102)	22	R12	R13	R14	R17	R25
		R41	R58	R81	R85	R102
		R107	R141	R151	R154	R155
		R158	R160	R163	R166	R167
		R199	R203			
3K3 1206 SMD 5% (00332)	22	R3	R5	R6	R20	R21
		R22	R23	R36	R46	R54
		R55	R62	R74	R105	R117
		R128	R132	R133	R138	R145
		R169	R170			
10K 1206 SMD 5% (00103)	23	R10	R16	R24	R39	R44
		R63	R78	R79	R99	R119
		R122	R124	R126	R130	R148
		R181	R182	R185	R189	R190
		R194	R195	R212		
33K 1206 SMD 5% (00333)	18	R11	R26	R27	R32	R33
		R35	R51	R75	R76	R91
		R104	R123	R127	R152	R180
		R188	R201	R218		
100K 1206 SMD 5% (00104)	19	R8	R28	R30	R31	R40
		R48	R49	R70	R82	R86
		R94	R95	R97	R98	R134
		R146	R196	R197	R219	
330K 1206 SMD 5% (00334)	5	R4	R66	R73	R83	R96
1M 1206 SMD 5% (00105)	8	R1	R2	R9	R65	R93
		R142	R153	R192		

Description	Qty	Component designators
3M3 1206 SMD 5% (00335)	2	R129 R178
10M 1206 SMD 5% (00106)	1	R191
EB2-9 RELAY (40006)	2	RL1 RL2
600R TRANSFORMER (37021)	1	T7
455KHZ 5MM COIL (34010)	3	T9 T10 L17
BALUN (36002)	6	T1 T6 T8 T11 T12 T13
QUADFILAR COIL (36000)	1	T5
MIXER TRANSF. SMD (36003)	1	T3
89C738 MICROPROCESSOR (76738)	1	U1
M48Z58 NV RAM (77058)	1	U2
74AC04 HEX INVERTOR (74004)	2	U29 U30
74HC00 QUAD NAND (73000)	1	U6
MC145220F SYNTH (71220)	1	U16
74HC573 OCTAL LATCH (73573)	1	U3
74HC595 SHIFT REG (73595)	2	U10 U11
4046 PLL (75046)	1	U18
4053 3POLE C/O (75053)	1	U22
DAC0800 D TO A (78800)	2	U13 U15
HC4040 COUNTER (75040)	2	U7 U14
LM339 COMPARATOR (70339)	2	U4 U19
LM358 OP AMP (70358)	3	U20 U25 U27
LM384 AMPLIFIER (70384)	1	U28
LM1496 MIXER (71496)	1	U24
ERA3 AMPLIFIER (71003)	1	U21
MC145436 DTMF (74436)	1	U9
NE576D ALC CHIP (70576)	1	U26
TDA1572T AM RECEIVER (71572)	1	U23
6P TRIMMER (16002)	2	VC5 VC6
40P TRIMMER (16000)	2	VC2 VC3
P100K SMD POT (06104)	1	VR1
P1K SMD POT (06102)	1	VR3
74HC04 HEX INVERTOR (73004)	1	U8
7257, 6KHZ CRYSTAL (80007)	1	X2

Description	Qty	Component designators				
7302, 4KHZ CRYSTAL (80006)	1	X3				
3.579MHZ SMD RESONATOR (80014)	1	X4				
RED LED (67010)	8	Y1	Y2	Y3	Y4	Y5
		Y6	Y7	Y8		
24MHZ TCXO (81000)	1	TC1				
PLCC44 MICRO SOCKET (50035)	1	U1				
N10N 1206 NPO SMD (15103)	1	C28				
NIL (NOT FITTED)	8	C109	C160	C225	C252	R148
		R183	R204	R207		

15.3 PASW PCB parts list (ISSUE Q)

Description	Qty	Component designators				
10P 0805 SMD NP0 HI/V (15100)	4	C54	C117	C121	C122	
33P 1206 SMD NP0 HI/V (15330)	12	C1	C4	C77	C84	C91
		C108	C109	C111	C115	C116
		C148	C158			
100P 1206 SMD NP0 HI/V (15101)	20	C2	C58	C83	C85	C86
		C95	C97	C99	C100	C102
		C103	C104	C105	C110	C114
		C119	C120	C123	C143	C146
330P 1206 SMD NP0 HI/V (15331)	11	C3	C15	C35	C78	C87
		C90	C92	C98	C112	C113
		C118				
1N 1206 SMD NP0 HI/V (15102)	13	C5	C13	C24	C82	C88
		C89	C93	C94	C107	C133
		C137	C142	C160		
2N2 1206 SMD NP0 HI/V (15222)	5	C96	C101	C106	C159	C161
3N3 1206 SMD X7R (10332)	4	C65	C131	C132	C136	
10N 1206 SMD X7R (10103)	6	C8	C25	C52	C53	C164
		C165				
100N 1206 SMD X7R (10104)	61	C6	C7	C9	C10	C11
		C12	C14	C16	C17	C18
		C22	C26	C27	C28	C29
		C30	C31	C32	C33	C36
		C38	C40	C41	C42	C43
		C44	C45	C46	C47	C48
		C50	C51	C55	C56	C57
		C59	C60	C61	C62	C64
		C66	C67	C68	C69	C70
		C71	C72	C79	C81	C124
		C125	C126	C128	C129	C130
		C134	C135	C140	C144	C145
		C147				
33N 1206 SMD X7R (10333)	2	C162	C163			

Description	Qty	Component designators				
1U SIZE A TANT 35V (10105)	3	C34	C37	C39		
10U SIZE C TANT 16V (10106)	5	C19	C21	C49	C63	C127
100U SMD ELECTRO (17107)	4	C75	C80	C149	C150	
22U SMD ELECTRO (17226)	7	C76	C139	C141	C154	C155
		C156	C157			
33U SMD ELECTRO (17336)	4	C138	C151	C152	C153	
470U/25V ELECTRO (10477)	3	C20	C73	C74		
BAS16T SMD DIODE (65003)	2	D1	D2			
BAV70 SMD DIODE (65000)	4	D3	D8	D9	D17	
BAV99 SMD DIODE (65001)	2	D4	D6			
BYV28-200 FAST DIODE (65007)	1	D5				
BZD27C33 TRANZORB (65018)	1	D7				
6Y TOROID (37012)	1	L18				
8Y TOROID (37011)	2	L16	L17			
10Y TOROID (37010)	2	L14	L15			
12R TOROID (37009)	2	L12	L13			
15R TOROID (37008)	2	L10	L11			
19R TOROID (37007)	2	L8	L9			
24R TOROID (37006)	1	L7				
330NH 5MM COIL (35002)	1	L20				
37004 CURRENT XFMR (37004)	1	L19				
37015 INDUCTOR (37015)	1	L5				
37016 INDUCTOR (37016)	1	L4				
37017 INDUCTOR (37017)	1	L6				
10PIN SOCKET (50010)	4	PL1	PL2	PL3	PL4	
BC807 SMD PNP (60100)	1	Q11				
BC847 SMD NPN (60000)	1	Q7				
BD136 POWER PNP (60600)	1	Q13				
BD139 POWER NPN (60500)	2	Q8	Q12			
BSD22 SMD MOSFET (60201)	1	Q9				
IRF830 MOSFET (60301)	2	Q3	Q4			
MTP2955 MOSFET (60401)	1	Q14				
36018 100UH SMD (36018)	2	L1	L3			
36019 100VH SMD (36019)	1	L2				
BYD77D FAST DIODE (65017)	1	D10				
MTP3055E MOSFET (60300)	2	Q5	Q6			

Description	Qty	Component designators				
VN88AFD MOSFET (60304)	2	Q1	Q2			
0R 1206 SMD (00000)	6	R99	R100	R101	R102	R103
		R105				
3R3 1206 SMD 5% (00339)	2	R38	R50			
10R 1206 SMD 5% (00100)	15	R2	R3	R24	R25	R26
		R27	R28	R29	R37	R55
		R79	R82	R86	R92	R109
33R 1206 SMD 5% (00330)	1	R32				
100R 1206 SMD 5% (00101)	19	R1	R21	R41	R42	R43
		R44	R47	R48	R49	R51
		R72	R73	R84	R85	R88
		R89	R90	R91	R93	
330R 1206 SMD 5% (00331)	7	R4	R5	R19	R45	R63
		R87	R94			
1K 1206 SMD 5% (00102)	15	R22	R23	R30	R31	R59
		R66	R67	R71	R76	R81
		R95	R106	R107	R108	R110
3K3 1206 SMD 5% (00332)	11	R6	R8	R14	R20	R36
		R52	R56	R57	R58	R75
		R83				
10K 1206 SMD 5% (00103)	11	R11	R12	R13	R53	R54
		R60	R61	R64	R65	R68
		R97				
33K 1206 SMD 5% (00333)	4	R7	R10	R35	R74	
100K 1206 SMD 5% (00104)	5	R16	R69	R70	R77	R104
330K 1206 SMD 5% (00334)	2	R15	R78			
1M 1206 SMD 5% (00105)	2	R9	R96			
3M3 1206 SMD 5% (00335)	1	R17				
22R1W RESISTOR (05220)	2	R39	R40			
220R1W RESISTOR (05221)	2	R33	R34			
EA2-9 RELAY (40006)	2	RL1	RL2			
EB2-12T RELAY (40000)	6	RL3	RL4	RL5	RL6	RL7
		RL8				

Description	Qty	Component designators		
SIEMENS RELAY(40002)	1	RL9		
36002 HYBRID (36002)	1	T4	T6	
36000 BALUN (36000)	1	T5		
37003 OUTPUT XFMR (37003)	1	T3		
37005 CHOKE (37005)	2	T1	T2	
CLC404 OP AMP (70404)	2	U1	U11	
LM358 OP AMP (70358)	2	U2	U3	
LM2594-5.0 REGULATOR (79594)	1	U9		
LM2840CT5 5V REGULATOR (79840)	1	U10		
74HC595 SHIFT REG (73595)	2	U5	U7	
TL494CD SMP SUPPLY (79494)	1	U4		
ULN2003L DARLINGTON (72003)	2	U6	U8	
P1K SMD POT (06102)	2	VR1	VR2	
P10K SMD POT (06103)	1	VR3		
THERMISTOR 470R (08002)	1	TH1		
3U3H SMD INDUCTOR (35021)	2	L21	L22	
POLYSWITCH RXE110 (08003)	3	P1	P2	P3
470U/16V ELECTRO (10477)	3	C73	C167	C168
1000U/50V ELETCRO (10108)	3	C20	C74	C166
NIL	2	R46	R80	

16. PCB OVERLAYS

Please refer to the following pages for PCB overlays .....

REFER OVERLAY DIAGRAM
IN FILE NAMED “DISPN1.xxx”

REFER OVERLAY DIAGRAM
IN FILE NAMED “DISPN2.xxx”

REFER OVERLAY DIAGRAM
IN FILE NAMED “RXMPV1.xxx”

REFER OVERLAY DIAGRAM
IN FILE NAMED “RXMPV2.xxx”

REFER OVERLAY DIAGRAM
IN FILE NAMED “PASWQ1.xxx”

REFER OVERLAY DIAGRAM
IN FILE NAMED “PASWQ2.xxx”

17. SCHEMATIC DIAGRAMS

Please refer to the following pages for schematic diagrams .....

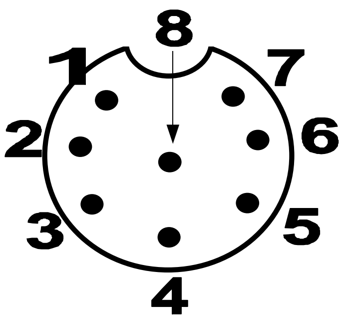
REFER SCHEMATIC DIAGRAM
"HF-90 DISPLAY 90000"
IN FILE NAMED "QMACDISP.xxx"

REFER SCHEMATIC DIAGRAM
“HF-90 I.F STRIP, MICRO SECTION & SYNTH 90001”
IN FILES NAMED “QMACRXA.xxx” AND “QMACRXB.xxx”

REFER SCHEMATIC DIAGRAM
“HF-90 P.A. & POWER SUPPLY 90002”
IN FILE NAMED “QMAPAPS.xxx”

18. EXTERNAL CONNECTORS

Microphone connector (front panel)

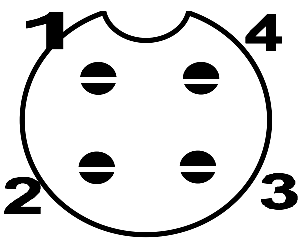


The illustration above shows the pin numbers on the front panel microphone connector.

(viewed into front of connector)

Pin No.	Function
1	Microphone 1
2	Transmit data
3	Receive data
4	Loud speaker
5	Press to talk
6	Ground
7	Microphone 2
8	+5volt

Power connector (rear panel)

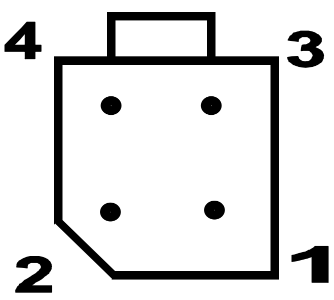


The illustration above shows the pin numbers on the rear panel power connector.

(viewed into front of connector)

Pin No.	Function
1	Ground
2	Loud speaker
3	Aux. power
4	+12 to +28volt

Loudspeaker receptacle (on cable)



(viewed looking into pins)

Pin No.	Function
1	Ground
2	Aux Power
3	Loud Speaker
4	+12 to +28volt

19. DEVICE PINOUTS & CODES

Please refer to the following page for device pinouts & codes .....

REFER DEVICE PINOUTS DIAGRAM
IN FILE NAMED “QMACPINS.xxx”

19.1 SMD capacitor codes

Marking	Value
A0	1p
N0	3p3
A1	10p
N1	33p
A2	100p
N2	330p
A3	1n
N3	3n3
A4	10n
N4	33n
A5	100n
N5	330n

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