TW100F FLY-AWAY HF SSB TRANSCEIVER OPERATOR'S MANUAL

TRANSWORLD™
for communications

Manual Part No. TW100F-MSOP
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Warranty

Trans World Communications, Inc. (TWC) warrants that new TWC equipment has been manufactured free of defects in design, material and workmanship. If the equipment does not give satisfactory service due to defects covered by this warranty, TWC will, at its option, replace or repair the equipment free of charge.

The warranty is for a period of 90 days from the date of installation. In the event that the equipment is not installed within 90 days of factory shipment, satisfactory evidence of the installation date must be submitted.

Limitations:

This warranty does not cover physical damage caused by impact, liquids or gases. Defects caused by lightning, static discharge, voltage transients, or application of incorrect supply voltages are specifically excluded from this warranty.

Return Of Equipment - USA:

The equipment shall be returned freight prepaid to the Service Department, Trans World Communications, Inc., 304 Enterprise Street, Escondido, California 92029. The equipment should be packed securely, as TWC will not be responsible for damage incurred in transit. Please include a letter containing the following information:

- Model, serial number, and date of installation.
- Name of dealer or supplier of equipment.
- Detailed explanation of problem.
- Return shipping instructions.

TWC will return the equipment prepaid by United Parcel Service, Parcel Post or truck. If alternate shipping is specified, freight charges will be made collect.

Return Of Equipment - Foreign:

Write for specific instructions. Do not return equipment without authorization. It is usually not possible to clear equipment through U.S. Customs without the correct documentation. If equipment is returned without authorization, the sender is responsible for all taxes, customs duties and clearance charges.

Limited Parts Warranty:

This warranty shall cover all parts in the equipment for a period of 12 months from the date of installation, subject to the previous conditions and limitations. The parts will be replaced free of cost. The labor charges will be made at the current TWC hourly service rate.

Parts Replacement:

If it is not practical, or the purchaser does not want to return the equipment to the factory, this warranty is limited to the supply of replacement parts for a period of 12 months from the date of equipment installation. The following instructions for the supply of replacement parts should be followed:

- Return defective parts prepaid to: Parts Replacement, Trans World Communications, Inc., 304 Enterprise Street, Escondido, California 92029.

- Include a letter with the following information:

  Part number(s).

  Serial number and model of equipment.

  Date of installation.

Parts returned without this information will not be replaced. In the event of a dispute over the age of the replacement part, components date coded over 24 months prior will be considered out of warranty.

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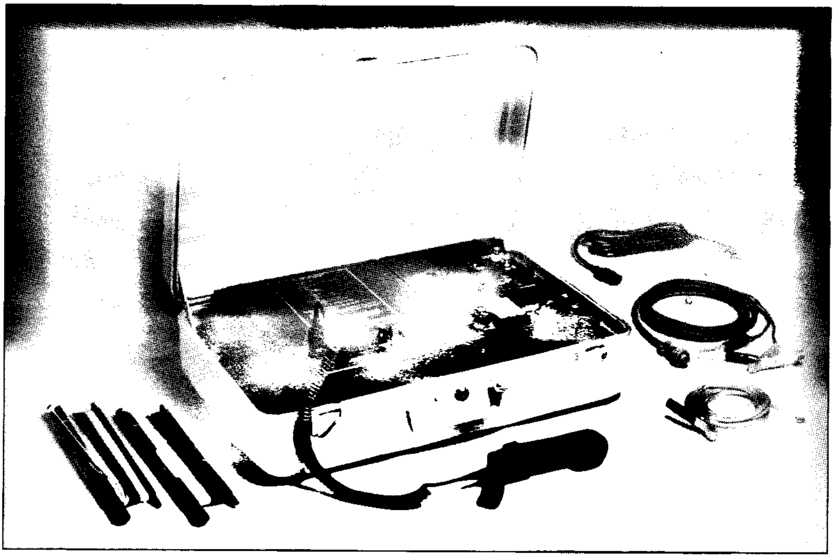

FIGURE 1-1.
TW100F Fly-Away Transceiver.

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, which means 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 affected by selective fading and interference, which gives 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 3 MHz 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 sunspot 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 lightning; 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 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 3 MHz, 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 3-5 MHz 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 efficiencies with mobile antennas in this range.

The medium frequencies from 5-11 MHz 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 12 MHz is favored for long-distance communications. The propagation will be severely affected by the ionosphere, and expert advice is essential in choosing the correct frequencies for long-distance operation. For example, frequencies as high as 30 MHz may be used for worldwide communications during the peak of the sunspot cycle. However, during periods of low sunspot activity, this HF 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

The modes of operation are as follows:

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 3.5-MHz and 7-MHz 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)

Radio teletype 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 Flyaway Transceiver

The Flyaway HF transceiver makes the concept of a compact, self-contained, long-distance radio telephone a reality. A specially designed, lightweight, 125-W, 1.6- to 30-MHz 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 12-V 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 Description

The transceiver is a solid-state, high-frequency, single-sideband transceiver operating in the frequency range from 1.6-30 MHz. The range is covered in 100-Hz 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 125 W PEP (100 W AVG) and a switch-selected low-power setting of 10 W. The power output is controlled by automatic circuitry which also protects against mismatched antennas. In order to minimize weight, the transceiver uses a small heat sink 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 105-125 V and 210-245 V. The power supply frequency may range from 50 to 400 Hz. 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 12-V battery.

A built-in antenna tuner will match the transceiver to a wide variety of whip and wire antennas up to 25 m 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 constructed 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 with 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 75 MHz and the main selectivity at 1650 kHz. With this system, the main spurious products do not fall within the operating range, which ensures 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 which gives freedom from intermodulation and overload. The antenna is coupled to the transceiver through six 7-pole, elliptic-function filters that provide 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 1 the transceiver channel frequencies can be programmed by the operator. Channel 00 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.

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 00 may be programmed by the operator but will only operate in the receive mode.

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.

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 integrated circuits has resulted in an extremely efficient and simple synthesizer design. Two separate loops are used. The 10-kHz loop is used for the first conversion stage and covers the full frequency range in 10-kHz steps.

The 100-Hz loop is used for the second conversion stage and covers a 10-kHz range in 100-Hz steps. Both loops are direct, which ensures freedom from spurious responses. The frequency control is derived from a single temperature-controlled 5120-kHz crystal oscillator.

The synthesizers are controlled by the microprocessor through the keypad. The use of a synthesizer is a special advantage in a multichannel transceiver. Apart from 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. Older synthesizer designs suffered, not only from great complexity, but also internal spurs. The spurs caused whistles in the tuning range of the receiver, which made the transceiver unusable on many frequencies. The transceiver has no spurs exceeding 0.5 μV and has no unusable frequencies from 1.6-30 MHz.

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 0-dBm transmit and receive audio inputs and outputs. The transmit audio level is self-adjusting and will compensate for a wide range of input levels.

1.10 Specifications

Technical specifications for the transceiver are listed in Table 1-1.

TABLE 1-1.
Technical Specifications.

GENERAL	
Frequency Range:	**1.6-30 MHz in 100-Hz 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 00 by keypad entry. Mode 1: Transmit & receive. Mode 2: Receive only. Mode 3: Disabled.

TABLE 1-1.
Technical Specifications (Continued).

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), 100-Hz steps.
Scanning:	Automatic on up to 98 channels.
Antenna Inpedance:	50 ohms.
Temperature Range:	-30° to +55° C.
Frequency Control:	Temperature-controlled master oscillator ± 0.0001 %, ±20 Hz maximum.
Modes:	Simplex and half-duplex.
Operation Modes:	A3J, (USB/LSB), A3H (compatible AM), A1 (CW), F1 teletypes (optional).
TRANSCEIVER:	
Size (w x h x d):	43.2 cm x 14 cm x 28.7 cm.
Weight:	10 kg.
Installed In Carrying Case With Accessories:	
Size (w x h x d):	53 cm x 18 cm x 33 cm.
Weight:	14 kg.
POWER SUPPLY	
13.6 Vdc:	Receive 600 mA, transmit 12 A average SSB.
	Internal ac power supply 105-125 V/210-245 V, 50/60/400 Hz for SSB operation.

TABLE 1-1.
Technical Specifications (Continued).

TRANSMITTER	
Power Output:	125 W PEP, 100 W average, ±1 dB at ambient.
Antenna Mismatch:	Protected against mismatch including open and shorted antennas.
Carrier Suppression:	Greater than -50 dB.
Unwanted Sideband:	-60 dB at 1 kHz, typical.
Spurious Suppression:	Greater than -63 dB, typical.
Audio Input:	150 ohms, VOGAD for constant audio level. 600 ohms, 0 dBm.
Audio Bandwidth:	2.4 kHz.
Intermodulation Distortion:	Greater than -32 dB, typical.
ALC:	Less than 1 dB increase for 20 dB increase in audio input.
Metering:	Relative RF output, tune power.
RECEIVER	
Sensitivity:	0.35 μV for 10 dB S + N/N.
Selectivity:	300 to 2700 Hz -6 dB, -60 dB at 5 kHz typical.
Image Rejection:	Greater than 80 dB.
If Rejection:	Greater than 80 dB.
Conducted Radiation:	-70 dBm.
Agc Characteristics:	Less than 6 dB audio increase from 3 μV to 300,000 mV.
Intercept Point:	+11 dBm.
Intermodulation:	-85 dB.
Clarifier:	±125 Hz.

TABLE 1-1.
Technical Specifications (Continued).

Squelch:	Audio derived, noise immune.
Audio Output:	4 W into 3 ohms, internal loudspeaker. 600 ohms 0 dBm.
Metering:	RX signal strength.
ANTENNA TUNER	
Impedance:	6, 12, 50, 120 ohms.
Series Inductance:	0-23 microhenrys.
Shunt Capacitance:	10-100 pF.

Specifications subject to change without notice.

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Operation

2.1 Introduction

The Flyaway transceiver is designed for operation in almost any place at any time. Before starting on a mission, ensure that 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 2-2.

2.2 Choosing The Location

It is important to choose the best location, and this choice will be determined by the antenna. The success or failure of the communications will be largely dependent on the antenna system. Since the antenna system is so important, Chapter 3 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.

2.3 Power Source

Ac and 12-Vdc operation are described in the sections that follow.

2.3.1 AC Operation

Determine the voltage of the power source. A three-position switch is located on the right-hand 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.

CAUTION!

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

If there is any doubt about the voltage of the supply, select the 240-V switch position. The transceiver will operate at voltages down to 200 V 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 115-V position.

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.

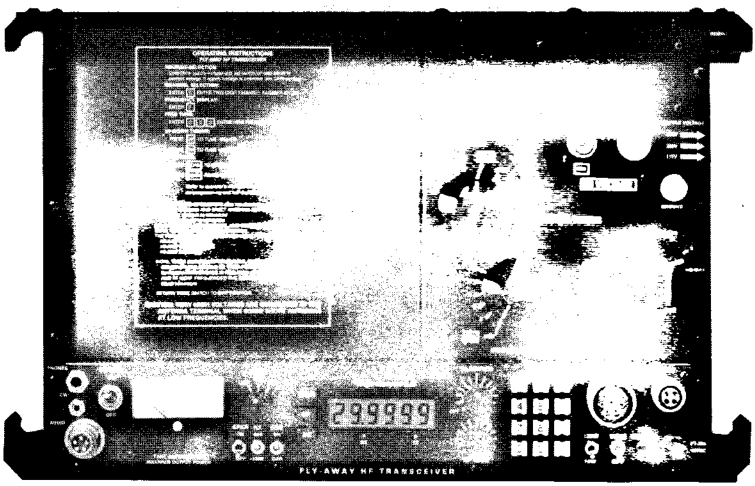


FIGURE 2-1.
Front Panel.

2.3.2 12 -Vdc Operation

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

The transceiver is supplied with a 12-V cable fitted with a connector and two battery clips. Plug the cable into the connector marked 12 Vdc, 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 (8 AWG) to prevent excessive voltage drop.

WARNING!

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.

2.4 Antennas & Ground

Refer to Section 3 for full information on the ground, antenna systems and operation of the antenna tuner.

2.5 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.

2.6 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.

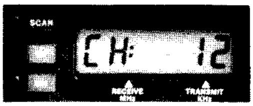
- Mode 1: All facilities are available in this mode, including the programming of transmitting frequencies. This mode is normally only available to trained operators.

- Mode 2: In this mode the operator has no control over the transmitting frequency and must operate in the pre-programmed channel frequencies. Channel 00 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.

2.7 Channel Selection - Keypad (2)

Enter **C** followed by a 2-digit channel number.



If CH: 00 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.***

2.8 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.

2.9 Free-Tune Channel 00

Channel 00 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 00**. 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 00.

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".

2.10 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 100 Hz. 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 (00) it is possible to change the frequency in memory permanently by pressing the **F** key after stepping.

2.11 AF Gain (3)

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

2.12 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.

2.13 Attenuator Switch - RX (5)

The attenuator switch reduces the gain of the transceiver by 12 dB (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 (-12-dB 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 +23 dBm, while the sensitivity is still better than 1.2 microvolts.)

2.14 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.

2.15 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.

2.16 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 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.

2.17 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 100-W 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.

2.18 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.

2.19 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 by ensuring that 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.

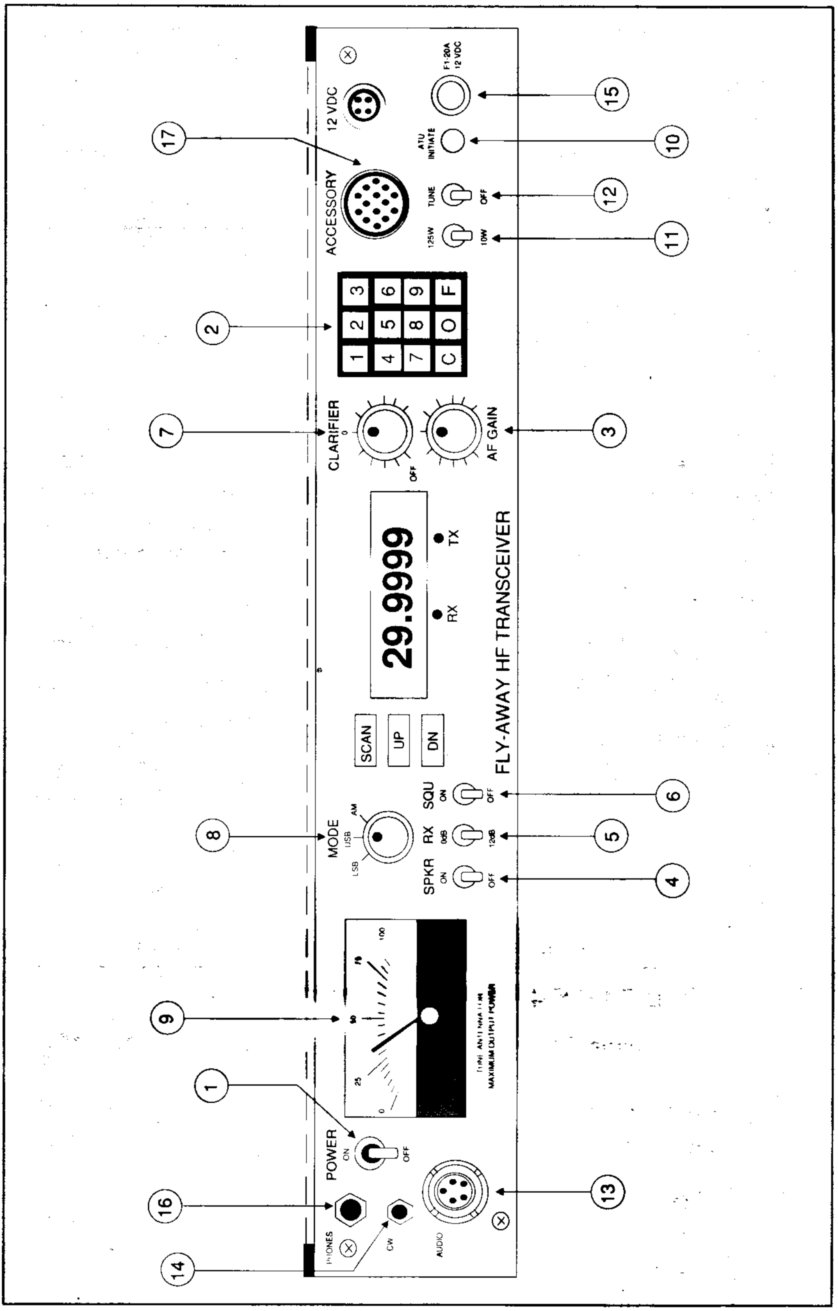


FIGURE 2-2.
Front Panel Controls.

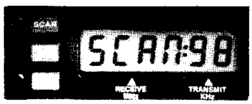
Enter **F** then repeat the double keystroke action **F C** and check to ensure that the pointer has moved to "transmit frequency". Enter the transmit frequency and press **F** .

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 be changed at five year intervals.

2.20 Scan Mode

It is possible to scan between 2 and 98 channels in the scan mode. Program the desired frequencies starting at channel 01. 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 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.

2.21 125/10-W 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.

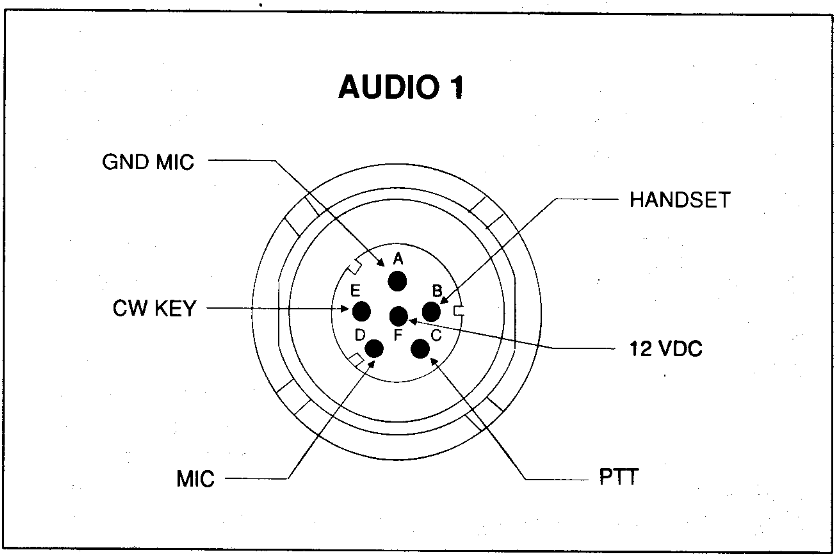


FIGURE 2-3.
Audio Connector - Internal Connections.

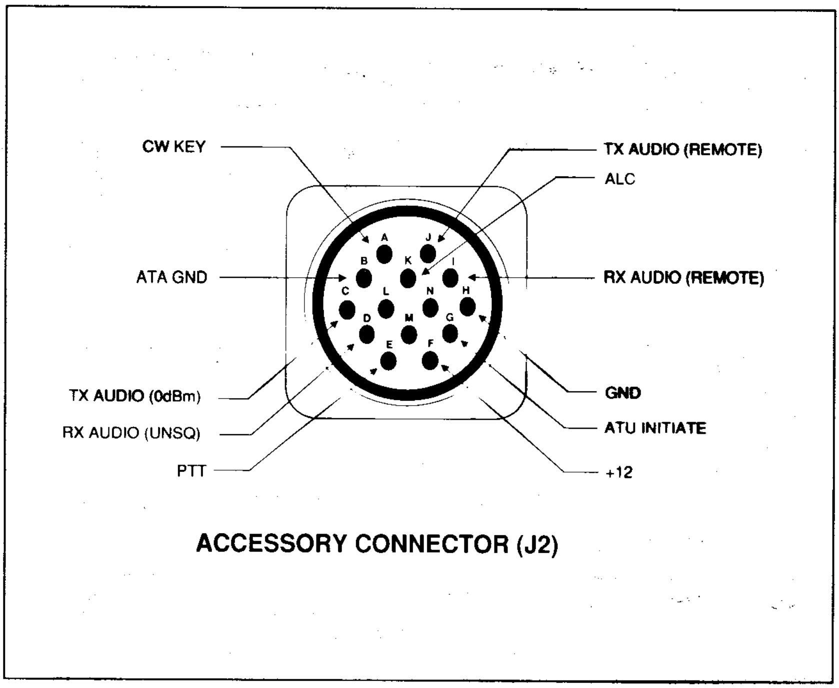


FIGURE 2-4.
Accessory Connector - Internal Connections.

2.22 Tune Switch (12)

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

2.23 Handset (13)

The handset is connected to the connector marked AUDIO. Figure 2-3 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.

2.24 Headphones (14)

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

2.25 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 12-Vdc supply fuse (F1, rated 20 A) is located on the control panel.
3) The 12-Vdc regulator fuse (F3, rated 5A) is located on M8 and protects only that portion of the transceiver supplied with ***regulated*** 12 Vdc.

WARNING!

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

2.26 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.

2.27 Accessory Connector (17)

The connections to the accessory connector are shown in Figure 2-4. This connector is normally used for operation with external audio accessories such as a modem or a message terminal for RTTY operation. 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.

2.28 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 13.6 V at 20 A, 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.

2.29 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.

2.30 Operation—Selcall

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 (001 to 255). This code is internally programmed in the Selcall module.

Press the "S.C." key and enter the three-digit code for the desired station. Press the "CALL" button, 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. The Selcall module at the station called displays "CALL" on the LCD display, and sounds the call alarm tone at both stations.

When a call is received, press the "SCAN" key to stop the scan. After the call is completed, press any key on the keypad to cancel the "CALL" display. If the scan mode is in use, press the "SCAN" key again to initiate scan.

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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 clear of wires, electrical machinery, or any potential source of electrical shock.

DO NOT TAKE RISKS!

3.1 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.

3.2 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 3.3 and 3.4.

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.

3.3 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 2 MHz, this height is 75 meters and is 13 meters at 12 MHz. 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 is relatively unimportant.

Figures 3-1 and 3-2 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.

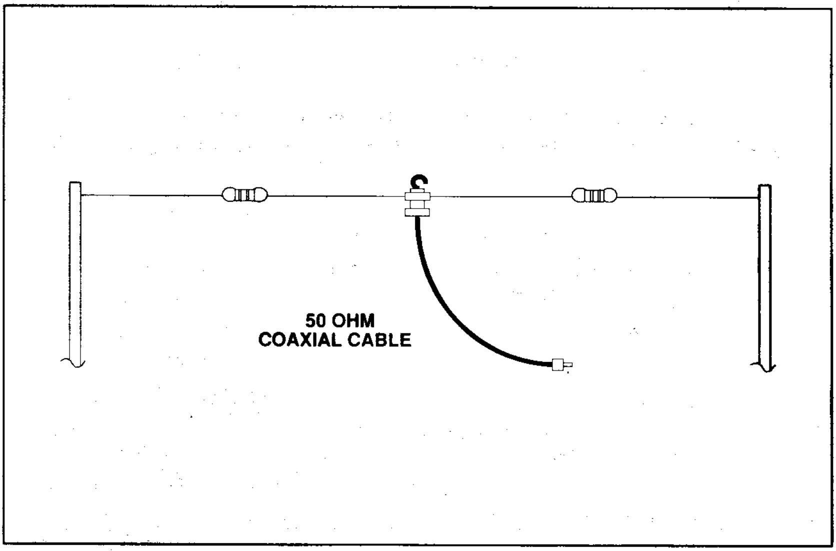

FIGURE 3-1.
Half-Wavelength Dipole.

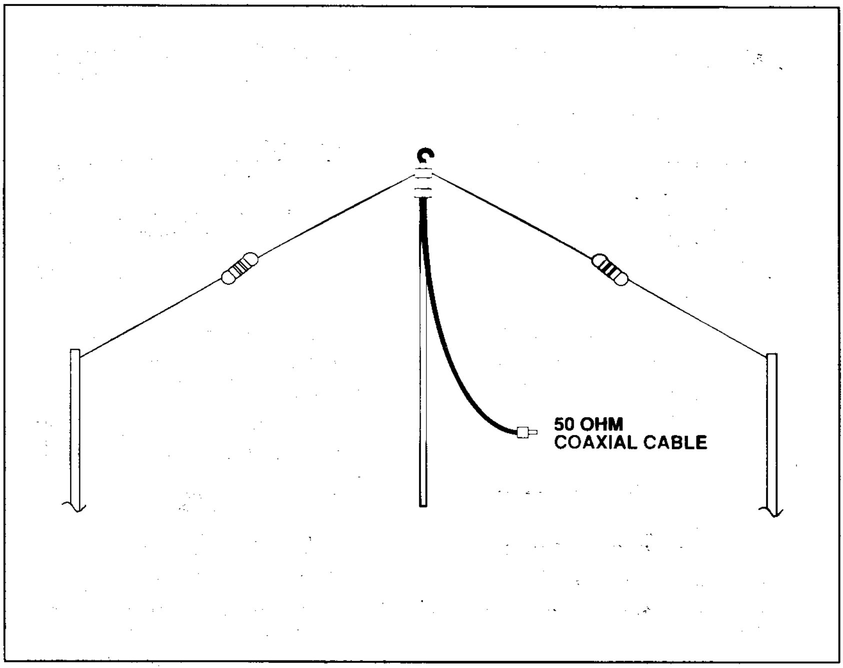

FIGURE 3-2.
Inverted "V" Antenna.

3.4 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 3.5 MHz to 30 MHz 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.

3.5 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.

3.6 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**—Since the entire antenna radiates, 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. 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 3-3. 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

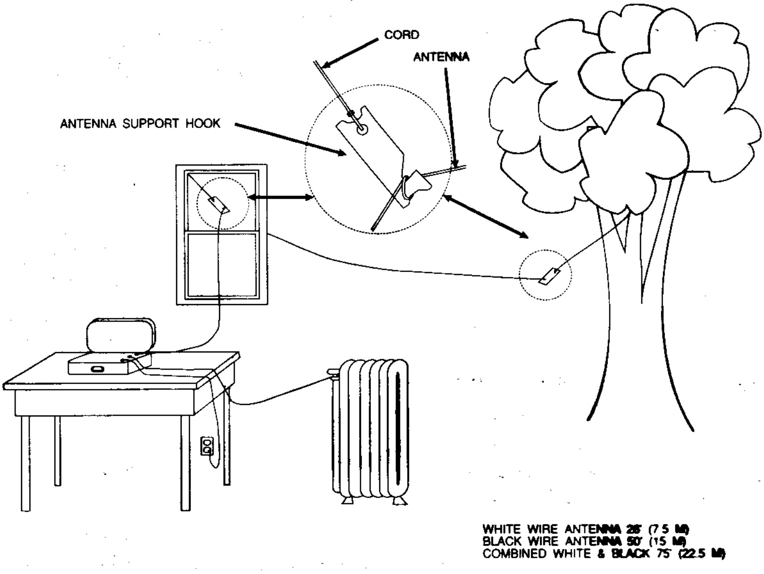

FIGURE 3-3.
Example of Transceiver Installation.

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 2000 V, 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.

3.7 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, which causes 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.

3.8 Antenna Tuner

A discussion of the antenna tuner follows.

3.8.1 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.

3.8.2 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.

3.8.3 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		
Feet	**Meters**	**Frequency Range**
10	3.0	4.2-30 MHz
25	7.5	3.0-30 MHz
50	15.0	2.0-30 MHz
75	22.5	2.0-30 MHz*

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

3.8.4 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 (50 pF) is required for the 75-foot antenna in the range 3.0-4.5 MHz. This capacitor is mounted on the antenna terminal and the antenna is connected to the other end of the capacitor (See Figure 3-4). The series capacitor should be tried if a long antenna cannot be matched. This is usually only necessary on frequencies below 5.5 MHz.

3.9 Tuner Adjustment

Information on antenna tuner adjustment follows.

3.9.1 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 3-1.)

3.9.2 Metering

In the TUNE position the meter displays the transceiver power output in the lower power mode. The meter is calibrated to read approximately 90 % of full scale at 10-W 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

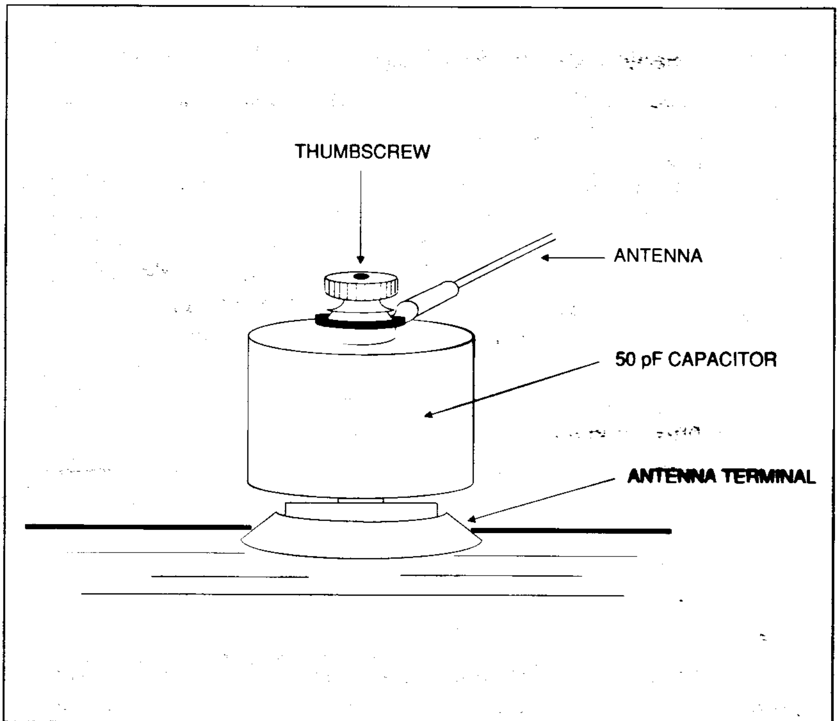

FIGURE 3-4.
Installation of 50-pF Capacitor in Series With Long-Wire

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.

3.9.3 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 3.8.3 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 (50 pF) 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.

TABLE 3-1.
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 tap 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.

Accessories

4.1 General Information

The TW100F transceiver is supplied with the following accessories:

1) 1 each, MHS handset (microphone/earphone).
2) 1 each, antenna assembly, 7.5 m long, black, wound on stowage blade.
3) 1 each, antenna assembly, 15 m long, white, wound on stowage blade.
4) 2 each, hook, antenna support, with cord.
5) 1 each, capacitor assembly, 50 pF.
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, 5 A; 5 each, fuse, 20 A; 5 each, fuse, 3 A (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.

4.2 Optional Accessories

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

1. Headphones, Morse key, heavy-duty hand microphone.
2. ATD adjustable tape dipole antenna.
3. AT100 and RAT100 automatic antenna tuners.
4. TW5201 and RT5201 remote-control consoles.
5. TW5500 and RT5500 full-function message terminals.
6. TW5800 telephone coupler.
7. TW100PP portable power source.

Figure 4-1 is a detailed block diagram showing the TW100F and its family of optional accessory equipment. Connections are made via three connectors on the front panel of the transceiver. As can be seen from the figure, there are more audio accessories than there are available transceiver connectors. Therefore, if it is desired to attach more than one audio accessory to the rear panel, special cabling must be made up. Either Y-cables or junction boxes are generally used, with each installation being given special consideration.

4.2.1 Accessory Connections

J2 is the accessory connector used to provide control information to companion accessory equipment. The audio levels are 0 dBm and 600 ohms. Table 4-1 shows the pinouts for J2.

4.2.2 DC Input Power Connections

J4 is the accessory connector used to provide primary dc power to the TW100F from external power supplies, such as the TW100PP portable power source. Table 4-2 shows the

TABLE 4-1.
TW100F (J2) Connector Pin-outs and Accessory Equipment Connections.

Pins on TW100F (J2)	Description	Pins on AT100	Pins on RT/TW5500	Pins on TW5201	Pins on TW5800
A	Key	2	—	—	—
B	Ground	—	—	—	
C	TX Audio (0dBm)	—	A	—	3
D	RX Audio (Unsq)	—	C	—	2
E	PTT	—	E	—	4
F	+12 Vdc	4	—	—	5
G	ATU Initiate	3	—	—	—
H	Ground	1	B,D,H	1	1
I	RX Audio (remote)	—	—	2	—
J	TX Audio (remote)	—	—	3	—
K	ALC	—	—	—	—

TABLE 4-2.
TW100F (J4) Connector Pin-outs and Accessory Equipment Connections.

Pins on TW100F (J4)	Pins on Description	TW100PP (J1/J2)
A	+14 Vdc	A
B	+14 Vdc	A
C	Ground	B
D	Ground	B

TABLE 4-3.
TW100PP (J1, J2) Connector Pin-outs and Transceiver Connections.

Pins on TW100PP (J1/J2)	Description	Pins on TW100F (J4)	Pins on TW100 (J6)	Pins on RT100/MP (J4)
A	+14 Vdc	A,B	A	A
B	Ground	C,D	B	B

pinouts for J4. Refer to Section 4.3 for more detailed information on the TW100PP.

4.2.3 RF Output Connections

J12 is used for either a 50-ohm antenna or for an external antenna tuner such as the AT100 or RAT100. The following RF cables are used with Transworld antenna tuners:

1. TW100F to AT100 RF cable C991535
2. TW100F to RAT100 RF cable C991526

The antenna (ANT) connector can hook directly to an external long-wire antenna. In this case, the internal TW100F antenna tuner is used to match the antenna.

4.3 TW100PP Portable Power Source

The following is a discussion of the TW100PP portable power source.

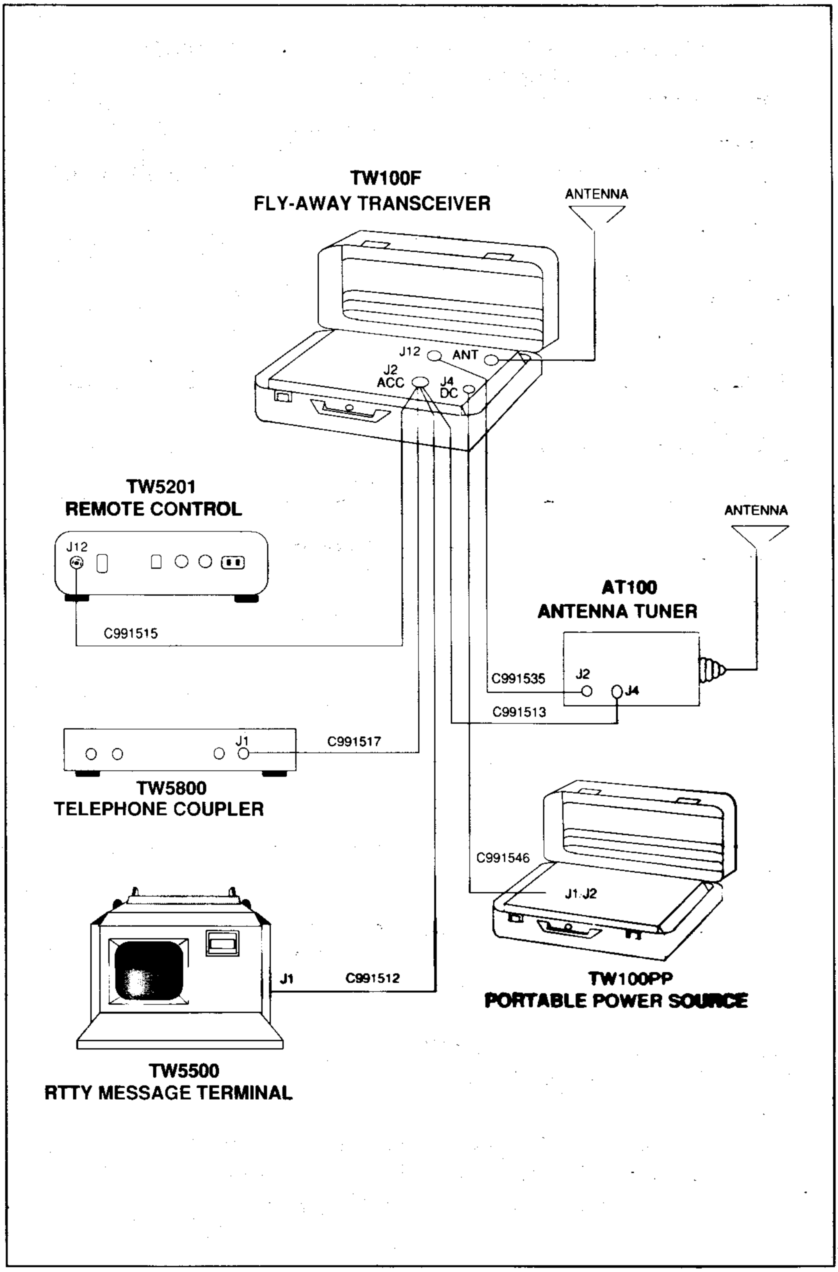

FIGURE 4-1.
TW100F Transceiver and Optional Accessories.

4.3.1 General

The TW100PP is a self-contained portable power source for use with the TW100 and RT100/MP series of transceivers. It is packaged in a rugged aluminum attache-type case matching the TW100F "flyaway" radio. The TW100PP contains a built-in battery charger which is switch selectable for 115 V/230-V 50- to 60-Hz operation. The charger is a constant-current type which uses a fast charge of 2.5 A, which results in a complete charge cycle of ten hours. A built-in timer automatically switches to a float charge of 50 mA at the completion of the charge cycle. A separate panel connector is provided for optional solar charging. The battery voltage is monitored by the panel voltmeter when the power switch is on.

4.3.2 Operational Characteristics

The TW100PP has been designed to operate any of the TW100 or RT100/MP range of transceivers. The battery life, for voice operation on a 1:9 transmit-receive duty cycle is 16 hours. Other accessories may be operated from the TW100PP with the appropriate reduction in battery life. The TW100PP will operate over an extended temperature range, and capacity is reduced to only 90 % at 0° C and 50 % at -30° C. The cells are vented for 50 PSI and may be safely operated at any altitude.

The TW100PP uses seven 25-Ah Gates energy cells as the power source. The U.S.-manufactured Gates energy cells overcome the limitations of normal lead-acid cells, yet retain the reliability, ruggedness, and long life of the lead-acid system. The cell is truly sealed—no acid, acid vapor or water loss—and incorporates recombination of gases within a starved electrolyte system. The cell is maintenance free and the special internal construction results in low impedance, low corrosion and long life. The overall system weight is comparable to nickel-cadmium batteries without the problems of "memory" effects or cell reversal.

The cell also has excellent shock and vibration characteristics due to the packaging design which limits plate movement in any direction. Storage characteristics are also

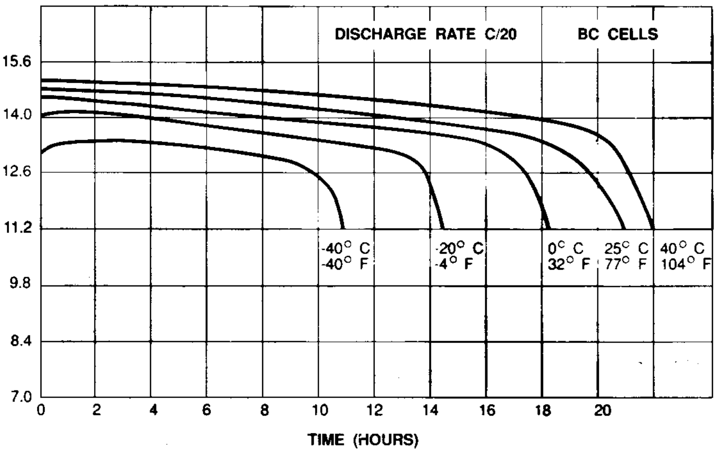

FIGURE 4-2.
Supply Voltage Versus Time.

excellent as the cell may be stored for three years at room temperature and then recharged with no loss in cell reliability or performance capabilities.

Another feature of the TW100PP is that the cell discharge characteristic is relatively flat, which ensures that the overall supply voltage will not fall below 13.6 V until the battery is almost completely discharged. The transceivers are able to operate at full power output during the entire discharge cycle. Figure 4-2 is a plot of the supply voltage versus time for a discharge rate of C/20 (1.25 A average) which approximates typical transceiver operation.

4.3.3 Operation Of The TW100PP

1. **Power-Supply Operation.** The transceiver to be powered should be connected to the TW100PP using the appropriate accessory power cable. The power cables necessary to connect the TW100PP to the TW100F, TW100, or RT100/MP transceivers, are as follows:

1.	TW100PP to **TW100F**	C991546
2.	TW100PP to TW100	C991545
3.	TW100PP to RT100/MP	C991543

Table 4-3 shows the pinouts for the dc output connectors J1 and J2.

The TW100PP has two monitors of terminal voltage—the front-panel meter, which is a direct indication of terminal voltage, and the "undervoltage" light, which will remain off as long as the battery cells are in the safe operating region. This light is set to go "on" when 100 % capacity has been removed from the cells. ***Discharging the cells after the light has come on will impair the ability of the cells to accept a charge.*** This voltage threshold is approximately 9.5 V. At this point the load should be disconnected from the TW100PP.

An alternate procedure to follow if the voltage has dropped to 9.5 V and continued receiver operation is desired, is to plug in the charger part of the power source while keeping the radio connected. The charger has sufficient capability to both charge the battery cells and operate the receiver part of the radio for an indefinite period of time (or at least until the battery is fully charged again).

2. **Battery Charger Operation.** To operate the battery charger in the TW100PP, first select the proper ac voltage by the front-panel selector switch. Then plug the ac power cord into the mains and turn the front-panel switch to the "on" position. When the charger is operating in the "fast-charge," mode the charger light will be "on".

This mode is automatically activated whenever the charger is connected and the terminal battery voltage falls below

15.0 V. The "fast-charge" state will continue until the battery voltage reaches 19.5 V. At this point the charge will cycle between "high" rate and trickle until the batteries do not sag below 15 V. When the charge light goes out and stays out the batteries are fully recharged.

The TW100PP uses a constant-current charger. Constant-current charging of a cell or battery is accomplished by the application of a nonvarying constant-current source. This charge method is especially effective when several cells are charged in series, since it tends to eliminate any charge imbalance in a battery. Constant-current charging charges all cells equally because it is independent of the charging voltage of each cell in the battery.

While constant-current charging is an efficient method of charging, continued application at rates above C/500, after the cell is fully charged, can be detrimental to the life of the cell. At overnight charge rates (C/10 to C/20), the large increase in voltage at the nearly fully charged state is a useful indicator for terminating or reducing the rates for a constant-current charger. If the rate is reduced to C/500, the cell can be left connected continuously and give 8 to 10 years' life at 25° C. The trickle charge rate of the power source at 50 mA represents a C/500 rate. Refer to the TW100PP manual for a technical description of the portable power source.

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. 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 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 And Module Replacement

Module location diagrams are shown in Figures 5-2 and 5-3. Access to and replacement of modules is as follows.

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 modules M7 and M10. Use caution as these RF voltages can cause 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 5-2). 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 permit 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 5/16-in or 8-mm wrench.

During module replacement, it is important that the semi-rigid coax connectors be sufficiently tight. However, 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 1/4-in 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. Take 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 nontechnical 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 vertical 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 +13.6-V (red) leads at the connection to F1, and by unsoldering the 13.6-V (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 5120-kHz reference output. This is the front connector on Module 5. The output is 50 ohms and may be directly connected to the counter.

2. Turn on the transceiver and wait for 10 minutes so that thermal stability is reached.

3. Adjust the piston trimmer C21, (accessible through the hole in the top cover of Module 5) until the counter reads 5120.000 kHz.

4. This completes the calibration procedure. Reconnect the cable to the module.

Periodic checks should be made of the 1650-kHz oscillator. This is a stable, low-frequency oscillator and should seldom require adjustment.

1. Connect an accurate frequency counter to the carrier oscillator output test point. This can be accessed through the indicated hole in the M1 cover.

2. Switch the clarifier to the off position.

3. Adjust the 1.650 oscillator adjustment (R59) until the frequency reads exactly 1650.000 kHz.

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 10 Hz.

5.5 Basic Fault Location - Table 5-2

This information will assist in locating faulty modules without the use of test equipment. This information provides only a basic guide, and some fault conditions cannot be recognized without test equipment. Use this procedure to try and determine the fault area. If this approach is not successful, the modules should be replaced systematically until the faulty module is located. Remember that some of the preliminary tests can indicate which modules are operational. For example, the two synthesizer modules M5 and M6 are used in both the receive and transmit modes. This means that they are not faulty if either the transmitter or receiver is operational.

Before replacing any modules, check all cables and connections carefully. A broken wire or a loose connector may prevent the module from operating. When modules are replaced, it is not normally necessary to make any adjustments or to realign the transceiver.

With the exception of the RF power module M10, all modules may be replaced using a wrench and a screwdriver. The correct procedure for replacing the modules is described in Section 8.6 of the technical manual.

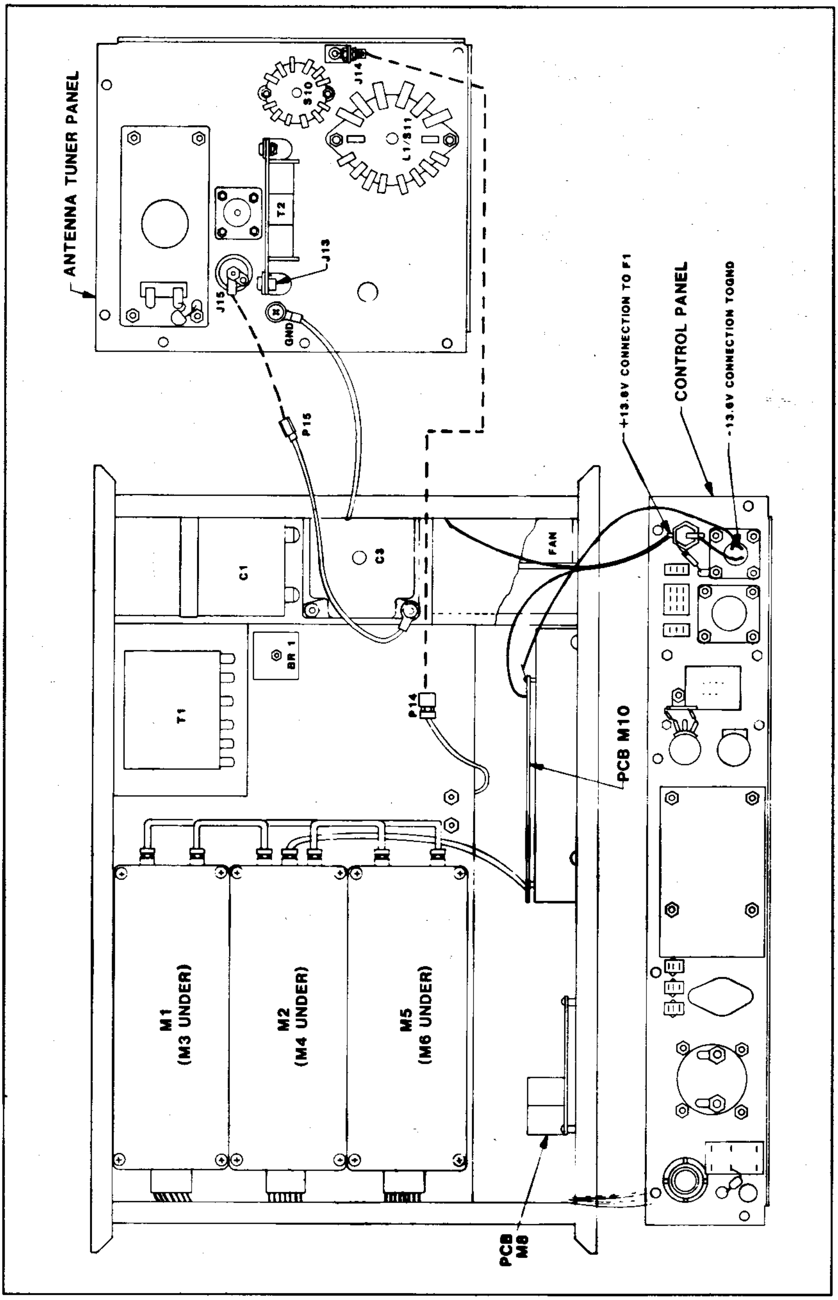

FIGURE 5-1.
Module Location Diagram - Top.

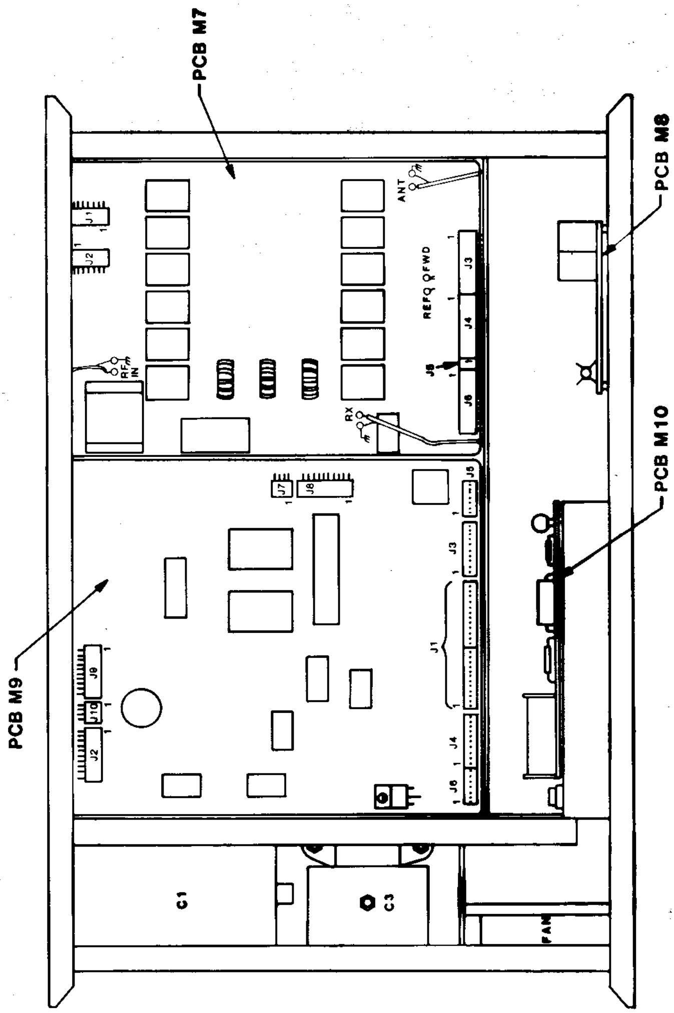

FIGURE 5-2.
Module Location Diagram - Bottom.

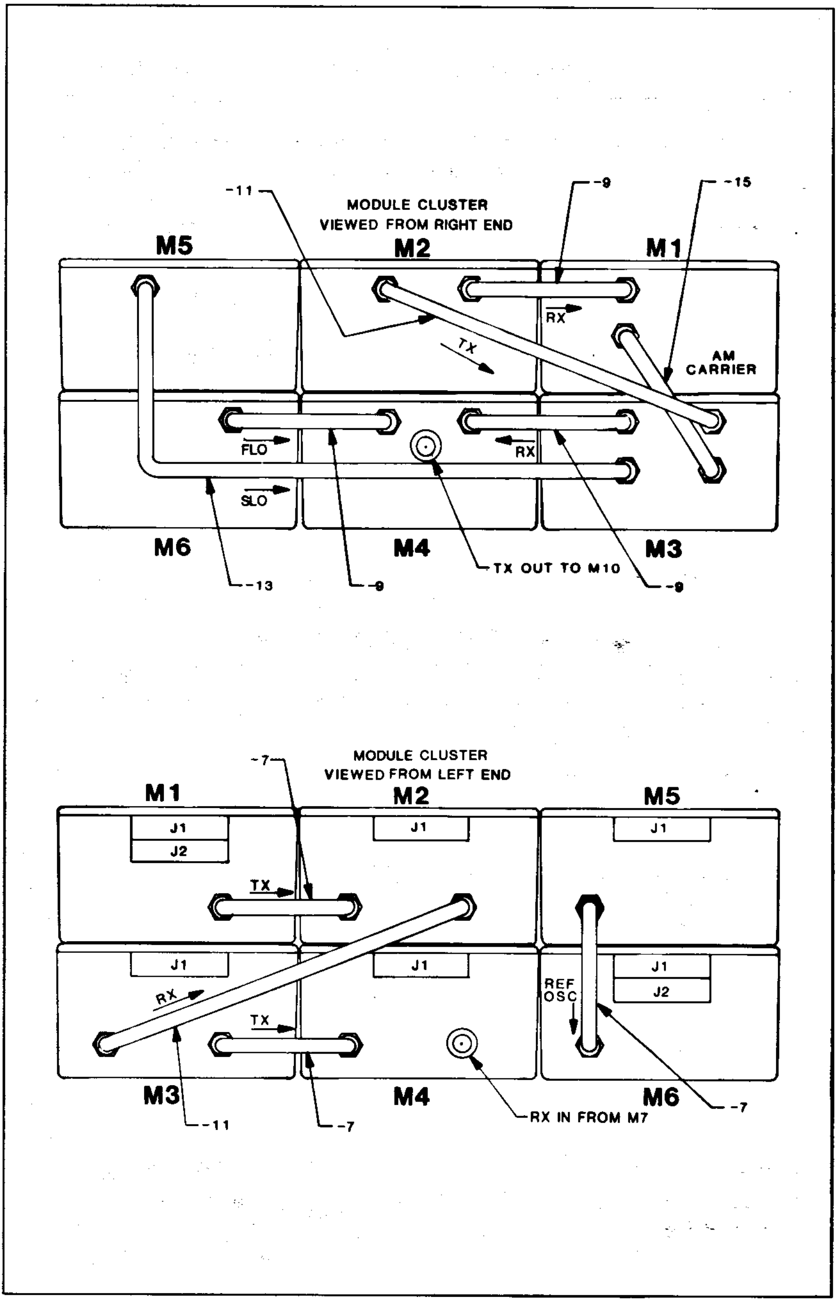

FIGURE 5-3.
Physical Arrangement of Modules M1 through M6.

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.	Measure power source voltage under load.
Blown fuse(s).	Replace fuse.	
NOTE *If the fuse blows again, check the "Transorb," D1, mounted on the 20-A fuse holder on the control panel. The "Transorb" may fail in the shorted mode if subjected to sustained overload or a transient exceeding 5 kW. 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, loudspeaker 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 nonoperating frequency(ies).

TABLE 5-1.
Fault Location (Continued).

Transceiver does not operate on frequencies above/below 15 MHz.	Defect in VCO Q1 (2-15 MHz) or Q2 (15-30 MHz).	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 fine tune 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.	■ 1650-kHz 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 1650-kHz IF 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 75-MHz 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.

TABLE 5-2.
Module Fault-Location Chart (Continued).

M5 Synthesizer - 100-Hz 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.
M6 Synthesizer - 10-kHz Loop	
Transceiver operates in either transmit or receive mode.	■ Module is operational.
Channel frequencies do not operate below 15 MHz.	■ Defective 1.6 to 15-MHz VCO in module.
Channel frequencies do not operate above 15 MHz.	■ Defective 15 to 30-MHz 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 chart for T/R power switching.	
Relay K1.	■ Check relay clicks when PTT operated.
Signal path through filters from antenna.	■ Disconnect "RX-ANT" coaxial connector from M4. Temporarily connect antenna to "RX-ANT" connector. If receiver operates, defect in M7, filter selection or connections to antenna connector.

TABLE 5-2.
Module Fault-Location Chart (Continued).

M8 Power-Supply Regulator	
Check input voltage to module at input terminal.	■ Should be above 12 V in dc operation. ■ Should be approximately 18 V 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.
Failure to retain channel frequencies when transceiver is switched off.	■ Replace lithium battery. (Nominal life is 10 years.)
M10 RF Power Amplifier	
No simple check without instruments.	■ Voltages and connections should be carefully checked before replacement.
M11 LCD-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.