TRANS WORLD COMMUNICATIONS, INC.

TW100F FLY-AWAY
HF SSB TRANSCEIVER
OPERATORS MANUAL

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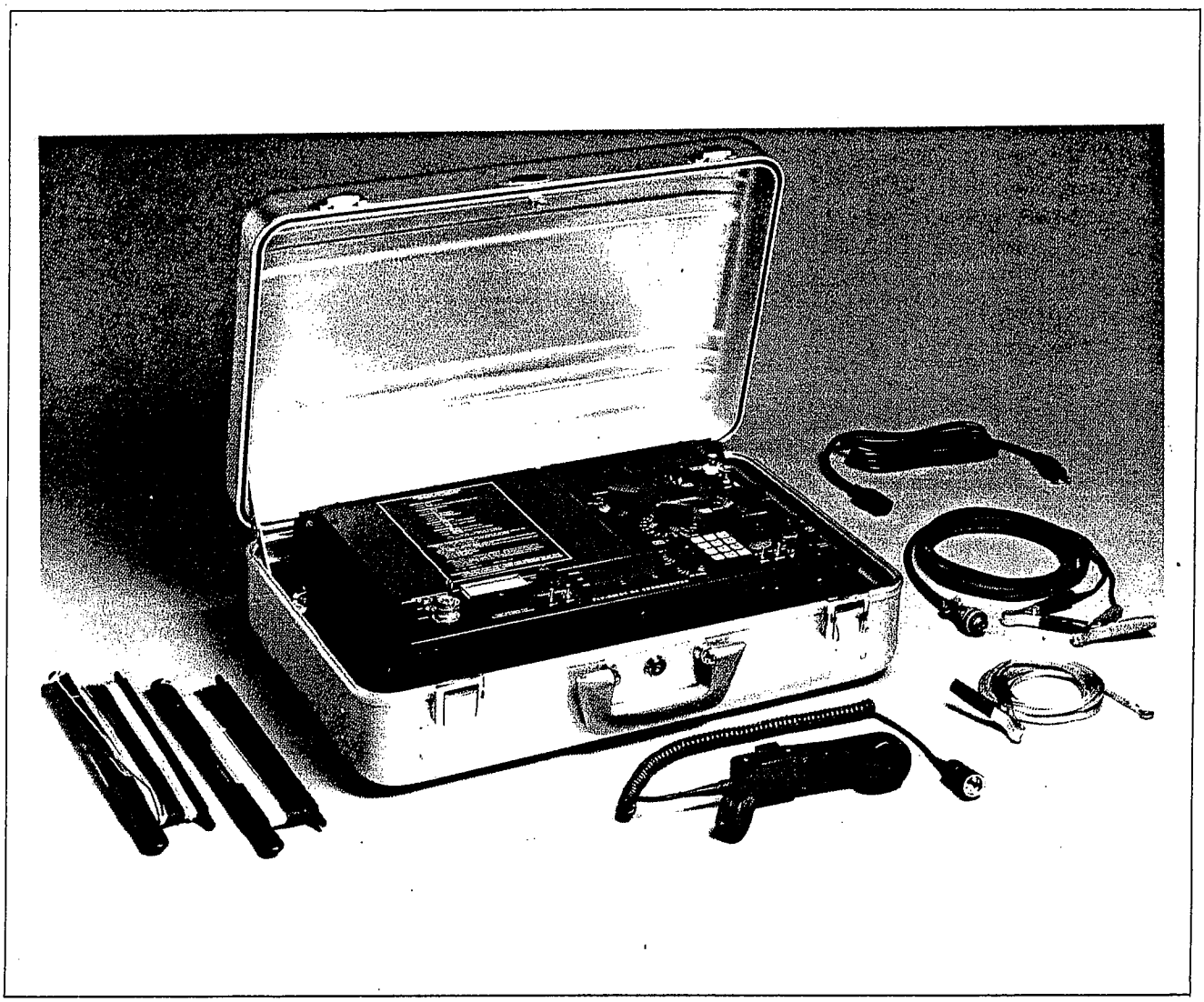


FIGURE 1-1. Fly-Away Transceiver.

SECTION 1
GENERAL INFORMATION

1.1 GENERAL DESCRIPTION

This manual has been prepared for the operator of the TRANSWORLD TW100F transceiver. It has not been designed for the technician or engineer and does not cover detailed technical or installation information. The TW100F-MS Technical Manual gives comprehensive information on the transceiver and is essential for servicing and adjustment of the transceiver.

1.2 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.

1.3 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 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 affected 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 (300-400 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 (300-400 kilometers) during the day. At night, considerable distances are possible, although static will be a 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.

1.4 MODES OF OPERATION

1.4.1 SINGLE SIDEBAND

Single sideband or SSB will be used for all regular voice communications. Most commercial operation is on the upper sideband (USB), and lower sideband (LSB) is usually used to avoid interference. There are some countries that specify LSB operation. LSB is also used by amateur radio operators in the 3.5MHz and 7MHz bands. In some countries LSB operation is not permitted. When this restriction is specified, the LSB filter will not be installed.

1.4.2 AM

AM has now almost disappeared from the HF bands for communications, since AM mode is now used almost exclusively for broadcasting. An AM mode is provided in the transceiver to permit reception by simple radio equipment. It should be noted that reception is in the compatible AM mode which uses the SSB receiver tuned to the carrier frequency of the AM station. Accurate tuning is essential for undistorted AM reception.

1.4.3 CW

There is still some CW (Morse Code) operation in the HF bands, and the transceiver does have provision for CW communications. Under poor conditions, good operators will be able to communicate on CW when voice operation would not be possible. The transceiver operates in the CW mode on either USB or LSB by plugging in the morse key.

1.4.4 RADIO TELETYPE (FSK)

Radioteletype is used for the transmission of data. The transceiver may be used for RTTY or other FSK transmission in the low power mode. It will be necessary to use a self-contained message terminal such as the TW5500 or a teletype machine with a separate modem. It should be noted that the internal power supply and antenna tuner are not suitable for continuous RTTY operation in the high power mode. Data burst transmission not exceeding two minutes may be made in the high power mode using the tuner.

1.5 THE FLY-AWAY TRANSCEIVER

The Fly-Away HF Transceiver makes the concept of a compact, self contained, long distance radio telephone a reality. A specially designed, lightweight, 125W, 1.6-30MHz transceiver is packaged on shock mounts inside of a rugged metal suitcase small enough to be carried under an aircraft seat. The transceiver contains a universal AC power supply for operation anywhere in the world and also has a separate cable for direct operation from a 12V vehicle battery. A built-in antenna tuner permits operation from a variety of whip and wire antennas as well as dipoles and other 50 ohm antennas. The case contains a microphone, headset, connecting leads, and wire antennas. It is usually practical to have the transceiver in operation within minutes of arrival at the operating site.

1.6 TRANSCEIVER DESCRIPTON

The transceiver is an advanced, solid state, high frequency, single sideband transceiver operating in the frequency range from 1.6-30MHz. The range is covered in 100Hz steps, and there are no gaps or disallowed frequencies in the coverage. The transceiver will operate on any frequency and will store 100 different frequencies in permanent memory. Scanning is available on ten channels.

The transmitter uses a special gain controlled amplifier to give constant output with different voice levels. A front panel meter is used to measure received signal strength and transmitter

power output. The meter is also used as a tuning indicator for the antenna tuner.

The transceiver has a power output of 125W PEP (100W AVG) and a switch-selected low power setting of 10W. The power output is controlled by automatic circuitry which also protects against mismatched antennas. In order to minimize weight, the transceiver uses a small heatsink that is cooled by a small muffin type fan. The fan is thermostatically controlled and will only operate on prolonged transmissions. In the event of overheating the transmitter automatically switches to the low power mode.

The transceiver contains a universal AC power supply which will operate from 105-125V and 210-245V. The power supply frequency may range from 50 to 400Hz. The correct voltage taps on the transformer are selected by means of a three position switch on the side of the transceiver. The transceiver also has a separate connector for direct operation from a 12V battery.

A built-in antenna tuner will match the transceiver to a wide variety of whip and wire antennas up to 25M in length. A low power tune position is provided, and the front panel meter is tuned for maximum power. A 50 ohm antenna connection is provided for coaxial feed, and the antenna tuner may be used to provide correct matching with VSWR's up to 3:1.

The transceiver is contructed in a lightweight aluminum case with all of the operating controls on the top panel. Most of the circuitry is contained in six diecast boxes using SMA connectors, and the microprocessor and filter modules are mounted under the chassis. All modules use connectors and are simple to replace by unskilled personnel. The transceiver is mounted on four shock mounts inside the high quality "Zero" aluminum carrying case. The transceiver is normally operated inside the case, but can be quickly removed by loosening the four wingnuts on the shock mounts.

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 six 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.

1.7 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 preprogrammed 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.

1.8 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.

1.9 AUDIO INPUTS

The transceiver uses a standard military audio connector and is supplied with a military handset. The transceiver may also be used with other audio accessories, including encryption equipment designed for SSB service. The accessory connector is wired with 0dBm transmit and receive audio inputs and outputs. The transmit audio level is self-adjusting and will compensate for a wide range of input levels.

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°C.
	FREQUENCY CONTROL: Temperature controlled master oscillator ± 0.0001%, ±20Hz maximum.
	MODES: Simplex and Half-duplex.
	OPERATION MODES: A3J, (USB/LSB), A3H (compatible AM), A1 (CW), F1 - teletypes (Optional).
	TRANSCEIVER
	SIZE: 14cm x 28.7cm x 43.2cm
	WEIGHT: 10kg
	INSTALLED IN CARRYING CASE WITH ACCESSORIES:
	SIZE: 18cm x 33cm x 53cm
	WEIGHT: 14kg

TABLE 2-1. Technical Specifications, Continued.

POWER SUPPLY	13.6Vdc: Receive 600mA, Transmit 12A Average SSB.
	Internal AC power supply 105-125V/210-245V, 50/60/400Hz for SSB operation.
TRANSMITTER	POWER OUTPUT:
	HIGH: 125W PEP, 100W Average.
	LOW: 12.5W PEP, 10W Average.
	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. 600 Ohms, 0dBm.
	AUDIO BANDWIDTH: 2.4kHz.
	INTERMODULATION DISTORTION: -32dB typical.
	ALC: Less than 1dB increase for 20dB increase in audio input.
	METERING: Relative RF output, Tune Power.
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 6dB audio increase from 3uV to 300,000uV.
	INTERCEPT POINT: +11dBm.
	INTERMODULATION: -85dB.
	CLARIFIER: ±125Hz.

TABLE 2-1. Technical Specifications, Continued.

RECEIVER (Continued)	
	SQUELCH: Audio derived, noise immune.
	AUDIO OUTPUT: 4W into 3 Ohms, internal loudspeaker. 600 Ohms 0dBm.
	METERING: RX signal strength.
ANTENNA TUNER	IMPEDANCE: 6, 12, 50, 120 Ohms.
	SERIES INDUCTANCE: 0-23 microhenrys.
	SHUNT CAPACITANCE: 10-100pF.

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
M1D6	Isolation Diode	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

TABLE 2-2. Semiconductors, Continued.

Designator	Function	Description
M3D3	Carrier Level RF Switch	BA482 PIN Diode
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

TABLE 2-2. Semiconductors, Continued.

Designator	Function	Description
M6Q1	77-90MHz Oscillator	J310 FET Transistor
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	1N34A Diode
M7D16	ALC Detector	1N4148 Diode
M7D17	Forward Power Protection	1N4148 Diode
M7D18	Reverse Isolation	1N34A 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	1N756 Zener Diode
M7D27	Forward Isolation	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	5 Volt 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
M9Q1	Switch	2N6427 Darlington Transistor
M9Q2	Switch	2N3565 NPN Transistor
M9Q3	Switch	2N3565 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

TABLE 2-2. Semiconductors, Continued.

Designator	Function	Description
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
M12U1	Display Driver	MD4332 Integrated Circuit
M12U2	Display Driver	MD4332 Integrated Circuit

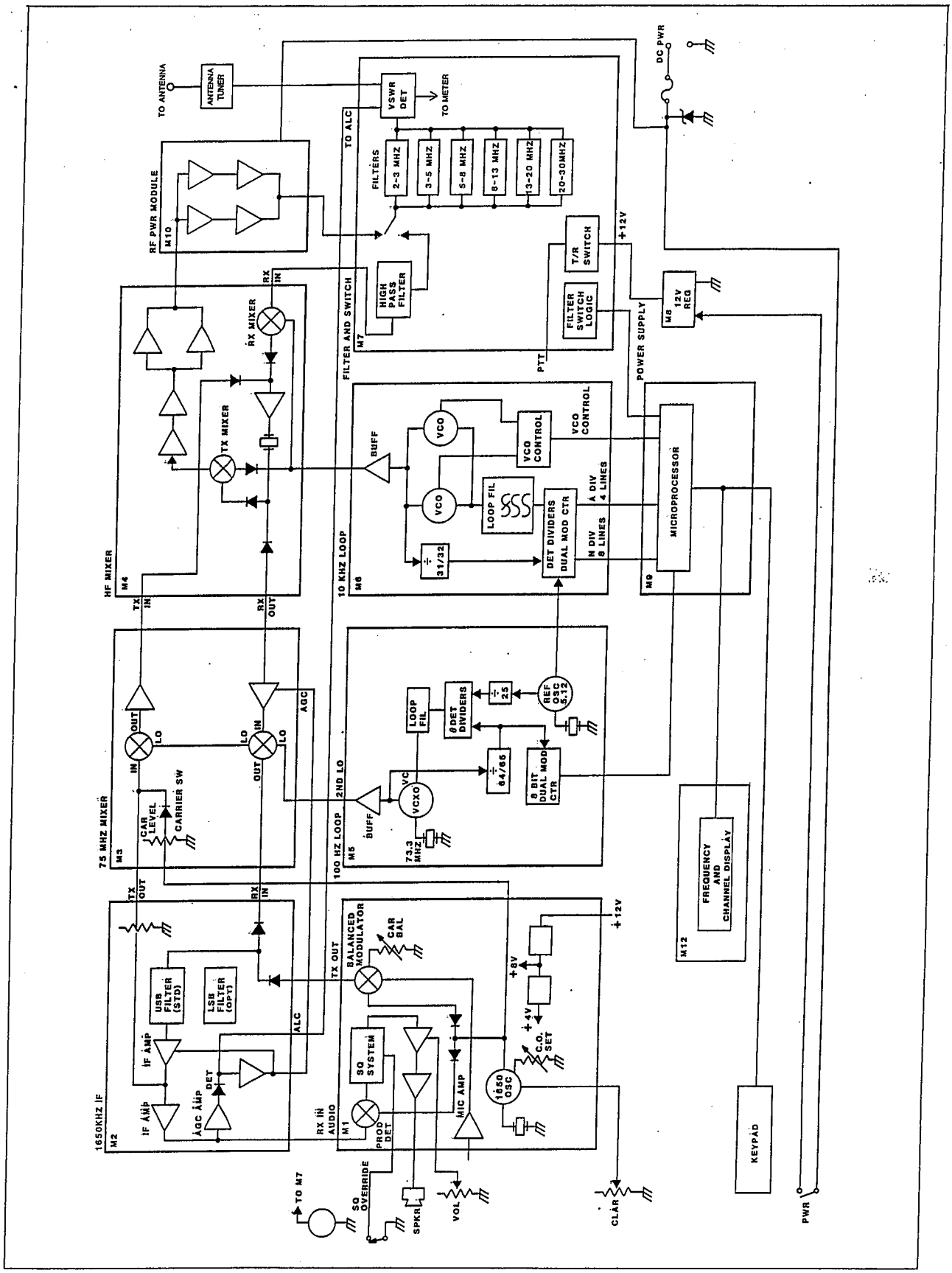


FIGURE 2-1. Block Diagram.

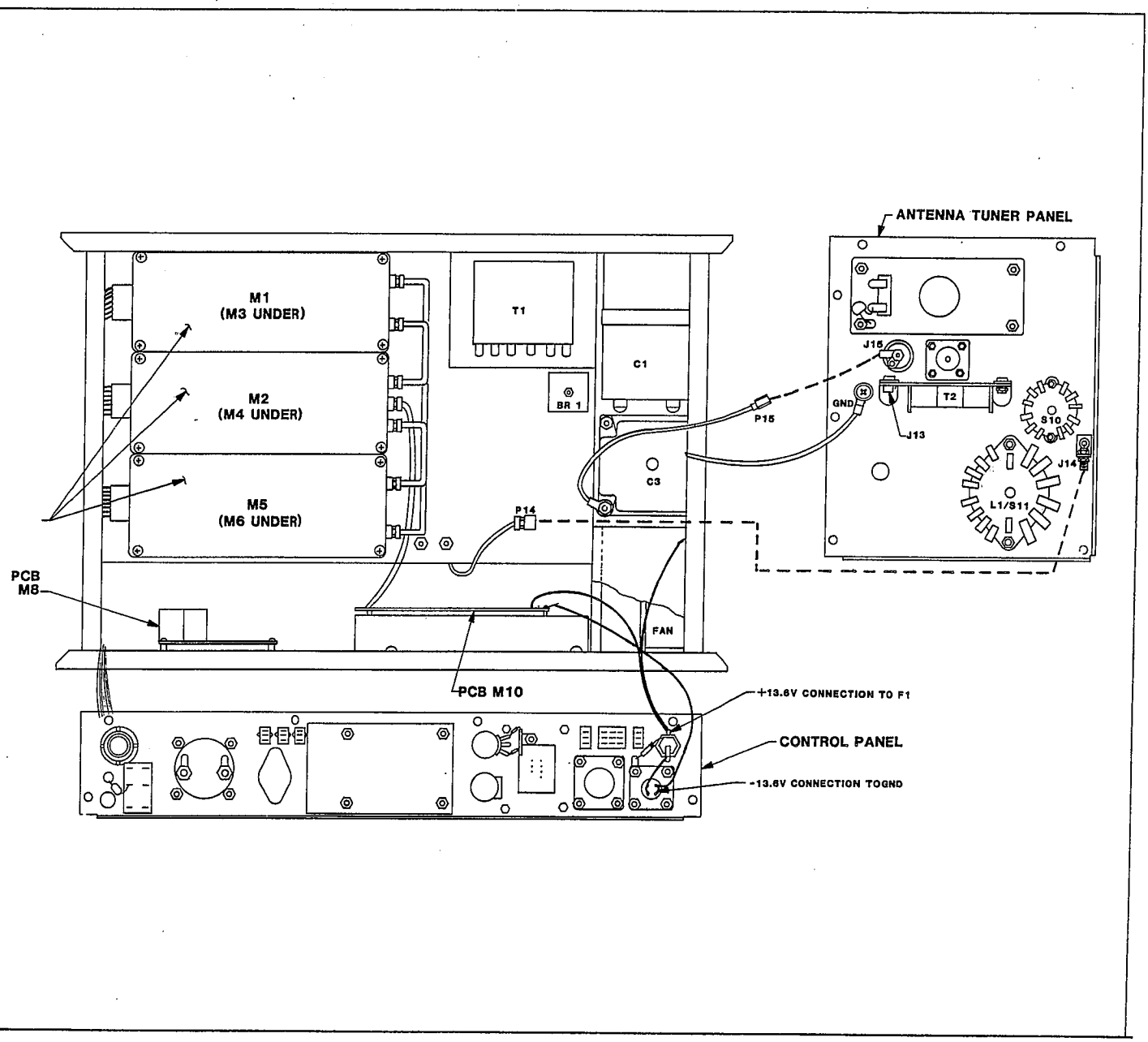


FIGURE 2-2. Module Location Diagram - Top.

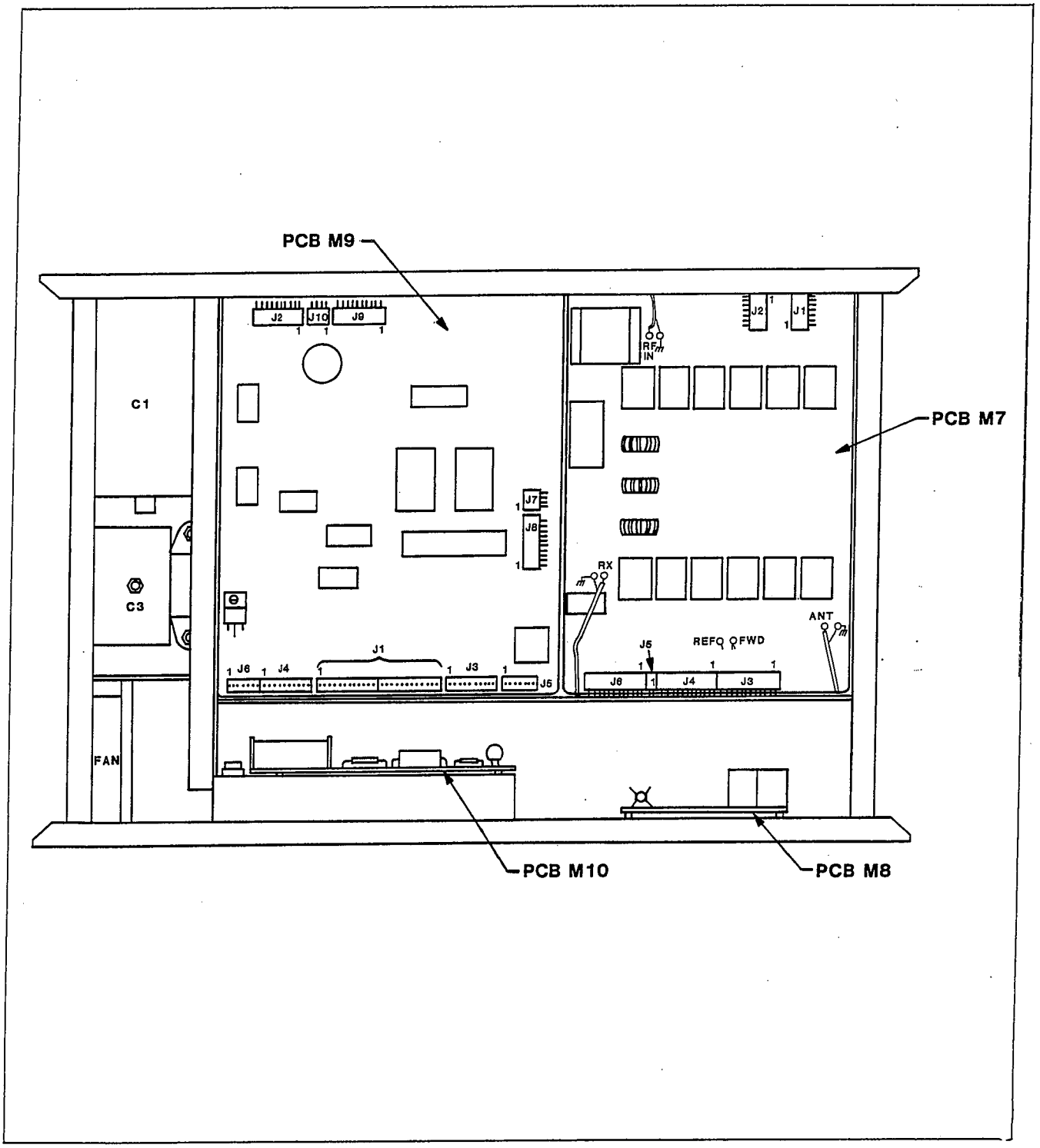


FIGURE 2-3. Module Location Diagram - Bottom.

SECTION 3
OPERATION

3.1 INTRODUCTION

The Fly-Away transceiver is designed for operation in almost any place at any time. It is very important to check the equipment out before starting on a mission and ensuring all of the accessories are packed with the transceiver. Read through the instructions carefully. You do not have to be a technician to operate the equipment, but you must understand the functions of the controls and know how to set up the equipment correctly.

NOTE

The numbers in parentheses following the section sub-headings refer to the location of front panel controls indicated in Figure 3-2.

3.2 CHOOSING THE LOCATION

It is very important to choose the best location, and this will be determined by the antenna. The success or failure of the communications will be largely dependent on the antenna system. The antenna system is so important that Chapter 4 is devoted entirely to this subject. A power source is also essential for operation of the transceiver, although using an extension power cable will not affect the performance of the transceiver. However, using a poorly located antenna may prevent completely satisfactory operations.

3.3 POWER SOURCE

3.3.1 AC OPERATION

Determine the voltage of the power source. A three position switch is located on the righthand side of the transceiver near the AC supply cord receptacle. Switch positions corresponding to three different supply voltages are designated by arrows imprinted below the speaker grill. Set the switch to the proper voltage before connecting the AC supply cord to the transceiver.

NOTE

Never operate the transceiver on voltages in the 200V range when the switch is in the 115V position. **Serious damage may result.**

If there is any doubt about the voltage of the supply, select the 240V switch position. The transceiver will operate at voltages down to 200V with only a small drop in output power. If the transceiver does not operate, make a definite determination of supply voltage before switching to the 115V position.

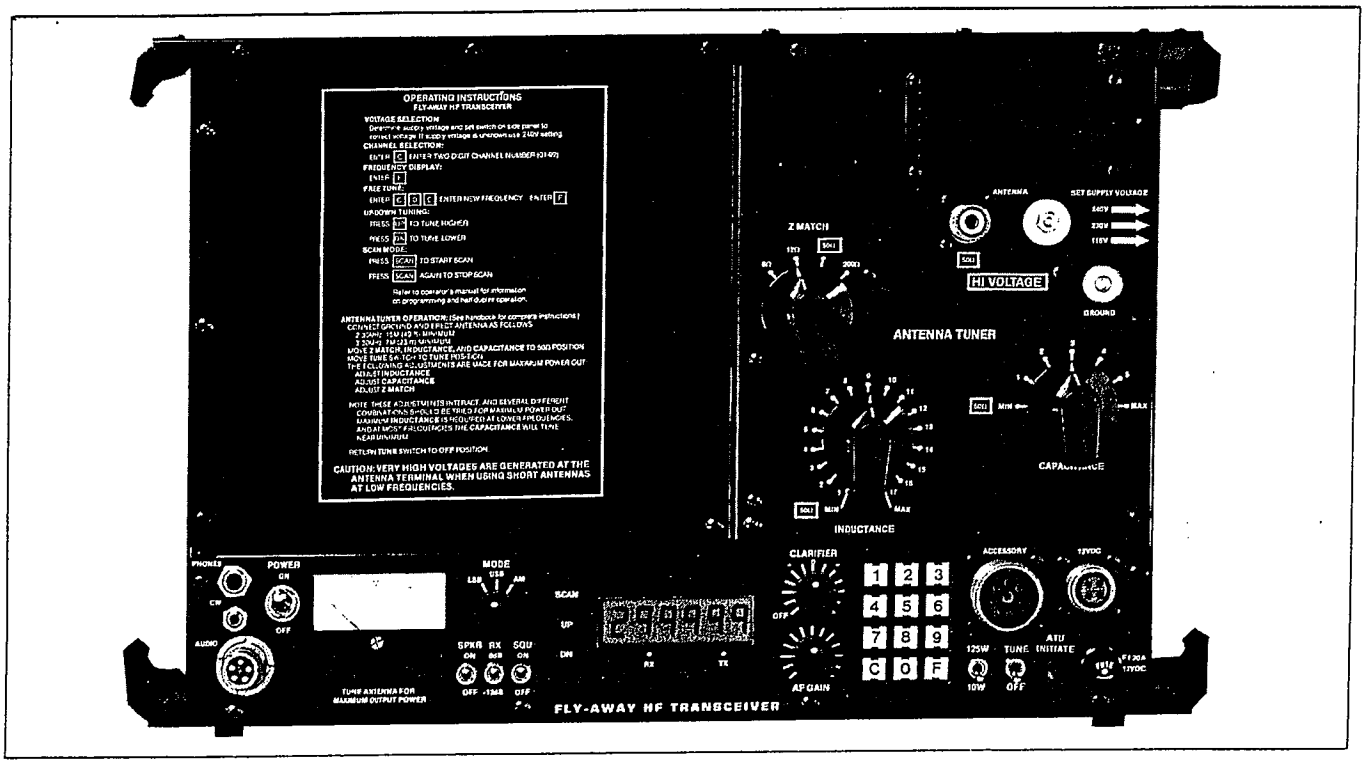


FIGURE 3-1. Front Panel.

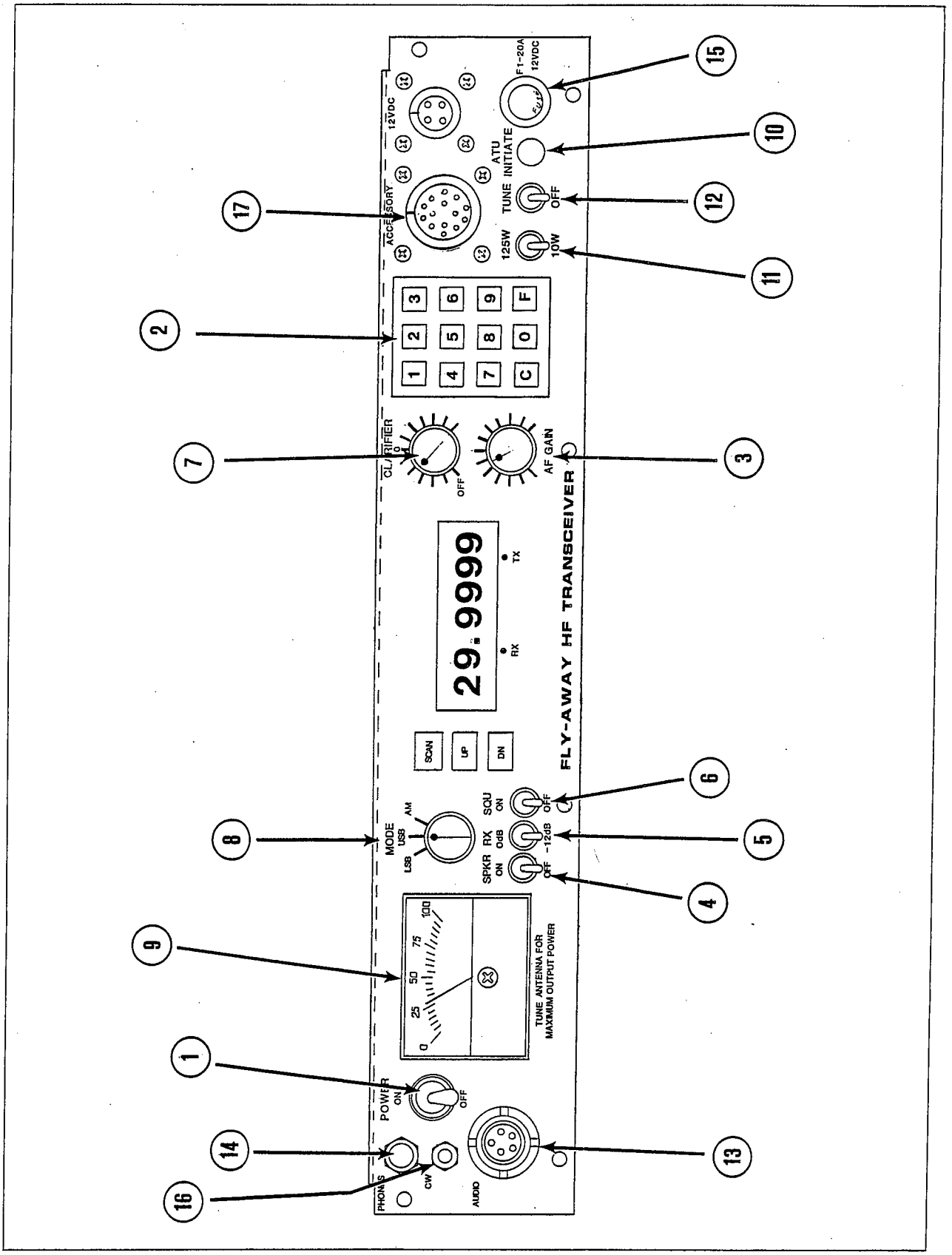


FIGURE 3-2. Front Panel Controls.

Always try to use the ground pin on the cable connector. If an adapter for foreign type outlets is used, make sure that a ground connection is provided.

3.3.2 12Vdc OPERATION

The transceiver will operate from a 12V supply source with a maximum current capability of 20A peak. The most convenient source will be a heavy duty 12V automobile or truck battery. Make sure that the battery is fully charged. For full transmitter power output, the supply voltage should be 13.6V and should never be lower than 11V.

The transceiver is supplied with a 12V cable fitted with a connector and two battery clips. Plug the cable into the connector marked 12Vdc, then connect the RED clip to the positive terminal (+) of the battery and the BLACK clip to the negative (-) terminal. Be very careful not to reverse the polarity as the DC supply fuse will blow immediately.

If it is necessary to use longer battery leads, use very heavy gauge wire (8AWG) to prevent excessive voltage drop.

NOTE

Do not connect the transceiver to the battery when the AC power cable is installed. This could cause damage to both the battery and the transceiver.

3.4 ANTENNAS & GROUND

Refer to Section 4 for full information on the ground, antenna systems and the operation of the antenna tuner.

3.5 POWER ON/OFF SWITCH (1)

This switch controls the power to the transceiver with both AC and DC power sources. The frequency display lights when the power is switched on.

3.6 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.

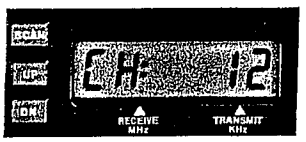
Mode 1: All facilities are available in this mode, including the programming of transmitting frequencies. This mode is normally only available to trained operators.

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.

3.7 CHANNEL SELECTION - KEYPAD (2)

Enter [C] followed by 2 digit channel number.



If CH: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.**

3.8 FREQUENCY DISPLAY

Press [F] and the channel frequency is displayed. The position of the decimal point 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.

3.9 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 ØØ.

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".

3.10 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.

3.11 AF GAIN (3)
Turn the squelch off and adjust the audio frequency gain control to a comfortable level.

3.12 SPEAKER ON/OFF (4)
This control turns off the loudspeaker. The LS OFF position is used to turn off the loudspeaker when headphones are used.

3.13 ATTENUATOR SWITCH - RX (5)
The attenuator switch reduces the gain of the transceiver by 12dB (equivalent to a power reduction of 16 times). The receiver is very sensitive, and most of the time the background noise level will prevent the reception of very weak signals. Under these conditions, switch in the attenuator (-12dB position) to reduce the background noise level. The attenuator should also be used to prevent receiver overload when exceptionally strong signals are present. (With the attenuator in the circuit, the input intercept point is +23dBm, while the sensitivity is still better than 1.2 microvolts.)

3.14 SQUELCH ON/OFF (6)
The squelch circuit is used to eliminate background noise when there are no signals on the channel. The squelch circuit is automatic in operation and is preset to open on weak voice signals.

3.15 CLARIFIER (7)
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.

3.16 MODE SWITCH (8)
This switch has the following markings:

USB: Upper sideband operation. This mode 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.

3.17 METER (9)
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.

Tune: The meter reads approximately 9 on the tune position when the antenna is correctly tuned.

3.18 ATU (10)
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.

3.19 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 to ensure that 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 10 years. It is recommended that the battery is changed at five year intervals.

3.20 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 the 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 3 per second.

Inititate 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.

3.21 125/10W SWITCH (11)

This switch selects the power output of the transceiver. If signals are strong, the low power position may be used to reduce the chance of interception and to prevent interference with other stations.

3.22 TUNE SWITCH (12)

The tune switch is used when adjusting the antenna tuner. Refer to Section 4 for information on the tuning procedure.

3.23 HANDSET (13)

The handset is connected to the connector marked AUDIO. Figure 3-3 shows the internal connections for the audio connector. The connector is the standard U.S. military audio connector and may be used with standard military audio accessories such as handsets and SSB encryption equipment. The transceiver uses a gain adjusting microphone amplifer and will provide the correct level with a wide range of audio levels.

3.24 HEADPHONES (14)

The larger of the two jacks is used for headphone operation. The speaker switch (4) may be turned off for headphone operation.

3.25 FUSES (15)

There are three fuses in the transceiver.

1) The AC fuse (F2, rated 3A) is mounted on the right side of the transceiver near the AC receptacle.
2) The main 12Vdc supply fuse (F1, rated 20A) is located on the control panel.
3) The 12Vdc Regulator fuse (F3, rated 5A) is located on M8 and protects only that portion of the transceiver supplied with **regulated** 12Vdc.

NOTE

Never use a larger fuse than specified. This could cause serious damage to the transceiver.

3.26 CW-TELEGRAPHY (16)

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.

3.27 ACCESSORY CONNECTOR (17)

The connections to the accessory connector are shown in Figure 3-4. This connector is normally used for operation with external audio accessories

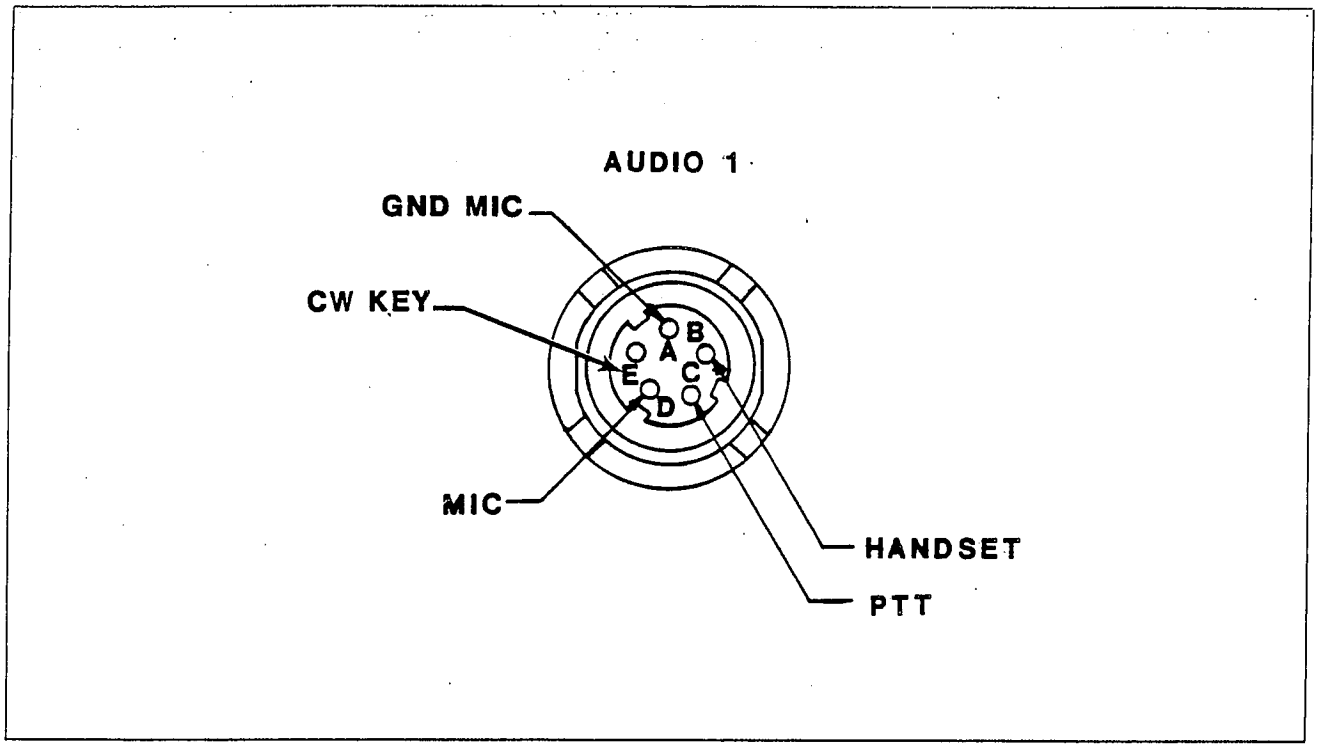


FIGURE 3-3. Audio Connector - Internal Connections.

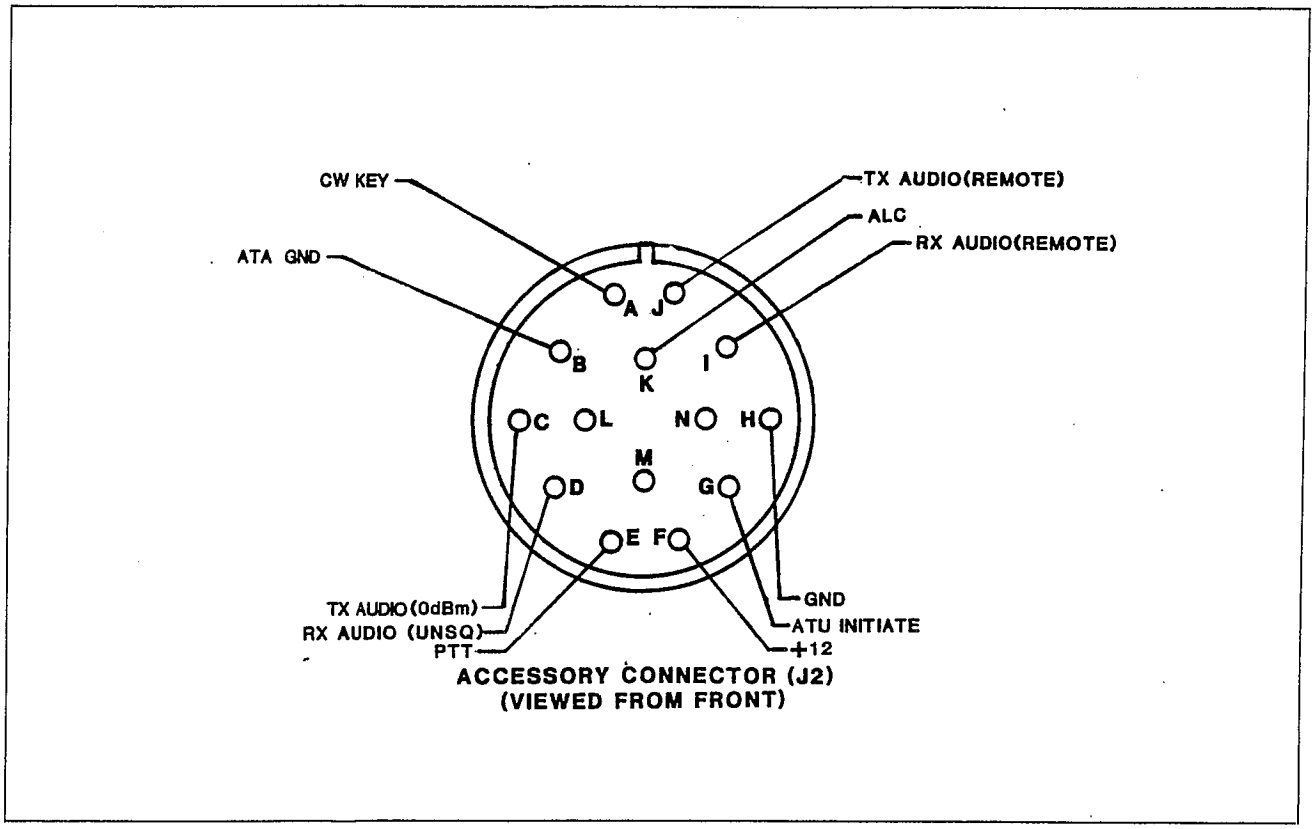


FIGURE 3-4. Accessory Connector - Internal Connections.

such as a modem or a message terminal for RTTY oper ation. The connector will also be used with operational wiring if the automatic antenna tuner is used.

NOTE

Other wiring options may be used for other accessory equipment.

3.28 RTTY OR DATA COMMUNICATIONS

The transceiver power supply and antenna tuner are not rated for radio teletype operation or other data communications at full power. Unless the transceiver is used with an optional power supply rated for 13.6V at 20A, RTTY or data communications should be made in the low power mode. The transceiver may be used for burst transmissions not exceeding two minutes in the high power mode.

3.29 COOLING

The transceiver uses a small cooling fan mounted on the right side of the transceiver to cool the final amplifier heat sink. The air enters through the bottom cover and exhausts at the right side of the transceiver. It is very important to see that the air inlet and outlet are not obstructed. Make sure that the accessory bags are removed while the tranceiver is in operation. The cooling fan does not run continuously. It is switched on only when the heat sink temperature reaches 60°C. A second thermostat on the heat sink will switch the transceiver to the low power mode if the temperature reaches 75°C. This is unlikely to happen during voice transmissions, but may occur on radio teletype operation at elevated temperatures or on extended transmissions.

NOTE

High power radio teletype operation is only permitted when using an external heavy duty power supply.

SECTION 4
ANTENNAS

WARNING - ELECTROCUTION HAZARD
Extreme care should be taken in the erection of antennas, particularly improvised antennas, to make sure that all parts of the antenna system are well clear of wires, electrical machinery, or any potential source of electrical shock. DO NOT TAKE RISKS!

4.1 INTRODUCTION

The performance of a modern HF SSB transceiver is completely dependent upon the antenna and the ground system. With a good antenna system and the correct choice of frequency, the TW100F will communicate over ranges of many thousands of kilometers. With poor antennas communications may be impossible, even over short distances. The transceiver is designed for portable and emergency situations and it will not often be possible to use a properly designed antenna located in a good position. This makes this section of the manual extremely important and we recommend that it be read very carefully.

4.2 ANTENNA TYPES

The transceiver is designed to operate into a 50 ohm antenna system or, with the use of the antenna tuner, can be used with wire or whip antennas of random length. The 50 ohm antenna is usually a resonant dipole or a wideband antenna designed to provide a good match at the operating frequencies. The antenna is fed using a 50 ohm coaxial cable and is not dependent on the ground system for good results. This type of antenna will give superior results compared to the wire or whip antennas, and should be used whenever practical. Further information is given on two types of 50 ohm antenna in paragraphs 4.3 and 4.4.

Unfortunately, it is not always practical to operate with a coaxial fed 50 ohm antenna, so an end fed antenna must be used. The transceiver does contain a built-in antenna tuner, and is capable of matching to a wide variety of antennas. The end fed antenna operates with the ground as an image antenna. This means that a good ground is essential for this type of antenna.

4.3 DIPOLE ANTENNAS

The half wavelength dipole is the best all around antenna for HF operation. The antenna is one half wavelength long and is center fed with a 50 ohm coaxial cable. The antenna may be erected between two supports or in the form of an inverted "V" with a single support at the center and the ends sloping towards the ground. The optimum height for long distance communications is one half wavelength above ground. At 2MHz, this height is 75 meters and is 13 meters at 12MHz. On the lower frequencies, often it is not possible to erect the antenna at the optimum height and the antenna is simply erected as high as possible. Good results are usually obtained with the antenna center at heights of 10 meters or more.

The antenna has maximum radiation at broadside to the antenna and is minimum off the ends. The directivity is reduced if the dipole is erected in the inverted "V" configuration. If possible, choose a site so that the antenna is clear of obstructions such as buildings and trees. Keep the antenna away from power lines and other sources of noise. The coaxial feed line will not pick up any noise and the location of the transceiver and is relatively unimportant.

Figures 4-1 and 4-2 show the construction of the standard half wavelength dipole in both the horizontal and inverted "V" configurations. The top section of the antenna should be cut to length according to the following formula.

Total length in feet = 468/F MHz.
(Meters = 146.5/F MHz)

A special portable version of the dipole antenna uses two calibrated steel tapes on reels. The dipole is unreeled to the correct frequency and locked in place. This is a simple and effective antenna for portable operation.

4.4 BROADBAND ANTENNAS

There are many manufacturers of broadband dipole antennas for the HF range. Some antennas, such as log periodics, are directional and must be oriented correctly. The ABB1 antenna is a broadband folded dipole covering the frequency range 3.5MHz to 30MHz with a typical VSWR not exceeding 2:1. While this antenna is not as efficient as the single frequency dipole, the performance is much better than most end fed antennas and the directivity is similar to the resonant dipole antenna.

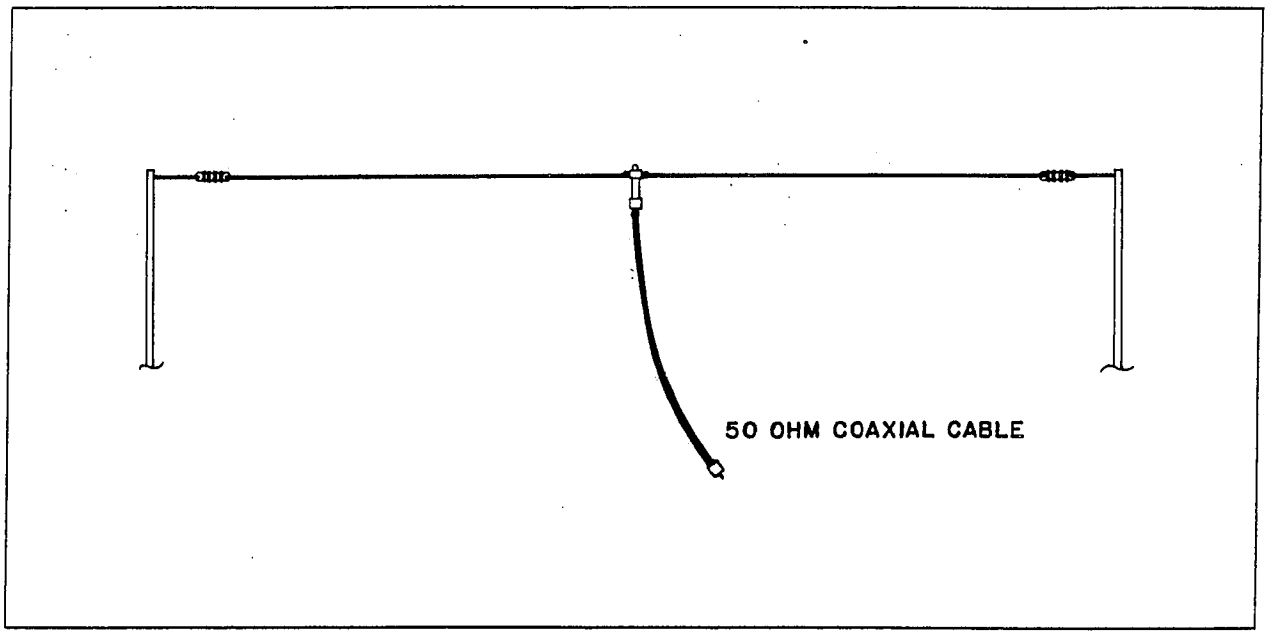


FIGURE 4-1. Half Wavelength Dipole.

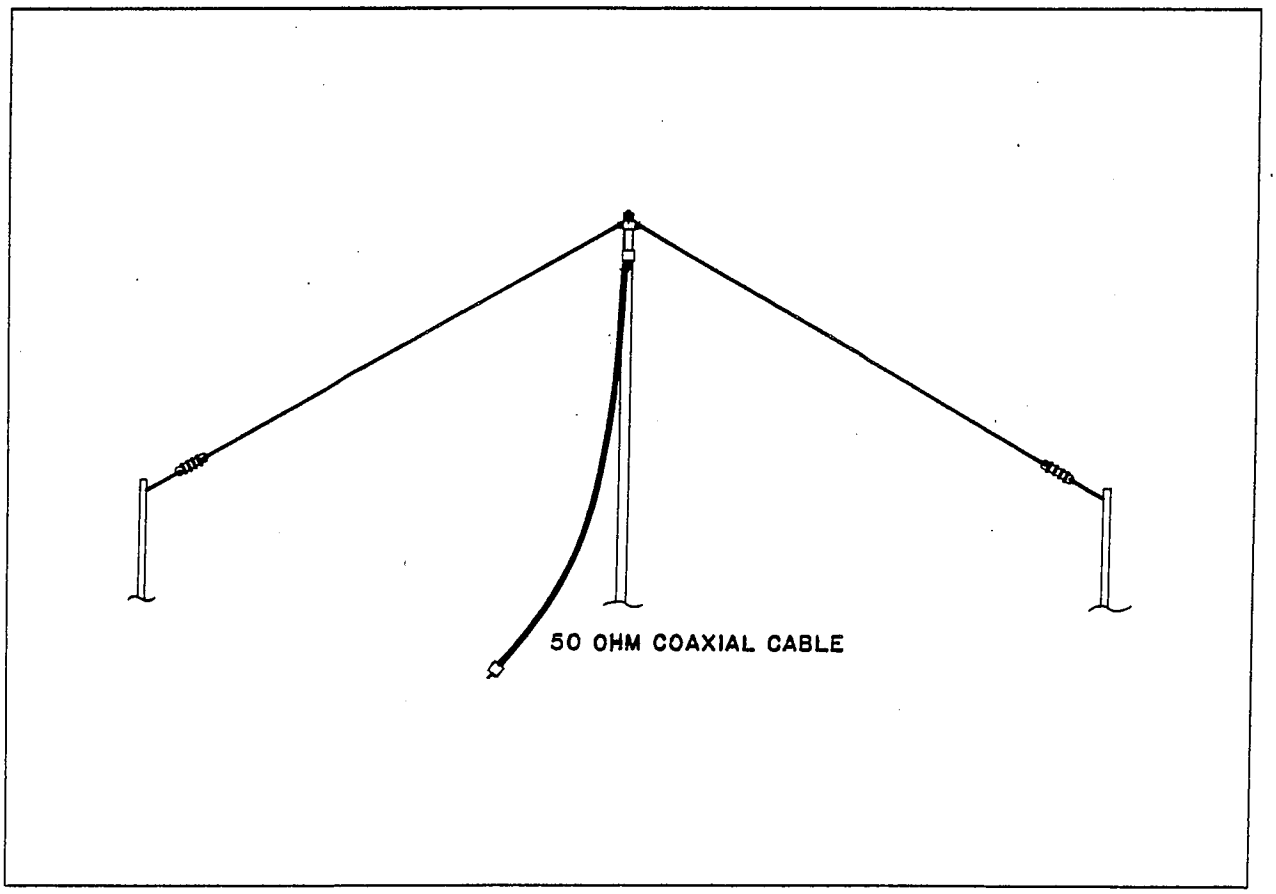


FIGURE 4-2. Inverted "V" Antenna.

4.5 TUNING DIPOLE ANTENNA

The resonant dipole antenna provides a satisfactory match at only one frequency and the broadband dipole may exhibit a poor match at some operating frequencies. The antenna tuning unit in the transceiver may be used to compensate for an unsatisfactory match and will extend the bandwidth of the dipole antenna considerably. The antenna tuner may be used to match the transceiver to the antenna. If the VSWR to the antenna is less than 3:1, the losses in the coaxial cable will be small. Refer to the normal tuning procedure for the antenna tuner.

4.6 END FED ANTENNAS

Although it is desirable to use a balanced antenna system, such as a center fed dipole, there will be many installations where it is only practical to use an end fed antenna. This type of antenna is only efficient when the radiating portion of the antenna is in the clear and there is an excellent ground system. These conditions are usually difficult to achieve at a portable location. The end fed antenna is usually a length of wire or a whip. The following points should be carefully noted.

a) Length - maximum efficiency is achieved with resonant antennas. The antenna will be resonant at one quarter wavelength and multiples of this. It is best to avoid the even multiples, as the antenna impedance will be very high at these points and it will be difficult to match the antenna to the transceiver. A quarter wavelength can be calculated by dividing 234 by the frequency in MHz to give the length in feet. (Divide 72.3 by MHz to give length in meters.) If the antenna is substantially less than one quarter wavelength, the efficiency will be reduced.

b) Location - The entire antenna radiates and it is important to keep it clear of all obstructions and as high as possible. Remember, the antenna radiates beginning at the connection on the transceiver, and if the first part of the antenna is close to obstructions, much of the radiated energy will be absorbed. In a hotel room or building, the transceiver should be located right at the window, as a ferro-concrete building will provide almost complete shielding. See the transceiver installation example, Figure 4-3. It is also important to keep the antenna as far away as possible from noise sources, such as power lines.

c) Construction - This will often depend on the operator's ingenuity. The antenna may be a vertical one, a horizontal one, an inverted L, or any combination of twists and bends that get the maximum length of wire up in the clear. If a whip antenna is used, make sure that the transceiver is located as close to the bottom of the whip as possible. A typical installation in a house might have the transceiver in a room close to a window, with the antenna wire going up to the eaves of the house and then across to a tree. In a hotel room or building, the antenna may run up to the roof. If the room is on an upper floor, the antenna can be hung down outside the window, with a weight on the end. If this is done, the antenna must be kept clear of the walls. A broom handle might form a convenient prop.

d) Radiation Pattern - Maximum radiation is broadside to the antenna and minimum off the ends. A vertical antenna will have an omnidirectional pattern and will radiate equally well in all directions. If the antenna is in the form of an "inverted L," maximum radiation will be from the longest part of the antenna. Always try to erect a horizontal antenna broadside to the desired direction of communications.

e) Height - The lowest angle of radiation occurs with the antenna approximately one half wavelength above ground. Low angle radiation is desirable for long distance communications. Higher angles are used for shorter distances. At the lower frequencies it will seldom be possible to erect the antenna at the optimum height, but effective communications at distances of several hundred kilometers may often be obtained with quite low antennas. It is better to have an antenna of reasonable length only a few meters above the ground than to try to operate with a very short whip or wire antenna.

f) Insulation - The antenna must be carefully insulated from the supports and other surfaces. The voltages on the antenna can be as high as 2000V, so good insulation is essential. Never run the antenna close to conducting surfaces without an airgap of several centimeters. Also ensure that a metal window frame is never closed on the antenna wire.

g) Indoor Antennas - Indoor antennas will sometimes work with reasonable efficiency in wooden

buildings. The antenna may be in the attic or pinned along the curtain rail. It may be necessary to go around three sides of the room to get sufficient length. Do try to keep the antenna as far as possible from the electrical wiring.

h) Invisible Antennas - The thickness of the wire will have little effect on the efficiency of the antenna. This makes it practical to use a length of very light gauge enameled wire for temporary antenna installations. If nylon fishing line is used for the supports, the antenna will be very difficult to see, and the nylon will provide excellent insulation.

4.7 GROUNDS

The ground system is extremely important when using the end fed antenna. Without a good ground system the antenna will be difficult to tune and will not radiate efficiently. The case of the transceiver may become hot to RF, causing malfunctions and operator burns. The transceiver is provided with a ground strap 2.5 meters long. This is the maximum recommended length for the ground. If possible, shorten the ground strap by forming a loop in the surplus strap and twisting the strap together. It is best to relocate the transceiver rather than extend the ground connection even if this means that some part of the antenna must come inside the building. The best ground systems use multiple radials buried under the antenna or some form of ground mesh. If the soil has good conductivity, several ground rods may be strapped together with low impedance cables. Unfortunately, good grounds are seldom available for temporary installations. A metal rod driven at least one meter into moist soil will usually give satisfactory results. Alternatively, a connection to a metal cold water pipe, just before it enters the ground, will usually be satisfactory. Frequently the transceiver will be located in an upstairs room and a satisfactory ground cannot be obtained. A counterpoise ground must then be used in place of the real ground. This counterpoise could consist of one or more quarter wavelength wires laid under the antenna. Connection to a hot water radiator or the plumbing system may be effective. Metal window frames may be connected to the building framework to form a good counterpoise. As a last resort, the electrical wiring ground should be used. In outdoor installations the body of a car or truck forms a fairly effective counterpoise.

4.8 ANTENNA TUNER

4.8.1 GENERAL

The transceiver uses an efficient internal antenna tuner to match a variety of antennas to the transceiver. The tuner is coupled to both the 50 ohm coaxial cable connector and the antenna insulator for operation with both end fed and balanced antenna systems. The tuner uses a high voltage variable capacitor shunted from the antenna terminal to ground, a series 22 microhenry inductor with 17 tap positions, and a matching transformer with 6, 12, and 200 ohm taps.

4.8.2 BALANCED ANTENNAS

The tuner may be used with balanced antennas using coaxial cable feed. These usually provide a good match at the resonant frequency, and the tuner will be switched out of circuit by tuning the three controls to 50 ohm positions. The tuner will extend the operating range of the resonant antenna by compensating for a mismatch on the line. If a heavy duty cable is used, the line losses will not become excessive up to VSWR's of more than 3:1. This means that the antenna may be operated over a bandwidth of approximately 10%. It is also possible to match the antenna at the three quarter wavelength point (3 times the normal frequency). The tuner may also be used to provide an exact match for broadband antenna systems.

4.8.3 ANTENNA LENGTHS - END FED ANTENNAS

The antenna tuner is extremely compact, which places some limitations on the matching range and the operating voltage. The following table shows the frequency range for different lengths of antennas.

Length		Frequency Range
Feet	Meters	
10	3.0	4.2-30MHz
25	7.5	3.0-30MHz
50	15.0	2.0-30MHz
75	22.5	2.0-30MHz*

*Series Capacitor 50pF required from 3.0-4.5MHz.

4.8.4 LONG ANTENNAS

The antenna tuner will not match antennas exceeding 50 feet (15 meters) at all frequencies in the tuning range. As an example, the table above indicates that a series capacitor (50pF) is required for the 75 foot antenna in the range 3.0-4.5MHz. This capacitor is mounted on the

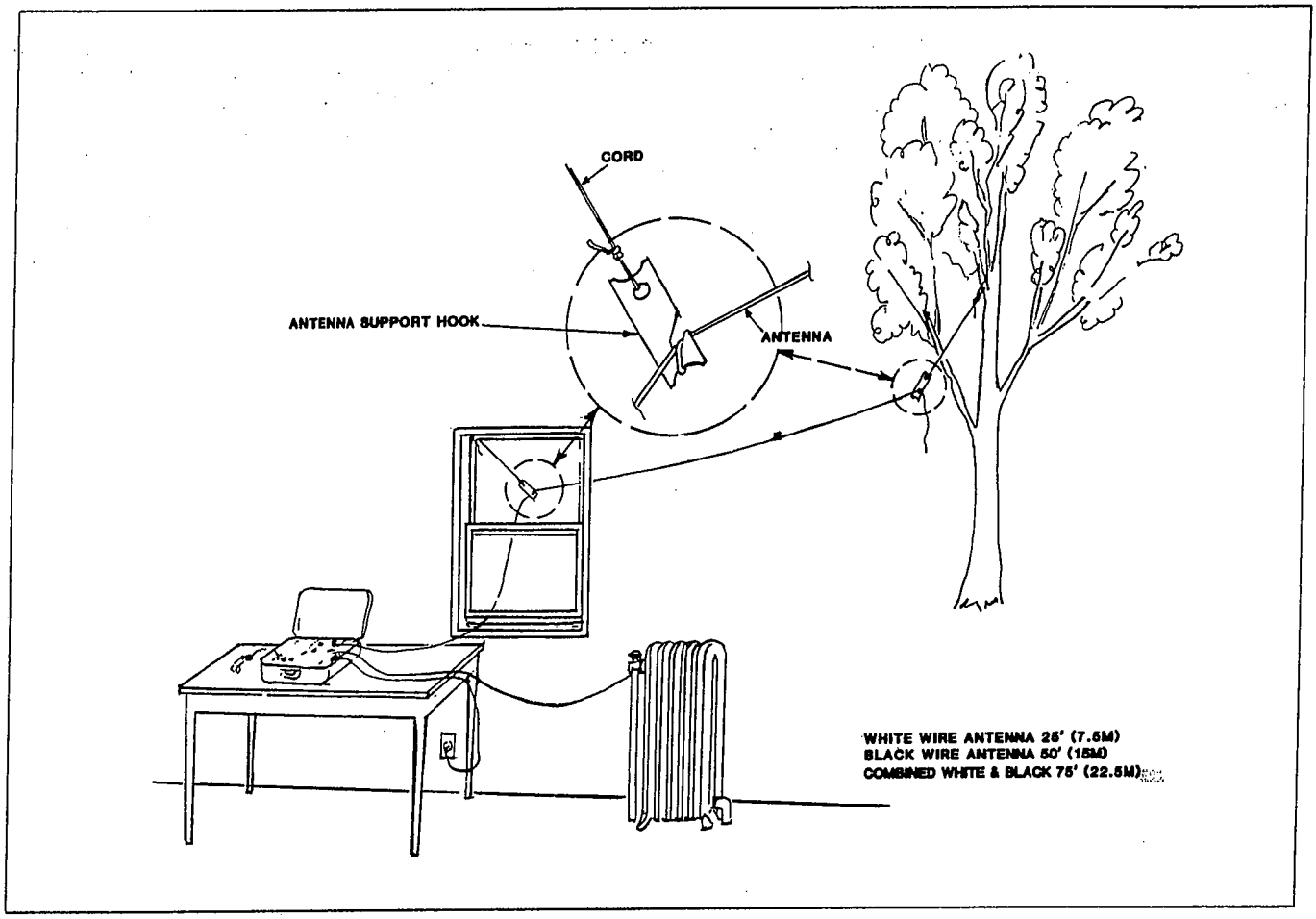


FIGURE 4-3. Example Of Transceiver Installation.

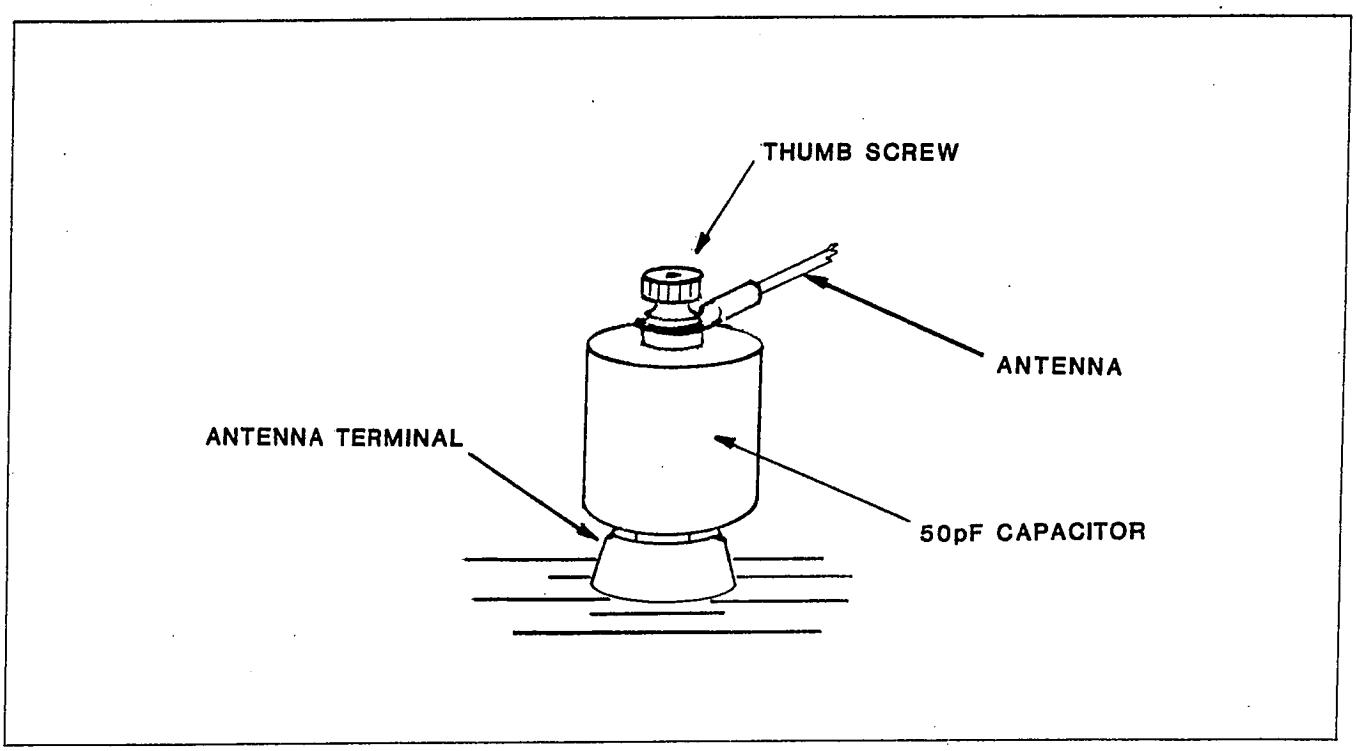


FIGURE 4-4. Installation Of 50pF Capacitor In Series With Long Wire Antenna.

TABLE 4-1. Tuning Procedure.

1. Set the three antenna tuner controls to the 50 ohm position.
2. Turn the TUNE switch to the TUNE position.
3. The meter will show only a small reading when the antenna is mismatched.
4. Always tune for maximum power. It is important to tune accurately. Even power increases of 2 or 3 percent indicate improvements in the matching.
5. The meter will indicate at least 90 when the antenna is correctly matched.
6. Turn the INDUCTANCE switch, stopping at the position of maximum output.
7. Turn the CAPACITANCE control for maximum output.
8. Repeat procedure, trying higher and lower inductance steps until the combination of inductance and capacitance giving the maximum output is found.
9. Repeat these procedures using the 12 ohm and 200 ohm taps. If the 12 ohm taps shows improved output, try the 6 ohm tap.
10. Select the Z match and the combination of inductance and capacitance that gives the maximum output power.
11. Return TUNE switch to OFF position.

NOTES:

a. The tuning will be very critical with short antennas and good ground systems.

b. With some antennas, it may not be possible to detect the optimum inductance tap with the Z match in the 50 ohm position. In this case, try again using the 12 ohm or 200 ohm taps.

c. The initial search is made with the capacitor in the minimum CAPACITANCE position. This is the correct procedure on most frequencies. If the tuning is unsatisfactory, repeat the tuning procedure with the CAPACITANCE set to maximum.

antenna terminal and the antenna is connected to the other end of the capacitor (See Figure 4-4). The series capacitor should be tried if a long antenna cannot be matched. This is usually only necessary on frequencies below 5.5MHz.

4.9 TUNER ADJUSTMENT

4.9.1 INTRODUCTION

Matching the antenna to the transceiver is much more difficult to describe than it is to do. There are three different controls which give a very large number of possible tuning combinations, but only one such combination is likely to give the correct match. Fortunately, the human brain has little difficulty in detecting the tuning trend and rapidly reaches the correct combination. It is recommended that the operator practice tuning the transceiver on a number of different frequencies to get familiar with the operation of the tuner. (See Table 4-1.)

4.9.2 METERING

In the TUNE position the meter reads the transceiver power output in the lower power mode. The meter is calibrated to read approximately 90% of full scale at 10W output. A special circuit detects the degree of antenna mismatch and reduces the power output in relationship to the severity

of the mismatch. Full power output is only available when the match is very close to correct. The system is very effective because a maximum reading on the meter not only ensures maximum power to the load but also ensures the amplifier is seeing the correct match for minimum distortion and correct operation in the high power position. It is very important to tune for the maximum meter indication, as the transceiver is capable of putting substantial power into mismatched loads.

4.9.3 PROBLEMS

If the transceiver does not tune, check that the ground is satisfactory; the majority of problems in tuning can be traced to poor grounds. Not only will the antenna not match correctly, but the chassis of the transceiver will be part of the antenna system. This means that the transceiver may malfunction, and the operator will get small RF burns from the metal parts of the transceiver. It is also possible that the antenna tuner does not have sufficient tuning range to match the antenna.

Check the table in Section 4.8.3 to see that the antenna is at least the minimum length for the frequency of operation. If a long antenna is used, it may be necessary to place the series capacitor (50pF) in series with the antenna lead. If none of these measures are successful, try changing the antenna length. It is possible that a particular antenna and ground system cannot be matched with the tuner. Changing the antenna length will probably change the matching so that it falls within the tuner range.

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 non-technical 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 non-technical 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 AND MODULE REPLACEMENT

5.3.1 GENERAL INFORMATION

Modules 1 through 6, antenna tuner components, and control panel components are accessible while the transceiver is installed in the suitcase. However, service access to the transceiver is generally facilitated by the removal of the transceiver from the suitcase. This is accomplished by loosening the four wingnuts which secure the transceiver to the shock mounts in the corners of the suitcase, and lifting the transceiver out of the suitcase.

Modules M7, M8, M9 and M10 are accessible after the removal of the bottom panel, which is secured by 14 screws.

Power supply components are accessible after removal of the antenna tuner panel.

CAUTION

The full main supply voltage is present at the transformer primary, input connector, input voltage selector switch, fuse holder and front panel power switch. It is recommended that an external DC power supply be 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

Remove the upper left panel which displays the operating instructions (retained by seven screws). Modules M1-M6 are housed in die-cast boxes and are arranged in two layers with modules M1, M2 and M5 on the top layer. Adjustments to these may be made without removing the modules from the transceiver.

The bottom layer consists of modules M3, M4 and M6 (See Figure 5.3.1). Access to the bottom layer and the removal of any of the modules M1 through M6 require that the cluster of six modules be lifted clear of the transceiver frame. This is accomplished by removing the six retaining screws located at the extreme corners of the three boxes in the upper layer. These are long round head screws and are not to be confused with the flat head screws which retain the module covers. The cluster of six modules may now be raised clear of the frame, constrained only by the wiring harness and flexible coax connectors.

The removal of the two flexible coax cables from M4 and the separation of harness plugs from the modules permits the entire cluster of modules to be moved to a work bench for module replacement. Those semi-rigid coax links which connect to the module to be replaced are loosened by unscrewing the connectors with a 5/16in or 8mm wrench.

During module replacement, it is important that the semi-rigid coax connectors be sufficiently tight, but care must be taken not to tighten them

to the degree that the mating fitting in the module box is rotated, which could damage the internal connection. If the coax fitting in the box is loose, it should be tightened by removing the cover and tightening the fitting on the inside with a 1/4in wrench.

5.3.3 MODULE REPLACEMENT, M7

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

5.3.4 MODULE REPLACEMENT, M8

M8 is mounted on a bracket which is secured to the inside of the front of the frame by four screws. Removal of these screws and the disconnecting of the four push-on leads permits the bracket and module to be removed through the bottom of the transceiver.

To remove the PC board and transistors from the bracket, unscrew the four mounting screws in each corner of the module and remove the mounting hardware from the two TAB PACK 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 be 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 at various points throughout the transceiver. 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 vertically when removing. 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.

5.3.8.1 CONTROL PANEL COMPONENT ACCESS

The control panel may be hinged outward on its harness after the removal of its six retaining screws. Additional movement may be provided by unsoldering the +13.6V (red) leads at the connection to F1, and by unsoldering the 13.6V (black) ground lead at the DC power connector.

5.3.8.2 ANTENNA TUNER COMPONENT ACCESS

After removing the CAPACITANCE knob (5/64 hex key) and after removing the six attaching screws, the left side of the antenna tuner panel is raised slightly to permit the separation of the coax connector, located near the Z MATCH switch. The right side of the panel is then raised sufficiently to permit separation of the two-pin speaker connector, which is mounted on the RF transformer backing board, and the separation of the RF slip connector from the variable capacitor stator. The panel and components can then be removed from the transceiver.

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 PIT 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.

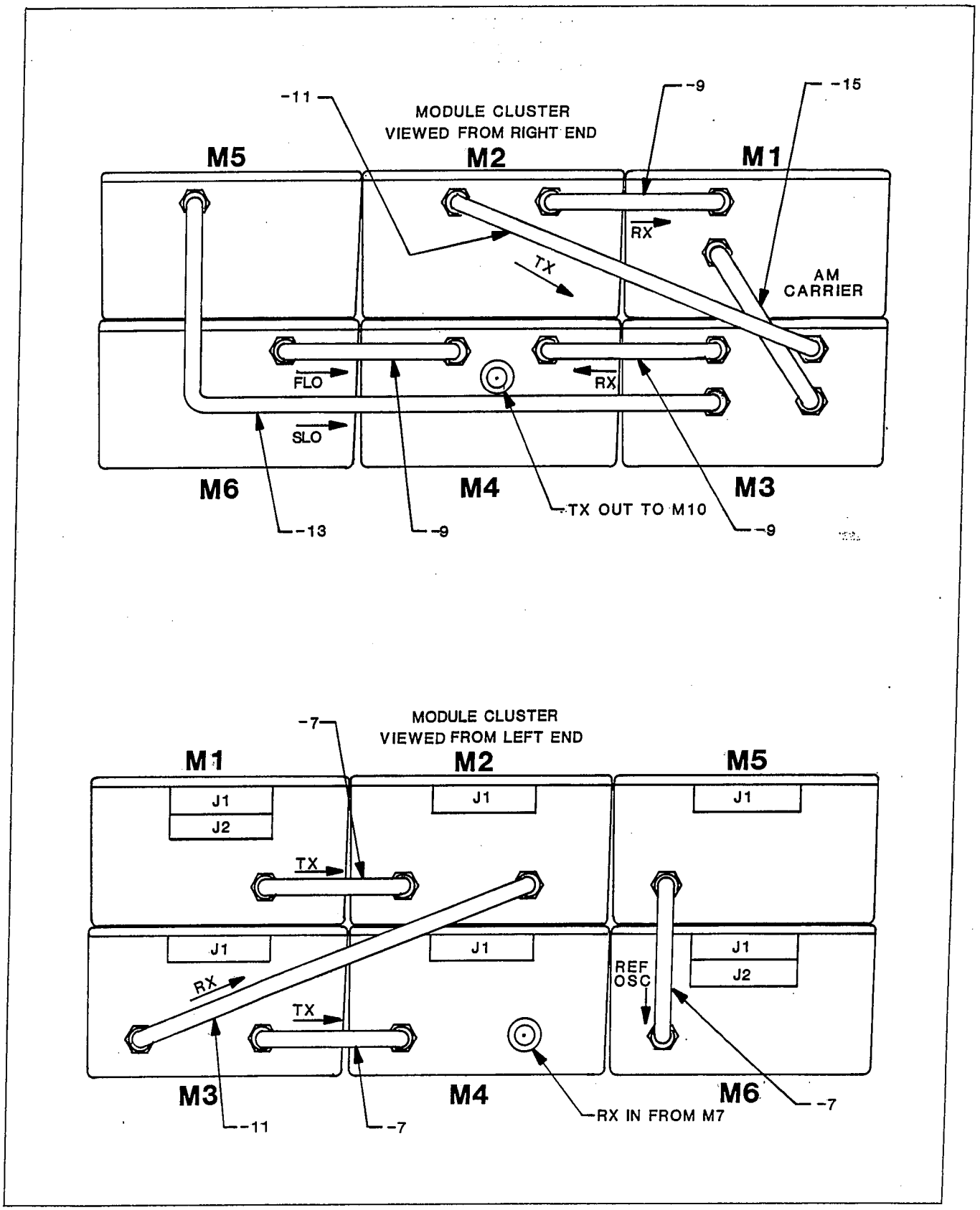


FIGURE 5-1. Physical Arrangement of Modules M1 Through M6.

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
Display 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 control panel. The "Transorb" may fail in the shorted mode if subjected to sustained overload or a 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. (Squelch Off)	Defect in M1, Loud-speaker, or Squelch Switch.	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 not 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.	Measure VSWR and adjust antenna or tuner as required.
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 C in microphone socket to ground.

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 with 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" 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 operation. * Should be approximately 18V in AC operation.
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.

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

M11 FREQUENCY DISPLAY MODULE	
Transceiver appears to be operating correctly but display is not operating.	* Check connections.
MICROPHONE	
Transmitter does not operate.	* Check by replacement of microphone. * Ground pin C of connector and touch pin D with hand. If transmitter shows RF output, microphone is faulty.

SECTION 6
ACCESSORIES

6.1 GENERAL INFORMATION

The TW100F transceiver is supplied with the following accessories:

1) 1 each, MHS Handset (microphone/earphone).
2) 1 each, Antenna Assembly, 7.5M long, black, wound on stowage blade.
3) 1 each, Antenna Assembly, 15M long, white, wound on stowage blade.
4) 2 each, Hook, Antenna Support, with Cord.
5) 1 each, Capacitor Assembly, 50pF.
6) 1 each, Power Cable, DC.
7) 1 each, Ground Cable.
8) 1 each, Power Cable, AC.
9) 1 set, Adapters for foreign AC outlets (4 pieces).
10) 2 each, Fuse, 5A; 2 each, Fuse, 20A; 1 each, Fuse, 3A (all contained in box).
11) 2 each, Stowage Pouch.
12) Operator's Manual.

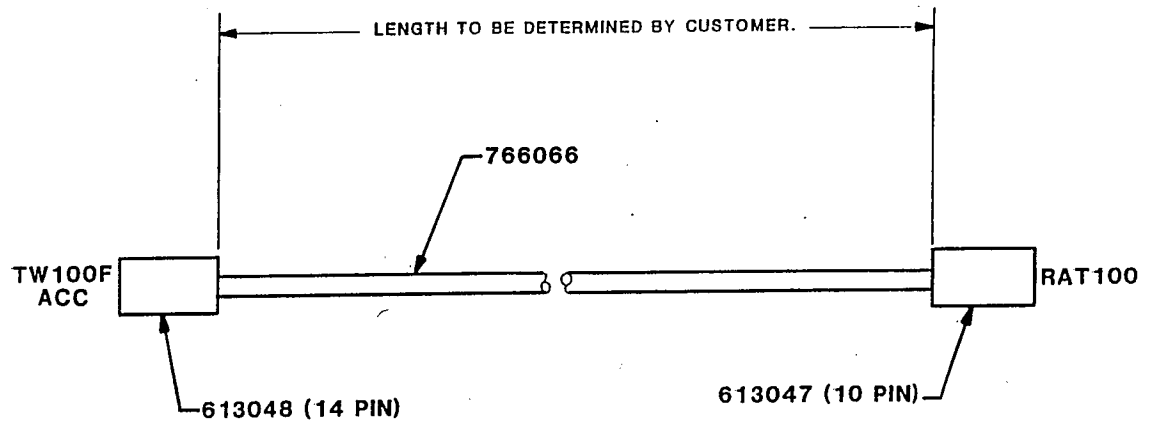
Items 1 through 11 are stowed in 2 pouches (item 11), and the pouches are placed within the suitcase at the left and right hand sides of the transceiver.

6.2 OPTIONAL ACCESSORIES

Many optional accessories are available with the TW100F. These accessories include:

1. Headphones, Morse Key, Heavy Duty Hand Microphone.
2. Dipole and End-Fed Antenna Kits.
3. RAT100 and AT100 Automatic Antenna Tuners.
4. RT5201 and TW5201 Remote Control Consoles.
5. RT5500 and TW5500 Full-Function Message Terminals.
6. TW5800 Telephone Coupler.

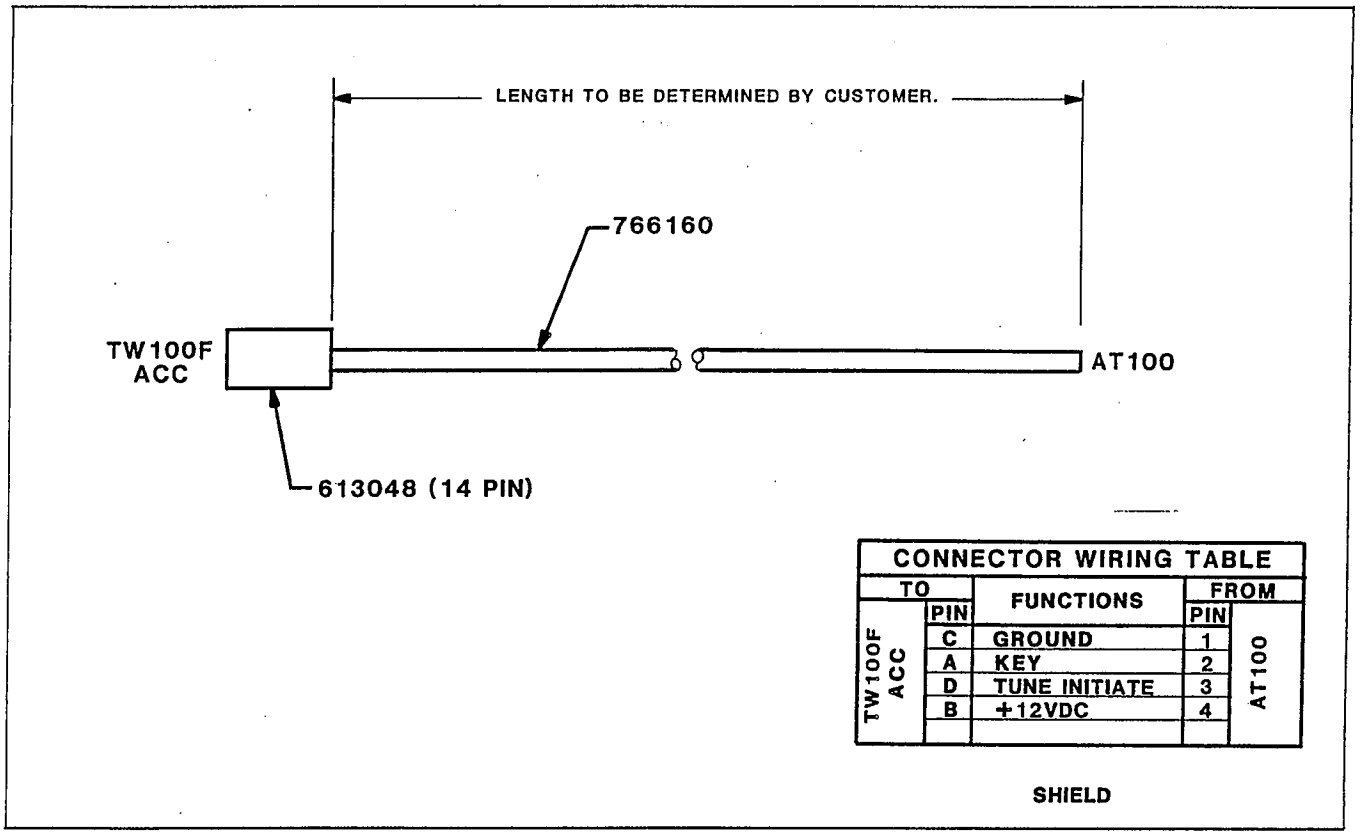
Figures 6-1 through 6-7 show exploded drawings and parts lists for the accessory cables necessary to interface with the optional equipment listed above.



CONNECTOR WIRING TABLE

TO		FUNCTIONS	FROM	
	PIN		PIN	
TW100F ACC	A	KEY	A	RAT100
	B	+12VDC	F	
	C	GROUND	B	
	D	TUNE INITIATE	G	

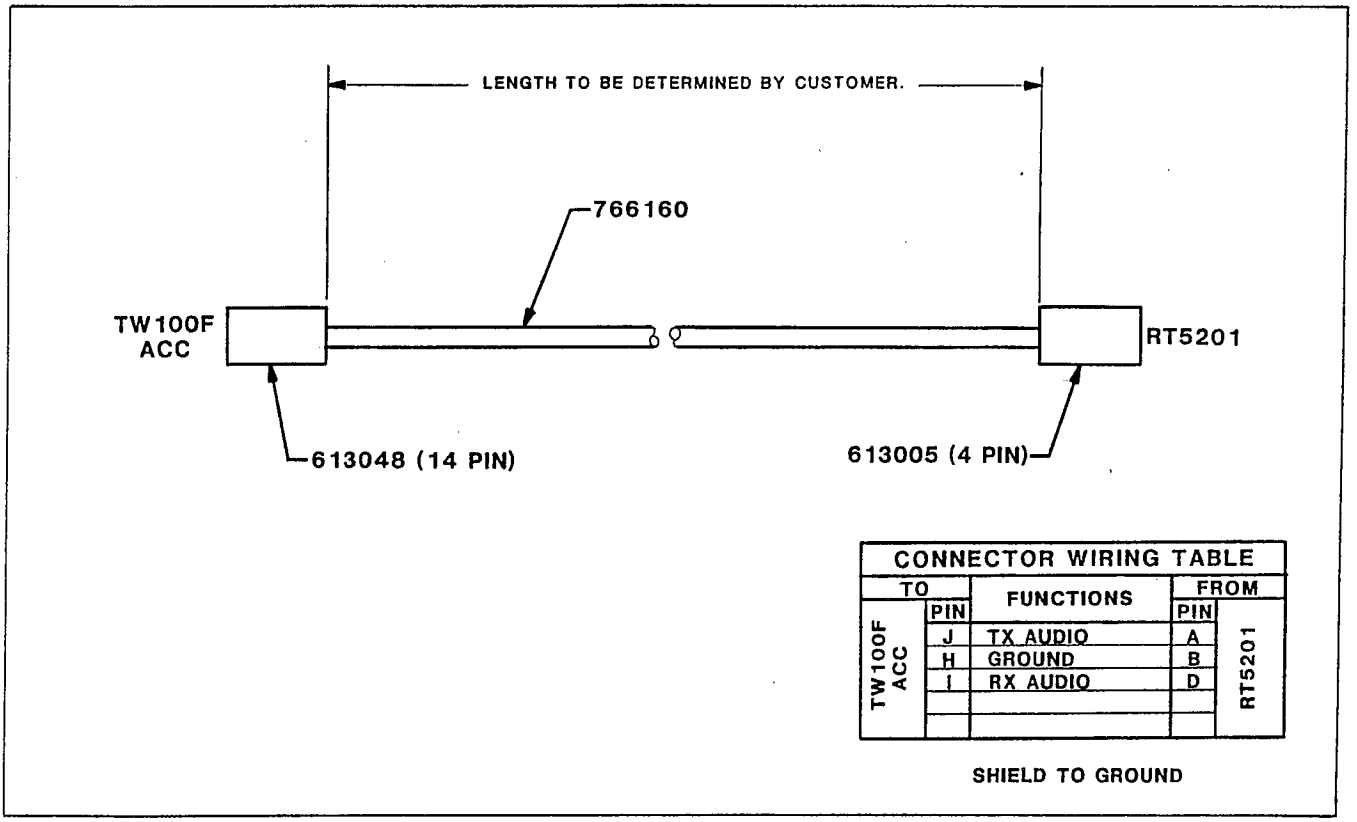
FIGURE 6-1. Accessory Cable - TW100F to RAT100 Automatic Antenna Tuner.



CONNECTOR WIRING TABLE				
TO		FUNCTIONS	FROM	
	PIN		PIN	
TW100F ACC	C	GROUND	1	AT100
	A	KEY	2	
	D	TUNE INITIATE	3	
	B	+12VDC	4	

SHIELD

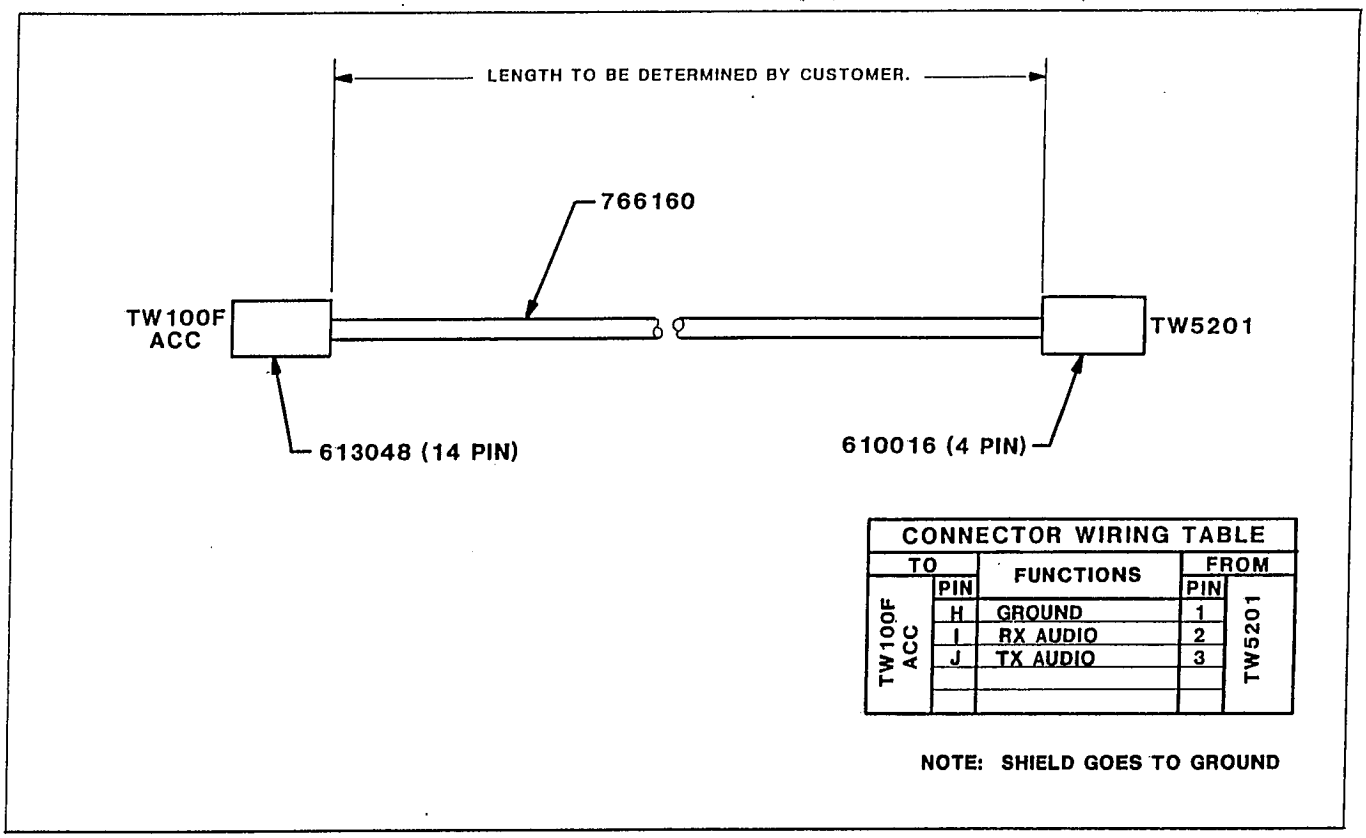
FIGURE 6-2. Accessory Cable - TW100F to AT100 Automatic Antenna Tuner.



CONNECTOR WIRING TABLE				
TO		FUNCTIONS	FROM	
	PIN		PIN	
TW100F ACC	J	TX AUDIO	A	RT5201
	H	GROUND	B	
	I	RX AUDIO	D	

SHIELD TO GROUND

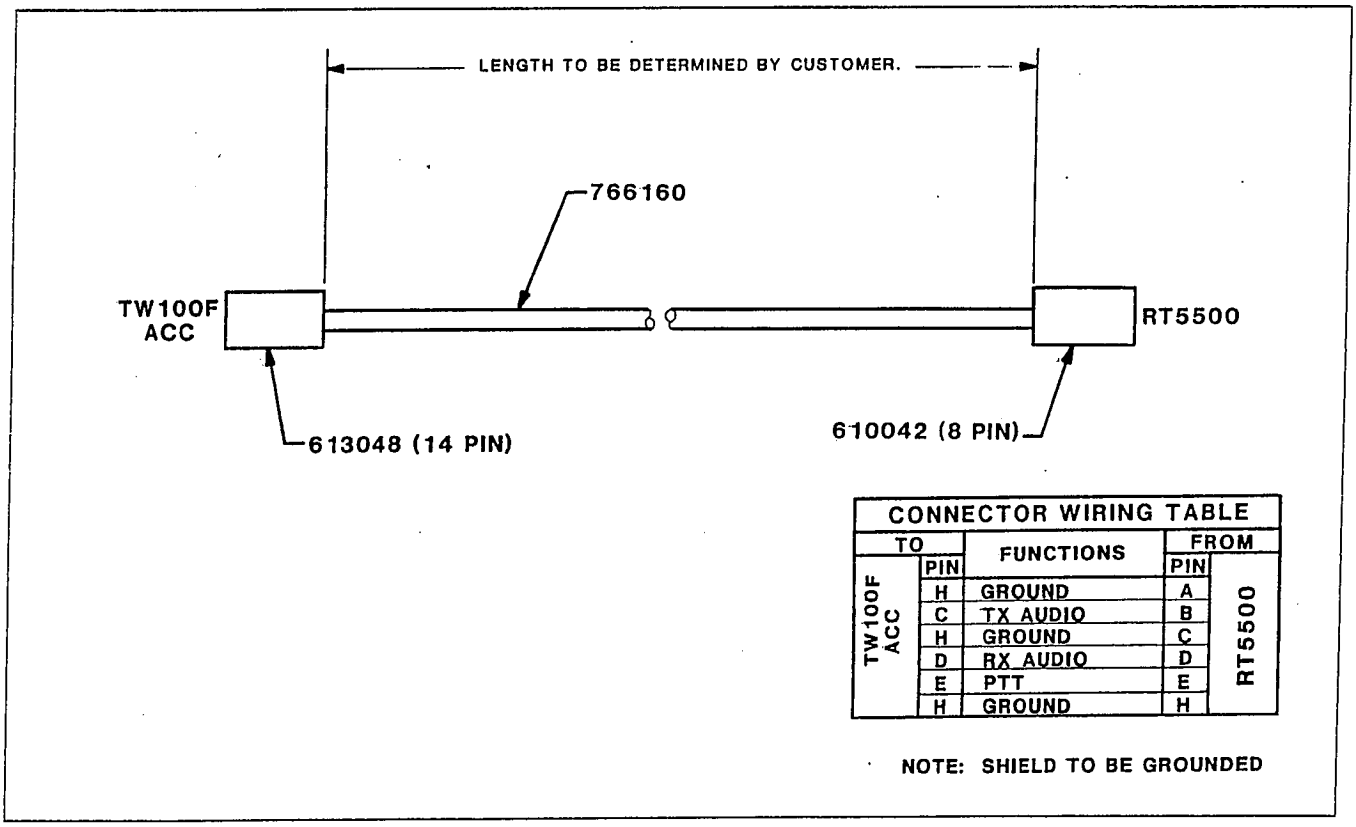
FIGURE 6-3. Accessory Cable - TW100F to RT5201 Remote Control.



CONNECTOR WIRING TABLE				
TO		FUNCTIONS	FROM	
	PIN		PIN	
TW100F ACC	H	GROUND	1	TW5201
	I	RX AUDIO	2	
	J	TX AUDIO	3	

NOTE: SHIELD GOES TO GROUND

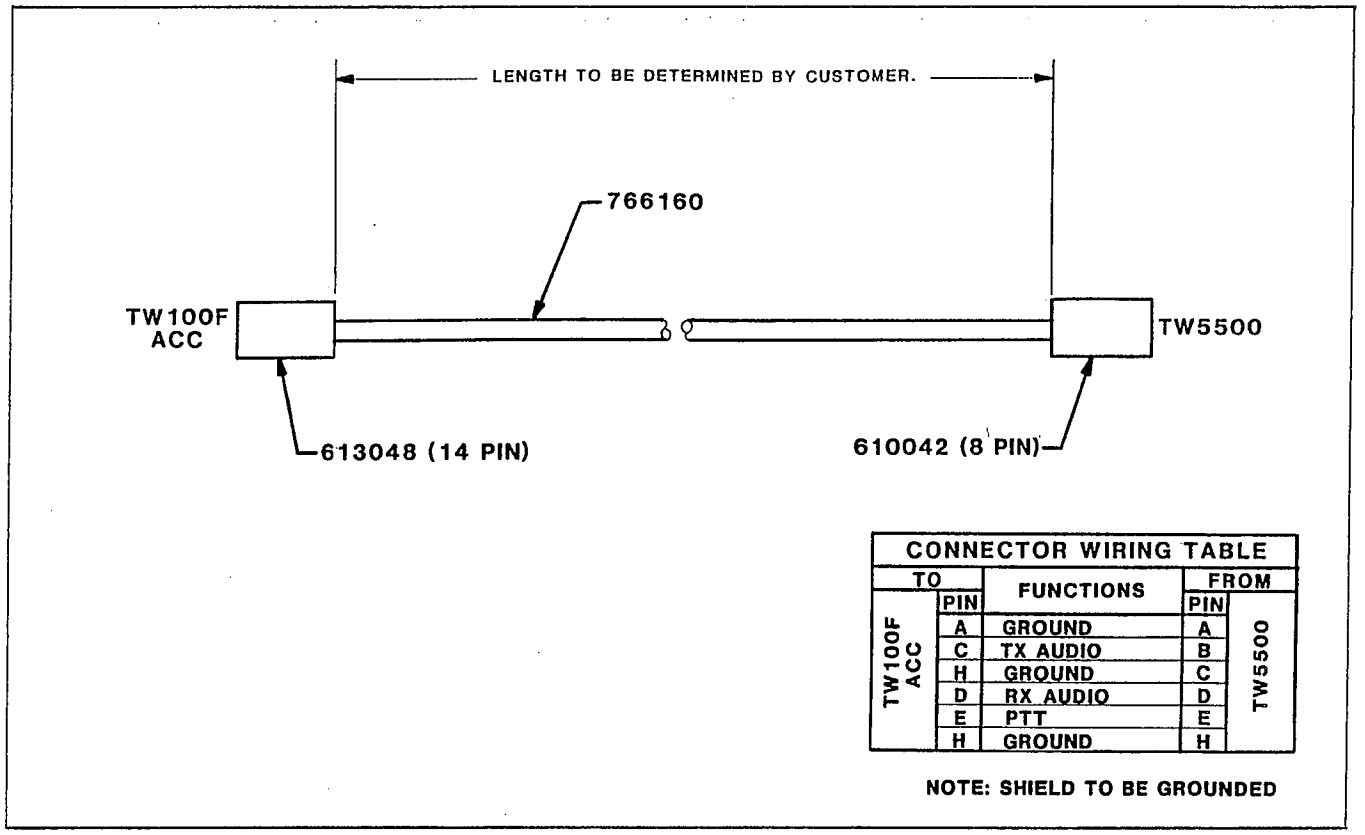
FIGURE 6-4. Accessory Cable - TW100F to TW5201 Remote Control.



CONNECTOR WIRING TABLE				
TO		FUNCTIONS	FROM	
	PIN		PIN	
TW100F ACC	H	GROUND	A	RT5500
	C	TX AUDIO	B	
	H	GROUND	C	
	D	RX AUDIO	D	
	E	PTT	E	
	H	GROUND	H	

NOTE: SHIELD TO BE GROUNDED

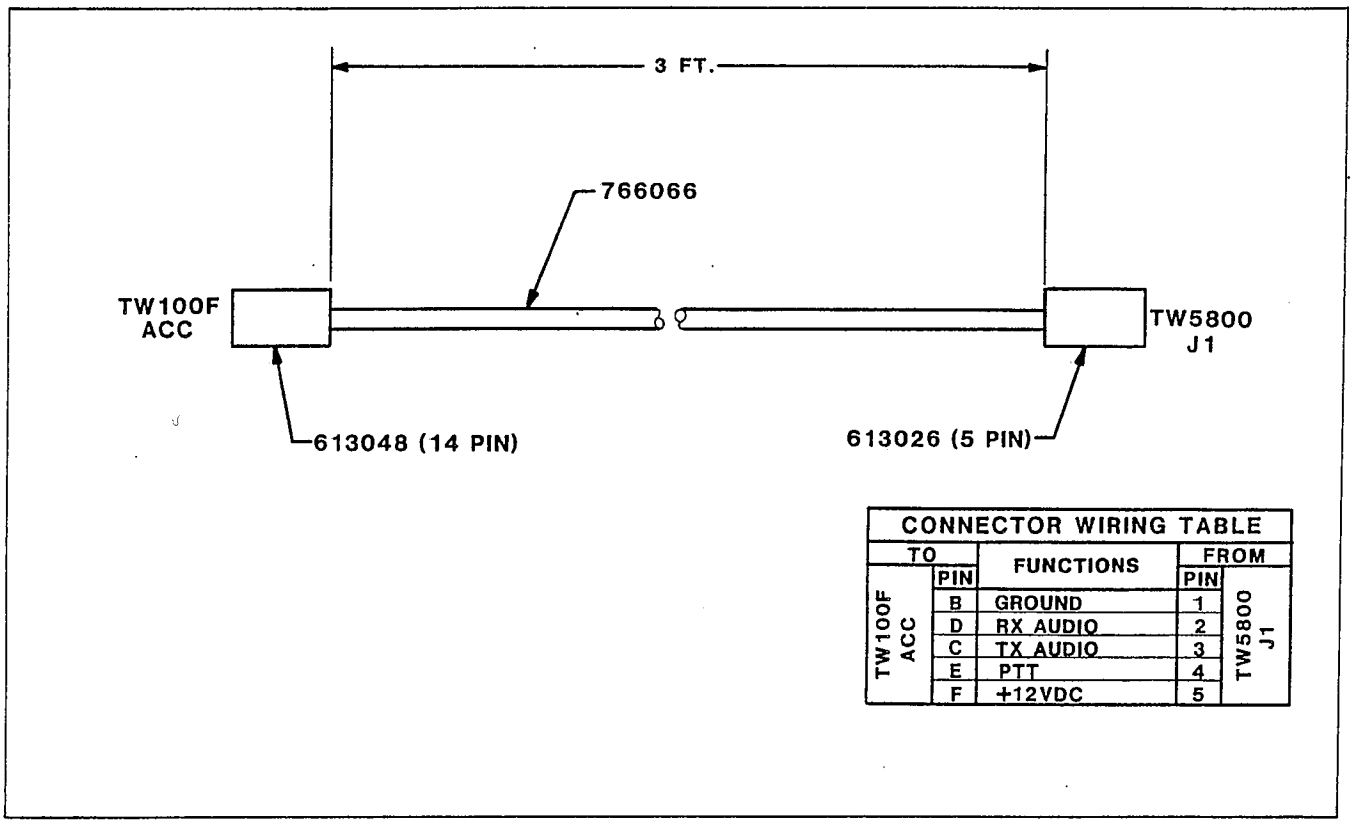
FIGURE 6-5. Accessory Cable - TW100F to RT5500 Message Terminal.



CONNECTOR WIRING TABLE				
TO		FUNCTIONS	FROM	
TW100F ACC	PIN		PIN	TW5500
	A	GROUND	A	
	C	TX AUDIO	B	
	H	GROUND	C	
	D	RX AUDIO	D	
	E	PTT	E	
	H	GROUND	H	

NOTE: SHIELD TO BE GROUNDED

FIGURE 6-6. Accessory Cable - TW100F to TW5500 Message Terminal.



CONNECTOR WIRING TABLE				
TO		FUNCTIONS	FROM	
TW100F ACC	PIN		PIN	TW5800 J1
	B	GROUND	1	
	D	RX AUDIO	2	
	C	TX AUDIO	3	
	E	PTT	4	
	F	+12VDC	5	

FIGURE 6-7. Accessory Cable - TW100F to TW5800 Telephone Coupler.