TRANS WORLD COMMUNICATIONS, INC.

TW100 MICROPROCESSOR CONTROLLED HF SSB TRANSCEIVER OPERATORS MANUAL

M9 Prosser Board
Blue BCD Dip Switch 8 switches
off Position

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TABLE OF CONTENTS

SECTION 1 - GENERAL INFORMATION

SECTION 2 - TRANSCEIVER SPECIFICATIONS

SECTION 3 - INSTALLATION

SECTION 4 - OPERATION

TABLE OF CONTENTS - Continued

SECTION 5 - SERVICING

TABLE OF CONTENTS - Continued

FIGURES

TABLES

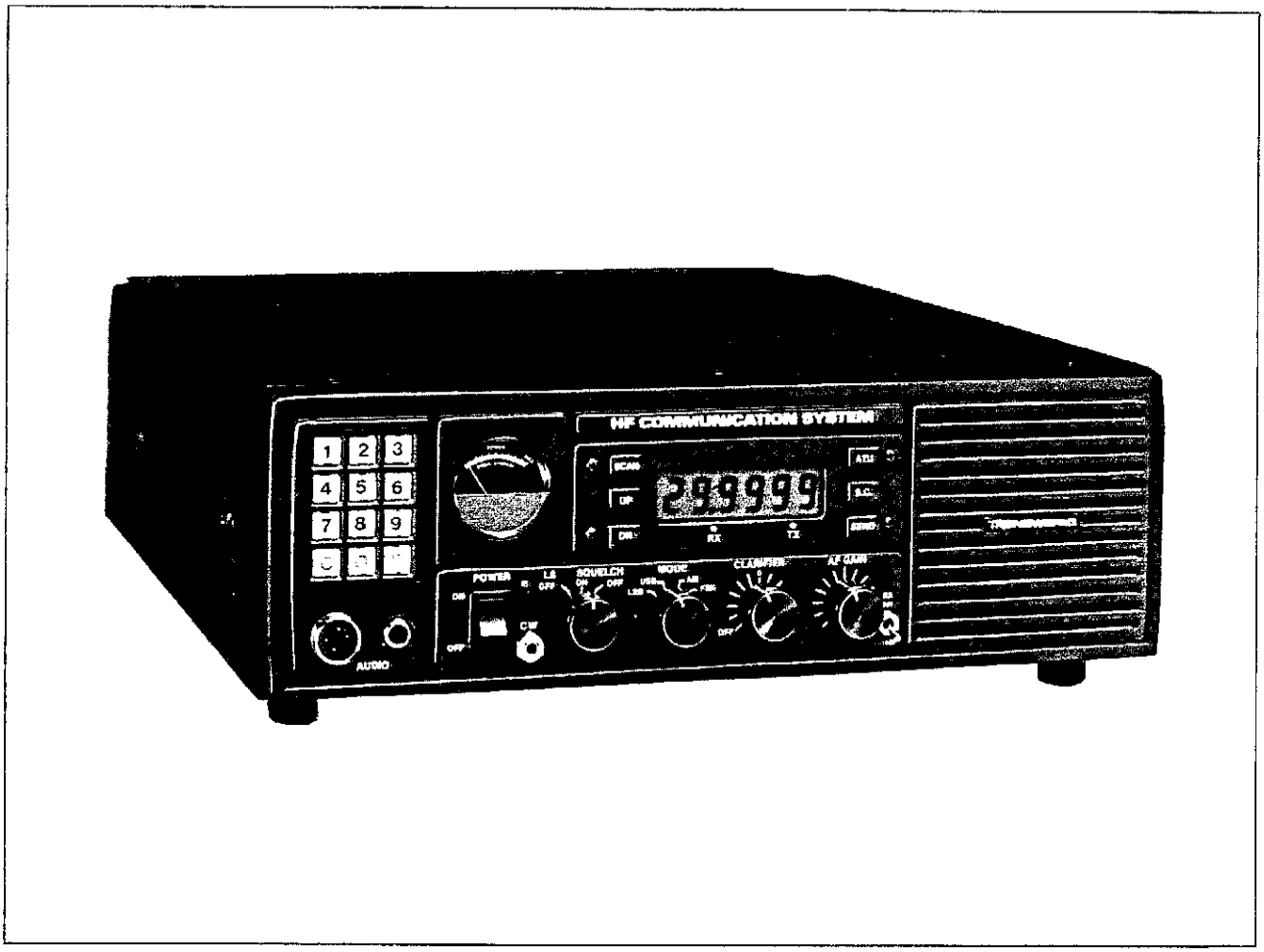


FIGURE 1-1. Microprocessor Controlled HF SSB Transceiver.

SECTION 1
GENERAL INFORMATION

1.0 INTRODUCTION

This manual has been prepared for the operator of the TRANSWORLD TW100 transceiver. It has not been designed for the technician or engineer and does not cover detailed technical or installation information. The TW100-MS Technical Manual gives comprehensive information on the transceiver and is essential for servicing, adjustment and installation of the transceiver.

1.1 SINGLE SIDEBAND

The transceiver provides voice communications in the single sideband mode. This mode is almost universally used for voice communications in the HF spectrum and provides a major advantage over the AM mode. The single sideband (SSB) transmitter uses special circuitry to suppress the carrier and one of the sidebands of an AM signal. This gives a great increase in efficiency as only 1/6th of the total power in an AM signal is in each sideband. The carrier carries no information and one of the sidebands is redundant meaning that the SSB signal puts all of the power into an information carrying sideband - a six hundred percent increase in efficiency. Apart from the improved power efficiency, the SSB signal occupies less than half the channel space of an AM signal and permits increased utilization of the crowded HF spectrum. The SSB signal is more intelligible at poor signal levels and is much less effected by selective fading and interference, giving an overall advantage much greater than the increase in effective power. It is necessary to use a special receiver for SSB as the transmission is unintelligible without the reinsertion of the carrier. The transceiver does have a compatible AM mode so that the transceiver can communicate with an AM station.

1.2 HF COMMUNICATIONS

The high frequency (HF) communications spectrum is primarily used for long distance communications, while the VHF and UHF spectrum is favored for local communications. If the correct frequencies and antenna systems are used, the HF spectrum will provide effective communications over almost any distance including intercontinental ranges. There are two main modes of propagation of HF signals - ground wave and sky wave. The ground wave follows the surface of the earth and provides reliable signals over short ranges. The signals are attenuated very rapidly as they pass over the surface of the earth so that high powers and good antennas are essential for good ground wave coverage. The ground wave attenuation increases as a function of frequency and the lower frequencies below 3MHz are favored for ground wave operation. This mode may be the only effective method for local coverage in areas too mountainous for VHF and UHF operation.

Most HF communication is by sky wave where the signals bounce off the reflecting layers of the ionosphere. Long distances can be covered with little signal attenuation provided the correct frequency is chosen. The ionosphere does not stay constant; it varies with the time of day, time of year, the sun spot cycle and the activity of the sun. Solar flares can cause complete radio blackouts with little warning. HF communications are effected by static caused by lighting; sometimes from storms many hundreds or thousands of kilometers away. A clear channel can never be assured as long distance propagation may cause strong interfering signals on the frequency from great distances. It must always be understood that although long distance communications are possible with low powers and simple antennas, high reliability and freedom from interference is not possible. In spite of the problems, a surprisingly good standard of communications can be achieved, provided that care is taken to select the correct frequency, and to use good equipment with an efficient antenna system.

The correct choice of frequency is beyond the scope of this manual and in any case may be limited by the frequencies made available by the licensing authorities. If a choice of frequencies is available the following information may give a starting point in making the choice. Remember the final guide should be an actual test, as often only a small change in frequency may make a big difference in signal strength.

The low frequencies, below 3MHz, will normally be restricted to short ranges during the day. At night, longer ranges (3-400 kilometers) are possible, but interference and static may be major problems. Good antennas and high power are essential for anything but the shortest distances.

The medium frequencies from 3-5MHz may be a good choice for moderate distances (3-400 kilometers) during the day. At night, considerable distances are possible, although static will be frequent

problem during summer months. The physical length of a good antenna is still quite long, and it is difficult to achieve good efficiences with mobile antennas in this range.

The medium frequencies from 5-11MHz are the most popular for communications up to 1000 kilometers. Good ranges are possible during the day with the higher frequencies being favored for the longer distances. Communications may become more difficult at night with interfering signals from all over the world.

The higher end of the spectrum, above 12MHz is favored for long distance communications. The propagation will be severely effected by the ionosphere and expert advice is essential in choosing the correct frequencies for long distance operation. For example, frequencies as high as 30MHz may be used for worldwide communications during the peak of the sunspot cycle, while during periods of low sunspot activity, this frequency range will be completely dead. It is important to remember that at the higher frequencies there can be skip zones, and a strong signal may be received from 2000 kilometers away, while closer stations cannot be heard.

1.3 MODES OF OPERATION

As mentioned in Section 1.1 single sideband (SSB) is the premier mode for voice communications in the HF range. Most commercial operation is on the upper sideband (USB) although there are some countries where lower sideband (LSB) is specified. The transceiver will be equipped for USB operation unless LSB is specifically requested. If the licensing authorities permit USB and LSB operation the transceiver may be equipped for operation on both sidebands. This is an advantage as sidebands may be switched to avoid interference or give an additional channel frequency.

AM has almost disappeared from the HF bands except for broadcast stations. The compatible AM mode (A3H) is available in the transceiver and is used for communicating with AM stations. Telegraphy (CW) is sometimes used for HF communications and skilled operators may achieve superior communications under difficult conditions.

Radioteletype operation has become an increasingly important form of HF communication and the transceiver has been designed for operation in this mode (FSK). A special modem is required to convert the FSK signal for interface with the terminal unit. The RTTY modem is mounted in a special base for the transceiver which contains the modem, heavy duty power supply and cooling fans for continuous FSK operation. A completely self-contained terminal, modem and printer combination is available. See the RTTY Terminal Manual for more information.

1.4 TRANSCEIVER DESCRIPTION

The transceiver is an advanced solid state high frequency, single sideband transceiver operating in the HF spectrum from 1.6-30MHz. Complete coverage of this range is available in 100Hz increments with no gaps or disallowed frequencies in the coverage.

A VOGAD (Voice Operated Gain Adjusting Device) amplifier maintains constant output without distortion on soft and loud voices. A meter measures received signal strength in the receive mode and relative power output in transmit. Although the transceiver is capable of complete frequency coverage, the operator using the channelized models is restricted to the programmed channel frequencies, and the transceiver meets all government restrictions on frequency control.

The transceiver has a minimum power output of 100W (PEP or average). Over much of the frequency range, the power output may be set as high as 150W PEP. The adjustable ALC circuitry may be set to limit the power output at any desired level.

The transceiver is constructed in an aluminum case with diecast front panel and heavy diecast rear heatsink fitted with recessed connectors. All external hardware is stainless steel and all parts are protected for operation in marine environments. The internal circuitry is contained in 6 diecast boxes, fitted with connectors. These modules may be simply interchanged for servicing. The Microprocessor Module and RF Filter and Switching Module are mounted under the main chassis and are easily accessible when the bottom cover is removed. The final amplifier is mounted directly on the rear heatsink. The entire transceiver construction is very rugged and suitable for use in the most severe environments.

The transceiver is fitted with a VSWR bridge. The reverse arm of the bridge is connected to the ALC circuit and automatically reduces power when the VSWR increases. This protects the final amplifier against all conditions of mismatch. An internal connection is provided so that the front panel meter may be used to indicate relative VSWR.

The transceiver uses an up conversion system with the first IF at 75MHz and the main selectivity at 1650kHz. With this system, the main spurious products do not fall within the operating range ensuring exceptional freedom from spurious response in both the transmitter and the receiver. The front end of the receiver uses a passive double balanced mixer with a high intercept point giving freedom from intermodulation and overload. The antenna is coupled to the transceiver through 6 high performance, 7-pole, elliptic function filters providing a high degree of harmonic attenuation and rejection of out of band signals. The receiver is equipped with a special noise immune squelch system designed for SSB operation. This is a great operator convenience as it eliminates background noise, yet opens reliably, even on weak SSB signals. The squelch circuit is preset and is controlled by an ON/OFF switch.

1.5 FREQUENCY SELECTION

The transceiver uses a microprocessor to control the frequency selection. The microprocessor operates in three different modes to suit the particular class of operation desired. The operational mode may be selected by an internal switch or may be permanently set by the use of a special coding circuit.

In Mode 3 the operator may select any one of the pre-programmed channel frequencies by entering the channel number on the keypad. The channel number is shown on the display.

In Mode 2 the operator can also display the channel frequency on any of the preprogrammed frequencies. If the channel is programmed for semi-duplex operation the transmit frequency may be displayed. Channel ØØ may be programmed by the operator but will only operate in the receive mode.

In Mode 1 the transceiver channel frequencies can be programmed by the operator. Channel ØØ is designated as the free tuning channel and the frequencies may be quickly changed from the keypad and may be programmed for simplex or duplex operation.

No crystals are required for all frequency control is derived from a single temperature controlled, precision crystal oscillator. No tuning or adjustment is required for any frequency change. The channel frequencies are permanently retained in memory using a lithium battery with a life in excess of 10 years.

1.6 SYNTHESIZER DESCRIPTION

The use of advanced new integrated circuits has resulted in an extremely efficient and simple synthesizer design. Two separate loops are used. The 10kHz loop is used for the first conversion stage and covers the 1.6-30MHz range in 10kHz steps. Only three IC's are used in this loop. The 100Hz loop is used for the second conversion stage and covers a 10kHz range in 100Hz steps. The loop uses six IC's. Both loops are direct, ensuring freedom from spurious responses and the frequency control is derived from a single temperature controlled 5120kHz crystal oscillator.

The synthesizers are controlled by the microprocessor through the keypad. The use of a synthesizer is a special advantage in a multi-channel transceiver. Apart from the savings in cost and preventing delays in getting channel crystals, all frequencies are directly synthesized from a highly stable master oscillator. Provided this oscillator is on frequency (a single adjustment) all channels are on frequency. Usually a channel is programmed to a standard frequency station such as WWV so that the calibration can be checked frequently. Older synthesizer designs suffered, not only from great complexity, but also internal spurs giving whistles in the tuning range of the receiver, which made the transceiver unusable on many frequencies. The transceiver has no spurs exceeding 0.5uV and has no unusable frequencies from 1.6-30MHz.

1.7 POWER SUPPLIES

The transceiver circuitry operates at 12V and is designed for direct operation from a 12V vehicle type battery. The final amplifier operates directly from the supply source (the transistors have a maximum collector voltage of 36V) and is protected from voltage surges by a 20V "TRANSORB". The transceiver circuitry is supplied through a special 12V regulator that maintains full output with almost no input voltage differential. If the voltage falls below 12V, the full available input voltage will be applied to the exciter, which continues to operate down to 11V. This system provides safe operation from a 12V vehicular system even with poor regulation. An optional internal 115V/230V, 50/60Hz AC supply may be fitted for SSB operation. A separate heavy duty power supply is used for FSK operation. An optional model is available for 24-32V operation.

1.8 MICROPHONES

The microphone input is nominally 150 ohms and operates satisfactorily with a range of inputs from 100–2000 ohms. The microphone amplifier is a VOGAD providing constant output over a 60dB range of input levels. The transceiver can be used with almost any high quality dynamic, ceramic or controlled magnetic communications microphone equipped with a PTT switch.

1.9 REMOTE CONTROL (Optional)

The transceiver may be fitted with the optional remote control. The tone (AFSK) remote control provides full control of the transceiver over a telephone line and is particularly useful when the transceiver cannot be installed at the operating site.

1.10 SELECTIVE CALLING (Optional)

The transceiver has provision for internal installation of the Selective Calling System. This system has 255 call codes and provides call indication and a sounder. A transponder gives an automatic answer from an unmanned transceiver. The system is very reliable and does not require precision control of the transceiver frequency. The Selective Calling System is operated through the key pad.

1.11 ANTENNAS

Further information on antennas is provided in Section 4 of the transceiver technical manual. The transceiver will operate correctly into any matched 50 ohm antenna.

SECTION 2
TRANSCEIVER SPECIFICATIONS

2.1 GENERAL INFORMATION

Section 2 contains technical specifications in Table 2-1, semiconductors in Table 2-2, the block diagram (Figure 2-1), and the module location diagrams (Figures 2-2 and 2-3).

TABLE 2-1. Technical Specifications.

GENERAL	FREQUENCY RANGE: 1.6 - 30MHz in 100Hz synthesized steps.
	FREQUENCY ENTRY: Keypad controlled microprocessor.
	CHANNELS: 100 Simplex and Half-duplex.
	CHANNEL PROGRAMMING: Mode 1 Front Panel. Mode 2/3 Internal.
	CONTINUOUS ENTRY: Channel ØØ by keypad entry. Mode 1: Transmit & Receive. Mode 2: Receive Only. Mode 3: Disabled.
	FREQUENCY DISPLAY: 6 Digit by keystroke (locked out in Mode 3).
	PROTECTION AGAINST UNAUTHORIZED FREQUENCY CHANGE: Coding device may be removed to lock transceiver in Mode 2 or Mode 3.
	TUNING: Up & Down Pushbutton Switches (receive only), 100Hz Steps.
	SCANNING: Automatic on up to 10 channels.
	ANTENNA INPEDANCE: 50 Ohms.
	TEMPERATURE RANGE: -30° to $+55^{\circ}$C.
	FREQUENCY CONTROL: Temperature controlled master oscillator $\pm$0.0001%, $\pm$20Hz maximum.
	MODES: Simplex and Half-duplex.
	OPERATION MODES: A3J, (USB/LSB*), A3A* (SSB reduced carrier), A3H (compatible AM), A1 (CW), F1 (teletypes).* *Optional
	SIZE: (ac & dc) Ht. 10.7cm Width 34.5cm Depth 41.4cm.
	WEIGHT: ac - 11.0kg, DC - 8.6kg.
POWER SUPPLY	13.6Vdc: Receive 550mA, Transmit 12A Average SSB.
	28Vdc: Receive: 350mA, Transmit 7A average SSB.
	Internal ac power supply 110/230V, 50/60Hz for SSB operation.
	External power supply 110/230V, 50/60Hz for FSK operation, complete with built-in FSK modem.

TABLE 2-1. Technical Specifications, Continued.

TRANSMITTER	POWER OUTPUT: 125W PEP, 100W Average (FCC Type Accepted at 120 Watts).
	ANTENNA MISMATCH: Protected against mismatch including open and shorted antennas.
	CARRIER SUPPRESSION: Greater than -50dB.
	UNWANTED SIDEBAND: -60dB at 1kHz, typical.
	SPURIOUS SUPPRESSION: Greater than -63dB.
	HARMONIC SUPPRESSION: -63dB (except below 2MHz).
	AUDIO INPUT: 150 Ohms, VOGAD for constant audio level.
	AUDIO BANDWIDTH: 2.4kHz.
	INTERMODULATION DISTORTION: -32dB typical.
	ALC: Less than 1dB increase for 20dB increase in audio input.
	METERING: Relative RF output, VSWR (internal connection).
RECEIVER	SENSITIVITY: 0.3uV for 10dB S + N/N.
	SELECTIVITY: 300 to 2700Hz -6dB, -60dB at 5kHz typical.
	IMAGE REJECTION: Greater than 80dB.
	IF REJECTION: Greater than 80dB.
	CONDUCTED RADIATION: -70dBm.
	AGC CHARACTERISTICS: Less than 3dB audio increase from 3uV to 300,000uV.
	INTERCEPT POINT: +11dBm.
	INTERMODULATION: -85dB.
	CLARIFIER: ±125Hz.
	SQUELCH: Audio derived, noise immune.
	AUDIO OUTPUT: 4W into 3 ohms, internal loudspeaker.
	METERING: RX signal strength.

Specifications subject to change without notice.

TABLE 2-2. Semiconductors.

Designator	Function	Description
M1D1	Isolation Diode	1N4148 Diode
M1D2	Isolation Diode	1N4148 Diode
M1D3	Rate Detector Neg.	1N4148 Diode
M1D4	Rate Detector Pos.	1N4148 Diode
M1D5	Rectifier	1N4148 Diode
M1D7	Isolation Diode	1N4148 Diode
M1D8	Isolation Diode	1N4148 Diode
M1D9	Carrier Osc. Switch	1N4148 Diode
M1D10	Carrier Osc. Switch	1N4148 Diode
M1D12	Carrier Osc. Freq. Set	BB809 Diode
M1D13	Carrier Osc. Freq. Set	BB809 Diode
M1Q1	Squelch Audio Switch	MPF4393 FET Transistor
M1Q2	Clarifier Switch	2N3565 NPN Transistor
M1Q3	Carrier Oscillator	2N5770 NPN Transistor
M1Q4	Clarifier Switch	2N3565 NPN Transistor
M1U1	Product Detector	SL1640C Integrated Circuit
M1U2	Squelch Audio Amp	LM324N Integrated Circuit
M1U3	NOR Logic Gates	CD4001 Integrated Circuit
M1U4	DC Controlled Audio Amp	MC3340P Integrated Circuit
M1U5	Audio Power Amp	TDA2002-H Integrated Circuit
M1U6	Balanced Modulator	SL1640C Integrated Circuit
M1U7	Product Det Amp	RC1458CP-1 Integrated Circuit
M1U8	8V Regulator	78L08 Integrated Circuit
M1U9	Auto. Level Mic Amp	SL6270CDP Integrated Circuit
M1U10	Timer	NE555N Integrated Circuit
M2D1	AGC Detector	1N4148 Diode
M2D2	AGC Detector	1N4148 Diode
M2D4	USB/LSB Switch	BA482 PIN Diode
M2D5-8	USB/LSB Switch	1N4148 Diode
M2D9	USB/LSB Switch	BA482 PIN Diode
M2D10	Filter Switching Diode	BA482 PIN Diode
M2D11	Filter Switching Diode	BA482 PIN Diode
M2D12	Timing Diode	1N4148 Diode
M2Q1	IF Amplifier	3N204 Transistor
M2Q2	Receive IF Amplifier	2N5770 NPN Transistor
M2Q3	AGC IF Amplifier	2N3565 NPN Transistor
M2Q4	AGC DC Amplifier	2N3565 NPN Transistor
M2Q5	Switching Transistor	2N3638 PNP Transistor
M2Q6	Switching Transistor	2N3565 NPN Transistor
M2U1	Timer	NE555 Integrated Circuit
M2U2	AGC Time Constant Transmission	CD4066BE Integrated Circuit Gate
M3D1	Carrier Switch	BA482 PIN Diode
M3D2	Carrier Switch	BA482 PIN Diode
M3D3	Carrier Level RF Switch	BA482 PIN Diode

TABLE 2-2. Semiconductors, Continued.

Designator	Function	Description
M3Q1	TX 75MHz Amplifier	J310 FET Transistor
M3Q2	Rx 75MHz Amplifier	3N204 MFT Transistor
M3Q3	RX Mixer 75MHz-1650kHz	J310 FET Transistor
M3U1	Tx Balanced Mixer	MC1496P Integrated Circuit
M4D1	75MHz RF Switch Rx	BA482 PIN Diode
M4D2	75MHz RF Switch Tx	BA482 PIN Diode
M4D3	75MHz RF Switch Rx	BA482 PIN Diode
M4D4	75MHz RF Switch Dx	BA482 PIN Diode
M4D5	75MHz RS Switch Rx	BA482 PIN Diode
M4D6	HF Osc. RF Switch	BA482 PIN Diode
M4D7	HF Osc. FR Switch	BA482 PIN Diode
M4Q1	Tx/Rx 75MHz IF Amp.	2N5109 Transistor
M4Q2	2-30MHz Tx Amplifier	J310 FET Transistor
M4Q3	2-30MHz Tx Amplifier	J310 FET Transistor
M4Q4	Predrive Amplifier	2N4427 NPN Transistor
M4Q5	Predrive Amplifier	2N4427 NPN Transistor
M4U1	Rx Mixer	Mixer, Double Balanced
M4U2	Tx Mixer	Mixer, Double Balanced
M5D1	Tuning for VCXO	MV2205 Varactor Diode
M5D2	Osc. Bias Compensation	1N4148 Diode
M5Q1	VCXO Oscillator	2N5770 NPN Transistor
M5Q2	Oscillator Buffer	2N5770 NPN Transistor
M5Q3	Output Amplifier	2N5770 NPN Transistor
M5Q4	Reference Oscillator	2N5770 NPN Transistor
M5Q5	Ref. Oscillator Buffer	2N5770 NPN Transistor
M5U1	÷64/65 Dual Modulus Prescaler	MC12017P Integrated Circuit
M5U2	16 Bit Binary Counter	MC14526 Integrated Circuit
M5U3	16 Bit Binary Counter	MC14526 Integrated Circuit
M5U5	15 Bit Synthesizer	MC145151 Integrated Circuit
M5U6	8V Regulator	78L08 Integrated Circuit
M5U7	10 Bit BCD Down Counter	MC14522 Integrated Circuit
M5U8	10 Bit BCD Down Counter	MC14522 Integrated Circuit
M5U9	5V Regulator	78L05 Integrated Circuit
M5U10	8V Regulator	78L08 Integrated
M6D1	Tuning Diode 77-90MHz VCO	BB809 Diode
M6D2	Limiter	1N4148 Diode
M6D3	Limiter	1N4148 Diode
M6D4	Tuning Diode 90-105MHz VCO	BB809 Diode
M6D5	Coupling for VCO	BA482 PIN Diode
M6D6	Coupling for VCO	BA482 PIN Diode
M6D7	VCO Switching Level Shift	1N751 Zener Diode
M6Q1	77-90MHz Oscillator	J310 FET Transistor

TABLE 2-2. Semiconductors, Continued.

Designator	Function	Description
M6Q2	77-90MHz Buffer	J310 FET Transistor
M6Q3	90-105MHz Oscillator	J310 FET Transistor
M6Q4	90-105MHz Buffer	J310 FET Transistor
M6Q5	90-105MHz B+ Switching	2N3565 NPN Transistor
M6Q6	77-90MHz B+ Switching	3N3638 PNP Transistor
M6Q7	VCO Buffer	2N5770 NPN Transistor
M6Q8	VCO Amplifier	2N5770 NPN Transistor
M6Q9	Isolation Amplifier	2N5770 NPN Transistor
M6Q10	Logic Switch	2N3565 NPN Transistor
M6Q11	VCO Switching	2N3565 NPN Transistor
M6Q12	Buffer	2N5770 NPN Transistor
M6U1	8V Regulator	78L08 Integrated Circuit
M6U2	8V Regulator	78L08 Integrated Circuit
M6U3	5V Regulator	78L05 Integrated Circuit
M6U4	Op Amp	RC1458CP-1 Integrated Circuit
M6U5	÷32/33 Dual Modulus Prescaler	MC12015P Integrated Circuit
M6U6	Synthesizer	MC145152P Integrated Circuit
M7D1	DC Isolation	1N4001 Diode
M7D2	DC Isolation PTT	1N4148 Diode
M7D3	ALC Detector	1N4148 Diode
M7D4	Relay Trans. Sup. Diode	1N4148 Diode
M7D5	Relay Trans. Sup. Diode	1N4148 Diode
M7D6	Relay Trans. Sup. Diode	1N4148 Diode
M7D7	Relay Trans. Sup. Diode	1N4148 Diode
M7D8	Relay Trans. Sup. Diode	1N4148 Diode
M7D10	T/R Switch	BA482 Diode
M7D11	Reverse Isolation	1N4148 Diode
M7D12	Level Shifting	1N751 Zener Diode
M7D13	Front End Protection	1N4148 Diode
M7D14	Front End Protection	1N4148 Diode
M7D15	ALC Detector	1N4148 Diode
M7D16	ALC Detector	1N4148 Diode
M7D17	Forward Power Protection	1N4148 Diode
M7D18	Reverse Isolation	1N4148 Diode
M7D19	Reverse Isolation	1N4148 Diode
M7D20	Reverse Isolation	1N4148 Diode
M7D21	Reverse Isolation	1N4148 Diode
M7D22	Reverse Isolation	1N4148 Diode
M7D23	Forward Isolation	1N4148 Diode
M7D24	Forward Isolation	1N4148 Diode
M7D25	Forward Isolation	1N4148 Diode
M7D26	Level Switching	1N751 Zener Diode
M7D27	Forward Isolation	1N4148 Diode
M7D28	Switch	1N4148 Diode
M7Q1	Relay Driver	2N6427 Darlington Transistor
M7Q2	Relay Driver	2N6427 Darlington Transistor
M7Q3	Relay Driver	2N6427 Darlington Transistor
M7Q4	Relay Driver	2N6427 Darlington Transistor

TABLE 2-2. Semiconductors, Continued.

Designator	Function	Description
M7Q5	Relay Driver	2N6427 Darlington Transistor
M7Q6	Relay Driver	2N6427 Darlington Transistor
M7Q7	Logic Switch	PN2222A NPN Transistor
M7Q8	Logic Switch	PN2222A NPN Transistor
M7Q9	CW PTT Switch	PN2222A NPN Transistor
M7Q10	S Meter Amplifier	2N3567 NPN Transistor
M7Q11	Panel Meter Switch	2N3567 NPN Transistor
M7Q12	Level Switcher	2N3567 NPN Transistor
M7Q13	Logic Switch	MP5D54 Transistor
M7Q14	Logic Switch	PN2907A NPN Transistor
M7Q15	Logic Switch	2N3567 NPN Transistor
M7U1	BCD to Dec. Converter	MC14028BCP Integrated Circuit
M7U2	Operational Amplifier	LM1458 Integrated Circuit
M8Q10	Pass Transistor	TIP36A Transistor
M8Q11	Driver Transistor	TIP31 Transistor
M8Q12	DC Amplifier	2N3638 PNP Transistor
M8U10	5V Regulator	78L05 Integrated Circuit
M9D1	Isolation	1N4148 Diode
M9D2	Isolation	1N4148 Diode
M9D3	Isolation	1N4148 Diode
M9D4	Isolation	1N4148 Diode
M9D5	Isolation	1N4148 Diode
M9D6	Isolation	1N4148 Diode
M9D7	Isolation	1N4148 Diode
M9D8	Isolation	1N4148 Diode
M9D9	Isolation	1N4148 Diode
M9D10	Clamp	1N751 Zener Diode
M9D11	Clamp	1N4148 Diode
M9D12	Isolation	1N4148 Diode
M9D13	Isolation	1N4148 Diode
M9D14	Isolation	1N4148 Diode
M9D15	Isolation	1N4148 Diode
M9D16	Isolation	1N4148 Diode
M9D17	Isolation	1N4148 Diode
M9D40	Isolation	1N4148 Diode
M9D41	Isolation	1N4148 Diode
M9D101	Isolation	1N4148 Diode
M9D102	Isolation	1N4148 Diode
M9Q1	Switch	2N6427 Darlington Transistor
M9Q2	Switch	2N3565 NPN Transistor
M9Q3	Switch	2N3565 NPN Transistor
M9Q4	Amplifier	2N3567 NPN Transistor
M9Q5	Clamp	J175 Transistor
M9Q6	Switch	PN2222A Transistor
M9Q15	Switch	2N6427 Darlington Transistor
M9Q101	Switch	PN2222A NPN Transistor

TABLE 2-2. Semiconductors, Continued.

Designator	Function	Description
M9Q102	Switch	PN2222A NPN Transistor
M9Q103	Switch	PN2222A NPN Transistor
M9Q104	Switch	PN2222A NPN Transistor
M9Q105	Switch	PN2222A NPN Transistor
M9Q106	Switch	PN2222A NPN Transistor
M9Q107	Switch	PN2222A NPN Transistor
M9Q108	Switch	PN2222A NPN Transistor
M9U1	CPU	80C39 Integrated Circuit
M9U2	Lower Address Byte Latch	74H573N Integrated Circuit
M9U3	Program Memory	UPD2716D Programmed NEC
M9U4	System Memory	MCM6116P15 Integrated Circuit
M9U5	Tranceiver Control	CD4094BE Integrated Circuit
M9U6	Tranceiver Control	CD4094BE Integrated Circuit
M9U7	Tranceiver Control	CD4094BE Integrated Circuit
M9U8	Tranceiver Control	CD4094BE Integrated Circuit
M9U9	Tranceiver Control	CD4094BE Integrated Circuit
M9U10	Buffer	F4104BPC Integrated Circuit
M9U12	Low Speed Timer	CD4060AE Integrated Circuit
M9U14	On Board Supplies	78L08 Integrated Circuit
M9U15	On Board Supplies	LM340T-5.0 Integrated Circuit
M9U16	SC Timer & INT Pulse	MC14528BCP Integrated Circuit
M10D1	Base Protection Diode	1N4001 Diode
M10D2	Bias Regulator	1N4001 Diode
M10D3	Bias Regulator	1N4001 Diode
M10Q1	Driver Amplifier	30W HF RF Transistor
M10Q2	Final Power Amplifier	30W HF RF Transistor
M10Q3	Final Power Amplifier	100W PWR RF Transistor
M10Q4	Bias Regulator	100W PWR RF Transistor
M10Q5	Bias Regulator	TIP31 NPN Transistor
M10Q6	Bias Regulator	MJE29A Transistor
M10Q7	Bias Regulator	NPN 2N5191 Transistor
M10U1	Current Limit Amplifier	RC1458CP-1 Integrated Circuit
M11U1	Display Driver	MD4332 Integrated Circuit
M11U2	Display Driver	MD4332 Integrated Circuit

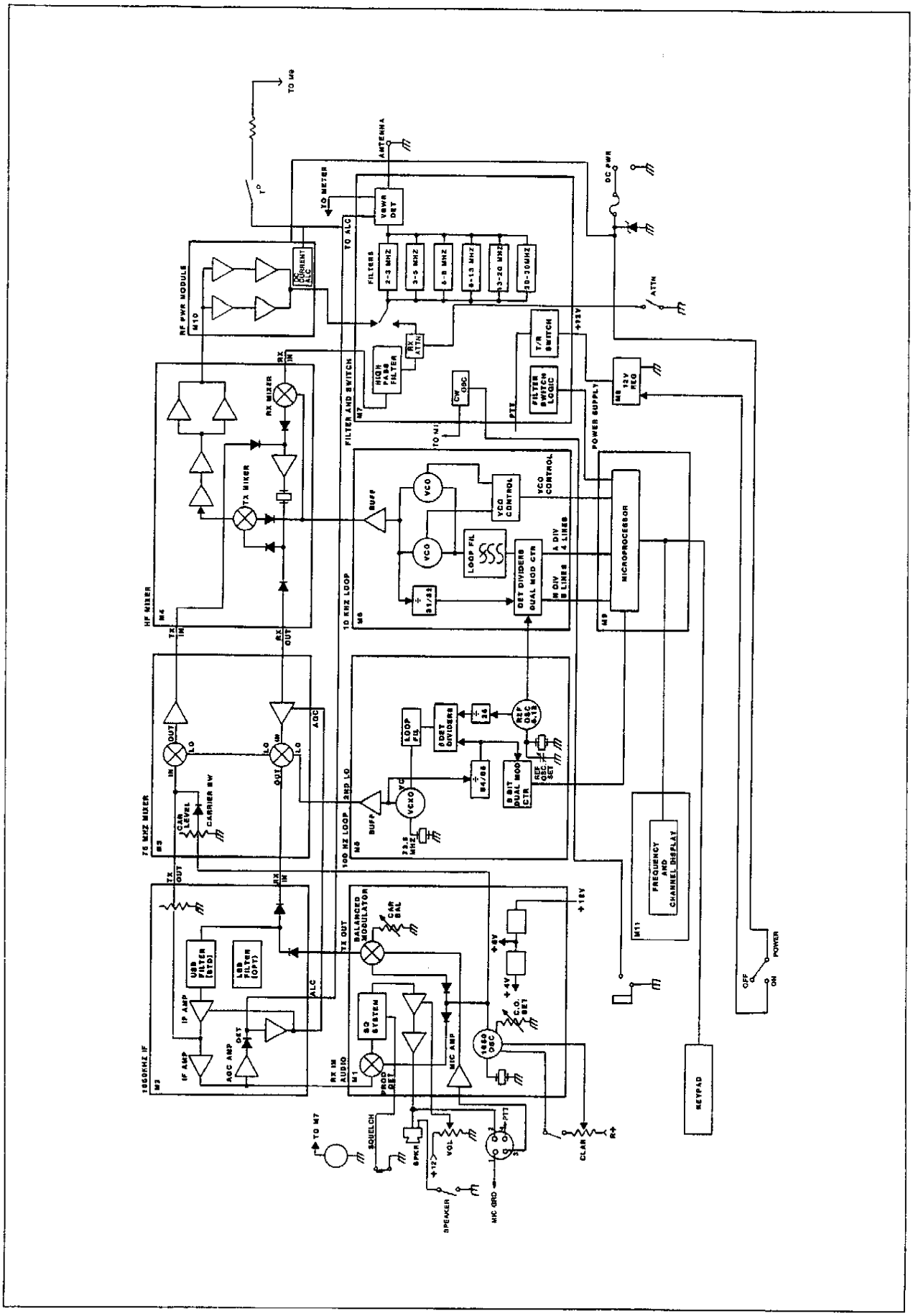


FIGURE 2-1. Block Diagram.

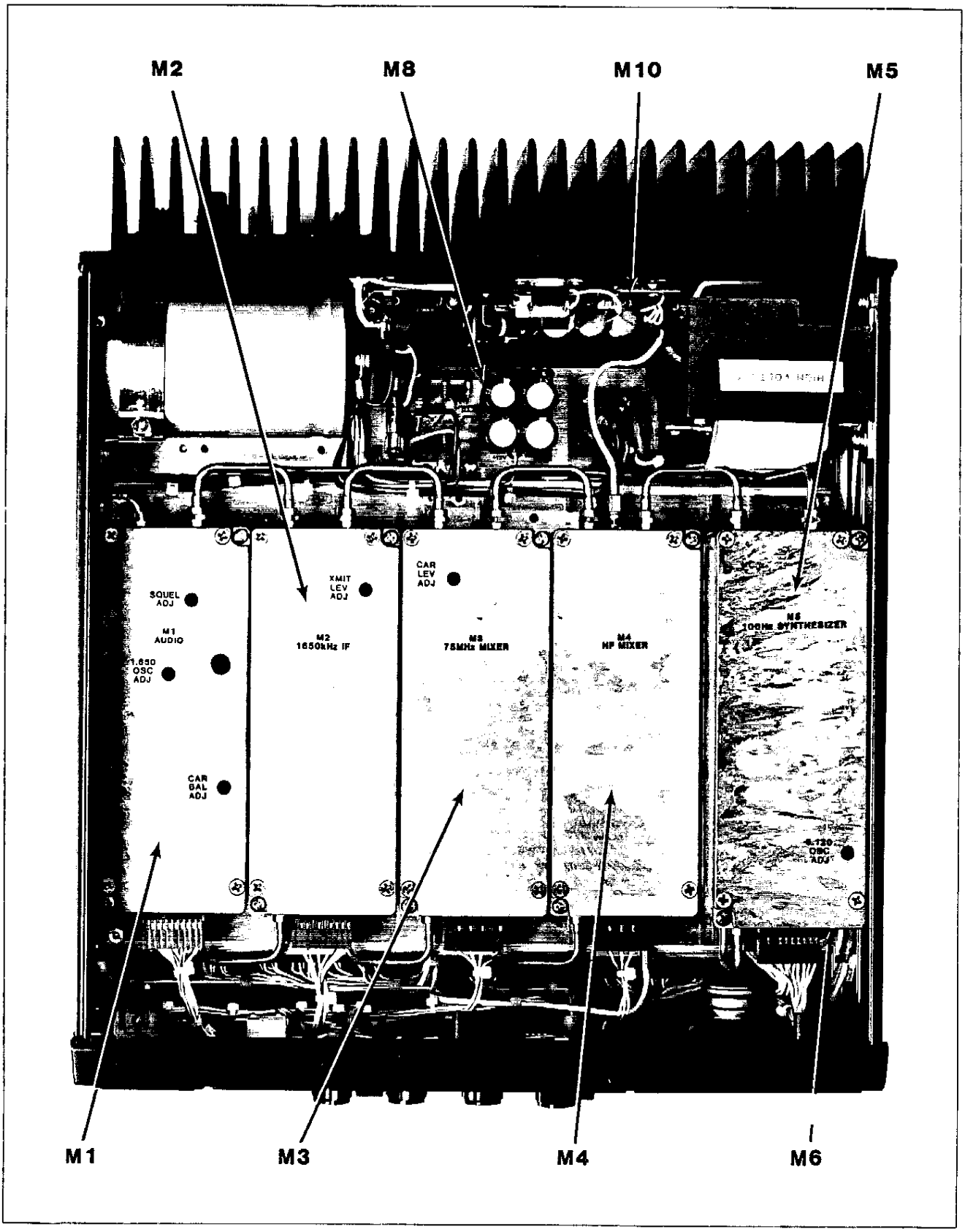


FIGURE 2-2. Module Location Diagram - Top.

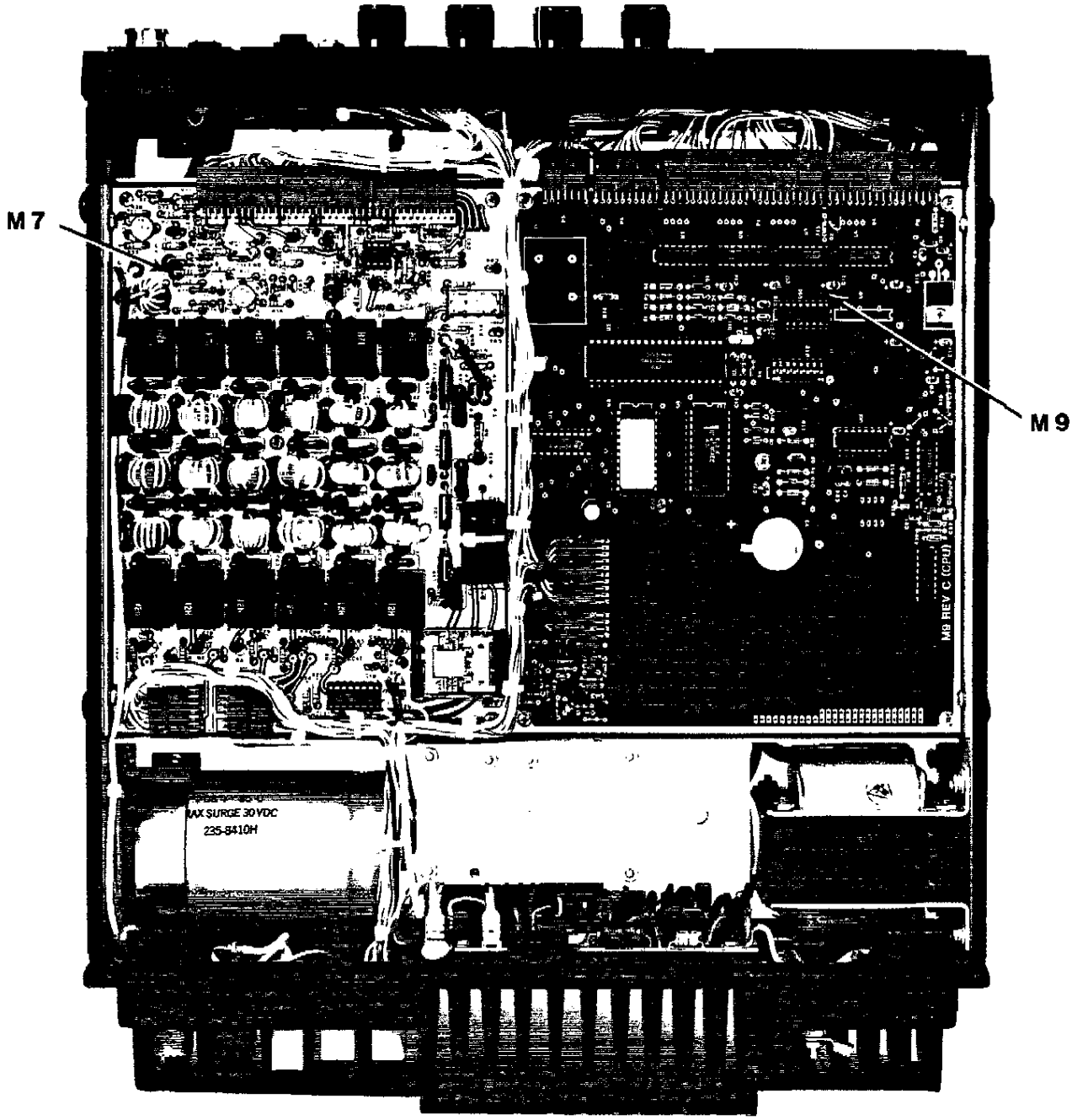


FIGURE 2-3. Module Location Diagram - Bottom.

SECTION 3
INSTALLATION

3.1 INTRODUCTION
To get the correct performance from the transceiver it is necessary to install the transceiver correctly. This is particularly important in marine and land mobile installations where mounting and power source connections can make a material difference to the transceiver performance. In every installation, the antenna system is the key to satisfactory performance and care should be taken to ensure that the best possible antenna, adjusted for low VSWR on each channel, is used. Most complaints of poor performance can be traced to an unsatisfactory antenna installation.

3.2 POWER SUPPLY
Two power connectors are installed in the rear panel casting. The AC power connection is made through the preassembled power cable fitted with a three pin connector that plugs into the connector at the rear of the transceiver. The other end of the cable is fitted with a three pin power connector. One of the following wire codes will be used.

PHASE	BLACK	BROWN
NEUTRAL	WHITE	BLUE
GROUND	GREEN	GREEN-YELLOW STRIPE

The power cable will indicate the correct voltage for the AC power supply. If the voltage is not correct, the connections for the power transformer must be changed in accordance with the instructions in the diagram Figure 3-1. The fuse should also be changed (115V 3A, 230V 1.5A).

The transceiver is supplied with a 14AWG power cable and a two pin connector. This cable is not assembled to facilitate connections to the DC power source. Connections to the rear panel should be made as shown in diagram Figure 3-2. The power source should apply 13.6V at 20A and the connections should be made to minimize voltage drop in the cable. Do take care not to reverse the supply polarity. This will cause the DC supply fuse to blow.

CAUTION

Do not operate the transceiver on the AC supply while connected to the DC power source. This could result in overcharging the battery or charging at an excessive rate.

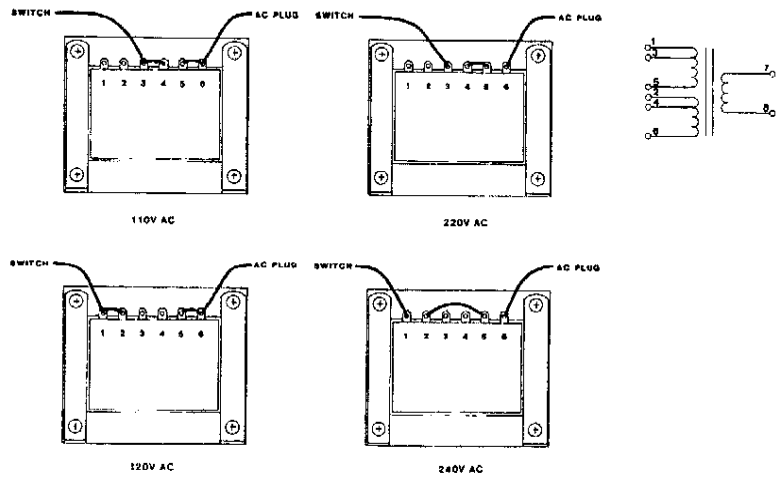
3.3 POWER CONNECTIONS
The power cable should be connected to the battery by the shortest possible route. It is essential that a low resistance connection is made to the battery terminals for correct operation of the transceiver. Do not use the vehicle body to make the negative ground return. Use heavy gauge cable for the wiring (#14 AWG up to 3 meters, #10 or #12 AWG for longer runs). Make sure that the cable is clear of the vehicles pedals and other moving parts. The cable can probably be routed through an existing grommet in the fire wall and should be kept as far as possible from the ignition wiring to prevent the pick-up of noise. If a new hole is required in the fire wall, make sure that a grommet is fitted to prevent chafing of the wire. Remember that a short in the power cable could cause a fire in the vehicle. High resistance connections can cause heating, and eventually will arc causing another fire hazard as well as seriously affecting the transceiver performance. It is a good precaution to fit a 50A fuse in the positive line at the battery. Figure 3-3 is a drawing of the DC power cable showing material P/Ns and pin connections.

3.4 FIXED STATION
The transceiver is shipped ready for operation on a desk top. Make sure there is adequate space for ventilation around the heatsink. The front of the transceiver may be raised by lifting the bale under the front feet.

3.5 MARINE INSTALLATION
The transceiver is mounted in place using the mobile mounting brackets. The brackets are arranged so that they may be reversed for top or bottom mounting.

3.6 VEHICULAR INSTALLATION
The mobile mounts are used to mount the transceiver from the top to bottom. It will frequently be necessary to fabricate supplementary brackets to suite the particular vehicle. After mounting the transceiver, ensure a low resistance connection is made to the frame of the vehicle.

3.7 MOBILE NOISE SUPPRESSION
The engine can cause severe interference in the receiver if noise suppressors are not fitted. Modern vehicles are sometimes fitted with suppressors and no further attention may be required.



NOTE

To gain access to the power transformer connections, remove the screws from each corner of the heatsink. Remove the ground connection to the main filter capacitor. The rear panel may be tilted back to give full access to the power transformer primary.

FIGURE 3-1. Power Transformer Connectors.

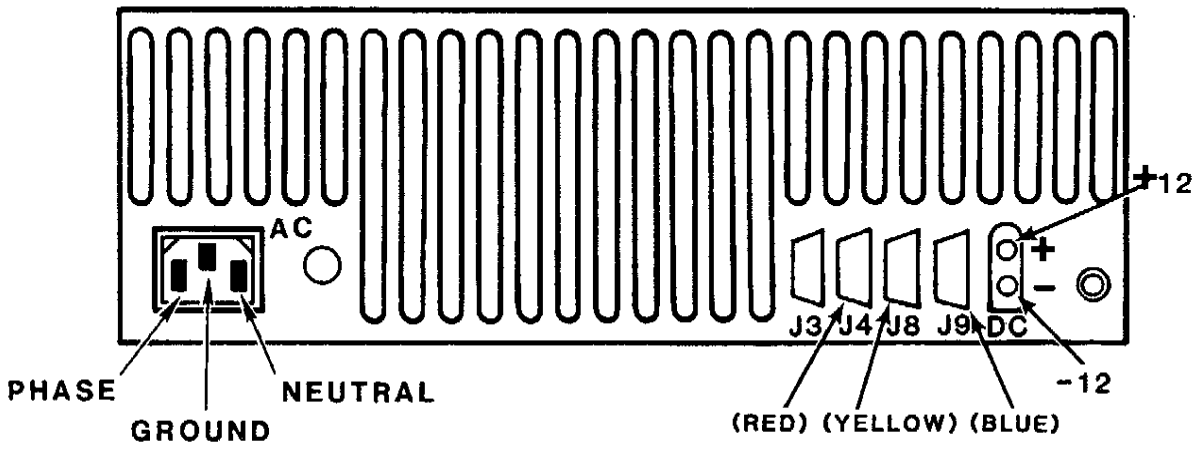
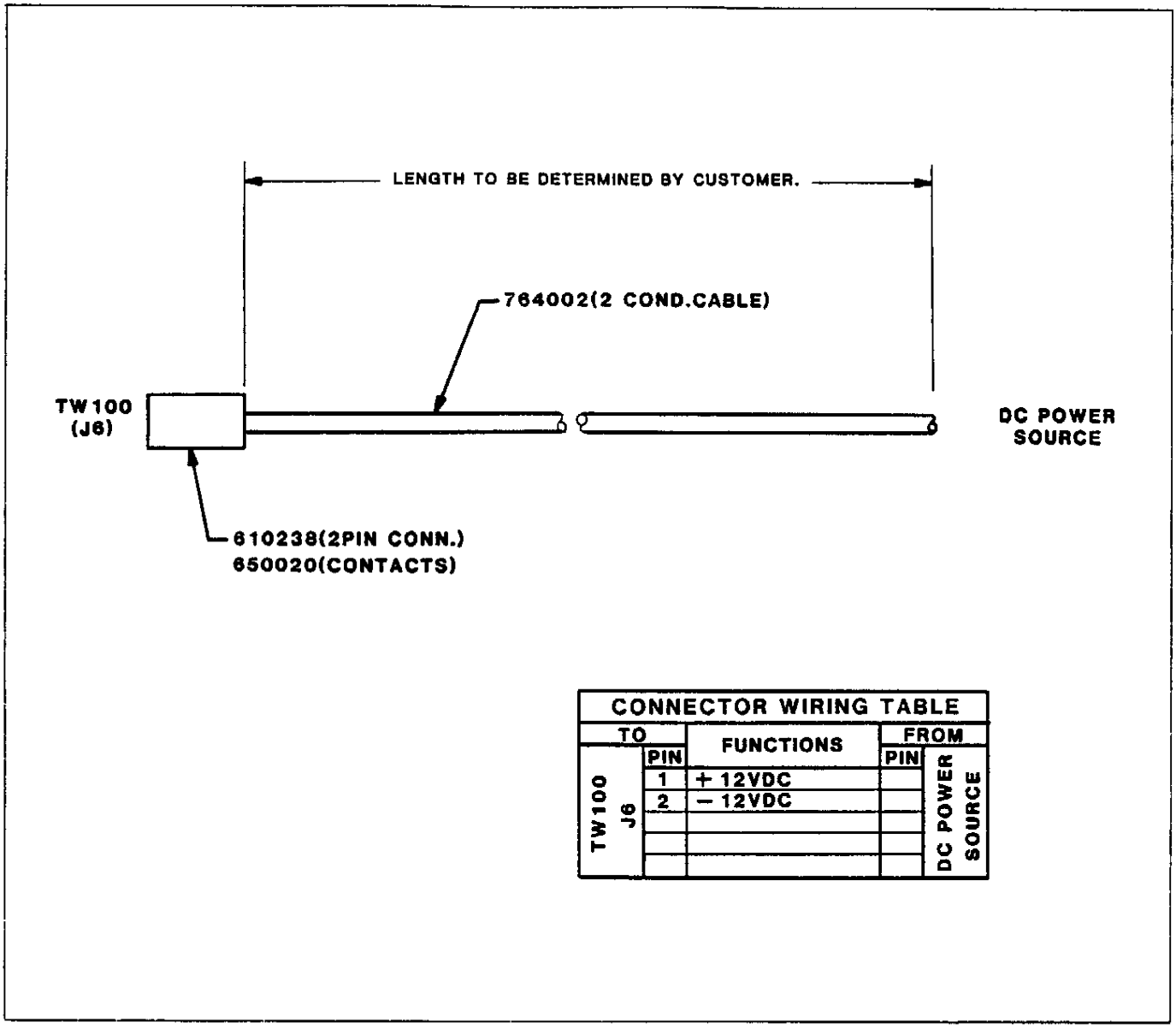


FIGURE 3-2. Rear Panel Connectors.



CONNECTOR WIRING TABLE				
TO		FUNCTIONS	FROM	
	PIN		PIN	
TW100 J6	1	+ 12VDC		DC POWER SOURCE
	2	− 12VDC		

FIGURE 3-3. DC Power Cable.

The transceiver should be installed and the receiver checked for interference to determine if suppressors need to be fitted. The two main sources of interference are the ignition and the generator. The components should be fitted in accordance with the direction supplied with the kit. In some vehicles, noise may still be present even after standard noise suppression methods have been used. Further information on mobile noise suppression is beyond the scope of this manual, and it is recommended that reference be made to a textbook on mobile installation.

3.8 TUNING ADJUSTMENTS

The transceiver is completely broadband in both the receiver and transmitter. This means no retuning is required after installation or after changing channel frequencies. It is very important that the antenna system is correctly adjusted to provide a correct match on all channel frequencies. Refer to the transceiver technical manual for detailed information on the antenna system and method of adjustment.

3.9 MICROPHONE

If the transceiver has been ordered without a microphone, a connector will be supplied. The transceiver will operate satisfactorily with most dynamic, magnetic or ceramic microphones. The gain of the VOGAD adjusts automatically to compensate for both microphone output and voice level.

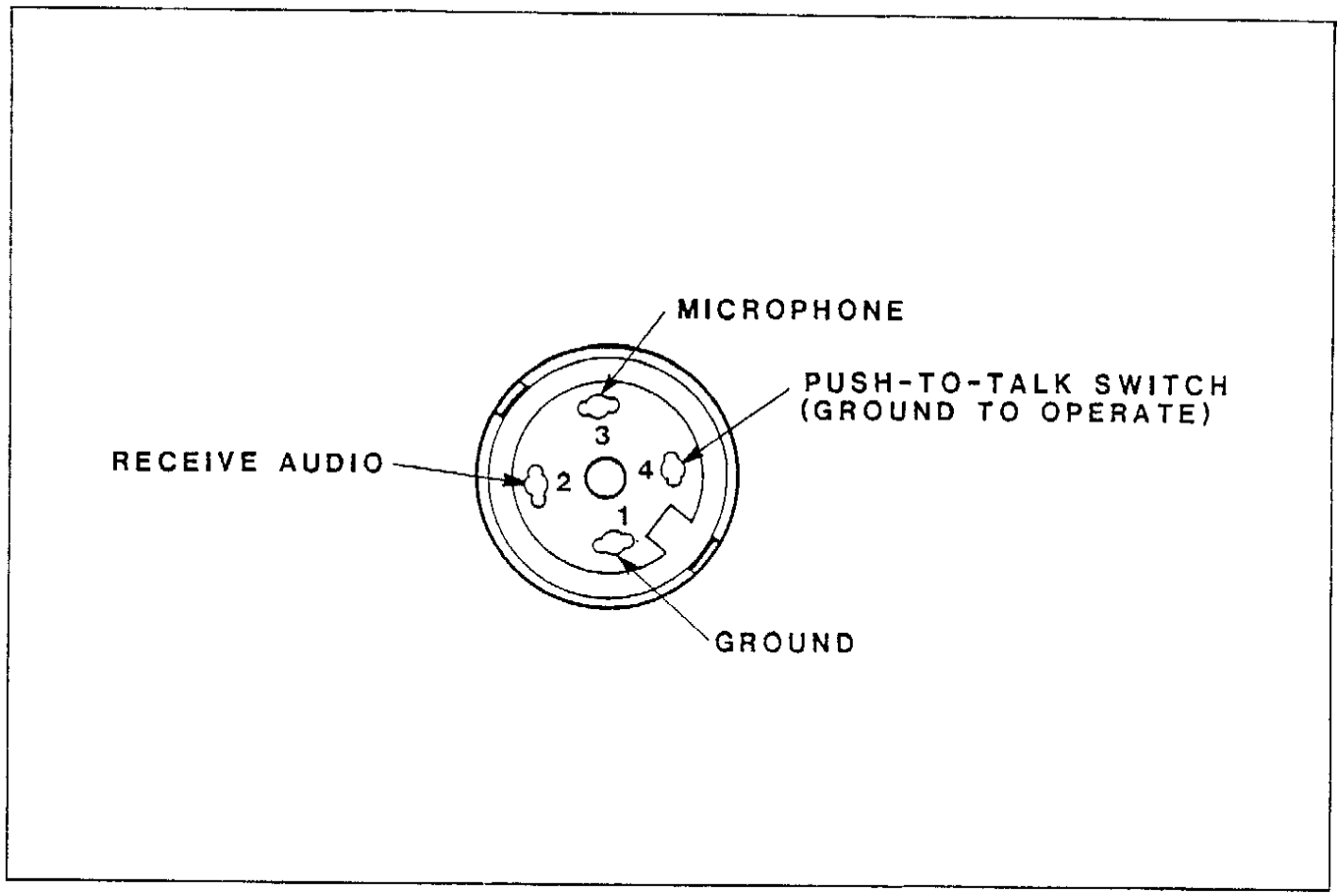


FIGURE 3-4. Microphone Connections.

SECTION 4
OPERATION

4.1 INTRODUCTION

The transceiver is designed for use by unskilled operators and is almost as simple to use as a telephone. Operation normally involves the selection of the correct channel frequency, setting audio gain control to a comfortable level and pressing the microphone switch to transmit. The following instructions explain how to use the operating controls. Refer to Figure 4-1.

4.2 POWER ON/OFF SWITCH

The switch controls the power to the transceiver with both AC and DC power sources. The red indicator lights when the power is switched on.

4.3 FREQUENCY SELECTION

The transceiver may be supplied in one of three operating modes. The choice of operating mode will usually be determined by the licensing authority for the equipment. Check the operating mode of the equipment as some features are not available in Modes 2 and 3.

Mode 1: All facilities are available in this mode including the programming of transmitting frequencies. This mode is normally only available to trained operators.

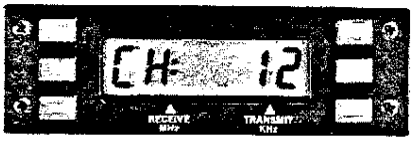
Mode 2: In this mode the operator has no control over the transmitting frequency and must operate in the pre-programmed channel frequencies. Channel ØØ is available as a free tuning receiver.

Mode 3: In this mode the transceiver operates as a channelized transceiver with permanently programmed channels. The tuneable receiver is not available and channel frequencies cannot be displayed.

FIGURE 4-1. Front Panel.

4.4 CHANNEL SELECTION

Enter [C] followed by 2 digit channel number.



If Channel ØØ is entered, the channel frequency is automatically displayed. In Mode 3 the frequency display is suppressed.

NOTE

All channel numbers have 2 digits (01 to 99). **Channel selection is the only function available in Mode 3.**

4.5 FREQUENCY DISPLAY

Press [F] and the channel frequency is displayed. The position will indicate if the receive or transmit frequency is displayed.

Press [F] twice to display and monitor the transmit frequency. The receiver will automatically return to the receive frequency after the transmit switch is pushed.

NOTE

The transmit and receive frequencies are the same on simplex channels.

4.6 FREE TUNE CHANNEL ØØ

Channel ØØ is available for free tuning the transceiver. In Mode 2 this channel is only available in the receive mode. The last entered frequency will be retained in memory until changed.

ENTER [C][Ø][Ø]. The transceiver is now in the free tune mode. The frequency may be changed by entering the new channel frequency, then [F]. Remember [F] must be entered after every frequency change. Frequencies are displayed during and after transmitting on channel Ø Ø.

Half-Duplex

When one frequency is entered the transceiver automatically assumes that it is a simplex frequency. For half-duplex operation enter the receive frequency first, then press [F] twice and enter the transmit frequency and press [F]. Check that the pointer indicates "transmit frequency".

4.7 UP DOWN TUNING

The [UP] and [DN] keys permit tuning the transceiver frequency up or down from the original frequency displayed. A single push steps the transceiver 100Hz. If the key is held down the transceiver steps at a rate of 40 steps per second.

Only the receiver frequency can be changed in this way. Any offset thus entered is retained until the channel is changed. On the free tune channel (ØØ) it is possible to change the frequency in memory permanently by pressing the [F] key after stepping.

4.8 AF GAIN

Turn the squelch off and adjust the audio frequency gain control to a comfortable level.

4.9 LS SQUELCH

This control turns off the loudspeaker and the squelch. The LS OFF position is used to turn off the loudspeaker when headphones are used. It may also be used to mute the receiver in the Selective Call mode. In the SQUELCH ON/OFF positions the loudspeaker is switched on. The squelch circuit eliminates background noise and is internally set to open on weak voice signals.

4.10 CLARIFIER

In the OFF position (fully counter clockwise) the clarifier is disconnected and the receiver operates on the same frequency as the transmitter. The clarifier permits a small change of the receiver frequency and is used to correct pitch of the voice, or tune an FSK signal.

4.11 MODE SWITCH

This switch has the following markings:

USB: Upper sideband operation. This mode used is used for most normal SSB communications.

LSB: Lower sideband operation. LSB is usually used to if there is interference on the other sideband. Both transceivers must be operating in the LSB mode or communication is not possible. In many countries (including the USA) this mode is illegal and will not be fitted to the transceiver.

AM: Compatible AM. This mode is used to provide a signal that is intelligible on an AM signal. It is unlikely to be required for normal communications.

FSK: This mode is for use with RTTY Systems.

4.12 METER

Receive: The meter indicates the relative signal strength of the received signal. The midscale position is calibrated for a signal strength of 100 microvolts.

Transmit: The meter reads average power output and should read approximately full scale at 100W output. The meter will indicate between 3 and 4 on a normal voice transmission and should deflect to almost full scale on a whistle in the CW mode. A low meter reading usually indicates a mismatched antenna.

4.13 ATU

The ATU switch is fitted when the automatic antenna tuner is used. Press the switch when the transceiver is first switched on and when the frequency is changed. The tuning sequence is automatic and a tone is present in the loudspeaker while the tuning cycle is in progress.

4.14 PROGRAMMING CHANNEL FREQUENCIES

The channel frequencies can only be changed in Mode 1.

Enter the channel number (C ? ?). Press the F key and hold it down, then press the C key. It is important to follow this sequence ensuring the F key is pressed before the C key and not released until after the C key is depressed. Enter the channel frequency and press F.

Half-Duplex

Enter the receive frequency as described above. Enter F then repeat the double keystroke action F C and check the pointer has moved to "transmit frequency". Enter the transmit frequency and press F.

The channel frequencies are entered into permanent memory and retained by a lithium battery with a nominal shelf life of ten years. It is recommended that the battery is changed at five year intervals.

4.15 SCAN MODE

It is possible to scan between 2 and 98 channels in the scan mode. Program the desired frequencies starting at channel Ø1. Go to the channel which is one more than the highest channel to be scanned. Press the F key and hold it down, then press the C key as if programming the frequency as above. Now press SCAN.

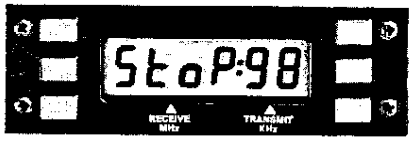
The scan limit will now be set as desired and the channels below this limit will be scanned three per second.

Initiate Scan

Press the SCAN key.

Stop Scan

Press the SCAN key again.



NOTE

It is necessary to stop the scan to enter new keypad functions.

4.16 SELECTIVE CALL

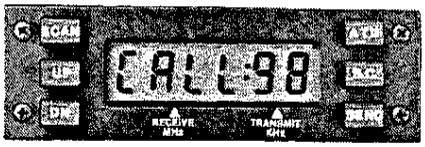
The selective calling system is an optional feature. Check that it is fitted to the transceiver before using this function.

Each transceiver is assigned a selective call code (ØØØ to 254). This code is internally programmed in the selective calling module.

Press the S.C. key and enter the three digit code for the desired station. Press the SEND

key, this will switch the transmitter on, and will then send the selective call code.

The station called will stop scanning and send back a transpond signal. This respond signal should be monitored to ensure the call was received.
The selective call initiates a 150 second scan hold timer, displays "CALL" on the LCD display and sounds the call buzzer.



When a call is received turn on the loudspeaker and answer the call. Pressing the transmit switch automatically updates the scan hold timer for 150 seconds. Alternately press the [SCAN] key to stop the scan. After the call is completed press any key to cancel the "CALL" display. If the scan mode is in use press the [SCAN] key again to initiate scan.

The loudspeaker may be turned off to eliminate background noise while monitoring the channel in scan mode.

4.17 MICROPHONE

The VOGAD circuit automatically adjusts the audio gain to provide full transmitter output. Speak close to the microphone in a clear voice. Shouting will not provide any increased output and may reduce intelligibility.

4.18 CW-TELEGRAPHY

To operate on CW (Morse) plug the key into the small jack and use either USB or LSB. The transmitter automatically switches on when the key is pressed. Make a short pause in the keying and the transceiver will return to the receive mode.

4.19 RX ATTENUATOR

A 12dB attenuator can be switched into the receiver front end by use of this front panel switch. This feature can be used to improve the IMD performance of the receiver and is especially effective in a strong signal environment.

SECTION 5
SERVICING

5.1 INTRODUCTION

Detailed servicing information is beyond the scope of this manual and only experienced personnel should make adjustments or attempt any serious service work. Reference to the technical manual is essential.

The transceiver is of modular construction and if spare modules are available nontechnical personnel will be able to repair most faults in the field. Frequency calibration is a very simple procedure in the transceiver and information has been included on this adjustment. It is very strongly recommended that the nontechnical personnel receive instruction from an experienced technician in the replacement of modules.

5.2 ROUTINE MAINTENANCE

The transceiver normally requires no periodic maintenance except to check the calibration of the master oscillator. This procedure is described in Section 5.4. It is often convenient to program an unused channel to a known frequency standard such as WWV. This will enable the operator to make regular checks of the frequency calibration.

The exterior of the transceiver should be kept clean by wiping with a damp cloth and polishing with a soft dry cloth. Make sure that all knobs are secure and the connectors are tight. When the transceiver is opened, make sure the coaxial connectors are tight and the module connectors are firmly in place. If the small pin connectors are removed, it is advisable to tighten the spring contacts by squeezing with a pair of pliers before replacement. Remove any dirt or dust using compressed air.

5.3 ACCESS & MODULE REPLACEMENT

5.3.1 Cover Removal

The top and bottom covers are each retained by six screws. Remove the retaining screws and the covers can then be lifted off the transceiver.

CAUTION

If the transceiver is fitted with an AC power supply, the full main supply voltage is present at the transformer primary, input connector, fuse holder and front panel power switch. It is recommended that an external DC power supply is used when servicing the transceiver. When the transmitter is operating, high RF voltages are present on the modules M7 and M10. Use caution as these RF voltages can cause unpleasant burns.

5.3.2 Module Replacement M1-M6

Modules M1-M6 are the six modules contained in the diecast boxes. The modules are retained by screws in the front left and rear right corners. Remove these screws first as this permits the modules to move forward and backward and gives more room to unscrew the coaxial connectors. These connectors and the ten pin connectors should be removed and the module can be lifted out of the transceiver. Modules M5 and M6 are stacked and the retaining screws hold both modules in place.

5.3.3 Module Replacement M7

This module is removed by disconnecting all of the connectors. Remove the five mounting screws.

5.3.4 Module Replacement M8

Remove the three pin connectors. Unscrew the four mounting screws in each corner and one screw in the center of the module. Remove the mounting hardware from the "TABPACK" transistors taking care not to lose the special shoulder washer and the insulator. When the module is replaced, take care to use thermal compound on the transistor flange. The insulator must be in place and the shoulder washer mounted so that there is no possibility of a short to the chassis. Tighten the transistor mounting screws securely so that there is a good thermal contact to the chassis.

5.3.5 Module Replacement M9

This module is removed by disconnecting all of the connectors. Unscrew the five retaining screws.

5.3.6 Module Replacement M10

It is not recommended that the RF power module is replaced by non-technical personnel. Detailed information on the replacement of this module is covered in Section 8.6.6 of the technical manual.

5.3.7 Pin Connectors

Small pin contacts are used for connecting wires to modules M7, 8 and 9 and for internal use inside the enclosed modules. These pins have an excellent locking action and will require a firm pull for removal. Always grasp the body of the pin with a pair of pliers and pull directly vertical

when removing the connectors. If the contact is moved from side to side to aid removal, it will weaken the spring tension in the contact. If this happens, squeeze the end of the contact back together using a pair of pliers. It is very important to ensure that the pins snap firmly in place when the contacts are reinstalled.

5.3.8 Panel Components

It is possible to remove and replace most panel components with front panel in place. If it is necessary to obtain greater access to the panel, remove modules M1, M5 and M6. This will give access to the four screws holding the panel in place. These screws are located on the two plates at each side of the rear of the panel. Remove the four screws and the panel can be tipped forward to give complete access to all components.

5.3.9 Component Access Modules M1-M6

The top side of the printed circuit board is accessible when the top covers of the boxes are removed by unscrewing the four screws at each corner of the box. This gives access to all test points and alignment adjustments.

The integrated circuits are installed in sockets and can be replaced without removal of the circuit boards. When a circuit board must be removed for service, disconnect the pin connectors from the coaxial connectors at each end of the box. Remove the four mounting screws at each corner of the circuit board. The multipin connector will lift out of the slot at the end of the box and the circuit board and connector can be removed together without unsoldering the leads.

NOTE

There are two additional mounting screws holding the PC board in place in the module M6. It will also be necessary to remove the two screws holding the connector filter in this module. The screws are located at the end of the box on each side of the connector.

5.4 FREQUENCY CALIBRATION

The transceiver uses one temperature controlled master oscillator to control both synthesizers. This means that only one adjustment is required for all channel frequencies. The adjustment procedure requires the use of an accurate frequency counter.

1. Connect the frequency counter to the output of the transceiver through an attenuator.
2. Turn on the transceiver to the highest channel frequency and wait for 10 minutes so that thermal stability is reached.
3. Turn the mode switch to AM and press the PTT switch.
4. Adjust the piston trimmer C21, (accessible through the hole in the top cover of Module 5) until the counter reads the exact channel frequency.
5. This completes the calibration procedure.

In an emergency, it is possible to calibrate the transceiver by programming one of the channels to receive a frequency standard such as WWV. If there is any beat note present, the transceiver requires calibration. Turn the clarifier to "OFF". Turn up the volume and adjust C21 on Module 5 to zero beat. It will be difficult to hear the low frequency beat because the carrier frequency is suppressed by the IF filter. It is possible to hear the beat against the reference tone and as a roughness on the voice modulation. With careful adjustment, it is possible to calibrate the transceiver within at least 10Hz.

TABLE 5-1. Fault Location Chart.

(This chart gives fault symptoms that can be isolated by observation of the transceiver operation).

SYMPTOM	POSSIBLE FAULT	ACTION
Power LED does not light.	Faulty power source. Blown fuse(s).	Measure power source. Replace fuse.
NOTE If the fuse blows again, check the "Transorb", D1, mounted on the 20A fuse holder on the rear heatsink. The "Transorb" may fail in the shorted mode if subjected to sustained overload or a voltage transient exceeding 5KW. If the "Transorb" has blown, it is important to determine the cause, which is certain to be external to the transceiver. Repeated replacement of fuses and "Transorb" may cause severe damage to the transceiver.		
No Audio Output.	Defect in M1, loudspeaker or squelch on.	Turn squelch off, and turn audio gain up. If the speaker is completely dead, the fault is probably in the module or speaker. Repair or replace.
Transceiver does operate on one frequency or group of frequencies.	Defect in M7 RF Filter Module.	Check relays and filter components for non-operating frequency(ies).
Transceiver does not operate on frequencies above/below 15MHz.	Defect in VCO Q1 (2-15MHz) or Q2 (15-30MHz).	Replace module M7 or repair.
Transmitter has no output except for carrier in AM mode.	Defective microphone. Defective audio module M1.	Replace or repair. Replace or repair
Transmitter has low output on one channel	Antenna or tuner mismatch. required.	Measure VSWR and adjust antenna or tuner as
Speech sounds garbled and/or clarifier consistently tunes at extremes of range.	Master oscillator out of calibration	Recalibrate (refer to Section 5.4).
Transmitter does not operate when PTT Switch is activated.	Defective microphone. Defective T/R Switching.	Check by shorting pin 4 On microphone socket.

TABLE 5-2. Module Fault Location Chart.

PRELIMINARY Check power switching. Press PTT switch. Relay should click and receiver should mute.	
M1 AUDIO MODULE	
Transceiver operates in either Tx or Rx mode.	* 1650kHz carrier oscillator is operational.
Audio completely dead, not even slight hiss, squelch off, and maximum audio gain.	* Module or loudspeaker defective.
No output from microphone. Carrier present in AM mode.	* M1 or M2 defective, also check microphone.
M2 1650kHz MODULE	
Receiver operational.	* Module will also be operating in transmit mode.
Disconnect "Rx Out" coax connector.	If noise level does not decrease, module is defective.
M3 75MHz MIXERS MODULE	
Carrier output in AM mode.	* M3, M4, M5, M6, M10 operational in transmit mode.
Disconnect "Rx Out" coax connector.	* If noise level does not decrease, module is defective.
M4 HF MIXERS & DRIVER MODULE	
Carrier output in Am mode.	* M3, M4, M5, M6, M10 operational in transmit mode.
Disconnect "Rx Out" coaxial connector.	* If noise level does not decrease, module is defective.
M5 SYNTHESIZER - 10kHz LOOP	
Transceiver operates in either transmit or receive mode.	* Module is operational.
Disconnect "OSC Out" coax connector.	* If noise level does not decrease module may be defective.

TABLE 5-2. Module Fault Location Chart, Continued.

M6 SYNTHESIZER - 10kHz LOOP	
Transceiver operates in either transmit or receive mode.	* Module is operational.
Channel Frequencies do not operate.	* Defective 1.6-15MHz VCO in module.
Channel frequencies do not operate above 15MHz.	* Defective 15-30MHz VCO in module.
NOTE A failure in the master reference oscillator in the module M5 will stop M6 from operating.	
M7 RF FILTER MODULE	
Refer to "Preliminary" at beginning of of chart for T/R power switching.	
Relay K1.	* Check Relay Clicks when PTT operated.
Signal path through filters from antenna.	* Disconnect "Rx ANT" antenna. Coax connector from M4. Temporarily connect antenna to "Rx ANT" connector. If receiver operates, defect in M7. Filter selection or connections to antenna connector.
M8 POWER SUPPLY REGULATOR	
Check input voltage to module at input terminal.	* Should be above 12V in DC model. * Should be approximately 18V in AC model.
No output from M8 in both transmit and receive mode.	* Module defective.
M9 MICROPROCESSOR MODULE	
Faults in this module are indicated by incorrect channel selection.	* Check wires and connections.
M10 RF POWER AMPLIFIER	
No simple check without instruments.	* Voltages and connections should be carefully checked before replacement.
MICROPHONE	
Transmitter does not operate.	* Check by replacement of microphone. * Ground pin 4 of connector and touch pin 3 with hand. If transmitter shows RF output, microphone is faulty.